Journal of
Advanced Psychology
(JAPSY)

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CARI Journals

Journal of Advanced Psychology
ISSN: 2791-3244 (Online)
Vol.7, Issue No. 4, pp 55 - 71, 2025
www.carijournals.org

Psychological and Environmental Impacts of Climate Change in Villages around the Mutanda Mining Site (Lualaba Province, Democratic Republic of Congo)

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Accepted: 20th Nov, 2025, Received in Revised Form: 8th Dec, 2025, Published: 15th Dec, 2025

ABSTRACT

Purpose: This study investigates the psychological and environmental impacts of climate change and mining degradation in the villages surrounding the Mutanda Mining site in the Lualaba province of the Democratic Republic of Congo.

Methodology: Using a mixed-methods approach combining psychological surveys, environmental measurements, direct observations, and semi-structured interviews.

Findings: The findings reveal that proximity to the mining site is a major determinant of ecological deterioration and psychological distress. Villages located within 5 km of the mining site show higher levels of environmental degradation, stronger perceptions of climate change, and significantly elevated eco-anxiety and ecological stress levels, supported by correlation analysis. More distant villages experience reduced but still notable impacts. The study also highlights the presence of community resilience mechanisms such as social support, community gardens, and local ecological restoration initiatives which partially mitigate psychological impacts.

Unique Contribution to Theory, Policy and Practice: Overall, the findings emphasize the importance of integrating environmental mental health into mining and climate interventions by strengthening local adaptive capacity and community-based resilience strategies.

Keywords: *Eco-anxiety, Mining Degradation, Climate Change Perception, Community Resilience*

1. INTRODUCTION

The Democratic Republic of Congo (DRC) hosts some of the world's most significant mineral reserves, with Lualaba Province, particularly the Mutanda Mining (MUMI) site, playing a central role in large-scale extraction activities. Mining in this region has caused extensive environmental transformations, including deforestation, soil and water contamination, land degradation, and the reduction of agricultural areas (Kabamba & Tshimanga, 2022). These impacts are compounded by climate change, manifesting as erratic rainfall, prolonged droughts, and increased food insecurity (IPCC, 2023; Hickman et al., 2021).

Environmental degradation and climate instability do not only affect ecosystems but also produce psychological effects. Concepts such as ecological stress, environmental grief, and eco-anxiety describe the spectrum of emotional and cognitive responses triggered by environmental decline and climate threats (Clayton & Karazsia, 2020; Pihkala, 2020; Bilotta et al., 2018; Helmen et al., 2018; Hoggett, 2019). Research in Africa remains limited, particularly among rural populations living near mining operations, where exposure to combined environmental and climatic pressures is often severe (Weissbecker, 2011; Norgaard, 2011; Brulle, 2019; Kabemba et al., 2022).

Despite these challenges, communities deploy various resilience and adaptation strategies, including social support networks, cultural coping mechanisms, collective organization, and locally driven environmental practices, which contribute to socio-ecological resilience (Norris et al., 2008; Folke et al., 2010; Adger, 2003; Adger et al., 2009; Kems & Akerman, 2019; Verlie, 2019; Brugger et al., 2013; Berglund, 2019). Understanding these dynamics is crucial for informing public policy, natural resource governance, and corporate social responsibility initiatives aimed at sustainable development.

The rural communities surrounding Mutanda Mining face a dual burden: direct environmental degradation from mining and the broader impacts of climate change, which threaten livelihoods and food security (Kabamba & Tshimanga, 2022). These changes can induce chronic stress, climate-related anxiety, uncertainty, and emotional exhaustion (Clayton & Karazsia, 2020; Hickman et al., 2021; Pihkala, 2020; Pearse et al., 2010; Bamwell & Watson, 2020; Spratt & Gall, 2018). Nevertheless, limited empirical research has examined the intersection of mining, climate change, and psychological well-being in African rural contexts.

