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The Implementation of Cross-Sector Collaboration in Post-Mining Environmental Governance in Indonesia

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Abstract

Mining activities contribute significantly to the economy but often leave complex environmental impacts that require effective and sustainable post-mining management. Challenges in post-mining environmental governance in Indonesia often include company non-compliance, weak government oversight, and minimal community participation. These issues indicate the need for a cross-sectoral collaborative approach involving the government, the private sector, communities, and academics to achieve sustainable development goals. This study aims to analyze effective cross-sectoral collaboration models in post-mining environmental governance in Indonesia based on existing scientific literature, policies, and best practices. The research method used is a systematic literature review by examining various secondary data sources, including national and international journals, laws and regulations (such as Law No. 32 of 2009 concerning Environmental Protection and Management), research reports, and related policy documents. The collected data were analyzed qualitatively to identify patterns, barriers, enabling factors, and successful collaboration models implemented in similar contexts. The analysis shows that effective cross-sectoral collaboration requires a clear governance framework, equitable distribution of roles and responsibilities, and transparent conflict resolution mechanisms. Key factors for successful implementation include shared commitment, strong regulations, the availability of human and financial resources, and building trust between actors. The collaborative governance model has the potential to be an ideal approach for managing the complexity of post-mining environmental issues.
Keywords: cross-sector, collaboration, environmental, governance, post-mining, Indonesia

1. Introduction

Mining activities often have significant environmental impacts, such as soil structure damage, acid mine drainage pollution, landscape changes, and biodiversity loss. This threatens the sustainability of ecosystems and the quality of life of surrounding communities. Therefore, implementing environmental governance is crucial to minimize these negative impacts and ensure the sustainability of natural resources (Amalia & Arseyani, 2023).

By law, companies are required to reclaim and sustainably manage post-mining land. However, many ex-mining areas, such as thousands of mine pits in Indonesia, remain improperly rehabilitated or abandoned. Sustainable and responsible mining management requires adherence to the principles of benefit, environmental awareness, legal certainty, participation, and accountability. To this end, the government implemented changes through the enactment of Law No. 3 of 2020 concerning amendments to Law No. 4 of 2009 concerning mineral and coal mining. These changes were made so that sustainable mining management could make a real contribution to society (As'ari, Mulyanie, & Rohmat, 2019; Marfai & King, 2008).

Post-mining management involves complex issues, encompassing environmental, social, and economic aspects, which cannot be addressed by a single party or sector. Sectoral governance approaches, or those dominated by a single actor (e.g., a company or government), tend to be ineffective in comprehensively addressing the dynamics of post-mining issues. This often leads to imbalanced power relations and a lack of space for local communities or MSMEs to actively participate.

A collaborative governance model that integrates various stakeholders (government, private sector, community, academic, and non-governmental organizations) is needed to ensure effective, transparent, and sustainable planning and implementation of post-mining programs. The principles of Good Environmental Governance (Azizah & Sudibyo, 2023) emphasize the importance of public participation, the rule of law, and information transparency as the foundations of effective environmental governance. This collaboration is crucial for building trust, optimizing resources, and

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creating long-term impacts on community well-being and environmental preservation.
This literature review aims to identify and analyze how cross-sector collaboration is implemented in practice, the challenges faced, and the key factors supporting the success of post-mining environmental governance in Indonesia.

2. Method

Research Design

This study employs a qualitative approach with a systematic literature review method. This specific approach was chosen because the study aims to understand and analyze effective cross-sectoral collaboration models in post-mining environmental governance based on existing scientific literature, policies, and best practices. Unlike field research that explores social phenomena through direct interaction, this method allows the researcher to explore the complexity of governance issues, including company non-compliance and weak oversight, by examining various texts. Through this design, the researcher intends to describe the patterns, barriers, enabling factors, and successful collaboration models implemented in similar contexts without manipulating the data sources, allowing a comprehensive understanding of sustainable development goals to emerge from the synthesis of various documents.

