UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

FACULTY OF INTEGRATED MANAGEMENT SCIENCE

DEPARTMENT OF MANAGEMENT STUDIES

ASSESSING THE ENVIRONMENTAL EFFECTS OF ILLEGAL MINING ACTIVITIES ON THE HEALTH OF INDIVIDUALS IN MINING COMMUNITIES IN GHANA: A CASE STUDY OF ABOSO, SAMAHU AND TARKWA

BY

BUAH MICHAEL KOFI

MASTER OF SCIENCE IN ENGINEERING MANAGEMENT

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A THESIS REPORT ENTITLED

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BUAH MICHAEL KOFI

SUBMITTED TO THE DEPARTMENT OF MANAGEMENT STUDIES UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

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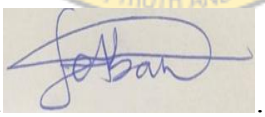

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DECLARATION

I declare that this project thesis is my work. It is being submitted for the degree of MASTER OF SCIENCE IN ENGINEERING MANAGEMENT in the University of Mines and Technology (UMaT), Tarkwa. It has not been submitted for any degree or examination in any other University.

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(Signature of candidate)

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ABSTRACT

Illegal mining activities have gained widespread recognition worldwide. It employs thousands of people in Ghana and has a direct impact on the livelihoods of numerous households located within the communities where they operate. The study places a strong emphasis on illegal mining activities and their associated effects on the health of individuals and the environment in selected mining communities. The study focused on three mining communities. A total of 147 respondents were contacted for pertinent information, with the primary research instruments being questionnaires and in-depth interviews conducted with members of mining communities and other stakeholders. Illegal mining activities deplete environmental resources such as water and vegetation and increase the risk of complex health problems, according to the study's findings. The paper concluded that major streams in the communities have been heavily polluted by illegal mining activities, that land has been stripped bare and rendered unusable for agricultural purposes, and that dust laced with toxic chemicals is being released into the open air, resulting in complicated health issues. Based on the foregoing, the paper recommended the following: effective community participation in environmental decision-making to ensure sustainable mining activities; restructuring the registration process for illegal miners to make it easier for more to obtain licenses, developing environmental protection campaigns against illegal mining, and enforcing the Minamata Convention on mercury imports into Ghana.

DEDICATION

I humbly dedicate this work to my parents Mr. and Mrs. Buah they have been my source of hope and inspiration in all these years and to my sisters Josephine Buah, Masha Buah and Margaret Buah for their morale and financial support throughout my education.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Mining contributes to the development of other industrial sectors that are essential for the well-being of the world's population and the proper functioning of the global economy. On the other hand, it has the potential to have negative health and environmental consequences, which could undermine public acceptance of the sector. Chauhan & Singh (2010), indicated that mining at its core, a destructive development activity in which the environment suffers at the expense of economic development. Contemporary mining activities, in connection with environmental protection and restoration of mined deserts, and also the cautious use of methods in exploring, and the search for eco-friendly alternatives, would have to provide a remarkable insight on the impact of mining on human health. According to Ostergren and Le Bosse (2011), the interaction between humans and their environments is one of the fundamental facts of life.

The environment has a plethora of consequences that are dependent on how one treats it. Unfortunately, some of these decisions, according to Bagyina (2012), whether or not they were necessary, have catalyzed environmental degradation, resulting in significant environmental changes. Cristescu et al., (2012) reported that degradation induced by mining has long-term harmful consequences for the environment's flora and fauna. When toxic chemicals are dumped into the environment and the earth's crust is severely damaged and for an extended amount of time, the cumulative effects of all these conditions prohibit plants from growing and regenerating. The exploration of natural resources has been a critical issue to

deal with in the past few decades (Lei et al., 2016). The transition from exploration to exploitation has resulted in catastrophic consequences for the environment and the health of the general public. In recent years, the mining industry's contribution to the economic development of Ghana has received widespread recognition (Roe and Samuel 2017).

In Ghana, illegal mining is described as mining by any means that does not require significant expense by an individual or group of individuals no larger than nine, or by a sustainable system of ten or more individuals who do not meet the legal mining requirement in Ghana (Wilson et al., 2015). According to Yaro (2010), illegal mining is a significant source of natural resource exploitation in poor nations like Ghana as these activities have been related to the ruin of forest reserves, the loss of habitats, and the extinction of species (Majer, 2013).

Even though mining is necessary, it is considered illegal when it is carried out without a permit or in unapproved areas such as forest reserves, along with water bodies, game resources, or even with a secured permit around such catchment areas, all in the name of profit. Illegal mining, also known as "galamsey" in Ghana, is a growing concern among the general public and many researchers because the activities of galamsey operators constitute a serious threat to the environment (Asiedu, 2013). Although it has provided employment opportunities for some sections of the youth and has contributed to the country's overall gold production on an annual basis, the mine's environmental consequences are numerous and extremely detrimental (Amponsah-Tawiah and Dartey-Baah, 2011).

Globally, an estimated 20 million people are involved in illegal mining activities, with illegal mining accounting for approximately one-quarter of the world's ore production. Although illegal mining activities have the potential to aid in poverty alleviation, they also have negative consequences for the environment and the health of those who engage in them. Owusu-Boateng and Kumi-Aboagye (2013) indicated that illegal mining in its most basic form entails the extraction of minerals from deposits using archaic tools and primitive mining processing techniques. It frequently involves the employment of unskilled and stark illiterate individuals who, for a variety of reasons, have little or no awareness about the environmental consequences of their actions. Large and dangerous excavations, vegetation destruction, contamination of soil, air, and water with hazardous chemicals and heavy metal residues, as well as the release of hazardous chemicals and heavy metals into the environment, are all examples of activities that degrade the environment to varying degrees. The greatest evident result of mining is the pollution of water bodies, vegetation cover, and soil. Due to the high water requirements for washing the ore, illegal miners are commonly discovered mining near sources of water (Fatawu and Allan, 2014; Mudyazhezha and Kanhukamwe, 2014). As a result, tailings are dumped directly into rivers without any form of treatment, resulting in significant contamination of the streams or rivers with debris (Kessey and Arko, 2013).

Not only does it change the aesthetic appearance of the river or stream, but it also changes the Physico-chemical and biological parameters of the water, rendering it unfit for domestic use. Regrettably, underground geological resources (minerals) are often placed on top of above-ground biotic resources in the majority of the world, resulting in a loss of productivity (forests). Ghana has a particularly strong presence in this regard. As a result, illegal mining

activities are inextricably linked to deforestation, habitat destruction, and the extinction of biodiversity. In Addition, ore and mineral extraction processing result in significant environmental contamination. However, humanity cannot afford to abandon its underground geological riches, which provide critical raw materials for progress. This is especially true for the developing world (Kessey and Arko, 2013; Mudyazhezha and Kanhukamwe, 2014). In addition to endangering environmental and aquatic life, these chemicals are also hazardous to the health of miners and the residents of nearby villages. In many cases, illegal mining activities can result in the destruction of productive lands for the extraction of natural resources and which frequently results in environmental and health problems (Opoku-Ware, 2010), which this study is particularly interested in investigating.

1.2 Statement of Problem

Small-scale mining, like other extractive industries, poses several health-related risks to humans. Humans have been studying the effects of heavy metal pollution on their health for many centuries, and it has been established that heavy metal contamination can result in severe sickness or death. In addition to illegal mining, it can come from the air, water, or soil. It can also be caused by other factors (Galadima and Garba, 2012). Environmental pollution as a result of illegal mining activities has continued to have negative consequences on human health and economic development throughout the world, particularly in developing countries (Adamu et al., 2014).

It has long been recognised that mining creates hazardous working environments that are perilous to the health and lives of those who work in and live in such environments (Gibbs

and O'leary, 2014). Workers engaged in illegal mining operations are exposed to a wide range of hazards that can be life-threatening, including excessive dust inhalation, which can cause severe lung infections, silicosis from blasting, and hearing impairment. In comparison to highly organized or regulated mine operations, illegal mining activities pose greater risks to the environment and to the health of those who participate in them. Despite the fact that illegal mining operations are operated by definition with a small number of people due to the extremely large number of chemicals used and the uncalculated high concentrations of chemicals in use, the environment and the health of individuals are put at risk as a result of such illegal mining operations. Although illegal mining operations provide economic benefits to a large proportion of the unemployed in the areas where they are conducted, the practice should be discouraged (Bawa, 2010).

However, despite the economic benefits, illegal mining activities pose significant environmental challenges, especially in health and safety, and the environment (Basu et al, 2015). In addition to being extremely important, thousands of households rely on agriculture and fishing for their livelihoods with an estimated 400 000 illicit miners now working illegally (Metacalf and Veiga, 2012). Illegal mining activities have traditionally consisted of the excavation of river bottom sediment used in the extraction of ore from the earth. After processing the river sediments, the precious heavy metal is separated from non-target material, which is subsequently recycled (Saldarriaga and Arango 2013).

However, there is a slew of broader occupational safety and public health matters that merit to be addressed, and the fact that so many people are forced to engage in this practice as a matter

of survival has resulted in it being classified as high risk due to the large number of people who do so. The problems government regulators face in curbing health and safety risks while dealing with small funds to satisfy inspection requirements highlight the importance of a regional and comprehensive manner to research on health and safety issues in the artisanal mining sector, incorporating quantitative and qualitative data collection methodologies. Tunnels with inadequate ventilation and other unsafe mining procedures used by these illicit gold miners have a major detrimental impact on the workers' health and safety (Smith et al, 2016).

Protective clothing and equipment such as helmets, ear plugs, and dust masks are not worn by the vast majority of these miners, putting them at substantial risk of dust and chemical exposure. Furthermore, illegal miners work long hours, which means they are exposed to chemicals and dust for extended periods. As a result, they expose nearby communities to dust and chemicals that are harmful to their health as a result of their work. In addition to the harm that these illegal mining activities cause to people's health, safety, and well-being, they can destroy water courses and the environment. It has been observed that aquatic organisms have been severely harmed, with no signs of life being observed in affected parts of river systems (Dalu et al, 2016).

Illegal mining activities wash tonnes of soil into rivers, resulting in a major loss of aquatic species. While these illicit mining operations devastate enormous areas of terrestrial and aquatic ecosystems, they also jeopardise the livelihoods of thousands of peasants living along the riverbanks where these operations are concentrated. The widespread cyanide and mercury

spills caused by these illicit mining activities contaminate water sources, injure food crops, and have a severe effect on overall human health (Agyemang, 2010). Herbs traditionally picked from river banks by rural community homes to produce natural homemade treatments for mild ailments are fast vanishing or no longer growing along river banks due to heavy pollution from harmful chemicals used in unlawful mining operations (Jiang et al., 2012). This study's goal is to assess the effects of illegal mining on Ghanaian communities' health and quality of life.

1.3 Objectives of the Study

I. To identify the environmental risk factors associated with illegal mining activities in mining communities.

II. To examine the environmental effects of illegal mining activities and their effects on the health of individuals in mining communities.

III. To determine the measures for reducing the effects of illegal mining activities on the environment and the health of individuals in mining communities.

1.4 Research Questions

I. What are the environmental risk factors associated with illegal mining activities?

II. What are the environmental impacts of illegal mining and their effects on the health of individuals in miming communities?

III. What measures can be adopted to reduce the effects of illegal mining activities on the environment and the health of individuals in mining communities?

1.5 Significance of the Study

The significance of this study is that it will contribute to the existing literature by evaluating the environmental effects of illegal mining activities on the health of Ghanaian citizens. Although the study is primarily concerned with the rural Ghanaian context, some developing countries are primarily concerned with illegal mining activities. As a result, countries that face similar challenges can benefit from the findings of this study. Some of the findings and recommendations derived from this study can be applied in these countries as well, to a limited degree. The findings of this study, when viewed in the context of policy, can assist developing countries confronted with the challenges of mineral exploitation in designing and implementing viable policies to meet those challenges.

The health of people and the health of our planet are inextricably linked, as is the health of the people who live on it. The destruction of our habitat threatens our access to the most fundamental requisites for human survival: safe water, clean air, nutritious food, and a safe place to live. If uncontrolled mining activities in Ghana are not stopped, they will cause irreversible changes to the state of the environment, putting ecosystems at risk. Because of concerns about environmental pollution, the Ministry of Natural Resources and Environment has ordered a six-month suspension of illegal mining activities in the country. Polluted ecosystems have a high potential for generating chronic and unpredictable exposures, which may result in direct or indirect, immediate and long-term health consequences.

It is recognized that several physical, chemical, biological, and psychosocial dangers exist throughout the mining process, and the findings of this study will provide policymakers with in-depth strategies on how to address and minimize the negative impacts that illegal mining activities have on the environment and health of individuals in Ghanaian communities, according to the authors. To broaden the knowledge base in this area of research, the methodology used in this study can easily be replicated in other studies. The findings of this study can be used to inform policies aimed at improving mineral exploration by providing a practical understanding of the subject matter as well as a theoretical foundation that establishes its relevance.

1.6 Limitation and Scope of the Study

This project aims to raise awareness about the dangers of illegal mining activities, as well as the problems that can arise as a result, for both human health and the environment as a whole. As a technique, this project uses a qualitative approach that includes a questionnaire, participant observation, and interviews to assess the environmental impacts of illegal mining activities on the health of individuals in mining communities, as well as how these illegal mining activities can be minimised to the greatest extent possible while still protecting the environment and the health of individuals.

Although the research revealed its objectives, there were some unavoidable limitations. This research was based primarily on qualitative research methods, and while the case studies were rigorously conducted and validated, the results are limited by the sample size of the case

studies, which was chosen in all three towns because of the time allotted for the research to be conducted.

Another limitation of the data collection process was that some illegal mining operators were unwilling to open up about sensitive issues pertaining to their activities during verbal interviews or when administering the questionnaires, which made the process more difficult.

1.7 Organisation of the Study

The Thesis comprises 5 chapters. Chapter 1 contains an introduction, which includes a presentation of the study and a structure for the thesis. Chapter 2 is largely devoted to a review of the literature on illegal mining from the perspective of illegal mining activities in rural areas and their improvement, with a particular emphasis on the impact of illegal mining activities on health and, on the other hand, ways to integrate good environmental practices to improve rural livelihoods. Chapter 3 discusses the methodology, techniques, and methods used in the thesis. In Chapter 4, a summary of the study's findings is discussed, with some themes focusing on ways to restore resources and others on other aspects, including the role of the individual and its health status, which was chosen to support the study. Chapter 5 concludes with conclusions and recommendations regarding the impact of illegal mining activities on the environment and health to gain a better understanding of rural life in Ghana and ways to improve livelihoods through reclamation.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Chapter two entails the literature review of the study. It focuses on the theoretical review which discusses the underlining theories related to the topic as well as empirical evidence from other scholars and concludes with a conceptual framework that conceptualises the goal of the study in a pictorial view.

2.1 Theoretical Review

Several theories give much insight into the subject matter. Below are some well-established theories that were used for the study.

2.1.1 Organisational Sustainability Theory

Approaches to managing social, environmental, and economic issues in a coherent process to modify organizations in a way that contributes to the long-term development of the economy and society while remaining mindful of the ecosystem's limitations are referred to as sustainability management (Walker and Perego, 2013). The charter of the Ford Board of Directors described sustainability as the ability to meet present consumer wants while simultaneously considering future generations' needs." (Ford, 2012). The long-term preservation and enhancement of financial, environmental, and social capital are all components of a value-creating paradigm that places a premium on long-term preservation

and enhancement. Theorising about organisational sustainability is more directly related to corporate culture than to specific rules and processes.

Illegal mining enterprises provide a major contribution to the global economy (Zeballos and Garry, 2010). Despite the threat posed by illicit mining activities, they continue to operate and have come under fire in recent years for failing to establish sustainable methods (Govindan et al., 2014). Deloitte performed global research earlier this year on the challenges and constraints affecting the sustainability of mining activities in both the formal and informal sectors. According to the research, the ever-increasing demand for mined resources, as well as the consumption of resources required to operate them, continue to be a key source of concern. This is partly because mineral resources are finite and non-renewable (Vintro et al., 2012), leaving the relationship between sustainable development and mining somewhat ambiguous.

On the other side, one may argue that sustainability, defined as serving present demands without risking future generations' requirements (Gorman and Dzombak, 2018), should be incorporated into the manufacturing industry best practices (Bartels, 2014). Adopting sustainable mining practices will aid in the preservation of the environment and economic health. While not a new concept, the triple bottom line (TBL) approach, which has dominated the definition of operating sustainability, recognises the critical nature of considering the economic, social, and environmental aspects of operations. By applying institutional theory to the long-term survival of illegal mining activities, this study addresses a long-standing research hole. According to institutional theory, illicit mining operators' ability to adhere to

institutional forces, including coercive, mimetic, and normative pressures, as proposed by DiMaggio and Powell in 1983, is important to their organisations' success.

According to institutional theory, the major mechanism by which an organisation can ensure its longevity is by adhering to socially acceptable behavioural norms. Coercive pressure is justified based on political power and the difficulties connected with legitimate authority. Mimetic pressure is a term that refers to organisations being pushed to emulate peers that have succeeded in a certain path of action (Bansal 2005). Moral obligations, responsibilities, and behaviour are at the centre of society's normative demands. Institutional theory has previously been used to examine how corporations manage their environmental and human resource management (Yang et al., 2019). According to Berrone et al. (2010), institutional theory's strength is that it explains why certain practises are adopted even when they do not appear to generate an evident economic return to prepare the way for sustainability. Additionally, institutional theory gives an additional theoretical lens for evaluating environmental management (Frederiksen, 2018).

Additionally, organisational theory application to sustainability challenges is still in its infancy (Caldera et al., 2019), particularly in the context of illicit mining operations in underdeveloped nations, where the focus is on illegal mining companies' sustainability practices. Confronted with coercive pressure and environmental initiatives, despite increased public awareness about environmental sustainability, there is little to no consensus on the term's definition. Dyllick and Hockerts (2002) define sustainable development as "filling the demands of a firm's direct and indirect stakeholders without jeopardising the firm's ability to

meet the needs of future stakeholders." Corporate sustainability, according to Bansal (2005) and White (2009), is achieved when economic progress, environmental protection, and social responsibility are all considered in concert.

We define sustainability in this study as an approach aimed at shaping the environmental, social, and economic consequences of illegal mining activities in such a way that, first, the operations' longevity is increased, and second, the operations significantly contribute to the socioeconomic development and well-being of host communities. When an operation's success is dependent on the acceptance or permission of a third party, the concept of coercive pressure is constantly in play. This often implies that illegal mining businesses have access to resources, while legitimate government authorities regulate the pace of their activities to assure their long-term sustainability (Heugens and Lander, 2009).

Environmental control solutions will be welcomed by the large majority of illegal mining activities to avoid penalties and external restrictions (Bansal and Roth, 2010). Governments worldwide impose coercive pressure on organisations that rely on natural resources to enact environmental restrictions (Perez-Aleman, 2011). Additionally, it is critical to recognise that in the illegal mining context, coercive or regulatory pressures are imposed not only by legal sources, such as government authorities or highly effective enterprises but also by community-based social actors. While sustainability projects have not always been portrayed as the continent's most successful enterprise, some important accomplishments have occurred in recent years.

