



Mining and Environmental Degradation: a Gift Brings Grief Scenario for Mining Communities in Sierra Leone

M. Fayiah*

Department of Forestry, School of Natural Resources Management, Njala University, Njala, Sierra Leone

Received 6 August 2019; received in revised form 25 February 2020; accepted 27 February 2020

Keywords

Mining operations

Environmental considerations

Environmental degradation

Sierra Leone

Artisanal mining

Mineral resources

Abstract

Sierra Leone is blessed with abundant natural resources but yet prone to environmental degradation due to the mining operations. Most often, the mining communities are faced with social tensions, as a result of the possible trade-off between the expected employment impact and the cost of mining operations to the environment. Over the past decades, the contribution of the mining sector to the development of the country has been overshadowed by the fact that the mining operations have had adverse negative effects, mainly due to the country's weak environmental policies and the failure of the mine monitoring institutions, to supervise the operations of mining company operations. This article seeks to examine both the environmental and the social implication of mining operations on three mining edge communities in Sierra Leone. This paper also utilizes secondary data from the published articles, government's reports, workshops and conference proceedings, policy documents of non-governmental organizations, newspapers, and the like to generate this writer's view on the topic under review. The thrust of the review will be on the following: Sierra Rutile Limited, Koidu Holdings Limited, and Shandong Iron Ore Mines. The above mining companies have been carefully selected due to the fact that they are located close to dwelling communities, and have been mining in Sierra Leone over a long period of time. The environmental performance index and the mining impact framework are used to clearly show the impact of mining operations on the environment in Sierra Leone. As a result of mining operations, deforestation is skyrocketing, public discomfort and air pollution has worsened, and social unrest has increased as a result of some unacceptable consequences including pollution of water source without recourse to short-term remedy. The literature reviewed by this writer reveals that the mining activities have two faces in Sierra Leone. One is that it serves as a resource curse. An example to this sad reality is the outbreak of civil war, social unrest among others. On the other hand, the mining sector is one of the principal backbones of the economy. It contributes to the livelihood of the country. This paper introduces three-way approaches of mining sector operation remedies that include but not limited to: 1) sound Environmental Impact Assessment (EIA) adoption before mining operations starts; 2) carrying out Strategic Environmental Assessment (SEA); 3) regular engagement with all stakeholders of mining-affected communities. This article recommends that restoration activities by mining companies go along with extraction and adequate compensation.

1. Introduction

Mining provides raw materials that have been a major source of revenue of Sierra Leone. This sector has made life easy and comfortable, and has equally been a major source of employment for thousands from mainly rural indigenes.

However, the sector's benefit has not gone without the acknowledgment of the fact that the sector has exposed rural communities to pollution and other environmental related problems [1]. Mining and its environmental, social, and economic

consequences are a global concern, and have stimulated active debates among the environmentalist in this 21st century [2]. Most often, mining communities are faced with social tensions as a result of the possible trade-off between the expected job impact and the negative consequences of environmental degradation [1]. Mining is synonymous to both the environmental and social disorders on one hand, while, on the other hand, it is an engine for the socio-economic development of nations. Nonetheless, mining operations have disfigured and impacted the environment negatively, and are directly connected with the social impacts and life inequalities [3], especially in the adjacent communities. Specifically, mining operations have the potential to generate heavy environmental externalities like water and air pollution, soil erosion, chemical leakages, soil degradation and compaction, biodiversity loss [1, 2], and ecosystem functioning disturbance. Basically, human health impacts, income disparity, and environmental misuse of mining operations are mostly felt at the local level, and these issues are the source of tension between the affected mining edge communities, governments, and mining companies [4].

1.1. Background

Sierra Leone is endowed with a significant amount of mineral resources such as bauxite, gold, diamonds, and rutile, among others. Despite the significance of these mineral resources, a large school of thoughts believe that the exploitation of these capital-intensive minerals have not benefited local communities as expected [5]. Gold and iron ores were the first to be discovered in the late 1920s, followed by diamonds in the early 1930s, while bauxite and rutile were discovered in the 1960s [6] and Chromite in 1937 [7]. The exploitation of diamonds in Sierra Leone is dated back to the 1930s, and since then, it has played a major role in the political and economic spheres of the nation [8] but not without adverse environmental effects. The heavy gains from mineral extraction posed a serious environmental, social, and human right uncertainty and safety [9] to the least developing nations for which Sierra Leone is no exception. The discovery and mining of diverse mineral resources over the years have given mix feelings among citizens across the country. There are those who believe that the nation's catastrophe and environmental degradation is deeply rooted in it abundant natural resources; while another faction believe that the

abundance of these natural resources has helped to shape the country's economy and political landscape [7]. Sierra Leone's diamond industry was dubbed "blood diamonds" and believed to help fuel the civil war and other atrocities in Sierra Leone in the early 1990s [8]. Studies have proven that a clear relationship exists between the human insecurity and the environmental degradation in Sierra Leone [10]. Understanding the environmental, social, and economic consequences of mining activities in Sierra Leone is critical to combat future environmental dilapidation due to mining operations. There is justification for the understanding of the root causes and the impacts of environmental degradation given the number of mineral resources Sierra Leone has, and also for the fact that this will help in stimulating an efficient and sustainable mining policy for the country that will serve the test of time. Sierra Leone is being rated as one of the least developing nations on the earth. As a nation that had gone through civil war and most recently natural disasters such as Ebola and mudslides that killed over two thousand people, a paper like this is very significant as the nation requires a huge financial revenue source, for which the mining sector is a key. In a similar vein, environmental sustainability is crucial in the midst of mining (large- and small-scale), and it has been the greatest culprit of environmental degradation in Sierra Leone since 1930, followed by shifting agriculture. FAO [11] warns that inasmuch as the government increases its emphasis on the economic growth, it will definitely require sound environmental policies, together with a sustainable management to prevent uncontrolled environmental damage, mostly caused by mining and agriculture. There is virtually no doubt that natural resources such as bauxite, diamond, gold, and iron ore, among other deposits, can greatly contribute to the economic growth and development [12, 13] in regions where they are found. However, such activities overtime have left a devastating footprint on the environment for decades.