Research Location

The scope of this research is focused on the context of post-mining environmental governance in Indonesia. The selection of this scope is based on the consideration that mining activities contribute significantly to the economy but leave complex environmental impacts that require effective management. Specifically, the research focuses on the cross-sectoral collaborative approach involving the government, the private sector, communities, and academics. This context is crucial because challenges such as minimal community participation and environmental degradation indicate the need for a collaborative governance model to achieve sustainable development goals. The research is conducted by examining data spanning a relevant time period to capture the evolution of policies and practices in the post-mining sector.

Data Sources

Data sources in this study are exclusively categorized as secondary data. Unlike field studies that rely on primary data from interviews, this research obtains data from authoritative documents and academic records. The main sources for this data include national and international journals, laws and regulations such as Law No. 32 of 2009 concerning Environmental Protection and Management, research reports, and related policy documents. These documents provide the necessary context regarding the normative framework and empirical realities of post-mining management, offering a robust foundation to identify clear governance frameworks and equitable distribution of roles.

Data Selection Technique

In this literature review, the data sources were selected using a purposive selection strategy. The researcher determines documents based on specific criteria to ensure the data obtained is relevant to the research objectives and capable of answering the research problems regarding effective collaboration. The criteria established for selecting documents include literature that explicitly discusses cross-sectoral collaboration, post-mining issues, and environmental governance, as well as documents that are credible and relevant to the Indonesian context. This selection method ensures that the data analyzed provides specific knowledge regarding shared commitment, strong regulations, and the availability of resources required for the study.

Data Collection

To obtain complete and valid data, the researcher utilizes documentation techniques carried out systematically. The researcher collects data by searching and examining various secondary data sources to identify patterns and frameworks relevant to the study. This involves gathering legal texts, academic articles, and official reports to understand the complexity of post-mining environmental issues. By aggregating these documents, the researcher can comprehensively capture the nuances of government oversight, corporate responsibility, and community involvement without the need for physical field observation, ensuring that the necessary information regarding trust-building and conflict resolution mechanisms is obtained.

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Data Validity

To ensure the validity and credibility of the data, this study uses source triangulation. The researcher will compare the information obtained from different types of documents to verify the accuracy of the analysis. For instance, the normative framework provided in Law No. 32 of 2009 will be cross-checked with empirical findings from research journals and field reports regarding actual implementation. This process helps to verify the consistency between policy intent and practical reality, minimizing the bias of relying on a single type of document and ensuring that the identified barriers and enabling factors are corroborated by multiple evidence sources.

Data Analysis

Data analysis is carried out using the interactive model proposed by Miles, Huberman, and Saldaña, which consists of three continuous flows of activity. The first flow is data condensation, where the researcher selects, focuses, simplifies, and abstracts the raw data found in the literature to identify key themes such as governance frameworks and conflict resolution mechanisms. The second flow is data display, where the researcher organizes the compressed information into narrative text to facilitate the understanding of how shared commitment and trust impact collaboration. The third flow is conclusion drawing and verification, where the researcher draws initial conclusions based on the findings and continuously verifies them with valid evidence throughout the research process until credible final conclusions are reached regarding the ideal collaborative governance model for post-mining environments.

3. Results and Discussion

Environmental Governance Performance

Performance measurement itself requires a set of principles and indicators that can be tested across contexts. The OECD Water Governance Framework (2020) identifies twelve principles as "must-haves" for effectiveness, efficiency, and inclusiveness, then translates them into the Water Governance Indicator Framework, which serves as a multi-stakeholder self-assessment tool. Updates and enhancements to practices from 2018 through to the public briefing in 2024 emphasize the framework's role in assessing what is working, what needs improvement, and who is doing what—thus providing an operational bridge between governance norms and measurable performance. Furthermore, recent literature on water governance indicators emphasizes the importance of linking institutional indicators to biophysical and socioeconomic variables to prevent performance assessment from becoming trapped solely in procedural compliance.