Numerous African countries have recently upgraded their regulatory frameworks and organisational structures in response to growing socioeconomic and environmental concerns about unlawful mining. The extent to which businesses implement environmental sustainability principles into their operations is directly and positively connected to the amount of coercive pressure they face.

2.1.2 Environmental Sustainability

Environmental sustainability requires close observation and monitoring of human activities' impact on the natural environment, such as illicit mining operations. It comprises the prudent use of both renewable and non-renewable resources, as well as pollution avoidance and waste assimilation (Chow and Chen, 2012). The principle of environmental integrity, which argues that people's actions must not harm the environment or pollute air and water resources, is one of the most famous descriptions of the dimension of environmental sustainability. A recent study has revealed a high prevalence of institutional isomorphism in the context of environmental sustainability, which has policy consequences (Adebanjo et al, 2016).

However, the literature does not contain a sufficient study of the variables associated with sustainability implementation, performance, monitoring, and evaluation (Hogevold et al, 2015). Zhu and Sarkis (2007) established that firms are influenced by coercive isomorphic pressures, particularly illegal mining operators, who are the primary polluters and are responsible for a greater proportion of resource depletion than other institutions found in communities, and thus are subject to greater external pressure than other institutions found in communities. According to Hsu et al. (2013), illicit mining activities in Malaysia were motivated by coercive incentives to practise environmental sustainability in their operating

procedures. They discovered that the most influential components in the decision-making process were societal and regulatory influences.

On the other hand, the importance of isomorphic pressures in the context of implementing sustainable practices continues to expand with time (Diabat and Govindan, 2011). Illegal mining is often conducted on broad areas of abandoned mine sites and can endanger public safety and the environment. Land degradation is a major environmental issue in today's context of sustainable development (Bian et al, 2012). Without a question, illicit mining operations have an adverse effect on the environment and human health, whether directly or indirectly through their operations. According to the Aragón and Rud (2016) report, illicit mining can result in forest loss and degradation, air pollution, and groundwater contamination, all of which have a severe impact on human health, agricultural production, biodiversity, and human settlement.

Additionally, illegal mining activities are usually located in isolated and environmentally sensitive places where environmental concerns are high and alternative locations are scarce (Gifford et al., 2010). According to Slack (2012), conducting illicit mining activities or constructing a significant number of crushers is impossible without damaging the environment and the health of the people involved. While such harm can be mitigated, it can never be entirely removed. On the other side, illegal mining operators frequently claim that they have little choice about where they operate and are obliged to travel where the ore or minerals are found. This may include working in socially and environmentally sensitive areas to attain financial success while flouting established rules.

As a result, illegal mining operations are more likely to occur in isolated locations, where the ramifications are more localised. Illegal mining operations must be undertaken cautiously due to the inherent dangers. As a result, the localised context establishes a link between the environmental impact of illicit mining operations and social considerations, as the most severe impacts are frequently felt by local populations (Burger, 2014). In the field of natural resources, there is a sizable body of literature devoted to the question of whether and how resource-rich countries develop, and more specifically why some countries, such as Botswana and Chile, have been able to translate resource wealth into a path of sustainable development, while others, such as the Democratic Republic of the Congo, Ghana, and Nigeria, have been unable to do so (van der Ploeg, 2011). Recently, the effects of unlawful mining operations on communities have garnered attention, as has the risk of natural resources harming the social environment as a result of resource exploitation (Loayza et al, 2013).

There is much concern about these societal effects, which include inquiries into whether illegal mining operations contribute to local poverty reduction, various types of pollution, land degradation, and several health problems (Collins & Fleischman, 2013). Illegal mining operations usually necessitate the exploitation of previously agricultural or socially useful land or water. Recent studies (Aragón and Rud, 2013; Chuhan-Pole, Dabalen, Kotsadam et al., 2015; Chuhan-Pole, Dabalen, Land et al., 2015; Loayza et al., 2013; Ticci & Escobal, 2015) have discovered that illegal mining has a positive effect on average community incomes (Aragón and Rud, 2013).

However, the impact on poverty reduction may be mitigated as a result of rising income disparity, as employees in direct jobs benefit monetarily while those in other sectors such as agriculture do not. However, the activity is contentious for a variety of reasons, including the fact that using non-mechanized technologies results in low production and poses harm to human health and the environment as a whole. Maintaining the integrity of affected communities will be easier if they implement sustainable mining solutions, which ensure that equipment and methods of operation are consistent with long-term processes. However, the triple bottom line (TBL) approach, which has dominated the definition of operating sustainably, acknowledges the importance of economic, social, and environmental dimensions, whereas organisational theory places pressure on institutions to enforce environmental, social, and economic sustainability. According to the Earth Charter Initiative, people must re-examine sustainable policies relating to environmental preservation, social responsibility, and economic practices to ensure the well-being of future generations.

2.2. Illegal Mining

Illegal is the practice of extracting ore or minerals from the earth without first acquiring land rights, getting a mining licence, performing an assessment, obtaining a mineral transportation permit, or obtaining any other needed document. It is controlled by either the Environmental Protection Agency or the Minerals Commission in Ghana, or both. It is also subject to environmental regulations. Mining without registration and regulation is illegal, since they are unregulated and operate outside of the law, (Amoah-Frimpong, 2013). Ghana's land surface is covered with many mineral belts. The Birimian gold is found in the first belt, which stretches for 15 to 40 kilometres in width. West African Supracrustal rocks containing birimian gold

have been discovered in areas ranging from Ghana to as far north as Burkina Faso in the north, and as far west as Senegal and Mauritania in the western parts of the region (Adu-Gyamfi, 2014).

Because of the mineral-rich contents of the soil, illegal mining activities in Ghana generate a substantial amount of revenue. Studies have revealed that artisanal small-scale mining, which often leads to illegal mining activities, is often unregulated and has resulted in the destruction of the environment in a variety of different ways (Baah-Ennumh, 2010; Hilson, 2017; Hilson and Maconachie, 2020; Veiga and Morais, 2014).

Recently, issues related to illicit mining, such as excessive use of toxic chemicals, water pollution, poor health and safety conditions, and child labour, have garnered some attention in the global discourse, particularly in the United States (Antwi-Boateng and Akudugu, 2020; Buss et al., 2019). As a result, the negative repercussions of illegal mining have eclipsed the industry's positive impact on the livelihoods of numerous host communities. Despite this, it is believed that the intensity of operations and production has increased in developing countries, owing to an increase in the number of foreign miners, the bulk of whom are from China, India, and Serbia in addition (Armah et al., 2013; Banchirigah, 2006; Hilson, 2009; Hilson et al., 2014; Hilson and Garforth, 2013).

Environmental concerns about illegal mining in Ghana are comparable to those in other nations in Sub-Saharan Africa. Mercury contamination from gold processing, pollution of water bodies, and deforestation of natural and agricultural lands are the most important

environmental challenges (Amankwah, 2013; Clifford, 2017; Nartey et al., 2011). These concerns have emerged as a result of the actions of both legitimate and illegal mining operators, both of whom are equally implicated in illicit mining. According to Baah-Enumah (2010), illegal mining in Ghana refers to all mining activities that occur without the required permits from regulatory bodies and that employ poor practices such as mining in bodies of water, violating appropriate buffer restrictions, and failing to reclaim lands following mining.

Illegal mining is considered to be carried out by some of the world's poorest people, who are concentrated mostly in rural places (Buxton, 2013). Despite widespread criticism that illegal mining activities cause severe environmental damage, the World Bank (2015) says that illegal or artisanal small-scale mining is a significant industry that provides a source of income for many people living in unstable rural economies globally. This is because entry requirements are modest, requiring only a small commitment of time, money, and technology resources. Due to its accessibility, this venture offers a unique possibility for a huge number of people to join. As a result, it is prudent to enact the appropriate rules to clean up the industry.

Illegal mining employs between 20 and 30 million people worldwide, with the industry directly employing between three and five individuals for every illegal miner (Buxton, 2013). Additionally, illicit mining activities account for between 15% and 20% of global mineral and metal production, accounting for around 80% of sapphire production, 20% of gold production, and up to 20% of diamond production (Levin, 2013). Due to the sector's high profitability in terms of contribution to household income and economic growth, the high number of people engaged in illegal mining activities worldwide, as well as the magnitude of its contribution to

global gold and metal production, can be attributed to the sector's profitability (Siegel & Viega, 2009).

Illegal mining has been an important source of revenue in Ghana since the pre-colonial period, and the business has grown dramatically in recent years as a result of the country's poverty (Hilson et al., 2007). Labourers, small-scale farmers, unemployed public-sector workers, teachers (and other educators), and college-bound students looking for extra money to assist pay for their education fees are among those attracted to illicit mining activities (Hilson and Ackah-Baidoo, 2010). According to published data, 60% of Ghana's mining labour force is employed in illegal or small-scale mines (Centre for Development Studies, 2009), making industry control extremely difficult. The authors of this study are especially concerned with the environmental and public health repercussions of unlawful mining.

2.3 Conceptualisation of Variables

Environmental problems related with unlawful mining for precious minerals in Ghana fall into three broad groups, each of which is discussed below. The first classification encompasses all impacts on the lithosphere. Land degradation, which is the major result of mining activities, is a frequent occurrence at many unmanaged, unmonitored small-scale mining sites. Miners leave behind "moonlike" landscapes comprising, among other things, of unstable waste piles, abandoned excavations, and wide swathes of desolate ground. Typically, excavated pits are left unfilled and abandoned to act as water storage vessels. Mosquitoes thrive in these conditions and can cause major health problems in both humans and animals. Large swaths of agricultural land are also being damaged as a result of excessive plant removal and soil

structure disturbance. When unlawful mining occurs, the topsoil that supports plant development is generally removed, rendering the area barren and exposing it to erosion.

The second category incorporates all of the hydrosphere's impacts collectively. Numerous illicit mining villages suffer damage to their drainage systems as a result of these operations. Rivers and streams are polluted by solid suspensions and mercury, which are regularly dumped into resident water bodies during the sluicing and amalgamation operations. As a result of this contamination, water bodies become silted and discoloured. Due to faulty tailings management, waste water can reach streams and rivers during heavy rains, generating sedimentation and rendering the water unfit for human consumption or industrial use.

Additionally, removing vegetation increases soil erosion, which leads to an increase in the turbidity of runoff surface waters. Water pollution caused by the discharge of lubricants and other oils into streams can also cause de-oxygenation of the water, endangering aquatic life. The final category encompasses all of the atmosphere's impacts. Since operations take place in ambient air, it is thought that the environmental impact of small-scale precious mineral mining is minor. Despite this, contaminants are discharged into the atmosphere as gaseous pollutants. Mining operations that need ore size reduction, such as illegal mining, can generate dust that is potentially detrimental to human health, as the particles formed by such sources fall within the inhalable dust range and have the potential to cause dust-related disorders.

Additionally, the open burning of gold amalgam is a prevalent practice among illegal mining enterprises, notably gold miners in Ghana. Mercury vapours are created and emitted into the

atmosphere as a result of this technique. In some instances, the amalgam-burning process takes place in poorly ventilated rooms, exposing miners to mercury contamination. Notable is the refusal of many illegal miners to employ the protective machinery known as an amalgam retort, which effectively separates gold and mercury while generating no fumes into the environment. Sponsors provide cash just for extraction (which he may closely control), but not for health and environmental rehabilitation, or any other purpose (Aryee et al, 2013). As a result, this research's primary objective is to ascertain the environmental and health implications of illicit mining.

2.4 Dimensions of the Variables.

Small-scale mining has exploded in popularity in most low- and middle-income countries over the past decade, owing to the high demand for precious metals and the marketability of gold in particular (Anon., 2016). The small-scale mining industry employs more than 100 million people, all of whom make significant contributions to the development of global economies, both directly and indirectly, through their work. Despite the significant economic contributions made by small-scale mining, it is believed that its operations cause significant environmental damage in addition to contributing significantly to occupational injuries (Wilson et al, 2015). It is estimated that approximately 13 million workers in more than 30 countries are employed in this sector, with the majority of their activities being carried out under unfriendly, harsh, and potentially dangerous working conditions for low wages.

This is not a new problem in Ghana; indeed, it exists in practically every country that mines gold. The scale of the problem is most apparent in the informal mines, locally referred to as

"galamsey." Although much small-scale gold mining in Ghana is illegal, it has enormous patronage, accounting for around one-third of total gold production in the country (Tagoe et al, 2017). The absence of safety rules and enforcement, a dearth of educational and training opportunities, and a dearth of functional infrastructure and equipment are all frequently cited as contributing to the increase in casualties among small-scale miners, with no exception in Ghana (Wilson et al 2015). According to an International Labor Organization (ILO) survey, small-scale miners are six to seven times more likely to experience injuries than large-scale miners (Teschner, 2012).

Engineering controls are the primary method of managing mine safety threats. However, these tactics are typically not applied in resource-constrained contexts, such as those in which the majority of illicit miners operate. Surprisingly, according to the statistics, the usage of personal protective equipment such as hardhats, safety glasses, gloves, and work boots, which are regarded as less desirable options to mitigating occupational risks by some, appears to be uncommon among these miners (Chinamise et al 2010). This raises concerns about why the least expensive and most prevalent way of preventing injuries is being rejected in the small-scale mining sector. Separate assessments of small-scale miners in various regions of Ghana found that the overwhelming majority of miners had never worn any sort of personal protective equipment (Chinamise et al, 2010).

Almost all illegal mining operations are highly mechanised, with few safety precautions taken. Additionally, the techniques used by small-scale miners are deemed antiquated, exposing employees to additional hazards of injury and illness (Teschner, 2012). Even though

manual equipment is known to cause more injuries than automated equipment, the majority of the equipment utilised in this business is operated manually. Because a wide array of human activities affect the environment, academics have spent considerable effort investigating the interactions between humans and their physical environment. The term "environmental variables" encompasses both biotic (living organisms and microbes) and abiotic (inanimate things) components (hydrosphere, lithosphere, and atmosphere).

Pollution is described as the introduction of dangerous compounds into the environment, as opposed to the removal of harmful substances. Pollutants are potentially dangerous solids, liquids, or gases that are created in excess of typical levels and undermine the quality of our environment. They can be solids, liquids, or gases. Polluting the environment inadvertently by human activity has detrimental effects on the ecosystem, including the water we drink, the air we breathe, and the soil in which plants thrive. While the industrial revolution was a huge accomplishment in terms of technology, society, and the supply of a diverse range of services, it also led to the production of large amounts of pollutants that are damaging to human health and are discharged into the atmosphere in large numbers. Without a question, global environmental pollution is a major public health risk on a worldwide scale, with a variety of facets. Concerns regarding social, economic, and political difficulties, as well as personal behaviours, are all interconnected with this significant issue. We can observe that urbanisation and industrialization are escalating to unprecedented and alarming levels across our time. Given that human air pollution is responsible for nearly 9 million fatalities each year, it is one of the world's most critical public health issues. Without a question, all of the above-

mentioned difficulties are inextricably linked to climate change, and if the situation deteriorates, the repercussions for humanity might be catastrophic (Moores, 2009).

Air pollution has several detrimental health effects. Even in seasons of minimal air pollution, susceptible persons' health can be harmed. Exposure to air pollution for a short period is connected with chronic obstructive pulmonary disease (COPD), coughing, shortness of breath, wheezing, asthma, respiratory disease, and a high likelihood of hospitalisation, among other symptoms (a measurement of morbidity). Chronic asthma and pulmonary insufficiency, as well as cardiovascular illnesses and mortality from cardiovascular disease, are all long-term impacts of air pollution. Diabetes appears to be caused by long-term exposure to air pollution, according to the findings of Swedish cohort research (Eze et al., 2014). Additionally, air pollution appears to have many negative health consequences on children and adolescents, including respiratory, cardiovascular, mental, and perinatal issues, which can result in newborn mortality or chronic disease in adulthood (Kelishadi and Poursafa, 2010). By corrupting precipitation and enabling it to fall into water and soil settings, air pollution can affect the quality of soil and water bodies. Notably, acid precipitation has the potential to modify the chemistry of soils by influencing plants, cultures, and water quality, all of which can have adverse effects (Pathak et al, 2011). Additionally, soil acidity facilitates the migration of heavy metals, which is transferred into the aquatic environment, making it harmful to rely on the environment for living.

2.4.1. Health Impacts

Illegal mining activities are a fast-growing sector of the worldwide mineral and metals business, accounting for up to 20% of global production (Buxton, 2013). According to some estimates, there are more than 13 million people worldwide who work in illegal mining operations; however, others believe the figure could be as high as 50 million (Veiga and Baker 2014). Additionally, each worker directly employed in illegal mining is fully dependant on the activity for a living (Hilson and McQuilken, 2014). As illustrated in the graph below, the global resource boom, combined with continuous diversification of rural livelihoods, has had an effect on climate change over the last decade (Agrawal, 2010). According to Banchirigah and Hilson (2010) and increasing population pressures (Lahiri-Dutt 2004), the number of individuals who rely on illegal mining activities is gradually increasing, and illegal mining operations continue to be a significant source of income for rural people worldwide.

On the other hand, illegal mining activities pose a significant threat to public safety. In rural areas of developing countries, agricultural livelihoods and risk are inextricably intertwined. Environmental concerns such as harsh weather conditions (Agrawal, 2010), natural catastrophes, and market volatility all represent a threat to rural livelihoods, however, these threats can be addressed by the use of techniques such as mobility or diversification. Individuals and households that rely on illicit mining for a living face the repercussions of these externalities, but they also face the dangers connected with mining and mining-related pursuits (i.e., processing ore). When Bryceson and Jnsson (2010) surveyed former miners in Tanzania, they revealed that 45% had left the business due to the "unhealthy, challenging, and dangerous nature of their labour" (Bryceson et al., 2010).

In Ghana, for example, illicit mining activities known as "galamsey" or small-scale mining are carried out as the most dangerous source of revenue available to the populace (together with taxi driving and using a chain saw) (Tschakert, 2009). While illicit mining operations may contribute to more sustainable living choices, bad working conditions, accidents, and disease can lower worker productivity and income for dependents, putting a strain on families and communities. Illegal mining, sometimes referred to as artisanal and small-scale mining, is characterised by strenuous and precarious manual labour, as well as the use of primitive or risky mining and mineral processing processes.

Additionally, the consequences of illegal mining frequently extend beyond the miners' immediate families and communities, which are exposed to environmental pollutants and hazards as a result of their involvement in various segments of the mining commodity chain or as a result of living in close proximity to mining operations (Maier et al., 2014). Due to the irresponsible use of mercury in illegal mining activities, there is little doubt that it is the most important issue affecting health and safety in these operations. This is because mercury is detrimental to both human health and the environment. Academics, policymakers, and development practitioners have been alerted to the dangers connected with the use of mercury in artisanal and small-scale gold mining.

Apart from the well-documented effects of mercury on human health and the environment (Cordy et al., 2011; Gibb and O'Leary 2014; Schwarzenbach et al., 2010; Spiegel and Viega 2010), illegal mining operations are the primary source of mercury emissions, accounting for

approximately 35% of total anthropogenic mercury emissions globally (Cordy and colleagues, 2011).

