Bulletin of Community Engagement
Vol. 6, No. 2, August 2026
https://attractivejournal.com/index.php/bce//index

Green Mining for Marine Environmental Protection: A Legal Analysis of Nickel Mining on Raja Ampat

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ARTICLE INFO
Article history:
Received
March 11, 2026
Revised
August 07, 2026
Accepted
August 31, 2026

Abstract

The continued development of electric vehicles (EVs) has increased demand for nickel as a key material in EV batteries, providing substantial economic benefits to Indonesia as one of the world's leading nickel producers and the holder of the world's largest nickel reserves. Nevertheless, nickel-mining activities pose significant risks to Indonesia's marine environment, particularly in Raja Ampat. Indonesia has adopted international and national legal instruments governing marine environmental protection. Articles 193 and 194 of the United Nations Convention on the Law of the Sea (UNCLOS) recognize States' sovereign right to exploit their natural resources while requiring them to protect and preserve the marine environment and prevent, reduce, and control marine pollution from any source. At the national level, Law No. 32 of 2014 on Maritime Affairs and Law No. 27 of 2007 on the Management of Coastal Areas and Small Islands establish governmental responsibilities for managing, protecting, and conserving coastal and small-island resources. However, the 2025 revocation of four mining licences in Raja Ampat, while PT Gag Nikel's authorization remained effective, demonstrates regulatory and enforcement uncertainty. The central legal issue is the overlap between mining authorization under the Minerba regime and restrictions on small-island utilization under the coastal and small-island regime. Using a legal normative method, this article analyses legislation, official government information, and relevant academic literature to determine whether a formally valid mining authorization may continue to be exercised on a protected small island. It will also analyze the potential to implement green mining through Indonesia's national legal instruments to balance the importance of sustainable mineral development with marine environmental protection in Raja Ampat.

Keywords: Nickel Mining; Green Mining; Land-Based Pollution.

Published by CV. Creative Tugu Pena
ISSN 2774-7077
Website https://attractivejournal.com/index.php/bce/

INTRODUCTION

Global efforts to address the various challenges to sustaining life on Earth are reflected in initiatives to achieve the targets set out in the Sustainable Development Goals (SDGs). One concrete example is the development of electric vehicles (EVs) to support the achievement of SDGs 7, 12, and 13. In addressing climate change under Goal 13, the implementation of Goals 7 and 12 is closely connected to the transition from fossil-fueled vehicles to EVs (Abdelkareem et al., 2025; Haryadi et al., 2024). The continued use of fossil-fueled vehicles has raised concerns about the depletion of the natural resources used to produce their fuels, as well as the emissions they generate, which contribute to air pollution and global warming. Innovation and development in EVs therefore seek to address the problems associated with fossil-fueled vehicles (Abdelkareem et al., 2025). In addition to producing fewer emissions during operation, EVs run on rechargeable batteries when the power runs out, making them a potential alternative to fossil-fueled vehicles (Khalil & Broughel, 2025). The development of EVs can thus be regarded as part of a strategy to combat climate change, while greater use of renewable energy can support more effective and efficient use of natural resources, contributing simultaneously to the achievement of Goals 7, 12, and 13.

However, although EV development can be considered one solution to climate change, nickel mining to meet the demand for EV battery production and other stainless-steel components poses its own threats to the surrounding environment. As the country with the world's largest nickel reserves, Indonesia also ranks as the world's largest nickel producer, bringing substantial benefits to its economy. Nevertheless, rising demand for nickel, driven by the rapid expansion of EV production, has compelled Indonesia to sacrifice environmental protection to make way for nickel mining. One such problem concerns the marine environment of Raja Ampat, where nickel mining on several islands has caused sedimentation and contaminated seawater with heavy metals that can endanger both ecosystems and human health. This situation is particularly ironic because Raja Ampat has been designated as a Marine Conservation Area under the Decree of the Minister of Marine Affairs and Fisheries No. 13 of 2021, and mineral mining that may cause environmental damage and pollution harmful to local communities is prohibited. Raja Ampat has been designated as a marine protected area (MPA), an approach that seeks to protect marine ecosystems and habitats while integrating the conservation of marine living resources with ecosystem protection (Oktivana, 2023). Therefore, activities within or affecting protected marine areas must be assessed against the conservation objectives and applicable environmental restrictions.

