

The Impact of Nickel Mining on Environmental Damage and Public Health in Obi Island: A Review

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Abstract: Obi Island, North Maluku, is one of Indonesia's largest nickel mining centers and plays an important role in supporting the electric vehicle battery industry and the national clean energy transition. However, nickel mining activities in this region have serious impacts on the environment and the health of local communities. This literature review examines scientific reports and empirical data related to pollution of seawater and rivers by toxic waste containing heavy metals such as hexavalent chromium, damage to mangrove ecosystems, and degradation of soil quality and agricultural yields that threaten local food security. Public health impacts in the form of gastrointestinal disorders and the risk of chronic diseases due to exposure to pollutants are also a major concern, exacerbated by limited community access to clean water. In addition, declining incomes of fishermen and farmers and social conflicts due to inequitable natural resource management highlight the unequal economic benefits of the nickel industry. This study emphasizes the need for sustainable mining management with close supervision, transparency, environmental rehabilitation and public health protection to ensure a balance between economic development and environmental sustainability on Obi Island. The findings are important as a basis for developing responsive and inclusive policies to address the challenges of nickel mining in Indonesia.

Keywords: Environmental, nickel, public health, Obi

1. Introduction

Indonesia is one of the largest nickel-producing countries in the world, with very abundant nickel reserves, especially in the North Maluku region, including Obi Island (Mulya, 2024). The island is known to have high nickel content and has been the center of mining activity since the early 2010s, especially by companies such as Harita Nickel, which manages mining business licenses covering thousands of hectares (Gultom, 2024). Nickel mining activities on Obi Island not only contribute significantly to the national economy through exports and downstreaming the electric vehicle battery industry but also become part of Indonesia's strategy in supporting the global energy transition (*Indonesia: Nickel Waste*

Disposal by Harita Group Shown to Have Polluted Water Sources on Obi Island, NGO Report Says, n.d.).

The history of nickel mining in Indonesia dates back to the Dutch colonial era, with exploration and production continuing to grow until today. However, the rapid development of this industry on Obi Island, which began around 2010, brought new challenges related to environmental management and social impacts. Building smelters and nickel sulfate processing plants on Obi Island helps Indonesia become a key supplier of materials for electric vehicle batteries, but it also leads to more intense mining and processing activities that directly affect the local environment (Gultom et al., 2023).

The environmental impact of nickel mining on Obi Island has been a serious concern. Studies and investigation reports reveal that nickel mining and processing activities cause water, soil, and air pollution, as well as damage to coastal and marine ecosystems on which local communities depend (Vardar & Dörrer, 2025). Toxic waste and heavy metals generated from nickel extraction and processing have contaminated clean water sources, changed the color and quality of river and sea water, and decreased biodiversity, especially fish and mangrove populations that are vital to the ecosystem and livelihoods of local residents (Sawal, 2025).

In terms of public health, exposure to waste and pollutants from nickel mining activities poses serious health risks. Communities around Obi Island report health problems such as gastrointestinal disorders and respiratory problems thought to be related to water and air contamination from mine waste (Sawal, 2022). Community reliance on polluted water sources due to limited access to clean water exacerbates these health impacts, while adequate information and protection are lacking.

In addition to environmental and health impacts, nickel mining activities have also triggered social and economic conflicts on Obi Island (Sawal & Belseran, 2023). The decline in fish catches and agricultural productivity due to pollution and land degradation has reduced the income of local communities, most of whom depend on these sectors. The massive mining land clearing process has also led to land grabbing and intimidation of residents, creating social tensions and resistance to mining companies and government policies that are considered less responsive to community grievances (Bartzas et al., 2021; Rakuasa, Khromykh, et al., 2025).

These conditions emphasize the urgent need for more sustainable and environmentally sound nickel mining management, as well as the protection of the health and rights of affected communities. The government and industry players must strengthen regulation, supervision, and transparency in waste management and conduct effective environmental rehabilitation. A participatory approach that involves local communities in decision-making is also crucial to ensure that the development of the nickel industry does not come at the expense of environmental sustainability and the welfare of the Obi Island community. Based on this background, this research aims to determine the impact of nickel mining activities on environmental damage and public health on Obi Island through literature studies.