Basu et al. (2015) has published research that offers an overview of the health and safety risks connected with illicit mining operations in Ghana and argues for the use of empirical and scientific literature to inform public policy decision-making. The authors evaluate mercury and other heavy metal exposures, as well as the health risks faced by miners and their communities as a result of accidents and exposure to hazardous materials, through an integrated assessment (Basu et al., 2015).

Additionally, the authors discuss existing data on mental health, nutrition, cardiovascular and respiratory health, sexual health, and access to water and sanitation (Basu et al., 2015). This study highlights a variety of health and safety concerns that affect both illegal mining operators and their communities, and it emphasises the importance of conducting more systematic studies that examine the relationship between illegal mining activities and health outcomes, as well as the need for increased funding for such studies. Mining typically involves both occupational and community health and safety hazards, which affect not just miners, but also their families and communities. Family members frequently participate in ore processing, exposing them to mercury, dust, and other harmful pollutants. Women, in particular, are more sensitive to the mining industry's health and safety dangers (Armah et al. 2015; Lu, 2012).

The most detrimental effects on the nervous system are caused by heavy metals (lead, mercury, and arsenic), as well as dioxins. Neurotoxicity has been found following exposure to arsenic, lead, or mercury, manifesting as neuropathies, which exhibit symptoms such as memory impairment, sleep difficulties, rage, exhaustion, hand tremors, blurred vision, and slurred speech, among others (Lahiri-Dutt, 2011). Lu (2012), estimates that roughly 3.5 to 4 million women work in illicit mining activities, with women accounting for up to 50% of the workforce in some situations (Vingrd and Elgstrand, 2013). Women are also underrepresented in general in the mining industry. Women commonly endure the "double load" of managing work and household duties (Lu, 2012), and they are frequently at the bottom of the sector's hierarchy, rendering them more vulnerable to health and safety issues (Dreschler, 2010).

They may also face health and safety risks as a result of the widespread lack of distinction between different activity areas. Among other things, in certain communities, women process ore near to or within the home area, crushing ore and assisting in refining the ore while simultaneously caring for their children (Collins and Lawson, 2014). As a result, women and children may be exposed to dust and chemicals used in the ore processing. Certain studies have discovered that the social context in which mining activities take place poses major health and safety concerns to miners and their communities and that these risks are particularly severe. Illegal mining activities are frequently located in isolated places with inadequate access to health care, education, basic sanitation, and other social amenities (Vingrd and Elgstrand, 2013).

Apart from that, mining camps are frequently located in areas with a high prevalence of prostitution and drug use, which increases the risk of HIV/AIDS and other sexually transmitted illnesses among miners and their communities (Hentschel et al., 2009). The adverse health impacts of mining might be worsened by factors such as one's manner of life. According to current studies, smoking crusher operators are at a greater risk of acquiring lung disease than non-smoking miners, for example, due to the compounding effects of smoke and dust particle exposure (Lu, 2012). These operations jeopardise public health, which is a point of emphasis for the study.

2.4.2 Environmental Impacts

The environment has a range of effects on our health. Numerous research on the interaction of human health and the environment have established that environmental hazards have a substantial influence on human health, either directly via exposure to hazardous agents or indirectly through interference with the functioning of life-sustaining ecosystems. While it is hard to quantify the exact contribution of environmental variables to the development of mortality and illness, the World Health Organization estimates that each year, thirteen million people die as a consequence of preventable environmental causes (Rehmondou, 2009). Environmental factors, the report states, are responsible for 24% of the global disease burden (measured in healthy life years lost) and 23% of all deaths (measured in premature mortality), with the environmental burden of the disease being 15 times greater in developing countries than in developed countries. This is because of variations in exposure to environmental hazards and the availability of health care services.

On the other side, rapid economic development and population increase have resulted in the continuance of environmental deterioration. Agriculture intensification, industrialisation of manufacturing, and increased energy use are the primary contributors to environmental health concerns. For developing countries in their early stages of development, the most serious environmental hazards to human health are associated with widespread poverty and a severe lack of public infrastructures, such as safe drinking water, sanitation, and health care, as well as the emergence of industrial pollution-related problems. On the other hand, environmental health concerns are not exclusive to developing countries.

2.4.3 Air Pollution

It is indisputable that some physical activities (volcanoes, fires, etc.) can emit a variety of contaminants into the environment. On the other hand, anthropogenic activities constitute the principal source of environmental air pollution. While hazardous substances can be discharged accidentally into the environment, a vast number of air pollutants are emitted by industrial facilities and other activities, and these pollutants can have a detrimental effect on both human health and the ecosystem if not managed. An air pollutant, by definition, is any material that has the potential to cause harm to both living and nonliving objects. A pollutant in the air may lead to an increase in mortality or morbidity in humans, or it may constitute a hazard to one's physical or mental health.

Gaseous pollutants contribute significantly to the composition of atmospheric fluctuations generated principally by the combustion of fossil fuels, as well as by other sources (Katsouyanni, 2009). Nitrogen oxides are emitted as NO, which rapidly interacts with ozone

or other radicals in the environment to generate NO2. The most prominent anthropogenic sources are mobile and permanent combustion sources. Additionally, ozone is generated in the lower atmospheric layers as a result of a chain reaction involving NO2 and volatile organic compounds, which is activated by solar radiation. Carbon dioxide, on the other hand, is a result of incomplete combustion, but carbon monoxide is not. Its primary source of energy is road transportation. While anthropogenic SO2 is produced by the combustion of sulphur-containing fossil fuels (mainly coal and heavy oils) and the smelting of sulphur-containing ores, natural SO2 is formed through organic matter decomposition.

Lead, mercury, cadmium, silver, nickel, vanadium, chromium, and manganese are all examples of heavy metals, as are other rare earth metals. They are impervious to degradation or destruction since they are naturally occurring components of the earth's crust. They are airborne and can be consumed via drinking water and human food supply. Additionally, they infiltrate the environment via a variety of mechanisms, including combustion, waste water discharge, and manufacturing facilities. Their presence in the human body is restricted due to their function as trace elements required for the normal functioning of all metabolic reactions. However, even in relatively low quantities, these chemicals may be harmful (Jarup, 2013). Sporadic episodes of air pollution, such as the infamous London fog of 1952, and other epidemiological studies conducted over short and extended periods examined the effect of changes in air quality on human health. The fact that air pollution is associated with an increased risk of death and hospitalisation is widely recognised (Castanas, 2008).

The various chemical compositions of air pollutants, as well as the quantity and duration of exposure, as well as the fact that humans are often exposed to pollutant mixes rather than single compounds, can all have a variety of health repercussions. Human health implications might range from nausea and respiratory difficulties to skin irritation and even cancer. Additionally, they include birth deformities, severe developmental delays in children, and a weakened immune system, which can result in a number of diseases. Additionally, a range of risk variables exists, including age, dietary status, and predisposing diseases. Among the health effects are acute and chronic diseases. According to epidemiology and animal model data, the cardiovascular and pulmonary systems are the most often impacted. However, this illness can also affect the function of a variety of other organs (Cohen et al., 2015)

Particulate matter in the air, black smoke emissions, noise, and vibration have been the principal sources of grievances about air quality in affected neighbourhoods. Respirable dust, sulphur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO), and black smoke are only some of the airborne contaminants causing concern in the Tarkwa area. Site preparation, road construction, open-pit drilling and blasting, loading and hauling, vehicular movement, ore and waste rock handling, and unlawful heap leach crushing during heap leach processing are all examples of operations that contribute to the generation of this particulate matter. Among the other pollutants are fumes released during the traditional roasting of sulphide ores and their enterprises' refining processes.

The emission of particulate matter into the atmosphere, primarily in the form of minute dust particles smaller than 10 microns in diameter, poses a health danger to Tarkwa people. When

fine dust is inhaled at a high concentration, it has the potential to induce respiratory diseases and disorders, as well as aggravate the condition of persons who already have asthma or arthritis. Dust from gold mining operations is high in silica, which has been related to the spread of silicosis and silicon tuberculosis in the region (Akabzaa, 2009).

Air pollution is a serious environmental health issue, causing an estimated two million premature deaths per year worldwide. Reduced air pollution is predicted to lessen the worldwide burden of disease caused by respiratory infections, cardiovascular disease, and lung cancer, among others. Given that air quality is a significant source of concern in both developed and developing countries, various empirical studies have been done to evaluate the health benefits of improving air quality. According to Opoku-Ware (2010), air pollution in illicit mining settlements is a result of the dusty unpaved roads that are regularly used by heavy-duty trucks to move machinery and other equipment to the operational locations.

Although chemical vapours, fumes, and smoke are not easily visible at mine sites, dust is expelled into the atmosphere during prolonged blasting. As a result, chemicals used in the blasting process are released into the atmosphere, and the surrounding neighbourhood is prohibited from using rainwater. According to field observations, crushing sites generate a significant amount of dust, which contributes to an increase in respiratory diseases such as the flu and cold (catarrh), as noted by the majority of respondents to the survey questions. According to the findings, fine dust exposed at a high level has the potential to induce respiratory diseases and disorders, as well as exacerbate the health of persons living in such areas who suffer from asthma and bronchial stiffness.

Figure 2.1: Dust from a Changfa crusher polluting the air at Aboso.
Source: Field Survey, 2021

2.4.4 Water Pollution

Mining activities affect the rate of contamination of water resources due to their physical degrading nature. Additionally, they involve the use of chemicals and other potentially harmful substances (Adjei, 2012). Thus, whether on a small or large scale, the pursuit of mineral resources implies a threat to water resources (surface and groundwater resources). The most visible effects of mining on the environment are pollution of water bodies, vegetation cover, and soil. Due to the high water requirements for washing the ore, illegal miners are frequently discovered working near bodies of water (Fatawu and Allan, 2014; Mudyazhezha and Kanhukamwe, 2014). As a result of this practice, tailings are dumped directly into rivers without treatment, resulting in significant debris contamination of streams and rivers (Kessey and Arko, 2013). Not only does it alter the river/aesthetic stream's

appearance, but it also alters the water's physiochemical and biological parameters, rendering it unfit for domestic use.

Destruction of river banks and rerouting of the river has resulted in severe flooding when even a trace of rain falls (Fatawu and Allan, 2014). Illegal mining has a detrimental effect on fresh water due to the extensive use of water in the ore processing process, as well as pollution from discharged mining waste and seepage from tailings and waste rock impoundments. Human activities such as mining, for example, are threatening water supplies in an increasing number of ways. Water is referred to as the "most frequent victim of mining (Allan, 2014). Environmental damage left behind by illegal mining activities conducted with little or no regard for the environment is becoming increasingly recognised. Illegal mining depletes, diverts, and has the potential to pollute water supplies by its very nature.

There are a variety of impacts on water quality, including heavy metal contamination and leaching, processing chemical pollution, erosion and sedimentation, and nutrient contamination. Eleven studies conducted in Ghana were reviewed for this study, all of which demonstrate the pollution of water bodies, as well as the consequences for the environment and human health. A significant amount of mercury and arsenic contamination has been found in samples taken from the environment near mining sites in Ghana, both in biotic and abiotic samples. In most cases, small-scale miners operate along the banks of rivers, destroying river banks and making them more prone to overflowing after heavy rains. Consequently, flooding has recently occurred in mining communities as a result of this situation. There is no control over the flow of water, which flows into neighbouring homes and the surrounding

environment, destroying property and threatening human life. Most rivers and streams have had their natural courses altered or completely blocked to make way for illegal mining operations.

Illegal mining activities commonly referred to as "galamsey" in Ghana and other developing countries, are considered a source of subsistence as well as a contributing factor to environmental degradation (Agyemang, 2010). Illegal mining activities in Ghana are thought to account for approximately 5% of the country's annual gold production, according to estimates. However, in recent years, this type of ore mining has fallen out of favour because it is perceived to be a significant source of heavy metal contamination of the environment (Cobbina et al, 2013). Some of the negative consequences of these illegal mining activities include the destruction of vegetation, the degradation of land, and the pollution of water bodies, to name a few examples. The alarming rate at which mercury is being released into the environment and water bodies is a cause for concern (Tom-Dery et al, 2012).

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In illegal mining operations, simple tools are used to recover ore from the ground to avoid detection. Pits are dug haphazardly and remain uncovered for an extended time following illegal mining operations. An investigation into the presence of mercury in the soil was conducted during prospecting work in a field, according to reports. A pit was dug and the results were revealed. Tetteh et al. (2010) found high levels of mercury and zinc in the top soil of towns in Wassa communities, which they attributed to human activity. In contrast, the concentration levels dropped as one moved away from the main mining centres and increased as one moved further away from the main mining centres, most likely as a result of aerial

dispersion of metal from mining areas. Amalgamation is the preferred method for extracting free metals such as gold from their ores, and it is also the most expensive.

In most cases, the gold amalgam is roasted to release the mercury while also concentrating the gold. A significant amount of excess mercury that is discarded into the environment eventually finds its way into water bodies (Ezeh, 2007). In the aftermath of the gold amalgam, methyl mercury in water and mercury oxides in the air find their way into humans through the food chain, such as through the consumption of mercury-contaminated food or fish, and through inhalation of mercury oxides in the air (Nartey et al, 2011).

According to Tarkwa stakeholders, illegal mining activities in the area surrounding the river have significantly altered the natural course of the rivers. Some stakeholders attributed this to the illegal mining activities described by a key informant from the Ghana Water Company at the Bonsa intake points: "the soil is heavily scooped and processed for gold, after which debris is abandoned in and around the river." Additionally, observers have noted that the river has turned an opaque brown colour; however, those who responded indicated that this has not always been the case. According to some residents in the area, farmers used to drink river water directly without treatment in the years preceding the onset of illegal mining activities along the river's banks. According to those who live nearby, this was due to the clear colour of the water.

Additionally, as impurity levels rise, turbidity levels rise, lowering the pH of river water. As demonstrated by Boachie-Yiadom and others, a decrease in pH regulates a variety of aquatic

reactions, including the dissolution of metal oxides (2010). According to the evidence, in the presence of a constant drop in pH, the oxides of certain metal elements appear to find their way into the water and dissolve.

In 2011, the Centre for Environmental Impact Analysis published a report titled "Human Health Risk Assessment and Epidemiological Studies from Toxic Chemical Exposure" in the Ghanaian municipalities of Tarkwa-Nsuaem and Prestea-HuniValley. The report was conducted in the municipalities of Tarkwa-Nsuaem and Prestea-HuniValley (Kusi-Ampofo and Boakye-Yiadom, 2012) Using water and soil/sediment samples, as well as cassava contaminated with toxic chemicals such as arsenic, cadmium, cobalt, copper, lead, manganese, mercury, and zinc, this study discovered that residents of the Tarkwa-Nsuaem Municipality and Prestea-HuniValley Districts had elevated levels of toxic chemicals in their whole blood and blood serum when they ingested them or came into contact with them.

Illegal mining, for example, degrades water quality and increases water treatment costs for water companies that treat water for public consumption and distribution. Pollution can be so severe that it necessitates the use of large amounts of chemicals to treat the water, lowering the quality of water supplied to the general public and forcing water companies to close their operations (Emmanuel, 2013). According to Adjei (2012), illegal mining activities affect the rate of water resource contamination due to their physical degradation and the use of chemicals and other harmful substances during the mining process. Thus, the pursuit of mineral resources, whether on a small or large scale, implies the jeopardisation of water resources (surface and groundwater resources).

Gardner et al. (2015) assert that the use of water in mining has the potential to contaminate nearby surface and groundwater, which is frequently cited as a major source of concern by stakeholders. Gardner et al. (2015) assert that the use of water in mining has the potential to contaminate nearby surface and groundwater, which is frequently cited as a major source of concern by stakeholders. Galaz (2015) argues in this vein that mining operations, whether small or large in scale, frequently require the use of water, which affects water resources even after the operations have ceased. Illegal small-scale mining has been identified as a significant contributor to the mining industry's failure to follow sound environmental practices, as evidenced by mercury and other pollutants discharged into streams and rivers as a result of the practice. In line with the findings of Nasirudeen (2015), who discovered that large mining companies' reckless cyanide spillage significantly contributes to the pollution of rivers and streams in these areas, posing a threat to human and aquatic life.

Figure 2.2: Pollution of a stream at Aboso due to illegal mining activities.
Source: Field Survey, 2021

Surface and groundwater pollution has been a major source of concern due to the concentration of mining operations in Tarkwa and its environs. Tarkwa's mining areas have been identified as having four significant water pollution problems. Chemical contamination of groundwater and streams, siltation caused by increased sediment load, increased faeces, and dewatering effects are just a few of the consequences of deforestation (Akabzaa, 2009).

2.4.5 Land Degradation

Figure 2.3: Farmlands are being destroyed due to illegal mining activities at Aboso and Samahu.

Ghana's gold mining industry, according to Standing and Hilson (2013), contributes to the country's overall economy. However, individual communities on a local level are confronted with a variety of social and environmental issues, such as the destruction of agricultural land

(Standing and Hilson, 2013). According to the results of interviews conducted with residents of selected communities, one of the most significant consequences of illegal mining is land degradation. For example, the presence of rocks and debris from illegal mining activities hampered plant growth and rendered farming operations impossible in some of the host communities (Yeboah, 2008).

Respondents also expressed concern that illegal mining activities have resulted in the formation of pits and heavy holes/trenches, which have rendered these areas inaccessible to the local population due to the dangers they pose. Once again, illegal mining is followed by land degradation, which has negative consequences for the environment. Numerous pits are dug haphazardly, with pit sizes ranging from 400 to 4000 sqft and depths ranging from 6 to 30ft (Kessey and Arko, 2013). Unfortunately, even after illegal mining operations have been halted or relocated, they continue to be discovered and investigated (Kpan et al., 2014). Pits become flooded with rainwater, forming breeding grounds for mosquitoes and emitting a nauseating stench into the environment. They also serve as death traps for people who fall into them (Awaomim, 2013).

Furthermore, these activities result in the depletion of valuable topsoil (Asiedu, 2013), rendering the land unsuitable for the production of agricultural products. These consequences are least noticeable among certified legal miners, who have reclamation plans in place; however, the same cannot be said for illegal mining operations, which lack such plans. All of the illegal mining operation centres are located throughout the country. The field study revealed that illegal mining has had a significant impact on the ecosystem, with greater

proportions of the land area being stripped bare as a result of the activities. The illegal mining activities in many areas, including Nankaba, Compound No 2, Gollof, and others, have resulted in large tracts of land losing their vegetation cover as a result of the loss of vegetation cover.

Massive gullies, excessive runoff, severe erosion, decreased soil infiltration, decreased groundwater recharge, and consequent loss of land productivity has occurred. Along with erosion, the land has lost its agricultural viability and as a result, habitat for birds and other animals has been lost. These activities have resulted in the world wide destruction of lush vegetation, biodiversity, cultural sites, and water bodies. Schueler and Collagues (2011) argue that small-scale gold mining is to blame for the eradication of vast amounts of surface vegetation and Ghana's mass deforestation. According to Akabzaa and Darimani (2009), extensive areas of land and vegetation in Tarkwa have been cleared to make way for illegal mining activities.

