# Spatial Optimization Strategies for Post-Mining Areas in Cempaka: Integrating Land Reclamation with Community-Based Development

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## ABSTRACT

Artisanal mining activities in Cempaka District, Banjarbaru, have left significant spatial and ecological impacts, including abandoned excavation pits, informal settlements, and ecosystem degradation. This study aims to analyse the transformation of the post-mining landscape and formulate strategic approaches for sustainable spatial utilization. A qualitative-descriptive approach was employed, combining spatial overlay analysis, stakeholder interviews, field observations, and a review of spatial planning documents. The findings reveal a mismatch between actual land use and designated spatial functions in the existing spatial plan, triggering spatial conflicts and ecological risks. Despite these challenges, the area holds strategic potential to be redeveloped into zones for ecotourism, adaptive agroforestry, and community-based economic hubs. Key recommendations include integrating reclamation programs into spatial planning policies, establishing participatory zoning frameworks, and strengthening local identity as a foundation for inclusive and sustainable post-mining area regeneration.

**Keywords:** Post-mining, spatial planning, reclamation, community-based development, ecotourism

## INTRODUCTION

Artisanal mining activities in Cempaka Subdistrict, Banjarbaru City, South Kalimantan, Indonesia, have been carried out for generations and form an integral part of the local community's socio-economic identity. However, the exploitation of natural resources without adequate spatial planning has led to significant environmental degradation. Abandoned mining pits, soil and water contamination, and the threat of landslides now represent pressing ecological challenges in the area [1], echoing findings from Ghana on the ecological pressures caused by informal mining activities [2].

Post-mining landscapes across Indonesia generally exhibit concerning trends. Rohaendi and Herlinawati have emphasized that the majority of post-mining areas remain underutilized and poorly managed [3]. The lack of integration between reclamation activities, spatial planning policies, and community empowerment has emerged as a core barrier to transforming these areas sustainably [4]. As part of rehabilitation efforts, ecotourism and agroforestry-based approaches have been identified as promising strategies. Integrating ecotourism with conservation and productive activities not only supports ecological recovery but also holds potential to enhance the livelihoods of local communities [5]. This potential is reinforced by findings on the development of agroecotourism in areas prone to spatial conflict [4], as well as the critical role of communities in the success of post-mining village ecotourism programs [6].

Nevertheless, field realities indicate that post-mining development efforts continue to be hindered by overlapping regulations and weak legal certainty. Inconsistent law enforcement and fragmented governance have left many post-mining lands abandoned and unmanaged [7]. The absence of comprehensive spatial risk mapping further exacerbates the area's vulnerability to environmental hazards [8]. In terms of spatial planning, it is crucial that post-mining areas are explicitly included within regional spatial planning documents to ensure

that development aligns with sustainability principles and ecological justice [9]. This aligns with the multifunctional land-use transition framework proposed [10].

Furthermore, the success of post-mining landscape transformation strongly depends on active community engagement in the planning process. A participatory approach is essential to ensure the long-term sustainability of land use in post-mining contexts [11]. Studies by Ahmad and Hossain have also shown that participatory rehabilitation models have yielded significant results in several Southeast Asian regions [12]. Based on this background, the present study aims to formulate spatial optimization strategies for the post-mining area in Cempaka through an integrative approach encompassing spatial, ecological, social, and economic dimensions. This research is expected to contribute both scientifically and practically to the formulation of adaptive, inclusive, and sustainable post-mining area management policies at local and national levels.

# METHODOLOGY

This study employs a qualitative-descriptive approach aimed at understanding the spatial, ecological, and social dynamics within the post-mining landscape of artisanal mining in Cempaka Subdistrict. This approach enables in-depth exploration of the complex phenomena surrounding spatial governance and the transformation potential of post-mining areas.

## Study Area

The research was conducted in Pumpung Village, Cempaka Subdistrict, Banjarbaru City, South Kalimantan Province, Indonesia. This area is known as one of the oldest traditional diamond mining sites in the country, where local communities still engage in artisanal mining activities. The location was selected due to its complex post-mining landscape characteristics, including abandoned mining pits, informal settlements, spatial planning conflicts, and emerging local initiatives such as educational tourism and community-based economic activities.

Administratively, the site falls under the jurisdiction of the Banjarbaru City Government and is closely linked to the spatial planning policies of South Kalimantan Province. The area is accessible via a well-connected road network linking the city center to the mining zone and is located near government institutions such as the Banjarbaru City Hall and the Governor's Office of South Kalimantan. These factors make Pumpung Village a representative site for an in-depth and context-specific examination of spatial optimization strategies in post-mining areas.

