

Environmental and Socio-Economic Impact of Mining on Operational Communities in Tonkolili District Northern Sierra Leone

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ABSTRACT

Sierra Leone is a resource-rich country with mining being one of the main economic activity in the country. Mining operations has yielded mixed results across the country with the provision of employment opportunities, and revenues generation on one hand, and severe social, economic, and environmental impacts on the other hand. The present study investigates the environmental and socio-economic impacts of mining on local communities in Northern Sierra Leone. The overriding objectives were to assess local perception of the environment and socio-economic impacts of mining in their communities. To achieve this, 50 respondents were selected using a purposive sampling technique. The result revealed that 80% of the study participants stated that mining has created employment opportunities in contrast to 20% who stated otherwise. With regard to the impact of mining on livelihood, 70% of the respondents mentioned that mining operations have positively impacted their livelihood but 30% had an opposing view with some of them mentioning that mining has exacerbated the rate of loss of agricultural land and loss of other livelihood strategies. Mining has caused a wide array of environmental problems in the operational communities including land degradation, loss of land cover, water pollution, and siltation or sedimentation of water bodies. Thus, the government and other relevant authorities in Sierra Leone should enforce mining laws and policies to ensure that (1) operational communities benefit from mining proceeds, and (2) mining companies comply with their corporate social responsibilities and reduce the environmental, and social cost associated with their operations. Furthermore, environmental awareness campaigns should be strengthened in the affected communities targeting mining companies and artisanal miners alike on the need for environmental protection and sustainability.

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Introduction

Mining is one of the oldest industries in the history of man's development, albeit its nature and form have evolved over the years [1]. It has provided employment opportunities for millions of people across the world. For example, in Australia, the mining sector provided direct employment to 208,200 people between 2013 and 2014, whereas in Ghana, it has created employment for 34,363 people as of 2020 [2,3]. Mining has also significantly contributed to the economic development of many nations such as Jordan where government revenues from the mining sector were US\$ 180.4 million and US\$ 152.3 million in 2011 and 2012 respectively [4]. Moreover, in the second quarter of 2021, the contribution of the mining and quarrying sector to Ghana's GDP was approximately US\$ 809.4 million, and mining export account for 48.4% of Ghana's total exports as of 2020 [3,5]. It was reported that the GDP from mining in Liberia increased to 462.30 US\$ Million in 2020, while in Sierra Leone, mineral

exports contributed about 0.7 to the country's GDP in 2018, and accounts for 64% of the total exports in 2018 alone [6,7].

Mining, is described as a "paradox of plenty" or a "resource curse", signifying that despite its positive economic impact, there are also negative externalities and anomalies associated with its operations [8]. Mining activities have been reported to have a negative impact on the physio-chemical parameters of local streams, consequently making the water unfit for other recreational and agricultural uses such as irrigation, and swimming [9-11]. It has also been reported to cause siltation and sedimentation of local streams, and river pollution [12-14]. In some other regions, mining operations have affected drinking water quality, as reported in the Republic of Guinea where the Lefa gold mine (LGM) released tailing into a lake nearby communities used for domestic chores, resulting in clean drinking water crisis [10].

Furthermore, mining operations are a major point source of air pollution in operational communities, and often release elevated

levels of particulate matter (PM), especially PM10 [15]. Hauling trucks, drilling, blasting, quarrying, and crushing not only create noise but produce dust, affecting the variables of air quality in mining communities [11, 16]. This poses a threat to the health of the miners as well as the local population [16]. In some cases, it could even result in health complications and death, especially in local residents with heart and lung disorders [17]. Other studies on mining found that it can cause the disappearance of aquatic flora and fauna [10-11]. In India, for instance, pollution of the Uppateru estuarine by Iron ore tailing negatively affected the density, diversity, and spatial distribution of Benthic foraminiferal fauna [18]. In Mexico, a significant change was found in the composition of floral communities in a mining site contaminated with heavy metals [19]. Deforestation and soil pollution, heavy metals pollution of soil are other notable environmental impacts of mining [19-21]. The review by other researchers have discussed the impact of mining on human well-being and environmental quality [22].