Tarkwa's open-pit concessions now cover more than 70% of the town's total land area. This has a detrimental effect on the land and vegetation, which are the primary sources of income for the indigenous people. Atuabo and Dumasi are already experiencing a land shortage, resulting in a scramble for available farmland. The environment is rapidly deteriorating in parts of Tarkwa, and the region's enormous economic value is dwindling year after year, owing largely to the area's high concentration of illegal mining activities. Not only are agricultural lands degraded in general, but the land loss has also resulted in a reduction in the length of the fallow period, which has decreased from 10-15 years to 2-3 years as a result of

land loss. Due to a lack of available land, the traditional bush fallow system, which successfully recycled significant amounts of nutrients and made the subsequent cycle productive, cannot be practised. It is widely accepted that illegal mining activities continue to deplete the area's vegetation to dangerous levels for biological diversity (Akabzaa and Darimani, 2009).

Surface mining results in deforestation which has long-term consequences, even after the mine is closed and the soil is replanted with new vegetation. The introduction of new species has the potential to alter the topsoil composition, thereby affecting soil fertility and the length of time crops can be left fallow between harvests. Along with erosion, when surface vegetation is depleted, the land's viability for agricultural purposes decreases, as does the availability of habitat for birds and other wildlife. This has progressed to the point of destroying luxuriant plant life, biodiversity, cultural sites, and water bodies (Akabzaa and Darimani, 2009). By the time large-scale mining companies have exhausted all of their concessions and relocated to new locations, a total of 16 ridges ranging in height from 120m to 340m will have been twisted into massive craters by illegal mining operations (Akabzaa and Darimani, 2009).

Figure 2.4: Fertile land being degraded due to Illegal mining activities.

Source: Field Survey, 2021.

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2.5. Indicators of the Variables

The environment and natural resources are critical to the Ghanaian people, as their way of existence require continual and direct engagement with the natural environment inside their communities. Land, health, water, and air pollution are only some of the environmental consequences and natural resources considered in this study while evaluating the effects of mining activities in Ghana. These variables have a considerable impact on the quality of life for residents of diverse communities. Ghana's 1986 Mining and Minerals Act, aims to restrict government engagement in the economy while simultaneously promoting foreign direct

investment into the country's extractive sector. The Act became law in 1986.(Campbell, 2009; Akabzaa, 2009).

As a result of these practices, considerable environmental degradation has occurred, as well as displacement of indigenous people, an increase in human rights violations, and confrontations between corporations and communities. Bridge (2014) claimed that throughout seven centuries, concerns about the effects of illegal mining and mineral processing have been voiced, which have occasionally been eased briefly through legal ways. This is unsurprising given mining's considerable environmental impact and as a result, its transformation into a high-risk sector (Amponsah-Tawiah and Dartey-Baah, 2011). This is a point that is regularly disputed throughout the world (Kemp and Owen, 2013).

Illegal mining has a detrimental effect on the ecosystem in Sub-Saharan Africa, as has been proven extensively (Edwards et al., 2014). For instance, mining wreaks havoc on the ecosystem, resulting in deforestation and persistent poverty. Additionally, it contributes to environmental contamination through the noise, water, and air pollution, resulting in changes to the physical landscape (Kitula, 2006). The majority of environmental problems produced by unlawful mining are either physical degradation or pollution-related problems (Kumah, 2006). Other studies, in a similar vein, have examined the environmental effects of mining, including pollution, biodiversity loss, environmental governance, and land degradation (Hilson and Maconachie, 2008; Spiegel, 2009). We have developed a systematic understanding of the nature and scale of the environmental concerns related with illicit mining

as a result of these studies over the previous few decades, as well as a proliferation of laws, initiatives, and measures aimed at resolving these issues.

2.6 Empirical Review

Illegal mining as a sensitive subject area has been explored by many researchers on other variables and all these researchers had their unique conclusions after their respective studies. Below are some perspectives that were brought forth during the study conducted by some selected researchers.

2.6.1 Global Perspective

While unlawful mining poses multiple threats to the environment and public health, mercury usage is by far the most dangerous. Due to the widespread use of mercury in illegal mining, dozens of countries travelled to Switzerland in 2013 to sign the Minamata Convention during the Intergovernmental Negotiating Committee's fifth session in Geneva (UNEP, 2013). The Minamata Convention, among other things, provided a model for the cross-sectoral efforts necessary to promote and preserve the health of populations depending on illicit or small-scale gold production. This agreement's objective was to coordinate efforts to prevent the emergence of new mercury mining operations, to close existing mines, to develop control measures for mercury emissions into the atmosphere, and to develop regulatory frameworks for the informal mining sector to avoid health and environmental risks associated with mercury exposure.

While the treaty has focused most of the public sector's attention on the consequences of mercury on human health, notably on miners and civilians living near mining sites (Black et al., 2017), it has also resulted in reinvigorated research efforts on mercury pollution caused by unlawful mining activities (Black et al., 2017). Clifford, (2017) is of the view that illegal mining is not confined to Africa; it occurs in a variety of locales throughout the developed and developing worlds. Over 40 minerals, including precious and semiprecious stones, heavy and industrial minerals, and building and construction materials, are recovered from the ground. Gold and gemstones are the most often mined of these materials due to their inclination to earn wealth quickly.

Minerals are a blessing to humanity. They are natural gifts that may be developed, sold, and used to assist the majority of countries in developing their economies (British Geological Survey, 2012). Numerous industrialised countries, including Australia, Canada, Sweden, and the United States, have based their economic success on resource exploration and extraction. Mineral production creates revenue and foreign cash through exports, and it also benefits the local economy. Illegal mining can take place on a small, medium, or big scale, and is often conducted utilising primitive and instinctual tactics that do not require long-term planning. As a result, conventional approaches such as geological research, drilling, establishing proven reserves, or conducting engineering studies are abandoned in favour of primitive and instinctual techniques (Hinton et al. 2013).

Illegal mining activities have been a source of contention in recent years due to the severe impact they have on the environment and human health (Ali, 2006). However, as the mineral

market gained prominence globally, production of this resource expanded, reaching more than 2,500 tonnes in 2010 (British Geological Survey). For instance, gold has substantial environmental repercussions as a result of the usage of cyanide and mercury in the ore beneficiation process required for gold extraction.

On the other hand, modern and mechanised gold businesses rely nearly solely on cyanide, while amalgamation, which utilises liquid mercury, has been phased out due to significant health and environmental issues (Longsdon et al., 2010). As a result of these discoveries, countries such as Venezuela have completely banned the use of mercury in mining activities. In comparison, the small-scale artisanal mining industry accounts for between 20% and 30% of global gold production (Veiga et al., 2006). Mercury separation and extraction of gold from gold-bearing minerals in the surrounding environment is a necessary procedure in the gold mining business (Veiga et al., 2006). Due to the usage of mercury, individual miners can finish the entire process without forming partnerships with other miners. Mercury is easy to employ, extremely successful at capturing gold, abundantly available, easily transportable, and less expensive than other procedures (Telmer and Veiga, 2009). By contrast, this has a detrimental effect on the environment and overall quality of life, which are the study's key objectives.

2.6.2 Developing Countries.

Mining has always been a key economic activity in Africa. Since the colonial era, it has been known that significant quantities of minerals have been taken and processed for sale on the worldwide market. Since the turn of the twentieth century, when the first diamond rushes

began in Southern Africa, the continent's resource economy has grown at a breakneck pace. Numerous local and international enterprises are actively processing high-quality resources such as bauxite, gold, diamonds, coal, and iron on a massive scale (for example, Placer Dome Inc., Ashanti Goldfields, Zambian Consolidated Copper Company Ltd., Konkola Copper Mines Ltd., among others). Many more mines, however, operate on a lesser scale and illegally, resulting in a dense concentration of mines.

Even though each mine produces a tiny fraction of what larger miners produce. This industry sector has a disproportionate socioeconomic impact on rural communities, as abandoned pets and mine sites are being exploited for illicit mining operations in Africa's poorest regions, notably rural areas. Typically, employment opportunities are sparse, earnings are low, and the illiteracy rate is high in these places. Labour-intensive illicit mining operations create welcome new economic prospects because the salaries obtained by people working in this sector are higher than those earned by those employed in conventional agriculture and rural building, which are more temporary. Additionally, these remote operations frequently result in the expansion of a number of critical auxiliary industries, including polishing and blacksmithing; construction; secondary manufacturing; and merchant operations; and they contribute significantly to national mineral exports and foreign exchange earnings.

Additionally, despite the documented socioeconomic benefits of small-scale mining in Africa, small-scale mining operations have resulted in a variety of detrimental environmental impacts. The majority of mine operators have only intermediate technology at their disposal, and their operations are primitive. As a result, they have a variety of negative effects on the ecosystem.

African mines operating on a small scale are not subject to the same regulatory standards as large-scale enterprises; in fact, practically all environmental legislation in African countries are still in their infancy. As a result, several environmental challenges have arisen and persist across the business, including soil deterioration, chemical contamination, and air pollution.

Due to the increasing prevalence of illegal mining activities across the continent, disturbances are likely to worsen, making it even more necessary to develop and implement viable environmental policies as soon as feasible. A complete industry shutdown is not a viable option. Government backing, partnerships, and more technological diffusion can all help resolve environmental challenges. Additionally, illicit mining is a substantial industry in several developing nations since it provides a primary and secondary source of income, especially in rural areas where economic options for agriculture are limited. Illegal mining is a burgeoning sector in many developing countries, as it provides a major and secondary source of revenue. Global demand for natural resources is pushing an increasingly aggressive approach to resource extraction and land usage on a local level (Defrire et al, 2010).

For developing countries, harnessing the profitable forces of global demand in the interest of social and environmental sustainability is becoming increasingly difficult, all the more so as the global economy grows more intertwined. As a result, emerging countries bear disproportionate environmental costs in comparison to rich countries that acquire raw materials from these developing countries (Behrens et al, 2007). Gold is an excellent example of a globally traded commodity that has a significant impact in developing countries due to its widespread availability. Gold's price has climbed 360% over the last decade, with an annual

growth rate of around 18% continuing to be maintained. Gold prices continue to surge to new highs, recently exceeding $1400 per ounce. As a result, non-industrial illegal gold mining has increased in poor countries, wreaking havoc on the environment and posing serious health risks to individuals involved (Larmer, 2009).

According to the World Gold Council, deforestation, acid mine drainage, and air and water pollution from arsenic, cyanide, and mercury contamination are all significant environmental risks produced by gold mining in the developing world (Veiga et al, 2006). Although mercury's adverse effects on the environment and human health are well recognised, its usage in artisanal mining remains a crucial component of today's industry (Fraser, 2009). Gold miners in underdeveloped nations are exposed to mercury via vapours and dissolved liquids during the extraction process, resulting in mercury being discharged directly into sediments, waterways, and the atmosphere (Telmer and Veiga, 2009).

Illegal mining is estimated to have produced between 20% and 30% of global gold production since 1998, and approximately a third of all mercury discharged into the environment (on average, about 1000 ton/year) (Telmer and Veiga, 2009). While many developing countries have negotiated environmental agreements with large gold mining corporations that normally do not use mercury in their operations, they continue to battle with the control and regulation of illegal mining operations, particularly in remote locations (Veiga et al., 2006). Surface and groundwater sources have been affected throughout Ghana, with pollution levels being notably high in gold mining communities. However, gold mining has recently lost popularity since it is a significant source of mercury, lead, and other heavy metal contamination in the

environment, owing to activities such as mineral exploitation, ore transportation, smelting, refining, and disposal of tailings and wastewaters near operational sites, among others (Paruchuri et al., 2010).

The most major environmental problems induced by unlawful mining activities are mercury pollution from gold processing and land deterioration. Cobbina et al., (2012) report that inhabitants' children and adults are in danger of mercury exposure in shallow dug-wells and dugouts located near the contaminated site. Essumang et al., (2007) documented cases of waterlogged pits, soil erosion, contamination of fresh vegetables and food items, and pollution of rivers and other bodies of water that serve as a source of drinking water for communities living near illegal mining operations (Obiri et al., 2010; Paruchuri et al., 2010). Residents living downstream suffer significantly as a result of illicit mining operations' activities, which contribute significantly to water contamination. Mineral mining, on the whole, causes environmental degradation on a scale that few other human activities can match.

In addition to deforestation and soil erosion, it is responsible for significant water pollution as well as air pollution. Because developing countries produce a large portion of the world's minerals, the environmental consequences are particularly severe in those countries where mining is practised. Across Africa, in countries with abundant mineral resources but depressed economies, thousands of unemployed people are digging for fortunes in businesses that are illegal and unregulated. These miners employ primitive extraction techniques, such as dynamite, pickaxes, mercury, and their physical strength, to extract valuable minerals

(Harkinson, 2013). Indeed, these miners make a living by engaging in illegal mining, although it endangers their own lives as well as the lives of others in the community.

2.6.3. Sub-Saharan Africa

Africa is a landlocked continent endowed with natural resources. This continent contains a significant amount of platinum and gold, as well as 40% of the world's chrome, 28% of its manganese, 51% of its vanadium, 60% of its cobalt, and 78% of the world's diamonds (Darimani, 2009; Edwards et al., 2014). A typical illicit mining operation in Sub-Saharan Africa will often employ a broad range of people, each with their own set of skills and educational backgrounds. Numerous people were expendable as a result of structural adjustment and transformation. Thousands of laid-off civil servants, teachers, and large-scale mine workers have fled to rural areas in search of work, unable to find a feasible replacement position in their prior employment (Banchirigah, 2006).

Illegal mining is expected to result in the informal sector creating new jobs. This sector is expected to provide six new informal jobs. Jobs for cab drivers, cooks, apparel vendors, and semi-skilled workers, as well as machine operators, repairers, bookkeepers, accountants, and technicians, have been established in the region as a result of small-scale mining activities. Concerns have been expressed on the detrimental consequences of unlawful mining (Spiegel and Veiga, 2010). Additionally, in the case of gold panning, these activities result in the destruction of enormous swaths of landscape and the release of significant amounts of mercury pollution into the natural environment. Operators and staff frequently operate in hazardous and unclean situations.

Numerous villages in Sub-Saharan Africa have also developed a reputation as "hot areas" for prostitution, sickness, and narcotics use as a result of the aforementioned circumstances. Journalists, government officials, and, to a lesser extent, benefactors have taken notice of these "ills." Many of them have unfavourably portrayed illegal mining operations, so influencing and misinforming the general public. Illegal mining has become a topic of concern in the media and public forums, as various talks have taken place on the matter, particularly concerning child labour (Hilson, 2008).

Due to the informal nature of illegal mining, reliable figures on the scope of the problem are difficult to collect. However, estimates indicate that it employs over three million people directly in Sub-Saharan Africa. It is evident that the sector can alleviate poverty and secure livelihoods in the world's poorest region, as has been widely documented in the scholarly literature (Maconachie and Binns, 2007; Fisher et al., 2009). On the other hand, illegal mining operations are beset by a host of social and environmental difficulties, making them a poor investment. For some time, the detrimental effects of illegal mining in Sub-Saharan Africa have been documented in the literature. It has been connected to environmental degradation (Kitula, 2006), a rise in child labour (Hilson, 2010), bad health impacts (Tschakert and Singha, 2007), prostitution and criminal activity (Tschakert and Singha, 2007), and an increase in child labour (Tschakert and Singha, 2007).

For some years, international human rights campaigners have been concerned about the precarious working conditions and poverty cycle associated with illegal mining, which pits diggers at the bottom of the industrial chain. In this perspective, some have claimed that

illegal mining activities serve as a catalyst for marginalisation, owing to the fact that they thrive in isolated places with a weak state, few rules, and educated elites capturing resources primarily through "accumulation by exploitation" (Fisher, 2007). Against this context, scholars have claimed that the primary impediments to resolving these concerns stem from the sector's unregulated nature, which works beyond the bounds of legislation and hence cannot be addressed (Clausen et al., 2011). According to the World Bank, these behaviours, as well as the economic standing afforded illicit mining activities, are in part a reaction to inferior production practices and the social and environmental problems connected with illegal mining.

2.6.4 Ghanaian Experience

There is undeniable evidence that natural resources such as gold, diamonds, bauxite, and crude oil deposits may contribute significantly to economic growth and development. Ghana, historically known as the Gold Coast, is Africa's second-largest gold producer and the ninth largest gold producer in the world; gold production contributes for around 40% of total export profits, 14% of total tax revenues, and 5.5% of total GDP (Ayee et al., 2011). Ghana has two forms of mining: small-scale mining and large-scale mining. Typically, small-scale mining requires a lesser initial capital commitment. Small craftsmen do the majority of applied ecology and environmental sciences, whereas foreigners dominate Ghana's large-scale mining business. The principal participants in Ghana's large-scale mining industry are small artisans.

The Ghanaian government and private Ghanaian investors own fewer than 15% of the mines, with the remainder held by international investors (Akabzaa and Dramani, 2010). Surface

mining is the most often used form of extraction in illicit mining due to its low cost, low capital investment, and low level of technical skill requirement. Due to the high initial investment, vast workforce, and complex technology required, large-scale mining often adopts the deep-pit method of extraction (Amponsah and Dartey-Baah, 2011). Additionally, due to the requirement for a licence, it is frequently subject to government approval. Prior to 1989, small-scale mining was deemed illegal in Ghana, and it was also generally unregulated. In 2007, as part of the Economic Recovery Program, the Ghanaian government moved to modernise and legitimise this sector by enacting the Small-Scale Gold Mining Law (Act 218 of the PNDC).

Despite this advancement, only a tiny number of craftspeople engaged in small-scale mining are officially recognised. As a result, the vast majorities of artisanal miners are unregistered and work illegally, making it exceedingly difficult to monitor their activities and assure compliance with mining legislation (Aryee et al., 2013). The bureaucratic nature of the registration procedure frustrates people, even though the law compels them to register with the Minerals Commission to be assigned specific blocks or areas in which to conduct business. Despite these regulations, environmental degradation is a problem in Ghana's mining villages, posing grave threats and raising severe concerns. The extent to which mineral mining has harmed the environment in Ghana has been thoroughly documented (Armah and Gyeabour, 2013).

Nonetheless, the extent of the harm is mostly determined by the kind of mineral extraction used (Schueler et al, 2011). This has become increasingly disturbing in recent years, raising

severe concerns about low entry barriers to the business, inadequate research techniques, a lack of cooperation among regulatory agencies, inadequate mercury management, and a shortage of staff and resources among key stakeholders (Okoh and Hilson, 2011). Inadequate research, poor community participation, lengthy processes for registering small-scale mine sites, and a lack of environmental education and awareness-building have all been identified as contributing to Ghana's continued environmental deterioration caused by mining operations.

Significant increases in illicit mining in Tarkwa, one of Ghana's mining villages, have led to disproportionate contamination of key water bodies, leading to the extinction of aquatic creatures, biodiversity, flora, soil depletion, and agricultural extinction. Serfoh et al. (2006), for example, discovered elevated arsenic and antimony concentrations in rivers in Prestea, ranging from 0.90 to 8.25 parts per million (ppm) and 0.09 to 0.75 parts per million (ppm), respectively, far exceeding the World Health Organization's recommended values of 0.01 and 0.005 parts per million (ppm). On the other side, on October 23, 2004, Bilington Bogoso Gold, now Golden Star Resources Bogoso/Prestea Limited, participated in surface mining, resulting in a spill.