The natural mineral composition in Sierra Leone is made up of three sub-categories, stated as follow: (1) large-scale production of non-precious and precious minerals-rutile, bauxite, and diamonds; (2) mechanized small-scale mines, mostly diamonds; and (3) artisanal production of precious minerals such as diamonds and, to a much lesser extent, gold. The heavy use of machineries in extracting minerals has a destructive effect on the vegetation and can

generate dust and noise pollutions [14]. The extractive industry, by its very nature, has a massive ecological footprint [15], and it has affected the mining edge communities negatively. While the mining industry provides job and income to the local communities, its environmental havoc far outweighs its output and support. This is even more severe when the government or relevant monitoring authorities pay little or no attention to its operations and fail to listen to the concerns of the affected community members. In Sub Sahara Africa and other developing countries, mining companies' genuine corporate-community engagement has been highly questioned as a result of power inequities [16] and the mining companies are inflexible to native stakeholder's authority preferences but focus on the pre-defined 'development' goals of the mining sector [17, 18]. Mining is the second largest and important industry after agriculture regarding job employment and revenue generation [19] in Sierra Leone. In Sierra Leone, the weak implementation of mining agreement by companies and the little or no pressure by responsible government agencies to force companies to adhere to the sustainable mining protocols have contributed to the irreversible environmental catastrophe in most mining areas across Sierra Leone. The environment is the natural resource giver (mineral) and, at the same time, the receiver of damages caused mainly by the extractive industry. The extraction of natural resources is mostly a catastrophic process that destroys the rainforest ecosystem, hence causing problems for the nearby residents and downstream rivers [20]. The International Finance Corporation (IFC) [15] caution is that although mining only employs 1% of the world labor force, it is rated as the most hazardous occupation and is responsible for 8% of fatal accidents globally.

1.2. Overview of mining policies in Sierra Leone

Over the past decades, the following environmental instruments have been instituted to help protect the environment in the midst of

mining and other land related activities. These instruments include the National Environmental Policy (NEP, 1990); National environmental Action Plan (NEAP, 1995); National Commission on Environment and Forestry (NaCEF, 2005), and the Environmental Protection Agency (EPA) (2008). In addition to these policy instruments, the Ministry of Lands and Country planning of Sierra Leone equally has the mandate to protect the environment [21]. Besides the above environmental protection policies, the Mineral Acts (1927), Revised Mineral Act (1960), Mines and Mineral Decree (1994), Mines and Mineral Acts (2009), National Mineral Agency (2012), and Mines and Mineral Operation Regulations (2013) have been equally in charge with the responsibility to sustain the environment through responsible mining [6] over the past decades. However, the national environmental protection policies have not been able to adequately guard and protect the local communities from the adverse impacts of mining operations, and this has led not only to environmental degradation but deepening the poverty levels among the local population [22]. Mining operations have started in Sierra Leone over a decade; however, the country is still at the bottom of the development and environmental performance index ranking. This could be attributed to the poor adherence to sustainably mining protocols. Unsustainably, mining has adversely affected the environment over the years to a crisis level involving major degradation of the land, loss of biodiversity, and health risks.

Valuable forest trees have been destroyed causing the animals to migrate to areas of less threat or go into extinction [22]. The environmental performance index ranking of Sierra Leone over the past years is listed below (Table 1). Sierra Leone has been ranked at the bottom of the index for years with 2018 ranking being the best year among the rest. The worst rankings have been seen in 2010, 2014, and 2016, respectively. This ranking is a wakeup call for the concern of authorities nationwide.

Table 1. Environmental Performance Index Ranking of Sierra Leone over the years. Source: Adapted from [23] Environmental Performance Index Ranking and [24].

Date	Country	Ranking	Total countries	Scores
2006	Sierra Leone	111	133	49.70
2008	Sierra Leone	147	149	40.00
2010	Sierra Leone	163	163	32.10
2014	Sierra Leone	173	178	21.74
2016	Sierra Leone	162	180	45.98
2018	Sierra Leone	155	180	42.54

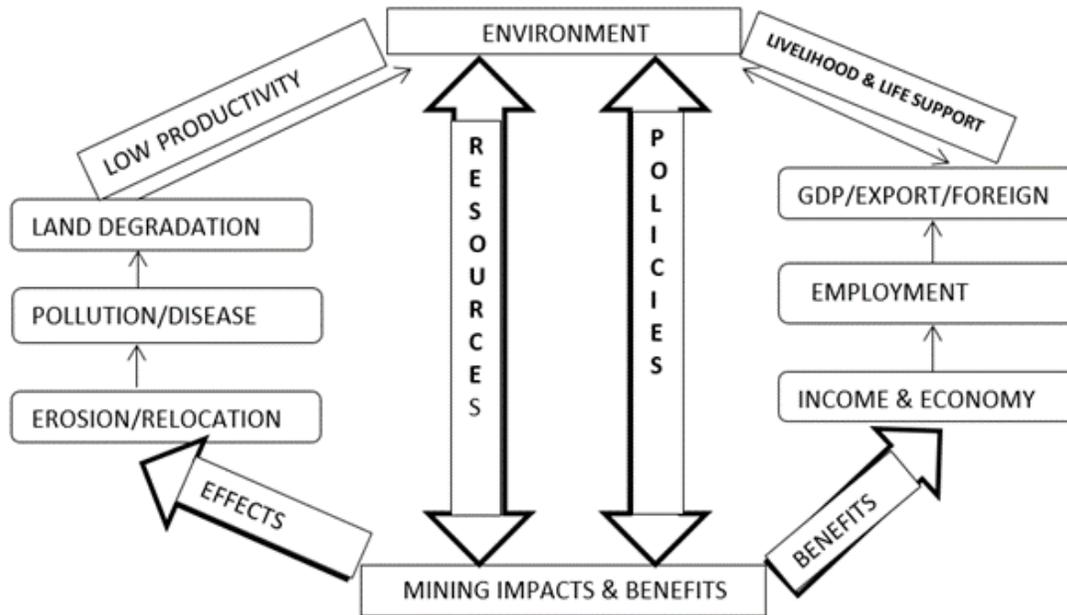


Figure 1. Mining and its environmental impact framework.

Mining serves as a source of income through taxes, royalties, land lease payment, employment, and source of export with special reference to Sierra Leone (Figure 1). This revenue improves the livelihood in the mining communities and the country as a whole. On the other hand, mining leads to land degradation, erosion, run-off, pollution, landscape transformation, etc. These activities lead to low productivity, hence, making the land barrel and impacting local livelihood negatively.

