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Economic Opportunities, Environmental Costs, and Attitudes of Mining Communities: Exploratory Evidence from Two Rounds of Independent Surveys in Sierra Leone

Weitong Ji *

Cranbrook Kingswood Upper School, Bloomfield Hills, Michigan 48304, USA

* WJI28@cranbrook.edu

Abstract

Mining in Sierra Leone has provided fiscal revenue and employment for the local people, but there are also problems such as land degradation, water shortage, dust pollution, disruption of traditional life, and an uneven distribution of community benefits. Two rounds of separate cross-sectional surveys investigated whether the residents of the mining area believed the economic benefits compensated for the environmental and social costs. After quality inspection, 33 of the first-round questionnaires were kept, and 40 complete questionnaires formed the second-round main sample. Items Q6–Q22 were five-point Likert scales, and descriptive statistics, Cronbach's alpha, Spearman correlations with Holm correction, Mann–Whitney U tests, and exploratory regression using HC3 robust standard errors were performed. In the second round, 67.5% of the respondents believed that mining created job or income opportunities, but only 37.5% felt that the general benefits exceeded the costs. Employment and income opportunities were positively correlated with the overall assessment ($\rho = 0.600$, $p < 0.001$); environmental impact, livelihood pressure and a combined inequality–participation index were all strongly negatively correlated. A model of employment opportunities and environmental impact reached an adjusted R^2 of 0.564, and employment was positively correlated with the overall assessment while environmental impact was negatively correlated. Employment prospects (Q14) were positively correlated with the overall assessment (Q19) in both waves and thus remained unchanged after cross-sample analysis. The differences between the rounds may be due to changes in the survey location and sample, not time. The people are not entirely for or against the mine; they weigh employment benefits, environmental damage, traditional livelihoods and distributional fairness. The quality of employment, ecological responsibility, community participation and economic restructuring of mining governance should be strengthened.

Keywords

Sierra Leone, mining communities, environmental impact, livelihood, community participation, conditional support.

1. Introduction

Sierra Leone is a relatively resource-rich country that has diamonds, gold, iron ore, bauxite, rutile, etc. Mining has long been a major source of national export earnings, fiscal revenue and local jobs; at the same time, it is also a key industry that the government hopes will promote infrastructure construction and economic development [1]. Although there are abundant mineral resources, the people living in the mining area have not necessarily seen an increase in their income as a result. Earlier research has indicated that, although mining activities are economically beneficial and create jobs, they are also harmful to the environment, resulting in damage such as land degradation, water pollution, deforestation, increased dust and noise,

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damage to agriculture and disruption of traditional life [2, 3, 4]. Thus, the impact of mining on local development will not be reflected merely in output value, exports or the number of jobs. It is also necessary to consider how the benefits and costs will be shared among the people in the community.

Sierra Leone is a typical case mentioned above. Formal mining enterprises and artisanal and small-scale mines provide income for the residents without stable jobs and drive the development of transportation, retail and other service industries. At the same time, land and water resources are also necessary for the mining industry, and they also provide a living for rural families to sustain agriculture and daily life. As mining expands, the degree of mechanisation increases, or mineral resources gradually become depleted, some families may face multiple risks simultaneously, such as reduced agricultural production, unstable mining employment, and a single-income source [5, 6]. Therefore, the attitude of the residents towards mining is likely not a simple case of either full support or outright opposition, but rather an all-around evaluation of economic benefits, environmental costs, disruption of life, and fairness in management.

The existing literature has adequately documented the environmental issues, agricultural impacts, corporate social responsibility, and regulatory deficiencies in the Sierra Leone mining area. However, there are still two interrelated research areas that remain to be explored. First, many studies have focused on ordinary residents, farmers or manual miners, but have insufficiently discussed the differences in the position of interests between the employees of formal mining companies and other community members. Mining employees may directly receive wages and benefits, which makes it easier for them to feel the benefits of the mining industry; Farmers and ordinary residents may bear more costs related to land, water resources and living environment. Second, most studies rely on a single cross-sectional survey. When a convenient sample is highly concentrated in terms of location, occupation or gender, the research results may mainly reflect the composition of the sample rather than the general attitudes of the residents in the mining area. By using two samples from different sources to test whether the core relationship recurs, it can add certain internal robustness to exploratory research.

Based on this, this article employs two rounds of independent questionnaire surveys, with the aim of addressing three key questions: First, how do the residents of mining communities evaluate the employment and income opportunities, environmental impacts, livelihood pressures, revenue distribution, and community participation brought about by mining? Secondly, how do these perceptions relate to the residents' overall judgment on whether the "mining profits exceed the costs"? Thirdly, when the survey location and the composition of respondents are different, can the core results be replicated in the two independent samples? This article does not interpret the two rounds of surveys as a longitudinal tracking of the same group, nor does it explain the differences in rounds as changes that occur over time. The second round of data serves as the main analytical sample, while the first round of data is used to verify the cross-sample replicability of key individual indicators and their relationships.