This leak occurred as a result of the company's new tailings dam, which flowed into the River Aprepre, which runs into several other rivers, including the Egya Nsiah, Bemanyah, Manse, and Ankobra. The cyanide spillage is believed to have impacted the communities of Dumasi, Goloto, Juaben, and Egyabroni; some residents of Dumasi and other villages in this area picked up and consumed dead fish, crabs, shrimp, and other aquatic organisms found floating

on the river's surface; and some residents of Dumasi and other villages in this area were exposed to the cyanide spillage (Singh et al, 2007).

Field observations revealed that main streams in the study areas had been extensively polluted as a result of illegal mining activity. These streams had previously served as the primary source of water for household uses in the surrounding communities. Mining, particularly surface mining, has a detrimental effect on Ghana's water bodies (rivers and streams) because of the discharge of effluents including contaminants such as mercury, arsenic, and solid suspensions (Bloch and Owusu, 2012).

Additionally, Kumah (2006), showed that between 1994 and 2001, five major cyanide spills and leaks occurred, contaminating important waterways in Ghana. He added that cyanide spills and leaks by mining corporations like Teberebie Goldfields Ltd and Ashanti Goldfield Company Ltd (now AngloGold Ashanti) result in the poisoning of Ghana's western region's Anikoko, Angonabe, Bodwire, and Assaman streams. As a result of this, a large loss of aquatic organisms happened, as did the displacement of people and depletion of livelihood and drinking water in some areas. Additionally, it was discovered that mining operations, particularly illegal small-scale mining, are conducted in the open without the application of appropriate safeguards and environmental standards, resulting in the release of contaminated water into the surrounding environment, polluting nearby rivers, soils, and vegetation.

This is consistent with the findings of (Hilson, 2012), who discovered that small-scale mining craftsmen dump around 5 tonnes of mercury into various water bodies each year, resulting in

siltation and colouring. He continued by stating that mercury discharge results in siltation and colouring of water bodies, as well as deoxygenation, destruction of aquatic organisms and their physical habitat, all of which impair aquatic organisms' growth and ultimately result in their extinction. Mercury is often utilised in illegal mining activities, according to Assel (2006), since it is added to the refined concentrate to make a gold amalgam, which is then heated to separate the gold from the amalgam. Another study conducted in the Dumasi Township in Ghana's western area (Bloch and Owusu, 2012) discovered substantial mercury contamination in groundwater, river sediments, and fish.

Additionally, the method of surface mining used by the majority of registered large-scale, small-scale, and unregistered artisans frequently results in the excessive destruction of productive land, deforestation, and mass trenching, exposing productive arable lands to the elements and increasing runoff and turbidity in the environment. When mineral resources are removed, considerable soil degradation occurs as a result of vegetation clearance and microbial community modification, resulting in decreased soil fertility and productivity. According to the Food and Agriculture Ministry, illegal mining activities in Ghana significantly contributed to land degradation and the loss of arable land between 1990 and 2005, resulting in a massive loss of forest cover (26%) and arable land (15 to 20%) in the Tarkwa, Ayanfuri, Dunkwa, Esaase, and Bogoso mining areas (Babut et al, 2013).

As such, this research explores the environmental and health effects of illicit mining in several selected mining towns in Ghana, with a particular emphasis on the current state of affairs in each of the study areas. As a result of the study's findings, awareness of the present

environmental and health implications of illicit mining activities will be increased, and politicians will be prompted to seek solutions to the impacted areas' current environmental concerns.

2.7 Conceptual Framework

The conceptual framework used for the study shows the environmental and health impacts of illegal mining activities.

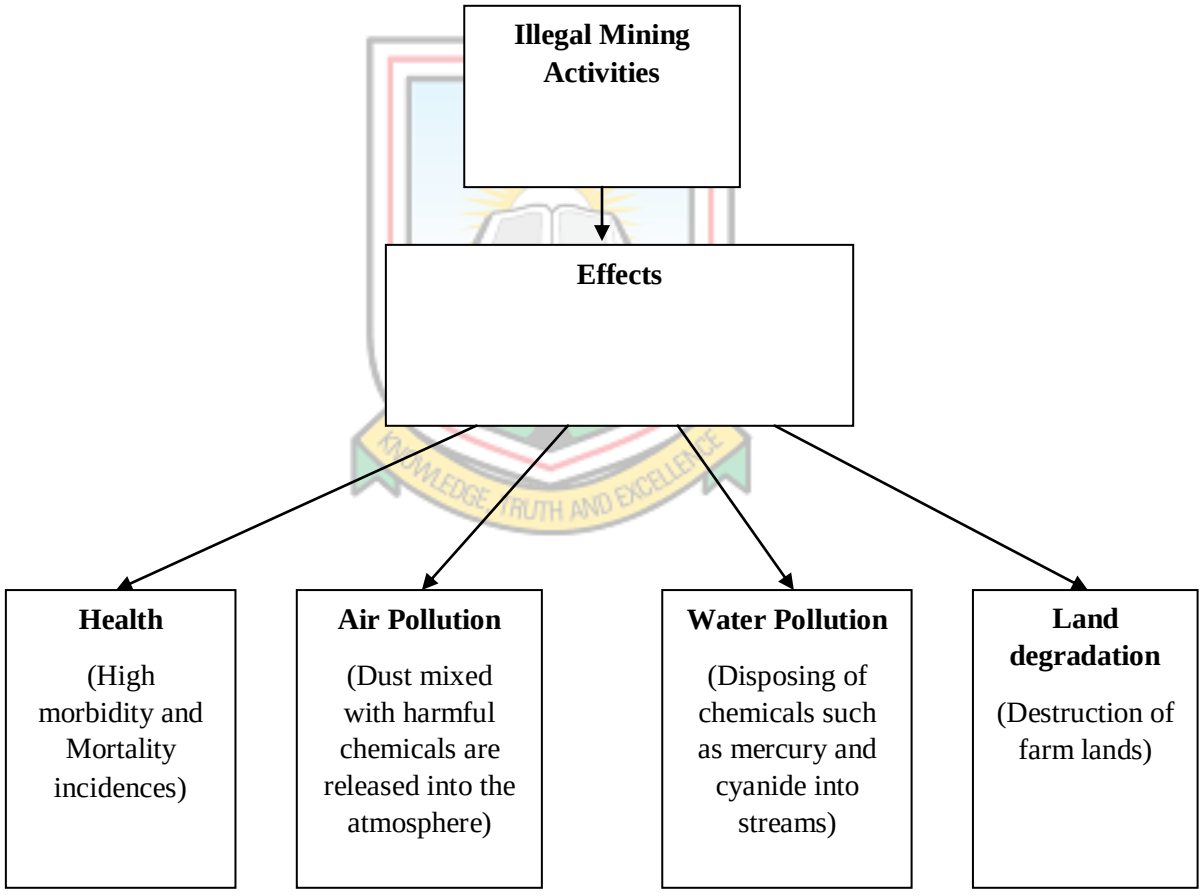

Figure2.5: Conceptual Framework

Source; Researcher's Own Construct, 2021.

To comprehend the distinction between illegal and informal mining, the terminology must first be defined. It is prohibited to perform mineral exploration and extraction without a mining authority's title, authorization, or concession (Chaparro, 2009). During the artisanal mining beneficiation process, mercury forms an amalgam with gold. This enables for more effective gold amalgamation (gold separation from non-monetary materials) in artisanal mining. This is achieved by using two ways that each release a different amount of mercury into the atmosphere (Telmer and Veiga, 2009; Hylander et al.; 2007). The first method comprises crushing, grinding, and washing the material to a homogeneous consistency.

Environmentalists claim this is the most harmful approach because it takes between 3 and 50 units of mercury to make one unit of gold. When 10g mercury is used to make 1g gold, nine grammes of mercury is instantly discharged into the environment, and one gramme of mercury stays in the amalgam after the process. Second, gold-bearing material is screened or gravimetrically concentrated, where the auriferous mineral aggregates with the heavier particles in a pan and the water wash away the lighter particles. When the pan is empty, mercury is added to join or amalgamate the residual gold particles. In this case, one to two units of mercury is required to make one unit of gold. This technique adheres 85-90% of the employed mercury to the amalgamation.

Miners roast (heat) the amalgam (50% gold, 50% mercury) to retrieve the gold contained inside it. The full amount of mercury contained within the amalgam is discharged into the atmosphere when conducted outside. Retorts should be used in conjunction with other technologies to trap mercury vapour and recover up to 95% of useable mercury. These

practices are anticipated to emit 1000 tonnes of waste mercury into the environment each year, 40% of which is released into the atmosphere and 60% into soil and water bodies worldwide (Pirrone et al., 2009, Cordy et al., 2011). This extremely toxic element remains in the environment and food chain and has negative impacts on human health and welfare (Liu et al., 2012).

Mercury in its inorganic form can induce renal damage, high blood pressure, digestive issues, and acrodynia, among other things (EPA, 2007). However, methyl-mercury, an organic form of mercury, is the most toxic and lethal mercury compound. It can cause lifelong brain damage, blindness, clouded vision, deafness, ataxia, and death in foetuses, as well as neurological abnormalities and deformities (Liu et al, 2012).

Gold production is second only to fossil fuel combustion in terms of mercury emissions. The mercury released into the air during the roasting of amalgam causes respiratory issues in people who inhale it (Cordy et al. 2011). When mishaps occur, mercury is dumped into soil and water (Telmer and Veiga 2009). Mercury in the soil is believed to be absorbed by plants and subsequently enter herbivores' fruits and seeds (Eisler, 2014). Chemo accumulation occurs across the food chain and is particularly significant in predators of fish and other aquatic organisms (Liu et al., 2012). Humans receive mercury from methyl mercury-infected fish or plants cultivated on polluted soils, negatively impacting the environment and making it a potentially hazardous habitat (Eisler, 2014).

Socially, legal mining is linked to poverty and lawlessness. It is often the only means of livelihood, especially in rural areas with few economic options. In most cases, the resources required to handle the corresponding concessions or mining rights are insufficient to execute environmental mitigation strategies.

2.8 Chapter Summary

The following is the chapter's organizational structure: An introduction emphasizing the detrimental impacts of illegal mining on the ecosystem and the health of host community residents. The theoretical review focuses on the theories relating to variables and their conceptualization, as well as their application. The following section provides a high-level overview of the dimensions and indicators of the variables that are of particular interest to the researchers. The empirical review sheds additional light on illegal mining activities and their consequences around the world, particularly in developing countries, sub-Saharan Africa, and Ghana. This chapter also contains a description of a proposed integrated conceptual model for illegal mining activities, which is relevant to this chapter.

CHAPTER 3

METHODOLOGY

3.0 Introduction

It is presented in this chapter how the study was designed, including the sampling method used, the sample size, the data sources used, the data collection methods used, and the instruments used. Also emphasized are the validity and reliability of this research, the operationalisation of variables and measurements, data management, and analysis, as well as ethical considerations. The first section discusses the methods that were used for the study, data collection, and the techniques that were used to obtain all of the necessary information from the respondents. Moreover, it continues to discuss the obstacles or challenges that the researcher encountered before the completion of the study. Research methodologies are therefore concerned with the steps or processes involved in obtaining the necessary data for the study, as well as the types of research tools and procedures that will be used.

3.1 Research Design

The questions that were posed were investigated using qualitative research methods. In light of the geographic distance, time constraints, and anticipated scope of the research, extensive interviews conducted through audio recordings are the most appropriate method of gathering data for the study. In addition to data collection, questionnaires were used to gather information. Qualitative research entails the systematic collection and analysis of more subjective narrative materials through the use of procedures in which there is typically a minimum of research-imposed control, as opposed to quantitative research. Most likely, there is an existing authenticity that could be discovered and exploited in some way. Based on these

considerations, the researcher conducts a deducible examination of the predicament and thus examines the various thoughts that are relevant, based on either current concepts or his or her analysis of the phenomenon, to better understand the real-world situation.

3.2 Unit of Analysis

The mining villages of Aboso, Samahu, and Tarkwa are employed as analytical units in this study. Questionnaires were prepared and circulated to these key stakeholders to elicit information from them. The sample methodology employed in this study was a combination of stratified and purposive sampling. Since the data included a variety of characteristics about the target population, such as job location and distance to operational sites, as well as disparities in perceptions of illicit mining activities and their effect on the environment, the data was deemed representative.

Following the selection of study communities based on their closeness to one another, 147 persons were randomly selected to participate in the administration of a detailed questionnaire using the interview method, ensuring that the questionnaire was completed completely. While the sample size was justified by the fact that the study's time and resources were insufficient to cover the full area of about fifty thousand population, three settlements were chosen for additional investigation due to their relative proximity to mining sites or containment locations. Fifty (50) respondents were chosen for the questionnaire administration from localities located around 0.5-1.5 kilometres from the operational sites. This was done to determine whether there were any changes in respondents' replies regarding the consequences of illicit mining on local populations based on the distance between the sites and their houses.

This distribution resulted in a total of 147 persons. Due to the fact that the three villages chosen for this survey were not concentrated in a single region, but rather were spread throughout the municipality, the opinions acquired from the overall sample one hundred forty seven (147) respondents were a good representation of the general community.

Additionally, two (2) Environmental Protection Agency (EPA) officials and five (5) representatives from each of the participating towns were questioned. Five health care experts were interviewed to elicit pertinent information regarding the reported health issues. The information acquired included background information on respondents, awareness, perceptions, and effects of mining on surrounding communities, the health status of surrounding community residents, food security, and the status of health facilities provided to surrounding community people. Additionally, data on the mining industry as a whole was acquired.

Additionally, data on operation procedures and trash disposal activities were acquired for later examination. Similarly, data on the environmental impacts of unlawful mining activities were acquired and assessed. Apart from that, data on environmental intervention measures, as well as data on the safety and health measures implemented by some operators, were obtained and examined. Additionally, data on the operations of government agencies and organisations such as the Environmental Protection Agency (EPA), the Ghana Minerals Commission, and the Ghana Chamber of Mines in enforcing the country's anti-illegal mining laws were acquired.

3.2.1 Sampling Method

Purposive sampling strategy was utilised in this study, in which populations (chosen communities) were separated into strata (or subgroups) and random samples were taken from each selected community. A subgroup is a collection of elements that occurs naturally. Subgroups may be constructed based on a variety of characteristics, including the size of the operational site, gender, employment, or role at the operational site. Purposive sampling was used to limit the amount of variation within the population. The group was founded to ensure that each designated community is suitably represented.

3.2.2 Sample Size

In total, 147 people from the selected communities took part in the study, which resulted in the collection and analysis of information. Qualitative research entails large sample size but there is a risk of repetitive data, it was observed that adding more responses to the study does not add more information which indicated attainment of saturation for which Aboso and Tarkwa community provided fifty (50) responses to the survey and Samahu forty seven (47). The community in question was chosen as a case study because, according to literature, illegal mining operations are the primary source of income in the area. Furthermore, it contributes to the expansion of the small-scale mining industry in Ghana and West Africa as a whole. Finally, because the researcher is intimately familiar with the communities, the researcher's chosen communities are the most convenient means of obtaining information.

3.3 Sources of Data

This study gathered data from both primary and secondary sources. Primary data collection methods included field administration of questionnaires to residents of neighbouring communities and recording their responses. Several opinion leaders from the targeted communities were interviewed as part of the research, as well as representatives from governmental organisations such as the Prestea Huni –Valley Municipal Assembly, the Environmental Protection Agency (EPA), the Ministry of Lands, Forests, and Mines, the Ghana Chamber of Mines, and other non-governmental organisations (NGOs) operating in the area. Additionally, officials and employees of area healthcare facilities were contacted to gather pertinent information. A formal interview process was conducted with local chiefs and other opinion leaders.

Additionally, field observations were made at mining operation sites and other locations to ascertain the environmental impact of mining operations. Secondhand information was gathered from books, pertinent journal articles, and reports of research studies on the effects of mining operations on the surrounding communities. All of these were obtained through the University of Mines and Technology, Tarkwa's library, the Internet, and other sources such as the Environmental Protection Agency, the Ministry of Lands, Forestry, and Mines, the Ghana Chamber of Mines, and other publications from relevant non-governmental organisations (NGOs). Additionally, it was possible to collect and analyse data on diseases associated with illegal mining that were reported at various health centres in the communities' immediate vicinity.

3.4 Data Collection Methods

The questionnaire used in this study is an open-ended (semi-structured) questionnaire. These are planned in such a way that they will generate the information necessary to answer the research questions while also providing dependability and legitimacy. The thoroughness with which inquiries are conducted, as well as their relevance to the subject matter under investigation determines the efficiency of an investigation. As a result, the survey was organized logically, with straightforward questions at the beginning, followed by more difficult questions that covered the residents' perceptions of environmental impact using both structured and unstructured methodologies. My supervisor will need to provide some preliminary guidance on the representation and suitability of the questions before they can be used. Once the questionnaires are completed, they will be tested on a small number of people from the communities that have been chosen. This will help to ensure that the content is valid and that any necessary adjustments are made. After the information has been gathered, it will be analyzed and summarized to produce a final report.

3.5 Questionnaires

For this study, residents of the study communities were asked to complete an open-ended questionnaire with semi-structured interviewing questions to learn about their perceptions of how illegal mining activities have impacted the community's environment. These include questions about the consequences of air pollution, water pollution, and land degradation on human health.

3.6 Instrumentation

Qualitative designs can be considered just as systematic as quantitative designs, with the exception that they place a greater emphasis on collecting data on naturally occurring phenomena. It is necessary to search and explore various methods until a vivid understanding of the data is achieved because the majority of the information collected is in the form of words. The qualitative research design is the most appropriate for this study. It was decided to conduct this study using a questionnaire, document analysis, and semi-structured interviews. With the help of a questionnaire, it is possible to collect a high proportion of data from a large sample of people.

The questionnaire contained twenty open-ended questions about health, air pollution, water pollution, and land degradation, which served as variables, with each question requiring a unique response. Along with providing insight into respondents' frames of reference and, presumably, their motivations for responding, this prepared the way for the collecting of factual data. The second mode of data collection was semi-structured interviews. The interviews were conducted in an open-ended manner. Researchers were able to elicit firsthand knowledge from interviewees by employing open-ended interviewing strategies. Because interviews are a more effective method of data collecting, it is vital to ensure that the individual being questioned understands the research and has no preconceived beliefs about the study's outcome before conducting the interview.

According to the study, when confronted with a questionnaire, people are more ready to speak about their experiences than to write about them. Once rapport has been built with the

interviewer, the subject may be willing to give personal information that they are hesitant to put in writing. Another advantage of conducting interviews is that the interviewer can explain the investigation's goal more explicitly. Additionally, if the interviewer suspects that the questions have been misconstrued, a clarification question may be asked. Additionally, the interviewer can examine the interviewee's honesty and insight, as well as their topic area knowledge, during the interview. Additionally, the interviewer may be able to elicit the subject's insight into his or her own experiences, resulting in the discovery of crucial topics not included in the initial investigation plan.