The legal gap between the designation of Raja Ampat as Marine Conservation Area (MPA) under the Decree of the Minister of Marine Affairs and Fisheries No. 13 of 2021 and the prohibition of mineral mining that posed a risk to damage the surrounding environment, set forth on the Law No. 27 of 2007. The gap presented by Indonesia's existing laws and the actual situation in Raja Ampat suggest that the law enforcement in Indonesia is still poorly enforced. Similar concerns have been raised in North Konawe where nickel mining has reportedly caused water pollution and the operations still continue despite the area's status as a conservation area under Decree of the Minister of Environment and Forestry No. 451/Kpts-II/1999 . Examining this issue, Taufik et al. (2025) emphasize the need for stronger enforcement against regulatory violations. Although stronger enforcement remains necessary, the present study argues that enforcement alone is insufficient to address the relationship between mining activities and marine environmental protection. Previous studies have addressed mining-related environmental harm, domestic regulatory controls, conservation measures, and cleaner mining practices, but the relationship among these subjects requires closer legal examination. In particular, research on green mining tends to emphasize technical solutions and environmental performance, while giving less consideration to the legal mechanisms needed to make these practices binding on mining operators. The present study consequently moves beyond calls for stricter legal enforcement to examine how green-mining approaches can be incorporated into Indonesian law through operational requirements, permit conditions, and compliance duties. By connecting mining regulation and mining methods with marine protection efforts, this study seeks to clarify how Indonesia's nickel industry can be required to prevent pollution in environmentally sensitive areas such as Raja Ampat.

With aforementioned background, this research examines the following questions:
(1) How does nickel mining, as a source of land-based pollution, affect the protection of the marine environment?
(2) What measures can be implemented to balance nickel mining development with marine environmental protection in Raja Ampat?

This article aims to identify appropriate steps for implementing a green mining approach in Indonesia, in response to increasing demand for nickel production, while safeguarding marine ecosystems in accordance with international and national law. Unlike previous studies that primarily examined environmental damage and weak law enforcement of nickel mining practices in conservation areas, this study is the first to integrate Indonesia's international legal obligations, gaps in Indonesian regulations, and comparative green-mining practices as a way to minimize environmental impact resulting from nickel mining, particularly within Raja Ampat. Thereby offering a new legal framework for preventing land-based marine pollution in Raja Ampat from nickel mining.

METHODS

This study will use normative legal research methods to analyse the discussion of marine environmental protection from pollution resulting from land-based activities, particularly nickel mining. The legal materials comprised international conventions, relevant principles of

international law, Indonesian laws and regulations, and supporting legal documents were assessed qualitatively through the interpretation of legal provisions and the comparison of applicable norms. The examination began by establishing Indonesia's international duties to protect the marine environment, followed by an assessment of how Indonesian legislation gives effect to those duties. It then considered whether the legal requirements governing mining permits align with restrictions intended to safeguard marine conservation areas. Finally, the study compared the legal approaches supporting green mining in China and Finland to determine which regulatory measures could be adapted to strengthen pollution prevention within Indonesia's mining laws and policies.

RESULTS AND DISCUSSION

Land-based Pollution Impact Towards Marine Ecosystems

Land-based pollution is pollution generated from land-based activities, such as improperly managed industrial waste, mining, and other activities that are carried by river currents, rainwater, and other sources, which eventually end up in the ocean and polluting seawater (Attard et al., 2016). Tanaka & Schechinger (2017) Pollution resulting from such activities produces hazardous substances that ultimately damage marine ecosystems. According to a UNGA Report, most marine pollution originates from land-based sources, contributing approximately 80% of total marine pollution (UN General Assembly, 2004). Indonesia's waters are not immune to the threat of pollution caused by land-based activities, particularly mining operations (Qing-Nan, 1987). The protection of Indonesia's marine environment is also connected to the broader application of the law of the sea, which regulates the use of marine resources while requiring consideration of environmental protection (Siswandi, 2017). The eroded land of mining sites can easily be carried into the ocean by water runoff, creating sediment deposits in marine areas (Vithanage et al., 2025). This mining waste that contains dangerous heavy metals can settle in marine sediments and threaten marine ecosystems with toxic contamination (Bruggmann et al., 2024; Gissi et al., 2016; Prazelia et al., 2026; Steward et al., 2026).