The two contributions of this article are as follows. All-around analysis systems are used in the empirical study to consider the acceptance of mining by local residents from their own perspectives, covering trade-offs such as economic opportunities, environmental costs, disruption of traditional life, distribution fairness and governance participation. In terms of method, the two different convenience samples were not simply combined to increase the sample size. The study separated the main analysis, independent replication evidence and cross-sample differences instead. Therefore, the changes in sample composition cannot be mistaken for shifts in time or causal effects; otherwise, the conclusions of this study may not align with the actual support level of the existing data.

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2. Literature Review

2.1. Research Background

Mining has been a relatively stable source of government revenue, exports and employment [1]. However, most previous research has shown that the economic benefits of mining have not been effectively circulated to improve the living standards of people in mining areas [7]. Instead, there may be local costs such as land degradation, water pollution, deforestation and damage to traditional livelihoods [2, 4]. Given that most of the rural residents depend on farming for their living expenses, mining activities that take over farmland, pollute water sources and harm the environment will directly damage the natural resource foundation of life for these residents [8].

On the one hand, artisanal mining offers a source of income for residents without formal employment, and it is also a way of life for rural families to cope with poverty and unemployment [5, 9]. On the other hand, Sheriff et al. [3] and Turay [10] have also found that such mining activities are generally highly informal and suffer from problems such as old technology, poor environmental management and unclear reclamation responsibilities [3, 9, 10]. Although the existing laws have regulated the issues of mining permits, environmental impact assessments, compensation for residents and land reclamation, there is a lack of regulatory capacity, insufficient funds and limited community participation, and thus the actual effect of these policies has been reduced [11, 12].

2.2. Research Methods

Existing studies mainly adopt four methodological approaches: questionnaire surveys, mixed-methods research, longitudinal fieldwork, and policy and institutional analysis. Firstly, some studies have examined the effects of mining activities on residents' livelihoods through large-scale questionnaire surveys. Komba et al. conducted a survey of 358 farmers in the Kenema region, using a partial least squares structural equation model to examine the relationships between mining activities, sustainable livelihood assets, corporate social responsibility, and mining acceptance [8].

Secondly, some studies employ a mixed research approach that combines questionnaires with qualitative materials. Sheriff et al. distributed questionnaires to 76 manual gold miners, mining supervisors, environmental protection personnel and local residents, and analyzed the impact of manual gold mining from both quantitative and qualitative perspectives [3].

Furthermore, the research conducted by Maconachie and Conteh is based on over 20 years of long-term field data, focusing on the livelihood adjustments of miners, young people, and rural families in the face of the gradual depletion of mineral resources. This longitudinal approach reveals long-term social changes in mining communities and avoids drawing conclusions about residents' circumstances from a single cross-sectional survey [6].

Finally, policy and governance research mainly employs legal text analysis, institutional assessment, and cross-national comparisons. Mason, based on the field research conducted in Sierra Leone in 2011, focused on analyzing the Mines and Minerals Act 2009, the environmental impact assessment system, and the regulatory capabilities of the Environmental Protection Agency [11].

2.3. Research Objectives

Overall, the main subjects of the existing research are the residents in the mining area, rather than the employees of the formal mining enterprises. Mabey et al. investigated the residents of communities surrounding three large mining areas, focusing on their perception of environmental changes [2]. Komba et al. further narrowed down their research subjects to

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farmers in agricultural communities, analyzing the impact of mining on their natural, social, material and financial livelihood assets [8].

Some studies also included both residents and personnel from the mining industry. Sheriff et al.'s sample included artisanal miners, mining supervisors, environmental protection personnel and local residents. However, most of the artisanal miners in this group are informal or individual miners, and cannot be fully equated with the formal employees working in large mining enterprises. Maconachie and Conteh mainly focused on miners, young people, and rural families engaged in agriculture in artisanal mining communities, and did not separately identify the employees of formal mining enterprises as the research group [6].

Therefore, the existing literature has provided a relatively comprehensive account of the situations of residents and artisanal miners, but pays insufficient attention to the formal employees, management personnel of large mining companies, and their families. This constitutes a significant gap in the current research.

2.4. Main Results

In terms of environmental impact, the existing research has reached a relatively consistent conclusion. The main problems caused by mining activities include deforestation, destruction of farmland, land degradation, water pollution, deterioration of air quality and noise pollution [2]. Artisanal gold mining can also create abandoned, unfilled mining pits and pools of stagnant water, alter the course of rivers and increase the turbidity of water bodies [3].

