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Effects of Illegal Mining on the Environment, Economy, and Agricultural Productivity

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Abstract: The mining of minerals has contributed enormously to most African countries' economies. However, the activities involved in these sectors have turned to hunt our environment and human life due to the lack of regulation in this sector. This paper is a review of the effects of illegal mining on the environment, the economy and agricultural productivity in Ghana. The review employed key word findings at the initial stage to obtain relevant articles; peer-reviewed and non-reviewed articles, both published and non-published and other articles from reputable media sources. The findings from the study revealed that in Ghana, just like most African countries, artisanal and small-scale mining has contributed positively to the economy through job creation, increased mineral output, specifically gold, and concurrently increased the GDP of the country. Nonetheless, the downsides of unregistered and unregulated small-scale mining activities overshadow the benefits derived from it. Notable negativities associated with artisanal and small scale mining include: loss of mineral revenue through smuggling, food insecurity, destruction to surface and underground water through toxic contamination and pollution caused by mud and sediments, air and noise pollution and destruction of biodiversity, including the natural flora and fauna and water species. Death, injuries, respiratory and skin diseases, noise-induced hearing loss, physical and psychological stress, malaria, and HIV are among the common legacies of illegal mining. Among other recommendations, the study suggests that perpetrators found in illegal mining activities should be duly dealt with according to law. Also, small-scale mining concessions duly registered and regulated should be demarcated to avoid encroachment into forest reserves, farmlands, and river courses.

Keywords: Ghana, Illegal Mining, *Galamsey,* Agriculture, Economic Cost, Environmental Impact, Health

1. Introduction

The interaction between humans and the environment is an essential life phenomenon, and according to Ostergren and Le Bossé several implications come along with it [1]. They also emphasized that the environment presents humans with endless possibilities upon which they make imperative choices largely influenced by cultural and technological developments. Unfortunately, most humans' choices have turned into the principal forces driving environmental degradation and climate change. It is no doubt that the exploration of the environment presents vast opportunities for economic growth. However, the change in perspective from investigation to exploitation of environmental resources cannot be overlooked. Future generations, therefore, would suffer the implications of poor ecological choices, no matter

the level of economic growth [2].

Over the past decades, the mining sector in Ghana has experienced explorative dynamics that could be described as counterproductive to environmental sustainability. The illegal activities of artisanal mining, popularly known in Ghana as "Galamsey," have been subjected to researchers and policymakers; however, efforts to tackle impacts caused by operations of the sector have been mired. In light of this, the effects of illegal mining operations in Ghana should be more emphasized for the necessary redress. This review objectively focuses on the impact of illegal mining on Ghana's agricultural productivity and its economy. The ultimate goal is to emphasize the economic cost of illegal mining and how mining affects the food security of the local population to create awareness for the necessary policy redress.

The study was principally based on a desk review of relevant articles and publications in order to draw research findings. Key word findings were used in the extraction of relevant literature. Paper titles and abstracts were used as prescreening for inclusion, after which a further detailed review of the full text was made. Literature materials, both published and unpublished, and contents from reputable media publications were ascertained and used.

2. Mining in Ghana

2.1. Structure and Contribution of the Mining Industry to Ghana's Economy

The mining sector in Ghana has a complicated structure and is composed of large- and small-scale mines [3]. The large-scale mines are made up of multinational companies from Canada, Australia, South Africa, and the United States and control up to 85% of Ghana's mining industry [4]. The remaining 15% comprises small-scale mines, which include both legal and artisanal mining operations. The large-scale mining sector employs 28,000 people, whereas the small-scale industry employs over 1 million people directly engaged in a small-scale gold mine, and the number of dependents for these small-scale gold miners has been estimated at 4,400,000 [5, 6]. Occasional clashes have been reported between the large-scale and the small-scale mining sectors, chiefly caused by disputes regarding land use [7, 3].

Between 1493 and 1600, Ghana was the world's leading producer of gold, accounting for 36% of world's total gold production [8, 3] and was therefore called Gold Coast until March 4, 1957, when the name was changed to Ghana. The mining sector offers a vast contribution to Ghana's economic development, which has been widely acknowledged [9-11]. The Ghana Chamber of Mines [11] reported that the mining sector directly contributed 38.3% of Ghana's total corporate tax earnings, 27.6% government revenue, 6% to the country's GDP in 2011, and more than 40% total foreign exchange earnings. Recent statistics show that the mining sector contributed GH₵6290.59 million to GDP as of January 2020 after it has attained the highest value since 2006 of GH₵7410.50 million in the fourth quarter of 2019. As of January 2019, the GDP contribution of the mining sector was reported at GH₵5840.2 million, while contributions for January 2018 and January 2017 were GH₵4868.27 million and GH₵4612.18 million, respectively. Table 1 presents the contribution to GDP by the mining sector in the past three years [12].

Table 1. *Contribution of Mining to Ghana's GDP in the Last Three Years (in million GH₵).*

Period	Jan. 2017	Jul. 2017	Jan.2018	Jul. 2018	Jan. 2019	Jul. 2019	Jan. 2020
GDP	4612.18	5099.51	4868.27	6357.49	5840.2	7247.54	6290.59

Source: Trading Economics (2020).

Akabzaa [4] reported that gold constitutes 90% of the total mining output in Ghana. Other notable minerals mined in Ghana include manganese, diamond, and bauxite [3].

