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Impact of Mining Induced Noise Pollution in Commuinities

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Abstract

Mining contributes significantly to national economic development; however, noise generated from mining operations can adversely affect the wellbeing of nearby communities. This study assessed environmental noise exposure and community perceptions of mining-related noise in six communities located near licensed mining operations in the Ellembele District of Ghana, with attention to the broader issue of cumulative noise exposure from multiple mining activities in the area. A mixed-methods descriptive design was employed, combining short-term environmental noise monitoring with a household survey of 184 residents and interviews with key informants. Quantitative data were analysed using descriptive statistics and comparison with Ghana EPA permissible limits, while qualitative responses were examined through content analysis. Measured noise levels during both morning and evening periods exceeded recommended guideline limits at some locations, indicating potential exposure to elevated environmental noise. Consistent with this, most respondents (82.6%) reported that mining-related noise was disturbing, particularly noise associated with blasting activities and haulage truck movements, and many reported effects on concentration, productivity, and overall quality of life. Residents also noted that noise exposure was irregular and unpredictable and that there had been limited improvement over time despite existing mitigation measures. The findings suggest that communities in the Ellembele District experience meaningful levels of noise disturbance linked to mining operations, and they highlight the importance of considering cumulative noise impacts from multiple industrial activities rather than assessing projects in isolation. Strengthening coordinated monitoring and regulatory oversight may help reduce noise-related impacts on mining-affected communities.

I. INTRODUCTION

Noise pollution has become one of the most pervasive environmental problems associated with industrialization and urban expansion (Hemmat et al., 2023). Among the various sectors contributing to environmental noise, mining operations stand out as a major source due to activities such as blasting, drilling, crushing, ore transportation, and the operation of heavy-duty machinery (Emmanuel et al., 2018). While mining is a vital contributor to national economies, particularly in developing countries like Ghana, its environmental footprint has generated growing concern, especially for communities located close to extraction and processing sites (Mensah et al., 2015).

In Ghana, the rapid expansion of both large and small-scale mining has intensified community exposure to environmental stressors, including air, water, and noise pollution (Emmanuel et al., 2018). However, while dust and water pollution have received substantial attention, the impact of noise pollution on the health and socio-economic well-being of nearby residents has been relatively understudied. Protracted exposure to high noise levels can lead to a range of adverse effects such as hearing impairment, sleep disturbances, annoyance, reduced work efficiency, and even cardiovascular stress. The World Health Organization (WHO) identifies prolonged exposure above 55 decibels (dB) during the day and 40 dB at night as potentially harmful to human health and quality of life (Münzel et al., 2018).

In mining communities, residents are often exposed to unpredictable noise peaks caused by blasting and the movement of haulage trucks. Such disturbances not only affect individual comfort and mental well-being but also have broader social and economic implications such as damaging property, lowering productivity, and reducing property values (Upadhyay et al., 2025). Despite the existence of environmental regulations and noise control guidelines by the Ghana Environmental Protection Agency (EPA), enforcement and compliance remain challenging,

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and there are limited studies on the impact of noise pollution on neighboring communities in Ghana. In many mining districts, noise exposure does not originate from a single source but accumulates from several mining activities operating simultaneously within the same landscape. Literature on environmental assessments shows that project-by-project evaluations often underestimate the real noise burden experienced by communities because they fail to consider overlapping contributions from blasting, crushing, haulage trucks, and processing plants operating at different times of the day. In Ghana, the presence of both large-scale mines and unregulated small-scale mining (galamsey) may further intensify cumulative noise exposures (Agyei, 2022), as galamsey sites frequently operate without standardized noise-control technologies and often work irregularly, including at night.

Although individual mining companies conduct environmental assessments as required by regulation, these assessments typically evaluate noise impacts separately for each project. This approach fails to capture the cumulative noise burden created when several large-scale mines and other mining-related activities operate within the same district. Consequently, communities in Ellembele may be exposed to the combined effects of overlapping blasting, machinery operations, and truck movements, which may create higher overall noise levels than any single mine would generate. This gap highlights the need to assess noise pollution from a cumulative perspective rather than relying solely on isolated project-specific evaluations. Despite the growing mining presence in the Ellembele District, there is little empirical research that quantifies community noise exposure while also documenting how residents perceive and experience mining-related noise. Existing studies in Ghana rarely integrate environmental noise measurements with social data, and most do not explicitly consider the potential for cumulative exposure from multiple operations. This study therefore provides one of the first mixed-methods assessments of mining-related environmental noise in the Ellembele District, combining noise monitoring data with community perceptions to generate a more comprehensive understanding of noise impacts on local residents. This study, therefore, assessed the extent of noise pollution caused by mining activities in the Ellembele District of Ghana. Specifically, the study aims to (1) determine the levels of noise generated by mining operations and compare them with industry standards, (2) analyze the socio-economic impacts of noise exposure on residents, and (3) evaluate the effectiveness of existing mitigation and regulatory measures. The findings provide empirical evidence for improving environmental management strategies and safeguarding the well-being of communities affected by mining-related noise.

II. METHODOLOGY

- *Study Area Description*

The survey was conducted in the Ellembele district of Ghana's Western Region (see Figure 1), which is home to 120,893 individuals. According to the Ghana Statistical Service (GSS), in 2021 the gender distribution in the district was relatively even, with males accounting for 50.1 percent and females for 49.9 percent of the population. The district has been geographically delineated into two distinct regions: an urban area and a rural area. The rural areas accommodate a significant majority of the district's inhabitants around 79.4 percent while the urban areas are home to the remaining 20.6 percent. The region's topography is predominantly undulating, with a peak elevation of approximately 450 feet above sea level. The geological composition of the region is predominantly characterized by the Cambrian stratum of the Birimian formation and the Tarkwaian Sandstone-Association of Quartzite and Phyllites formations. These formations are known to include economically significant mineral resources, including gold, kaolin, silica, and sandstone (Usmam et al., 2021).

This rich resource base has led to mining activities in certain parts of the district, with Adamus Resource Limited (previously known as Endeavour Mining Limited) and MC Wedam Company Limited both operating on a full scale. Additionally, small-scale gold mining operations are thriving, particularly in the Nkroful, Akango-Duale, and Salman communities (Owusu-Nimo et al., 2018). While these mining activities have contributed to the employment of a significant number of youths from the district and to improvements in the local economy, they have also brought significant environmental and social challenges to the district (Usmam et al., 2021).

