Journal of Creative Student Research
Volume 4, Nomor 4, Agustus 2026
e-ISSN: 2963-4776; p-ISSN: 2963-5942, Hal. 29-39
DOI: https://doi.org/10.55606/jcsr-politama.v4i4.6449
Tersedia: https://ejurnal.politeknikpratama.ac.id/index.php/jcsr

An Integrative Ecological Model for the Sustainable and Adaptive Rehabilitation and Utilization of Post-Coal Mining Land in Embalut

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Abstract. This study aims to formulate an ecological model for the sustainable rehabilitation and utilization of post-coal mining land in Embalut. This study employs a qualitative approach using a library research method through a systematic literature review of books, scientific reports, policy documents, SINTA-indexed journals, and international journals published between 2020 and 2026. The data were analyzed using qualitative content analysis and thematic synthesis, focusing on the themes of ecological rehabilitation, soil restoration, revegetation, ecosystem functions, land use, and sustainability monitoring. The findings indicate that post-mining rehabilitation cannot be adequately carried out merely through replanting, but must be directed toward soil restoration, the enhancement of vegetation diversity, the re-establishment of ecosystem functions, and long-term adaptive management. Post-mining land use needs to be aligned with ecological carrying capacity, socioeconomic conditions, landscape characteristics, and community needs. The resulting conceptual model integrates soil restoration, revegetation based on local and pioneer species, ecosystem function assessment, productive land-use alternatives such as agriculture, plantations, forest products, and conservation, as well as monitoring based on GIS, remote sensing, and stakeholder participation. This model is expected to serve as an initial framework for ecological, participatory, productive, and sustainable post-mining management in Embalut. Thus, this study provides a theoretical contribution to the development of post-mining studies and a practical contribution to the formulation of reclamation policies that are more measurable, contextual, and aligned with the ecological characteristics of the Embalut region, as well as to sustainable land management decision-making at the local level in Embalut.

Keywords: Ecological Rehabilitation; Embalut; Land Use; Post-Coal Mining; Sustainability.

1. INTRODUCTION

Mining is a temporary economic activity; however, its ecological impacts may persist over the long term if it is not accompanied by proper rehabilitation planning and post-mining land-use management. World Bank Group, (2021, p. 1) emphasizes that mining is a finite economic activity that provides temporary socioeconomic benefits for communities, shareholders, and business owners. Similarly, Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development, (2021, p. 1) states that mine closure and post-mining transition have become increasingly important issues for governments, industries, and communities. The number of mines expected to close in the coming years continues to increase, thereby intensifying collective attention to mineral resource management and sustainable land use. Therefore, post-mining land management should not merely be understood as an administrative obligation, but also as an essential component of ecological restoration and the sustainability of land functions after mining activities have ended.

In Indonesia, post-coal mining lands generally face several environmental problems, including vegetation degradation, landscape alteration, declining soil quality, and disruption of ecosystem functions. Nursaputra et al., (2021, p. 39) state that reclamation of former mining

Naskah Masuk: 18 Mei 2026; Revisi: 19 Juni 2026; Diterima: 09 Juli 2026; Terbit: 17 Juli 2026

lands is an essential and inseparable component of the mining process because it functions as an effort to restore environmental conditions and maintain ecosystem sustainability in mining areas. Pratiwi et al., (2021) also emphasize that the implementation of science-based practices is required to restore the functions of former mining lands. Thus, an ecological approach becomes relevant because it views post-mining rehabilitation as a process of system recovery, rather than merely a technical activity involving pit closure or land revegetation.

Embalut is one of the important areas in the study of post-coal mining lands in East Kalimantan. Rahayu et al., (2024, p. 98) state in their study that revegetation on post-coal mining land at PT Kitadin Site Embalut, East Kalimantan, aimed to assess plant growth and revegetation success in planting blocks from 2013, 2015, and 2017. The results showed that plants aged 7-9 years grew faster than those aged 9-11 years. In general, revegetation was classified as good; however, the composition of pioneer and local plant species, as well as the plant survival percentage in the 2017 block, still need to be improved through additional planting and maintenance. These findings indicate that Embalut already has a foundation of revegetation studies. However, these studies remain more focused on plant growth indicators and have not specifically developed an ecology-based model for post-mining land use.

