

Review

Long and short term implications of mineral mining operations in Sierra Leone: A review

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CITATION

Fayiah M, Fayiah MS. Long and short term implications of mineral mining operations in Sierra Leone: A review. *Natural Resources Conservation and Research*. 2024; 7(1): 4452.
<https://doi.org/10.24294/nrcr.v7i1.4452>

ARTICLE INFO

Received: 29 January 2024
Accepted: 18 February 2024
Available online: 7 April 2024

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Abstract: Sierra Leone is among the few countries endowed with substantial mineral resources deposits in Africa. This review throws light on the long- and short-term positive impact of the mining sector in Sierra Leone. Over the past decade, the revenue derived from mineral mining has had little impact on the economic development of the country. According to history, extensive mineral mining operations is traced back to the early 1930s. Nonetheless, the inception of mineral extractions in Sierra Leone has been characterized by political instability, war, biodiversity loss, corruption, hardship among others. Based on available literature, mineral extraction in Sierra Leone has directly or indirectly impacted the 1), environment (ecosystem and biodiversity) 2), governance and leadership (stakeholder's consultation) and 3) economic growth and development. The common negative impact are environmental pollution, degradation and social issues such as sexual violence, teenage pregnancy, early marriage, prostitutions, school dropout and spread of transmissible diseases among other issues. The source of data for this review was acquired from the secondary source. Information was source from both published and unpublished materials of interest. Key words such as mineral mining, mineral resources, mining benefits, mining policies, mining challenges were searched for important information on the subject matter. In some mining edge communities across Sierra Leone, protest and other human right abuses perpetrated by company's authorities and security officials is common within these communities in Sierra Leone. On the other hand, mineral mining has served as a means of sustainable livelihood booster for deprived mining edge communities in Sierra Leone. Additionally, some mining edge communities in Serra Leone enjoy better economic conditions from the cooperate social responsibility (CSR) scheme of most mining companies. Alternately, mineral mining has also been a source of political tension and tradeoff between local resident and mining companies/governments. To remedy this situation, the government in recent years, has enacted many policies, legislations and regulations that supports the judicious extraction and management of minerals for the benefits of all in Sierra Leone. It is therefore recommended that, best international practices and standard operating procedures related to mining extraction be adopted and applied across all mining sites in Sierra Leone. This will help in mitigating the human right abuses trade-off between mining communities and mining companies for a better future.

Keywords: Sierra Leone; mining; mineral; developing countries; communities; resources; operation

1. Introduction

Sierra Leone is among the least developed nations endowed with abundant mineral resources. On the global stage, Sierra Leone is ranked 10th among the world's diamond and rutile producers based on volume [1]. Extensive mining of

minerals in Sierra Leone could be traced back to 1930 and has since been in the spotlight for both economic and social unrest [2]. The mined minerals range from; Iron Ore, Diamonds, Gold, Bauxite, Rutile, Alumina, Petroleum, Titanium and Zirconium among others [3]. When sustainably mined, these minerals thus have multiple socio-economic importance on the living standard at the national, regional and local level. Equally, these minerals could serve as the engine of economic and sustainable development of Sierra Leone. Over the years, revenue from mineral extraction has been Sierra Leone's second largest economy booster after agriculture and the main source of export, employment and rural livelihood facilitator. Large scale and artisanal mining operations have over the past decades provided jobs for both skilled and unskilled labor across the country. Five types of mineral licenses right are given in Sierra Leone namely; large scale 1) exploration, 2) small scale 3) artisanal 4) and 5) reconnaissance [4]. Mineral mining incentives in the form of license fee, taxes, surface rent and custom taxes among others has provided huge revenue for successive governments to undertake pressing infrastructural and social services projects across the country [5]. For instance, in 2012, Sierra Leone gross domestic product (GDP) grew to 15.2% as a result of the boom in iron ore production. That same year, 71% of the total export income was from mineral proceedings [1]. Illegal mining has equally provided thousands of employment for jobless youths in mineral rich communities in Sierra Leone. The overdependence on the mining sector in Sierra Leone is linked to the high GDP contribution potential and export earning of the sector since 1930. In remote areas where minerals are located, mining activities have provided a sustainable source of livelihood for thousands of households [6].

