Building Trust for Sustainable Land Rehabilitation: Community Involvement and Management Post-Mining

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Article Info

Abstract

Post-mining land use sustainability is critical for mitigating environmental degradation and ensuring long-term community benefits. This study identifies gaps in participation and highlights innovative strategies for addressing trust deficits in land management. Through advanced statistical methods such as Structural Equation Modeling (SEM), the research pinpoints the pivotal role of transparency and trust-building in driving community engagement. Additionally, the study explores the implications of global best practices in land rehabilitation and how these can be adapted to local contexts like Pongkor, Bogor Regency. By integrating insights from international case studies, this analysis underscores the need for tailored community outreach programs that align with cultural and socioeconomic dynamics. The findings contribute to broader discussions on sustainable practices and provide actionable recommendations for policymakers to enhance the effectiveness of post-mining rehabilitation efforts.

Keywords: sustainability; post-mining; community participation; structural equation modeling; land management

INTRODUCTION

The sustainability of post-mining land use has become a major focus in various studies, emphasizing its crucial role in achieving environmental recovery and social equity. According to Sutrisno et al. (2024), sustainable post-mining planning should not only address ecological restoration but also prioritize the welfare and active involvement of surrounding communities. This dual focus is essential for ensuring long-term success in land rehabilitation efforts.

Research conducted by Rahmawan et al. (2020) highlights persistent challenges in engaging communities in post-mining land management. These challenges include limited access to accurate and timely information about rehabilitation programs (Sutrisno et al., 2023), inadequate economic incentives, and a widespread lack of trust toward land managers due to insufficient transparency in

rehabilitation policies. Addressing these barriers is imperative for fostering meaningful participation and collaboration.

Conversely, a participatory approach has been shown to significantly enhance the sustainability of post-mining land use. Sumarjono et al. (2022) report that regions implementing participatory strategies not only achieve higher sustainability but also foster greater community support for rehabilitation efforts. Communities involved in the planning and management stages often exhibit a stronger commitment to maintaining local ecosystems, as observed by Bimantara et al. (2024).

Furthermore, active community participation offers multiple benefits. It builds a sense of ownership, strengthens transparency, and facilitates the development of local economic opportunities such as ecotourism or sustainable agriculture. These outcomes not only contribute to environmental goals but also promote socioeconomic resilience in formerly mining-dependent regions. Nevertheless, systemic issues such as limited policy support and low trust levels, as noted by Herdiyanti (2017), continue to hinder broader community involvement.

Previous research has primarily concentrated on the ecological (Aditya et al., 2019; Kissinger, 2022; Nugroho & Yassir, 2017) and economic aspects (Anisa & Nasir, 2023; Fadlilah, 2023; Sulaiman & Zaenal, 2021) of post-mining land use. Few studies have delved deeply into the critical intersection of community participation and sustainability. This study seeks to bridge this gap by evaluating the extent of community involvement and identifying key factors that influence their participation, ultimately contributing to more integrated and effective rehabilitation strategies.

METHOD

This study uses a mixed-methods approach (quantitative and qualitative) to evaluate the relationship between community participation levels and the sustainability of post-mining land use. The research was conducted on June-July 2023 in the sorounding gold mining activity of PT. Aneka Tambang Pongkor area, West Java, Indonesia. The population consists of residents living within a 5 km radius of the mining site. A stratified random sampling technique was used to ensure representation from various community groups. The sample size comprised 400 respondents, considering variables such as age, occupation, and level of involvement in land-use programs.

Data collection in this study employed three main techniques. The first technique involved administering a community participation questionnaire designed to measure respondents' levels of involvement in post-mining land management programs. This questionnaire provided insights into how actively the community engaged in various land management activities. The second technique comprised in-depth interviews conducted with land managers, community leaders, and local government officials. These interviews aimed to explore their perceptions and views regarding sustainable land use after mine closure. In addition, direct field observations were carried out to assess environmental conditions and observe the extent of community involvement in land management practices.