An extensive review of relevant published documents was conducted in addition to a questionnaire and semi-structured interview. Documents are the records kept and written by actual participants in, or eyewitnesses to, an event. They are also known as primary sources. Primary and secondary sources of information may be included in documents. Eyewitness accounts are primary sources of information because they are reported by someone who was present at the event and witnessed it firsthand. Secondary sources are accounts of an event that was not witnessed by the observer in the first place (Best & Kahn, 2006). Because of the errors that can occur when information is passed from one person to another, secondary sources of data are typical of limited value for research purposes. In this study, relevant published literature was used as a source for the documents. The use of multiple methods was chosen as a means of buttressing the results to avoid bias and produce more adequate data.

The questionnaire and interview schedule were also piloted on sample groups of ten and five people from the selected communities as part of this study, which was conducted in addition.

Identical characteristics of the sample group and the study participants were found to exist. Respondents were encouraged to share their thoughts and provide feedback in both cases. The piloting process allowed researchers to gather information on whether the questionnaire takes too long to complete, whether the direction and items are clear, and whether the questions were understood. Every one of these factors contributes to the dependability and accuracy of the information gathered.

3.7 Validity and Reliability

3.7.1 Validity

The term "validity" refers to the ability to measure what is intended to be measured or to determine how truthful the findings of a research study are (Golfashani, 2013). Validity is also related to the degree to which the information gathered for a research project is accurate and complete. According to previously established theory or findings of previous studies, questionnaires were developed, and the questions were carefully and precisely worded in a way that related to the study and targeted illegal mining operators, both male and females, in various communities where illegal mining activities are their primary source of income. Two hundred questionnaires were distributed throughout the selected community, ensuring that they were representative of the entire population.

3.7.2 Reliability

A study's reliability is defined as the ability of the findings to be replicated in other studies after they have been published. It follows that if the methods used in this research are applied to other studies, similar outcomes can be obtained in both cases. The term "reliability" in

qualitative research, according to Twycross and Shields (2004), refers to the consistency of a research approach across different research studies and projects. Chakrabartty (2013) elaborates by stating that reliability is a method of determining the consistency, precision, repeatability, and trustworthiness of a research study's results. Throughout the data collection process, the importance of reliability was considered. It has been ensured that the results are precise, stable, and repeatable throughout the process.

The methods that were used were meticulously planned, and it was made certain that they were carried out in the same format for each measurement. Specifically, for interviews or observations, specific behaviours or responses were counted, and questions were phrased in the same way each time at the various communities; additionally, all questionnaires contained the same information and data collected was administered openly; and consistency was ensured from respondents to reduce the influence of external factors that can pave the way for variations in results at the various communities.

KNOWLEDGE, TRUTH AND EXCELLENCE

3.8 Operationalisation of Variables and Measurement

Illegal mining activities common in developing countries where people use traditional mechanisms instead of modernised mechanisms in their operations once set into operations poses a lot of danger to human health and the environment at large. This study is keen to analyse concepts on Health, Air, Water, Land degradation and perceptions on health and environmental impacts associated with illegal mining activities through an open-ended questionnaire. Open-ended questionnaires and observation were used in collecting primary data for this research. According to (Popping, 2015) open-ended questions do not provide

suggested answers to respondents but gives them the free will to express themselves in answering the questions. The variables for this research include; health, air pollution, water pollution and land degradation. Systematic sampling, which is a probability sampling technique was adopted in the selection of households in Aboso, Samahu and Tarkwa. Open-ended questionnaires were administered based on individuals the researcher comes into contact within the study communities. Open-ended questionnaires were used because the questions under each of the variables require in-depth responses in analyzing the problem.

Table3.1: Summary of Variable Measurement.

Variable	**Definition**	**Indicator**	**Measure**
Health	State of being free from illness or injury with a good balance that individual possesses with the social and physical environment.	Excavation serves as breeding grounds for mosquitoes	What kinds of diseases contribute much to ill-health?
		Exposure leading to complicated health issues such as bronchitis, tuberculosis and skin diseases.	The percentage growth of ill-health in the illegal mining community. What preventive measures can be used to minimize its effect?
Air pollution	Introducing a substance into the atmosphere or air has harmful effects	Dust is released into the atmosphere.	How does air pollution affect the environment?
			What diseases are contracted as a result of air pollution?
			What measures can be adopted to

	on health and the environment.		minimize its effect?
Water pollution	Introducing harmful substances often chemicals or micro-organisms which degrade water quality making it harmful to human health and the environment.	Harmful chemicals such as mercury, and cyanide disposed into streams	What activities in illegal mining contribute more to water pollution?
			What diseases are contracted most from polluted water bodies?
			What measures can we use to reduce the risk of exposure?
Land Degradation	A temporary or permanent deterioration or loss of the productive capacity of the land for present and future use.	Fertile lands are being excavated and cleared for illegal mining activities	Which activities in illegal mining degrade the land?
			What effects does illegal mining have on land?
			What measure can be used to reclaim degraded lands?

Source: Field Data, 2021

3.8.1 Data Management and Analysis

While quantitative methods provide valuable insights into the real world, qualitative research provides rich and compelling insights into the experiences and perspectives of illegal mining operations and health in ways that are completely distinct from and sometimes complementary to the knowledge we can obtain through quantitative methods. When conducting this research, thematic analysis is a good approach because the researchers are interested in learning about people's opinions, knowledge, and experiences related to illegal mining operations and their impacts on the environment and health from some selected communities. This will be accomplished through a set of survey responses from an open-ended questionnaire that will be analyzed. The thematic analysis gives you a great deal of flexibility in how you interpret the data, and it also allows you to approach large data sets more easily by categorizing them into broad themes (Clarke & Braun, 2013).

It is the most common type of analysis in qualitative research and is also the most time-consuming. It emphasises identifying, examining, and recording patterns or themes within data sets. Themes are patterns that appear in multiple data sets and are useful in analyzing research works or describing a phenomenon that is associated with a specific research project or study. Thematic analysis was carried out through the process of coding, in which the themes generated are transformed into categories of analysis. The process of coding is divided into six major phases, each of which helps to create well-meaning patterns.

3.9 Ethical Consideration

When it comes to ethical issues, they refer to the socio-cultural and psychological concerns, dilemmas, and conflicts that must be considered throughout the research process; these can include issues such as confidentiality, inconspicuousness, and privacy, among others. The study was entirely conducted through the use of an open-ended questionnaire, and the background to the research as well as the purpose of the study was thoroughly explained. The ethical concerns were addressed effectively through the use of informed consent, which is an ethical principle.

3.10 Chapter Summary

The first section addresses the data collection methods utilised in the research, as well as the approaches employed to elicit all necessary information from the respondents. Thus, research methodology is concerned with the process or processes, as well as the sorts of research tools and procedures that must be followed to collect the data essential for conducting a study. The purpose of this study is to ascertain the environmental effects of illegal mining operations on the environment and health of residents of Aboso, Samahu, and Tarkwa.

CHAPTER 4

RESEARCH FINDINGS AND DISCUSSIONS

4.0 Introduction

The research methodology that was used to carry out this study during the data collection phase was discussed in the chapter that came before it. It is presented in this chapter, along with the themes that emerged from the qualitative interviews conducted as part of the research. An explanation of the interviews and methods used to manipulate the data are included in this chapter. It is also presented, along with a discussion of the various thematic areas, a summary is provided at the end of the chapter.

4.1 Presentation of Data

Survey and interviews were conducted in the selected communities between February and April of the year (2021). The interviews lasted 20-40 minutes, and some were recorded on a digital tape recorder. Summary notes were taken to aid in the identification of themes in the in-depth interviews, which were conducted after the summary notes were completed. Because the interviews were geared toward answering research objectives, a total of 147 interviews were conducted as part of the process. The interviews were transcribed and typed out in real-time as they happened. The interviews were backed up by secondary data, which helped to strengthen the overall analysis. One important aspect of this was the coding and organization of the data into four themes to aid in the analysis process. Throughout this chapter, the findings of the interviews are discussed. Participant codes were provided to aid in the analysis process because personal information, such as positions, was intentionally omitted to protect

their privacy and to meet the requirements of social research ethics. These codes served to represent the participants' identities and to aid in the analysis process.

4.2 Demographic Information of Respondents

147 interviews were conducted in total, accounting for 73.5% of the total number of questionnaires distributed. First and foremost, some respondents were representatives of the mineral commission, which is responsible for policing illegal mining activities and enforcing the country's mining policies. In addition, opinion leaders from the study's target communities were interviewed for information pertaining to the study. According to the data, the average number of years spent engaging in illegal mining activities was 24.7 years, indicating that the next generation is at risk. The lowest and highest levels of education were junior high school and a first degree, respectively, according to the data. The findings also revealed that age and education are not related to the role illegal miners play in their operations; twenty-seven (27) illegal miners obtained their first degree at an average age of 25.8 years, with the majority of them completing their education in junior and senior high school. Males accounted for 92.52% of the total sample size of one hundred forty-seven (147), with 136 respondents representing 92.52% of the total sample size. Females accounted for 7.48% of the total sample size. The sample was skewed because the target population and the unit of analysis are predisposed to male dominance in illegal mining operations, which resulted in a skewed distribution of the sample. The issue of male dominance is not new in the context of Ghana, owing to the cultural and environmental factors that place women and children at a distinct disadvantage (See Table 4.1 and 4.2 below).

Table 4.1: Age Distribution of Respondents

Age	Males	Percentage	Females	Percentage
17-25	30	22.05	6	4.08
26 -33	65	47.79	5	3.40
34-42	22	16.17	0	-
43-51	15	11.03	0	-
Above 60	4	2.94	0	-
Totals	136	92.52	11	7.48

Source: Field Data, 2021.

Table 4.2: Education and Number of Working Years.

Education	Males	Females	No. of working Years	No. of Males	No. of Females
J.H.S	23	7	1-5	71	11
S.H.S	86	4	6-10	60	0
TERTIARY	27	0	Above 10	5	0
Totals	136	11		136	11

Source: Field Data, 2021.

4.3 Presentation of Interview Data and Thematic Areas

Presentation of Interview Thematic Areas

The purpose of this section of the report is to provide an overview of the 147 interviews that were conducted during the two months of data collection. Following are the themes that emerged from the responses to the questions posed during the in-depth interviews sessions, which were derived from the 147 interviews conducted. During the analysis process, this is

particularly important because the transcripts' details will be included as an appendix to the final report, which will aid in the analysis process. In this study, the major themes were coded, and subjective decisions about the four (4) counts of each theme were used to form the basis for an emerging major thematic area that was then discussed in more detail in the findings section. The major themes are presented in the order in which the data suggests they should be prioritized. Thematic areas are further examined and discussed in conjunction with the sub-questions of the study's objectives, which are discussed in parallel (See Table 4.3).

Table 4.3: Responses from the Selected Communities.

ID	Question Number	Response	Themes	Freq
01	2	Fetus deforming during gastrulation and neurulation	Health Concern	1 of 147
02	3	Upper respiratory tract infections such as tuberculosis, bronchitis	Health Concern	29 of 147
03	4	Digging of ponds for leaching	Land degradation	10 of 147
04	3	Inhalation of dust mixed with harmful chemicals	Health Concern	16 of 147
05	2	Crushing of ore in open space	Air pollution	10 of 147
06	5	Breeding grounds for typhoid and diarrhea	Health Concern	25 of 147
07	2	Sexually Transmitted Infections example .HIV, Gonorrhea	Health Concern	20 of 147
08	4	Digging and washing ore in streams	Water pollution	19 of 147
09	4	Farm lands turned into leaching ponds	Land degradation	15 of 147
10	2	Crushing of ore with changfa	Air pollution	11 of 147
11	3	Farm lands turned into leaching ponds	Land degradation	15 of 147
12	2	Malaria due to stagnant ponds at sites	Health Concern	60 of 147

13	4	Washing of waste into streams	Water pollution	19 of 147
14	4	Leaching ore near streams	Water pollution	20 of 147
15	2	Exposing people to harmful chemicals	Health Concern	21 of 147
16	1	Rising cases of coughs and tuberculosis	Air pollution	18 0f 147
17	2	Dust from crushing ore	Air pollution	10 of 147
18	4	Washing ore in streams	Water pollution	18 of 147
19	4	Clearing farmlands for leaching ponds	Land degradation	21 of 147
20	4	Leaching near streams	Water pollution	20 of 147
21	4	Digging ponds for leaching	Land degradation	20 of 147
22	2	Clearing farmlands for changfa sites	Land degradation	15 of 147
23	3	Fertile lands used as stock piles	Land degradation	15 of 147
24	3	Clearing farmlands for ponds	Land degradation	15 of 147
25	2	Crushing materials in open space	Air pollution	10 of 147
26	2	Deforestation due to changfa sites	Land degradation	15 of 147
27	5	Colds and coughs due to inhalation of harmful chemicals	Health concern	8 of 147
28	2	Dust released during crushing of ore	Air pollution	10 of 147
29	2	Ponds breeds mosquitoes	Health concern	60 of 147
30	2	Ponds leads to massive erosions	Land degradation	6 of 147
31		Dust during crushing of materials	Air pollution	10 of 147
32	2	Discharging harmful chemicals in streams	Water pollution	21 0f 147
33	2	Crushing of ore in open space	Air pollution	10 of 147
34	4	Deforestation	Land degradation	15 of 147
35	4	Digging of ponds for leaching	Land degradation	20 of 147
36	2	Cyanide and mercury released into streams	Water pollution	21 of 147
37	2	Washing of waste into streams	Water pollution	
38	5	Ponds resulting in massive erosions	Land degradation	6 of 147
39	2	Dust released from crushing of ore	Air pollution	10 of 147
40	2	Skin infections due to exposure to	Health concern	25 of 147

		harmful chemicals		
41	3	Malaria due to ponds breeding mosquitoes	Health concern	60 of 147
42	2	Colds and coughs due to exposure to dust	Health concern	8 of 147
43	1	Pregnant women being exposed to harmful chemicals	Health concern	21 0f 147
44	3	Farmlands being cleared for leaching sites	Land degradation	15 of 147
45	3	Ponds dug floods and destroys farms	Land degradation	15 of 147
46	5	Deforestation due to leaching sites	Land degradation	15 of 147
47	2	Release of dust into open air	Air pollution	10 of 147
48		Crushing ore without suppressing dust	Air pollution	10 of 147
49	3	Harmful gases released during leaching process	Air pollution	10 of 147
50	4	Discharging harmful chemicals into streams	Water pollution	21 0f 147
51	2	Digging of ponds for leaching ore	Land degradation	20 of147
52	3	Dug ponds breeds mosquitoes	Health Concern	60 of 147
53	1	Skin rashes due to exposure to harmful chemicals	Health Concern	25 of 147
54	4	Pregnant women being exposed to harmful chemicals	Health Concern	21 0f 147
55	3	Farmlands being destroyed	Land degradation	15 of 147
56	2	Harmful chemicals being released into streams	Water pollution	21 of 147
57	1	Inhalation of chemicals after blasting	Health Concern	16 of 147
58	3	Crushing of materials at changfa sites	Air pollution	10 of 147
59	2	Washing of waste back into streams	Water pollution	19 of 147
60	1	Skin rashes due to exposure to harmful chemicals	Health concern	25 of 147

61	2	Washing of waste back into streams	Water pollution	19 of 147
62	1	Harmful gases are released into open air during leaching	Air pollution	10 of 147
63	1	Inhalation of harmful gases after blasting	Air pollution	16 of 147
64	2	Discharging of cyanide into streams	Water pollution	21 of 147
65	2	Washing of crushed ore in streams	Water pollution	19 of147
66	3	Water in ponds breeds mosquitoes	Health concern	60 of 147
67	4	Farmland cleared for leaching sites	Land degradation	15 of 147
67	2	Dust released into air during crushing of ore.	Air pollution	10 of 147
68	1	Skin rashes due to exposure to chemicals	Health Concern	25 of 147
69	2	Discharging harmful chemicals into streams	Water pollution	21 of 147
70	2	Washing of ore near streams	Water pollution	19 of 147
71	4	Farmlands being cleared for leaching sites	Land degradation	15 of 147
72	1	Skin infections due to contact with contaminated streams	Health Concern	25 of 147
73	3	Constructing changfa crushers along river banks	Water pollution	19 of 147
74	1	Pregnant mothers being exposed to harmful chemicals	Health concern	21 of 147
75	4	Lack of ventilation during blasting	Health concern	16 of 147
76	3	Ponds breeds mosquitoes resulting in malaria	Health concern	60 of 147
77	2	Discharging waste into streams	Water pollution	19 of 147
78	2	Release of cyanide and mercury into streams	Water pollution	21 of 147
79	2	Not suppressing crushed materials	Air pollution	10 of 147

80	4	Diverting streams for washing ore	Water pollution	3 of 147
81	1	Skin rashes due to contact with contaminated water	Health concern	25 of 147
82	2	Washing of waste back into streams	Water pollution	19 of 147
83	3	Discharging of cyanide and mercury into streams	Water pollution	21 of 147
84	3	Coloration of streams	Water pollution	19 0f 147
85	1	Colds due to inhalation of harmful chemicals.	Health Concern	8 of 147
86	3	Malaria due to ponds breeding mosquitoes	Health Concern	60 of 147
87	2	Dust released to open air during crushing.	Air pollution	10 of 147
88	5	Colds and coughs due to inhalation of dust	Health concern	8 of 147
89	2	Dust released from crushing sites	Air pollution	10 of 147
90	3	Coloration of streams	Water pollution	19 of 147
91	4	Gases released during leaching	Air pollution	10 of 147
92	3	Ponds breeds mosquitoes	Health Concern	60 of 147
93	1	Skin rashes due to contact with contaminated streams	Health Concern	25 of 147
94	4	Deforestation due to site creation	Land degradation	15 of 147
95	2	Washing ore in streams	Water pollution	19 of 147
96	2	Washing waste into streams	Water pollution	19 of 147
97	1	Exposing pregnant mothers to harmful chemicals	Health Concern	21 of 147
98	1	Exposure to harmful chemicals	Health Concern	21 of 147
99	4	Excavations leads to massive erosions	Land degradation	6 of 147
100	4	Top soil being cleared away	Land Degradation	15 of 147
101	2	Releasing dust from crushing ore	Air pollution	10 of 147
102	2	Leaching near streams	Water pollution	19 of 147

103	1	Exposure to harmful chemicals	Health Concern	21 of 147
104	4	Rampant excavation leading to massive erosions	Land degradation	6 of 147
105	4	Deforestation due to opening of new sites	Land degradation	15 of 147
106	2	Discharging leaching waste into streams	Water pollution	19 of 147
107	1	Release of harmful chemical into air	Air pollution	21 of 147
108	1	Skin rashes due to exposure to chemicals	Health Concern	25 of 147
109	1	Exposure to cyanide and mercury	Health concern	21 of 147
110	2	Burning ore mixed with zinc during leaching	Air pollution	21 of 147
111	2	Discharging cyanide and zinc into streams	Water pollution	19 of 147
112	4	Erosion due to ponds being dug and collapse after blasting	Land degradation	6 of 147
113	3	Chemicals causing skin rashes and pillars collapse during blasting	Health concern	25 of 147
114	4	Farm lands cleared for ponds	Land degradation	15 of 147
115	4	Clearing farm lands for stock piles	Land degradation	15 of 147
116	2	Dumping harmful chemicals into streams	Water pollution	19 of 147
117	2	Washing of ore near streams	Water pollution	19 of 147
118	3	Ponds breeding mosquitoes	Health Concern	60 of 147
119	3	Exposure to cyanide and mercury and blasting chemicals	Health Concern	21 of 147
120	2	Not suppressing dust at sites	Health concern	10 of 147
121	2	Discharging cyanide into streams after leaching ore	Water pollution	19 of 147
122	2	Dumping of waste into streams	Water pollution	19 of 147

123	2	Leaching ore into streams	Water pollution	19 of 147
124	2	Dust from crushing ore	Air pollution	10 of 147
125	4	Drying ore mixed with chemicals	Air pollution	21 0f 147
126	3	Not suppressing dust during crushing	Air pollution	10 of 147
127	2	Crushing or in open space	Air pollution	10 of 147
128	2	Washing ore into streams	Water pollution	19 of 147
129	2	Setting leaching sites near streams	Water pollution	19 of 147
130	2	Discharging mercury into streams	Water pollution	19 of147
131	2	Washing chemicals into streams	Water pollution	19 of 147
132	4	Farm lands as storage grounds for ore.	Land degradation	15 of147
133	5	Breeding grounds for cholera and typhoid	Health concern	22 of 147
134	2	Chemicals causes skin diseases	Health Concern	25 of 147
135	4	Using farm lands as stock piles	Land degradation	15 of 147
136	4	Pulling down trees as site with no safety standards	Land degradation	15 of 147
137	3	Clearing for washing set-up	Land degradation	15 of 147
138	2	Crushing of ore in open space	Air pollution	10 of 147
139	3	Roasting ore in open space	Air pollution	10 of 147
140	2	Crushing ore in open air	Air pollution	10 of 147
141	5	Washing of mercury into streams	Water pollution	19 of 147
142	3	Leaching into streams and poor maintenance of equipment	Water pollution	19 of 147
143	4	Digging of ponds for leaching and license issues	Land degradation	19 of 147
144	3	Washing of ore into streams	Water pollution	19 of 147
145	2	Skin infections due to contact with chemicals and ground failures	Health Concern	25 of 147
146	2	Malaria due to ponds breeding mosquitoes	Health Concern	60 of 147
147	2	Inhalation of dust	Health Concern	10 of 147

4.3.1 Objective One;

The interview transcript showed that seven major themes were predominant in the three selected communities.