Mining is a crucial industry across several African countries. South Africa, the leading producer of Gold among African countries as of September 2019, produced 160,000 kilograms of gold in 2019 [13]. The Minerals Council South Africa (2020) published in 2018 that the country's mining sector contributed R351 billion to the country's GDP. Total employment was reported at 456,438 people, with each person employed having about nine indirect dependents to take care of. Next to South Africa is Ghana, followed by Sudan, Mali, and Congo, with each country, producing 120,000 Kg, 100,000 Kg, 46,000 Kg, and 39,000 Kg of gold, respectively, as of September 2019 [13]. In 2017, Extractive Industries Transparency Initiative (EITI) reported that industrial gold production in Mali increased by 23%. The contribution of extractive industries was reported at 61% to total exports, 5% to GDP, and 16% to total government revenue. Sudan, another essential mining company in Africa, produced about 4% of the world's total gold production in 2018, and mining has been declared as an important sector with a broad impact on the national economy, providing jobs, paying salaries, and generating value in all the 18 states within the country [14]. The mining sector across the African producing countries is notable in creating employment, and as a significant source of livelihoods for several households, contributes significantly to GDP and government revenue.

2.2. Overview of Illegal Mining in Ghana

Artisanal mining decorously called Galamsey, is very dominant in the small-scale mining sector in Ghana. The Ghana Minerals Commission and Human Rights Watch [15] reported that artisanal and small-scale mining constitutes 34% of gold mining in Ghana. This sector comprises mining communities, migrants, nomadic people, seasonal peasant farmers, and retrenched miners from the large-scale sector [7]. As stated in the preceding section, the artisanal and

small-scale mining sector employs over 1 million people and serves as a source of livelihood for 4,400,000 dependents. Power dynamics within the artisanal mining sector revolve around gold buyers and sponsors and landowners collaborating with traditional local authorities [16, 17]. They also stated that foreign migrants, in recent times, have dominated the artisanal mining operations benefiting significantly from the country's mineral resources. The mining of gold in this sector highly depends on noxious chemicals like mercury and cyanide. These harmful chemicals destruct the ecological balance through damage caused to the landscape, biodiversity, habitats, human health, and water bodies [2, 18]. Buxton [19] and the Human Rights Watch [15] also emphasized the downside of artisanal mining: the sector is characterized by non-compliance to environmental protocols, low productivity due to inefficient skills and qualification of miners, which ultimately culminates into low income in salaries.

Both Buxton [19] and the Human Rights Watch [15] opined that a universal definition of artisanal mining is yet to be recognized. Defining small-scale mining often differs and is country-specific. Reports adapted from studies would be used in this work concerning Ghana. Small-scale mining is defined as "operations of individual Ghanaians or organized groups of Ghanaians (4-8 individuals), or a co-operative often of more individuals, entirely financed by Ghanaian resources at a certain limit, and carried out on a full-time basis using simple equipment and tools [20]." Bugnosen, [21] also defined small-scale mining as "prospecting and mining in an area designated, and which uses specialized technologies and methods not involving substantial expenditure." [21]. Since not all artisanal and small-scale mining (ASM) operations are illegal, it is, therefore, essential to define illegal mining. The Law Insider Inc. [22], defines illegal mining as "the manner of undertaking mining inconsistent with mining plan/scheme of mining, clearances, permissions including transportation and storage of minerals as required under Act and Rules made thereunder."

3. Results and Discussions

3.1. Environmental Effects of Illegal Mining

The human population depends on the environment and natural resources for survival. Most Ghanaians in rural communities rely directly on the natural environment for livelihoods. However, illegal mining activities in river basins, forest reserves, old mine sites, and other locations pose great environmental threats. Hansen et al. [23] stated that mining is among the key factors driving the shrinking accessible rainforests in Ghana. Also, Akabzaa and Darimani [4] noted that illegal mining had left most rural communities in Ghana challenged with air and water pollution and other forms of environmental degradation. According to The Mining Review Africa [24], illegal mining in South Africa has been a cause of underground fires and destruction to infrastructure. It was also stated that the use of mercury in the mining of gold has a negative environmental implication. The subsequent sections present the effects of illegal mining activities on the environment, categorically, the hydrosphere, the atmosphere, and the biosphere.

3.1.1. Effects of Illegal Mining on the Hydrosphere

The nature of mining makes it one that consumes, diverts, and seriously pollutes water resources [25]. According to the mining reform and the World Bank report [26], water is deemed "mining's most common victim." The Ghana Broadcasting Corporation (GBC), in its commentary on the effects of illegal mining on the environment and the economy, stated that the Tano River, which is the main source of water for over 60% of the population in the then Brong Ahafo region of Ghana, is severely bearing the impact of illegal mining [27]. Freshwater is affected by mining through the use of high volumes of water in processing mineral ore. Another dimension through which mining causes water pollution is discharged mining waste into water bodies and seepage from tailings and waste rock impoundments [28]. It has been reported that 5 tons of mercury are released only from small-scale mining activities annually in Ghana [29]. Four major types of the impact of mining on water quality identified are acid mine drainage, heavy metal contamination, and leaching, processing chemicals pollution, and erosion and sedimentation [25].