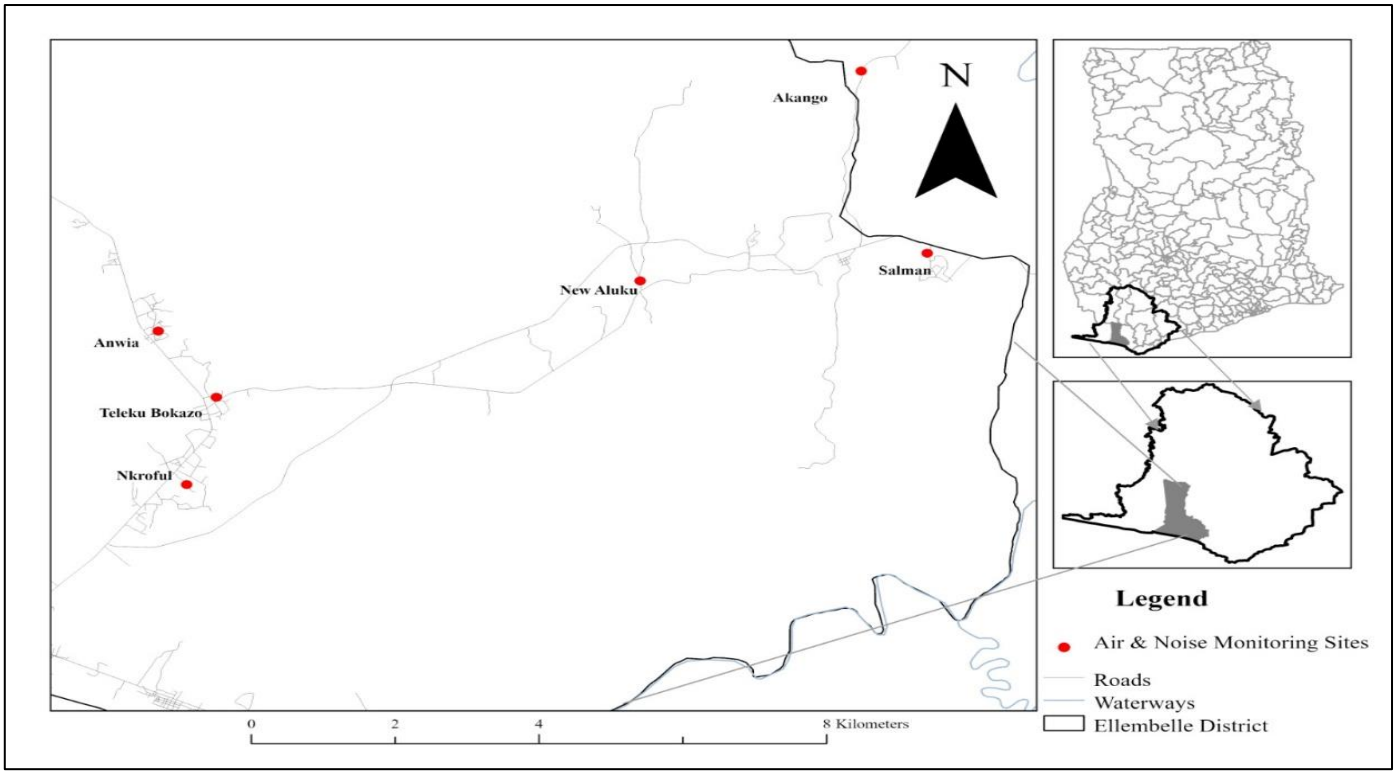

Fig 1 Map of the Study Site Showing Communities in the Ellembele District.

➢ *Research Design, Sampling Technique and Size*

The study used a mixed-methods research design, combining both quantitative and qualitative approaches to provide a comprehensive assessment of noise pollution in the Ellembele District. The quantitative component focused on objective noise and survey responses. Noise levels were recorded using CEL-63× sound level meter, and structured questionnaires were used to collect numerical data on the frequency of noise exposure, disturbance levels, and socio-economic effects. The qualitative data involved key informant interviews, open-ended survey responses and field observations. Interviews and focused group discussions were conducted with community leaders, health officers and mining company representatives to understand community experiences, regulatory issues and the combined effects of legal mining and illegal mining activities. A purposive sampling was used to select six communities (New Aluku, Nkroful, Salman, Akango, Anwia, Teleku-Bokazo) based on their close proximity to active mining operations which increases their exposure to noise from blasting, machinery and haulage trucks. A purposive sampling was used to identify individuals as respondents because of their in-depth knowledge of the impact of noise pollution.

By use of Israel's (1992) formula;

$$n = \frac{N}{1 + N(e^2)}$$

Where: n= is the sample size, N= population (179) and e are the significance level Israel 1992); using e = 0.05, with a confidence level of 95% a total sample size of 184 respondents was derived. The gender segregation of this study had 136 males and 48 females. Studies and reports have consistently highlighted the presence of gender inequality and disparities in the participation of men and women in opportunities that enhance the quality of life in Africa, including Ghana (Afele *et al.,* 2021).

Key informants were selected using purposive sampling. Individuals such as community leaders, health officers, school heads, and mining company representatives were chosen because they had direct experience and in-depth knowledge of mining activities and noise-related issues in the district. Community members also assisted in identifying people who were well-informed, ensuring that the selected informants could provide reliable and relevant insights for the study.

➢ *Data Collection Tools*

Primary data was collected using structured questionnaires. Additional data was gathered through key informant interviews. Ten key informants included community leaders, public health officials, and representatives of mining companies. Secondary data for the study were obtained from Environmental Protection Authority noise standards, mining company environmental reports, district assembly documents, and relevant published literature. Field measurement and observation were conducted to enhance the primary data collection process. This study used the CEL-63x Environmental & Occupational Noise Meter, which is designed to measure and assess environmental and occupational noise levels (Meter, 2014). The decibel (dB) scale on the sound level meter measures and shows the noise level. A wide variety of features, including real-time and integrated octave and 1/3-octave band analysis, are offered by the CEL-63x series. The measurements made by this device are compliant with international acoustic measurement standards and are automatically saved in a large internal Flash memory (Mydlarz et.al., 2017).

Noise measurements were conducted in six communities located near mining operations and haulage routes. Short-term environmental noise monitoring was undertaken using a CEL-63x series Type 1 integrating sound level meter (Casella, 63xseries). The instrument was field-calibrated before and after each monitoring session using a Class 1 acoustic calibrator generating 94 dB at 1 kHz, and measurements were repeated if the difference between pre- and post-calibration exceeded ±0.5 dB. A windshield was used during all measurements. The meter was configured to record A-weighted sound pressure levels with Fast time weighting. The logged parameters included the equivalent continuous sound level (LAeq), the maximum sound level with Fast weighting (LAFmax), and the minimum sound level (LAFmin). The microphone was positioned approximately 1.2–1.5 m above ground level and at least 3 m from building façades or other reflective surfaces. Measurements were conducted under suitable weather conditions, and monitoring was suspended during rainfall or when strong winds or gusts were present. Readings were also paused when vehicles or other transient noise sources passed in close proximity to the microphone. At each monitoring location, short-term measurements were obtained for one hour in the morning (06:00–10:00) and one hour in the evening (16:00–20:00), with instantaneous readings recorded at 15-minute intervals. These periods were selected to capture representative operational activity, including haul-truck movements, machinery operation, and community activity levels. Blasting events were not scheduled during the monitoring period and were therefore not captured directly in the measurements. For each monitoring site, GPS coordinates, surrounding land-use type, proximity to the nearest mine facility or haulage road, and the date and time of measurement were recorded. The monitoring protocol followed accepted environmental acoustics practice for short-term community noise assessment. One-hour sampling windows are commonly applied in short-term environmental noise studies to obtain representative snapshots of community exposure where 24-hour unattended logging is not feasible. The morning and evening periods were selected to reflect peak operational and community activity times, including haulage movements and machinery use. Although blasting events were not captured during the monitoring sessions, the measured LAeq and LAFmax values provide meaningful indicators of typical community-level exposures associated with ongoing operations.