This study investigates how climate and environmental changes associated with mining influence the psychological health of communities around MUMI and explores the resilience mechanisms mobilized in response. Specifically, it seeks to: (i) assess local perceptions of climate change and its effects on daily life, (ii) measure the psychological impacts of environmental and climatic transformations, and (iii) identify community-based strategies that mitigate these impacts (IPCC, 2023; Hickman et al., 2021; Clayton & Karazsia, 2020; Pihkala, 2020; Norris et al., 2008; Folke et al., 2010; Adger et al., 2009).

2. LITERATURE SURVEY

Understanding the psychological and environmental consequences of climate change in mining-affected rural communities requires an interdisciplinary synthesis bridging environmental science, psychology, and socio-ecological resilience research. Climate-psychology studies increasingly demonstrate that ecological degradation and perceived environmental threat produce measurable mental-health impacts conceptualized as eco-anxiety, ecological stress, environmental grief, and solastalgia (Pihkala, 2020; Berry, Bowen, & Kjellstrom, 2010; Cohn, O'Neill, & Ruether, 2020). These emotional responses are not isolated pathologies but socially mediated reactions shaped by lived experience, place attachment, and collective narratives of loss. Empirical work, including Van der Linden (2015), confirms that perceived threat and direct exposure to climate impacts correlate strongly with heightened anxiety and distress, especially when livelihoods and food security are at risk.

Parallel research on mining and rural development documents the biophysical pathways through which extractive industries degrade ecosystems—deforestation, soil erosion, water contamination, and land loss—which then undermine agricultural productivity and public health (Armah, Luginaah, & Obiri, 2014; Koffi, Mukadi, & Lwamba, 2021; Sakyi, Atta-Peters, & Owusu, 2019). Regional studies further show that proximity to large-scale mining operations intensifies land pressure, reduces access to arable land, and reshapes demographic patterns, exacerbating household vulnerability and livelihood instability (Akiwumi & Butler, 2022; Obiri, Dodoo, & Yeboah, 2020). These environmental pressures interact with climatic variability including irregular rainfall and periodic droughts—to generate cumulative shocks to rural production systems (IPCC, 2022), thereby intensifying both material insecurity and psychosocial strain.

The socio-ecological resilience framework provides an important conceptual bridge between environmental change and psychological outcomes. This literature highlights how social capital, local institutions, and adaptive capacity mediate the translation of ecological disruption into mental-health effects (Walker, Holling, Carpenter, & Kinzig, 2004; Schoon & Smith, 2020; UNEP, 2021). Evidence shows that community cohesion, collective action, and locally appropriate adaptation practices such as community gardens and ecosystem-restoration initiatives—can buffer psychological distress by restoring agency and stabilizing livelihoods. However, resilience is uneven across communities: factors including education, land access, and proximity to mining zones determine who can adapt effectively (D'Amato, Rekola, & Li, 2022). Studies in comparable contexts also observe diverse coping strategies, ranging from problem-focused adaptation to meaning-based coping, with collective mobilization often helping to reduce climate-related anxiety by transforming helplessness into purposeful action (Evans, 2019; Berry, Bowen, & Kjellstrom, 2010).

A growing strand of research focuses on measuring climate-related distress. Validated instruments such as the Climate Anxiety Scale and ecological-stress metrics support rigorous quantification of affective responses and allow for cross-context comparison (Pihkala, 2020; Cohn, O'Neill, & Ruether, 2020). Methodologically, scholars recommend mixed-methods designs that triangulate psychometric data, qualitative narratives, and objective environmental

indicators to capture the complex, place-based nature of climate-related distress (Crutzen & Steffen, 2003; Lecoanet, Raymond, & Thiry, 2020).