## Data Collection Techniques

A triangulated data collection strategy was employed to ensure the validity and reliability of the findings:

1. Field Observations and Visual Documentation: Direct observation was conducted at several abandoned mining sites in Cempaka to record physical land conditions, such as pit topography, vegetation cover, water accumulation, and existing infrastructure. Visual documentation through photography was systematically carried out to capture spatial and environmental evidence.

2. Spatial Planning Document Analysis: The study examined the current Regional Spatial Plan of Banjarbaru City, focusing on spatial pattern maps, structural plans, and land use allocations. The objective was to assess the extent to which post-mining areas are accommodated in formal spatial plans and to identify potential mismatches between actual land use and designated zoning.

3. In-depth Interviews: Semi-structured interviews were conducted with three key stakeholder groups: (1) government officials from relevant agencies such as the Department of Public Works and Spatial Planning, the Environmental Office, and the Regional Development Agency; (2) local residents directly involved in traditional mining activities; and (3) urban planners and spatial planning practitioners.

These interviews aimed to explore perceptions, experiences, and aspirations regarding post-mining land optimization.

4. Comparative Case Studies: To draw parallels and identify best practices, the study examined successful post-mining management cases from other regions in Indonesia, including Sawahlunto (West Sumatra), Pongkor (West Java), and Tanjung Enim (South Sumatra). The analysis focused on land rehabilitation models, supporting spatial planning policies, and innovations in post-mining economic empowerment.

### Data Analysis Techniques

Collected data were analysed using content and thematic analysis, consisting of the following stages:

1. Data Reduction – selecting relevant data related to spatial planning, existing conditions, and challenges of land rehabilitation;

2. Categorization – organizing data into thematic groups: ecological, social, economic, and spatial;

3. Interpretation – conducting in-depth interpretation to reveal inter-element relationships and to construct a conceptual narrative of post-mining spatial optimization strategies.
The credibility of findings was ensured through source triangulation and cross-verification between different data collection techniques. Data validation involved checking the consistency between observations, documents, and interview data.

## RESULTS AND DISCUSSION

### Existing Land Use and Spatial Conflicts

The Cempaka artisanal diamond mine has been in operation for a long time. The mining area has transformed into large water-filled pits with extremely high acid content. An analysis of river water quality in Pumpung Village, based on calculations using the STORET method, yielded a score of -24. This falls within the range of -11 to -30, placing it in Class C, which indicates a moderately polluted river category. In terms of soil characteristics, the land in Pumpung Village has an acidic pH ranging from 3.5 to 6.3. Mercury (Hg) levels also indicate that the soil has been contaminated due to mining activities—both in areas still actively mined and those that have been converted into agricultural land [13]. Furthermore, a study by Ramadhani et al., using four hydrological parameters, concluded that the presence of diamond mining in Kampung Pumpung, Cempaka District, poses a significant flood risk [14]. The post-mining landscape in Pumpung Village, Cempaka Subdistrict, exhibits a pattern of spontaneous, unplanned, and adaptive land use, primarily shaped by the immediate needs of the local population. Based on field observations and spatial analysis, the current land use in the former mining area can be categorized into three main forms:

1. Informal Settlements: Residential structures have emerged along accessible open lands, particularly near former mining paths and water ponds. These settlements largely lack formal permits and are not integrated with essential infrastructure such as drainage, sanitation, or proper road access.

2. Idle Lands and Bushes: These are areas left unused and often characterized by unstable topography from past mining excavations. Many of these lands are classified as degraded and prone to landslides.

3. Community-Based Tourism Initiatives: Local residents have informally converted abandoned mining pits into bathing ponds to attract visitors. While promising, these tourism efforts lack sustainability planning and do not comply with basic safety standards.

Spatial conflicts arise due to mismatches between actual land use and formal land allocation as stated in the official Regional Spatial Plan of Banjarbaru City. According to the Regional Spatial Plan, the area is designated for residential and tourism purposes. However, in reality, development has proceeded without regulatory oversight, violating building setback lines and ignoring environmental carrying capacities.

This situation has led to a fragmented spatial function that causes both ecological and social consequences. From an ecological perspective, land degradation has been accelerated by deforestation around former mining slopes and the absence of formal reclamation efforts. These conditions have increased the risks of slope instability, landslides, and localized flooding, especially during the rainy season. From a social perspective, disputes over land ownership have frequently occurred due to the lack of legal clarity regarding the status of former mining lands, which were often never formally registered.