In terms of economic and livelihood impacts, the research findings exhibit a clear duality. Mining can generate cash income and have a positive impact on the financial assets of some residents, but at the same time it can undermine other livelihood assets such as land, water resources and agricultural production [8]. The ultimate effect depends on the degree to which residents rely on mining income and the severity of environmental damage [3].

In terms of livelihood transformation, after the depletion of alluvial diamond resources, mining has gradually shifted from being the main livelihood activity for rural families to becoming a supplementary or alternative activity. Some miners have sought to return to agriculture or combine farming with mining as part of a broader process of livelihood diversification and re-agrarianisation [6, 13]. Many communities remained “stuck in transition” [6].

In terms of corporate responsibility and public governance, corporate social responsibility is regarded as an important mechanism shaping community acceptance of mining and companies’ social license to operate [14]. Komba et al. discovered that corporate social responsibility can play a significant mediating role between mining activities and community acceptance, indicating that residents not only care about whether mining generates income, but also about whether the enterprises fulfill their responsibilities for environmental restoration and community compensation [8]. However, the current governance of the mining industry still faces problems such as insufficient legal enforcement, limited capacity of regulatory agencies, shortage of funds, insufficient community participation, and poor coordination among departments [11, 12].

Overall, existing studies demonstrate that mining is characterized by the coexistence of short-term economic benefits and long-term environmental and social costs [5, 7, 15]. However, most studies focus on environmental consequences or residents’ subjective perceptions, with insufficient attention paid to differences across stakeholder groups. Future research could further compare the experiences of ordinary residents, farmers, artisanal miners and formal mining employees, in order to determine which groups receive the benefits of mining and which groups bear the environmental and social costs.

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3. Method

3.1. Research Design

This study adopted an exploratory quantitative research design, conducting two independent cross-sectional questionnaire surveys to examine the attitudes of residents in mining-related communities in Sierra Leone. The two rounds of questionnaires used the same core questions Q6 to Q22, but the survey locations and the composition of respondents were different. Given that the two rounds were not a follow-up of the same group of respondents, this article treats them as two independent convenience samples rather than longitudinal data. The second round of core data was complete, the occupational structure of the sample was more similar to that of ordinary community residents, and multiple comprehensive indicators had good internal consistency. Therefore, it was set as the main analysis sample; the first round was used to test whether the key findings could be replicated in another sample.

The analytical unit of this study is the individual who has actual residence, work or living connections with the mining community. The research focuses on the respondents' subjective perception and attitude towards the impact of mining, rather than on objective measurements of environmental pollution levels, the number of jobs created by enterprises, or the size of community funds. Therefore, all the results are interpreted as correlations within the sample and residents' experiences, and cannot independently prove that mining activities have caused a specific environmental or social outcome.

3.2. Questionnaire Structure and Variables

The questionnaire includes basic information of the respondents, as well as 22 Likert-type questions ranging from 1 to 5 and open-ended responses. The Likert scale ranges from 1 (which means "strongly disagree") to 5 (which means "strongly agree"). Q6–Q9 measure land, water quality, dust and noise levels, as well as the overall environmental vulnerability; Q10–Q13 measure difficulties in agriculture, employment substitution due to mechanization, unstable income, and pressure on land-based livelihoods; Q14 measures the perception of employment or income opportunities created by the mining industry; Q15–Q18 measure income concentration, residents' cost burden, community inequality and decision-making power; Q19: To measure whether the respondents believe that the overall revenue from mining is greater than the costs; Q20 to Q22 respectively measure the attitudes towards increasing mining support, strengthening supervision, and developing non-mining industries after the improvement of the environment.

In the second round of data, the comprehensive score for environmental impact is calculated as the average of Q6 to Q9, the comprehensive score for livelihood pressure is calculated as the average of Q10 to Q13, and the comprehensive score for inequality and community participation is calculated as the average of Q15 to Q18. The Cronbach's alpha values for the three indicators are 0.81, 0.86, and 0.70 respectively. The internal consistency of the corresponding indicators in the first round was relatively weak. Therefore, the first round of the replication analysis mainly used the same individual questions, rather than directly comparing the comprehensive scores of the two rounds.

3.3. Data Collection and Sample Formation

A total of 42 paper questionnaires were collected in the first round. After the investigation was completed, the researchers entered the basic information of the respondents, Q6–Q22 and the open-ended responses according to the unified variable coding rules. They then rechecked the numbers, scale scores, missing information and illegible content against the paper questionnaire. After review, 9 questionnaires were excluded and finally 33 were retained. The

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effective samples mainly came from Lalbanka (19 samples) and Lunsar (13 samples), with another 1 sample coming from Mange.