Basically, mineral mining investment is capital intensive with high risk and uncertainty but at the same time it's a highly rewarding investment [7]. Nonetheless, critics argued that, absence of satisfactory infrastructure designed to support sustainable mining operations has the tendencies to prevent direct future foreign investment in the mining sector [8]. Secondly, the civil war that lasted for 11 years reversed all previous gains made by governments to strengthen the mineral sector in Sierra Leone. Additionally, weak mineral extraction supervisory institutions and corruption has been deterring the actual realization of the full benefits of mineral extraction in Sierra Leone. Sierra Leone is under huge environmental pressure and was recently ranked 177 out of 180 countries for the 2020 Environmental Performance Index (EPI) [7] with mineral mining being the main culprit. Furthermore, research has proven that, mineral mining is the second major threats against biodiversity boom after agriculture in Sierra Leone [9]. In Sierra Leone, most mining companies seize operations abruptly hence stimulating huge economic, social and environmental implications for the mining communities after closures.

Sierra Leone is among the least developed nations endowed with abundant mineral resources. However, opinions are divided on the role play by mining operations revenue since the inception of mining activities in Sierra Leone. This review examines both the positive and negative effects of mining activities in Sierra Leone. The review further highlights the various reforms undertaken by the government of Sierra Leone to improve the mining environment over the past years. The article is poised to answer the following research questions 1) what are the

various policy reforms undertaken by the government over the past year 2), How has the revenue generated from extracted mineral resource contributed to the economic development of Sierra Leone 3) what are the social and environmental challenges emanating from mineral mining in Sierra Leone 4) and what is the livelihood implication of mineral mining especially to mining edge communities. With these research questions, this review article is poised to close the knowledge gap on the status of mineral mining and its development implication in Sierra Leone. Therefore, analyzing the long and short term positive and negative impacts of mineral mining in a developing country like Sierra Leone has the potential to inform relevant stakeholders and other key policy makers on the consequences of mineral mining across Sierra Leone. Results from this review will inform policy makers and provide useful insight on the long and short term impact of mineral mining in Sierra Leone. In summary, the main focus of this review is to highlights the long and short term implication of mineral mining on the environment in Sierra Leone.

2. Review of relevant literature on mineral mining implications in Sierra Leone

Mining in Sierra Leone is considered a great source of income for both citizens and foreign investors. The sector provides income continuously, employs all class of citizens, promote income distribution, community infrastructure improvement among others. Sierra Leone's mining sector has over the years been considered a key driver to the sustainable development of the country with great investment opportunities. The country is endowed with minerals of great global interest like diamonds, iron ore, rutile, gold among others [10]. However, the sector has over the years been characterized by both negative and positive implications such as death, unrest, income to household, source of revenue to government, disrupt societal and family norms of mining communities among others. Furthermore, mining has reduce ecosystem functions and results in biodiversity and habitat loss over the years [11]. Mineral mining negative implication is on the increase due to the fact that the price and value of minerals has doubled and as a result fast income is realized in the mining sector as compared to agriculture and other alternative sources of livelihood. In Sierra Leone and other part of Africa, mining on the artisanal scale is considered a quick path out of abject poverty or slow source of income in communities were other social income driven jobs are unavailable [12]. The quest to revolutionized the mining sector over the years have resulted to the establishment of agencies like the "Extractive Industries Transparency Initiative", "Global Reporting Initiative", "International Cyanide Management Code", "International Council on Mining and Metals" among others [13]. These bodies are charged with the responsibility to bring degradation and biodiversity loss sanity into the mining sector [14]. Mining activities have destroyed high conservation areas and biodiversity hotspot across Sierra Leone. In addition, ecosystem services and functions are being threatened by mining activities in rural areas. Furthermore, mining emit carbon directly through the use of heavy machines to process the minerals thereby impacting the environment negatively [15].