Studies on mine reclamation indicate that the success of rehabilitation is strongly influenced by local ecological characteristics. Pambudi et al., (2025, p. 148) state that their study highlights environmental challenges caused by coal mining in tropical and subtropical regions, particularly due to microclimatic complexity and ecological diversity that may hinder reclamation success. Amid the increasing global demand for coal, comparative studies across countries regarding reclamation remain limited. Based on this condition, the research gap of this study lies in the absence of library research that specifically synthesizes rehabilitation, ecosystem functions, and post-mining land use in Embalut into a single ecology-based conceptual model. In other words, the novelty of this study does not lie in the claim that Embalut has never been studied, but rather in the development of an integrative framework that connects revegetation, ecological restoration, land use, and post-mining sustainability.

World Bank Group emphasizes that each jurisdiction has different conditions; therefore, the solutions applied must be adjusted to the regulatory, cultural, economic, and historical contexts of each region (World Bank Group, 2021, p. 6). Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development states that this condition may increase financial, environmental, and social risks for various jurisdictions if mining companies are unable to fully meet their mine closure obligations. Several previous cases have shown that mines without financial assurance may be abandoned, resulting in hazardous and unsuitable

environmental conditions. In such situations, the responsibility for financing environmental recovery ultimately shifts to the government (Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development, 2021, p. 3). On this basis, research on Embalut is important because post-mining areas should not only be assessed based on revegetation success, but should also be directed toward land uses that are compatible with local ecological characteristics. Therefore, this study offers novelty by developing an ecological model for post-mining rehabilitation and land use in Embalut, integrating soil restoration, revegetation, ecosystem functions, alternative land-use options, and sustainability monitoring.

Pambudi et al. state in their study that they sought to address the limitations of previous studies by analyzing best practices in ecology-based reclamation. The method used was a qualitative approach with a comparative case study design, supported by a systematic literature review to evaluate policies and the implementation of ecology-based reclamation (Pambudi et al., 2025, p. 148). In line with this direction, the present study employs a library research method through a systematic review of books, scientific reports, SINTA-indexed journals, and international journals published between 2020 and 2026. The focus of this study is directed toward three aspects: the principles of ecological rehabilitation of post-coal mining land, forms of post-mining land use that are compatible with ecological carrying capacity, and the formulation of a conceptual model for the rehabilitation and post-mining utilization of Embalut. This study aims to analyze trends in post-mining rehabilitation studies, identify the gap between revegetation studies and land-use studies, and formulate an ecological model for the sustainable rehabilitation and utilization of post-coal mining land in Embalut.

2. RESEARCH METHOD

This study employed a qualitative approach using library research, which was conducted through a systematic literature review. Page et al., (2021, p. 1) state that the PRISMA 2020 statement replaced the 2009 version by providing new reporting guidelines that accommodate methodological developments in identifying, selecting, appraising, and synthesizing studies. The structure and presentation of the items were also updated to make them easier to apply. Based on this foundation, the library research method was selected in this study because the objective was not to conduct direct field measurements, but rather to develop a conceptual synthesis of the rehabilitation and utilization of post-mining land in Embalut based on an ecological approach. This method is relevant to the research gap identified in the introduction, namely the limited number of studies that connect revegetation, ecosystem functions, land use, and post-mining sustainability within a single conceptual model.

Data were collected through the exploration of scientific articles, books, scientific reports, and policy documents relevant to the themes of ecological rehabilitation, reclamation, revegetation, post-mining land use, and ecosystem sustainability. Atikah et al., (2023, p. 108) state that research data were collected using the Systematic Literature Review (SLR) approach through online searches for scientific articles in the ERIC and Google Scholar databases. On the same page, Atikah et al., (2023, p. 108) also explain that the screening process was carried out through keywords, index filters, title selection, abstract selection, and full-paper content analysis. In this study, literature sources were searched through Google Scholar, Garuda, SINTA, Scopus, ScienceDirect, SpringerLink, and the official websites of relevant institutions. The keywords used included "rehabilitasi pascatambang," "reklamasi tambang batubara," "revegetasi lahan pascatambang," "post-mining land use," "ecological reclamation," "mine closure," and "post-mining rehabilitation." The inclusion criteria consisted of sources published between 2020 and 2026, relevance to post-mining rehabilitation or land use, availability in full-text form, and origin from books, SINTA indexed journals, international journals, or official documents. The exclusion criteria included articles that did not discuss post-mining issues, lacked clear methodological information, were not available in full text, or only discussed technical aspects of mining without any relation to rehabilitation and land use.