Indonesia's international obligations provide a legal basis for addressing these issues. Articles 192–194 of UNCLOS establish the obligation to protect and preserve the marine environment, while Article 207 specifically addresses pollution from land-based sources (Churchill et al., 2022; Tanaka, 2017). These provisions require States to balance the exercise of sovereign rights over natural resources with their obligations to prevent and control marine environmental pollution. Article 3 of the CBD similarly recognises sovereign resource rights alongside responsibility for preventing environmental damage beyond national jurisdiction. The Stockholm and Rio Declarations further emphasise environmental protection and responsibility towards present and future generations. In particular, Principle 15 of the Rio Declaration calls for precaution according to States' capabilities and in the case where threats of serious or irreversible damage are present, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. Applied to mining waste issues, this principle enshrined the obligation to do early assessment, containment and monitoring before potentially irreversible marine damage occurs.

The obligations are also reflected Indonesia's regulation, particularly in Article 22(2) of Law No. 32/2014 on Maritime Affairs which promotes sustainable marine resource management, Law No. 32/2009 on Environmental Protection and Management which requires environmental preservation and pollution prevention (Law of the Republic of Indonesia No. 32 of 2009, Article 2-4), Law No. 04/2009 on Mineral and Coal Mining which requires sustainable and environmentally responsible mining (Law of the Republic of Indonesia No. 04 of 2009, Article 2(d)), as well Law No. 27/2007 which prohibits mineral mining that causes the environmental and community harm specified in that provision (Law of the Republic of Indonesia No. 27 of 2007, Article 35(k)). Indonesia also specifically regulates dumping into environmental media. The Law of Minister of Environment and Forestry Regulation No. 6 of 2021, articles 197–198 require Central Government approval for sea dumping and identify eligible waste streams, including hazardous tailings from mineral processing. Articles 200–201 impose requirements concerning waste treatment and testing, disposal locations, dumping methods and environmental monitoring. Article 205 excludes specified sensitive locations, including marine conservation areas, coral reefs, seagrass ecosystems and productive fishing grounds. Accordingly, reducing the toxicity of mining waste does not, by itself, make sea dumping lawful—the waste, location and disposal operation must satisfy the applicable requirements. These restrictions are particularly relevant to Raja Ampat, where any

proposed dumping location must be assessed against conservation boundaries and sensitive marine habitats.

Unfortunately, the reality that happened in Raja Ampat seems to indicate that the law has not yet been properly enforced. Rainwater carries mining soil into the sea, increasing sedimentation, reducing sunlight penetration, and damaging coral reefs and making it difficult for local fishermen to catch lobsters by free diving because of the murky waters (Biscéré et al., 2017; Jong, 2026). Heavy metals in mining waste may also threaten marine organisms and disrupt food chains (IPB University, 2025), resulting in reduced fish catches, hinder lobster fishing in murky waters, and undermine local livelihoods and tourism. Nevertheless, the government has defended continued mining by citing permits issued before the conservation designation (Law of the Republic of Indonesia No. 02 of 2025, Article 17A (2)), while Minister Bahlil Lahadalia has denied mining-related environmental damage. However, this permit must be read alongside applicable environmental and conservation requirements and prior permits do not remove operators' obligations to prevent pollution and environmental harm (Gillmore et al., 2020). The legal issue therefore lies on how operators have complied with their waste-management and pollution-control duties and whether authorities have adequately supervised that compliance.

While current regulations sufficiently outline the obligations of every entity to protect marine ecosystems, the problem of nickel mining activities in Raja Ampat still exists because of the improperly enforced law and regulations (Dewi, 2025). Therefore, if the government wants to continue, the implementation of mining activities requires a new, more concrete approach so that the damage towards the environment can be minimized.