Irrespective of its environmental implications, there are also social impacts of mining such as high cost of living especially for the non-mining population, high crime rate including violence and tension, and prostitution [8,10, 12-13]. The loss of traditional values and norms and a decrease in the rate of social interaction and habitation of families were also been identified as the social impact of mining on local communities [8]. There are several other social impacts of mining on local communities that have been discussed in the review by [23].

Sierra Leone stands out for its rich mineral resource endowment [12]. There has been a massive investment boom in the mining sector of Sierra Leone over the years, although slowed down by the Ebola Outbreak and Covid-19 pandemic respectively. Similarly, several studies have been reported on mining and its related impacts in Sierra Leone over the years. Some of them had examined the impact of mining on water quality, its impacts on and its potential to support community livelihood [9,12, 24-26]. The relationship between mining and arm conflict in Sierra Leone has also been studied [27]. Other researchers had studied the hydrogeomorphological environmental change caused by mining in Sierra Leone [28]. Moreover, the environmental impact of mining in different operation areas across the country was examined in a recent study [29]. Another study has reported the use of geographic information systems (GIS) in conducting environmental impact assessment (EIA) of mining projects [30].

The current study builds on preexisting studies by investigating the environmental and socioeconomic impacts of mining on selected communities in Tonkolili District, North of Sierra Leone. The objectives were (1) to investigate community perception of mining-related environmental impacts, and (2) to understand the socioeconomic impact of mining on local communities.

Methodology

Description of the study area

Tonkolili District is located in the center of Sierra Leone and

occupies a total area of 7,003km² (2,704 sq. mi). It is crossed by many rivers including the Pampana River and the Rokel River. The

district has both highlands and low lands, and it comprises eleven chiefdoms, with Magburaka as the capital, and mile 91, as the commercial center. According to the 2015 Population and housing census the district has a population of 530,776 [31]. Agriculture also plays a significant role in the district's economy, the biggest bioenergy company in Africa, sunbird petroleum, operates mostly in this district. There is also a significant agricultural activity at the Magbass sugar production facility and refinery run by compliant, a Chinese construction engineering firm. The major minerals mined in the district are iron ore, bauxite gold to lesser extent diamonds.

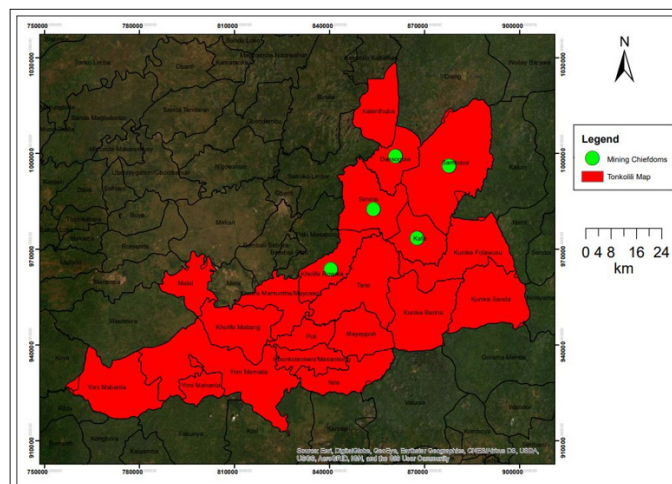


Figure 1: A map showing study area in the Tonkolili district

Sampling Procedure

Information on mining locations was obtained from buyers of gold, and chromite. Additional information was also sought from a staff of the National Mineral Agency (NMA) and the locals. A familiarization visit was made to the affected communities to engage stakeholders on the overarching aim of the study. Three students from the department of mining engineering, at Ernest Bai Koroma University of Science and Technology, were recruited as field enumerators. They were dispatched to specific communities which were randomly selected (Table 1) four mining chiefdoms (Figure 1). The random selection technique was used because the impact of mining is nearly the same in all the communities targeted in the study. This was confirmed during the familiarization visit to the various communities.

The study used both qualitative and quantitative methods. The qualitative approach collects data based on life experiences and participants' understanding and perceptions [13]. The study participants were carefully selected to obtain different information from each of them using a purposive sampling technique. The data obtained from the field was analyzed using Microsoft excel.

Ethical Consideration: Before questionnaires were administered to participants, their consent was sought, and questions were asked only to those who approved of the study consent. As part of the agreement in the consent form, the personal data of participants is not included in the analysis and thus kept anonymous.