The collected data were analyzed using qualitative content analysis and thematic synthesis. Kuckartz and Rädiker (2023, p. 2) state that textual data remain the most dominant form of qualitative data in social science research. On the same page, Kuckartz and Rädiker (2023, p. 2) also explain that qualitative content analysis methods are designed to analyze text-based data and, in principle, can be applied to other types of qualitative data. Literature data in the form of articles, books, reports, and policy documents can be analyzed systematically through the processes of reading, coding, theme grouping, and meaning interpretation. The stages of analysis in this study included: first, identifying the main concepts from each source; second, coding themes related to ecological rehabilitation, revegetation, soil restoration, ecosystem functions, land use, and sustainability monitoring; third, comparing findings across sources; and fourth, developing an ecology-based conceptual model for the rehabilitation and post-mining utilization of Embalut. The final output of this study is a narrative synthesis and conceptual model that explain the relationship among post-mining land conditions, ecological rehabilitation processes, ecosystem function restoration, land-use options, and sustainability evaluation.

3. RESULTS AND DISCUSSION

Principles of Ecological Rehabilitation of Post-Coal Mining Land

The results of the literature review indicate that post-mining land rehabilitation should be positioned within the framework of ecosystem restoration, rather than merely as a replanting activity. FAO, SER, and IUCN CEM state that the restoration of degraded ecosystems plays an important role in recovering biodiversity, maintaining ecosystem health, supporting climate change mitigation, and improving human well-being (FAO et al., 2023, p. 1). This statement implies that the restoration of damaged ecosystems is an essential need because it is closely related to biodiversity recovery, ecosystem health, environmental services, climate change mitigation, and human welfare.

Harsono et al. explain that reclamation age, the level of vegetation diversity, and soil chemical properties, particularly total nitrogen content, are important factors in assessing reclamation success in relation to biodiversity recovery (Harsono et al., 2024, p. 589). Adman et al., (2020, p. 83) state that former coal mining land needs to be rehabilitated so that its land functions can be restored. Their study also shows that not all plant species are able to grow well on former mining land due to excessive light intensity and extreme temperature fluctuations. Bach et al. argue that soil biodiversity is a fundamental basis for ecosystem restoration because soil is not merely a planting medium, but a living system that determines nutrient cycling, vegetation health, and ecosystem stability (Bach et al., 2020, p. 1).

Based on these findings, the principles of ecological rehabilitation on post-coal mining land in Embalut need to be developed through four main directions. First, rehabilitation should begin with the restoration of soil conditions, as soil serves as the foundation for successful vegetation growth. Second, plant species selection should consider ecological suitability, particularly the use of local species, pioneer species, and species capable of adapting to former mining land conditions. Third, rehabilitation success should not only be measured by plant survival rates, but also by improvements in vegetation diversity, soil properties, and the re-establishment of ecosystem functions. Fourth, rehabilitation should be implemented gradually and adaptively because post-mining land recovery is a long-term process. Thus, the findings of this discussion strengthen the argument presented in the introduction that Embalut should not only be examined through revegetation indicators, but should also be directed toward the comprehensive recovery of ecological systems.

Forms of Post-Mining Land Use Compatible with Ecological Carrying Capacity

The results of the literature review indicate that post-mining land use must be adjusted to the biophysical, social, economic, and institutional characteristics of the region. Pagouni et al., (2024, p. 14), referring to Arratia-Solar et al., (2022), explain that the selection of post-mining or post-quarry land use needs to consider the principles of sustainable development, which include economic, social, and environmental aspects. In addition, the determination of land use should also take into account the characteristics of the mining site, culture, technical aspects, governance, regional development, and geoethics so that post-mining land-use options are aligned with local conditions.