2. Review of relevant literatures

A good number of scholarly publications investigating the impacts of mining operations on the social and environmental degradation have been carried out over the years across the world. Chandra [25] believes that societal benefit from mining exceeds negative consequences but emphasizes that a sound public policy is very crucial in achieving this goal in a near future. Madeley [26] and Nguyen et al. [27] have also noted that mining is the fifth largest industry worldwide and that it has contributed significantly to the economic development, international trade, and reduce poverty. Wilson [16] has cross-examined the corporate social responsibility and power relations and impediments to community development in post-war Sierra Leone's diamond and rutile mining areas in Sierra Leone. He has concluded that "with the exception of the establishment of Kimbadu, the resettled town, implementation of corporate social responsibility

(CSR) initiative facilitated minimal, and at times, unsustainable, community development [16]. Akiwumu and Butler [28] have evaluated the environmental changes in parts of Sierra Leone, from rutile (titanium dioxide) between 1967 and 1995. They used the available multi-data infrared Landsat images supplemented with the field hydrological and biophysical data. They concluded that reservoir construction for mining caused flooding of alluvial lowlands, deforestation, and the creation of tailings and stockpiles over mined out portions of lease. Wilson [8] posed a critical question as to whether diamond exploitation in Sierra Leone from 1930 to 2010 was a resource curse? He argued that the impact of diamond exploitation in Sierra Leone was not fixed but rather had two face; it serves as blessing at some point and as a curse at certain point throughout the history of the country. Lichte [29] tried to understand the current environmental awareness, practices, and attitudes of affected populations and identify ideas, interest, and current capacity for small changes at the artisanal mine level to improve the social, economic, and environmental wellbeing of diamond miners and their communities. Wilson [30] has examined the corporate social responsibility and power relations and its influences on post-war Sierra Leone diamond communities and rutile mining area development. The author concludes that corporate social responsibility expectations of companies are unsustainable and minimal in terms of community development. Other relevant publications like

building peace via conflict diamond [31]; success or failure of artisanal diamond mining in Sierra Leone [32]; diamond, governance, and local development in post-war Sierra Leone [33]; mining companies-communities conflict over diamonds with special emphasis on Kono District [34]; diamonds are forever, controversial, and actors in the Sierra Leone civil war [35] have all examined the consequences of mining on the environment. Scholars such as Humphrey et al. [36], Auty, [37], and Sachs and Warner [38] using the “resource curse” hypothesis examined the developing countries that were heavily endowed with natural resources like oil and minerals. They have discovered that the developing countries endowed with great resource wealth mostly tend

to be poorer than those with few resources.

2.1. List of Major Mining companies in Sierra Leone

As at 2014, there were five major registered companies operating in Sierra Leone (Table 2). Due to the drop in demand of iron ore globally, the London Mining Company went bankrupt and folded up. Alternately, there are many smaller companies operating within the country, although most of them are unregistered. The leading companies among the major companies are Sierra Rutile Ltd, Koidu Holdings Ltd, and Shangdong mining, respectively.

Table 2. List of Major Mining Companies operating in Sierra Leone. Source: (Ministry of Mines and Mineral Resources [39]).

	Name of Company	Location	Mineral mine	Lease Agreement date
1	Koidu Holdings Limited	East	Diamonds	2010
2	Sierra Rutile Limited	Southeast	Rutile	20 th November, 2001
3	Shandong Mining Company (African Minerals)	North	Iron Ore	6 th August, 2010
4	Sierra Leone Minerals Limited (Vimetco)	South	Diamonds	16 th July, 2012
5	London Mining (Currently on hold)	North	Iron Ore	27 th February, 2012
6	SL Mining Limited	North	Iron ore	2017

Although some studies have investigated the negative and positive impacts of mining in Sierra Leone, attempts to examine the impact of mining on the environment and its livelihood implication is scarce. This paper seeks to synthesize and examine the impact of mining on the environment and its social implications to specifically mining edge communities. Furthermore, this paper pays close attentions not only to the negative impacts of mining on the environment but also its effects on local community livelihood, culture, and way of life. This article, in addition, seeks to answer the following research questions: 1) to what extent has mining operations degraded the environment? 2) has mining operations in Sierra Leone benefited the local communities? 3) what measures should be put in place to ensure sustainable mining in Sierra Leone?

3. Materials and methods

Sierra Leone is a small country in the West Coast of Africa with a population of slightly above 7 Million people. In this work, we examine the activities of three mining companies in Sierra Leone. These mining companies (Sierra Rutile Limited, Koidu Holdings, and Shangdon Iron Ore Mines) have been carefully selected because they are located close to dwelling communities and

have been mining in Sierra Leone for a stipulated period of time that is best suited for this peer review. Sierra Rutile Limited is located in the south, Koidu Holdings Ltd is in the east, and Shangdon Iron Ore Ltd is in the north of Sierra Leone. Synthesizing the impacts of mining on the environment is essential for a sustainable management, and can inform policy elites on the status of the mining communities in Sierra Leone.

3.1. Data collection

The data collection strategy for this article was secondary/desk review and field observation. The secondary sources of data were mainly from the published articles, newspapers, governments and NGOs reports and documents, consultancy reports, workshop and conference proceedings, and personal observation. Keywords like mining in Sierra Leone, environment consequences and mining communities, and mining and conflicts in Sierra Leone were used to search for the secondary information. The collected data was sorted, and the relevant information on mining and environmental consequences was extracted and analyzed to form the results and discussions. This article is organized as follows: introduction of Sierra Leone and its mineral resources followed by background; the overview of mining policies in

Sierra Leone; the list of major mining companies in Sierra Leone; the environmental consequences of mining operations in Sierra Leone; the social and economic impacts of mining in Sierra Leone; mining as a source of conflict in Sierra Leone; the artisanal mining and its environmental consequences; and the way forward and conclusion.

4. Results and Discussion

4.1. Environmental consequences of Koidu holdings Ltd, Sierra Rutile Ltd, and Shandong Iron Ore mining in Sierra Leone

Koidu Holdings Ltd is mainly engaged in kimberlitic mining, which was discovered in 1948 by Sierra Leone Selection; Sierra Rutile is the world's largest rutile mining company producing high quality minerals such as rutile, ilmenite, and zircon rich concentrate [40] using dredge mining methods; whereas, Shandong Iron Ore is engaged in Iron Ore mining using heavy excavators and machinery. The kimberlitic mining process employed by Koidu Holdings Ltd involves the bombardment of mines sites at least twice a week when operation is in full gear (Figures 2). This process has created many large pits, and has negatively impacted the soil structure, composition, fertility, and landscape. Negative environmental impacts such as biodiversity loss (wildlife, agro-diversity), loss of landscape, aesthetic beauty, degradation, noise pollution, soil contamination, surface water pollution/decreasing water (physico-chemical, biological) quality are some consequences of the Kimberlitic mining in Koidu [41].

Sierra Leone's rutile and ilmenite production mines are located solely within the Special Exclusive Prospecting License area comprising 580 km² in Moyamba and Bonthe Districts, Southern Province [42] (Figures 3). At Sierra Rutile Ltd (SRL), the mining operations require flooding mining areas prior to rutile extraction or dredging. The aftermath of these operations are worrisome and has affected over 13,000 ha previously used for the agricultural purposes. During the operation of the dredge, the soil nutrient is washed away and the only particle left is sand. This sand is then piled and rendered useless for agricultural and other land use activities for two or more decades if left alone. Besides the dredge mining, the companying is also engaged in dry mining, where the surface soil materials are removed by heavy machineries, thereby exposing the bare clay soil and removing the top fertile soil used for agricultural production.