- *Data Analysis*

The questionnaire data were analyzed using SPSS (Version 20). Frequencies and percentages were calculated to summarize respondent characteristics and community perceptions of noise exposure. Microsoft Excel was used to generate descriptive statistics for both the questionnaire and noise monitoring datasets. Content analysis was applied to interview transcripts and open-ended questionnaire responses to identify recurring themes relating to noise sources, disturbance, health concerns, and cumulative impacts from multiple mining activities.

The noise monitoring sites were selected purposively based on their proximity to mining operations, haulage routes, and residential areas where residents reported frequent disturbance. Sites were chosen to represent a range of exposure conditions, including communities closest to active mine pits, areas adjacent to haulage truck routes, and relatively quieter reference locations. Community leaders assisted in identifying areas where noise was most noticeable. Environmental noise measurements were analyzed using descriptive statistics. To determine whether the measured noise levels exceeded recommended guidelines, one-sample t-tests were conducted comparing the measured LAeq values with the Ghana Environmental Protection Agency (EPA) permissible ambient noise limits for residential areas. A daytime limit of 55 dB(A) and an evening/night-time limit of 48 dB(A) were used as the reference ("test") values, reflecting the predominantly residential land-use character of the study communities. Statistical significance was set at $p < 0.05$. In addition to hypothesis testing, the magnitude of exceedance was reported by presenting the difference between the measured mean and the regulatory limit, together with the proportion of individual measurements exceeding the applicable guideline value. The analysis of the socio-economic impacts of noise exposure relied primarily on descriptive statistics to summarize household perceptions and experiences.

III. RESULTS

- *Socio-economic Characteristics of Respondents in the Ellembele District of Ghana.*

The socio-economic characteristics of respondents from the Ellembele District are presented in this section. The gender distribution indicated that the majority of respondents were male (73.9%), while females constituted 26.1% of the sample. With the length of residence, most respondents (91.3%) had lived in their respective communities for more than 10 years, while 8.7% reported a length of stay between 5 and 10 years, indicating long-term familiarity with local mining activities and noise conditions.

With the age distribution, most respondents were within the economically active population. The largest proportion fell within the 20–35-year age group, followed by respondents aged 36–50 years, with a smaller proportion aged 50 years and above. This age structure suggests that the majority of respondents were actively engaged in work or livelihood activities that could be affected by environmental noise exposure.

- *The Levels of Noise Generated by the Mines*

The perceived level of noise disturbance from mining activities is presented in Figure 2. The majority of respondents (82.6%) reported that mining-related noise was somewhat disturbing. Smaller proportions indicated that the noise was not very disturbing (8.7%), not disturbing at all (4.3%), or very disturbing (4.3%). Overall, most respondents experienced some degree of disturbance from mining-related noise.

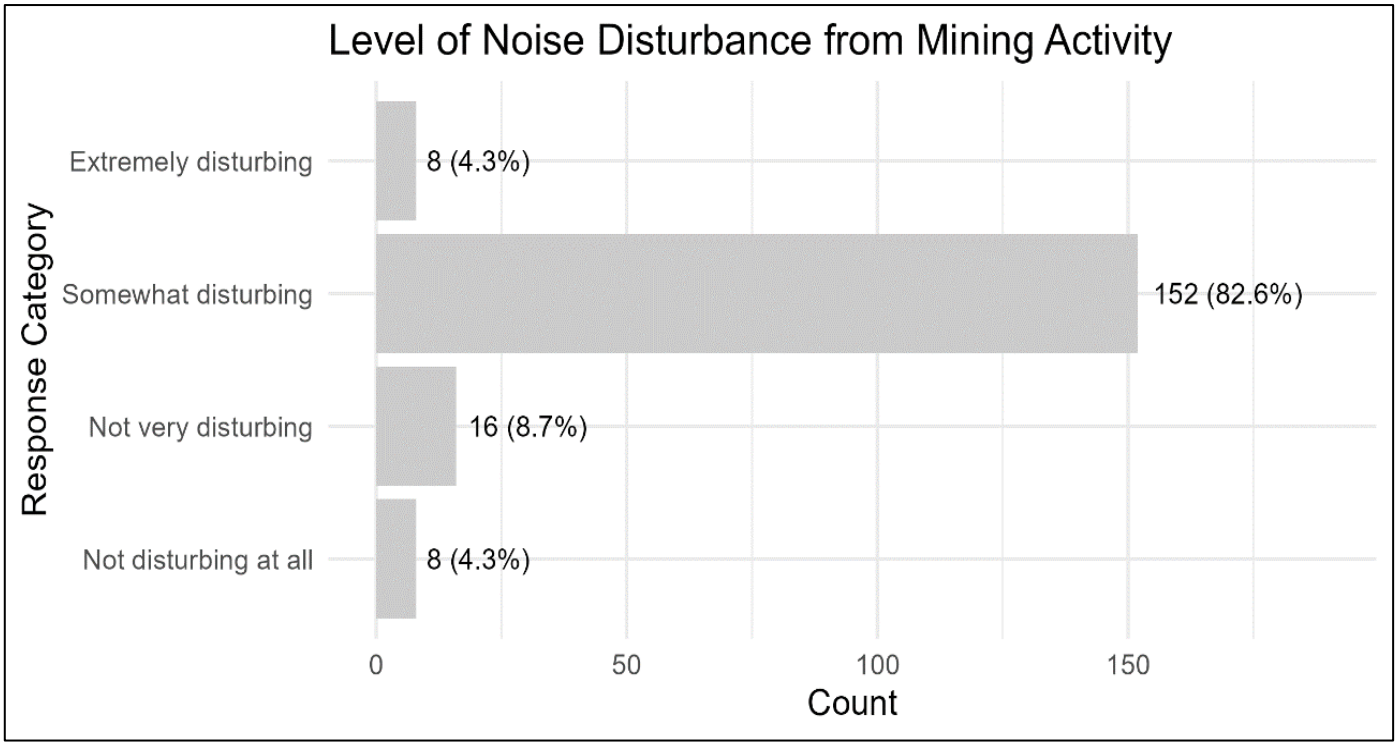

Fig 2 Showing the Level of Noise from the Mining Activity in the Communities in the Ellembele District.

Figure 3 illustrates the reported frequency of noise exposure. Most respondents (60.9%) indicated that they experienced noise randomly, while 21.7% reported experiencing noise frequently and 17.4% reported hearing noise seldomly. These findings suggest that noise exposure in the study communities is largely irregular and unpredictable, which may contribute to increased annoyance and stress among residents.