The final analysis data for the second round included 40 completed questionnaires covering the core items Q6 to Q22, which covered 10 Chiefdoms or regions. During the data consolidation process, different spellings of the same location were unified. For instance, Kono and Kono District were combined into the same location category. The second round of samples included more women, farmers, ordinary residents, long-term residents, and respondents living near the mining area. Therefore, it can provide a different community perspective from the first round. Since the sampling was not conducted randomly and the number of samples from different locations was not balanced, the second round still cannot be regarded as a representative sample of all mining communities in Sierra Leone.

3.4. Data Quality Review and Handling of Missing Values

The inclusion criteria for the first round of samples were as follows: The respondents had a practical connection with the surveyed community; Most of the core scale questions have been completed and can be clearly coded as 1 to 5 points; The responses can be regarded as independent opinions, without any obvious duplication. The respondents have sufficient local life experience to evaluate the community changes in recent years. The fact that the questionnaire is explained or recorded by the investigators does not constitute a reason for exclusion. However, Yes, No or unspecified selections that cannot be distinguished into specific Likert levels cannot be subjectively converted into scale scores.

The main reasons for excluding the questionnaires in the first round included the complete absence of the environmental module, the inability to code the core questions extensively, obvious duplication or plagiarism, and the fact that the local residents had lived there for less than one year. G2-17 is missing Q11 and Q18. However, all other core information is complete, so it is retained. For the missing questions, an effective case analysis is conducted instead of using 0 points, 3 points or the average score. Thus, the effective sample size for the majority of the first round analysis was 33, and it was 32 when Q11 or Q18 were involved. There were no missing values for Q6 to Q22 in the second round. All the exclusion and missing value handling is based on data quality standards, rather than depending on whether the answers support the expected conclusion.

3.5. Statistical Analysis

The analysis begins by reporting the sample characteristics, as well as the mean, standard deviation, median, and agreement rate of Q6 to Q22. Since the scale is ordinal data and the sample size is small, the correlation analysis uses Spearman rank correlation. The research focuses on identifying clear theoretical relationships among variables such as employment opportunities, environmental costs, livelihood pressures, distribution fairness, conditional support, and regulatory requirements. It also uses the Holm method to correct the first type of error risk arising from multiple comparisons.

In the second round, three alternative ordinary least squares regression models were further established. With Q19 as the dependent variable, Q14 employment and income opportunities were taken as common explanatory variables, and environmental impact, livelihood pressure or inequality, and the comprehensive score of community participation were respectively added. Since Q19 is strictly an ordinal variable, the OLS results are classified as exploratory analysis. All models report HC3 robust standard errors and check for VIF, Breusch-Pagan test, Shapiro-Wilk residual test, and Cook's distance.

Cross-sample analysis compares the results of the two rounds using the same individual questions. The differences in the rounds of Q6 to Q22 were analyzed using a two-sided Mann–Whitney U test, and Holm correction was applied to 17 comparisons. The effect size of the rank

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two-column correlation was also reported. The cross-sample analysis is mainly used to distinguish "recurring relationships" from "differences influenced by sample composition", and is not used for estimating time trends. Since the two rounds of surveys did not cover overlapping areas, this article does not consider the single combined coefficient of the 73 observation values as the main evidence.

4. Results and Discussion

4.1. Two-Round Sample Structure and Analysis Positioning

After quality review, 33 valid questionnaires were generated in the first round, and 40 complete questionnaires were produced in the second round. A total of 73 observations were provided in the two rounds, but the sample structures were different. In the first round, 84.8% were male and 51.5% were employees of formal mining companies. The survey sites were mainly concentrated in Lalbanka and Lunsar; In the second round, approximately 65% were men, 17.5% were formal mining employees, and farmers and ordinary residents together accounted for 55%, covering 10 Chiefdoms or regions. The second round also included more long-term residents and those who lived near the mining area.

These differences have direct explanatory significance. Professional mining workers are more likely to directly receive wages or company benefits, while farmers and ordinary residents are more likely to feel the impact of mining costs through land, water resources, roads and living conditions. Therefore, this paper focuses on the second round for the main analysis. The first round is used to verify the replicability of the core findings, and the differences between the two rounds are interpreted as sample heterogeneity resulting from the combined effects of location, occupation, and mining exposure methods.

Table 1: Comparison of Sample Characteristics in Two Rounds of Surveys

Sample Characteristics	First Round	Second Round	Explanation
Final valid sample	33	40	A total of 73 observations were conducted over two rounds
Investigation site	Mainly consisting of Lalbanka and Lunsar	Ten Chiefdoms or regions	The second round covers a wider area
Male ratio	84.8%	Approximately 65.0%	The first round was clearly biased towards men.
Formal mining company employees	51.5%	17.5%	The first round is closer to the perspective of mining employees
Farmers and ordinary residents	24.2%	55.0%	The second round is more oriented towards the perspective of community livelihoods.
Residing for more than 10 years	37.5% (n=32)	Approximately 60.0%	The second round saw an increase in the number of long-term residents.