The problem is exacerbated by weak institutional coordination in spatial control and monitoring. Various stakeholders—including local residents, small entrepreneurs, and village authorities—have vested interests in the post-mining lands, yet there is no integrative forum to align their aspirations with regulatory frameworks. This has resulted in what spatial planning literature refers to as a *spatial misfit* between formal planning and actual land use, which often leads to prolonged development stagnation and conflict [9] [10].

Therefore, any optimization strategy for post-mining areas must begin with identifying spatial overlaps, restructuring micro-zoning, and establishing priority areas for rehabilitation based on geological risks and local economic potential. Community engagement through participatory mapping can serve as a gateway for developing more adaptive and inclusive spatial planning scenarios, as advocated in the context of post-mining regions in developing countries [11].

**Spatial Potential of the Post-Mining Landscape**

The Pumpung area in Cempaka Subdistrict holds a variety of distinctive potentials that can be optimized as part of a sustainable tourism-based regional development strategy. One of its most prominent assets is the cultural heritage of diamond mining, which reflects strong historical value and local identity. Traditional diamond panning activities, which continue to this day, not only serve as a cultural attraction but can also be packaged as an educational tourism experience. This would allow visitors to learn firsthand about traditional mining processes and the local wisdom embedded in them.

In addition to cultural richness, the area is dotted with former mining ponds that form exotic natural landscapes with great potential to be developed into scenic recreational spaces. The tranquility and beauty of these lakes could attract tourists seeking outdoor and nature-based activities. Another distinctive feature is the presence of locally crafted gemstone souvenirs, such as diamonds and agates, which offer both economic value and cultural significance. These artisanal products could foster local creative economies and strengthen the region’s branding as a geological tourism destination.

**Figure 1.** Malinggang method & traditional mining tools

(Source: Renanda)

Moreover, the area is well-suited for sustainable ecotourism development, thanks to its capacity to integrate environmental conservation, community empowerment, and environmental education. Access to Pumpung is relatively easy via existing transportation infrastructure, which enhances regional connectivity and competitiveness. In terms of facilities, the area is already equipped with basic tourism support infrastructure such as parking areas, local food stalls, and accessible pathways—all of which can be gradually improved in

line with increasing tourist demand. These attributes align well with the concept of a community-based tourism village, which emphasizes active local participation in providing tourism services. Equally important, the surrounding environment remains relatively green and lush, with the presence of open green spaces that offer visual comfort and support the concept of nature- and education-oriented tourism. The combination of cultural value, natural beauty, accessibility, and community involvement makes Pumpung a strategic area for development as a leading sustainable tourism destination in South Kalimantan.


**Figure 2.** Development potential and key advantages of pumping

The limited level of education has a direct impact on the low level of job skills possessed by the majority of the population (Figure 3). Most residents rely on mining activities as their primary source of livelihood—an occupation that generally does not require specialized skills beyond manual labor. As mining activities begin to decline, communities lacking alternative skills face significant challenges in adapting to employment in the formal economic sector. This situation constrains the economic mobility of the population and eventually leads to social risks such as structural poverty and prolonged unemployment. Communities trapped in this condition often find it difficult to escape the cycle of poverty due to limited access to more stable and sustainable employment opportunities. Furthermore, the lack of skills becomes a major barrier to developing independent enterprises, which could otherwise serve as a pathway to greater economic self-reliance. This phenomenon underscores the urgent need for intervention in education and skills training. Without adequate access to continued education and capacity-building programs, the community will continue to face challenges in improving their standard of living. Skills-based training—such as entrepreneurship, technology, or agribusiness—can serve as an effective starting point to open new opportunities for the affected population.