Table 1: Name and location of the targeted communities

Name of community	Chiefdom	Section
Bendugu	Sambaya bendugu	Browa
Bumbuna	Kalansogia	Upper
Kamankay	Kalansongia	Lower
Kamathor	Kalansongia	Kamakatie
Nerakoroh	Kalansongia	Lower
Kalmaroh	Kholifa rowalla	Lalenken
Massanga	Kholifa rowalla	Lalenken
Makamba	Kholifa rowalla	Lalenken
Mayarba	Kafe simiria	Mayarba
Kemirukiuln	Kafe simiria	Makelifa
Masumbrie	Kafe simira	Simira
Matham	Kefe simiria	Mayaso
Malompoh	Kafe simiria	Makefla
Mabonto	Kafe simira	Mabonto

Result and Discussion

The questionnaires were administered to different segments of the population who are directly or indirectly impacted by mining operations. Those targeted include miners, teachers, representatives of youth and women groups, traditional authorities (i.e. town chiefs, section chiefs), farmers, businesswomen, commercial motorbike riders, and ordinary local residents.

Mining and Employment

Mining has contributed to employment in the affected communities as noted by 80% of the respondents. Of these, many are employed in the artisanal mining sector, while a few are employed by large-scale mining companies. The results reported herein are comparable to those reported from other places such as in the Upper East Region of Ghana where 80% of the study respondents say mining operations had provided jobs for them [32]. A study review has concluded that employment is the key positive social impact of mining [33]. Mining on the other hand is perceived by other locals as a non-contributor to employment, and it has instead increased unemployment rates in mining communities [33]. Twenty percent of respondents stated mining has not contributed to employment opportunities in the operational communities. The authors found out that these were respondents who are not engaged in the non-mining sector, and whose livelihood options have been affected by the presence of mining activities. Some of them also argued that the few jobs provided by the mining companies have only benefitted the non-locals. Indeed, the burden of mining on local communities could be severe especially when most of the employment opportunities are provided to non-residents [34]. Although the percentage of respondents who stated mining has not provided employment is in minority, it is comparable to studies in other countries such as in Chapagaon, Nepal where a minority (43%) of respondents noted mining provided job opportunities for the local population [11]. Other researchers reported that mining has led to a high rate of unemployment in the Tarkwa mining region in Ghana [13].

The Impact of Mining on Community Sources of Livelihood

Mining has either positively or negatively affected the livelihood of people residing in the affected communities. The study revealed that 70% of the respondents stated 'yes' mining has impacted their livelihood, while 15 (30%) stated 'no'. Those who answer 'yes' are the ones who have benefited either directly or indirectly from mining operations, as some of them have started small-scale enterprises, and other investments due to the proceeds from mining. This result is similar to those obtained in Uttar Pradesh in India where 81% of the studied population stated their livelihood depends on mining [1].

The respondents who stated 'no' on the other hand, were observed to be mostly agricultural workers. They are aggrieved that mining operations have encroached on their farmlands. Although other studies found artisanal mining is a complementary source of livelihood for people in rural areas in Sierra Leone, it is not always the case as some of the respondents in the current study depend entirely on agriculture and not vice versa [25]. A similar observation was noted in another study of gold mining's impact on livelihood in southern Sierra Leone, where 42.5% of respondents - mostly farmers - were not involved in mining, and claimed mining had destroyed their farmlands [12]. In mining communities, agricultural soils could be exposed to erosion, and the fugitive dust emanating from mining activities can affect soil quality [11]. One of the farmers (coded R45) noted: "I migrated to a neighboring community with my family last year to cultivate crops because miners have destroyed my farmlands".

The impact of mining on livelihood enablers such as agricultural lands is widely reported in other parts of the world. For example, it was found that the environmental destruction caused by gold mining affected the productivity of agricultural activities in the vicinity of the mines [35]. A study in Limpopo, South Africa reported that the destruction of agricultural land by mining activities affected local livelihood, especially agriculture [36]. In Taita-Taveta County, Kenya, loss of land to miners or mining was reported by some indigenous populations [8]. In the Vindhyan Region of Uttar Pradesh in India, 80% of respondents noted that mining caused a significant decrease in agricultural production due to the destruction of farmlands [1].