Green Mining Approach as a Way to Balance Nickel Mining Development and Marine Environmental Protection

Global awareness on the importance of protecting the environment has existed for a long time. Particularly in the mining industry, concepts such as sustainable mining, responsible mining, and green mining have been introduced as ways to reduce the damaging impacts resulting from it. These three concepts are not merely terminology. These three concepts introduce different approaches to addressing concerns about environmental damage caused by mining activities. Sustainable mining was introduced to emphasize that resource utilization in mining activities must be carried out with considerations for factors such as the obligation of mining permit holders to ensure that the production of resources remains below a predetermined limit, taking responsibility for land reclamation, and the implementation of other environmental control measures in areas affected by mining activities (Brundtland, 1987). Responsible mining entails a concept that views mining as an activity aimed at generating as much profit as possible, which is then shared with the surrounding community. This concept holds that these communities are entitled to receive shares from the profits earned by mining companies as a form of corporate social responsibility, whether through goodwill initiatives such as building health facilities and schools for the community or through taxes collected by the government, which are then allocated for national development and community welfare (Broad, 2014). The final concept is green mining that involves conducting mining activities by promoting material and energy efficiency, ensuring the sustainability of resources for the future, and providing an equitable sharing of benefits from the activities (Saepudin et al., 2022). Although the terms sound similar to sustainable mining, green mining emphasizes the use of environmentally friendly technologies and practices in the mining sector with the goal of reducing waste generated from mining equipment and utilizing existing resources as effectively and efficiently as possible, thereby ensuring that mining activities are carried out with less impact towards the environment (Onifade et al., 2024).

Indonesia gives binding effect to several of these objectives through its Good Mining Practice (GMP) framework. The Minister of Energy and Mineral Resources Regulation No. 26 of 2018 requires good mining principles encompassing environmental management, mineral conservation, reclamation and post-mining responsibilities. It also establishes principles of accountability and requirements concerning community development (Law of Minister of Energy and Mineral Resources Regulation No. 26 of 2018, Article 3(3)d, 20–22, 29 and 38). Analytically, these duties reflect elements of sustainable and responsible mining, although the regulation does not formally classify them under those two concepts. However, as aforementioned in the first discussion regarding the damage in Raja Ampat marine environment, it serves as evidence that the methods and concepts of sustainable and responsible mining enshrined in Indonesian law are not yet being

properly implemented and that mining practices continue to be exploitative and do not comply with existing regulations (To'at et al., 2024). This issue has pushed for more concrete changes to the mining practices that Indonesia has followed today.

The emergence of the term "green mining" is one approach that can be implemented to address this issue. The concept of "green mining" has been implemented before by several countries, including China and Finland. China and Finland offer approaches to integrating green mining into environmental governance (Xiang et al., 2024). China's revised Mineral Resources Law promotes resource efficiency and mineral recovery while requiring pollution prevention, restoration planning and public participation through the use of technology (Jia et al., 2025). These obligations provide a legal basis for reducing mining impacts throughout operations and closure (China's Mineral Resources Law, Articles 37–49). Green mining has increasingly been developed as an approach to reducing the environmental impacts of mining through improved resource efficiency, environmental management, and technological innovation (Maddala et al., 2021; Lei et al., 2016). The concept also incorporates technological and managerial measures to improve mining efficiency while reducing ecological impacts throughout mining operations (Wang et al., 2023). Finland's green-mining approach similarly extends beyond individual waste-management technologies to managing environmental and social impacts throughout the mining lifecycle (Nurmi, 2017; Kangaspunta et al., 2025). Finland has incorporated this initiative into its national regulations, Finnish Mining Act, which was issued by the Ministry of Economic Affairs and Employment. Finland provides a complementary reference through environmental permitting and research on mine-waste management. Its Geological Survey describes dry stacking, in which tailings are filtered to remove water and placed in engineered, compacted stacks with drainage and seepage controls. This method requires suitable closure measures; it does not simply involve spreading tailings over abandoned mines as a protective cover. Finland's success in implementing green mining has created investment opportunities for Finland, where in 2024, investment in the sector increased by 18%, amounting to approximately €449 million (Pirinen et al., 2026). Finland's success in implementing this concept has also garnered special attention from the EU. As evidence of this, the EU Union has made green mining as a basis of the Critical Raw Materials Act, which focuses on the green and digital transition of Europe's mining industry (Pacheco, 2024).