Indonesia is a country with significant natural resource potential, one of which is the mining sector. However, poorly managed mining activities contribute to environmental damage, including in the Bangka Belitung Islands Province. Atikah et al. (2025) examined disaster mitigation following onshore unconventional tin (TI) mining activities in the Bangka Belitung Islands Province from a collaborative governance perspective. The study found that collaborative governance can strengthen cross-sector coordination and oversight, encourage regulatory reform of artisanal mining, and ensure the implementation of post-mining environmental restoration obligations. Thus, collaborative governance is a crucial strategy in balancing community economic interests with environmental sustainability. In addition to Bangka Belitung, Kalimantan is a region with a mining industry that contributes significantly to the economy. In the mining industry, negative impacts are always a major risk in environmental management. Research in Kalimantan shows that mining companies that implement effective environmental management policies and conduct environmental impact assessments (EIA) involving the community tend to have lower negative impacts on the environment (Wulandari & Sisdianto, 2025). Improved corporate governance practices tend to improve a company's environmental performance. This suggests that a strong oversight and management structure encourages companies to be more aware of and responsible for the environmental impacts of their operations. Environmental performance is seen as a form of corporate social responsibility (CSR) and concern for the surrounding environment. Improved environmental performance, measured through, for example, PROPER or ISO 14001, can enhance a company's positive image in the eyes of the public and consumers. There are mixed results regarding the effect of environmental performance on financial performance. Some studies find a positive and significant effect, while others find no significant effect or even contradictory results.

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Similarly, the relationship between environmental performance and firm value also shows inconsistent results across studies. Some studies find a significant effect, while others do not.
Disclosure of environmental, social, and governance (ESG) information, or sustainability reporting, is considered important. Transparent disclosure can build stakeholder trust and potentially create a competitive advantage, although the average risk disclosure index remains relatively low in some contexts. Overall, this study emphasizes that effective environmental governance is a multi-level interaction between various parties (government, private sector, and civil society) aimed at achieving sustainable development. While non-financial benefits such as image and risk management are clearly evident, the direct relationship with financial performance remains debated in the academic literature.

Cross-sector Collaboration

Cross-sector collaboration in environmental governance in Indonesia generally shows an increasing trend and its urgency is recognized, although its implementation still faces various challenges. In public service delivery, the emerging collaboration model is hybrid, combining formal mechanisms with informal practices based on local values and customary authority. The role of non-state actors has proven significant in overcoming bureaucratic capacity limitations, particularly in the education, clean water, and basic healthcare sectors. These findings emphasize the importance of collaborative governance that is contextual and sensitive to local social dynamics, and broaden the scope of collaborative governance theory to include cultural and relational dimensions. The global implications of this study suggest that collaborative governance models Community-based laboratories can be an effective alternative for providing basic services in underdeveloped and pluralistic areas (Fonataba, 2025).
In the implementation of environmental governance, collaboration has successfully increased environmental awareness in communities and encouraged active participation in local programs, such as waste management, clean water provision, and reforestation initiatives. However, there is still a lack of understanding about sustainability, and collaboration between government, companies, and communities that can create innovative solutions (Wulandari & Sisdianto, 2025).
Multi-sectoral and cross-sectoral collaboration is also supported by regulatory frameworks in Indonesia, such as Law No. 32 of 2009 concerning Environmental Protection and Management (PPLH), which provides a foundation for multi-stakeholder participation in environmental planning and oversight. This supports research by Atikah et al. (2025), which found that collaborative governance can strengthen cross-sectoral coordination and oversight, encourage regulatory reform of artisanal mining, and ensure the implementation of post-mining environmental recovery obligations.
Related research studies have concluded that cross-sector collaboration is considered an integrative solution for achieving Sustainable Development Goals (SDGs) in the environmental sector, such as sustainable waste management, clean water provision, and climate resilience. These partnerships help ensure solutions are more inclusive and responsive to local needs.
Based on the results of the data source review, key barriers include weak coordination between institutions/sectors, a lack of effective communication, and imbalances in local institutional capacity. In this regard, weak governance, suboptimal regulatory frameworks at the operational level (for example, in mangrove management), and political influence can hinder the collaboration process. Low public participation and distrust stemming from past experiences can undermine the legitimacy of collaborative initiatives. Several studies also indicate that collaboration strategies often focus too much on end results and pay too little attention to effective process models.
In addition to barriers, supporting factors also contribute to the success of cross-sector collaboration. One such factor is the presence of leaders at various levels capable of bridging cross-sector interests. Furthermore, well-defined procedures, structures, and role allocations within collaboration can enhance effectiveness. Another supporter is an approach that adapts government policies to cultural practices and social relations at the local level, which has proven to be more inclusive and effective, especially in remote areas.