Aboka et al. [28] stated that water resources in the Obuasi Municipality of Ghana had mainly been compromised, and Yeboah [30] revealed that most water bodies, including streams and rivers, have been affected by chemical pollution and several others have dried up. For instance, research conducted in the Amansie Central in the Ashanti region of Ghana by Duncan [31] recorded heavy loads of lead (Pb), cadmium (Cd), and iron (Fe) in the river Fena. Similarly, the research conducted by Afum and Owusu [32] in the Birim river of Ghana recorded a high level of iron (Fe), above the WHO standard. The Obuasi Municipal development reported by Aboka et al. [28], states that the major streams and rivers in the Municipality (Kwabrafo, Pompo, Nyam, Jimi, Akapori, Wheaseammo, and Kunka) have vastly been polluted by mining and other human activities. This means the local inhabitants, often described as impoverished, lacking essential resources such as services to health care and clean potable water [28], would face a massive threat to their survival and quality of life. Farmers and local community members who used to drink from these rivers and streams without treatment due to the clear color of the water and its natural quality cannot do so anymore. Most water bodies have turned opaque brown caused by mud and chemical components from illegal mining activities [33]. The pollution of the major drainage features of Ghana through illegal mining activities is not affecting only people in the local communities. Cobbina et al. [34] revealed that water samples' turbidity levels from drinking water sources for all sampling points exceeded the maximum admissible limits set for drinking water by the World Health Organization (WHO). This was attributed to pollution from runoff and wastewater

from gold mining. The amount of pollution and chemical concentrations in water sources are so high that high quantities of chemicals are used in water treatment. This comes with two major setbacks; first, the quality of water supplied to the public is affected, and second, water companies who do not have the financial acumen to absorb such high running costs shut down operations [35]. It was a shocking incident when the Ghana Water Company Limited (GWCL) temporary shut down its water treatment plant at Kyebi in the Eastern Region as a result of extreme pollution of the Birim River; the main water source of the company, caused by illegal miners [36].

The surface water is affected, but groundwater quality is also affected by mining activities, especially when the operation is illegal. Greentumble [37] revealed that illegal mining could lead to the contamination of the soil and groundwater. In some two study communities, Sanso and Abompe, indigenes complained that water pumped from boreholes is inferior. This was attributed to the chemical pollution of underground water aquifers [28]. The use of mercury, cyanide, and other poisonous chemicals in illegal mining activities, which are not regulated, leaves behind high volumes of toxic substances when washing directly into nearby streams and rivers.

In contrast, chemical residues seep through the soil into the groundwater table, thereby affecting groundwater quality. Illegal mining along river banks has other spillover environmental effects. The destruction of river banks and diversion of natural river course makes rivers liable to flood after heavy rains. This has caused flooding in mining communities, causing devastation to property and human life, according to a Daily Guide Ghana report [38]. Mensah [39] stated that Ghana, South Africa, Zambia, and many other African countries are in a continuous loss of water bodies through the pollution of water and bad mining practices.

3.1.2. Effects of Illegal Mining on the Atmosphere

The effects of illegal mining on the atmosphere would be limited to illegal mining on surrounding air quality. As mentioned in the previous sections, illegal mining is characterized by harmful chemicals, the destruction of forest covers, vegetation, and other biotic features. Some of these features, such as the forest, serve as carbon sinks that mitigate the greenhouse effect [40] and helps in the detoxification of the environment. Destruction of these natural mechanisms thereby poses a severe challenge to the environment. Opoku-Ware [41] reported an increased incidence of air pollution in Kenyasi, a mining community in Ghana. This, he traced the major cause to untarred roads used by heavy-duty vehicles to convey machines and other equipment used in mining to mine sites. Blasting of rocks containing mineral deposits also creates high volumes of dust in the atmosphere. Opoku-Ware [41] further stated that the chemicals used for blasting get released into the atmosphere, and the neighboring communities have been banned from using rainwater due to chemical poisoning. Akabzaa and Darimani [4] associated the increased respiratory diseases such as cold (catarrh) and flu to the prevailing air pollution caused by mining. Air particulate pollution in Nigeria stemming from illegal mining has also been mentioned by Merem et al. [42].

Noise pollution is another nuisance caused by illegal mining activities and mining in general. However, Aboka et al. [28] disclosed that artisanal and small-scale miners might be exposed to a substantial risk of noise-induced hearing loss (NIHL). Whereas 23% of miners in a large-scale mining company in Ghana suffered NIHL [43], 35% of artisanal and small-scale miners in Nicaragua suffered NIHL [44]. The impact of noise pollution extends beyond the mine site, the miners, and the nearby environment and possibly affects the inhabitants of mining communities. Some causes of noise pollution from mining include the use of dynamite during the excavation process, extended use of shovels and pick-axe, generator-powered grinding machines for ore processing, heavy earth-moving equipment, among others [45].