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Very close to or relatively close to the mining area	65.6% (n=32)	Approximately 77.5%	The second round may expose even higher levels of potential issues.
Core topic is missing	Q11 and Q18 each are missing one item.	None	The second round is more complete.

Note. Both rounds were non-random convenience samples. The proportions were calculated based on the samples that entered the formal analysis.

4.2. Economic Opportunities and Overall Assessment of the Mining Industry

The respondents in the second round generally acknowledged that the mining industry could create certain employment and income opportunities, but they did not unanimously form a positive overall assessment of it. Q14: "Mining creates new employment or income opportunities" received an average score of 3.63, and 67.5% of the respondents agreed. In contrast, the average score for question Q19, "The benefits brought by mining outweigh the costs", was only 3.00. Among them, 37.5% agreed, 37.5% disagreed, and 25.0% remained neutral.

This difference indicates that "mining creates jobs" and "mining as a whole has more benefits than drawbacks" are not the same judgment. The former reflects whether residents have observed job positions, wages or indirect business opportunities, while the latter requires residents to consider land, water resources, agriculture, stability of livelihood and distribution of benefits at the same time. Residents can acknowledge that mining brings certain economic benefits, while also believing that these benefits are not sufficient to compensate for the environmental and social costs. This result is in line with the dual nature of the impact of mining that has been emphasized in previous studies: Mining can enhance the financial assets of some families, but it may undermine natural, livelihood and social assets [3, 4, 8].

Table 2: Descriptive Statistics of the Main Variables in the Second Round

Dimension	Item	n	M	SD	Agreement (%)
Environment	Q6 Land or Farmland Degradation	40	4.13	0.94	77.5%
Environment	Q7 Water Quality Decline	40	4.10	0.96	80.0%
Environment	Q8 Increase in dust, noise or air pollution	40	4.28	0.78	90.0%
Environment	Q9: The local environment has become more fragile	33	3.30	1.47	51.5%
Livelihood	Q10: Agricultural production has become more challenging.	40	4.05	1.04	80.0%
Livelihood	Q11: Mechanized mining reduces local employment	32	3.38	1.41	65.6%
Livelihood	Q12: Household income has become more unstable	33	3.48	1.35	54.5%
Livelihood	Q13 It becomes more difficult to make a living by relying on the land.	40	3.95	1.15	72.5%
Economic opportunity	Q14 Creating employment or income opportunities	40	3.63	1.08	67.5%

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Allocation	Q15: The profits mainly flow to a small number of individuals or enterprises.	40	4.20	0.91	77.5%
Allocation	Q16 Ordinary residents bear more costs	40	4.38	0.74	90.0%
Participation	Q17: Mining exacerbates community inequality	33	3.48	1.09	60.6%
Participation	Q18: Residents lack the power to make decisions	40	4.10	1.01	75.0%
Comprehensive evaluation	Q19: Revenue exceeds cost	40	3.00	1.30	37.5%
Policy	Q20 After environmental improvements, there is greater support for the mining industry.	40	4.45	0.60	95.0%
Policy	Q21: More stringent supervision is required.	40	4.53	0.51	100.0%
Policy	Q22: One should not rely solely on mining.	40	4.45	0.75	90.0%

Note. "Agreement Rate" refers to the proportion of respondents who chose a score of 4 or 5. Questions 6 to 22 all use the 1–5 point Likert scale.

4.3. Environmental Impact and Livelihood Pressure

In the second round of the survey, the respondents showed a high degree of agreement on several environmental issues. Q8: "Increased dust, noise or air pollution" received an average score of 4.28. 90.0% of the respondents agreed, making it the most prominent issue among environmental topics. The average scores for Q6 (land or farmland deterioration) and Q7 (water quality decline) were 4.13 and 4.10 respectively, and the approval rates were 77.5% and 80.0% respectively. These results are consistent with the findings of Mabey et al. [2] regarding the environmental perception of the mining area communities, and also echo the discussions of Sheriff et al. [3] and Turay [10] on the issues of land, water bodies and mining waste sites.

There is also a clear sense of pressure at the level of livelihood. 80.0% of the respondents in the second round believed that mining made agricultural production more difficult, and 72.5% thought that it made it harder for residents to rely on the land for their livelihoods. Mining may create wage employment and opportunities in transportation and retail. However, if it simultaneously undermines agricultural land and water resources, residents will need to reallocate family resources between the unstable mining income and the damaged traditional livelihoods. The concept of "stuck in transition" as described by Maconachie and Conteh [6] thus acquires practical significance: Mining and agriculture do not have a simple substitution relationship. Lack of investment in agriculture, job transitions and support for non-mining industries will cause families to remain in a state of unstable livelihood for a long time.