The impact of mining on livelihood is not only a result of direct land degradation but population displacement or relocation of locals due to mining concession, could also cause the loss of agricultural land. This had been reported for instance in the Geita mine in Tanzania, where an estimated 1800 local residents were relocated and thus, losing their arable farmland [37]. In Ghana, the operation of the Shaanxi Company had caused the displacement of over 500 farmers, and they were not compensated for the loss of their farmlands [32].

Other livelihood foundations such as fishing and traditional healers have also been affected by mining operations. A male respondent (coded R30) who identified himself as a fisherman stated "The use of local streams and rivers by miners to crush and wash the 'gravel' (i.e. earth suspected to contain minerals) has changed the colour of the water. And it is difficult to identify suitable areas to set fish traps, and identify good fishing spots"

A female respondent (coded R38) who is a traditional healer noted that "Deforestation caused by miners had destroyed most of the traditional herbs in the forest. Nowadays, I have to walk a long distance in search of local forest that has herbal medicines most of which were once abundant in my community"

The Environmental Impacts of Mining Operations

The environmental impacts of mining are widespread especially in rural communities in developing countries [38]. In the current study, 80% of respondents stated that mining caused environmental problems, whereas 20% had an opposing view (Table 2). The observable environmental impacts of mining operations as mentioned by the respondents and from field observation are deforestation, land degradation, and water pollution (Table 2, Figure 2). These results correspond very well with those reported in the literature. For example, an earlier study found that gold mining caused soil depression resulting in land degradation in Baomahun, Southern Sierra Leone [12]. Another study reported land degradation, loss of vegetation, and pollution as some of the pressing environmental impacts of mining mentioned by respondents across three districts in Sierra Leone [29]. A study in Guinea found mining caused land degradation and pollution which is affecting the size and availability of arable land [10]. Also, in the Hukaung Valley, northern Myanmar, the extraction of natural resources including gold mining caused a decrease in the percentage of tree cover [39]. A previous study in Indonesia noted a significant increase in forest loss in the operational areas of the Freeport gold mine which is in agreement with the findings of the current study that mining caused deforestation [40].



Figure 2: (a) mining in a forested area (b) scene of a degraded land caused by mining

Table 2: Community perception of the environmental impact of mining

Are the environmental problems caused by mining?	Yes (%)	No (%)	
	80	20	
The types of environmental problems	Deforestation (#/%)	Water pollution (#/%)	Land degradation (#/%)
	15 (30%)	40 (80%)	29 (58%)
Are there previous or current environmental education programs?	Yes (%)	No (%)	
	20	80	

Landfilling or reclamation is the practice of returning the land to a useful state after a major disturbance such as mining [41]. It was observed during field visits that mined pits are not reclaimed in most of the communities (Figure 3). This is consistent with findings of a study in Baomahun, Sierra Leone that reported the same [12]. In line with the findings reported herein, research conducted in the eastern Anti-Atlas, Morocco, also reported that barite mining creates deep and long trenches which are not reclaimed or covered after mining

posing a risk to people and animals [16]. This is one aspect of mining that the national government and the environment protection agency (EPA-SL) should work to address in mining communities. There is a need for land restoration programs to be introduced to replenish degraded lands in mining areas. To preserve ecological integrity and biodiversity, the Czech Republic, for example, introduced a national project on restoring landscapes degraded by coal mining [42].



Figure 3: (a - b) uncovered mining pits

Most of the water bodies in the study area are used by artisanal miners and small and medium scale companies to process dug-out earth suspected to contain minerals (Figure 4). In some of the communities, small-scale companies use machines to mine in the banks of streams and tributaries. This practice has changed the color of the water bodies in the mining communities and perhaps has also caused siltation and sedimentation of local water bodies. The presence of sediment in water bodies especially in rivers could cause “aggradation” in river channels [28]. This is a common mining practice in most parts of Sierra Leone. For instance, a previous study found that artisanal gold miners used local steams for gold extraction and processing, causing diversion and siltation of nearby water bodies [12].

There are contrasting views on whether or not there had been environmental education or awareness-raising programs about mining impacts. The majority (80%) of the respondents stated that there had never been any programme that educate miners or the locals about environmentally friendly mining practices and environmental protection. On the other hand, 20% of the study participants mentioned that there were previous environmental awareness campaigns pertaining to the mining but did not give details on the nature of the programs, and the organizations or institutions that had implemented the programs.