Finally, governance and environmental-justice literature emphasizes the crucial role of institutional accountability. Perceived institutional neglect or inadequate corporate social responsibility can intensify psychological harm and undermine both individual and community adaptation (Akiwumi & Butler, 2022; UNEP, 2021). Consequently, researchers advocate integrative interventions that combine environmental remediation, livelihood support, and culturally appropriate mental-health services (Koffi, Mukadi, & Lwamba, 2021; Sakyi, Atta-Peters, & Owusu, 2019). Taken together, this interdisciplinary corpus underscores that addressing the psychological impacts of climate change in mining landscapes requires simultaneous attention to ecological restoration, livelihood security, and community-level psychosocial support.

3. Methodology

2.1. Study Area

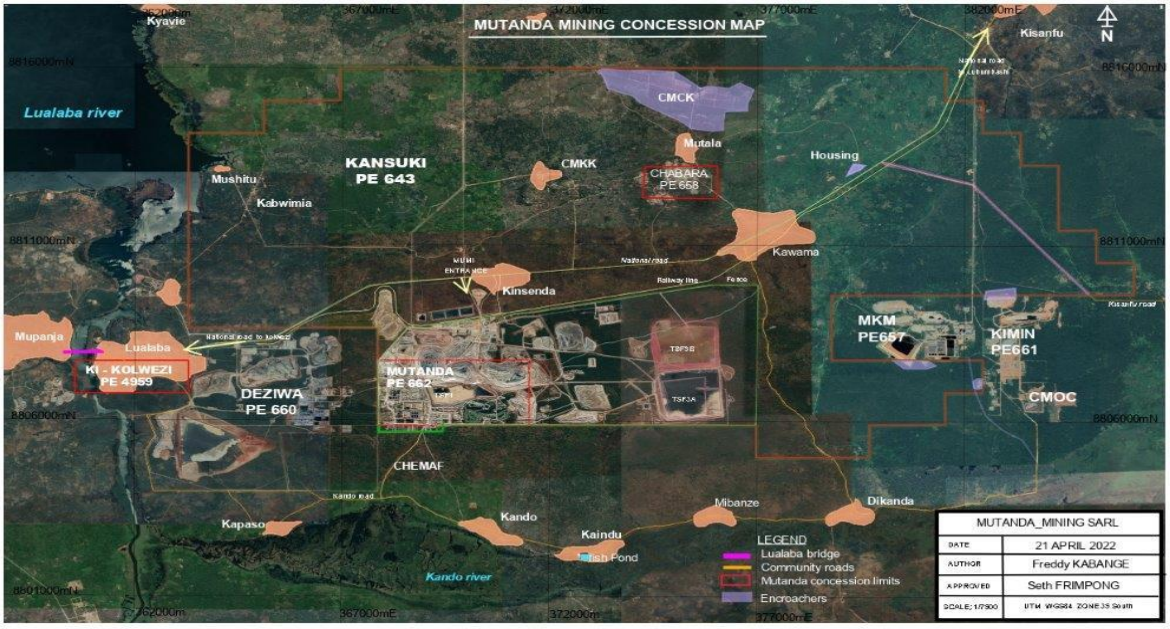

Figure 1. Villages around the Mutanda Mining site

The study was conducted in Lualaba Province, Democratic Republic of Congo, in the villages surrounding the Mutanda Mining (MUMI) industrial site—an area characterized by intensive mining activities and increasing climatic pressures. Six villages were included in the research: **Kawama, Kyavie, Kando, Mupanja, Kapaso, and Kahindu**. These villages were selected to capture contrasts between communities living in close proximity to the mine and those located farther away, thereby allowing an assessment of how distance influences psychological and environmental impacts linked to mining and climate change.

2.2. Research Design

The study employed a mixed-methods research design that combined both quantitative and qualitative approaches in order to capture measurable indicators of eco-anxiety and ecological stress, as well as the perceptions, lived experiences, and resilience strategies of local communities. This integrative design enhances the depth and reliability of the findings, as it allows the psychological dimensions of environmental degradation to be examined alongside objective ecological observations. The approach is consistent with contemporary recommendations in environmental psychology (Clayton & Karazsia, 2020; Pihkala, 2020) and the broader socio-ecological resilience framework (Folke, 2006; Adger, 2003; Norris et al., 2008), which emphasize the need to analyse environmental and psychosocial factors simultaneously.