The environmental impact resulting from the operation include: (i) the degradation of the vast expanse of land exploited; (ii) the risk of flooding of surrounding villages (caused by linkages from the surrounding 'dredging pond'); (iii) siltation in tidal creeks; and (iv) dislocation of several villages [43]. This type of mining has the tendencies to create artificial flooding and ponds in dry areas and destroy any living thing along its operational route. These artificial lakes have the tendency of harboring wild animals like crocodiles, as well as serving as the breeding ground for mosquitoes [44]. The landscape of Rutile mining communities have changed completely with lakes almost everywhere. Equally, the waste water coming from the Sierra Rutile factories are extremely toxic and polluted, and yet, its disposal safety practices is questioned by critics [45, 46]. These wastes are poorly handled in most cases, thereby leading to environmental pollution. Also these sites serve as a mosquito breeding ground, thereby putting the health of local residents at risk [47].

The Shandong Iron Ore mine contains an estimated 11.2 billion tonnes of Iron ores [48] and its extraction involves using big excavators and machineries on a daily basis (Figures 4). The first phase of operation by this company is large surface area clearance with caterpillars and other heavy machineries. The company has caused serious environmental damages such as sinkholes, soil contamination, biodiversity loss, mining process sediments, surface and ground water contamination, air pollution, landscape transformation, and noise pollution. The permanent loss of valuable lands for agricultural activities and its degradation will lead to poverty for the current and future generation since agriculture is the major source of food and income in these areas. The collective environmental impacts of these mining company operations are worrisome and require urgent interventions by stakeholders. FAO/FRA [49] by presenting an analysis of the change in the forest cover of Sierra Leone between 1990 and 2010, concluded that the country lost an average of 19,600 ha or 0.63% per year. When put together, from 1990 to 2010, the country lost 12.6% of its already limited forest cover or around 392,000 ha and the main culprit is mining both legal and illegal. Most of these losses are linked with mining by both the heavy and artisanal small-scale miners.

Mining on a larger scale, more especially, the open-pit method like the one used by Koidu Holdings Ltd and Shandong Iron Ore are causing

serious land degradation and deforestation through forest clearance for road construction within mining sites, hence exposing forest areas to illegal settlement, artisanal mining, and land grabbing [20]. The use of heavy machineries by these companies is a recipe for a greater environmental abuse, and this has left hectares of land bare and unproductive for the next decades. Furthermore, the exposure of these lands renders them susceptible to powerful erosion and run-off, especially during the raining season, thereby leading to environmental degradation. In most of these communities, the local hydrological cycles have also been affected either by company deposit or exposure of catchment areas close to the mining sites. Critics accuse the companies of turning all the potential agriculture lands and

fields into useless piles of red earth and have virtually diverted or block streams that use to flow into the nearby residential areas. Heavy machinery mining have resulted in excessive run-off, loss of productive lands, massive gullies, heavy erosion, water contamination, sink holes, reduction into soil infiltration, and nutrient leaching. This type of mining has the tendency of rendering previous viable lands barred for agricultural purposes as well as creating a non-habitable birds and animal environment. Jackson et al. [50] have concluded that mineral resource exploitation most times results to extensive soil degradation due to vegetation destruction and the alteration of microbial communities, thereby leading to low soil fertility and productivity.



Figures 2. Kimberlite mining and open-pits by Koidu Holdings Company [51, 52].



Figures 3. Sierra Rutile Dredge and artificial lakes and ponds [53, 54].

4.2. Social and economic impacts of Koidu Holdings Ltd, Sierra Rutile Ltd, and Shandong Iron Ore mining in Sierra Leone

Although the mining companies provide jobs, support the government through taxes, and pay royalties and land use compensations, their actions have not totally liberated the indigenes from their suffering. According to DIARSL [57], about 40% of Koidu Holdings Ltd profits is in the form of corporation tax (\$200,000 per annum), annual surface rent of \$25 per acre, and royalties totaling, and 5% of diamond sales and 4% of precious metal sales ultimately go to the state. For example, National Advocacy Coalition on Extractives (NACE) [58] has reported that the

Koidu Holdings employs approximately 600 workers with an average monthly salary of \$250, while the lowest being \$130, and the company is believed to be spending around \$300,000 a month on salary. According to the Koidu Holdings [59] report, the company further spends around \$100,000 to support the two major football teams and awarding scholarships to senior students in the district. These companies employ many local residents who are physically fit for labor jobs, while at the same time, employ citizens with skills from various parts of the country. Similar sponsorship programs and employments are undertaken by the Sierra Rutile and Shandong Iron ore mining companies.



Figures 4. Iron ore mining and clearing [55, 56].

However, the social injustice may outweigh the economic income earn from these companies. The Environmental Justice Atlas (EJA) [41] have reported that socio-economic impact such as displacement increase in violence and crime, militarization and increas police presence, prostitutions, violations of human rights, land dispossession, and loss of landscape are footprint of mining operations. For example, the Koidu Holding Ltd reports a compressive in balance and injustice between the mining company and the environment/community, especially in the recent times, and has unimaginable consequences for the human health and environmental security [61]. In the Tonkolili District, for instance, Steinweg and Römgens [60] have noted that for full development and exploitation of iron ore mining, the Shandong Iron Ore Company requires to relocate the Ferengbeya, Foria, and Wondugu

villages with hundreds of families. Relocations of families have proven to have negative impacts on the social and cultural way of life of indigenes. These relocations hampered the social, economic, and cultural human rights of local residents, especially the vulnerable families. The forceful removal or relocation of certain communities from their native's lands and communities automatically kill their livelihood and damages their cultural heritages and way of life, inherited from their ancestors [62]. Heritage sites such as ancient caves and secret society shrines (sacred groves) have all been destroyed along with all forms of biodiversity. Arable land for agricultural purpose has been destroyed together with agricultural crops and economic trees forcing farming communities into hostile alternative livelihoods [22]. Additionally, the unchecked actions of companies have led to the loss of

plantation fields, cultural, spiritual, societal, and monumental sites that once bind the local indigenes together with strong cultural and spiritual beliefs, as a village or community. The nearby communities who were not relocated are under constant discomfort caused by machines of adjacent mines sites, as well as dust, and eroded mine sediments. Abandoned mining sites and pits serve as a mosquito breeding ground, thereby putting the health of local residents at risk [47].