Worden et al., (2024, p. 1) explain that the selection of post-mining land use should not only be viewed at the scale of an individual mining site, but should also consider the regional scale. A regional approach enables more strategic planning because it takes into account landscape conditions, regional policies, community needs, and broader land-use opportunities. Therefore, a collaborative and interdisciplinary post-mining land use (PMLU) assessment method is required, involving mining operators, government, regulators, and regional stakeholders. This methodology can serve as an initial stage in determining post-mining land-use options that are compatible with regional capacity, although the final decision still requires more detailed planning at the mining site level.

Poudyal et al., (2024, p. 1) explain that public support for the mining industry is strongly influenced by reclamation success. Poor reclamation may reduce public support because post-mining land is unable to provide optimal benefits for landowners and surrounding communities. A study on surface mining in Kentucky showed that satisfaction with reclamation remained low due to inadequate reclamation practices. Land-use options considered more feasible and acceptable by landowners and surrounding communities include agriculture, forest products, and nature conservation. Meanwhile, financial incentives, legal assurance, and the strengthening of reclamation regulations are needed to support more effective utilization of reclaimed land.

Muhardini et al., (2020, p. 65) explain that post-coal mining land needs to be converted so that it can become a productive and beneficial area. Based on a qualitative study in Tanah Laut Regency, post-mining land has the potential to be developed as agricultural and plantation areas. This potential is supported by data on food-provisioning ecosystem services, which indicate that the landform is classified as moderate, meaning that it remains possible to utilize the land to support food needs through appropriate land management.

Based on the literature review, post-mining land use compatible with ecological carrying capacity needs to consider environmental, social, economic, land-characteristic, governance, and community-need aspects. The selection of land use should not be conducted solely at the mining-site scale, but should also consider the regional context so that it is aligned with landscape conditions and regional development directions. The success of post-mining land use is also strongly influenced by reclamation quality and community acceptance. Therefore, appropriate forms of land use are those that maintain ecological functions while also providing economic and social benefits, such as agriculture, plantations, forest products, and nature conservation. This is in line with the findings of Pagouni et al., (2024), Worden et al., (2024), Poudyal et al., (2024), and Muhardini et al., (2020), which emphasize the importance of aligning land use with regional capacity and local ecological conditions.

Ecology-Based Conceptual Model for Post-Mining Rehabilitation and Utilization in Embalut

The results of the literature review indicate that a post-mining land-use model needs to be designed integratively by connecting environmental data, stakeholders, monitoring technologies, and decision-making processes. Arratia-Solar et al., (2022, p. 1) explain that decarbonization pressures have led many coal-mining regions to face mine closure, thereby requiring more appropriate post-mining land-use planning. To support regional transition, a regional planning framework is needed that involves multiple stakeholders and integrates environmental, social, and technical data. The proposed framework incorporates community engagement, GIS, multi-criteria decision-making, and fuzzy logic to ensure that post-mining planning becomes more transparent, measurable, and aligned with a low-carbon future.

Prasetya and Tsai, (2025, p. 1) explain that remote sensing can be used to monitor coal-mining activities and reclamation without the need for direct field visits. Their study used Sentinel-1 and Sentinel-2 imagery, as well as deep learning methods with U-Net and ResNet architectures, to analyze changes in mining and reclamation areas in Tapin Regency, Kalimantan, during the 2016-2021 period. The results showed high accuracy, reaching 97.4% with a Kappa value of 0.91, and found that reclamation increased by more than twofold in 2020 following an expansion of mining areas in 2019. This method is considered effective for large-scale and long-term monitoring of open-pit mining, although its accuracy remains influenced by the resolution of the satellite imagery used.

Crofts and Phelan, (2025, p. 1) explain that the energy transition away from fossil fuels has made post-mining land-use planning increasingly important, particularly in coal-mining regions such as the Hunter Valley, Australia. Their study emphasizes the importance of

community involvement in the development of post-mining land use (PMLU) plans through Delphi expert panels and deliberative workshops with local residents. The outcome of this process was a report containing community perspectives, which can be used as input for energy transition policy formulation and post-mining land-use planning.