2. Methods

This research was conducted on Obi Island, North Maluku Province, Indonesia. The research method in this study uses a systematic literature study approach to collect, analyze, and synthesize various scientific sources related to the impact of nickel mining on Obi Island <https://jurnal.istekaisyiyah.id/index.php/ijsth>

on the environment and public health. Primary data were obtained from reputable international journal publications, government and non-government agency reports, and academic and technical documents relevant to the topics of nickel mining, environmental pollution, and public health in the region. The literature selection process was conducted with strict inclusion criteria, including studies that contained empirical data and analysis of environmental and health impacts, specifically focusing on Obi Island and its surroundings.

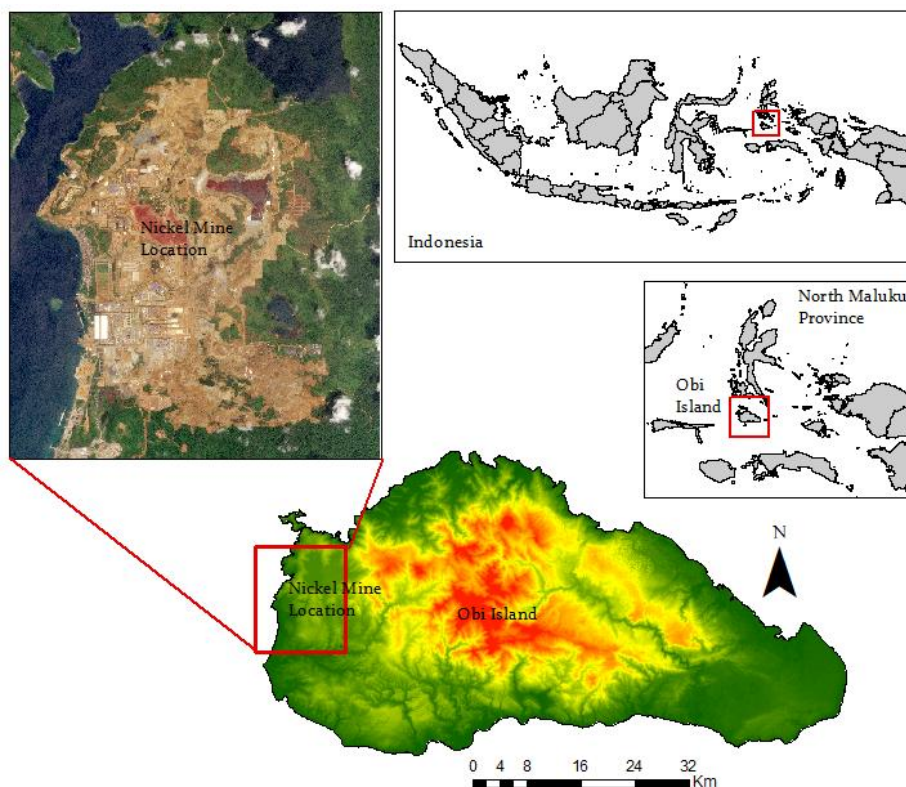


Figure 1. Research site, Obi Island, Indonesia

The analysis was conducted qualitatively to identify patterns, key findings, and research gaps, providing a comprehensive picture of the conditions and implications of nickel mining activities on Obi Island. This approach enabled researchers to present a comprehensive overview that supports the development of policy recommendations and sustainable management practices.

3. Results and Discussion

3.1. Environmental Impact of Nickel Mining on Obi Island

Nickel mining activities on Obi Island have had significant impacts on the surrounding marine and freshwater ecosystems. Discharges of toxic waste from nickel processing, particularly by companies such as PT Trimegah Bangun Persada, which is a subsidiary of the Harita Group, have polluted the marine and river waters of Obi Island (Sawal, 2025). These effluents contain heavy metals and hazardous compounds, including hexavalent chromium (Cr6), that exceed the established safe threshold for marine biota. One clear example is the pollution in the Todoku River, where Cr6 levels reached 0.056 mg/liter, exceeding the safe threshold of 0.05 mg/liter, threatening the survival of aquatic organisms and the drinking water quality of local communities. This pollution has also caused a change

in the color of seawater to brownish-red, which further demonstrates the damage to coastal ecosystems caused by mining activities (Sawal, 2022).