Mining instruments in Sierra Leone

Over the years, a plethora of mining policies, legislations and regulations have been enacted to aid the judicious extraction and management of minerals for the benefits of all in Sierra Leone. These policies are geared towards the improvement of mineral mining integrity for the maximization of benefits associated with mining. They include, the Mines and Mineral Act, 2009, the National Mineral Agency, 2012, the Environmental Protection Agency 2008, the Extractive Industries Revenue Act of 2018, the Sierra Leone Minerals Policy 2018, the Artisanal Mining Policy 2018 and the Sierra Leone Geodata Policy 2019 (**Table 1**). In order to maximize revenue gained from mineral mining, the government of Sierra Leone has introduced series of reforms aim at rebranding the sector for the sustainable development of the country over the past decades. These reforms are in the form of institutional reforms, established mining policies, mineral agreement criteria, environmental protection improvement measures, mining community financing, environment impact assessment and licenses among others [16,17]. The reforms were designed to overcome governance overlap, corruption and, policy implementation inconsistencies as well as legislative loopholes in the mining sector. The various reforms were further undertaken to improve environmental protection, biodiversity conservation and ecosystem services and enhance mining community financing. This was achieved by reviewing various regulations, policies, Acts, and other legal instruments to enhance a sustainable extraction and exploration of minerals that will be the nation. These policy and institutional reforms are intended to attract more private sector investors within the mining sector. Other benefits expected to be derived from these reforms are the sustainable exploitation of minerals and the possible integration of the division into the national economy and enhance a win-win scenario for the country and investors. It is expected that these policies will strengthened the compliance and monitoring mechanism of mining companies and enhance accountability and transparency within the mining industry [18]. Nonetheless, the Sierra Leone mineral policy is still the legal and legitimate mining policy governing mining activities in Sierra Leone [16,17].

Table 1. Policies and other legislative Instruments governing the mining sector in Sierra Leone.

| Policy title | Date of enactment | Status |
|---|-------------------|---------|
| Constitution of Sierra Leone 1991 | 1991 | NA |
| The National Minerals Agency in 2012 | 2012 | Agency |
| The Minerals Act 1927 | 1927 | Amended |
| Revised Minerals Act in 1960 | 1960 | Amended |
| The Environment Protection Agency in 2008 | 2008 | Amended |
| The Mines and Minerals Operational Regulations 2013 | 2013 | NA |
| The Mines and Minerals Act of 2009 | 2009 | Amended |
| The Public Financial Management Act of 2016 | 2016 | CA |
| Mines and Minerals Regulations 2009 | 2009 | Amended |
| The Extractive Industries Revenue Act of 2018 | 2018 | CA |

Table 1. (Continued).

| Policy title | Date of enactment | Status |
|---|--------------------------|---------------|
| Environmental and Social Regulations for the Minerals Sector 2012 | 2012 | CA |
| The Sierra Leone Minerals Policy | 2019 | CA |
| The Artisanal Mining Policy | 2018 | CA |
| The Geodata Management Policy | 2018 | CA |
| Diamond Cutting and Polishing Act, 2007 | 2007 | NA |
| Environment Protection (Mines and Minerals) Regulations 2012 | 2012 | NA |
| The Medium-Term National Development Plan 2019–2023 (MTNDP) | 2019 | Ongoing |
| National Land Policy and Land Commission Act 2004 | 2004 | Amended |
| The National Land Commission Act, 2021 | 2021 | CA |
| The National Protected Area Authority and Conservation Trust Fund Act, 2012 | 2012 | NA |
| Mines and Minerals Regulations in 1994 | 1994 | Amended |
| Mines and Minerals Decree Act | 1994 | Amended |
| The National Environmental Policy | 1994 | Amended |
| National Environmental Action Plan | 1995 | Amended |
| Mines and Minerals (Fees) Regulations in 2008 | 2008 | Amended |

Note*** NA = Not amended; CA = Currently applicable.

3. Materials and method

Sierra Leone is a relatively small and low-income country located in West Africa, with a population of about 7.8 million people [19]. Sierra Leone is bordered with Guinea in the north and Liberia in the East. The country is part of the Guinean Congo Basin biome and has a land area of 72,300 sq [20]. The country is rich in terms of minerals such as Gold, Diamonds, Rutile, Iron ore, Chrome, ilmenite, Bauxite among others. In such, the socio-economic development of Sierra Leone depends largely on mineral mining and their associated revenue. Sierra Leone is characterised by high youth unemployment, illiteracy, inequality and precarity, poverty and corruption and was ranked 179 of 188 countries in 2018 by the Human Development Index rating [21].

Data collection method

The data for this review was acquired from secondary sources. Key words like mining, mineral, corporate social responsibility, mineral resources, mining benefits, mining policies, mining challenges were searched for important information on the subject matter. Information was source from both published and unpublished materials of interest [22]. Documents of interest for the review were; published journal articles, governments report, Acts, and policies on mining activities and revenue, workshop and conference proceedings, international partners working on mineral resources sustainability reports and unpublished documents and thesis. In addition, mining company’s websites were search to see the corporate social responsibility activities undertaken by various mining companies in the country.