No.	Themes	Responses	Freq
1	Exposure to harmful chemicals (mercury, cyanide)	Chemicals are disposed into nearby streams	21 of 147
2	Ground failures	Pits collapse after blasting due to weak supports.	20 0f 147
3	Dust from crushing of materials.	We inhale the dust because there is no dust suppressing system	10 0f 147
4	Slip and fall	When carrying materials from underground	70 of 147
5	Struck by falling Objects	Loose rock and tools hit us underground	30 of 147
6	Machinery and tools (leakages,)	Poor maintenance carried on compressors and other equipment	20 of 147
7	Breeding grounds (Malaria, Typhoid)	Stagnant water in ponds and diverted streams serve as breeding grounds	60 of 147

Source: Field Data, 2021.

The use of various forms of personal protective equipment (PPE) among workers is tabulated below. The attitude of workers on the use of protective equipment is very low and this exposes them to all forms of dangers during operations which is the case among illegal mining activities. The commonest personal protective equipment used were safety boots representing 34.01% followed by helmet and hand gloves representing about 13.60%, dust masks representing 17% ear protectors representing about 10.88% safety glasses were the least

utilized PPE which was about 8.16%. Production targets set by "ghetto owners" are associated with an increased risk of injury during operations. The desire to achieve targets set makes individuals disregard safety rules which put their health and the environment at risk.

Table 4.4:Results on use of Personal Protective Equipment (PPE).

Type of PPE	Frequency	Percentage
Hand Gloves	20	13.60
Helmet or hard cap	20	13.60
Safety glasses	12	8.16
Work boot(steel toe, chemical resistance)	50	34.01
Ear protection(Ear plugs, Ear muff)	16	10.88
Dust Mask	25	17.00
Reflectors around dug pits	4	2.72

Source: Field Data, 2021.

Due to the risky nature of the illicit mining environment, workers must be vigilant and adhere to safety requirements. Underground illegal miners confront the dangers of pit collapse and slippery terrain. They lack the financial means to construct concrete walls or pillars to keep boulders from falling or pits from collapsing; instead, they block loose rocks with logs or bamboo sticks. Prevalent injuries reported was slip and fall which recorded 47.62% followed by struck by falling objects which accounted for 20.04%, the use of machinery and tools accounted for (13.60%), fall from height accounted for 11.56% and about seven 6.80% resulting from burns as a result of blasting misfire.

Table 4.5: Results on Risk and its Mechanism of Injury

Mechanism of Injury	Frequency	Percentage
Burns	10	6.80
Machinery or tools	20	13.60
Struck by falling Object	30	20.04
Fall from height	17	11.56
Slip and fall	70	47.62

4.3.2 Objective Two

The interview transcripts showed that six major illnesses were prevalent in the three selected communities under study.

Number	Prevalent illness in selected communities	Freq
1	Upper Respiratory Infections	29 of 147
2	Skin Infections	25 of 147
3	Malaria	60 of 147
4	Colds and Catarrh	8 of 147
5	Typhoid	22 of 147
6	Diarrhoeaa	3 of 147

Source: Field Data, 2021.

Upon further analysis on the responses from the selected communities (Aboso, Samahu and Tarkwa) it was found that residents suffer from malaria, skin diseases, diarrhoea, typhoid fever, colds and catarrh. Malaria accounted for about 40.82% to be the prevalent illness, followed by respiratory infections represented about 19.73%, skin infections represented

17.00%, typhoid fever recorded about 14.97%, diarrhoea, cold and catarrh recorded 2.04% and 5.44%.

Table 4.6: Results of Prevalent Illness within Selected Communities.

Prevalent illness	**Frequency**	**Percentage**
Malaria	60	40.82
Skin infections	25	17.00
Upper Respiratory Infections	29	19.73
Typhoid fever	22	14.97
Diarrhoea	3	2.04
Colds and Catarrh	8	5.44

Source: Field Data, 2021.

4.3.3 Objective Three

The table below indicates the perceptions of the interviewees on the measures to minimize the environmental impacts of illegal mining on the environment and well-being of individuals in selected mining communities. A critical look at the table depicts that 52.38% of the total interviewee agree with the public awareness by the ministry of lands and natural resource in collaboration with local authorities to educate the masses well on effects and means to minimize illegal mining activities and it was followed by 27.21, % who expressed their views that the ministry has to enforce foreign investors to carry out proper mining by respecting the rules and regulations governing mining activities in Ghana. Additionally, the respondents representing 14.97% of the total respondents approved the intervention of security agencies to prevent illegal mining as a measure to minimize illegal mining and its associated impacts this

is for capturing and punishing those who carry out illegal mining activities in the reserved forest, along river banks and 5.44% representing those who support reclaiming the land after operations, this will surely minimize the negative impacts that occur due to illegal mining, as a result, the environmental and health conditions of people living around mining communities will be improved and sustained.

Table 4.7: Results on Measures to Minimize Illegal Mining Activities.

Measures	**Frequency**	**Percentage**
Public education on illegal mining.	77	52.38
The intervention of security agencies to prevent illegal mining.	22	14.97
Attracting foreign investors to carry out a proper mining	40	27.21
Reclamation practices	8	5.44

Source: Field Data, 2021.

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4.4 Discussion Of Findings

Objective One: To identify the Environmental Risk Factors Associated with illegal mining activities.

Globally, there is a growing awareness of unlawful mining activities and the accompanying health and environmental dangers. According to anecdotal evidence, illegal mining activities offer more occupational hazards than well-regulated mining enterprises (Calys-Tagoe, et al., 2017). According to the investigation, several themes emerged among illicit miners in the

targeted localities that put them in danger during operations. The investigation discovered a dearth of occupational safety regulations.

Interviewee95 affirms that *"Changfa crushers are being operated without any safety measures in place, operators do not put on a dust mask, goggles and earplugs"* It was also observed from all the three communities that there was moderate use of hard steel boots but low use of other personal protective equipment which puts operators at risk resulting in several injuries. Illegal miners who acquire equipment's for their operations are not technically inclined they tend to poorly maintain their equipment a result causes leakages which pollutes the environment.

Interviewee142 elaborated that *"Most compressor machines used are not properly maintained resulting in oil hoses leakages which are washed into nearby streams"*. The tools and equipment used in illegal mining activities are largely manual and are constructed with poor safety safeguards. As a result, workers who used this manual equipment sustained more serious injuries than those who used advanced technology. However, according to Michelo's (2009) study, the most common cause of mortality among illegal miners is rockfall. Due to the risky nature of the illicit mining environment, workers must be vigilant and adhere to safety requirements. Underground illegal mining companies confront the dangers of pit collapse and treacherous terrain.

Interviewee113 elaborated more that *" Most pillars underground are weak and sometimes collapses during blasting resulting in severe injuries and at times death occurring"*. They

lack the capital necessary to create concrete walls or pillars to prevent falling boulders or collapsing pits; instead, they utilise logs or bamboo sticks to block falling rocks. Mechanization is extremely low in illegal mining activities, and the equipment utilised lacks adequate safety measures. Additionally, the techniques employed in clandestine mining operations are obsolete, exposing workers to danger and health risks (Teschner, 2012). The majority of the tools and equipment used in illegal mining are operated manually. According to Chimamise et al. (2010), in a well-established mining environment, humanly operated equipment poses more dangers than automated equipment.

From the field observation, it was observed from all the three communities that the land is degraded by excavations for which most are not backfilled which traps the workers resulting in severe injuries and at times the death of innocent children and interviewee120 elaborated much on *"illegal mining activities are normally done by people with no regard to safety they dig holes near streams and wash crushed materials mixed with toxic chemicals into them without backfilling"* which endangers the environment and put the workforce at risk.

Table 4.8: Summary on Risk and its Mechanism of Injuries during Illegal Mining Operations.

Mechanism of Injury	Frequency	Percentage
Burns	10	6.80
Machinery or tools	20	13.60
Struck by falling Object	30	20.04
Fall from height	17	11.56
Slip and fall	70	47.62

Source: Field Data, 2021.

Table 4.9: Summary on Use of Personal Protective Equipments.

Type of personal protective equipment	Frequency	Percentage
Hand Gloves	20	13.60
Helmet or hard cap	20	13.60
Safety glasses	12	8.16
Work boot(steel toe, chemical resistance)	50	34.01
Ear protection(Ear plugs, Ear muff)	16	10.88
Dust Mask	25	17.00
Reflectors around dug pits	4	2.72

Source: Field Data, 2021.

The risk associated with the use of manual equipment is prevalent by lack of PPE use. The low reported PPE use in selected communities is consistent with findings of other studies of illegal mining operations in Ghana and Sub-Saharan Africa. Moreover, the injuries associated with the risk could have been prevented or minimized by the higher use of personal protective equipment.

Objective Two: To examine the environmental impacts of illegal mining and their effects on the health of individuals in mining communities.

One of the problems associated with unlawful mining is indiscriminate excavation. These excavations are frequently death traps, posing a threat to human and animal life in communities where illegal mining occurs. According to the literature, these shallow and deep pits caused by illegal mining activities are not dissimilar to what occurs in the three selected localities. Here is what an interviewee115 from the Minerals Commission said *"Illegal mining operations have been defined by open pits swarmed by inexperienced adolescents confidently*

digging for gold to sell, oblivious to the dangers posed to themselves, the community, and the environment." Illegal mining operators often use simple tools and equipment such as a pickaxe, shovel, hammer, and chisel. Another interviewee17 from the Minerals Commission explained that *" illegal mining is done without any safety measure being put in place despite its dangers resulting in severe health problems which affect the operators and the environment at large"*.

The most noticeable effect of illegal mining activities is certainly environmental degradation (Siswanto et al., 2012). Illegal mining generally results in some kind of environmental damage (Tom-Dery et al., 2012). However, the activities of illegal mining operators are noted to pose a massive threat to the environment than the certified mining operators (Asiedu, 2013). This is because, illegal mining operators do not embark on reclamation and lack environmental safety education (Ontoyin and Agyeman, 2014; Essumang, 2015) and therefore destroy the environment, for which some are, gully erosion, removal of soil layers, land left with piles of waste tailings, shallow and deep dug-out pits, river siltation, encroachment and destruction of farmlands, pollution with chemicals (Ako et al., 2014; Rajaee et al.,2015).

The study's findings revealed significant environmental degradation, particularly in Aboso and Tarkwa, where extensive illegal mining is occurring. After unlawful mining activity at numerous concessions, large pits were excavated and not backfilled. As indicated in the literature, this has transformed the places into death traps for both humans and animals (Ofosu-Mensah and Ababio, 2011). Additionally, the dug holes and pits are filled with rainwater, providing a breeding environment for mosquitoes (Arthur, et al., 2016). These

trenches covered a bigger region, and one can see vividly how much land was lost to illicit mining. Again illegal mining involves clearing the topsoil from an area of operation and accumulating it into heaps. During operations (Asiedu, 2013), which invariably wastes the topsoil. Observation from the various operational sites showed that valuable topsoil at the various study areas had been removed. This removal of the topsoil has rendered the land unproductive for plant growth (Mensah et al., 2015).

Water pollution was one of the visible impacts on illegal mining communities. According to Amankwah, (2013), this pollution came from indiscriminate use of chemicals for gold extraction, washing of ores in streams and rivers, discharging of waste and into water bodies, heavy metal pollution from leakages and other illegal activities which affect the streams and rivers being used. It was observed a high level of turbidity in water bodies in all the three communities under study which is an indication of the presence of silt, suspended materials, fine and coarse organic materials and other inorganic and organic materials (Gyang and Ashano, 2010). This could be due to the washing of ore directly into the streams and run offs from the degraded lands, which added a lot of soil into the water bodies causing the high turbidity (Cobbina et al., 2013; Mudyazhezha and Kanhukamwe, 2014).

Interviewee 95 expressed his view that *"Most water bodies at Aboso such as "Nsukese" had a lot of fish which used to be sources of livelihood for the people but the use of toxic chemicals in illegal mining activities have made it change colour and unsafe for domestic purposes"*. Mercury and cyanide were identified as the main chemicals used by the illegal miners which are known to be the main chemical used in traditional gold mining (Soelistijo and Mili, 2014).

This chemical pollutes water bodies and land as well which endangers the lives of people in the communities. The mercury vapour and its converted methyl mercury are noted to bio-accumulate in vital organs of fishes and humans when entered into rivers or streams and the food chain (Idowu, et al., 2013).

Because illegal miners are unaware of the dangers of mercury, they expose themselves and their communities to the fatal consequences of mercury through inhalation, skin absorption, and ingestion. Interviewee01 who is a nurse from the Aboso health centre expressed *"Malformations during the embryologic period in the formation of the fetus during pregnancies example is fetus deforming during gastrulation and neurulation period due to harmful chemicals exposed to pregnant women who work at illegal mining sites as labourers"* and Interviewee04 expressed this view in strong terms as *"inhalation of dust that contains harmful chemicals resulting in severe health problems such as lung infections and bronchitis"*.

The research revealed that ailments such as malaria, skin disorders, diarrhoea, typhoid fever, tuberculosis, colds, and catarrh were prevalent in the targeted communities where respondents' perspectives were gathered. Malaria accounted for around 40.8% of the illnesses or diseases typically contracted by residents of the research area, followed by respiratory tract infections at nineteen 19.73% and skin-related diseases at 17. Typhoid fever accounted for approximately 15% of the diseases typically contracted by respondents in the selected communities, whereas diarrhoea and other disorders accounted for approximately 7.48%.

As a result, malaria remains the most prevalent disease in every community surveyed. The Aboso settlement, which is located within an abandoned Aboso Goldfields mine and is heavily dependent on rock blasting and changfa crushers, had the greatest rate of cold or cough, accounting for around 53% of all replies. Skin-related disorders were most frequently reported by those from Aboso, who accounted for 25% of replies, followed by Tarkwa, who accounted for 20%, and Samahu, who accounted for roughly 2%. The study in Aboso showed that the primary cause of skin illnesses was the contamination of water sources with dangerous chemicals during leaching operations, which some inhabitants still rely on for drinking, food, and other household functions.

According to some researchers, the high prevalence of malaria is due to diverting water bodies which has become prevalent within selected communities, as mosquitoes are capable of migrating from areas of high breeding to other parts of the community, provided they can find choked gutters and stagnant waters, such as ponds, for further breeding. The health consequences of illicit mining in the study communities, such as malaria, colds and coughs, and skin illnesses, are also worth noting. Such emotions diminish as one goes further away from the concessions. As a result, there is little doubt that the increase in the prevalence of these diseases is a result of the many types of pollution seen in communities, as previously described.

To substantiate this, health workers, including medical officers and nurses, were interviewed at various health centres throughout the selected communities (Aboso, Samahu, and the Tarkwa government hospital). They stated that the high rates of malaria, tuberculosis,

bronchitis, skin diseases, cough, and cold among patients were all caused by illegal mining activities in their communities (Aboso, Samahu, and the Tarkwa government hospital). As a result of the responses of respondents from all of the selected communities, it is possible to conclude that the high prevalence of malaria in the selected communities is the result of mosquito breeding in polluted water courses and stagnant waters, as well as leaching ponds created as a result of illegal mining activities. Respiratory illnesses could have been induced by air pollution caused by the discharge of dust mixed with other harmful compounds into the atmosphere as a result of material crushing. Skin disorders, typhoid fever, and diarrhoea have been connected to contaminated rivers, streams, and other water bodies that provide drinking water to residents in some portions of the selected communities.

Results from the field observations in the selected communities revealed that streams are being diverted in the communities such as river Bonsa and Huni, which used to serve as the main sources of water for domestic purposes by the communities that had been heavily polluted by illegal mining activities as expressed by interviewee09.*" illegal mining activities have rendered our main source of drinking water now deadly by putting in mercury and other illegal mining chemicals which recently killed two cows few minutes after drinking water from Nsukese stream"*. He indicated that cyanide spills and leakages by illegal mining activities through illegal gold leaching processes resulted in polluting the Nsukese stream at Aboso and its nearby water bodies, This led to a significant loss of aquatic organisms, depletion of livelihood and drinking water for nearby communities.