2.3. Target Population and Sampling

The target population consisted of households residing within the six villages selected around the Mutanda Mining site. A total of 200 households were surveyed using a stratified random sampling technique. Stratification was based on two key criteria: the household's distance from the mining site and the diversity of local socio-economic activities. This ensured a representative distribution of households across zones with varying levels of exposure to mining activities. To be included in the sample, households were required to have resided in the study area for at least five years and to engage in agricultural or natural-resource-dependent activities. These inclusion criteria are consistent with previous research conducted in similar rural mining contexts (Kabamba & Tshimanga, 2022), ensuring that participants possessed relevant experience with environmental changes and livelihood challenges.

2.4. Quantitative Data Collection

Quantitative data were collected through a structured questionnaire that incorporated two standardized psychological tools. The first was the Climate Anxiety Scale (CAS), designed to measure climate-related anxiety (Clayton & Karazsia, 2020). The second was an environmental stress scale adapted to rural African settings to assess perceived ecological stress resulting from land degradation, water pollution, and climatic instability (Pihkala, 2020). These instruments made it possible to quantify psychological responses associated with environmental degradation and changing climatic conditions.

2.5. Qualitative Data Collection

Qualitative data were obtained through semi-structured interviews conducted with household heads, community leaders, women, and youth in order to capture a diverse range of perspectives. The interviews explored participants' perceptions of environmental and climatic changes, their experiences with the impacts of mining activities, and the adaptation and resilience mechanisms they had developed. This qualitative component aligns with theoretical frameworks in social-ecological resilience (Folke, 2006; Adger, 2003) and community coping strategies (Norris et al., 2008), which emphasize the importance of examining how communities respond collectively to environmental pressures.

2.6. Direct Environmental Observation

Direct field observations were carried out to document objective indicators of environmental degradation, including soil erosion and compaction, water quality deterioration, and changes in land cover and vegetation structure. These observations provided essential empirical evidence that helped triangulate the quantitative and qualitative data. They also enabled the comparison between reported psychological impacts and observable ecological conditions, reinforcing the validity of the findings (Kabamba & Tshimanga, 2022).

2.7. Data Analysis

Quantitative data were processed using SPSS software. The analyses included an ANOVA test to compare levels of ecological stress and climate anxiety between populations living near and far from the mining site. Pearson correlation coefficients were computed to assess relationships between climate change perception, food security, and psychological indicators, following approaches recommended in environmental psychology (Clayton & Karazsia, 2020; Hickman et al., 2021). Qualitative data, collected through interviews, were transcribed and analysed using thematic analysis with NVivo software. The coding process was guided by key analytical categories such as climate perception, mining impacts, coping strategies, and collective resilience, in line with the frameworks proposed by Norris et al. (2008) and Folke (2006).

2.8. Overall Analytical Framework

Overall, the mixed-methods design employed in this study provides a robust and comprehensive framework for linking environmental degradation and climate variability with psychological well-being. It also highlights local resilience capacities, which constitute an essential dimension for understanding socio-ecological vulnerability in mining-affected landscapes of Central Africa. This analytical approach aligns with broader literature emphasizing the connection between environmental stressors, climate risks, and human well-being (IPCC, 2023; Adger, 2003; Folke, 2006), ensuring that the results reflect both global theoretical insights and local contextual realities.

3. RESULTS

The results are presented according to the study's specific objectives, integrating statistical analyses derived from questionnaires, psychological scales, interviews, and environmental observations.