Collected information was analyzed and sorted to extract critical information needed to develop various sections of the article as per [23].

4. Review findings: Mining and economic development of Sierra Leone

Mineral mining plays a critical role in the economic development of developing countries and is considered an important factor for the sustainable and social development of these countries [24]. Sierra Leone is categorized as a resource rich nation endowed with massive deposit of diamonds, rutile, bauxite, iron ore, gold among others. Sierra Leone is classified as a resource dependent country with the mining sector contributing a lion share of the country’s revenue, export and Gross Domestic Product annually [25, 26]. From time immemorial, revenue generated from mineral proceeds account for the main source of export, foreign exchange revenue and Gross Domestic Products of Sierra Leone. Mineral mining has been the mainstay of the government of Sierra Leone’s economy since independence in 1961 [5]. Economic development of Sierra Leone through mining of minerals have been realized through employment opportunities, foreign exchange earnings, foreign direct investment, government revenues and corporate social responsibilities of mining companies. Characterized by higher revenue potential, mineral mining in Sierra Leone has been over the years considered as a sustainable source of wealth use for the development of the country [27]. The mining sector in Sierra Leone contributes significantly to the GDP of the country and account for 50%–65% of export earning year in year out [28,29]. The sources of revenue use for development purpose in the mining sector range from royalty charges, annual mining fees and renewal charges, artisanal mining license, reconnaissance license, exploration license, large and small scale mining license (**Figure 1**). In addition, surface or land rent and lease agreement provide revenue for land holding families and the community in general. To enhance sustainable community development, large scale mining license holders are obliged to engagement in development activities within the mining community upon reaching a certain production level.

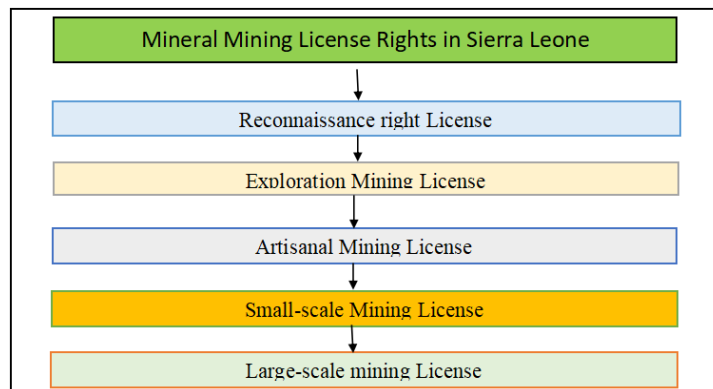


Figure 1. Mineral mining license right in Sierra Leone.

Critics however argue that, the abundance of mineral resources in Sierra Leone has not translated into economic growth or sustainable development, but has instead resulted into poverty for some mining communities since the commencement of

mineral extraction in 1930 [30,31]. Instead, Sierra Leone is among the least developed nations globally with high poverty rate and low standard of living. According to the Truth and Reconciliation Commission report [32] mineral resources mismanagement was among the root causes of the bloody 11 years' civil conflicts that ravaged Sierra Leone for a decade. In such, opinions vary among citizens on whether mineral resources of Sierra Leone are a "Resource curse" or a blessing to the nation [2].

4.1. Mineral mining and its social and environment related issues in Sierra Leone

Globally, mineral mining has contributed to the improvement in the standard of living of both developed and developing countries [33,34]. However, the mineral sector in Sierra Leone is faced with numerous challenges due to outdated mining laws and regulations that fall short of meeting international standards in the 21st century [6,17]. On the other hand, mineral mining in Sierra Leone has supported rural livelihood drive and national development agenda over the past decades. For instance, big mining companies like the Koidu Holdings Ltd and Sierra Rutile has supported education, built local clinics, support sporting activities and engage in infrastructural development within their operational territories. However, the social injustices associated with mineral mining in Sierra Leone and in other parts of the world has been considered a global concern and is attracting huge global debates [35] especially in meeting the sustainable development goals.