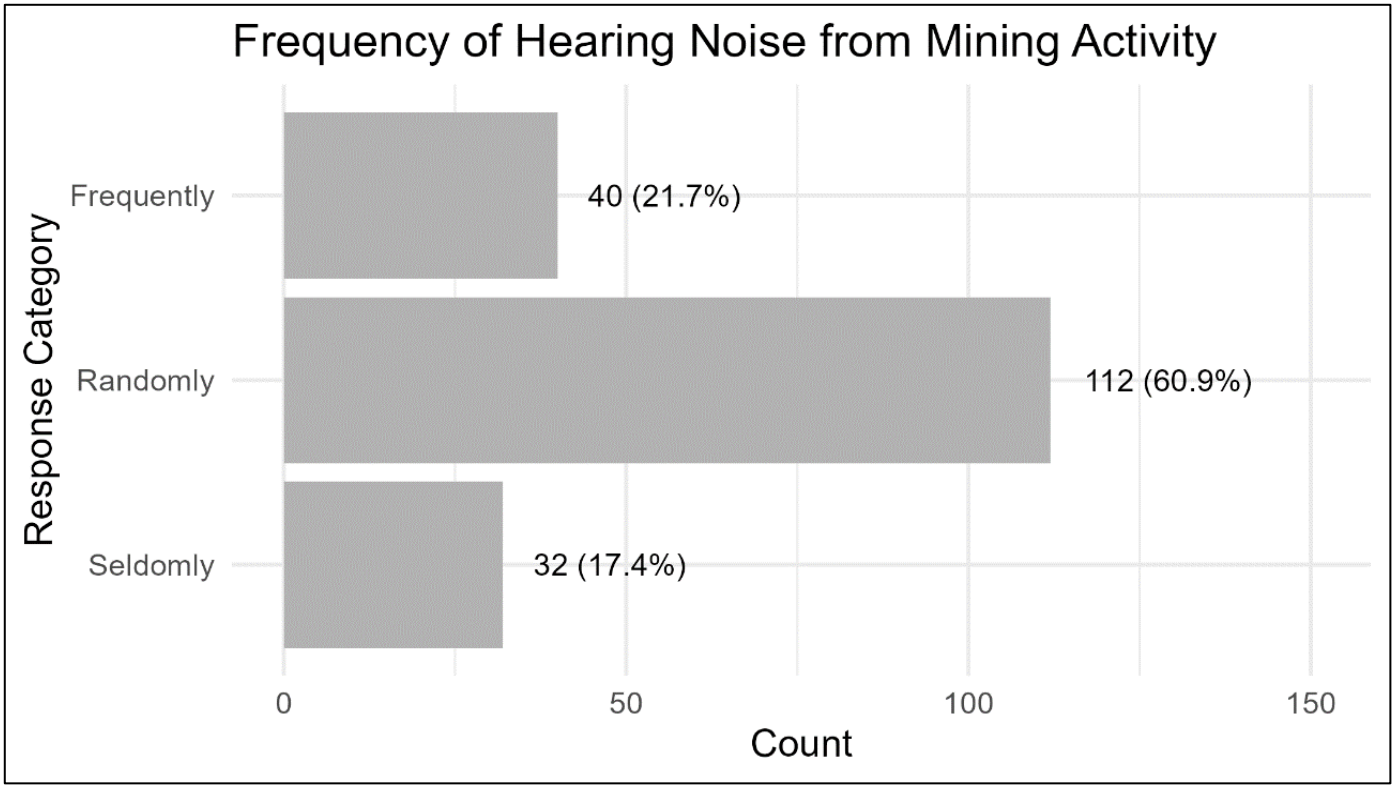

Fig 3 Showing the Frequency of Hearing Noise from Mining Activity in Communities in the Ellembele District.

➢ *Comparison of Noise with Industry Standards*

Descriptive statistics for measured noise levels (LAeq) during the morning and evening periods are presented in Figure 4. Morning noise levels had a mean LAeq of 50.99 dB (SD = 5.94), while evening levels recorded a lower mean LAeq of 44.10 dB (SD = 5.18). This indicates that noise levels were generally higher during the morning period, coinciding with peak mining and haulage activities.

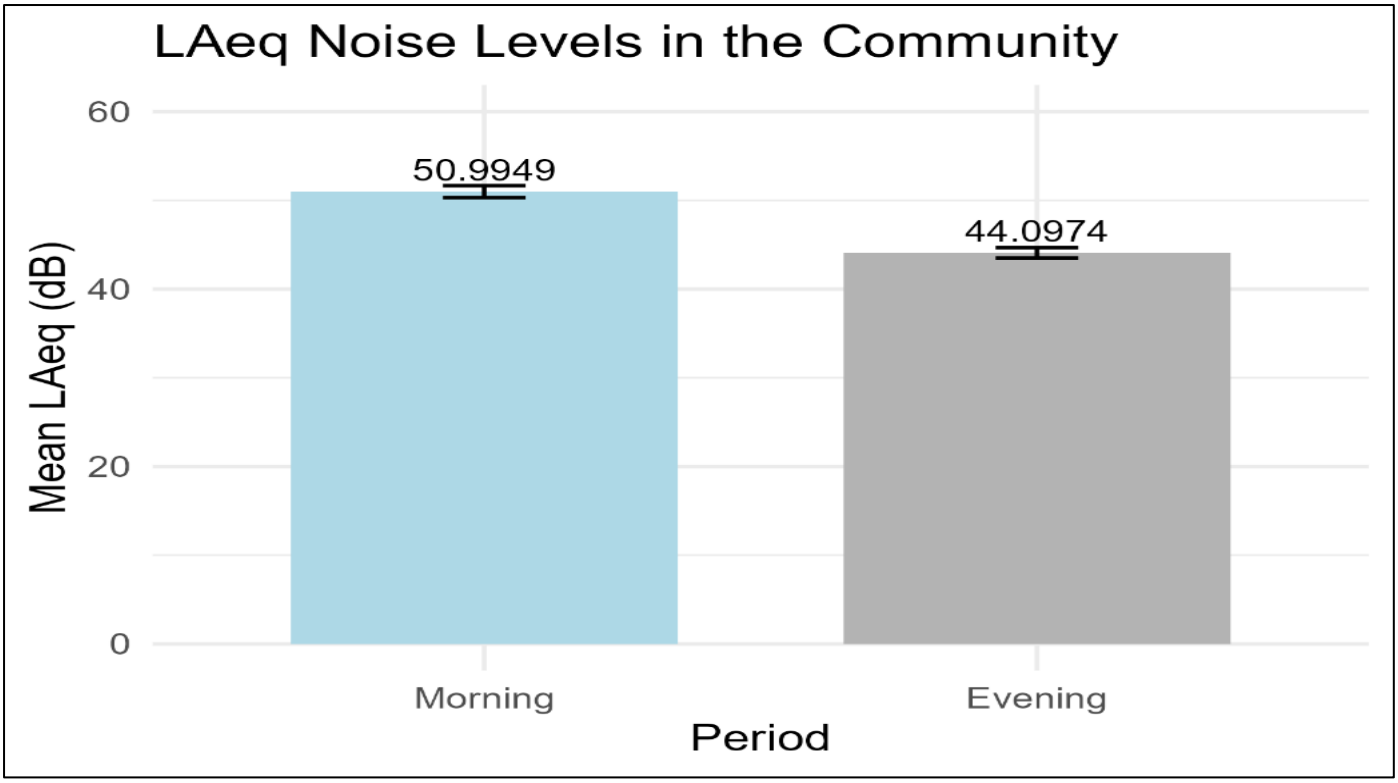

Fig 4 Shows the LAeq Noise Levels in the Communities in the Ellembele District.