Drawing on these approaches, Indonesia could strengthen its existing GMP framework under Minister of Energy and Mineral Resources Regulation No. 26 of 2018 by incorporating more specific waste-management requirements into implementing rules and environmental approvals. Operators should be required to identify waste characteristics, assess recovery and disposal alternatives, establish measurable pollution-control targets, and provide cost reclamation and monitoring plans. For Raja Ampat, the proposed reforms should establish measurable restoration obligations, adequate financial guarantees, coordinated supervision and public reporting (Cahyono et al., 2025). Waste-management technologies should support these enforceable duties (Domínguez Gómez et al., 2026), with their suitability assessed for each project (Onifade et al., 2024).

Technical measures would then serve as methods of fulfilling the existing legal obligations. Implementation should be supported by coordinated inspections, independently verified monitoring results and accessible public reporting. Established violations should trigger corrective orders and applicable sanctions through the prescribed procedures. Green mining would thereby provide a measurable basis for operator accountability and marine protection, while remaining subject to existing conservation restrictions and waste-disposal requirements.

DISCUSSION

This study's novelty lies in connecting Indonesia's duties to prevent marine pollution from land-based activities with the legal conditions governing nickel mining in Raja Ampat. By examining international obligations, domestic mining and conservation rules, and green-mining approaches from China and Finland together, it explains how environmental objectives can become enforceable operational requirements. This provides a legal basis for assessing both the compatibility of mining authorization with marine protection and the responsibilities attached to permitted activities. The main finding of this research shows that Indonesia already possesses substantial environmental safeguards, but their effectiveness depends on their consistent application through permitting and supervision. Articles 192–194 and 207 of UNCLOS establish marine protection and pollution-prevention duties, while Indonesian environmental, mining, and waste-management rules provide domestic controls. Read together, these provisions indicate that the rights to utilize its own

resource, including by mining activities, does not deprive continuing environmental responsibilities. Likewise, treating mining waste does not automatically authorize its disposal at sea.

The precautionary principle supports preventive assessment and monitoring where serious or irreversible harm is threatened despite scientific uncertainty. These findings are consistent with [Dewi (2025)](https://doi.org/10.47134/ijlj.v2i3.3541), who identifies weak supervision and law enforcement when it comes to corporate accountability in nickel-mining in North Maluku. They also correspond with [To'at et al. (2024)](https://ojs.literacyinstitute.org/index.php/iacseries/article/view/1516), whose research in the Konawe Islands highlights the need of a stricter policies to ensure surrounding communities active participation and fairer benefit sharing. In short, both studies support the need to make regulatory protection effective for affected communities. The present analysis extends this concern by examining how pollution-prevention duties should shape mining authorization and continuing compliance in the scope of marine environmental protection.

The proposed approach also complements existing green-mining research. [Saepudin et al. (2022)](https://doi.org/10.24018/ejdevelop.2022.2.5.169) identifies cooperation among government, companies, investors, and researchers to incorporate green mining through policy, management, investment, and technology. [Onifade et al. (2024)](https://doi.org/10.1016/j.gsme.2024.05.005) examine the contribution of green-mining technologies and practices to environmental performance. The present study connects these organizational and technical approaches to binding permit conditions and verifiable compliance. [Xiang et al. (2024)](https://doi.org/10.56028/aetr.12.1.356.2024) examine the development of green-mining policy in China, while [Nurmi (2017)](https://doi.org/10.4401/ag-7420) presents Finland's approach as encompassing resource efficiency, stakeholder participation, and restoration throughout the mining lifecycle. Together, these studies support treating green mining as an approach that requires institutional support alongside technical improvements.

The similarities perform a shared recognition that mining's environmental and social consequences require coordinated management and action. Differences primarily concern the questions and methods used where community research examines livelihood impacts and technological studies assess operational improvements, and this study interprets legal duties and compares regulatory approaches. Raja Ampat's marine conservation context also makes the relationship between land-based operations and protected waters especially significant. Consequently, lessons from China and Finland require adaptation to local ecological conditions, applicable restrictions, and administrative capacity rather than direct replication.