4.3. Mining as a source of conflicts in mining edge communities

Minerals are one of the root causes of the bloody civil war that lasting for more than a decade and took over 50,000 lives [8] in Sierra Leone. Ross [63] lend support and stated that “grievance mechanism” is when resource extraction creates grievances among the local population because of land expropriation, environmental hazards, insufficient job opportunities, and social disruptions caused by labor migration. Communities where mining operations are ongoing in Sierra Leone are the epicenter for conflicts and confrontations between companies’ securities and local residents. The current population of Sierra Leone stands at 7.2 m [64] with a majority living in rural areas, especially mining communities. For example, the clashes between protesters and company security personnel in December, 2007 in the Koidu City, where Koidu Holdings is in operation left two people from the community dead [65], and in Bumbuna in the north, clashes between the police and the protesters left one dead, some arrested, beaten, and many injured [66]. Upon their death, a commission of inquiry was set up, and their findings were that the main root causes were relocation and resettlement, forceful evacuation before blasting, lack of community benefits, and lack of community participation, among others [67]. Collier [68] argues that sometimes resource wealth has contributed to the conflict trap; even where the country stays at peace, it typically fails to grow; indeed, the surplus from natural resource exports significantly reduces growth. Similarly, In 2015, African Mineral now Shandong Iron Ore company was sued for allegation ranging from false imprisonment, assault and battering, land theft, trespass, rape, and the killing of a 24-year old local resident [62]. Several studies have shown that accountability and transparency have been a major challenge in mining industries across Sub-Saharan Africa [69, 70], and hence, the source of conflict. According to Wilson’s [16]

interview with the local residents of Imperi Chiefdom, Bonthe District, the youth of the community maintained that they were unaware of any tangible development initiative undertaken by the Sierra Rutile Limited and that the company and the traditional leaders sideline youths in decision-making. They have claimed that the company engages and gives community development funds to Paramount Chiefs and traditional leaders, who, in turn, use such funds solely for themselves. The omission of meaningful community engagement by relevant stakeholders and authorities in the extractive industry has affected the mining communities’ development [16]. Based on National Advocacy Coalition on Extractives (NACE) [58], experience especially in Africa, they warn that local benefits from mining companies are usually much smaller in scale than many people, governments, communities expect or claim; at worst, but also common, is that people are made poorer.

4.4. Artisanal mining and its environmental and social consequences in Sierra Leone

The Artisanal mining sector in Sierra Leone plays a significant role in extracting the country’s mineral resources. This sector employs more workers than the formal mining companies in total. The employment advantage of this sector is that it does not require formal education or job connection. All that, it requires physical fitness and willingness. Mensah et al. [13] opined that surface mining was the major approach usually adopted by small-scale mining artisans because of its cheap and require low capital intensity with little or no skill required. They stated that illegal small scale mining operations were conducted in open places with little or no protective gears or environmental best practices, thereby polluting and damaging the nearby vegetation and soils. Although these types of mining approaches have employed thousands of jobless youths in Sierra Leone, their environmental consequences are enormous and worrisome for environmental sustainability. Artisanal mining operations have contributed to massive deforestation and loss of diverse biodiversity and wildlife habitats in Sierra Leone. In the Kono District, for example, artisanal mining operations have destroyed and converted swamps that were once used for the agricultural activities into abandoned lands with pits everywhere. Sources of drinking waters have been reported to be contaminated and properties destroyed when diamonds are suspected at these locations. Small-scale artisanal surface mining

method can lead to the removal of large topsoil deposits, thereby leaving the land bare and exposing it to erosion [13]. The failure of the central government to ensure that mining companies abide by their commitments in the area of corporate social responsibility is making companies not to comply with the state mining protocols [16]. Nguyen et al. [47] have opined that a wide criticism have been directed to the mining activities for their role in shattering economic endeavors, subjecting local environments to irreversible degradation and impacting the health of local residents negatively. According to the Wilson's survey [71], 35 small scale mining companies and five transnational mining companies were operating in Sierra Leone as at 2010. Furthermore, the World Bank [19] has reported that Sierra Leone artisanal miners range of 200,000-300,000 mainly extracting diamonds and gold with 1,800,000 dependent families [72]. A formalized small-scale gold/diamond mining sector could generate significant employment opportunities for thousands of young men and women [73].

5. Way forward

Mining natural resources is actually not a crime but is depleting the environment beyond its potential to recover, and changing the landscape is unacceptable, and it is against the set sustainable development goals. Introducing a three-way approach of 1) sound environmental impact assessment (EIA) adoption before mining starts, 2) carrying out strategic environmental assessment (SEA), and 3) regular engagement with all community stakeholders in locations where mining operations are in progress or will commence are crucially significant to the development of the sector. The above sets of assessments should be done by different consultancies, and their findings made public. This will help the community people to be prepared for the shock and future adjustment in their livelihood activities as a result of the mining operations.

Secondly, the companies should make provisions for immediate restoration activities, rather than waiting to do so after closure, as it is apparent based on experience, they go bankrupt before the stipulated date of closure of their mining operations. Ecological restoration should be done using the recent ecological restoration approaches and by preferred plant species of the community with the local communities included in the process. Such species should be of economic

importance and have a shorter rotation period. Effective community participation in environmental decision-making should be ensured at all times. Companies should engage in environmental awareness campaigns in the mining areas and the nearby communities. Environmental oversight groups that will serve as the pressure force to companies for environmental compliance should be established by the communities. The environmental protection agency (EPA) should ensure the monitoring and assessment of environmental protection compliance protocols by all mining companies in Sierra Leone on a regular basis. The government should ensure that all the environmental management weaknesses and laps in the environmental mining policies be rectified on a regular basis. Sierra Leone should try and incorporate environmental security aspects in its post conflict development agenda and strategy to reduce the negative environmental effects of mining and abandoned mine sites.

6. Conclusions

The collective actions of mining companies in Sierra Leone have led to land degradation, ground water contamination, persistent noise, and air pollutions. In a similar negative vein, the harboring of contaminated waste water breeds mosquitoes that are causing malaria and other related illnesses. The unchecked actions of these mining companies in Sierra Leone have led to the reduction in farm lands, infertile lands, artificial lakes, desertification, and conversion of forest to grass lands, and the extinction of some plant and animals species. Most importantly, the ecosystem support function, provision, regulatory, and cultural capability that support local communities, especially in difficult times, is totally destroyed. The root cause of environmental degradation due to mining in Sierra Leone is due to: 1) severe lack of logistic and human capacity in all government departments associated with mine monitoring; 2) lack of transparency by mine officials; 3) the country lacks efficient mines monitoring the mechanism to ensure that companies comply with laid down environmental protection mandates by companies; 4) policies and other mining instruments have serious gaps and overlaps mandates with similar ministries. Although there are many environmental policies and regulation designs to curb mining atrocities, still the environment has not been free from abuse by mining operations in Sierra Leone. The social and economic injustice unleashed by mining companies in Sierra Leone far outweighs the

benefits realized from these companies. Alternately, there are so many reasons for why the mineral and mining companies have not been complying with the best mining practices in the three case studies. These include, but are not limited to, the following major reasons: corruption, illegal mining/trade, deficient state capacity, political interference of top government officials with company authorities behind the scene, weak institutions and agencies; lack of transparency in payment of royalties, taxes and greed by stakeholders. The environmental problems of mining are diverse, and can only be solved by good government mining policies, rigorous monitoring of mining operation, and the inclusion of community stakeholders in all environmental protection and management decision-making processes. This paper recommends that communities be adequately informed about mine blasting in time, mining edge communities should be adequately compensated and should be given good health care services, abandoned pits should be back-filled, afforestation and enrichment tree planting should be done on all mines sites, with species that can adapt to degraded soil composition, government should review and strengthen its mining policies, institution, regulations, and companies should be encouraged to implement their corporate social responsibilities.