A one-sample t-test was conducted to compare measured morning noise levels with the Ghana Environmental Protection Agency (EPA) permissible daytime limit of 55 dB (Figure 5). The mean morning LAeq (M = 50.99 dB) was statistically lower than the regulatory limit ($t = -5.953$, $df = 77$, $p < 0.001$), with a mean difference of 4.01 dB. This indicates that average morning noise levels were within the guideline value, although peak noise events were still observed.

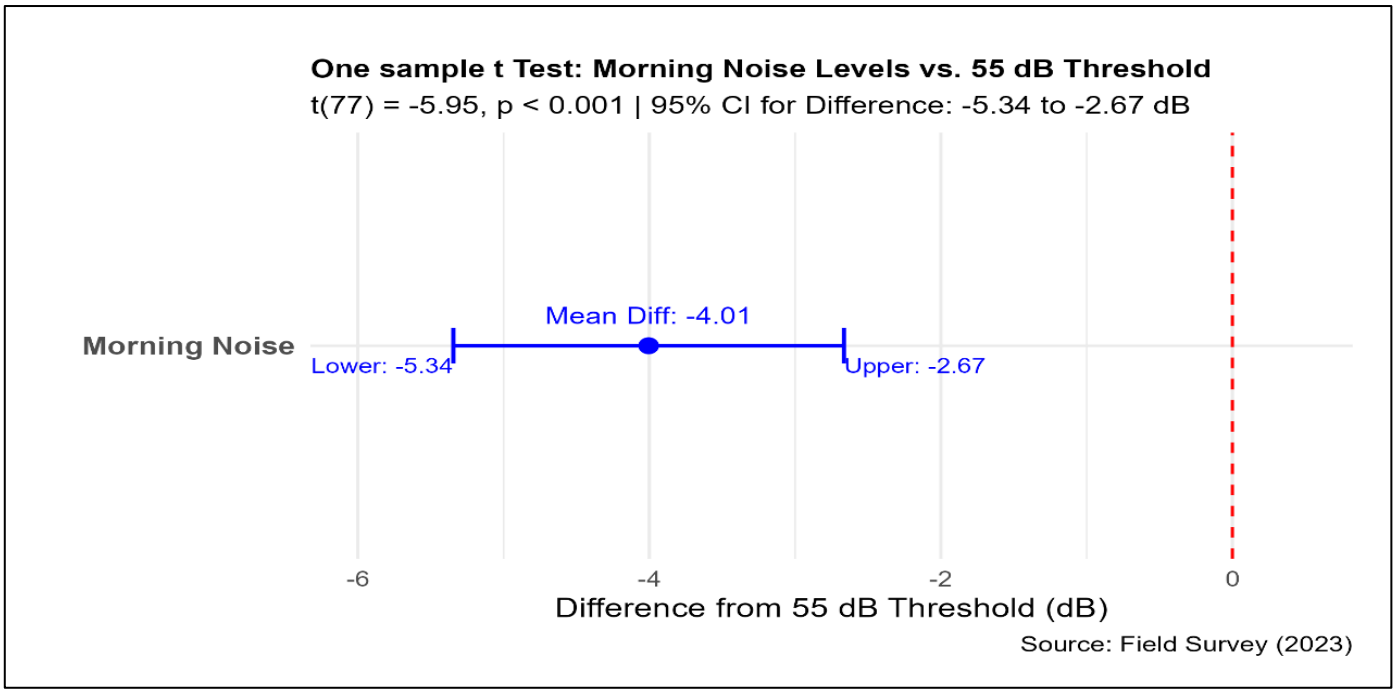

Fig 5 Showing the One Sample Test for Noise Produced by the Mining Firm in the Morning in the Ellembele District.

Evening noise levels were assessed using a one-sample t-test against the EPA evening/night-time limit of 48 dB (Figure 6). For LAFmax, the measured values significantly exceeded the regulatory limit ($M = 72.45$ dB; $t = 20.102$, $df = 77$, $p < 0.001$), indicating the presence of high-intensity noise events during the evening period. In contrast, both LAeq ($M = 44.10$ dB; $t = -6.660$, $p < 0.001$) and LAFmin values remained statistically below the regulatory threshold, suggesting that while average and minimum noise levels were within acceptable limits, intermittent peak noise events persisted.