Figure 4: (a) Brownish color of a tributary due to mining (b) artisanal miners gather at the bank of a stream to extract and process (c-d) a machine owned by one of the small-medium scale mining companies digging along the bank of a tributary

The environmental impact of mining mostly affects the labour force engaged in non-mining activities, and the implications have been consistently underestimated in national mining policies [38]. Because of the little benefit of mining to local communities, and the serious environmental impacts, there have been conflict between local communities and mining companies [43]. In Sierra Leone, conflict between local communities and mining companies, and artisanal miners over land rights and environmental damages have been documented, especially, in Kono District, and Bumbuna and its environs in Tonkolili District [29]. The loss of livelihood by locals, and the frequent clashes with miners and mining companies, has resulted in the emergence of a more environmentally conscious population [13]. For example, in Kono district, Eastern Sierra Leone, local residents filed a lawsuit against Ocea - a multinational mining company – in the Economic Community of West African States (ECOWAS) court. The aggrieved locals accused the company of water contamination and other environmental damage in its operational areas [44]. The grievances of affected communities deserve thoughtful consideration by both national and local governments.

Before a mining company commences operation, it is required to undertake an environmental, health, and social impact assessment (EHSIA) study. It is not clear whether mining companies are complying with their EHSIA. Many local residents have heavily criticized the manner in which the public disclosure of the EHSIA are done. Moreover, as part of the conditions of obtaining an artisanal mining license is the rehabilitation of mined out areas. However, artisanal miners renew their license without rehabilitating the mining out areas, which has also been reported in another study [12]. The current mining regulations have drawn criticism from various actors including civil society organization (CSOs) and non-governmental organizations (NGOs) because it has failed to address most of the issues faced by mining communities [29].

Impact of Mining on Community Development

As part of their cooperative social responsibilities, mining companies are required to give back to their operational areas by contributing to community development projects [8]. The literature on the contribution of mining in general or mining companies to be specific to community development is divisive. It was reported that local mining communities in Australia had seen little economic gains as opposed to urban areas where mining activities are not concentrated [45]. In Jordan, mining activities had largely failed to benefit local communities, as many of the development indicators in the non-mining regions in the Northern and Central parts of the country are better off compared to the Southern region where mining is heavily concentrated [4]. In contrast, the Lefa gold mine (LGM) in Guinea, has constructed roads, educational and healthcare facilities in its operational communities as part of its cooperate social responsibilities [10].

In the current study, social amenities such as hand dug wells, sanitation facilities (e.g. toilets), healthcare facilities, and schools are present in most of the communities. The participants were asked to identify who provided or constructed these facilities. Ten percent of respondents stated that they were constructed by mining companies, whereas 30% stated by NGOs, and 60% stated by the government. However, some of the facilities are dilapidated, and the hand dug wells in some of the communities were not working. Also, some of the community schools were without adequate furniture and teachers.

Table 3: Respondents' responses on community facilities

Who provided the facilities	NGO (%)	Mining companies (%)	Government (%)
	30	10	60
What is the status of the facilities	Working	Not in good condition	
	45	55	

It is understood that large and medium-scale mining companies operating in the communities pay surface rents to local communities and taxes to the government annually. The reflection of these monies on community development is largely unseen. A male respondent (coded R20) stated that “the local authorities are the ones reaping the benefit of mining operations, while the ordinary people suffer from the brunt of mining operations”. As is the case in most mining communities across the world, the benefits from mining taxes do not reflect in the socio-economic indicators of the affected communities [11]. This could be because local residents in the mining communities are poor negotiators on mining contracts or it could also be a result of the selfish or personal interest of local authorities [8].

Conclusion

This study reflects local discontent about mining operations and has disentangled the various impacts of these activities on local communities. There is a wide margin of disconnect between the scale of revenue generated from mining in the operational areas, and the level of local development in the mining-affected communities. The Government of Sierra Leone should strengthen the monitoring and supervision of mining companies and artisanal groups to ensure compliance with existing laws. Also, there is a need to sensibly evaluate the prevailing laws and regulations to ensure that proceeds from mining benefit affected communities, while environmental, social, and economic anomalies are minimized. It is recommended that land restoration programs are introduced to replenish degraded lands in severely degraded mining areas.

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