3.1.3. Effects of Illegal Mining on the Biosphere

There is strong evidence of the contamination of mercury and arsenic in biotic and abiotic samples in proximity to mining locations in Ghana [46]. The use of toxic chemicals in illegal mining often leaves chemical residues in soils and water bodies. When ingested through agricultural food products and water, these toxic substances cause a severe loss to human health. The presence of toxic chemicals affects human life and the entire biodiversity; plants, soil living organisms, aquatic species, mammals, and other land animals. This claim is supported by Greentumble [37], who stated that illegal mining causes a severe loss to biodiversity. Mining affects human health and could cause death among operators by breathing harmful chemicals or the absorption of toxic substances into the body through the skin. Illegal miners also face the immediate risk of death and life-threatening activities through the operation of heavy machinery, exposure to flooding, gas explosion, and cave-ins in mine pits [37]. There had been several incidences where hundreds of active youths had died through illegal mining activities. Adjei et al. [47] reported an incidence where a cave-in of a galamsey pit led to the loss of about 100 lives who were engaged in an illegal mining operation at Dunkwa-on-Offin on the Ofin River. Also, in the Ashanti region of Ghana, an incident occurred in a mining community, Attaso, where 12 galamsey operators got trapped in a collapsed mine pit, according to the Daily Guide Ghana [38]. Some health hazards associated with illegal mining include respiratory conditions such as silicosis, asbestosis, pneumoconiosis [48], and increased kidney diseases, which were attributed mainly to the use of mercury [33]. Between 2012 and 2015, over 300 artisanal and small-scale gold miners were reported dead in South Africa from collapsed gold tunnels [49].

Illicit social behaviors also accompany illegal mining. In its commentary, the GBC [27] reported the unacceptable social behaviors driven by illegal mining in specific local communities; open prostitution by girls whose ages range from as low as 10 to 15, abuse of alcohol, illegal use of

marijuana, and other hard drugs including cocaine and heroin. Armed robbery, fallen educational standards, and blatant disregard to laws, orders, and customs at the highest levels were also reported. The issue of open prostitution had also been supported by Amponsah-Tawia and Dartey-Baah [50], who claimed that several mining towns in Ghana harbor many commercial sex workers, a majority of them migrate to mining communities to seek jobs but end up in prostitution as a last resort for the lack of it. Todd [49] also reported that between 2013 to 2017, about 200 people were reportedly killed through robbery and violent attacks on illegal miners who are popularly known as "*Zama Zamas*," a native Zulu term which means "those who try to get something from nothing" for the characteristic illegal mining activity in abandoned mine sites. The human resource is undoubtedly the most crucial resource of every country. The degeneration of human capital and associated unacceptable social norms caused through illegal mining is a critical societal threat and a threat to the nation; to both present and future generations.

3.2. Effects of Illegal Mining on Agriculture

The agricultural sector of Ghana is considered the most critical sector of the economy employing about 33.5 percent of the country's workforce [51]. According to Statista [52], the agricultural sector of Ghana contributes 18.27% of the GDP of Ghana. Aboka et al. [28] describe it as the most crucial sector of the economy across Africa, contributing to about 30 percent of GDP in 2012 whiles employing the greatest proportion of the labor market. The exploration of oil, gold, and other mineral resources has contributed to the decline of the robustness of the agricultural sector in recent memories. Agriculture competes with several exploration activities for resources such as land use and water, and thus, often results in lasting impacts of exploration of natural resources on the sector. Ibrahim [53] in a study on "Artisanal Mining in Sudan – Opportunities, Challenges, and Impacts) found that the average wage of farm labor per day increased from SDG32 in 2011 to SDG80 in 2013, a notable hike attributed to the movement of the workforce from the agricultural sector to the artisanal mining sector. This section presents a detailed review of the effects of illegal mining operations on the agricultural sector. It emphasizes the effects of illegal mining on; land and crop production, irrigation water, and fishing.

3.2.1. Effects of Illegal Mining on Land and Crop Production

Artisanal and small-scale mining create lasting impacts on agricultural lands and crop production. Standing and Hilson [54] disclosed that gold mining (of which 34% is obtained from ASM) affects local communities by destroying farmlands. Based on the study conducted by Aboka et al. [28], it was shown that illegal mining operations are causing severe land degradation. They found out the various phases of the mining operations that affect land use for agriculture as follows. First, heavy earth-moving machines remove the topsoil, trees, and another vegetative cover. This deprives the land of its nutrients rendering it infertile and unproductive for various agricultural activities. Amponsah-Tawia and Dartey-Baah [50] also mentioned removing topsoil and vegetation through excavation for gold deposits as a land degradation process. Second, heavy rocks and mining debris impedes plant growth and makes it impossible to cultivate such lands. This was reported in one mining community (Sanso), according to Yeboah [30]. Another consideration of the destruction caused by mining to agriculture is concerning accessibility. Pits and heavy holes or trenches are common characteristics of illegal mining activities. The hazards these earth openings (with depths ranging from 50-70 m) pose on local people make affected agricultural lands inaccessible for farming [4]. It has also been mentioned that chemical pollution from illegal mining has also affected the use of still available lands for crop production [50]. The toxic chemicals such as cyanide and mercury used in mining render the soil inappropriate for crop production. Other studies [41, 55] also emphasized the destruction caused by illegal mining and mining in general agricultural operations. At Kenyasi, one of the mining communities in Ghana, Opoku-Ware [41] found out that indiscriminate gold mining, which is conducted without any expert assessment of potential gold-bearing lands and rocks, has caused massive destruction to agricultural lands.