4.4. Profit Distribution, Community Costs and Resident Participation

The respondents in the second round were not only concerned about whether the mining industry generated profits, but also about who would receive and bear the profits and costs. Q15: "The profits from mining mainly flow to a small number of individuals or enterprises." The average score for this question was 4.20, and 77.5% of the respondents agreed; Q16 "Ordinary residents should bear more of the mining costs" received an average score of 4.38, with the proportion of those in favor reaching 90.0%; Q18: "Residents lack the right to participate in

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mining-related decisions." The average score for this question was 4.10, and 75.0% of the respondents agreed.

This indicates that the acceptance of the mining community not only involves fair distribution of results, but also fair participation at the procedural level. Even if enterprises provide some infrastructure or employment opportunities, if ordinary residents believe that the benefits are concentrated among enterprises, community elites or a few families, while the losses of land, pollution and the pressure on life are borne by the broader community, the social legitimacy of mining projects may still decline. This discovery is consistent with the social permission theory's discussion on trust, procedural participation, and benefit distribution [14], and also supports the viewpoint of Mason [11] that enterprise-led governance is insufficient to replace public supervision and residents' rights protection.

4.5. Correlation and Regression Results: The Trade-Off Between Economic Opportunities and Environmental Costs

The second round of Spearman analysis revealed a strong positive correlation between Q14 employment and income opportunities and Q19 overall mining evaluation ($\rho = 0.600$, $p < 0.001$ after Holm correction). On the contrary, the environmental impact, livelihood pressure, inequality and the overall score of community participation were all strongly negatively correlated with Q19. From this, it can be seen that the residents who can more directly perceive employment or income opportunities are more likely to consider that the benefits of mining outweigh the costs; while those who are more strongly affected by environmental, livelihood and fairness issues are less likely to give a positive overall assessment.

There is also a high degree of correlation among the three negative impact indicators. The correlation coefficient between environmental impact and livelihood pressure is 0.796, the correlation coefficient between livelihood pressure and inequality and participation is 0.794, and the correlation coefficient between environmental impact and inequality and participation is 0.680. This may reflect the cumulative effect of mining: environmental deterioration may increase agricultural pressure, and the loss of livelihoods may deepen residents' perception of unfair distribution of benefits. However, all the indicators are derived from the same questionnaire. The high correlation might also be partly due to common method bias or the overall attitude tendencies of the respondents. Therefore, the regression analysis did not incorporate all three highly correlated composite indicators into the same model simultaneously.

Among the three alternative models, the employment opportunity and environmental impact model exhibited the most stable statistical performance. After controlling for environmental impacts, for every 1-point increase in Q14, the average score of Q19 increased by 0.555 points; After controlling Q14, for every 1-point increase in the comprehensive environmental impact score, Q19 decreased by an average of 0.882 points. The absolute values of the two standardized coefficients are close, indicating that positive economic opportunities and negative environmental costs have approximately the same level of importance in the overall judgment of the residents. Although the indicators of livelihood pressure and inequality were significantly correlated with Q19 in the correlation analysis, the independent coefficients after controlling for Q14 did not reach the 0.05 significance level. This is more likely to reflect the instability caused by small sample size, overlapping indicators, and high-impact cases, rather than suggesting that these issues are unimportant.

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Table 3: The Reliability of the Second Round of the Scale and the Main Spearman Correlation

Explanatory Variable or Indicator	Item	Cronbach's α	Outcome Variable	Spearman ρ	Holm p
Employment and income opportunities	Q14	—	Q19	0.600	<0.001
Environmental impact	Q6–Q9	0.81	Q19	-0.667	<0.001
Livelihood pressure	Q10–Q13	0.86	Q19	-0.675	<0.001
Inequality and Community Participation	Q15–Q18	0.70	Q19	-0.680	<0.001
Environmental impact	Q6–Q9	0.81	Q20	0.509	<0.001

Note. Q14 is a single variable and does not calculate Cronbach's alpha. The *p*-values have been corrected by Holm's multiple comparison method.