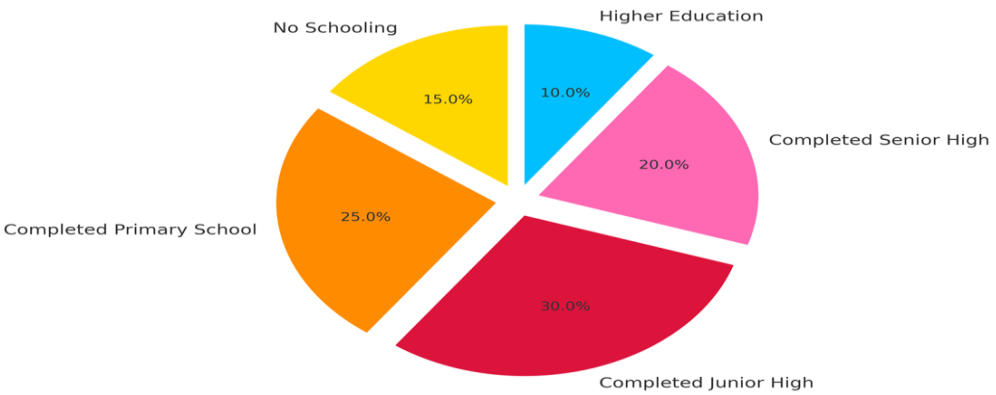


**Figure 3.** Percentage of Educational Attainment in Cempaka District (Source: *Cempaka in Figures 2024*)

## Spatial Potentials of the Post-Mining Landscape

Despite the ecological and institutional challenges facing the post-mining area of Pumpung Village in Cempaka Subdistrict, the region holds significant spatial potential for sustainable development. These potentials are not only physical in nature but also encompass social, economic, and cultural dimensions that can be strategically integrated into long-term spatial planning. Based on field observations, stakeholder interviews, and literature reviews, three key potentials have been identified as the foundation for transforming the post-mining landscape.

1. Development of Educational Ecotourism and Geotourism: The distinctive geomorphology of the former mining landscape—marked by water-filled pits and irregular terrain—offers a unique and visually compelling setting. This landscape holds considerable potential for geotourism development with an emphasis on educational and conservation-oriented approaches. Successful models have been implemented in historic mining sites such as Sawahlunto, Pongkor, and Tanjung Enim, where former mine areas have been integrated into museums, interpretive trails, and experiential tourism activities [3]. In addition, community-based ecotourism can enhance local livelihoods while preserving ecological integrity. Emphasizing geological education, landscape preservation, and local participation makes this model particularly relevant for Cempaka, which is also known for its diamond mining heritage [6].

2. Integration of Adaptive Agroforestry as a Rehabilitation Strategy: Ecological rehabilitation of the degraded post-mining area can be achieved through adaptive agroforestry systems involving the planting of productive and endemic species on critical lands. Tree species such as *Albizia chinensis* (Sengon), *Archidendron pauciflorum* (Jengkol), *Parkia speciosa* (Petai), or local medicinal plants contribute to soil stability, erosion control, and community livelihoods. Research by Kurniawan et al. indicates that agroforestry practices on post-mining land can improve soil water retention and reduce acidity (pH), which are common issues in open-pit mining areas [5]. Selection of plant species should be based on ecological suitability, market potential, and community capacity for sustainable management.

3. Preservation of Mining Culture and History through Public Space Design: The area also holds high historical and cultural value as one of Indonesia's traditional diamond mining centers. Local narratives—such as the struggle of artisanal miners, the discovery of the legendary *Trisakti* diamond, local land myths, and traditional diamond purification rituals—represent intangible cultural heritage that deserves preservation and promotion. Integrating these cultural elements into public spaces—through thematic parks, heritage trails, or signage that tells local stories—can strengthen the area’s identity and enhance tourism appeal [9]. Moreover, this approach fosters a sense of ownership among residents and reinforces the social legitimacy of landscape transformation efforts.

## Spatial Planning Strategies for the Post-Mining Area

The transformation of the post-mining landscape in Pumpung Village requires an adaptive spatial planning framework that responds to existing conditions while proactively fostering long-term sustainability. This approach necessitates the integration of formal planning instruments, community participation, supportive infrastructure, and intersectoral policy harmonization. Based on field observations and a review of relevant literature, the following key strategies are proposed:

1. Revision of the Spatial Plan with Specific Post-Mining Zoning: A critical initial step involves revising the Banjarbaru City Spatial Plan to explicitly incorporate post-mining zones. Currently, most of these areas lack appropriate land-use classifications that reflect their actual conditions and development potential. New zoning categories should be introduced, such as “Ecological Restoration Areas,” “Community Agroforestry Zones,” or “Post-Mining Ecotourism Corridors.” These designations would not only provide legal certainty and direction for development but also serve as a regulatory basis to control land use in alignment with environmental carrying capacity and disaster risk management [9].

This strategy is consistent with the principle of ecological justice and promotes inclusive planning in marginal areas.