Post-mining Management

Mining activities in Indonesia have shown significant growth over the past decade. The main driver of this growth comes from the increasing demand for construction materials, both from government and private projects. However, this mining expansion has not been matched by adequate environmental

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management. Mining carried out without strict controls triggers negative impacts such as soil erosion, river sedimentation, loss of soil-retaining vegetation, decreased water quality, and changes in river morphology.

This phenomenon creates a dilemma between short-term economic interests and long-term environmental sustainability. From an economic perspective, mining does contribute to local revenue (PAD) and creates jobs. However, the resulting ecological losses are often greater, particularly in the form of damage to water resources, land degradation, and decreased agricultural productivity. According to a 2021 report by the United Nations Environment Programme, unsustainable mining practices can cause economic losses greater than their benefits due to the extremely high costs of environmental restoration.

Post-mining management in Indonesia is strictly regulated within environmental governance to restore the natural and social functions of the environment. The primary regulatory framework involves the obligation for holders of Mining Business Permits (IUP) or Special Mining Business Permits (IUPK) to carry out reclamation and post-mining activities according to approved plans. The national legal framework already provides instruments for regulating and supervising mining activities. Law Number 32 of 2009 concerning Environmental Protection and Management mandates the central and regional governments to control the environmental impacts of various economic activities. The revised Law Number 3 of 2020 emphasizes the obligation for mining operators to develop reclamation plans, implement post-mining restoration, and establish reclamation guarantee funds as a condition of licensing.

Key activities in post-mining management include reclamation land management, water management, revegetation, waste management, and socio-economic aspects. Reclamation includes the arrangement of post-mining land, backfilling of mine voids (voids) if necessary, and other civil works according to land use. Water quality management and monitoring, including acid mine drainage mitigation, ensure environmental quality standards are met. Revegetation with local species is carried out to restore biodiversity and native ecosystems. Waste management, hazardous and toxic materials (B3), and hazardous waste generated during and after mining activities. Post-mining programs also emphasize economic recovery and the well-being of local communities, ensuring the sustainability of land functions and economic benefits in ex-mining areas. This is also reflected in research observations by Ikhsan et al. (2025), who implemented various rehabilitation strategies, including revegetation, wastewater management, and community empowerment through an agroforestry program. The success of this program is reflected in increased vegetation cover, land stability, and biodiversity indicators in the reclamation area.

Ecological-Social Impacts and Challenges

The concept of environmental management in contemporary policy science has shifted from a technocratic paradigm that positions the government as the sole controller to a multi-actor, networked, adaptive, and evidence-based governance. Within the Indonesian framework, the legal definition is formulated as a systematic and integrated effort to preserve environmental functions and prevent pollution/damage through planning, utilization, control, maintenance, supervision, and restoration. This operational definition is enshrined in Law Number 32 of 2009 (the Environmental Management Law) and serves as the normative anchor for all instruments such as permits, Environmental Impact Assessments (EIA), supervision, and administrative-criminal sanctions. This law also emphasizes the duties/authorities of the central and regional governments, the rights and obligations of citizens, and the role of the community, thus placing environmental management within an explicit state-citizen relationship.