The impact of mining waste pollution on marine biota and mangrove ecosystems is devastating. Declines in important fish populations such as skipjack, saltwater clams, and mangrove snapper have been reported, directly threatening the livelihoods of local fishermen. Studies from Khairun University indicate that heavy metals from mining activities have accumulated in various marine species around Obi, which not only reduces biodiversity but also poses health risks to consumers of such fish (Sawal, 2025). In addition, mangrove ecosystems that serve as important habitats and environmental buffers have also been damaged by mining waste runoff, which reduces their ability to maintain water quality and provide resources to local communities (Satyawati et al., 2023). The condition of the environmental impact of nickel mining on Obi Island can be seen in Figure 2.



Figure 2. Environmental conditions due to the impact of nickel mining on Obi Island
Source: (Sawal, 2025)

Environmental damage is not only limited to waters but also extends to land. Mining waste containing toxic materials contaminates soil and irrigation water, so the quality and quantity of agricultural products decrease dramatically. Prior to mining activities, the Obi Island community depended on agriculture as the main source of livelihood with relatively stable crop yields (Mahardhika, 2023). However, the pollution of soil and irrigation water caused a decrease in crop productivity, which affected local food security and increased the community's dependence on food supplies from outside the area. This shows the paradox between the government's efforts to support the nickel industry for clean energy transition and the negative impacts experienced by local communities (Vardar & Dörrer, 2025).

Overall, the environmental impact of nickel mining on Obi Island shows a complex and sustainable picture of ecosystem damage. Water pollution, damage to marine biota, and degradation of mangrove ecosystems, as well as soil pollution and decreased agricultural yields, are direct consequences that threaten environmental sustainability and community

welfare. Therefore, stricter waste management and the application of sustainable mining principles are needed to minimize these negative impacts while maintaining the viability of the community and ecosystem on Obi Island.

3.2. Impact on Public Health

Nickel mining activities on Obi Island have led to contamination of previously clear and clean drinking water sources. Residents have reported changes in the taste of the water as well as the appearance of unusual bubbles, which are associated with digestive disorders and other health problems. This condition is very worrying because drinking water is a basic need of the community that has been dependent on natural sources such as springs and rivers (Figure 3). The contamination is suspected to be from mining waste containing heavy metals and hazardous chemicals that enter the water cycle.

Exposure to heavy metals such as hexavalent chromium (Cr^{6+}) and other heavy metals poses potentially serious health risks to the public. Hexavalent chromium is known as a carcinogenic substance that can trigger cancer and other chronic diseases. However, information and warnings regarding the health risks of exposure to these heavy metals are still very minimal among the Obi Island community. This worsens the health condition because the community does not get adequate education to avoid or reduce the harmful exposure (Nell (née Campbell) et al., 2024).



Figure 3. Swamp and river polluted by nickel ore mud behind residential area

Source: (Sawal, 2022)

In addition, local communities face dependence on polluted water sources due to economic limitations. Many residents cannot afford bottled water, so they are forced to continue using polluted water for their daily needs. This dependency exacerbates health risks, especially for vulnerable groups such as children, women, and the elderly, who are more susceptible to diseases due to consumption of contaminated water (Gultom, 2024). Health impacts are also exacerbated by worsening environmental conditions due to the activities of mining support industries, such as coal-fired power plants that produce dust and air pollution. Exposure to this dust and pollution causes respiratory problems and other illnesses in surrounding communities (Figure 4). Children under five and women living near industrial areas are the most vulnerable to these health impacts. Overall, the combination of water and air pollution from nickel mining activities on Obi Island has created a public health crisis that urgently needs to be addressed (Serdar Vardar & Kiyo Dörrer, 2025).

3.3. Social and Economic Impacts

Nickel mining on Obi Island has caused a significant decline in the income of fishermen and farmers who have been dependent on local natural resources as their main livelihood. Pollution of sea and river water due to mining waste has caused a decline in fish populations, while pollution of soil and irrigation water has reduced the quality and quantity of agricultural products (Sunuhadi et al., 2024). These conditions have a direct impact on the income of people who depend on the fisheries and agriculture sectors, causing considerable economic losses and threatening local food security. This decline in natural products also forces communities to seek alternative livelihoods that are often less profitable and unsustainable (Levická & Orliková, 2024).

In addition to economic impacts, mining activities trigger conflicts and resistance from communities and environmental activists who reject mining waste disposal permits and the environmental damage that accompanies them. These protests and rejection actions emerged as a response to the damage to the ecosystem and the loss of people's living space that had been the foundation of their lives. Jatam reports and field observations show that the community experienced intimidation and violence when refusing land evictions and faced repressive actions from the authorities and mining companies. This conflict reflects worsening social tensions due to injustice in natural resource management and the lack of protection of the rights of indigenous and local communities (Rifai & Rakuasa, 2025).