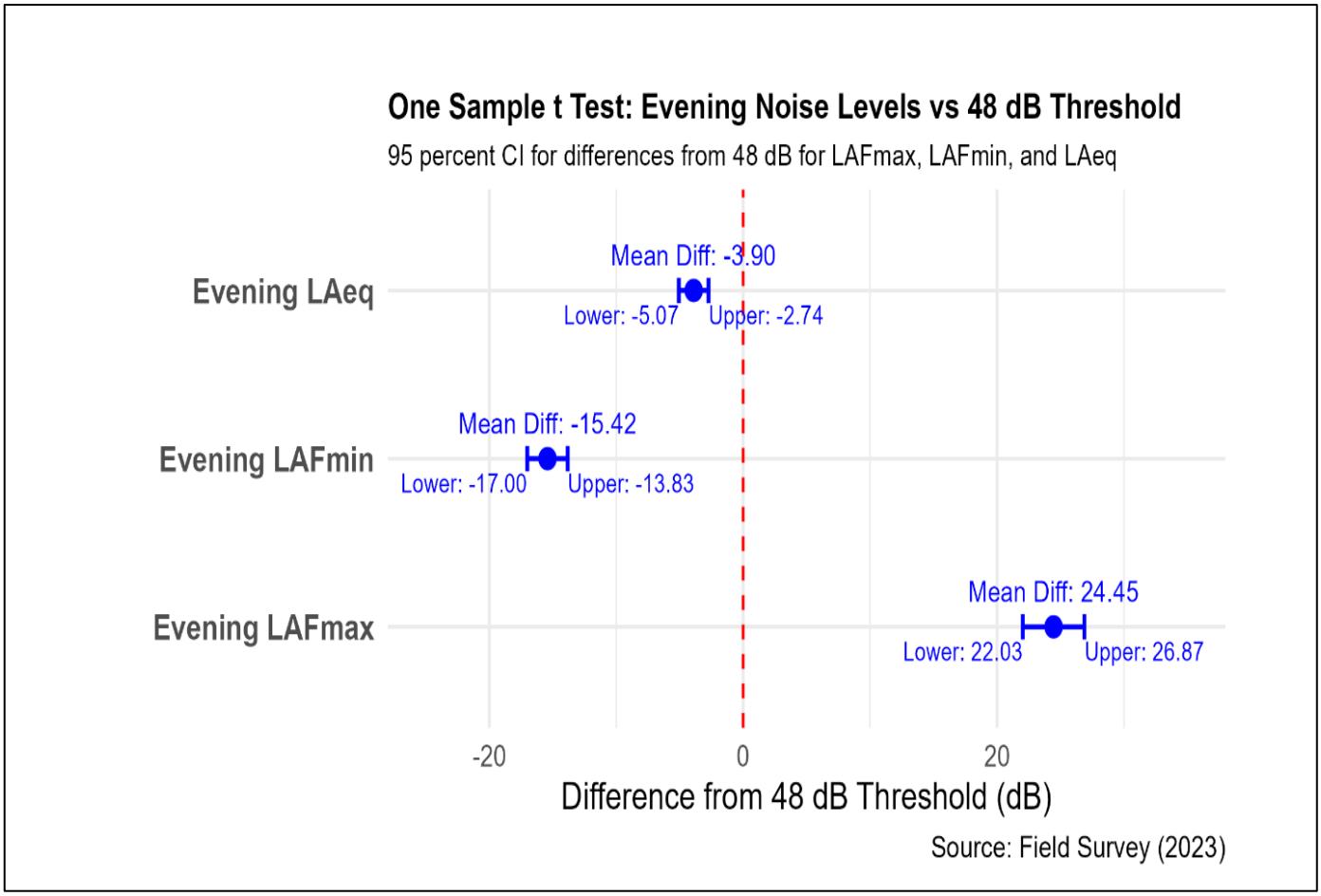

Fig 6 Shows One Sample Test for Noise Levels in the Evening in the Ellembele District.

Conversely, for LAFmin, the test value of 48 dB was significantly lower than the observed noise level, with a t-statistic of -19.350 (df = 77, p < .001). The mean difference demonstrated a substantial deviation of -15.42 dB from the test value. The 95% confidence interval of the difference ranged from -17.00 dB to -13.83 dB, underscoring that minimum noise levels consistently remained below the specified threshold in the evening. Similarly, for LAeq, the test value of 48 dB was significantly lower, with a t-statistic of -6.660 (df = 77, p < .001). The mean difference of -3.90 dB from the test value (M = 44.10 dB) was supported by a 95% confidence interval of the difference ranging from -5.07 dB to -2.74 dB.

- *The Socio-Economic Impact of Noise on Residents of the Mining Community.*

Table 1 summarizes residents' perceptions of the socio-economic impacts of mining-related noise. Nearly half of respondents (47.8%) reported that noise had a significant or very significant effect on their quality of life, indicating notable disruption to comfort and wellbeing. Although only 17.4% directly reported health-related effects or disruptions to daily activities, a substantial proportion (43.5%) were unsure, suggesting difficulty in attributing specific health symptoms directly to noise exposure.More than half of respondents (52.2%) reported that noise interfered with their ability to work or concentrate at home or within the community, highlighting noise as a major stressor affecting productivity. In terms of economic impacts, 57.2% of respondents reported declining property values associated with structural cracks attributed to blasting-related vibration and general mining disturbance. Despite these adverse effects, a large majority (80.0%) acknowledged that mining activities provided employment opportunities and economic benefits, reflecting a perceived trade-off between economic gains and environmental disturbance.

Table 1 Socio-Economic Impacts of Mining-Related Noise on Residents

Question	Mean	Very Significant (%)	Significant (%)	Unsure (%)	Not Significant (%)	Key Interpretation
Have you noticed any changes in your quality of life since the mining activity started in this area?	2.30	8.7	39.1	21.7	30.4	Some respondents reported change in life quality, but majority rated it moderate.
Have you experienced any health issues or disruptions to your daily activities due to noise from the mining operation?	1.80	-	17.4	43.5	39.1	Few reported health effects; many were unsure or unaffected.
Has the noise affected your ability to work or concentrate at home or in your community?	2.30	4.3	52.2	8.7	34.8	Over half of respondents indicated noise affects work and concentration.
Have property values in your community been affected by the presence of the mining activity (noise)?	2.60	14.3	42.9	28.6	14.3	Many observed that noise from mining contributes to reduced property values.
Are there job opportunities or economic benefits associated with the mining activity in your community?	2.50	25.0	55.0	10.0	10.0	Despite noise issues, majority acknowledged some economic benefits.

(n=184)
Source: Field Survey (2023)

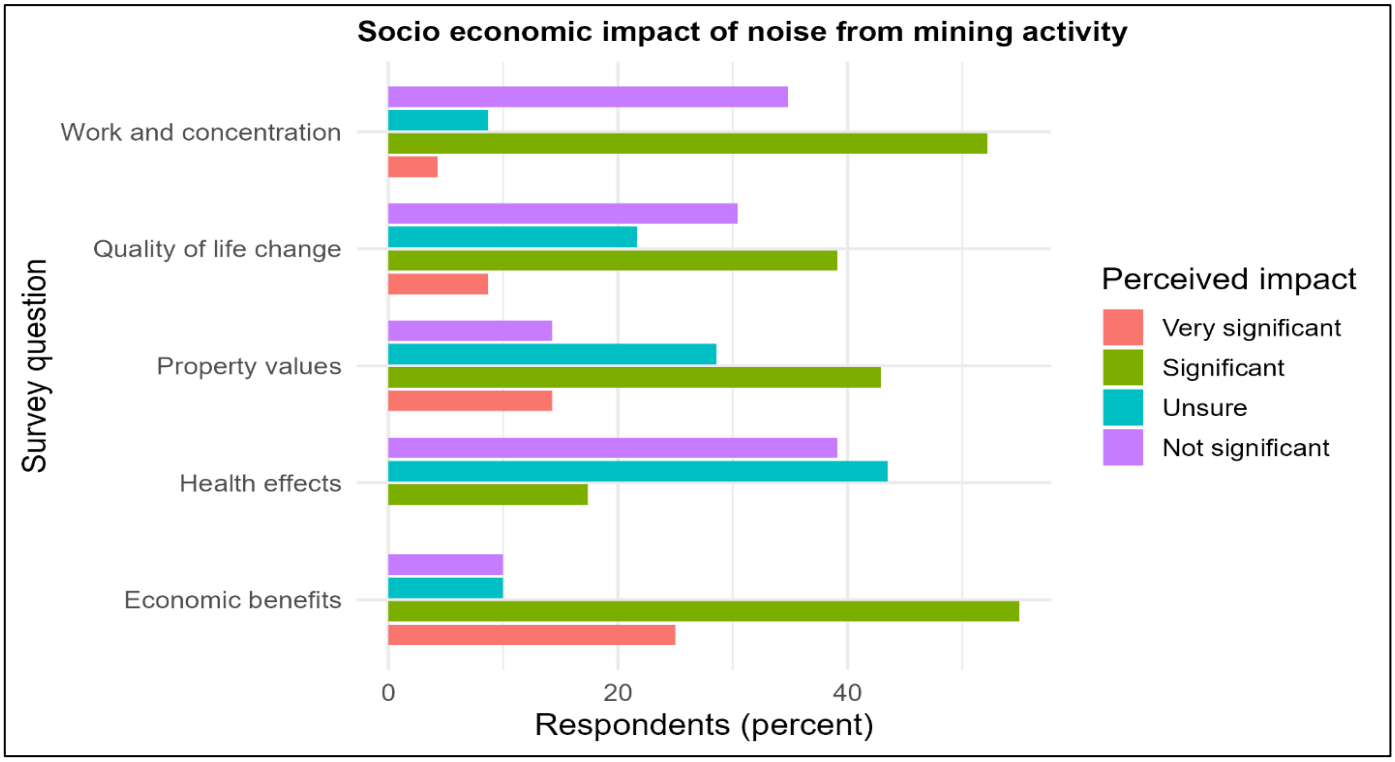

Fig 7 Shows Socio-Economic Impact of Noise from Mining Activity in the Ellembele District.