It could be argued that mining (whether legal or illegal) undoubtedly affects land resources. Opoku-Ware [41] revealed that, the damage caused by illegal mining activities is more pronounced. Ayensu-Ntim and colleagues [56] analyzed total agriculture land loss to mining in the Tarkwa, Bogoso/Prestea, and Damang concessions. It was found out that 4,935 hectares of land, representing 45.42% of total agricultural lands within the concessions, have been lost. Within the Bogoso/Prestea concessions, Duncan et al. [57], through a time-series analysis, revealed that between 1986 and 2006, there had been a reduction in agricultural land use by 661.54 hectares, a 15.45% reduction. Other operations driven by mining similarly affect land use for agricultural purposes. Duncan et al. [57] reported that a total of 335.71 hectares of land had been divested for mining-related activities such as human settlements and roads to facilitate mining operations.

In terms of crop production, it is undeniable that the decline in land use for agriculture caused by mining, particularly illegal mining, would affect crop production. Within Obuasi, an old mining community in the Ashanti region of Ghana, it was reported that there is low domestic food production. This condition had been attributed to mining (large-scale and ASM) activities since most arable lands had either been degraded or reserved for mining in the future. Cocoa, one of Ghana's major economic crops, is being affected in production since farmers are selling out their cocoa farms, and not only that, cashew in addition, for illegal mining activities [27]. It is common to expect a high cost of food and other necessities in such areas since more than usual, and local food needs would be sought from markets from afar. In a study conducted by Amoah-Frimpong [58] on the "effects of illegal gold mining on food availability for

smallholder farmers" in the Western region of Ghana, it was found out that food prices in the local markets doubled as land sizes for domestic food production reduced resulting from the lease of farmlands for illegal gold mining. The high increase in food prices stemmed from scarcity and the need for traders to travel long distances to other districts to transport food at an expensive cost.

3.2.2. Effects of Illegal Mining on Irrigation Water and Fishing

Illegal small-scale gold mining operations along river banks pollute water bodies and make them unsafe for domestic use and other activities [59], including agriculture. The chemical pollution of rivers and water bodies occurs from dumping mercury from the mercury-gold amalgamation process into water bodies, washing gold dust in rivers, and oil spills from generators used for drilling [59]. Due to the toxic nature of these chemicals, aquatic life is severely threatened when exposed. Amankwah [35] stated that fishes and other aquatic species are killed or life-threatened by chemical pollution caused by illegal gold mining. Aboka et al. [28] also found out that residents who made livelihoods from fishing in the Kwabrafo River have ceased operations prematurely since all fish species have died due to toxification. The compound effect of the above findings is so severe, and thus, could potentially lead to food insecurity, malnutrition, and loss of livelihood among local inhabitants.

Irrigation water quality is another matter of concern raised when discussing the downsides of illegal mining. Amankwah [35] further stated that illegal mining operations need to be stopped since it affects water quality for irrigation. Nukpezah et al. [60] conducted a study on "the impact of small scale mining on irrigation water quality in Asante Akim Central Municipality of Ghana." They measured the physical and chemical parameters of water samples from rivers and reservoirs exposed to illegal mining activities. It was discovered that quite many physicochemical parameters such as turbidity, pH, conductivity, TDS, and heavy metals including Pb and Hg were significantly higher given a 5% level of significance for samples from river sites compared to those from the reservoirs. Though it was found out that several of the parameters that were measured were within the acceptable range for irrigation water quality set by the Food and Agricultural Organization (FAO), Hg, Cd, K, and turbidity levels were found to be higher than the permissible limits for irrigation water quality set by the FAO. The high level of Mercury (Hg) is not surprising since its use in small-scale illegal mining in Ghana has been immensely discussed. According to the World Health Organization (WHO), mercury is rated among the top ten chemicals or groups of chemicals with major public health concerns. Exposure to mercury, even in small amounts, has the potential to cause serious health problems. In child development, at an early age, mercury exposure could pose a great threat. Mercury could also produce toxic effects on an individual's nervous and immune systems and affect specific vital organs such as the lungs, kidneys, eyes, and the skin [61].

3.3. Economic Effects of Illegal Mining

3.3.1. Economic Gains and Losses from Illegal Mining

Illegal mining also comes with economic returns, especially to the poor in rural communities where such activities take place. Yaro [62] and Bagyina [63] described illegal mining as a poverty-driven venture practiced in several developing economies where a more significant proportion of the population is poorly educated with few employment opportunities. As a result, these locals who see the prospects in illegal mining embrace it at their very own risk without careful analysis and consideration of the long-run implications. From the perspective of economic gains, Boadi et al. [64], in their research "An analysis of illegal mining on the Offin shelterbelt forest reserve, Ghana: Implications on community livelihood," revealed that illegal mining operations within the fringe communities led to an increase in income among indigenes by 13%, raised employment opportunities by 6.7%, and increased market operations by 2%. Miners earned a cash income of between $2.9 –$22.9 per day. Nwokolo [65] mentioned that a projected 200,000 Ghanaians who indirectly support about 3 million people make a living from artisanal and small-scale mining in 2017, making the sector a significant contributor to the economy and a vital family income source, particularly for poor communities. Nwokolo [65] revealed that Ghana was reported to have overtaken South Africa as the leading gold producer in Africa in May 2019. The increased production is from the aggregation of both legal and illegal gold mining activities. He also stated that gold constitutes about 49 percent of Ghana's total exports and contributes $8.35 billion to the country's $59 billion GDP. Todd (2019) asserted that the illegal mining group in South Africa has an estimated worth of R21 billion ($920 million) per year. The artisanal and small-scale mining industry in South Africa constitutes about 10% of the country's gold production and employs approximately 30,000 people, including women and children [66]. In Mali, the illegal mining sector is said to employ about 200,000 people who are engaged in gold washing and other direct fieldwork or related activities [67]. In Sudan, earnings from illegal gold mining were recorded between SDG1000-2000 ($100-200) per month for 48% of actors, with only 4% earning more than SDG3000 per month [53].