3.1. Socioeconomic Profiles and Correlation Matrix

The 200 households surveyed reflect typical rural communities affected by proximity to a large-scale mining project. Agriculture remains the primary livelihood activity (67%), but small-scale artisanal mining is increasingly significant (18%). Pearson correlations reveal that larger households have access to more land, higher education levels are negatively associated with agricultural activity, and proximity to mining infrastructure negatively affects land access. Demographic, land, and education dynamics are strongly linked to the economic pressures exerted by the mining operations.

Table 1. Pearson Correlation Matrix of Key Variables

Variables	Age	Household Size	Farm Size (ha)	Education Level	Distance to Mine
Age	1	0.21	0.18	-0.33	0.05
Household Size	0.21	1	0.27	-0.10	-0.07
Farm Size (ha)	0.18	0.27	1	-0.24	0.19
Education Level	-0.33	-0.10	-0.24	1	0.12
Distance to Mine	0.05	-0.07	0.19	0.12	1

The correlation analysis indicates that larger households generally have access to more land, while higher education levels are associated with less dependence on agriculture, reflecting a diversification of income sources in more educated households. Proximity to mining infrastructure negatively affects access to land, and demographic, land, and educational dynamics are closely linked to the economic pressures exerted by the mine.

- ✓ Age and education ($r = -0.33$): Older household heads tend to have lower education levels, reflecting limited access to schooling in rural areas during the 1970s–1990s. Younger generations have benefited from greater educational opportunities.
- ✓ Household size and farm size ($r = 0.27$): Larger households manage larger agricultural plots, consistent with rural labor availability and the capacity to maintain diversified crops.
- ✓ Education and farm size ($r = -0.24$): More educated households operate smaller plots, often diversifying into non-agricultural income sources (commerce, salaried employment, mining subcontracting).
- ✓ Farm size and distance to the mine ($r = 0.19$): Households further from the mine possess slightly larger land areas, reflecting land pressures and expropriations near mining concessions.
- ✓ Household size and proximity to the mine ($r = -0.07$): Families near the mine tend to be slightly smaller, possibly due to temporary male migration for mining work and increased mobility around industrial zones.
- ✓ Age and farm size ($r = 0.18$): Older household heads have accumulated more land over time, a typical rural economic trend.

3.2. Environmental Degradation

Table 2. Environmental Degradation Index by Distance from Mining Site

Village	Distance to Mine (km)	Degradation Index (Mean ± SD)
Kawama	1	4.3 ± 0.5
Kyavie	2	4.1 ± 0.6
Kando	4	3.8 ± 0.4
Mupanja	6	2.9 ± 0.5
Kapaso	7	2.7 ± 0.4
Kahindu	8	2.9 ± 0.5

Results indicate that environmental degradation is closely correlated with proximity to the mining site. Villages closest to MUMI show pronounced environmental impacts, including vegetation loss, soil erosion, and water pollution from heavy metals. More distant villages experience milder but perceptible degradation. On average, villages near the site have a mean degradation index of 4.2/5, while distant villages have 2.8/5, confirming that proximity amplifies exposure to environmental damage (Kabamba & Tshimanga, 2022).

3.3. Climate Change Perception

Survey results revealed that 82% of participants reported increased drought frequency and irregular rainfall affecting crops and food security. Pearson correlation analysis showed a significant positive relationship between climate change perception and ecological stress ($r = 0.62$, $p < 0.01$), indicating that households perceiving climate change as threatening experience higher psychological stress (Hickman et al., 2021; IPCC, 2023).