➢ *Evaluate the Effectiveness of Current Regulatory Policies in Reducing Noise Pollution in the Study Area.*

Perceptions of regulatory effectiveness are presented in Table 2. Respondents reported a mean score of 3.14 regarding improvements in quality of life related to noise pollution, indicating only modest perceived improvement following the introduction of mitigation measures. Few respondents reported extensive improvement, suggesting

that noise disturbance remains persistent. The noise-reduction measures, 34.8% of respondents acknowledged the presence of interventions such as controlled blasting schedules or noise barriers, while 30.4% were unsure and 26.1% reported observing no measures. This may reflect limited visibility of mitigation actions or insufficient communication between mining companies and communities. Perceptions of regulatory effectiveness were mixed. Only 4.5% rated current policies as highly effective, while 40.9% considered them somewhat effective and 36.4% viewed them as ineffective. Awareness of regulatory policies was also limited, with over one-third of respondents reporting low awareness or uncertainty, highlighting a significant information and enforcement gap.

Table 2 Perceived Effectiveness of Regulatory and Mitigation Measures for Noise Pollution in the Ellembele District (n=184)

Question	Mean	Not effective	Slightly effective	Moderately effective	Very effective
Have you seen an improvement in the quality of life in your area regarding noise pollution since these measures were put in place?	3.14	8 4.3%	40 21.7%	56 30.4%	80 43.5%
Have you observed any noise-reduction measures put in place by businesses or industries in the area?	2.77	16 8.7%	64 34.8%	56 30.4%	48 26.1%
In your opinion, how effective are the current regulatory policies in controlling noise pollution?	2.86	8 4.5%	72 40.9%	32 18.2%	64 36.4%
Are you aware of the existing regulatory policies and measures aimed at controlling noise pollution in this area?	2.54	48 27.3%	56 31.8%	8 4.5%	64 36.4%

Source: Field Survey (2024).

IV. DISCUSSION

➢ *The Level of Noise Generated by the Mines.*

A majority of the respondents reported some level of disturbance from noise from the activities of the mining company. This was in agreement with the results of Bansah and Bosompem (2015); Tsoumbou, 2018 who reported that the communities surrounding mining concessions usually suffer some noticeable levels of noise usually from the various activities such as blasting and crushing of rocks. The results show that the frequency of noise exposure experienced by the community members is random and unpredictable. These disturbances may lead to frustration as residents may not be psychologically prepared for the random noises which are in line with studies from Park and Lee (2019) which state that noise has been particularly linked with emotional responses. These findings show that the majority of residents experience moderate or manageable noise levels, which, if they are exposed to over time, could lead to negative health, social, and economic consequences similar to those reported by Hemmat et.al. (2023).

➢ *Comparison of Noise with Industry Standards*

The results in Figure 4 show that the average equivalent continuous noise level (LAeq) recorded in the morning was 50.99 dB, while that of the evening was 44.10 dB. This indicates that noise levels were generally higher during the morning than in the evening. The higher morning readings may be attributed to increased human and vehicular activities, machinery operation, and community movements during working hours, which typically elevate background noise levels (Hemmat et al., 2023).

The recorded morning LAeq of 50.99 dB, although below the Ghana Environmental Protection Agency's (EPA) daytime permissible limit of 55 dB for residential areas, still reflects moderate noise exposure that could cause irritation and discomfort among residents when experienced over time (Bempah and Ewusi,2016). The evening average of 44.10 dB was lower, which aligns with the natural reduction in human and industrial activities after working hours.

These results suggest that the mining firm's morning noise emissions exceeded the specified test value for LAFmax while remaining consistently below the threshold for LAFmin and LAeq. In essence, the mining firm's noise emissions surpassed the allowed limit for sudden peaks in noise (LAFmax) during the morning, yet the average and minimum noise levels during that period remained within the permissible range. This might indicate that while there were occasional loud or abrupt noise peaks that breached the set standard, the overall noise levels and the continuous average noise were generally within acceptable limits. This finding is in agreement with earlier assertions by respondents about the rate of noise and results by Emmanuel et al., 2018 who state that mining activities lead to noise pollution in the communities surrounding mining concessions.

These results indicate that during the evening, the mining firm's noise emissions consistently exceeded the specified test value for LAFmax while maintaining noise levels below the threshold for LAFmin and LAeq. The results reveal significant variations in the noise levels, with LAFmax surpassing the specified test value, while both LAFmin and LAeq fell below the designated threshold. This suggests that while the maximum instantaneous noise level exceeded expectations, the average and minimum noise levels remained below the specified standard during the mining firm's evening activities. This finding is in agreement earlier assertions by respondents about rate of

noise and results by Bansah and Bosompem (2015) who state that mining activities lead to noise pollution in the communities surrounding mining concessions.

- *The Socio-Economic Impact of Noise on Residents of the Mining Community.*

These results align with the general pattern found in mining communities across Sub-Saharan Africa, where residents experience psychological and social discomfort due to persistent industrial noise (Moroe and Kyoza-Shangase, 2022). Noise pollution not only disrupts communication and concentration but can also lead to long-term stress, sleep deprivation, and reduced life satisfaction (Jariwala et al., 2017). However, the high rate of uncertainty and acceptance of noise among respondents suggests a degree of normalization, as people may have adapted to it because of the perceived economic benefits of mining. Similar findings were reported by Naicker, 2024, who noted that communities often tolerate environmental disturbances when mining contributes to local employment and infrastructure. Nevertheless, the decline in property values and productivity losses underscore the hidden socio-economic costs of mining noise. These effects indicate the need for stricter noise-mitigation enforcement, such as acoustic barriers, buffer zones, and periodic monitoring to maintain noise within Ghana's EPA standards.

- *The Effectiveness of Current Regulatory Policies in Reducing Noise Pollution in the Ellembele District.*

The findings indicate that while efforts have been made to curb noise from mining activities, these measures have not been translated into substantial improvement in community well-being. The relatively high uncertainty and low awareness among residents suggest that noise-control initiatives are poorly publicized or inconsistently enforced. This supports observations by Hemmat et al. (2023) that regulatory measures in African mining zones often exist only on paper, with limited follow-through at the local level. The weak perception of policy effectiveness may also stem from poor stakeholder engagement. When residents are not involved in environmental monitoring or decision-making, they are less likely to recognize or appreciate the measures that are implemented. This finding aligns with studies from Charnley and Engelbert (2005), who reported that communities often tolerate environmental nuisances like noise because of economic dependence on mining rather than confidence in regulatory systems.