Based on the literature review, the ecology based conceptual model for post-mining rehabilitation and utilization in Embalut needs to be designed integratively by combining environmental, social, technical, technological, and stakeholder participation aspects. Post-mining planning should not only focus on land restoration, but should also support regional transition toward sustainable and low-carbon land utilization. Therefore, the model developed in this study needs to integrate environmental, social, and technical data through GIS based approaches, multi-criteria decision-making, and monitoring technologies such as remote sensing. This technology is important for periodically assessing reclamation progress and land-cover changes. In addition, the involvement of communities, government, academics, and mining companies is also an essential element to ensure that post-mining land-use plans are aligned with regional needs and accepted by the community. Thus, the ecology-based post-mining rehabilitation model for Embalut can be directed toward restoring environmental functions while also developing productive, measurable, participatory, and sustainable land use.

4. CONCLUSION AND RECOMMENDATIONS

Based on the results of the literature review, it can be concluded that the rehabilitation of post-coal mining land in Embalut should be understood as a comprehensive ecosystem restoration process, rather than merely a replanting activity or the fulfillment of reclamation obligations. Rehabilitation success needs to be assessed based on soil quality restoration, vegetation growth, biodiversity improvement, the recovery of ecosystem functions, and the ability of the land to be utilized sustainably. Therefore, the ecological model formulated in this study positions soil restoration, revegetation based on local and pioneer species, ecosystem functions, land use, and sustainability monitoring as the main components of post-mining management in Embalut.

The applicable solution is to develop post-mining management based on ecological carrying capacity and regional needs. Land use cannot be determined solely based on economic interests, but must also consider the biophysical conditions of the land, vegetation suitability, landscape characteristics, the social conditions of local communities, and regional development directions. Potential forms of land use include agriculture, plantations, forest products, nature

conservation, or a combination of productive and ecological uses that continue to maintain environmental stability. In addition, the use of technologies such as GIS and remote sensing can serve as an important solution for periodically monitoring land-cover changes, reclamation progress, and the sustainability of ecosystem functions.

This study recommends further research based on field data in the post-mining area of Embalut so that the conceptual model developed in this study can be tested and adjusted to actual site conditions. The government, mining companies, academics, and local communities need to be involved in the planning process so that the direction of post-mining land use becomes more participatory and acceptable to surrounding communities. Furthermore, reclamation and post-mining land-use policies should not only assess plant survival rates, but should also include indicators of soil restoration, vegetation diversity, ecosystem services, socioeconomic benefits, and long-term sustainability as the basis for evaluation.

REFERENCES

Adhani, A. F., Nugroho, A. W., & Yassir, I. (2020). The growth of local tree species on post-coal mining areas in East Kalimantan. *Indonesian Journal of Forestry Research*, *7*(2), 83–97. https://doi.org/10.59465/ijfr.2020.7.2.83-97

Arratia-Solar, A., Svobodova, K., Lèbre, É., & Owen, J. R. (2022). Conceptual framework to assist in the decision-making process when planning for post-mining land uses. *The Extractive Industries and Society*, *10*, Article 101083. https://doi.org/10.1016/j.exis.2022.101083

Atikah, Habiddin, Nazriati, Rahayu, S., & Dasna, I. W. (2023). A systematic literature review: Model mental pada konsep-konsep kimia. *Jurnal Inovasi Pendidikan Kimia*, *17*(2), 106–115. https://doi.org/10.15294/jipk.v17i2.39070

Bach, E. M., Ramirez, K. S., Fraser, T. D., & Wall, D. H. (2020). Soil biodiversity integrates solutions for a sustainable future. *Sustainability*, *12*(7), Article 2662. https://doi.org/10.3390/su12072662

Crofts, K., & Phelan, L. (2025). Delphi and deliberation: Engaging community expertise to inform post-mining land use in the Hunter Valley, Australia. *Energy Research & Social Science, 127,* Article 104218. https://doi.org/10.1016/j.erss.2025.104218

FAO, Society for Ecological Restoration, & IUCN Commission on Ecosystem Management. (2023). *Standards of practice to guide ecosystem restoration: Summary report*. FAO. https://doi.org/10.4060/cc5223en