Mineral mining has been regarded as the root to biodiversity decline and is regarded as the major threats to sustainable ecosystem function and biodiversity increase [9,16]. Both artisanal and large scale mining are engaged in clearing a large aspect of vegetation for their operations. Mining activities are destroying viable forests ecologies, riparian zones, and coral reefs that harbors varieties of wildlife and other forms of biodiversity [9]. Artisanal mining activities like sand and stone mining being practiced along coastal ecologies like the Freetown peninsular area has resulted in devastating beach erosion and aquatic ecologies alterations. Swamp ecologies have been converted to artificial ponds after dredge mining activities in Moyamba District [36].

Environmental pollution is also a by-product of mining activities across Sierra Leone. Most mining communities suffer from water and land pollution due to mining operations [37]. Traditional sources of pure drinking water have been contaminated and in some cases destroyed. Ground waters has been polluted by heavy machineries and oil spillage in some mining communities due to leaching. Mining in some communities disrupt the water drainage system and create irregular heaps across mined landscapes [6]. For instance, the Kimberlite mining processing practiced by the Koidu Holding Ltd in Kono District includes sites bombardment that mostly results in large artificial pits and the destruction of soil structure, composition and biodiversity [38]. In Kono District, mineral mining is considered a controversial investment with both positive and negative face.

In a nutshell, good drinking water is a fundamental problem in most mining communities in Sierra Leone. Mining activities don't only affect the immediate mining community but the downstream communities equally suffer from polluted

water. For example, the Taia River in Moyamba District has change color due to mining activities being undertaken upstream by miners. The water quality in these mining sites is deteriorated and sometime serve as mosquito breeding ground [6]. Similarly, dust and noise pollution have been reported in mining edge communities [39]. Mining areas in Sierra Leone are characterized by poor health and sanitary conditions that has eventually resulted in blindness and disability. Also, the constant noise produced by heavy machineries working in close proximity to mining towns and villages have left many local residents deaf [40,41]. Most mining communities in Sierra Leone lack essential drugs and hospital for treating chronic cold due to artisanal and illegal mining.

Other human right abuses portray by mining activities in Sierra Leone is child labor. Across mining communities in Sierra Leone, children from age 7 to 18 play active role in mining activities especially the artisanal and illegal mining operations. Parents and local investors use them as cheap unquestionable labor hence forcing them to drop out of normal school [15]. There is more premium place on mining activities in mineral rich communities across the country than education and other works of life. Another social issue driven by mineral mining is early marriages and teenage pregnancies. However, most of these early marriages and teenage pregnancies are associated with either poverty or sexual offences like rape among others [42]. The influx of young men in search of greener pasture in mining communities expose these areas to all caliber of criminals and human rights violators. These young miners take advantage of poor young girls and prey on them either deceitfully or forcefully.

4.2. Mining as a catalyst behind the civil war and social unrest in Sierra Leone

According to a study done by Ballentine and Sherman [43], a strong correlation was detected between natural resource abundance and arm conflict risk in developing countries. According to Kamara [44], the root cause of the civil conflict in Sierra Leone was diamonds, diamonds and diamonds. The term “blood diamond” from Sierra Leone is prominently featured across African and the world at large [45] based on the atrocities committed for diamond during the civil war. Fearon [46] also noted that mineral resources such as oil makes a country prone to civil conflict. However, institutional failure and corruption are sometimes regarded as the vehicle for arm conflicts and violence in resource rich countries like Sierra Leone [47]. Unlike other natural resources like oil and natural gas that requires sophisticated extraction techniques, diamonds are considered lootable resources that need little or no skill to extract. This characteristic made diamonds looting and smuggling by conflicting factions in Sierra Leone very easy as they had enough labor and the resource is portable [31,36]. Scholarly investigators have stated that, the simpler and lootable a natural resource, the more likely the resource will be of great benefits to fighting factions in a country [31,36]. The United Nations after careful consideration concluded that, illegal diamond mining across Sierra Leone played a great role in fueling and lengthening the civil war in Sierra Leone and Angola [48]. In such, Diamonds were the principal source of income and foreign exchange the

Revolutionary United Front (RUF) depended on to fuel the war for a decade. Mineral mining in Sierra Leone gained political recognition from the colonial era but the over reliance on the resource after independence in 1961 for economic development and political gains makes mineral mining a force to reckon with in terms of political stability and national security [49]. Mining communities are synonymous to social unrest in Sierra Leone over the past decades. These social unrests have caused major socio-economic problems, community instability and social disruption particular in mining communities [50]. Although article 138 of the Mines and Mineral Act 2009 requires mining companies to invest, rehabilitate and contribute to the socio-economic development of mining communities, however, the social unrest in these communities takes precedent over these legislative intentions [51]. The civil unrest in Sierra Leone wouldn't have lasted for 11 years without the aid of illegal diamonds sold in exchange for weapons and other warfare logistics. The proceedings from these minerals strengthened the rebels, gave them more power as well as political recognition [37,52].