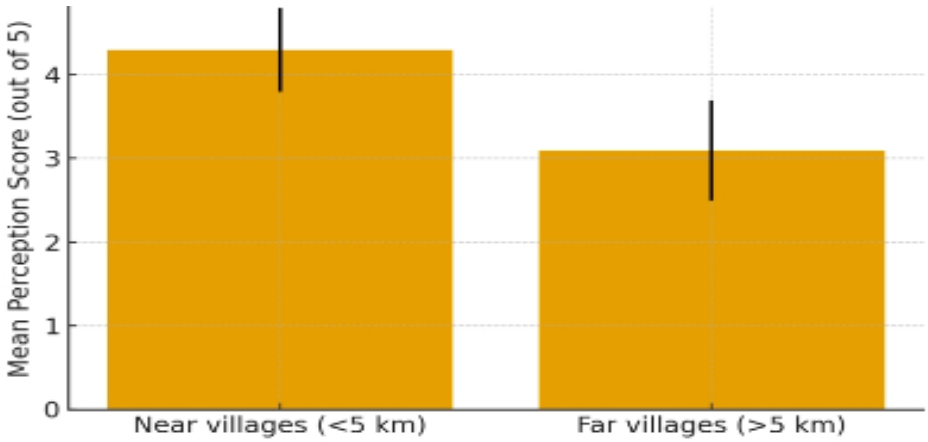

Figure 2. Climate Change Perception by Distance from Mining Site

(Mean perception score out of 5, where 5 = very high perception)

Villages near the mine (<5 km): 4.3 ± 0.5; Villages far from the mine (>5 km): 3.1 ± 0.6.

These results suggest that proximity to the mine amplifies climate change perception and its perceived impact on livelihoods, contributing to elevated psychological stress.

3.4. Psychological Impacts: Ecological Stress and Eco-Anxiety

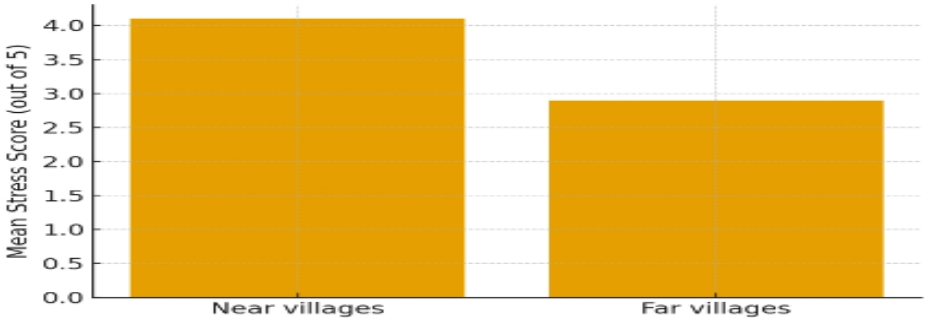

Figure 3. Comparison of ecological stress

Analysis of psychological questionnaires showed that 65% of respondents reported moderate to high ecological stress, and 50% exhibited significant eco-anxiety. ANOVA comparing ecological stress between near and distant populations revealed a statistically significant difference ($F(1,198) = 18.76$, $p < 0.001$), with mean scores of 4.1/5 for near populations versus 2.9/5 for distant populations. These findings confirm **Hypothesis 1**, illustrating the exacerbating effect of mine proximity on mental health (Clayton & Karazsia, 2020; Pihkala, 2020). Eco-anxiety was also significantly correlated with perception of environmental degradation ($r = 0.58$, $p < 0.01$), demonstrating that higher perceived environmental deterioration is associated with elevated anxiety levels.

3.5. Community Resilience Mechanisms

Semi-structured interviews and participant observation revealed that communities have developed several strategies to mitigate psychological and environmental impacts, including family and community mutual support, creation of community vegetable gardens, participation in soil and forest restoration activities, sharing of food and natural resources.

These resilience mechanisms act as moderators of ecological stress and eco-anxiety, confirming **Hypothesis 3**. Participants indicated that these initiatives reduce uncertainty associated with environmental and climatic disruptions, enhancing perceived control and psychological well-being.

Overall, results demonstrate that proximity to the mining site increases exposure to environmental impacts and psychological stress, while distant populations experience lower exposure and stress. Correlation analyses and ANOVA confirm that ecological stress and eco-anxiety are significantly associated with perceived environmental degradation and climate change, suggesting cumulative effects. Community-based resilience strategies play a critical moderating role, highlighting the importance of integrating psychological considerations into environmental and climate interventions targeting villages near mining operations.