In the international literature, influential conceptual milestones have come from environmental governance studies, which explain how the cross-scale, non-linear, and uncertain nature of environmental problems cannot be addressed by a single governance model. Lemos, Maria Carmen & Agrawal, Arun. (2006) argue that hybrid configurations—combining state, market, and community instruments—are more effective in reducing coordination failures, increasing accountability, and sharpening policy responsiveness to local variations. This argument emphasizes four domains: globalization (cross-border standards/transparency), decentralization (local authority), market incentives (instrumental political economy), and cross-scale governance (vertical integration). Thus,

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successful management depends on the design of relationships between decision centers that overlap but can coordinate.

The strengthening of the above concept is empirically supported by the development of polycentric theory. Instead of a single decision center, polycentric systems consist of multiple relatively autonomous "venues" that learn from each other and compete healthily, thus accelerating policy innovation, minimizing the risk of single failures, and increasing resilience in the face of turbulence (e.g., disasters or commodity market fluctuations). Recent literature outlines the "building blocks" of polycentricity—such as actor diversity, interconnectedness, and compatible rules of play—and demonstrates how intermediate collaborative forums can bridge cross-level coordination. In practice, relevant architecture for watershed and mining area management is mediated by multiple interests (conservation, building materials, agriculture, irrigation, public safety) (Tiffany H. Morrison, 2023).

The phenomena of erosion and sedimentation are classic and crucial issues in environmental governance, directly impacting ecological sustainability and the social well-being of communities. In the context of watersheds and mining activities, high erosion rates trigger land degradation and reduce natural buffering capacity, while excessive sedimentation alters river morphology, reducing water holding capacity, and exacerbating flood risks. Contemporary hydrological studies confirm that changes in erosion-sedimentation patterns are not only a technical ecological issue but also have significant social implications, especially for communities that depend on water resources and productive land for their livelihoods.

Water quality and availability are also affected by these dynamics. High sedimentation in water bodies causes increased turbidity, reducing water quality for consumption and irrigation, and disrupting aquatic ecosystems. Conversely, sedimentation in irrigation canals and reservoirs reduces effective water storage volume, thereby reducing the reliability of water supply for agriculture. This has implications for the safety of irrigation infrastructure, where excessive sedimentation accelerates technical deterioration and increases maintenance costs.

At the social level, the most obvious impacts are felt by downstream communities. The loss of productive land due to erosion, disruption of irrigation water distribution, and declining water quality directly impact agricultural yields, household incomes, and food security. Therefore, socio-ecological trends such as erosion, sedimentation, water availability, and the safety of irrigation infrastructure are inseparable from the discourse of sustainable development. They serve as vital indicators reflecting how environmental policy interventions, both at the national and regional levels, can maintain a balance between economic interests and ecological sustainability to support the livelihoods of downstream communities.

André Zumak (2025) found that approximately half of the population living in floodplain areas is at risk of erosion (26%) or sedimentation (18.5%), a figure that confirms that this geomorphic degradation is not only a biophysical phenomenon but also a significant social problem. Residents living along riverbanks face the loss of land, homes, and even livelihoods. In other words, erosion and sedimentation are not only environmental challenges but also threats to the sustainability of human communities. Furthermore, Vázquez-Tarrío (2024) highlighted that deforestation, urbanization, intensive agriculture, and mining are the main drivers of accelerated global erosion. The loss of vegetation cover causes the soil to lose its natural binding capacity, making it more easily transported by surface runoff. Urbanization, with its increased impermeable areas, increases runoff, while unconservative agricultural practices accelerate topsoil degradation.

In the context of quarry mining, the extraction of sand and gravel from rivers alters the balance of sediment transport. Kondolf et al. (2023) introduced the concept of "hungry water," a condition in which water flows are deprived of sediment supply due to mining, resulting in rivers becoming "starved" for sediment and eroding deeper into the riverbed. This phenomenon not only accelerates river morphological degradation but also increases the risk of damage to irrigation infrastructure, bridges, and water distribution channels.