2. Community-Based Participatory Spatial Planning: Experiences from various countries show that the success of post-mining rehabilitation efforts is highly dependent on the active participation of local communities [11] [12]. Therefore, land-use planning should be conducted through participatory mechanisms such as thematic spatial forums, participatory mapping, and community planning workshops. Involving local residents, artisanal miners, traditional leaders, and tourism actors enhances the legitimacy of the plan and ensures that the resulting strategies align with the community's needs and aspirations. Moreover, this approach strengthens the community's adaptive capacity to sustainably manage post-mining land.

3. Development of Sustainable Infrastructure and Accessibility: To fully realize the potential of the post-mining landscape, the provision of environmentally friendly and sustainable infrastructure is essential. Accessibility can be improved through the development of green transport corridors, such as bike paths and pedestrian walkways made from permeable materials, along with digital wayfinding tools integrated with the city's geospatial information system. Additionally, basic amenities such as sanitation, clean water supply, and waste management facilities in tourism zones are necessary to ensure visitor comfort and minimize environmental impacts.

4. Policy Integration and Regulatory Harmonization: One of the major challenges in post-mining area management is the fragmentation of policies across the environmental, mining, and spatial planning sectors. Spatial strategies must therefore be designed to synchronize the Regional Spatial Plan with other sectoral frameworks, including mine reclamation guidelines, local environmental action plans (RAD), and disaster risk mitigation policies. This integrated approach will enhance inter-agency coordination and prevent regulatory overlaps, as highlighted by Herdiansyah et al., who emphasized weak institutional coordination as a major barrier to successful landscape rehabilitation [7].

**Table 1**. Summary of Issues, Potentials, and Strategic Recommendations for Post-Mining Area in Cempaka

| No | Main Issue | Summary of the Issue | Potential | Recommendation |
|---|---|---|---|---|
| 1 | Severe Environmental Damage | Mining has caused land degradation, ecosystem loss, and pollution. | Ecological restoration through agroforestry and ecotourism. | Reclaim mined lands and conserve critical areas. |
| 2 | Economic Dependency on Mining | Local communities rely heavily on mining and lack skills for alternative livelihoods. | Diversification through tourism and creative industries. | Provide vocational training and support for small non-mining businesses. |
| 3 | Lack of Supporting Infrastructure | Inadequate facilities for tourism and creative economy; limited road access. | Development of tourism villages and training centers. | Improve infrastructure, accessibility, and tourist amenities. |
| 4 | Limited Social Access | Communities have poor access to healthcare and social support services. | Enhancing well-being through improved public services. | Expand healthcare access and integrate social support programs. |
| 5 | Weak Monitoring and Regulation | Lack of environmental regulation and regular monitoring mechanisms. | Establishing integrated and enforceable regulatory frameworks. | Implement cross-sectoral regulations with routine environmental audits. |