4. DISCUSSION

The results obtained from the 200 households surveyed across six villages reveal socio-economic dynamics closely intertwined with environmental and mining pressures. The positive correlation between household size and cultivated land confirms that family labor remains the

primary driver of agricultural production, a finding also highlighted by Wisner (2004), who emphasized the central role of internal household resources in reducing vulnerability. Larger households thus cultivate more land, enhancing food security, while smaller families, often located near the mining site, rely more heavily on non-agricultural income opportunities.

The negative relationship between education level and agricultural landholding suggests an economic transition characteristic of mining-affected areas, where more educated individuals pursue diversified activities, including commerce or wage employment. This observation aligns with Bebbington and Bury (2013), who noted the emergence of new livelihood strategies in mining territories. Such dynamics also reduce pressure on land, particularly in villages adjacent to mining infrastructure, where land competition is more intense. Additionally, correlations indicate that households located farther from the mine generally have larger agricultural plots, consistent with Hilson (2002), who described the progressive loss of farmland near industrial and artisanal mining operations, leading to increased demographic pressure and decreased availability of productive land. Households near the mine are thus constrained in their agricultural production, exposing them to higher food insecurity and greater reliance on unstable mining-related incomes.

The results further show that demographic structure, education, and proximity to the mining site strongly influence livelihoods, corroborating Pelling's (2011) work on resilience, which emphasizes how communities adjust strategies based on environmental and economic constraints. In this context, households develop differentiated resilience: some strengthen agricultural production through abundant family labor, while others diversify into non-agricultural activities to compensate for reduced land access. Overall, these findings indicate that household socio-economic organization is strongly shaped by proximity to the mine, land access, and human capital, which together explain variations in livelihood strategies and local vulnerability. This aligns with previous studies by Hilson (2002), Spratt and Dunlop (2019), Temple and Gall (2018), and Adams (2016), which report consistent patterns of vegetation loss, soil contamination, and water pollution in mining areas. The heightened degradation observed in villages within 5 km of the mining site also resonates with Bebbington and Bury (2013), who argued that mining-induced socio-ecological transformations exert strong pressure on land, water sources, and landscapes, profoundly affecting local well-being.

The increased levels of eco-anxiety and ecological stress observed in villages closest to the site correspond to Glenn Albrecht's (2005) concept of solastalgia, which describes the distress experienced when one's environment deteriorates rapidly. The significant correlation between perceived ecological degradation and psychological stress supports the findings of Reser and Swim (2011), Scott and Weems (2013), Myers (2014), and Thomas (2020), highlighting that perceived environmental risk is a key determinant of climate-related anxiety. This study further reveals that participants who perceive climate change more acutely also report higher stress levels, consistent with Randall (2005), Kassouf (2017), and Hickman et al. (2021), who demonstrated that climate concern is closely linked to personal experiences of environmental instability.

Statistical analyses, particularly the ANOVA showing significant differences between households near and far from the mining site, underscore the relevance of validated psychometric tools such as those proposed by Clayton and Karazsia (2020), which rigorously measure affective dimensions of climate change. The importance of this measurement is reinforced by Larionow et al. (2022), Hoggett (2019), and Andrews (2019), who emphasize the need to distinguish subdimensions of eco-anxiety to better understand psychosocial responses in affected populations. Qualitative results indicate that communities have developed several resilience mechanisms, including mutual support, community gardens, and participation in ecological restoration activities. These findings align with Folke (2006), Coverdale et al. (2018), and Pinsky and Guerrero (2020), who conceptualize resilience as a socio-ecological process enabling communities to maintain functionality despite environmental disturbances. They also converge with Norris et al. (2008), demonstrating that social capital, community cohesion, and support networks are critical resilience factors in the face of disasters and environmental pressures.