Regarding Ecological Impacts, Erosion and sedimentation have complex ecological impacts. In terrestrial ecosystems, the loss of fertile soil leads to decreased land productivity, destruction of animal habitats, and increased surface runoff, which exacerbates flooding. In aquatic ecosystems, sedimentation increases water turbidity, reduces light penetration, and damages aquatic ecosystems,

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particularly photosynthetic organisms such as phytoplankton and aquatic plants.
This is in line with Zhang et al. (2022), who emphasized that increased suspended sediment alters the structure of aquatic communities and reduces biodiversity. Sedimentation in reservoirs also reduces water holding capacity, shortens the dam's lifespan, and increases state operational costs. Thus, the ecological impacts of erosion and sedimentation are not only a matter of landscape degradation but also a threat to the stability of ecosystems that support the sustainability of natural resources. Beyond ecological impacts, the social impacts of erosion and sedimentation are most felt by downstream communities. The loss of agricultural land due to riverbank erosion means reduced planting area and decreased yields. Sedimentation in irrigation canals disrupts water distribution, making it difficult for farmers to obtain a stable water supply for their rice fields. Zumak (2025) cautions that floodplain communities are not only vulnerable to land loss but also face the risk of losing their social identity due to their attachment to eroded living spaces.
Similarly, Blaikie and Brookfield (2021), in their study of land degradation, emphasize that erosion is a symptom of social injustice, with poor rural communities more vulnerable to its impacts due to limited access to conservation technology and weak policy support. Therefore, the issues of erosion and sedimentation cannot be separated from the political-economic dimensions that influence the distribution of risks and social vulnerability. The case of the Amazon illustrates how erosion and sedimentation threaten ecosystem stability and human life. Recent studies have shown that land-use changes accelerate sediment transport, causing more frequent flooding, and destroying fish habitats that are a source of food for local communities. Meanwhile, in South Asia, the Indus River faces similar challenges. Bank erosion erodes agricultural land, while sedimentation in irrigation channels reduces the efficiency of water distribution. As a result, millions of farmers face reduced crop yields and increased canal maintenance costs. This case demonstrates that without integrated policy interventions, erosion and sedimentation can undermine regional food security.
Thus, it can be argued that erosion and sedimentation trends demonstrate that these ecological issues cannot be viewed solely as technical issues but as social challenges that impact the sustainability of community livelihoods. Recent expert opinions such as Zumak (2025), Vázquez-Tarrío (2024), and Kondolf (2023) emphasize that anthropogenic factors are accelerating geomorphic river degradation, with far-reaching impacts on water quality, infrastructure safety, and the livelihoods of downstream communities. Therefore, solutions require clear cross-level roles, consistent policy coordination, and the implementation of mitigation strategies based on scientific evidence and community participation. In this way, environmental governance can move beyond short-term responses to sustainable and socially equitable river ecosystem management.

4. Conclusion

Successful post-mining management cannot be achieved by a single institution; collaboration between government, companies, and civil society is a key factor for long-term positive impacts. Early socialization, environmental education, and program development involving all stakeholders are indicators of initial success. However, a clear environmental management strategy and a binding policy framework are needed to integrate management within a single post-mining landscape. Companies are often the dominant actors determining the direction of CSR or reclamation programs, while the government and communities (e.g., local MSMEs) remain passive beneficiaries, limiting their scope for aspirations. Limited capacity of local community organizations (e.g., in management literacy or legality) hinders their ability to negotiate and actively participate. Often, there is no clear and integrated environmental management strategy for the sustainability of post-mining forests or land that can effectively address the dynamics of the problem. Law enforcement against illegal mining activities (PETI) also faces challenges in inter-agency collaboration that need to be improved. Overall, the literature review emphasizes that effective post-mining environmental governance requires a comprehensive, integrated, and participatory approach from various stakeholders to address environmental damage and promote community well-being.

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