These figures might look impressive; however, misleading when compared to the financial, social, and other environmental costs. Mining Technology [66] revealed that ASM is 90 times more dangerous than large-scale formal mining operations. Mantey et al. [68] discoursed that illegal ASM and processing have a well-known cycle; discovery, migration, and relative economic prosperity are closely followed by depletion, outmigration, and economic destitution. The environmental impacts of illegal mining culminate into costs that affect the economy. It is also worth noting that there are also direct economic losses to the nation from illegal mining activities. Tschakert [69] discoursed that an estimated 300,000 – 500,000 Ghanaians engaged in artisanal mining operate without official licenses and have contributed to about $461.1 million loss to Ghana's economy

since 1989. Nwokolo [65] also claimed that in 2016, it was estimated that Ghana lost about $2.2 billion in uncollected taxes alone from illegal mining activities. He further stated that Ghana recorded a $5 billion discrepancy between trade statistics and gold exports reported in 2017. Todd [49] mentioned that South Africa loses about R21 billion ($1.38 billion) per year through illegal mining activities in lost sales, taxes, and royalties. Mining Technology [66] also stated that gold worth R7 billion is smuggled out of South Africa to neighboring countries every year. In DR. Congo, it has been reported that the country does not fully benefit from the gold mining industry, and it has been estimated that between 75% and 98% of gold mined in the country are illegally transported to Uganda [70]. The subsequent section presents the associated economic costs of illegal mining in Ghana.

3.3.2. Effects of Illegal Mining on Food Security

According to Moseley [71], during rainy seasons in rural West Africa, the young men engaging in farming instead engage in artisanal gold mining. Several villages in certain parts of Mali, Burkina Faso, Guinea, and Senegal would be populated by women, children, and older people, whiles the young men leave to pursue wealth in artisanal gold mining. Ibrahim [53] stated that due to sectorial migration from agriculture to ASM, there was less land cultivated, lower crop yield, food shortages, and fewer exports of agricultural products. With the active population leaving the agricultural sector, the domestic food supply would threaten the sub-region. Another way ASM affects food security is through the destruction of forest reserves and farmlands. Boadi et al. [64] stated that within five years of activity, illegal mining in two Ghanaian communities of the Offin shelterbelt forest reserve has led to the degradation of 2.5 Km^2 (4.4%) of the total land area of the Offin shelterbelt forest reserve. When put in percentage terms, it was reported that the degradation of the forest belt is at a rate of 0.88% per year caused solely by illegal mining. It is well-known that the role of forest reserve to microclimatic conditions and rainfall patterns within a given geographical area. Appiah et al. [72] opined that local communities depend on forests as a source of livelihood.

Illegal mining activities in forest reserves pose a significant threat to sustainable forest management and impacts local communities' livelihoods [64]. It could, therefore, be argued that the vast degradation of the forest reserve would potentially negatively impact agricultural operations within the impact areas. In addition, Boadi et al. [64] stated that cocoa farms and water bodies were destroyed for illegal mining, and farming activities within the communities reduced from 90% to 76% after illegal mining activities. This gives a vivid picture of the economic problem caused by illegal mining. Danyo and Osei-Bonsu [73] also stated that the significant galamsey regions of Ghana (Ashanti, the then Brong Ahafo, Eastern, Central, and Western) had progressively recorded lower food productivity with corresponding higher Consumer Price Indices than recorded national averages over the past five years, thus, from 2012 to 2016. This consequently affected the contribution of the agricultural sector to the country's GDP. The study concluded that galamsey is mostly responsible for the low food production, spikes in food prices, and the high cost of living, more so, in the galamsey-prone regions in Ghana through the degradation of arable lands, pollution of water bodies, air pollution, shifting labor from agriculture to mining and the displacement of farmers.

Another study by Aborah [74] on the "effects of small-scale mining on food production in the Amansie West District of the Ashanti region of Ghana" revealed a consistent decline in domestic food production within five years spanning from 2008 to 2012. The production of basic staples such as cassava, plantain, cocoyam, and yam was reduced significantly. Cassava production within the district reduced from 18,957 metric tons in 2008 to 10,200 metric tons in 2011, recording a 46% change; similarly, between those same periods, the production of cocoyam, plantains, and yam experience a reduction in production by 43%, 8%, and 82%, respectively. Though the study revealed increased production in maize and rice, it was discovered that the dominant communities for the production of those crops were not affected by illegal mining activities. Aborah [74] also discovered that the total land area under cultivation within the district decreased from 12,911 Ha to 7,873 Ha, representing a 39-percentage change from 2008 to 2011. His findings showed that 50% of the illegal miners had concessions over 5 acres, most of which was previously used for agriculture. Results also showed that 51% of the local farmers indicated that their farmlands had been over for illegal mining activities. Also, more than half (59%) of these farmers claimed that they received inadequate compensation for their loss. Labor for agriculture was also affected since most of the active labor force was engaged by the illegal mining sector.