The resulting contribution is a way to assess green mining through legally binding obligations. Conservation effort must first be established where mining is legally permissible, operational requirements should specify pollution controls, monitoring responsibilities, restoration duties, and consequences for non-compliance. This connects broad environmental commitments with decisions that authorities and operators can be held accountable for. It also clarifies that improved technology supports compliance without displacing restrictions on where mining or waste disposal may occur. For policy, these findings support strengthening Indonesia's Good Mining Practice framework through clearer waste-management standards and environmental approval conditions, backed by coordinated inspections and accessible monitoring reports. Restoration obligations should be supported by adequate financial guarantees, while established violations should trigger corrective measures and applicable sanctions. Academically, the study links marine environmental law with the regulation of mining operations. Its conclusions remain normative: the analysis does not establish site-specific pollution levels or prove that a particular technology is suitable for Raja Ampat. Future research should examine permit conditions, inspection records, and environmental monitoring data to test whether the proposed requirements improve compliance and marine protection.

CONCLUSION

Overall, it is widely acknowledged that global awareness of the challenges posed by climate change continues to grow, as evidenced by the fact that many countries are racing to find more environmentally friendly alternatives for renewable energy use, one of which is the development of EVs. As EVs continue to gain popularity, the demand for batteries continues to rise and this is accompanied by an increasing demand for nickel as a key raw material in battery production.

Indonesia, as the world's largest nickel-producing country, reaps economic benefits from nickel mining. However, behind these economic gains lies the threat of environmental damage that must not be ignored. Focusing on the issue of marine environmental damage occurring in Raja Ampat, nickel mining activities still continue despite Raja Ampat designation as an MPA. Evidence of damage, such as sedimentation and toxic waste discharged into the sea, resulting in environmental damage that affects the ecosystems and livelihoods of local communities serves as proof that mining activities in Indonesia are still not done in accordance with the provisions of Indonesian law, international agreements, or international principles that have been ratified and adopted by Indonesia. Regulations in Indonesia have been sufficiently established in accordance with international principles and regulations that uphold sustainability. When viewed in the concept of mining that is known globally, Indonesia's regulations tend to promote sustainable and responsible mining practices. Unfortunately, their implementation reveals a different reality, and the environmental damage that has occurred remains extensive.

This study has several limitations. First, it was conducted only on specific objects and during a particular period, so the findings cannot yet be generalized to all industrial sectors or regions. Second, the study used a limited set of variables, while other factors may also affect the dependent variable. Third, the research approach did not fully capture long-term changes. The findings should therefore be interpreted within the scope of this stud This study has several limitations. First, the research employs a normative legal approach that primarily examines legislation, international legal instruments, official government documents, and relevant academic literature. Therefore, the study does not include empirical research through field observations, interviews, or direct measurements of marine environmental conditions in Raja Ampat. Second, the discussion of green mining is developed through comparative references to approaches adopted in China and Finland, which may require further adaptation to Indonesia's legal, institutional, environmental, and mining characteristics. Third, the study focuses specifically on the legal relationship between nickel mining activities, land-based marine pollution, and marine environmental protection in Raja Ampat. The findings should therefore be understood within the scope and limitations of the legal materials and comparative approaches examined in this study.

Future research should expand this normative legal analysis through empirical studies concerning the implementation of environmental obligations by nickel-mining companies in Raja Ampat. Such research may involve field observations and interviews with government authorities, mining companies, coastal communities, and other relevant stakeholders. Further studies should also examine the application of specific green mining technologies, particularly those related to waste management, sedimentation control, marine ecosystem restoration, and environmental monitoring and reporting. At the regulatory level, the government should strengthen supervision mechanisms, establish measurable environmental restoration indicators, ensure adequate financial guarantees for reclamation and restoration, and integrate green mining requirements into mining permits and environmental approvals. These measures should be accompanied by coordinated supervision, independent verification of environmental monitoring results, and accessible public reporting to strengthen operator accountability and marine environmental protection.

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