Table 4: The Exploratory OLS Regression of the Second Round Q19 Overall Mining Assessment

Model	Explanatory Variable	B	Standardized β	HC3 p	95% CI
1A	Q14 Employment and Income Opportunities	0.555	0.460	0.004	[0.191, 0.919]
1A	Overall score for environmental impact	-0.882	-0.476	0.009	[-1.532, -0.232]
1B	Q14 Employment and Income Opportunities	0.496	0.411	0.085	[-0.071, 1.063]
1B	Overall score of livelihood pressure	-0.609	-0.392	0.114	[-1.371, 0.153]
1C	Q14 Employment and Income Opportunities	0.514	0.426	0.061	[-0.025, 1.053]
1C	Inequality and Community Participation	-0.761	-0.395	0.115	[-1.716, 0.195]

Note. The dependent variable is Q19. Model 1A: Adjusted R^2 = 0.564, AIC = 104.22; Model 1B: Adjusted R^2 = 0.468, AIC = 112.20; Model 1C: Adjusted R^2 = 0.477, AIC = 111.50. All models use HC3 robust standard errors.

4.6. Cross-Sample Replicability and Differences

The first round of data provided independent replication evidence for some of the core results. The average scores for the two rounds of Q14 regarding employment and income opportunities were 3.70 and 3.63 respectively, and the approval rates were 69.7% and 67.5% respectively. The results were highly similar. The average scores for the two rounds of Q19 mining revenue exceeding costs were 3.12 and 3.00 respectively, both being close to the midpoint of the scale. More importantly, the Spearman correlation coefficient between Q14 and Q19 was 0.505 in the first round and 0.600 in the second round. The direction and intensity were both relatively consistent. Therefore, the positive relationship between employment and income opportunities and the overall mining evaluation constitutes the most stable cross-sample finding of this study.

Dust, noise and air pollution also occurred repeatedly in both cases. The average scores of Question 8 in the first and second rounds were 4.00 and 4.28 respectively, and the difference was not statistically significant. Even though the survey locations and occupational structures

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were different in the two rounds, residents generally regarded dust, noise or air pollution as one of the most directly felt impacts of mining.

However, not all the results from the two rounds were the same. After Holm correction, the second round scored significantly higher in terms of water quality deterioration, land livelihood pressure, income concentration, and conditional support for environmental improvement. The second round included more farmers, ordinary residents, long-term residents and those living near the mining area, while in the first round, more than half of the samples were formal mining employees. Therefore, these differences cannot be interpreted as indicating that the mining problems in the second period have worsened. Instead, they are more likely to reflect differences in regions, occupational interests, and the ways in which mining is exposed. The difference in reliability between the two scales also indicates that cross-sample conclusions should be based primarily on the consistency of individual items and directions, rather than simply comparing the coefficients of comprehensive indicators.

Table 5: Replicated Results and Significant Differences of the Two Rounds of Investigations

Indicator or Relationship	First Round	Second Round	Cross-Sample Judgment
Q8 Mean	4.00	4.28	All focus on highlighting environmental issues
Q8 Agreement Rate	78.8%	90.0%	In the same direction
Q14 Mean	3.70	3.63	Very close to
Q14 Agreement Rate	69.7%	67.5%	Very close to
Q19 Mean	3.12	3.00	All are close to the midpoint of the scale
ρ of Q14 and Q19	0.505	0.600	The most stable replicated relationship
Q7 Water quality has deteriorated.	3.09	4.10	The second round was significantly higher; Holm p = 0.03
Q13 Land-based Livelihood Pressure	3.06	3.95	The second round was significantly higher; Holm p = 0.039
Q15 Revenue Concentration	3.15	4.20	The second round was significantly higher; Holm p = 0.048
Q20 Conditional Support	3.33	4.45	The second round was significantly higher; Holm p < 0.001

Note. The two rounds were composed of respondents from different locations and different groups. The significant differences cannot be attributed to changes over time. The effect sizes for Q7, Q13, Q15, and Q20 were 0.41, 0.40, 0.38, and 0.52 respectively.

4.7. Conditional Support, Regulatory Requirements and Economic Diversification

The environmental criticism expressed by the respondents in the second round was not equivalent to a complete rejection of mining. Q20: "If environmental protection is improved, it will provide greater support for the mining industry." The average score for this question was 4.45, and 95.0% of the respondents agreed. The comprehensive score of environmental impact was significantly positively correlated with Q20 ($\rho = 0.509$, $p < 0.001$), indicating that residents who perceived stronger environmental impacts were more likely to express conditional support: Their dissatisfaction mainly concerns the pollution, restoration and governance methods, rather than necessarily demanding the cessation of all mining activities.

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Q21 "Mining requires stricter regulation" received an average score of 4.53. All respondents in the second round chose to agree or strongly agree; Q22 "The local economy should not rely solely on mining" received an average score of 4.45, and 90.0% of the respondents agreed. This indicates that, even though the respondents had significant differences in their views on the overall revenue of the mining industry, they were still able to reach a high degree of consensus on strengthening supervision, improving environmental protection, and promoting non-mining industries. In terms of policies, reducing dust during production and transportation, protecting water sources, restoring damaged land, disclosing environmental monitoring and the use of community funds, as well as developing agriculture, small businesses and vocational training, may be more helpful in increasing community acceptance than simply promoting the number of jobs.