The 2012 and 2013 boom in Iron Ore, Rutile and Bauxite industry in Sierra Leone did not only contribute to economic development but serve as source of tension, conflict and protest across mining communities in Sierra Leone [37,41–43]. Across Sierra Leone, the epicenter for conflicts and frequent community skirmishes between local resident's and security forces mainly emanate from mining communities [2]. Mining communities are characterized by frequent tensions between unemployed youths and company's security forces. One notorious destination for mineral mining related confrontations and skirmishes between mining entities and their local counterpart in Sierra Leone is Koidu City, Kono District. Koidu City has been the epicenter for diamond mining since 1930 and has been the place where the biggest diamonds in the history of Sierra Leone located. In 2007, confrontation between Koidu holdings and protesters left two community members dead. This violent protest led to the besieging of the company foreign staff and kept under house arrest at their quarters BBC New [53]. Also, the Tonkolili Iron ore company was accused of multiple human rights abuses in 2010 and 2012 respectively [54]. Similar on 16 April 2012, confrontation occurred between aggrieved workers of the African Minerals Ltd Bumbuna and the police force leading to the death of one woman and injuring eight others severely [55–57].

4.3. Nexus between mineral mining extraction and internal displacement

A clear nexus exists between mineral mining extraction and forceful displacement or relocation in Sierra Leone. Displacement and resettlement due to mining is the process of relocating people affected by the mining operations from their original place of living to another location [38]. Since the inception of mineral mining in Sierra Leone, displacement and resettlement have been the fate of communities located where these minerals have been located. This process however has its consequences on cultures, norms, religion and the way of life of these poor communities. Besides the environmental damage caused by mineral mining, socioeconomic woes as well as social disruption is the order of the day for some mining edge communities in Sierra Leone [38]. What is most appalling is being the

forceful and involuntary displacement of people from their place of birth where their great ancestors lived and called home. Although some amount of compensations is given to help affected individuals restore their livelihood and start a new life, nevertheless, these incentives can't replace their ancestral home and place of birth [49]. According to Peligal [58] local resident's rights to water, land and livelihood was not only impeded but local residents and their families were forcefully evicted and relocated to an arid and harsh location around Bumbuna. This forceful relocation of local residents had adverse effect on their livelihood, food security, culture, norms and health. For instance, three villages namely Ferengbeya, Wondugu and Foria in the northern part of Sierra Leone were unwillingly relocated to pave way for Iron Ore mining in their former villages. In most cases, displacement due to mineral extraction has resulted to continual social and economic impoverishment hence exposing local resident to abject poverty with time [38]. In villages like Kanga and Madina in Bonthe District; Ferengbeya, Wondugu and Foria in Tonkolili District and Koidu in Kono District displacement or relocation contributed to sustained impoverishment with reference to basic livelihood amenities. Besides displacement and relocation, internal migration or influx of young men seeking employment has created more problems than mining communities can handle in Sierra Leone. These job seekers have been accused of various human right abuses and theft. Additionally, they are accused of being super spreaders of sexually transmitted disease, impregnating young girls, breaking of social cohesion and religious norms. In such, mineral mining in Sierra Leone is intricately connected and characterized with unwanted displacement or forceful relocation with meagre compensation.

4.4. Economic implication of mineral mining in Sierra Leone since 1930

Since the inception of mineral mining in 1930, revenue generated from the sale of these minerals has played an active role in supporting economic development in Sierra Leone. From 1930 to date, mineral resources have been the main source of foreign export from Sierra Leone [2]. The mining sector provides employment, taxes and other dividends that help facilitate diverse development projects that seek to provides services such as schools, education and other basic amenities. The 1972-star diamond found in Kono District weighed 968.9 carat and placed Sierra Leone on the spot light of mineral rich countries. This diamond was the third biggest diamond ever found on earth and was discovered in Kono. Similarly, a 709 carat diamond was found in 2017 and was class among the twenty biggest diamonds ever found [2,44,50]. Subsequent governments after independence remained deeply dependent on mineral resources proceedings to undertake various economic development activities across the country. Recent Statistics shows that approximately, 400,000 people are being employed by the sector between 2012–2013 and constitute 80% of foreign export [39,51]. If good mineral mining fiscal policies are put in place, the sector has the capacity of serving as the main engine of socio-economic development in Sierra Leone [58]. Mineral mining, stone and sand mining has equally been a major source of employment and by extension income for most uneducated youth in Sierra Leone. Mineral resources remained the main source direct foreign exchange and source of export over the past decades [5]. For instance, artisanal diamond

mining and export is dubbed a critical prosperity driver in Sierra Leone and employs thousands of unskilled labor.