References

- [1]. Antoci, A., Russu, P. and Ticci, E. (2019). Mining and local economies: Dilemma between environmental protection and job opportunities. *Sustainability* (Switzerland), 11 (22): 1–21.
- [2]. Nguyen, N., Boruff, B. and Tonts, M. (2018). Fool's gold: Understanding social, economic and environmental impacts from gold mining in Quang Nam province, Vietnam. *Sustainability* (Switzerland), 10 (5): 6–8.
- [3]. Carvalho, F.P. (2017). Mining industry and sustainable development: time for change. *Food and Energy Security*, 6 (2): 61–77
- [4]. Maier, R.M., Díaz-Barriga, F., Field, J.A., Hopkins, J., Klein, B. and Poulton, M.M. (2014). Socially responsible mining: the relationship between mining and poverty, human health and the environment. *Reviews on environmental health*, 29 (1-2): 83–89.
- [5]. Zulu, L. and Wilson, S. (2012). Whose minerals, whose development? Rhetoric and reality in Post-Conflict Sierra Leone. *Dev. Change*, 43 (5): 1103–1131.
- [6]. Alix, Y. and Freehills, H.S. (2015). Mining in Sierra Leone: an Overview of the Current Legal Framework, 20 May 2015 [Accessed June 2018].
- [7]. Jarrett .H.R. (1956). Lunsar: A Study of an Iron Ore Mining Center in Sierra Leone, *Economic Geography*, 32 (2) 153-161.
- [8]. Wilson, S.A. (2013). Diamond exploitation in Sierra Leone 1930 to 2010: a resource curse? December 2013, *Geo Journal*, 78 (6): 997–1012.
- [9]. Sturman, K. (2015). Evidence synthesis of the impact of extractive industries on political settlements and conflict in East Africa; Centre for Social Responsibility in Mining, Sustainable Minerals Institute the University of Queensland Brisbane, QLD, 4072 AUSTRALIA; Inception Report 27 February 2015.
- [10]. Lubovich, K. and Suthers, E. (2007). Improving Environmental Security in Sierra Leone: The Importance of Land Reclamation. Foundation for Environmental Security and Sustainability. (Retrieved July 2019) www.fess-global.org
- [11]. F.A.O. (2013). Sierra Leone, (Bioenergy and Food Security Projects) BEFS Country Brief <http://www.fao.org/3/a-aq167e.pdf>.
- [12]. Amankwah, R. and Anim-Sackey, C. (2003). Strategies for sustainable development of the small-scale gold and diamond mining industry of Ghana. *Resources Policy* 29 (3-4): 131-138.
- [13]. Mensah, A.K, Mahiri, I.O, Owusu, O, Mireku, O.D, Wireko, I. and Kissi, E.A (2015) "Environmental Impacts of Mining: A Study of Mining Communities in Ghana." *Applied Ecology and Environmental Sciences*, 3 (3): 81-94.
- [14]. I.L.O. (2005). Safe work, Global estimates of fatal work related diseases and occupational accidents, World Bank Regions.
- [15]. IFC. (2014). International Finance Cooperation. World Bank Group. A sustainable and responsible mining guide in Africa: A getting started guide: January 2014.
- [16]. Wilson, S.A. (2015). Corporate social responsibility and power relations: Impediments to community development in post-war Sierra Leone diamond and rutile mining areas, *The Extractive Industries and Society*, 2 (4): 704-713.
- [17]. Mutti, D., Yakovleva, N., Vazquez-Brust, D. and Di Marco, M.H. 2012. Corporate social responsibility in the mining industry: perspectives from stakeholder groups in Argentina. *Resour. Policy*, 37 (2): 212–222.
- [18]. Coumans, C., (2011). Whose development? mining, local resistance, and development agendas. In: Sagebien, J., Lindsay, N.M. (Eds.), *Governance Ecosystems: CSR in the Latin American Mining*

Sector. Palgrave Macmillan, London/New York, pp. 114–132.

[19]. World Bank. (2008). Sierra Leone Mining Sector Reform: A strategic environmental and social assessment. World Bank Sustainable Development Unit. Report No. 44655-SL July 10, 2008.

[20]. Heath, M.J., Merefield, J.R. and Paithankar, A.G. (1993). Environmental impact of mining in tropical forest. *Mining Environmental Management*, September 1993.

[21]. Blinker L. (2006). Country Environment Profile (CEP) Sierra Leone. GOSL and EU report. September 2006 Report.

[22]. Brima, A.A. (2004). Environment, Development and Sustainable Peace: Finding Paths to Environmental Peacemaking Wilton Park Conference-London 16th–19th September 2004.

[23]. Fayiah. M, Otesile A.A and Mattia. S.B. (2018). Review of Challenges Confronting the Implementation and Enforcement of Environmental Policies and Regulations in Sierra Leone. *Int. J. Adv. Res.* 6 (6): 530-541.

[24]. Wendling, Z, Levy, M.A and Sherbinin, A. (2018). Global metrics for the environment: Ranking country performance on high-priority environmental issues; Technical Report January 2018, DOI: 10.13140/RG.2.2.34995.12328

[25]. Chandra, K. (2009). Promoting Good Governance in the Extractive Industry Sector in Asia Pacific: A Value Chain Approach, October, 2009 [Accessed June 2019].

[26]. Madeley, J. (1999). Big business, poor peoples: The impact of transnational corporations on the world's poor. London New York: Zed Books.

[27]. GOSL and UNDP. (2007). Government of Sierra Leone Ministry of Transport and Aviation report. Freetown Sierra Leone, pp 5-20.

[28]. Akiwumi F.A and Butler, D.R. (2008). Mining and environmental change in Sierra Leone, West Africa: A remote sensing and hydrogeomorphological study; August 2008; *Environmental Monitoring and Assessment* 142(1-3):309-318.