Figure 4. Nickel industrial area

Source: (Rabul Sawal & Christ Belseran, 2023)

The mismatch between government policy and industry practice is also a major factor exacerbating socio-economic impacts on Obi Island. Mining companies often ignore environmental regulations and refuse to take responsibility for the damage caused, while the government has not revoked controversial waste disposal permits and has not conducted effective supervision. This has led to continued environmental damage and worsened the social conditions of the community. The study by Jatam highlighted that weak law enforcement and regulations strengthen the dominance of the mining industry, which tends to ignore aspects of sustainability and the welfare of local communities (Bidul & Widowaty, 2024).

Although the nickel industry contributes to an increase in South Halmahera's Gross Regional Domestic Product (GRDP), the economic benefits are unevenly distributed and often not felt by directly affected local communities (Bartzas et al., 2021). Economic studies show that the short-term economic benefits of nickel downstreaming are eroded by negative

impacts on public health, the environment, and the fisheries and agriculture sectors. In addition, the myth that the industry is able to improve the welfare of the local population through employment and wage increases is also debunked, as pollution and decreased work productivity actually reduce workers' income in the long run (Zam Zam & Putrawan, 2020). Therefore, there is a need for a thorough evaluation and more inclusive policies to ensure that the development of the nickel industry does not compromise the welfare of the Obi Island community.

3.4. Implications for Environmental Policy and Management

The development of the nickel industry in Indonesia, particularly on Obi Island, presents a significant contradiction between economic ambition and environmental protection (Hati et al., 2024b). Indonesia seeks to become a major producer of electric vehicle batteries as part of the global clean energy transition, but on the other hand, massive nickel mining activities cause serious negative impacts on the environment and the health of local communities. A philosophical study by Muthmainnah et al. (2020) emphasized that this dilemma is a major challenge in natural resource management in the postmodern era, where the needs of economic development often collide with the principles of environmental sustainability (Muthmainnah et al., 2020). Therefore, mining management policies must be able to balance these two aspects so as not to sacrifice the ecosystem and the quality of life of the community (Muthmainnah et al., 2020).

The need for stricter oversight and transparency is critical to address the negative impacts of nickel mining. The government has implemented strict regulations, including Environmental Impact Assessments (EIAs), periodic environmental audits, and wastewater quality standards that mining companies must comply with (Hati et al., 2024a), (Salakory, M., Rakuasa, 2022). However, the implementation and enforcement of these regulations still face various obstacles, such as limited supervisory resources and a lack of transparency from companies in disclosing environmental and health impacts (Rakuasa, Ahmat Rifai, et al., 2025). Stricter oversight and active community involvement in environmental monitoring can improve accountability and ensure that mining practices are in line with sustainability standards (Rifai et al., 2025).

The main recommendations arising from this study are the need for effective mitigation measures, rehabilitation of damaged ecosystems, and protection of the health of affected communities (Satyawan et al., 2023). Waste management should be carried out with environmentally friendly technologies and in accordance with strict quality standards, while rehabilitation of land and coastal ecosystems should be a priority to restore ecological functions lost due to mining activities (Nasution et al., 2024). In addition, public health protection programs, including the provision of clean water access and health risk education, should be strengthened to reduce direct impacts on local residents. This approach is in line with the principles of sustainable mining, which places a balance between economic, social, and environmental issues as the main focus (Bartzas et al., 2021).

Overall, the management of nickel mining on Obi Island requires synergy between government, industry, and communities to create transparent, responsible, and sustainable governance. Policies that integrate environmental and social aspects in every stage of mining activities must be consistently enforced. Thus, Indonesia can utilize the potential of nickel as

a strategic commodity without compromising environmental sustainability and the welfare of local communities while supporting national targets in the clean energy transition.