To enhance policy credibility, mining companies and regulators should strengthen public participation and improve communication about existing noise-control actions. Regular environmental education, community noise-monitoring programs, and transparent reporting of compliance results can improve residents' confidence in both the industry and enforcement agencies. Moreover, stricter adherence to Ghana EPA's permissible noise levels and routine environmental audits would ensure that noise reduction measures produce tangible improvements in quality of life (Madahana et al., 2020).

- *Cumulative Noise Exposure and Implications for the Ellembele Communities*

In this study, *cumulative noise* is defined as the overall noise exposure experienced by communities as a result of multiple coexisting noise sources operating within the same spatial and temporal environment. These sources include mining-related activities such as blasting, haulage truck movement, and machinery operation, which occur at different times of the day and overlap with background community noise. Cumulative noise therefore reflects the combined acoustic burden perceived by residents rather than the contribution of any single noise source in isolation. The findings suggest that noise exposure in the Ellembele District is experienced by residents as persistent and multi-source in nature. Although this study did not quantify cumulative noise impacts through acoustic propagation modelling or source-specific attribution, the measured site-level LAeq values, together with residents' reports of frequent and unpredictable noise events, indicate overlapping noise exposures occurring across morning and evening periods. This pattern is consistent with observations by Nanda (2012), who reported that cumulative noise exposure in mining regions often manifests as a combination of sustained background noise and intermittent high-intensity peaks. Previous studies have shown that environmental impact assessments focusing on individual mining projects may underestimate the overall noise burden where multiple operations coexist within the same district (Owen and Kemp, 2015). In such settings, the presence of licensed mining operations alongside informal or small-scale activities can intensify community exposure through irregular operating schedules and limited noise control. Although this study did not directly measure noise from illegal mining activities, respondents frequently described noise as arising from several simultaneous sources within the district, supporting a cumulative exposure perspective. The socio-economic impacts reported in this study including sleep disturbance, reduced concentration, stress, and perceived damage to buildings are consistent with cumulative noise impact patterns documented in mining communities internationally. These findings indicate the need to move beyond isolated, project-level noise assessments toward integrated approaches that acknowledge the combined noise burden experienced by residents living in mining-intensive landscapes. These observations reinforce that the regulatory focus on project-specific assessments may be inadequate in districts like Ellembele, where multiple mining concessions and widespread galamsey create a complex noise environment. To protect community wellbeing, environmental monitoring should shift toward district-wide cumulative noise assessments and coordinated regulatory enforcement, rather than relying on isolated evaluations of individual mining operations.

V. LIMITATIONS OF THE STUDY

This study has several limitations that should be considered when interpreting the findings. First, environmental noise monitoring was conducted over short-term periods in the morning and evening, which may

not fully capture temporal variability in noise exposure, including seasonal changes or night-time conditions. Second, the study employed a cross-sectional design and did not include a control community located far from mining activities, which limits the ability to isolate mining-related noise from other background environmental influences. Third, the study did not quantitatively assess or model cumulative noise impacts from multiple sources; rather, noise exposure was examined at selected sites and interpreted alongside community perceptions. In addition, the relatively small sample size may limit the generalizability of the findings beyond the study communities. Finally, reliance on self-reported survey responses introduces the possibility of recall bias and subjective variation in how noise impacts were perceived. Despite these limitations, the mixed-methods approach provides useful insight into noise exposure patterns and perceived socio-economic effects in mining-affected communities.

VI. POLICY AND SUSTAINABILITY IMPLICATIONS

The findings of this study have important implications for environmental management, public health, and sustainable development in mining-affected regions. Persistent exposure to environmental noise, even when average levels fall within regulatory limits, can negatively affect concentration, sleep quality, psychological well-being, and overall quality of life. These outcomes directly relate to Sustainable Development Goal (SDG) 3, which seeks to promote good health and well-being for all. The evidence from the Ellembele District suggests that noise management should be considered a public health priority within mining governance frameworks. The study also has implications for SDG 11, which emphasizes the creation of inclusive, safe, resilient, and sustainable communities. Residents' reports of noise-related disturbance, reduced productivity, and perceived damage to properties indicate that environmental noise can undermine the livability of mining communities if not adequately managed. Current regulatory approaches that focus primarily on project-specific compliance may be insufficient in districts where multiple mining activities operate within close proximity. Strengthening environmental planning to consider broader community exposure contexts could improve the sustainability of mining landscapes. From a policy perspective, the findings highlight the need for improved enforcement of Ghana Environmental Protection Agency (EPA) noise standards and enhanced transparency in monitoring and reporting. Regular community-level noise monitoring, clearer communication of mitigation measures, and increased public participation in environmental decision-making could improve trust between mining companies, regulators, and affected communities. In addition, integrating noise considerations into local development planning such as zoning, buffer zones, and haulage route management would help reduce community exposure and enhance long-term social sustainability. Incorporating community perceptions alongside environmental measurements provides a practical basis for strengthening noise-management strategies in mining regions. While this study does not quantify cumulative noise impacts, its findings underscore the importance of coordinated regulatory oversight and community-centered approaches in safeguarding well-being in mining-intensive districts such as Ellembele.

VII. CONCLUSION AND RECOMMENDATION

This study assessed the impacts of noise pollution from mining activities on communities in the Ellembele District, drawing on noise measurements, household surveys, and key informant interviews. The findings show that residents are exposed to noise levels that are sometimes above acceptable limits, particularly during morning and evening periods when blasting, machinery operations, and haulage truck movements are most active. Respondents consistently reported disturbance, sleep challenges, reduced concentration, vibration, and cracks in buildings, reflecting both the intensity and persistence of noise within the affected communities.

Although the study did not quantify cumulative noise levels through formal modeling, the evidence from field measurements and community perceptions indicates that the noise environment in Ellembele reflects the combined influence of multiple large-scale mining operations and widespread illegal mining activities (galamsey). This aligns with studies from Nanda,2012 suggesting that project-specific assessments often underestimate total community exposure because they do not consider overlapping noise sources within the same district. The unpredictability and directionality of noise reported by residents further support the presence of cumulative impacts, which heighten annoyance, reduce quality of life, and complicate regulatory monitoring.

The study concludes that noise pollution in the Ellembele District is not solely the result of isolated mining operations but is shaped by the aggregate effect of several small-scale activities. Addressing this challenge requires a shift from individual project assessments toward more integrated, district-wide monitoring frameworks that better reflect the real noise burden experienced by communities. Strengthening regulatory enforcement, improving community engagement, adopting CEA in EPA guildlines and implementing coordinated noise-control measures across both formal and informal mining operations are essential for protecting the wellbeing and living conditions of residents. Further research should be done on cumulative impacts from small-scale mining activities and other mining companies in the district and other mining districts.

- *Credit Authorship Contribution Statement*

Writing-review. Writing-original draft, Validation, Visualization, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization

Conceptualization, Methodology, Data collection, Formal analysis, Writing-original draft, Writing-review & editing

➢ *Declaration of Competing Interest*

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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➢ *Data Availability*

The data supporting the findings of this study are not publicly available due to ethical and confidentiality considerations but are available from the corresponding author upon reasonable request.

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