Harsono, S. S., Hartini, K. S., Suroso, M., & Laraswati, D. (2024). Keanekaragaman vegetasi pada beberapa umur revegetasi di lahan reklamasi pascatambang batubara PT Indominco Mandiri, Kalimantan Timur. *Jurnal Ilmu Lingkungan, 22*(3), 589–599. https://doi.org/10.14710/jil.22.3.589-599

Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development. (2021). *Current status of mine closure readiness: Are governments prepared?* International

Institute for Sustainable Development. https://www.iisd.org/system/files/2021-08/status-mine-closure-readiness-en.pdf

Kuckartz, U., & Rädiker, S. (2023). *Qualitative content analysis: Methods, practice and using software* (2nd ed.). SAGE. https://qca-method.net/documents/Kuckartz_Raediker_2023_Qualitative_Content_Analysis_2ed_Chapter1_Excerpt.pdf

Muhardini, S., Rahmani, D. R., & Setiawan, Y. F. (2020). Kesesuaian lahan pasca tambang batu bara berdasarkan data jasa ekosistem penyedia pangan di Kabupaten Tanah Laut. *SINTA Journal, 1*(2), 65–70. https://doi.org/10.37638/sinta.1.2.65-70

Nursaputra, M., Larekeng, S. H., Nasri, Hamzah, A. S., Mustari, A. S., Arif, A. R., Ambodo, A. P., Lawang, Y., & Ardiansyah, A. (2021). Pemanfaatan penginderaan jauh dalam penilaian keberhasilan reklamasi di lahan pasca tambang PT Vale Indonesia. *Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan, 11*(1), 39–48. https://doi.org/10.29244/jpsl.11.1.39-48

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., Stewart, L. A., Thomas, J., Tricco, A. C., Welch, V. A., Whiting, P., & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, Article n71. https://doi.org/10.1136/bmj.n71

Pagouni, C., Pavloudakis, F., Roumpos, C., Spanidis, P. M., & Pavloudaki, E. (2024). Transitional and post-mining land uses: A global review of regulatory frameworks, decision-making criteria, and methods. *Land, 13*(7), Article 1051. https://doi.org/10.3390/land13071051

Pambudi, P. A., Utomo, S. W., & Handoko, R. S. (2025). Coal mining reclamation: Lessons learned from tropical and subtropical countries. *Journal of Environmental Science and Sustainable Development, 8*(1), 148–184. https://doi.org/10.7454/jessd.v8i1.1299

Poudyal, N. C., Gyawali, B. R., & Acharya, S. (2024). Reclamation satisfaction and post-mining land use potential in Central Appalachia, US. *The Extractive Industries and Society, 20*, Article 101550. https://doi.org/10.1016/j.exis.2024.101550

Prasetya, K. D., & Tsai, F. (2025). Multitemporal spatial analysis for monitoring and classification of coal mining and reclamation using satellite imagery. *Remote Sensing, 17*(6), Article 1090. https://doi.org/10.3390/rs17061090

Pratiwi, Narendra, B. H., Siregar, C. A., Turjaman, M., Hidayat, A., Rachmat, H. H., Mulyanto, B., Suwardi, Iskandar, Maharani, R., Rayadin, Y., Prayudyaningsih, R., Yuwati, T. W., Prematuri, R., & Susilowati, A. (2021). Managing and reforesting degraded post-mining landscape in Indonesia: A review. *Land, 10*(6), Article 658. https://doi.org/10.3390/land10060658

Rahayu, R. N., Sarminah, S., & Hardwinarto, S. (2024). Pertumbuhan tanaman dan indikator keberhasilan revegetasi di areal pasca tambang batubara PT Kitadin Site Embalut Provinsi Kalimantan Timur. *Jurnal Hutan Tropika, 19*(1), 98–107. https://doi.org/10.36873/jht.v19i1.14038

Worden, S., Svobodova, K., Côte, C., & Bolz, P. (2024). Regional post-mining land use assessment: An interdisciplinary and multi-stakeholder approach. *Resources Policy, 89*, Article 104680. https://doi.org/10.1016/j.resourpol.2024.104680

World Bank Group. (2021). *Mine closure: A toolbox for governments*. World Bank. https://documents1.worldbank.org/curated/en/278451617774355047/pdf/Mine-Closure-A-Toolbox-for-Governments.pdf