Predominantly agrarian communities (about 90% of inhabitants engaged in farming) embrace illegal mining activities led by influential local leaders and international migrants, exploit the environment for temporary gains, and live the rest of several decades to come in perpetual poverty, characterized by polluted water bodies, degraded farmlands, lost plantations (cocoa, oil palm, plantain, etc.) and ill-health. Eshun [75] argues that mining communities in Ghana experience harmful living standards and undesirable mining outcomes, such as water pollution, loss of farmlands and jobs. The reduced farming activities and destruction of existing farms and farmlands also mean that food supply within such local communities would be affected, increasing food insecurity and malnourishment, which is prevalent among rural communities in Ghana. Mensah [39] asserted that illegal mining puts communities in fear of food insecurity as basic staples are grown locally have to be imported from major cities.

3.3.3. Cost of Land Reclamation After Illegal Mining

The damage caused by illegal mining on land resources is so enormous that it would take several years, resources, and

efforts to restore degraded lands, forests, and water bodies into their natural state or an appreciable state. The effort to restore illegal mine sites, flush out illegal miners and keep them from returning to the sites look more complicated. It requires substantial financial investment in the human capital to provide alternative livelihoods that are better-off to illegal mining or more sustainable, proper education and sensitization of the citizenry, among others. The Ghana Extractive Industries Transparency Initiative (GHEITI) stated that though the government may have succeeded in the flushing out of thousands of illegal small-scale miners, the majorities are foreigners, the colossal task of restoring the damage caused is yet to be tackled [76]. Mr. John Peter Amewu, the then Minister of Lands and Natural Resources, in 2017, reported in news media that the Government of Ghana would require GH₵60,000 ($10,371.65) to restore one hectare of degraded land caused by illegal mining activities. He further stated that 238,000-kilometer squares of the country's land, representing about 4% of the country's total land area, had been degraded, and it would require millions of dollars to reclaim these degraded lands, clean water bodies that have been polluted and provide alternative livelihoods to artisanal and small-scale miners [77].

Mantey et al. [68], in their research on the "cost reclamation and decommissioning strategy for galamsey operations in 11 selected MDAs of the Western Region, Ghana," revealed that a total monetary value of GH₵987,707,164.53 ($171,476,937.19) would be needed to restore lands within the research area affected by galamsey operations to states that are closer to their original forms. The cost estimate includes flushing out illegal miners and restricting access to mine sites to the general public. It also involves the cost of long-term drainage management, the demolition, and removal of infrastructure used in galamsey operations, backfilling of open pits and sealing of holes, cost of surveying site characteristics/geochemistry, pumping and treatment of polluted waters, rehabilitated sites, general cost, and maintenance, among many others. Nwokolo [65] also mentioned that a monetary estimate of $250 million is needed to recover degraded lands and polluted water bodies caused by galamsey operation in the Western region of Ghana alone. The reclamation cost could be so high from the national viewpoint because five regions have mainly been affected by the illegal mining operation [73].

The review on the cost of restoring degraded lands from illegal mining activities is so huge that it may require more years of leaving through the damage caused before the needed redress could be taken. Mantey et al. [68] stated that, after the depletion of easily exploitable gold reserves, sites get abandoned, and indigenes are left to contend with the heirloom of environmental degradation and extreme poverty. Reclamation of degraded lands in Ghana is fraught with so many challenges. The GHEITI stated that there is nobody to be held responsible for the massive mess created from illegal mining operations since illegal miners abandon mine sites and polluted water bodies pushing the responsibility of reclamation on the government. It was further stated that funds and logistics are what the government needs to restore the extensive degradation caused. However, such funds and logistics are lacking at the moment [76].

Information on the cost of reclaiming abandoned illegal mines and degraded land and water resources in other African countries is hardly available. The following section, therefore, looks at the various means countries have adopted in the reclamation process.

3.3.4. Cost of ASM on Human Health - Water, Food, and Air

The health implications of illegal mining have been captured in brief in some sections above. This section, however, gives a detailed review of the downside of ASM on health. Mining, in general, has associated health challenges. However, it is found out that artisanal and small-scale mining pose the greatest health risk to individuals and societies [78]. Illegal mining poses a serious health problem that comes at so great a cost compared to the benefits. Basu et al. [45] mentioned that illegal mining is faced with peculiar health challenges that are not found in large-scale mining activities. These include; psychosocial, cardiovascular, respiratory, and sexual risks. Issues concerning nutrition, water, and sanitation were also mentioned. These, according to Basu et al. [45] culminating in an increased incidence of malaria, upper respiratory tract ailments such as pulmonary tuberculosis and silicosis, and skin diseases. Injuries on mine sites and accidents were also mentioned among the overall health risks of illegal small-scale gold mining. Other studies [79-81] also discoursed that mining severely poses health risks to local populations globally through erosion, creation of sinkholes, deforestation, loss of biodiversity, momentous water usage, damming of rivers and pond waters, disposal of wastewater, and soil, ground and surface water pollution through acid mine drainage. The pollution of surface and groundwater through toxic chemicals such as mercury and cyanide has been widely discussed. Damming rivers and water stagnation affects the quality of surface water for rural folks and creates a suitable environment for breeding mosquitoes, hence, the mention of malaria amongst the health implications of ASM. According to [80], activities such as flooding (often aided by diversion of river courses and mining alongside riverbanks), erosion, deforestation, and the destruction and use of surface and groundwater put stress on the health of local communities, lead to the reduced food supply, and transports toxins into food chains. Mercury usage in artisanal and small-scale gold mining also results in methyl-mercury contamination of local environments and poisoning by the ingestion of such toxins through locally cultivated foods. Stewart [78] also stated that mercury is harmful and affects brain functioning and development and the nervous system, and may lead to the Minamata disease. The Minerals Council South Africa [82] discoursed that the use of exceptionally environmentally unreceptive methods and materials for mineral refining puts the health of illegal miners at serious risk.