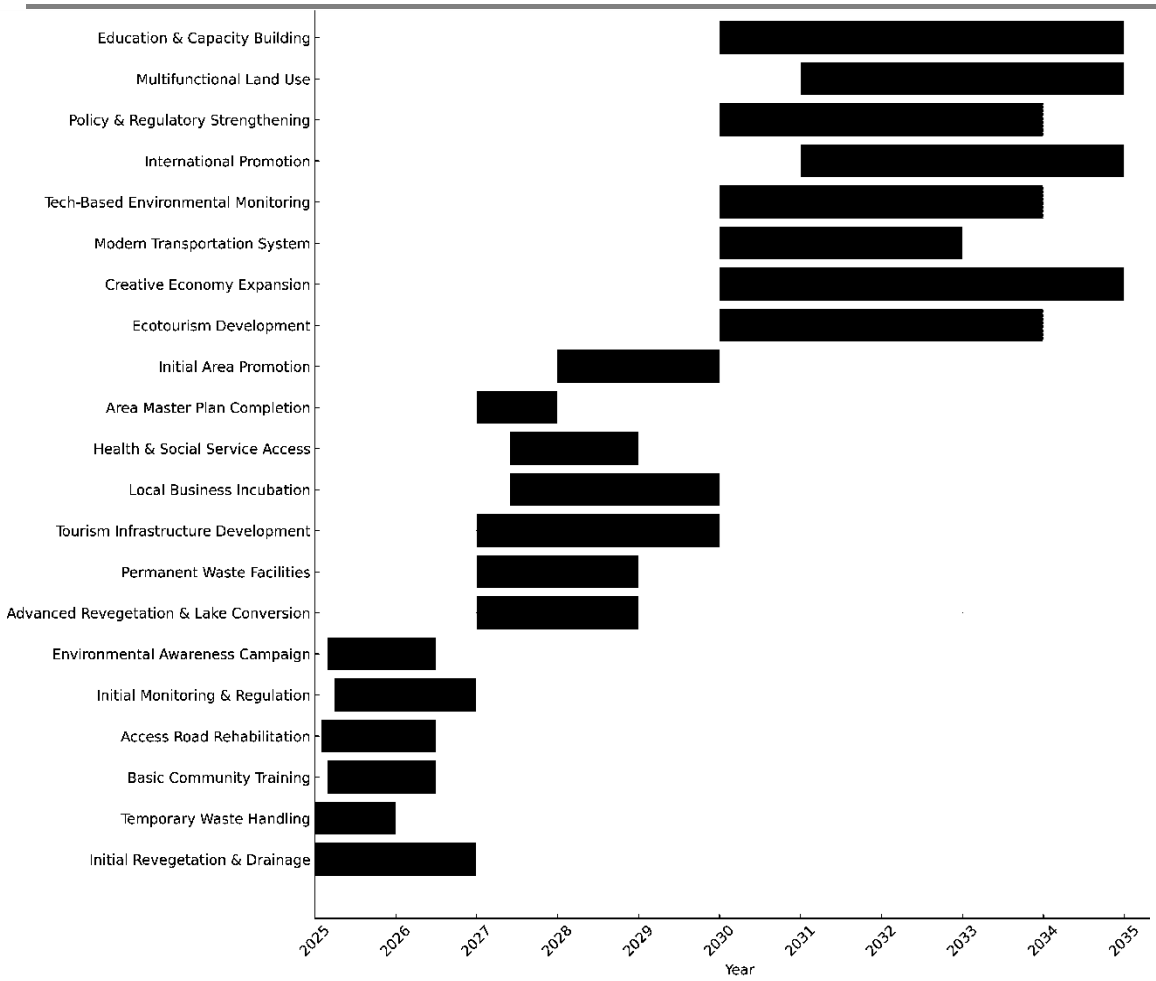


**Figure 4.** Implementation roadmap for post-mining area development in Pumpung (2025–2034)

## CONCLUSION

Post-mining landscapes, often regarded as marginal, degraded, and environmentally hazardous, possess significant potential to be transformed into productive, inclusive, and sustainable territories. This study reveals that a spatial planning approach rooted in local ecological conditions and supported by participatory governance can effectively revitalize the post-mining area of Cempaka into a multifaceted asset—environmentally restored, socially empowering, and economically viable. The findings highlight five critical and interrelated challenges that hinder regeneration efforts: extensive environmental degradation caused by acidic abandoned pits and the lack of structured reclamation; economic vulnerability stemming from local dependence on informal and unsustainable mining practices; limited basic infrastructure, including inadequate access roads and public facilities; institutional weakness marked by poor regulatory enforcement and the absence of integrated environmental monitoring; and fragmented policy landscapes across spatial, environmental, and mining sectors.

Despite these obstacles, the area presents a range of strategic opportunities. These include the development of ecotourism and geotourism that showcase the site's unique geology and cultural identity, the implementation of adaptive agroforestry systems that serve both ecological and livelihood functions, the conservation of diamond mining heritage through public spaces that reinforce place identity, the promotion of community-based tourism that enables grassroots economic participation, and the creation of green and creative economy jobs aligned with sustainable development goals. Synthesizing these opportunities, the study calls for an urgent revision of existing spatial plans to explicitly designate post-mining zones as priority development areas. It also advocates for micro-zoning strategies led by community participation, the upgrading of green infrastructure, and the harmonization of cross-sectoral policies to ensure coherence between spatial planning, environmental regulation, and mining governance.

Looking forward, future research should strengthen the scientific and policy basis for post-mining regeneration by conducting longitudinal monitoring of environmental indicators such as soil, water, and vegetation quality; assessing the economic feasibility of alternative land uses like ecotourism, agroforestry, and circular economies; and investigating the social dimensions of transition, including trust-building, land tenure security, and community collaboration. Additionally, exploring the climate resilience potential of rehabilitated landscapes and developing policy simulation tools that allow local governments to test various development scenarios under uncertainty would greatly enhance planning efforts. This study affirms that with integrated strategies, strong community involvement, and institutional commitment, post-mining areas such as Cempaka can be transformed into replicable models of sustainable development across extractive regions in Indonesia and beyond.

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