[29]. Lichte, R. (2014). Artisanal Diamond Mining In Sierra Leone: Social Impacts, Environmental Awareness And Opportunities For Change: Master's Project Submitted In Partial Fulfillment Of The Requirements For The Master Of Environmental Management Degree Nicholas School Of The Environment Duke University.

[30]. Wilson, S.A. (2015). Corporate social responsibility and power relations: Impediments to community development in post-war Sierra Leone diamond and rutile mining areas. *Extractive Industries and Society.* 2 (4): 704–713.

[31]. Le Billon, P. and Levin, E. (2009). Building peace with conflict diamonds? Merging security and development in Sierra Leone. *Development and Change.* 40 (4): 693–715.

[32]. Levin, E. and Turay, A.B. (2008). Artisanal diamond cooperatives in Sierra Leone: Success or Failure? http://www.ddiglobal.org/contentDocuments/Sierra_Leone_Cooperatives_Study_2008.pdf. [Accessed 5 Jan 2019].

[33]. Maconachie, R. (2009). Diamonds, governance and 'local' development in post-conflict Sierra Leone: Lessons for artisanal and small-scale mining in sub-Saharan Africa? *Resources Policy,* 34, 71–79.

[34]. Wilson, S.A. (2012). Company-community conflicts over diamond resources in Kono District Sierra Leone. *Society and Natural Resources: An International Journal.* 26, (3) 254-269.

[35]. Alao, A. 1999. Diamonds are forever ... but so also are controversies: Diamonds and the actors in Sierra Leone's civil war. *Civil Wars.* 2 (3): 43–64.

[36]. Humphreys, M., Sachs, J.D. and Stiglitz, J.E. (2007). *Escaping the resource curse.* New York: Columbia University Press.

[37]. Auty, R.M. (2001). *Resource abundance and economic development.* London: Oxford University Press.

[38]. Sachs, J.D. and Warner, A.M. 2001. The curse of natural resources. *European Economic Review,* 45, 285–306.

[39]. Ministry of Mines and Mineral Resources. (2018). Mining Agreements [Accessed, November, 2019] <https://slminerals.org/contracts/>.

[40]. Sierra Rutile Ltd Iluka. (2017). Environmental, Social and Health Impact Assessment (ESHIA) for the Sierra Rutile Sembahun Haul Road, Bridge and Transmission Line Project: Environmental, Social and Health Management Plan (ESHMP): CEMMATS Group Ltd, December 2017.

[41]. Environmental Justice Atlas (EJA). (2014). Koidu Diamong Mining conflicts Sierra Leone. (Accessed 23 May 2019).

[42]. Akiwumi, F.A. (2011). Transnational mining corporations and sustainable resource-based livelihoods in Sierra Leone; *Singapore Journal of Tropical Geography.* 32: 53–70.

[43]. World Bank, .1994. Sierra Leone Initial Assessment of environmental Problems, February 7th 1994 Report No: 11920 SL.

[44]. Gbenda T.S and Tucker, P.H. (2014). London Mining Destroying Sierra Leone's Economy [Accessed June 2019] <http://standardtimespress.org/?p=4381>.

- [45]. Akiwumi, F.A .2006. Environmental and Social Change In south Western Sierra Leone: Timber Extraction (1832-1898) And Rutile Mining (1967-2005), Dissertation Presented To The Graduate Council of Texas State University – San Marcos In Partial Fulfillment of The Requirements For The Degree Doctor Of Philosophy, Texas State University, U.S.A.
- [46]. Davis, J.P., Pratt, L.T.T. and Keili, A.K. 1994. The importance of metallurgy in mine planning at Sierra Rutile Ltd. Minerals Industry International, (Jan.): 22-32.
- [47]. Abrahams, A. 2001. Dancing with the chameleon: Sierra Leone and the elusive quest for peace. *Journal of Contemporary African Studies*, 19 (2): 205–228.
- [48]. Mcleod, H.P. (2012). Sustainable Development and Iron Ore Production in Sierra Leone. In *Economic Challenges and Policy Issues in Early Twenty-First-Century Sierra Leone*, Ed. O.E.G. Johnson (International Growth Center; 2012).
- [49]. FAO/FRA, (2005/2010) Forest Cover, Forest types, Breakdown of forest types, Change in Forest Cover, Primary forests, Forest designation, Disturbances affecting forest land, Value of forests, Production, trade and consumption of forest products -- The Food and Agriculture Organization of The United Nations's Global Forest Resources Assessment (2005 & 2010) and the State of the World's Forests (2009, 2007, 2005, 2003, 2001) Available https://rainforests.mongabay.com/deforestation/2000/Sierra_Leone.htm
- [50]. Jackson L.E, Strauss R.B, Firestone M.K and Bartolome J.W. 1990. Influence of tree canopies on grassland productivity and nitrogen dynamics in deciduous oak savanna. *Agriculture, Ecosystems and Environments* 32 (1): 89-105.
- [51]. This is Sierra Leone; Sierra Leone premier online news portal business news .2012. Sierra Leone Diamond town of Koidu lacks old lustre. Koidu Sierra Leone, May 27, 2012.
- [52]. Koidu Holdings Limited page. (2018). Our Mine Through Time, [Accessed on November, 2019] available <http://www.koiduholdings.com/operations-kkp-our-mine-through-time.php>
- [53]. Lord Consulting Engineers. (2006). Sierra Leone: Large Mineral Sands Mining Operation - New Dredge (Accessed, 30 May, 2019).
- [54] Mining Journal .2018. Storied past, future potential for Sierra Rutile; World's largest natural rutile deposit supports long-term production plan. 20th September, 2018 [Accessed November, 2018].
- [55]. Ford, N. 2016. Sierra Leone: Chinese steel firm to invest in \$700m iron ore processing plant; *African Business* 12 December 2016 [Accessed 30 May 2018].
- [56]. African Mining Brief. 2013 Tonkolili Mine Expansion Project, Sierra Leone; August, 27, 2013. [Accessed November, 2019] available at <https://ambriefonline.com/tonkolili-mine-expansion-project-sierra-leone/>
- [57]. Diamond Industry Annual Review Sierra Leone (DIARSL, 2005). Koidu Holdings: The Rewards and Risks of Foreign Investment; The Diamonds and Human Security Project. ISBN: 1-894888-71-5. (Accessed 23 May 2018).
- [58]. National Advocacy Coalition on Extractives [NACE]. (2009). Sierra Leone at the crossroads: Seizing the chance to benefit from mining. www.nacesl.org, Accessed September 3, 2018.
- [59]. Koidu Holdings Limited. (2011). Sports. <http://www.koiduholdings.com/sustainability-community-sports.php>
- [59]. Herbert Smith Freehills, L.L.P. (2015). Mining in Sierra Leone: an Overview of the Current Legal Framework, [Accessed 20 May 2019] available at: <https://s3.amazonaws.com/documents.lexology.com/f101af0b-7452-43c3-a0c9598137bb2fa5.pdf>
- [60]. Steinweg, T and Römgens, I. (2015). African Minerals in Sierra Leone How a controversial iron ore company went bankrupt and what that means for local communities First edition April 2015. ISBN: 978-94-6207-059-2. Stichting Onderzoek Multinationale Ondernemingen (SOMO) Centre for Research on Multinational Corporations.
- [61]. Akabzaa, T. (2000). Boom and dislocation; the environmental and social impacts of mining in the Wassawest district of Ghana. TWN, Africa. [Accessed June 2018]. <https://trove.nla.gov.au/work/33423645?q&versionId=41062909>
- [62]. Africanland Post. (2015). Violated villagers in Sierra Leone fight mining giant. December 7th, 2015. Accessed June, 2018 and available at: <http://www.africanlandpost.com/violated-villagers-sierra-leone-fight-mining-giant/>
- [63]. Ross, M.L. 2004. How Do Natural Resources Influence Civil War? Evidence from Thirteen Cases; *International Organization*. 58 (1): 35-67.
- [64]. Statistics Sierra Leone. (2015). Population and housing census summary of final results planning a better future. freetown sierra leone [Accessed December, 2018].
- [65]. Nina, D. (2012). Violent strike halts work at Sierra Leone Koidu diamond mine. Accessed June, 2018.
- [66]. Gurdian Newspaper. (2012). Mining company accused over deadly police crackdown in Sierra Leone, April 2012.
- [67]. Kawamoto and Kazumi. 2012. Diamonds in war, diamonds for peace: Diamond sector management and kimberlite mining in Sierra Leone. (Accessed 1 August 2019).