Besides surface rents, royalties, license fees and other source of revenue received from mining companies in Sierra Leone, most companies like the Koidu holding Ltd, former African Minerals, Sierra Rutile Ltd among others have satisfactorily undertaken various cooperate social responsibility (CSR) in the form of building clinics, markets, schools, community centers, providing safe drinking water, giving scholarships etc. The provision of these facilities has positively influenced the socio-economic and livelihood pattern of mining community residents over the years. Similarly, scientific evidence has shown that, there is a great boom of business exchange/ activities in mining territories as compared to non-mining territories. Within mining communities in Sierra Leone, petty trading is financially beneficial and yield great dividend over time. Mining activities especially in mineral rich communities has stimulated internal migration of energetic youth from remote parts of the country to mining areas [5].

4.5. Mineral mining and livelihood security in Sierra Leone

Sierra Leone is a low income country thereby making its livelihood un-insure in diverse ways. Mineral mining can serve as a mean of sustainable livelihood booster for mining edge communities in Sierra Leone if international mining standards are adhered to and applied. The emergence of mineral mining in Sierra Leone between 1920–1930 have had mix reaction about their contribution to livelihood. Mineral. However, mineral mining especially in Sierra Leone has made residents of nearby communities vulnerable to various health risk and uncertainties. Nonetheless, some communities in Serra Leone enjoy better economic conditions from the Cooperate Social Responsibility (CSR) scheme of most mining companies. The CRS scheme seek to positively contribute to the social, economic, and environmental benefits of host communities for sustainable development [52]. The CSR scheme makes sure that mining companies take full responsibility for their imprint on mining societies. Over the years, mineral companies have made socio-economic contributions to society in the form of built community centers, hospitals, clinics, schools, water taps, resettlement buildings, feeder road maintenance and educational scholarship among others. These activities support rural livelihoods and enhance sustainable socio-economic development in some from Although mineral mining has negative foot print on the environment, yet still, its contributions have in some ways benefited locals in their livelihood quest.

Mining has over the years had both positive and negative implication on the livelihood of mining edge communities in Sierra Leone [53]. Scientific literature suggests that mining affects the livelihood of communities directly or indirectly in Sierra Leone [38,59]. One fundamental source of livelihood support provided by mineral mining is direct employment of community members living within mining communities. Across Sierra Leone, employment within the mining industry support livelihood activities through salary and income earned from mining work. These earning are mostly above the average income earn by farming or other livelihood activities undertaken in most mining communities in the country. In most cases,

livelihood enhancement is stimulated by type of mining activities practice in a community. While large scale mining employ plenty workers, artisanal and small scale mining contributes more to rural livelihood due to the volume of local inhabitant employ or involve in the process [5].

4.6. Mineral mining implication on biodiversity conservation

In Sierra Leone, mineral mining has been proven to be the major cause of flora and fauna loss as well as environmental degradation on a large scale [2]. Loss of natural ecosystem/habitat through mineral mining is considered the biggest reason behind biodiversity loss in mostly mining landscapes hence making the future of biodiversity increase uncertain [60]. The socio-economic and environmental implication of mineral mining have dominated the global discourse of major causes of biodiversity loss for decades [58–60]. The impact of mining is mostly felt at international, regional, local and individual level around the world. Mining and its related implication on biodiversity conservation is a hot global discourse that has attracted both decision and policy makers around the world. Mining activities though financially beneficial, it is however subjected to environmental pollution and biodiversity loss. Across Sierra Leone, mining has destroyed and continue to degrade mining ecologies nearby communities. Mining is a crucial sector in the sustainable development of any nation as well as the source of income that supports human survival. Nonetheless, its negative impacts on ecosystem and biodiversity cannot be underestimated especially in a developing country like Sierra Leone [61]. Besides biodiversity loss impact of mining, mining result to landslides, soil pollution, erosion, ground water contamination, disease outbreak and degradation [62]. In mining communities, forests ecosystems have been cleared, biodiversity affected and the environments altered permanently. Most wildlife in mining areas around Serra Leone are mostly forced to migrate to unsuitable environment where they are faced with survival risk. As a results, most wild animals once occupying mine areas has gone into extinction. Some wild animals have migrated to neighboring countries were mining activities and ecosystem destruction is minimal. This migration has led to the disappearance of valuable and important animal's species from Sierra Leone. In such, mining activities has place huge pressure on biodiversity increase with the problems showing no signs of abatement any time soon in Sierra Leone. In forested communities across Sierra Leone, biodiversity conservation plays an integral role in enhancing rural livelihoods, protecting traditions and norms, improving the quality of life, contribute to national economy development and improve eco-tourism.