The use of chemical dust, blasting of rocks and mineral ores, and uncontrolled destruction of the vegetation also lead

to increased air pollutants. Stewart [78] mentioned that, mining bears significant responsibility for increasing particulate matter. These particulate matters affect the quality of air within a considerable radius of a mining enclave. Csavina et al. [83] and Meyer et al. [84] revealed that mining plays a significant role in creating atmospheric dust and aerosols and the movement of metal and metalloid pollutants. The dissipation of these suspending pollutants in the air would require several years and Stewart [78] also stated that these particulate matters are often too heavy to travel far. Barbieri et al. [85] and Zota et al. [86] claimed that the particulate matters are coarse particles that form a significant part of ensuring dust particles and, since they are too heavy to move over a long distance, mine workers and residents nearby are the principal sufferers.

In some cases, the movement of heavy metals used in mining activities by mechanical dispersion through water and wind has been recorded at four kilometers distance from mine sites [87]. Poor households with limited housing choices are found living close to unsafe mine sites and some even on top of mine wastes [88]. In such cases, children and pregnant women have been identified as the most vulnerable [86, 89] (Zota et al., 2016; Lewis et al., 2017). In Nigeria, food contamination through household gold processing activity led to acute lead poisoning outbreaks, resulting in the death of between 400 to 500 children below five years old while several thousand were affected [90, 91]. In Ghana, it had been reported that about 5 tons of mercury are released into the environment annually from small-scale mining activities [29]. This has had its toll on food safety as mercury concentrations found in fish in some polluted river bodies were three times higher than the levels considered safe by the United States Environmental protection Agency (USEPA), according to Aboka et al. [28]. In five mining communities (Sanso, Anyinam, Anyinamadokrom, Abompe, and Tutuka) all located in the Obuasi Municipality of the Ashanti region of Ghana, studies found that indigenes suffer from malaria, diarrhea, fever, colds, catarrh, and skin diseases. Compared to communities distant from mine sites, the prevalence of the named diseases in the identified communities was attributed to mining operations [30]. Also, in the Amansie West District, high occurrences of Buruli ulcer diseases were associated with artisanal and small-scale mining [92]. The disturbance of streambed by ASM was identified as the dominant mechanism facilitating the spread of the disease [93, 94]. Silicosis and hearing loss attributed to noise and dust pollution from blasting and drilling activities are among the health risks of ASM reported in Ghana [50].

It has also been argued that the migration of people to mine sites to find work often creates poor infrastructure and crowded living conditions and is characterized by lack of social cohesion and support with increased risk of exposure to pathogens such as tuberculosis and HIV as well as stress [45]. HIV arises when most migrants, particularly women, who move to mine communities to look for jobs, often end up as sex workers [50, 95]. Other health problems associated with ASM are minimal in large-scale mining due to increased mechanization, including back pain and pain in the upper and lower limb [96]. Fractures and contusions are also common injuries in ASM, with increased rates of accidents mainly caused by the collapse of mine pits, crushing and falls, and drowning [45, 97]. Calys-Tagoe et al. [98] and Long et al. [99] asserted that Ghana records high rates of small-scale mining accidents than the rate of accident occurrence in the large-scale mines of the United States and South Africa.

4. Conclusion and Recommendation

Illegal mining activities come with some gains. Specifically, illegal mining has contributed to employment, increased mineral output, and the GDP of Ghana. However, the cost to social and economic life overshadows the benefits and must not be overlooked. Through unregulated small scale mining activities, Ghana has suffered great loss in the area of the environment, the economy as well as food and water security. Smuggling of minerals is found to be common to the sector and has resulted in loss of mineral revenue. Food insecurity, pollution of air, surface and ground water, destruction of biodiversity, loss of human life and related medical problems, malaria and HIV are among the major downsides of illegal mining. It is essential to restore degraded lands and polluted water bodies caused by illegal mining, but the cost is too huge for government to meet presently.

The study recommends that ASM activities be registered and monitored to ensure compliance to standards in using chemicals and to avoid tax evasion and losses of mineral proceeds to the country. Perpetrators found in illegal mining activities should be duly dealt with according to law. Also, small-scale mining concessions should be demarcated to avoid encroachment into forest reserves, farmlands, and river courses. Together with the various regulatory bodies such as Lands and Minerals Commission, Environmental Protection Agency, the Miner Associations should collaborate to restore degraded lands and water bodies.

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