[68]. Collier, P. (2007). *The Bottom million: Why the Poorest Countries are Failing* New York: Oxford University Press.

[69]. Maconachie, R. and Hilson, G. (2013). Editorial introduction: the extractive industries, community development and livelihood change in developing countries. *Community Dev. J.* 48 (3): 347–359.

[70]. Campbell, B. (2012). Corporate social responsibility and development in Africa: redefining the roles and responsibilities of public and private actors in the mining sector. *Resour. Policy* 37 (2): 138–143.

[71]. Hilson, G. (2006). Championing the Rhetoric Corporate social responsibility in Ghana's Mining Sector. *Greener Manage. Int.* 53, 43–56.

[72]. Hilson, G. (2016). *Artisanal and small-scale mining and agriculture: Exploring their links in rural sub-Saharan Africa*. IIED, London.

[73]. Maconachie, R. and Hilson, G. (2009): Artisanal Gold Mining: A New Frontier in Post-Conflict Journal Sierra Leone? *Journal of development studies.* 47 (4): 595-616.

معدن و تخریب محیط زیست: هدیه‌ای که سناریوی اندوه را برای جوامع معدنکاری در سیرالئون به ارمغان می‌آورد

موشه فیاح*

گروه جنگلداری، دانشکده مدیریت منابع طبیعی، دانشگاه نجاله، نجاله، سیرالئون

ارسال 2019/08/13، پذیرش 2020/02/27

* نویسنده مسئول مکاتبات: moses.fayiah@yahoo.co.uk

چکیده:

سیرالئون از منابع طبیعی فراوان برخوردار است اما به دلیل عملیات معدنکاری مستعد تخریب محیط زیست است. بیشتر اوقات، هزینه‌ها و آسیب‌های وارده به محیط زیست در اثر عملیات معدنکاری، جوامع معدنی را با تنش‌های اجتماعی روبرو می‌کند. طی دهه‌های گذشته، سهم بخش معدن در توسعه کشور تحت الشعاع این واقعیت است که عملیات معدن اثرات منفی بر محیط زیست داشته است. عمده این اثرات منفی به دلیل سیاست‌های ضعیف زیست محیطی کشور و عدم موفقیت موسسات ناظر بر معادن و عملکرد شرکت‌های معدنی است. این مقاله به دنبال بررسی مفهوم معدنکاری در سه بعد جوامع معدنی در سیرالئون است. همچنین این مقاله از داده‌های ثانویه از مقالات منتشر شده، گزارشات دولتی، کارگاه‌ها و کنفرانس‌های برگزار شده، اسناد سیاسی سازمان‌های غیر دولتی، روزنامه‌ها و موارد مشابه استفاده کرده است تا دیدگاه این نویسنده را در مورد موضوع مورد بررسی مشخص کند. معادن مورد بررسی به شرح زیر است: محدوده‌ی Sierra Rutile، محدوده‌ی Koidu Holdings و معادن سنگ آهن Shandong. محدوده‌های معدنی ذکر شده با دقت بسیاری انتخاب شده‌اند بطوری که تمام آنها در نزدیکی مناطق مسکونی بوده و برای مدت زمان طولانی در سیرالئون استخراج می‌شوند. از شاخص عملکرد محیطی و چارچوب تأثیر معادن برای نشان دادن میزان تأثیر عملیات معدنکاری بر محیط زیست در سیرالئون استفاده شده است. به عنوان پیامدهای معدنکاری می‌توان به افزایش جنگل‌زدایی، نارضایتی عمومی و آلودگی هوا اشاره کرد و همچنین و نارضایتی‌های اجتماعی به دلیل برخی از عواقب غیرقابل قبول از جمله آلودگی منابع آب افزایش یافته است. سابقه موضوع بررسی شده توسط نویسنده آشکار کرد که فعالیت‌های معدنی در سیرالئون دو رو دارند. یک روی آن به عنوان یک نفرین است که به وقوع جنگ‌های داخلی و ناآرامی و نارضایتی‌های اجتماعی دامن زده است. همچنین بخش معدنکاری ستون فقرات اقتصاد است. یعنی این امر به معیشت کشور کمک می‌کند. در این مقاله، رویکردهای سه جانبه روش‌های درمانی بخش معدن معرفی شده است که شامل موارد زیر است: الف) ارزیابی اثرات زیست محیطی (EIA) قبل از شروع عملیات معدنکاری تصویب شود. ب) انجام ارزیابی استراتژیک زیست محیطی (SEA). ج- تعامل منظم با همه ذی‌نفعان جوامع تحت تأثیر معدنکاری. در این مقاله توصیه می‌شود که فعالیتهای بازسازی توسط شرکتهای معدن با گسترش و افزایش بیشتری همراه باشد.

کلمات کلیدی: ملاحظات زیست محیطی، تخریب محیط زیست، سیرالئون، معدنکاری صنایع دستی، منابع معدنی.