Table 4.10: Summary of Prevalent Illness within Selected Communities

Prevalent illness	**Frequency**	**Percentage**
Malaria	60	40.82
Skin infections	25	17.00
Upper Respiratory Infections	29	19.73
Typhoid fever	22	14.97
Diarrhoea	3	2.04
Colds and Cattarh	8	5.44

Source: Field Data, 2021

Concerning impacts on land, the study found out that a greater proportion of the landmass has been rendered bare due to illegal mining activities. Large tracts of land in the selected communities such as Aboso Goldfields, Tarkwa Banso, Ajah Bippo among others, have lost their vegetation cover and farmlands as a result of illegal mining activities. This leads to, heavy erosion resulting in loss of land productivity. According to interviewee19,*" the land cannot be used for agricultural purposes because of the heavy erosions created on them"*. This has lead to the destruction of the vegetation, farms and surrounding water bodies. Interviewee26 also adds that *"Illegal mining has been responsible for the removal of vast quantities of vegetation and mass deforestation in selected communities making agricultural activities a non-lucrative venture"* in the community. Illegal mining activities are being carried out without considering the health and environmental impacts it poses for which the study has addressed.

Objective Three: To determine the measures that can be adopted to minimize the effects of illegal mining activities on the environment and health of individuals in miming communities.

From the analysis some themes were identified during operations and the following measures can be adopted to minimize its effect. The study found a very low level of workplace safety protocols, Illegal mining operators do not regard any health and safeguarding the environment protocols during operations which endangers the communities. Interviewee 136 elaborated on *"Most illegal mining operators have to be safety conscious whiles working to reduce environmental pollution by so doing safeguarding their health".*

Acquisition of licenses should be effectively decentralized to the District Offices to make the processes less bureaucratic and cheaper to enable illegal miners to acquire concessions to minimize illegal mining and its consequences interviewee143 affirms that*"Most illegal mining operators are ready and would like to acquire licenses but the partisan and bureaucratic nature attached to the process scares them away"*

The Ghana National Association of Small Scale Miners (GNASSM) should be proactive and effective in promoting the importance of obtaining a license, as well as organizing training programs on environmental sustainability, the importance of working safely, and the effects of mercury pollution. Programs to promote direct smelting should be initiated, and the Direct Smelting method should be vigorously supported and promoted by the environmental protection agency. To mitigate the environmental impacts of illegal mining, it is critical to conduct educational campaigns that educate both illegal mining operators and affected communities about the extent of the damage. It is critical to educate them about the benefits of

more technologically efficient mining and extractive practices that maximize mineral recovery while minimizing environmental degradation.

All relevant ministries, the Minerals Commission, the environmental protection agency, non-governmental organizations (NGO's), the Municipal Assembly, chiefs and prominent locals at festivals and durbars, as well as educational institutions, should conduct such educational campaigns jointly and severally. Delineation of ore zones via exploration may be undertaken by government-sponsored institutions such as universities and the Geological Survey Department. This will help to reduce the haphazard and indiscriminate mining that is characteristic of illegal mining operations. Through education, the Ministry of Health, religious organizations, schools, corporate organizations, and community leaders can all contribute to mitigating negative environmental impacts. These educational campaigns should address the effects of pollution, the effects of land degradation, and the importance of workplace safety protocols.

Community members require education about environmental and health hazards, such as water pollution and land degradation caused by illegal mining operations, to mitigate illegal mining's adverse effects on the health of mining communities and the surrounding environment (Mihaye, 2013).

4.5 Chapter Summary

This chapter discussed the findings from the interviews conducted to address the study's research objectives. To aid in the analysis, the interviews were first coded and transcribed. Second, the study's primary demographic variables were age, gender, the highest level of education, and years in operations. The discussions included a section on presenting the findings by grouping the interviews into major themes for further analysis. The health and environmental consequences of illegal mining activities are briefly discussed, as are some of the factors that contribute to persistent environmental degradation in selected communities.

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CHAPTER 5

SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.0 Introduction

This chapter of the study summarizes the entire study, makes conclusions based on the results of the study, and then makes recommendations to policy, practices and further research. The study focuses on assessing the environmental impacts of illegal mining activities on the health of individuals in some selected mining communities in Ghana.

5.1 Summary of Major Findings

Illegal mining activities are carried out on an individual basis, with the majority of them being carried out by people with little technical knowledge or access to mining equipment. A large number of people are involved in illegal mining activities, either directly or indirectly. The majority of these people are not miners by trade, but they are forced to do so out of necessity, putting their health and the environment at risk. Different groups of people have different perspectives on illegal mining, and these perspectives differ from one another. Even though Ghana's economy is primarily agricultural, many illegal mining operators profit from and rely entirely on illegal mining. These illegal mining operators, through their activities, sought to advance their economic gain at the expense of the negative impact on their health and the environmental consequences of their actions. The following is a summary of the research findings.

Objective One: In the case of illegal mining activities, there is a slew of broader environmental and public health issues that deserve to be addressed, which has led to this practice being classified as high risk due to the dangers it poses to the environment and to many individuals who engage in it out of a need to make a living. Under Table 4.3.1, illegal mining activities pose a significant risk to the workforce and the environment as a result of the risky mining practices employed by these illegal miners, which pose significant health and environmental threat. The fact that the majority of these miners do not wear protective equipment such as safety glasses, dust masks, hand gloves, or safety boots increases the risk of dust and chemical exposure during their operations.

Furthermore, illegal miners work long hours, sometimes for more than 24 hours at a time, which means they are exposed to toxic chemicals and dust for extended periods. As a result, communities are also exposed to the dust and harmful chemicals that are disposed of during the illegal mining operation's operations. These illegal mining practices cause severe and negative changes to the environment, as well as harm to human health and well-being. In addition to increasing the risk of upper respiratory infections (including malaria), skin diseases (including diarrhoea), fever (including colds), and catarrh (including catarrh), their practices also result in ecosystem destruction through sediment and chemical pollution, which results in severe and negative changes to the river's ecology.

Objective Two: While the ingenuity of illegal mining operations is a marvel, the cost to the environment is unreasonably high. Deep excavations created as a result of leaching ponds and diverted water courses serve as death traps and breeding grounds for diseases such as malaria

and typhoid, among other things, among others. In addition to harmful chemicals such as mercury and cyanide, the extraction process makes use of other harmful substances. The environmental and public health issues, on the other hand, are much more widespread and require attention. Environmental pollution caused by illegal miners has also resulted in the contamination of local watercourses, which residents rely on for domestic purposes. This has resulted in complicated health issues such as upper respiratory infections, malaria, skin diseases, typhoid and other related health issues, which have been reported by both medical professionals and residents of the study communities.

Approximately 40.82% of the population was affected by malaria, which was followed by upper respiratory infections, which accounted for approximately 19.73%, and skin-related infections, which accounted for approximately 17%. Stream contamination and overflow from leaching ponds that enter other watercourses, contaminating them with toxic chemicals, was a significant contributor to the high prevalence of skin diseases. Some residents rely on these water sources for drinking water and other domestic purposes, which were contaminated with toxic chemicals. As a result of their location away from active illegal minefields, other diseases such as colds or coughs, skin diseases, typhoid fever and diarrhoea were uncommon at Samahu. This can be attributed to the fact that they were away from active illegal minefields. Most crushing sections in their operations do not have a dust suppression system in place, which can lead to an increase in respiratory ailments such as flu and cold (catarrh), as well as upper respiratory infections, as reported by the majority of respondents.

Objective Three: In addition, illegal mining activities have resulted in a significant loss of aquatic organisms, depletion of livelihood and drinking water for some communities, and diverted stream and watercourses, which have paved the way for an increased occurrence rate of malaria, as well as all types of skin and other related diseases due to exposure to toxic or harmful chemicals such as cyanide, mercury, and arsenic, resulting in complex health problems.

For illegal mining activities to have the least amount of negative environmental impact possible, it is critical to conduct educational campaigns to make both illegal mining operators and the communities they operate in aware of the harm that is being done. They should be informed about the benefits of more technically efficient mining and extractive practices, which can maximize mineral recovery while simultaneously minimizing environmental degradation. This is especially important in developing countries. This type of educational campaign should be carried out by all relevant ministries, the Minerals Commission, the Environmental Protection Agency, non-governmental organizations (NGOs), the Municipal Assembly, chiefs and prominent locals at festivals and durbars, and by educational institutions in the communities.

5.2 Conclusion

According to the findings of the study, illegal mining has had a negative impact on the health and environment (including land and water bodies) of the communities under investigation. Deep trenches were dug without backfilling, resulting in death traps and disease breeding grounds for those trapped inside. Illegal miners demolished farmland, rendering the lands

unusable for farming. The presence of numerous heaps of crushed material as stockpiles on farmlands, as observed in most of the selected communities, has resulted in acres of farmland being abandoned as a result of large ponds that have formed along the path. Illegal mining activities, on the other hand, have a variety of negative health consequences. For example, increased risk of malaria, skin diseases, diarrheal diseases, typhoid fever, colds and catarrh, and severe upper respiratory tract infections such as tuberculosis and bronchitis, as well as the transmission of HIV/AIDS by individuals are all associated with illegal mining activities in the surrounding communities.

These include air pollution caused by heavy dust released from crushing ore and blasting operations, pollution of water bodies caused by chemicals such as cyanide, zinc, arsenic, mercury, and carbon from extracting minerals after leaching, degradation of agricultural land caused by heavy metals and other pollutants, resulting in the depletion of agricultural land and reduction in food production, and degradation of soil caused by heavy metals and other pollutants.

Water bodies, particularly ponds and streams, were diverted and polluted with toxic chemicals washed away from the ore, resulting in a negative environmental impact. Despite this, there has been no attempt to bring the situation under control from the illegal mining operators. The streams' conditions, as observed, had deteriorated to the point where they were no longer capable of serving their intended purposes for domestic purposes. As a result, it is critical that the Environmental Protection Agency, in collaboration with the Mineral Commission, take immediate action to rein in the activities of illegal miners. Furthermore, laws should be

strictly enforced to ensure that illegal mining activities do not take place in or near water bodies. Public education should be carried out to inform the general public about the health and environmental consequences of illegal mining activities, as well as the importance of reclaiming lands and maintaining the environment after mining has taken place.

5.3 Recommendations and Policy Implications

5.3.1 Recommendations

For adequate environmental protection, an assessment of the risks associated with mining, an evaluation of mining laws and monitoring protocols, as well as improved enforcement of existing laws, are required. According to the findings of the study:

Enforcing and strengthening mercury import limits is critical for the government to satisfy its 2013 Minamata Convention on Mercury signatory commitment. Mercury monitoring and limits must be managed more effectively for the benefit of all stakeholders to protect the environment and the health of residents. Ministry of Lands and Natural Resources should liase with governing bodies to facilitate the introduction of clean technologies, restructuring regulatory mechanisms, conducting environmental and health assessment and building capacities in local laboratories to continue monitoring mercury pollution as it is being enforced in large mining companies to switch from Mercury to Carbon in their operations to meet the Minamata commitment.

It is advised that government agencies, non-governmental organisations and all other stakeholders take a great interest in the protection and preservation of all our natural resources for the sake of sustainable development. Sustainable development focuses much on protecting

the environment so it can support the needs of the present and future generations. It was found out from the study that human activities such as illegal mining operations exploits the environments and the natural resources resulting in vast land degradation and polluting the environment at large, therefore an urgent need for policy reforms and it enforcement to protect the environment and health of future generations to meet the set sustainable development goal. Stakeholders must collaborate to create a more complete framework for mining legislation to ensure that miners have the requisite skills and credentials before operations commencing.

The Environmental Protection Agency and the Ministry of Lands and Natural Resources should also strictly enforce primary jurisdiction over mining operations within Ghana's borders and manage environmental impacts associated with illegal mining on a case-by-case basis through the use of permits and licenses, as other countries in the region have done.

The environmental decision-making process should incorporate substantial public input. While traditional techniques of public consultation should be used, such engagement should also include opportunities for open exchange of ideas, mutual learning, and informed and representative decision-making procedures. This participatory concept will address the legal status of individuals and civil society groups in the realm of environmental policy by asserting the procedural rights of access to information, public engagement, and access to justice. As a result, effective community participation will safeguard interests while also resolving issues between llicit mining and affected communities, benefiting everyone.

5.3.2 Implications of the Study

Activities of illegal mining in reserved forests are seen as a major threat to sustainable forest management and impacts of livelihoods of communities. Illegal mining operations turn to exploit reserved forests as a results the need to develop and enforce methods for sustainable forest management focusing on socio-economic improvements of forest dependent local communities and environmental protection.

Illegal mining is a poverty driven activity in areas where there are few employment opportunities. Government must collaborate with Non-Governmental Organisations to invest more in career building to empower the youth to create job opportunities for self employment and also support more skilled young entrepreneurs through programmes such as National Entrepreneurship and Innovation Plan(NEIP) to equip young generations which will curb the rate at which the youth engage in illegal mining operations.

Ineffective and bureaucratic processes to acquire license have made illegal mining activities appealing and a very lucrative venture. The bureaucratic process linked to license acquisition before operations have made most miners to ignore the need to get the required documents. Restructuring the documentation process will help reduce this menace.

5.4 Future Research Direction.

The study showed that although illegal mining offered support in terms of employment and improved economic status for host communities, respondents pointed out that the effects such as destruction of farmlands, polluting air and water sources and increase in complicated health issues and school dropout outweighs its benefits. Host community require structured education on environmental and health effects associated with illegal mining activities in order to reduce the adverse effects on the health of mining communities and the surrounding environment. The study led to illegal mining activities and the heavily involvement of children during operations, a new avenue for future researcher to explore that the study did not focus on.

Upon a second thought of this conventional view on children and work has been proposed given the evidence that work and school can be compatible, especially in the African culture where work forms part of childhood (Abebe & Bessell, 2011). The perception that there should be a work-free childhood has been propagated by international laws and policies which demand a childhood devoid of responsibility and strenuous work (Osei-Tutu, 2017). Childhood is characterized by schooling and separated from strenuous work, meaning that childhood and strenuous work are not compatible. This view can be unrealistic as it is argued that the socioeconomic variations in our societies demand children's work (Abebe & Bessell, 2011).Children involved in illegal mining operations are widely reported across mining communities in Africa. Children between 8–17 years are well noted for working in small-scale mining, and boys often constitute the majority. Their activities include breaking rocks, digging trenches, and washing minerals (Thorsen, 2012).

Females have duties including preparing food and petty trading. In the course of work, children are exposed to serious hazards at the mining sites that endanger their health and safety resulting in death at times (Thorsen et al, 2012). Besides, the immediate risk resulting from the work itself, children can be physically and socially abused. The approach employed in Ghana, specifically the recent ban on all illegal mining activities, brought temporal sanity to the sector but at the same time resulted in economic hardship and livelihood loss for host communities especially women and children (Orleans-Boham et al., 2020). This is a major challenge that calls for further research, the cause of child labor in the mines, and how the illegal mining operators can be supported for collective national development.

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APPENDICES

Table 3.1: Summary of Variable Measurement.

Variable	Definition	Indicator	Measure
		Excavation serves as breeding grounds for mosquitoes	What kinds of diseases contribute much to ill-health?
Health	State of being free from illness or injury with a good balance that an individual posses with the social and physical environment.	Exposure leading to complicated health issues such as bronchitis, tuberculosis and skin diseases.	The percentage growth of ill-health in illegal mining community.
			What preventive measures can be used to minimize it effect?
			How does air pollution affects the environments?
Air pollution	Introducing a substance into the atmosphere or air which has harmful effects on health and the environment.	Dust released into the atmosphere.	What diseases are contracted as a result of air pollution?
			What measures can be adopted to minimize its effect?
Water pollution	Introducing harmful substances often chemicals or microorganism which degrades water quality making it harmful to human health and the environment.	Harmful chemicals such as mercury, and cyanide disposed into streams	What activities in illegal mining contribute more to water pollution?
			What diseases are contracted most from polluted water

			bodies?
			What measures can we use to reduce the risk of exposure?
Land Degradation	A temporary or permanent deterioration or loss of the productive capacity of the land for present and future use.	Fertile lands are being excavated and cleared for illegal mining activities	Which activities in illegal mining degrade the land?
			What effects does illegal mining has on land?
			What measure can be used to reclaim degraded lands?

Table 4.4: Results on use of personal protective equipment

Type of personal protective equipment	Frequency	Percentage
Hand Gloves	20	13.60
Helmet or hard cap	20	13.60
Safety glasses	12	8.16
Work boot(steel toe, chemical resistance)	50	34.01
Ear protection(Ear plugs, Ear muff)	16	10.88
Dust Mask	25	17.00
Reflectors around dug pits	4	2.72
	Total=147	

Table 4.5: Results of prevalent illness within selected communities

Prevalent illness	Frequency	Percentage
Malaria	60	40.82
Skin infections	25	17.00
Upper Respiratory Infections	29	19.73
Typhoid fever	22	14.97
Diarrhoea	3	2.04
Colds and Catarrh	8	5.44
	Total=147	

Table 4.6: Results on measures to minimize illegal mining activities

Measures	Frequency	Percentage
Public education on illegal mining.	77	52.38
Intervention of security agencies to prevent illegal mining.	22	14.97
Attracting foreign investors to carry out proper mining	40	27.21
Reclamation practices	8	5.44
	Total =147	

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I would be glad if you could spare a few minutes of your busy schedules to complete the following questionnaire for me. This is mainly for my graduate thesis on the topic shown below. Thus, your responses will be treated with all the needed confidentially as much as possible. I appreciate your time and effort so much.

TOPIC

ASSESSING THE ENVIRONMENTAL IMPACTS OF ILLEGAL MINING ACTIVITIES ON THE HEALTH OF INDIVIDUALS IN MINING COMMUNITIES IN GHANA: A CASE STUDY OF ABOSO, SAMAHU AND TARKWA

COMMUNITY: ..... **DATE:** .....

GENDER..... **AGE:** .....

HEALTH

1. Do you think illegal mining is the root cause of ill-health within the illegal mining community?

   ……..

2. What risk in your view do illegal mining activities pose on health within the community?

   ……

3. In your view, what diseases contribute much to the rise in ill-health of the community?

   ……

4. In your view which disease dominates much in the community and how can it be minimized?

   ……

5. What is your view on the effect of this rise in ill-health on the young generation in the next five years?

   ……

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AIR POLLUTION

1. In your view does illegal mining have any negative impact on air?

   ……..

2. In what way does air pollution affect the environment of an illegal mining community?

   ……

3. Which disease do you think can be contracted from air pollution caused by illegal mining activities in the community?

   ……

4. In what possible way can air pollution be reduced to a minimum effect?

   ……

5. How can individuals in an illegal mining community protect themselves from air pollution?

   ……

WATER POLLUTION

1. In your view do you think illegal mining is the major cause of water pollution?

   ……

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2. What activities in illegal mining do you think contribute much to water pollution?

……

3. In your view how bad is water pollution in the community?

……

4. Is there alternative way for water pollution to be reduced whiles illegal mining continues?

……

5. In your view what practices can be done to revert polluted water caused by illegal mining to its natural state?

……

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LAND DEGRADATION

1. In your view what impact does illegal mining have on land?

   ……

2. What impact does land degradation from illegal mining have on lives?

   ……

3. How bad do you think the land will be in the next years (10) if illegal mining continues?

   ……

4. What measures should be implemented to control land degradation if illegal mining continues?

   ……

5. What is your view on how to restore degraded land from illegal mining back to its original state?

   ……

Thank you for your time and effort. I really appreciate it.