Conclusions

The impact of nickel mining on Obi Island has caused significant environmental damage, including pollution of seawater and rivers by toxic waste containing heavy metals such as hexavalent chromium, damage to mangrove ecosystems, and a decline in soil quality and agricultural yields that threatens local food security. These conditions have a direct impact on the health of the community, which suffers from contamination of drinking water sources and exposure to hazardous pollutants, while limited access to clean water exacerbates health risks. Socially and economically, the decline in the income of fishermen and farmers as well as social conflicts arising from the injustice of natural resource management indicate that the economic benefits of the nickel industry have not been felt equally by local communities. The policy implications demand stricter oversight, corporate transparency, and integrated environmental rehabilitation and public health protection. Therefore, the management of nickel mining on Obi Island must prioritize the principle of sustainability that is balanced between economic development, environmental preservation, and the welfare of local communities to support the clean energy transition without compromising the quality of life and preservation of local ecosystems.

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Conflicts of Interest

The authors declare no conflict of interest

References

- Adrian Mulya, Yuli Z., Rabul Sawal, A. P. (2024). *Nickel mining's toll on Indonesia's small islands: stories of resistance and survival*. Dialogue Earth. <https://dialogue.earth/en/justice/nickel-minings-toll-on-indonesias-small-islands-stories-of-resistance-and-survival/>
- Bartzas, G., Tsakiridis, P. E., & Komnitsas, K. (2021). Nickel industry: Heavy metal(loid)s contamination - sources, environmental impacts and recent advances on waste valorization. *Current Opinion in Environmental Science & Health*, 21, 100253. <https://doi.org/10.1016/j.coesh.2021.100253>
- Bidul, S., & Widowaty, Y. (2024). Analisis Yuridis Dampak Pencemaran Lingkungan Pertambangan Mangan dan Nikel di Provinsi Maluku Utara. *JUSTISI*, 9(3), 412–426. <https://doi.org/10.33506/js.v9i3.2768>
- Gultom, T. H. (2024). Integrated vertical mining and processing for Critical Mineral: A case study in Obi Island, North Maluku Province. *IOP Conference Series: Earth and Environmental Science*, 1422(1), 012023. <https://doi.org/10.1088/1755-1315/1422/1/012023>
- Gultom, T., Nugraha, D., Sugiyarno, & Iqbal, M. (2023). Contribution of Obi Island Reducing the Carbon Footprint in the Transport Sector. *IOP Conference Series: Earth and Environmental Science*, 1175(1), 012015. <https://doi.org/10.1088/1755-1315/1175/1/012015>
- Hati, S. N. A. P., Hapsari, M. A., Ika, S. R., & Widagdo, A. K. (2024a). Nickel ore export prohibition and mapping the business performance of nickel mining companies in Indonesia. *IOP Conference Series: Earth and Environmental Science*, 1412(1), 12026. <https://jurnal.istekaisyiyah.id/index.php/ijsth>