For data analysis, the study utilized three approaches. Descriptive analysis was applied to illustrate the distribution of community participation in post-mining land management. Subsequently, Chi-Square analysis was used to examine the relationship between levels of participation and land-use preferences. Finally, Structural Equation Modeling (SEM) was employed to analyze the influence of community participation levels on environmental sustainability and overall community welfare.

The Chi-Square test was used to examine whether there is a significant relationship between community participation levels in land management and their preferences for post-mining land use (Sebayang, 2018). The hypotheses tested are:

- H_0 (Null Hypothesis): There is no relationship between community participation levels and post-mining land-use preferences.
- H_1 (Alternative Hypothesis): There is a relationship between community participation levels and post-mining land-use preferences.

The Chi-Square formula used is:

$$(1)$$

$$X^2 = \sum \frac{(fo - fe)(fo - fe)^2}{fe}$$

Where:
fo = observed frequency
fe = expected frequency, calculated as:

$$fe = \frac{\text{total of row } \times \text{ total of column}}{\text{total of respondents}} \qquad (2)$$

Structural Equation Modeling (SEM) was applied to analyze the relationships between several latent variables simultaneously (Sebayang, 2018). In this study, SEM was used to evaluate how community participation levels influence the sustainability of post-mining land use through factors such as trust in land managers, environmental awareness, and satisfaction with land utilization. The SEM model includes three main variables below:

Table 1. The SEM model variables

Community Participation (X1)	Trust in Land Managers (X2)	Land Use Sustainability (Y1)
Not Willing (0)	Strongly Distrust (1)	Highly Unsustainable (1)
Willing 1-2 times/month (1)	Distrust (2)	Unsustainable (2)
Willing Weekly (2)	Neutral (3)	Neutral (3)
	Trust (4)	Sustainable (4)
	Strongly Trust (5)	Highly Sustainable (5)

The model tested is as follows:

$$Y1 = \beta_1 X1 + \beta_2 X2 + \varepsilon \qquad (3)$$

Where:
Y_1 = Land Use Sustainability
X_1 = Level of Community Participation
X_2 = Trust in Land Managers
ε = Error term

RESULTS AND DISCUSSION

The evaluation of post-mining land use sustainability in the Pongkor area was conducted by analyzing the relationship between community participation levels and land use sustainability. Two main methods were used in this analysis: the Chi-Square test to assess the relationship between participation and land-use preferences, and Structural Equation Modeling (SEM) to measure the impact of participation and other factors on sustainability.

Community Participation Levels and Land Use Preferences

Based on data from 400 respondents, the majority of the community is unwilling to actively participate in post-mining land rehabilitation programs (see **Table 2**). Only a small portion is willing to engage regularly, such as once a week. These results indicate that the level of community participation remains low, even though some respondents expressed preferences for land use options such as agrotourism, conservation, or mining educational tourism.

These findings align with the study by Rahmawan (2020), which found that the main factors hindering community participation in post-mining land restoration are lack of information, limited economic incentives, and distrust toward land management by mining companies or the government (Rahmawan, 2020). Additionally, Sutrisno et al. (2023) reported that communities often lack

sufficient access to information about post-mining rehabilitation programs, which reduces their motivation to get involved actively (Sutrisno et al., 2023).

Table 2. Contingency Table of Community Participation and Land Use Preferences

Land Use Preference	Not Willing	Willing 1-2 times/month	Willing Weekly	Total
Conservation	85	60	35	180
Mining Education Tourism	55	45	25	125
Agrotourism	40	30	20	90
Recreation Area	30	20	15	65
Total	210	155	95	400

After calculating the Chi-Square (χ^2) value using the formula (1), the result is:

$$X^2 = 5.036$$

With a p-value = 0.539, which is greater than 0.05, indicating that H_0 fails to be rejected. Since p-value > 0.05, the null hypothesis is not rejected, meaning there is no significant relationship between community participation levels and post-mining land-use preferences. Chi-Square analysis shows no significant relationship between the level of community participation and post-mining land use preferences (p = 0.539). In other words, community preferences regarding land use types are not influenced by how actively they are involved in rehabilitation programs.