The cultural and identity-related dimension of environmental distress observed in villages near the mine echoes the conclusions of Cunsolo Willox (2015) and Wainwright et al. (2020), showing that land degradation generates strong identity-related suffering and transforms emotional and symbolic relationships with the environment. Identified coping strategies, such as community action and collective mobilization, correspond to the engagement-oriented cognitive strategies described by Ojala (2012), which reduce climate anxiety through collective agency. Moreover, Coffey et al. (2021) highlight the diversity of eco-anxiety manifestations, corroborating this study's findings that ecological distress encompasses complex emotions, including powerlessness, anger, and ecological grief. The results also support Wray et al. (2022) regarding the moral dimension of climate anxiety, expressed in narratives from populations confronted with mining-induced degradation. These findings have important implications for environmental governance. As Pelling (2011) notes, perceptions of institutional inaction can amplify distress and weaken community resilience, a pattern visible in this study through testimonies of populations feeling abandoned in the face of mining impacts. Similarly, Wisner (2004) emphasizes the heightened vulnerability of marginalized communities and the necessity of participatory and localized approaches to strengthen resilience. Observations align with Spiegel (2017) on the health consequences of mining, showing that pollution and environmental changes exacerbate not only physical but also psychological risks. Finally, Kabamba and Tshimanga (2022) confirm the relevance of these findings in the Congolese context, demonstrating that communities near mining areas face triple pressures environmental, psychosocial, and economic.

In summary, this discussion demonstrates that the environmental and psychological impacts observed in the study area are neither isolated nor anomalous but fit within well-established theoretical and empirical frameworks. The findings underscore the urgent need to integrate environmental mental health into mining policies and local resilience strategies, consistent with international recommendations in climate psychology and socio-ecological governance.

5. Conclusion

The findings of this study clearly demonstrate that proximity to the Mutanda Mining site intensifies both environmental and psychological pressures, exposing nearby communities to heightened soil, water, and vegetation degradation, as well as significantly elevated levels of ecological stress and eco-anxiety. Statistical analyses confirm that the perception of climate-related risks and environmental degradation act cumulatively to increase psychological distress. Despite these pressures, communities exhibit notable resilience capacities through social, economic, and ecological mechanisms, although these remain insufficient to fully cope with the scale of observed disturbances.

These results underscore the critical need to integrate environmental mental health considerations into public policies, mining programs, and climate change adaptation strategies. Based on these findings, three main recommendations emerge. First, it is essential to establish community-based environmental monitoring and psychological awareness programs to support the populations most exposed to mining and climate-related impacts. Second, ecological restoration initiatives—including watercourse protection, reforestation, and soil improvement—should be actively supported by mining companies and local authorities. Third, strengthening community resilience mechanisms is imperative by promoting local initiatives such as community gardens, village associations, and social solidarity networks, which play a crucial role in alleviating stress and fostering collective well-being.

Overall, these recommendations highlight the need for integrated socio-ecological interventions that address both the environmental and psychological dimensions of mining impacts, ensuring sustainable livelihoods and mental health in vulnerable rural communities.

6. FUTURE SCOPE

The present study offers important insights into the psychological and environmental impacts of mining and climate variability on rural communities; however, several avenues remain open for future research. First, expanding the sample size and including additional villages across different mining sites would improve the generalizability of findings and allow for comparative analyses across ecological and socio-economic contexts. Second, longitudinal studies tracking changes in ecological stress, eco-anxiety, and resilience over time could capture dynamic responses to environmental degradation and climate events, providing stronger causal evidence. Third, incorporating biomarker or physiological measures of stress alongside psychometric scales could enhance objectivity in assessing psychological impacts. Finally, integrating remote sensing and GIS analyses could more precisely quantify environmental degradation and correlate it with socio-psychological indicators. Despite these limitations, this research advances knowledge compared to historical studies by combining quantitative psychological assessment with qualitative insights and direct environmental observations, offering a holistic view of socio-ecological vulnerability and resilience in mining-affected rural settings—a perspective largely absent in prior African-focused research.

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