4.7. Mineral mining influence on climate change uncertainties

The mining sector is becoming increasingly vulnerable to climate change especially in a developing country like Sierra Leone. This could be attributed to the fact that mining is energy intensive and a good emitter of greenhouse gases [63–64]. It is estimated that the mining sector account for 2% to 3% of emission emanated from global carbon and its play an important role in the greenhouse gas emissions. In such, mineral mining tends to have both direct and indirect effects on climate change uncertainties and vulnerability over a long period of time [65]. The negative impact

of the mining sector in Sierra Leone goes far beyond biodiversity loss and extend to climate change vulnerabilities and uncertainties. There is a clear connection between the mining sector and climate change vulnerabilities in countries like Sierra Leone. Although Sierra Leone is not an advanced industrialized country, however, it shares greater portion of climate risk as a result of unsustainable mining being practiced throughout the country. Sierra Leone is among the nations that lacks active climate change adaptation strategies but has large mineral extraction capability with great climate risk and uncertainties [66]. Moreover, high dependence on natural resources like minerals couple with unsustainable and weak mining policy enforcement render Sierra Leone extremely vulnerable to climate change impact and risk [67]. The continued environmental degradation of mined ecologies in Sierra Leone exposes the country to climate-induced risk and uncertainties [68]. Climate change is not the only risk associated with mineral mining in Sierra Leone but fishes and people are equally vulnerable to climate change risk posed by mining activities in Sierra Leone [69–70].

The mining sector especially the artisanal sector contributes to massive environmental degradation and at the same time influence the micro-climate of mining communities in Sierra Leone [71–75]. In recent times, mineral mining equipment installation operation and performance have been impacted by extreme climatic events in mines sites across Sierra Leone [76–80]. The sustainability of the mining sector is heavily dependent on the ability of a nation to devise a suitable climate risk, uncertainties and vulnerability. A sustainably mined sites help improve the environment and by extension the climate of the surrounding area.

5. Conclusion

Although Sierra Leone is endowed with abundant natural resources, yet its extraction and management is characterized by socio-political tension and unrest in mining communities. Across Sierra Leone, the loss of natural ecosystem/ecologies through mineral mining is considered the biggest motive behind biodiversity loss in mining landscapes in Sierra Leone. The review discovered that mineral mining has both positive and negative impact on the sustainable livelihood of mining societies in Sierra Leone. The positive aspect entails the socio-economic development contribution in the form of clinics, scholarships, community centers, agricultural support etc. On the other hand, the negative aspect comprises of environmental degradation, environmental and noise pollution, biodiversity decline, and landscape fragmentation. Mineral extraction has over the years resulted to coarse internal displacement of local residents. This forceful relocation of local residents has had adverse effect on their livelihood in the form of, culture, tradition, food security, norms, health and belief. Since independence, Sierra Leone has enacted a plethora of mining reform and these reforms are in the form of institutional reforms, mining agreement criteria, established mining policies, mining community financing, environmental protection improvement measures, environment impact assessment and licenses among other reforms. However, the review concludes that, Sierra Leone is still far away from judicious managements of resources earned from mineral mining for the benefits of the country and could be attributed to rampant corruption,

weak policy implementation and loopholes in some mining policies. The adoption of best internationally adopted standard on mineral extraction be introduced in Sierra Leone for the benefits of the environment and the society as a whole. It's recommended that rigorous and unbiased environmental impact assessment be carried to understand the depth of future challenges associated with mining.

Conflict of interest: The authors declare no conflict of interest.

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