It should be noted that there is a significant ceiling effect for questions Q20 to Q22, especially as question Q21 lacks neutral or opposing answers. These questions demonstrate a high level of policy support, but they are not suitable for strictly differentiating between different attitude groups. The specific magnitude of the correlation coefficient also requires careful interpretation.

4.8. Research Limitations

This study has several limitations. Firstly, both rounds were non-random convenience sampling, with sample sizes of 33 and 40 respectively, which does not meet the requirements for inferring the overall parameters of the entire population of residents in the mining areas of Sierra Leone. Secondly, the two rounds of data do not overlap significantly. The survey rounds are intertwined with the location, occupation, and level of mining exposure. Therefore, the differences between the rounds cannot be interpreted as a time trend. Thirdly, all the variables are based on self-reports taken at the same point in time, and they may be affected by common method bias, social expectations, and the way investigators interpret the data. Fourth, in the first round, the reliability of multiple comprehensive indicators was relatively low. In the second round, the correlations among multiple negative indicators were high, which restricted the comparison of cross-round comprehensive indicators and the identification of independent effects. Fifth, Q14 encompasses both employment and income concepts, making it impossible to distinguish between formal jobs, temporary employment, family mining income, and indirect business opportunities. Sixth, Q19 is an ordered variable. The OLS regression in this study is merely an exploratory approximation. In the future, a more comprehensive sample should be used to verify this using an ordered Logit model or another model suitable for ordered outcomes.

5. Conclusion

This article uses two rounds of independent questionnaires from mining communities in Sierra Leone to analyze how residents form their overall judgment regarding the economic opportunities brought by mining versus the environmental and social costs. The study did not simply treat the two distinct convenience samples as homogeneous data. Instead, it used the second round as the main analysis and utilized the first round to test the replicability of the core findings. This approach enables the conclusion to simultaneously reflect the statistical structure of the main sample and the consistency across samples, and also avoids mistakenly attributing location and occupation differences to temporal changes.

The study first confirmed the dual nature of the impact of mining. Most of the respondents in the second round acknowledged that the mining industry could create job or income opportunities, but less than 40% believed that the overall benefits of mining outweighed its costs. Whether residents perceive employment and income opportunities is in a stable positive correlation with their overall assessment of the mining industry; Environmental impact,

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livelihood pressure, inequality and community participation are negatively correlated with the overall assessment. In the regression analysis, the employment opportunity and environmental impact model was the most stable, and the absolute values of the standardized coefficients for both were close. This indicates that residents do not overlook the costs of land, water quality, dust, noise and the overall environment simply because mining creates certain jobs. Nor do they completely deny the economic contributions of mining due to concerns about environmental issues. Their overall attitude is more like a realistic assessment.

The second important finding of the study is that the positive correlation between employment and income opportunities and the overall mining evaluation was repeated in both sets of samples. Although there were significant differences in the survey locations, gender and occupational structure between the two rounds, there was still a relatively strong positive correlation in the direction between Q14 and Q19. This repetition makes this relationship the most reliable quantitative finding of this article. In contrast, the differences in the rounds of water quality, land livelihoods, income concentration, and conditional support are more likely to be influenced by the composition of the sample. Therefore, they cannot be generalized as the common situation for all mining areas.

The research also indicates that the governance of mining communities should not merely focus on whether the mining industry generates total revenue. Residents are also concerned about whether the benefits are distributed fairly to ordinary families, who bears the costs of the environment and living, and whether community members can participate in decision-making regarding compensation, projects and funds. In the second round of respondents, there was a high level of support for improving the environment, strengthening supervision, and developing non-mining industries. This attitude is not simply an anti-mining stance; rather, it represents the demand for a more viable and responsible mining development model. If enterprises and governments wish to maintain the social approval for mining projects, they need to consider environmental restoration, community participation, financial transparency and diversification of livelihoods as integral parts of mining development, rather than as additional compensations after the increase in output.

Given that this study employed a small-scale, non-randomized cross-sectional sample, all the conclusions should be regarded as exploratory evidence and cannot be used for causal inference or nationwide application. Future research can adopt a stratified sampling design based on mineral types, enterprises, locations and occupations, and combine the questionnaires with water and air quality tests, enterprise employment records, community development fund information and in-depth interviews. Only by observing the changes in the objective environment, the results of family livelihoods, and the decision-making process of the system simultaneously can future research more accurately answer which groups in Sierra Leone have been provided opportunities by the mining industry, and which groups have borne the long-term costs.

Data and Ethical Considerations

The questionnaire of this study uses anonymous numbers in the analysis database and does not present any information that could identify individual identities.

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