- <https://doi.org/10.1088/1755-1315/1412/1/012026>
- Hati, S. N. A. P., Hapsari, M. A., Ika, S. R., & Widagdo, A. K. (2024b). Nickel ore export prohibition and mapping the business performance of nickel mining companies in Indonesia. *IOP Conference Series: Earth and Environmental Science*, 1412(1), 012026. <https://doi.org/10.1088/1755-1315/1412/1/012026>
- Indonesia: Nickel waste disposal by Harita Group shown to have polluted water sources on Obi Island, NGO report says. (n.d.).
- Levická, J., & Orliková, M. (2024). The Toxic Legacy of Nickel Production and Its Impact on Environmental Health: A Case Study. *International Journal of Environmental Research and Public Health*, 21(12), 1641. <https://doi.org/10.3390/ijerph21121641>
- Lorenzo Anugrah Mahardhika. (2023). *Jelajah EV: Kisah Harita Nickel Terbitkan Harapan Petani Pulau Obi*. Bisnis.Com. <https://ekonomi.bisnis.com/read/20231211/44/1722847/jelajah-ev-kisah-harita-nickel-terbitkan-harapan-petani-pulau-obi>
- Muthmainnah, L., Mustansyir, R., & Tjahyadi, S. (2020). Meninjau Ulang Sustainable Development: Kajian Filosofis Atas Dilema Pengelolaan Lingkungan Hidup di Era Post Modern. *Jurnal Filsafat*, 30(1), 23. <https://doi.org/10.22146/jf.49109>
- Nasution, M. J., Tugiyono, Bakri, S., Setiawan, A., Murhadi, Wulandari, C., & Wahono, E. P. (2024). The Impact of Increasing Nickel Production on Forest and Environment in Indonesia: A Review. *Jurnal Sylva Lestari*, 12(3), 549–579. <https://doi.org/10.23960/jsl.v12i3.847>
- Nell (née Campbell), K., Valenta, R. K., Forbes, G., Yahyaei, M., & Ilyas, H. M. A. (2024). Sustainable Resource Management: The End of Nickel Mining? *Recycling*, 9(6), 102. <https://doi.org/10.3390/recycling9060102>
- Rabul Sawal. (2022). *Red seas and no fish: Nickel mining takes its toll on Indonesia's spice islands*. News.Mongabay.Com. <https://news.mongabay.com/2022/02/red-seas-and-no-fish-nickel-mining-takes-its-toll-on-indonesias-spice-islands/>
- Rabul Sawal. (2025). *Kala Kawasan Perairan dan Biota Laut di Malut Tercemar Logam Berat*. Mongabay. <https://mongabay.co.id/2024/07/17/kala-kawasan-perairan-dan-biota-laut-di-malut-tercemar-logam-berat-1/>
- Rabul Sawal & Christ Belseran. (2023). *Mereka Suarakan Kerusakan Pulau Obi Dampak Industri Nikel*. Mongabay. <https://mongabay.co.id/2023/04/16/mereka-suarakan-kerusakan-pulau-obi-dampak-industri-nikel/>
- Rakuasa, H., Ahmat Rifai, A. R., Latulanit, A. K., Amahoru, A. H., Laitupa, R. A., Diaz Astiza, D. A., & Rajani, L. M. (2025). Detection of Land Cover Change in Nickel Mining Areas, in Weda Tengah Sub-district, Halmahera Island, Indonesia using Planet-Scope Satellite Images. *Frontiers in Sustainable Science and Technology*, 2(1), 41–50. <https://doi.org/10.69930/fsst.v2i1.379>
- Rakuasa, H., Khromykh, V. V., Rifai, A., & Latue, P. C. (2025). Spatial Analysis of the Impact of Nickel Mining on Vegetation Cover Change in Obi Island, Indonesia. *BIOPENDIX: Jurnal Biologi, Pendidikan Dan Terapan*, 12(2), 77–85. <https://doi.org/10.30598/biopendixvol12issue2page77-85>
- Rifai, A., & Rakuasa, H. (2025). Spatial Dynamics of Land Cover Change in Tidore Island, Indonesia 2015-2025. *KnE Social Sciences*, 10(10), 324–330. <https://doi.org/10.18502/kss.v10i10.18682>
- Rifai, A., Rakuasa, H., & Latue, P. C. (2025). Spatial Dynamics of Land Cover Change of Gag Island, Indonesia. *Jurnal Geosains West Science*, 3(02), 57–65. <https://doi.org/10.58812/jgws.v3i02.2295>
- Salakory, M., Rakuasa, H. (2022). Modeling of Cellular Automata Markov Chain for predicting the carrying capacity of Ambon City. *Jurnal Pengelolaan Sumberdaya Alam Dan Lingkungan (JPSSL)*, 12(2), 372–387. <https://doi.org/https://doi.org/10.29244/jpsl.12.2.372-387>
- Satyawan, I. A., Pardede, T. M., & Kevin, M. S. (2023). Nickel mining in Obi Island: problem <https://jurnal.istekaisyiyah.id/index.php/ijsth>

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- or solution for mitigating climate change effects? *E3S Web of Conferences*, 467, 02005. <https://doi.org/10.1051/e3sconf/202346702005>
- Serdar Vardar & Kiyo Dörrer. (2025). *Pulau Obi: Antara Kemakmuran Nikel dan Kerusakan Lingkungan*. Deutsche Welle. <https://www.dw.com/id/pulau-obi-antara-kemakmuran-nikel-dan-kerusakan-lingkungan/a-72404080>
- Sunuhadi, D. N., Ernowo, Hilman, P. M., & Suseno, T. (2024). Availability of Indonesian nickel reserves and efforts to improve reserves resistance and its impact to economic growth. *Mineral Economics*, 37(3), 601–617. <https://doi.org/10.1007/s13563-024-00443-0>
- Zam Zam, Z., & Putrawan, I. M. (2020). EVALUASI KEBIJAKAN PENGELOLAAN LINGKUNGAN PERTAMBANGAN DI PULAU OBI PROVINSI MALUKU UTARA. *Jurnal Ilmiah Pendidikan Lingkungan Dan Pembangunan*, 21(02), 58–68. <https://doi.org/10.21009/PLPB.212.05>
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