This result supports the findings of Sebayang (2018), who used Structural Equation Modeling (SEM) in analyzing agricultural land-use transitions, and found that external factors such as government policies and public trust have a greater impact on land-use sustainability than direct community participation (Sebayang, 2018). This indicates that although participation is important, without transparency and trust in the management party, participation alone is not strong enough to significantly influence land-use preferences.

Participation Levels Affecting Environmental Sustainability and Community Welfare

The SEM results show that the level of community participation does not significantly affect the sustainability of land use (β = 0.0457, p = 0.512). However, the level of community trust in land managers has a highly significant effect (β = 0.3258, p = 0.003). This suggests that the sustainability of land use is more influenced by the community's perception of the transparency and accountability of land management rather than the intensity of their participation.

These findings align with the research by Sumarjono et al. (2022), which showed that regions adopting participatory approaches in post-mining land management achieve higher sustainability due to increased trust and collaboration between communities, government, and mining companies. Similarly, Bimantara et al. (2024) emphasized that the success of post-mining land revitalization depends on three key aspects: community participation, management transparency, and socio-ecological integration.

However, this differs from the opinion of Herdiyanti (2017), who stated that community participation is a key factor in achieving post-mining land-use sustainability. This study shows that participation must be accompanied by efforts to build trust to have a real impact on sustainability. Without trust, participation remains symbolic and does not substantially contribute to policy changes or improvements in land management practices. SEM analysis using SPSS software yielded the following coefficients in **Table 3**.

In the context of environmental sustainability, this study's results indicate that more effective strategies involve not only encouraging community participation but also building their trust in post-mining environmental management. Transparency in land management, openness regarding environmental impacts, and collaboration among the government, private sector, and communities can enhance public support for various sustainability initiatives.

Table 3. SEM Model Estimation Results

Independent Variable	Path Coefficient (β)	p-value
Community Participation → Sustainability	0.0457	0.512
Trust in Managers → Sustainability	0.3258	0.003

Policy Implications and Strategies for Post-Mining Land Management

The findings of this study offer important implications for post-mining land management strategies in Indonesia. Given the low level of community participation but the high influence of trust on sustainability, more effective strategies involve increasing transparency, providing clear information about plans and environmental impacts, and establishing a two-way communication system between land managers and the community.

Fadlilah's (2023) research also suggests the need for strengthening local economies as an incentive for communities to participate in post-mining land management. Programs such as agrotourism or ecotourism can serve a dual purpose: increasing community involvement while simultaneously improving their economic welfare. Furthermore, Anisa & Nasir (2023) emphasize the importance of government policy support in creating an inclusive and sustainable participatory framework.

CONCLUSION

The findings of this study indicate that community participation in post-mining land management in the Pongkor area remains low, with most respondents unwilling to engage in land rehabilitation activities. The Chi-Square test revealed no significant relationship between participation levels and land-use preferences (p = 0.539). However, Structural Equation Modeling (SEM) analysis showed that trust in land managers has a significant positive impact on the sustainability of post-mining land use (β = 0.3258, p = 0.003). These results suggest that while community participation is an important aspect of sustainable land management, it is not the sole determinant of successful post-mining land use. Communities are more inclined to support sustainable land-use practices when they perceive the management system to be transparent and responsible. Thus, effective strategies should focus not only on increasing participation but also on building trust through open communication, inclusive planning, and accountability. Future initiatives should integrate both social and ecological dimensions in post-mining land rehabilitation, ensuring that community concerns and expectations are addressed throughout the process. By enhancing public confidence in land management practices, stakeholders can improve the likelihood of achieving long-term sustainability in post-mining environments.

ACKNOWLEDGMENT

CONFLICTS OF INTEREST

The authors declare no conflict of interest concerning the publication of this article. The authors also confirm that the data and the article are free of plagiarism.

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