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Indonesia's Nickel Downstreaming and the Green Transition Paradox: Green Extractivism, Socio-Ecological Transformation, and Environmental Justice

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ABSTRACT

The global shift toward a low-carbon energy system has driven surging demand for nickel as a critical input for electric vehicles and energy storage technologies, positioning Indonesia, the world's largest nickel reserve holder and producer, strategically through its downstreaming policy since the 2020 raw ore export ban. This study analyzes the interconnections between nickel downstreaming, the green transition agenda, and the reproduction of extractive logic, while identifying implications for the socio-ecological justice of communities in production regions. Using a qualitative, analytical-descriptive method grounded in a literature review, the study analyzed secondary data from academic journals and institutional publications through source triangulation. It examined them through the lenses of green extractivism and environmental justice, encompassing distributive, procedural, and recognition dimensions. The findings reveal that while downstreaming enhances economic value-added, investment, and Indonesia's integration into global value chains, the expansion of the nickel industry simultaneously accelerates deforestation, transforms landscapes and community livelihood structures, and produces an unequal distribution of benefits and burdens: economic gains largely accrue to the state, corporations, and skilled workers. At the same time, social and ecological impacts fall disproportionately on communities near mining and industrial zones. The study concludes that the green transition, as pursued through nickel downstreaming, risks reproducing extractive practices under the new legitimacy of decarbonization discourse. Consequently, its success should be measured not merely by increased production and economic value, but also by equitable distribution of benefits, meaningful community participation, and recognition of local communities' rights.

INTRODUCTION

The transition to a low-carbon energy system has driven global demand for minerals used in electric vehicles, batteries, and various clean energy technologies. Nickel has emerged as a strategic mineral due to its vital role in several energy storage and electrification technologies (Reich & Simon, 2026). This situation shows that the energy transition involves more than shifts in technology and energy sources; it also requires strengthening material supply chains within mineral-producing nations. Consequently, the decarbonization agenda encompasses social and political dimensions linked to resource extraction and processing. Literature on critical minerals indicates that expanding mining activities to meet energy transition demands can create environmental, social, and governance risks. This raises the question of how mineral-producing countries and communities in mining regions can achieve a low-carbon transition equitably (Carr-Wilson et al., 2024).

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Indonesia holds a strategic position in the global critical minerals economy due to its substantial nickel reserves and production capacity. As of 2024, the country is estimated to possess approximately 55 million tons of nickel reserves, representing around 42% of the global total. That same year, Indonesia's nickel production reached approximately 2.2 million tons, accounting for about 62% of global output. These figures show Indonesia's role as a key player in the global nickel supply chain, particularly in meeting demand from the battery industry and low-carbon energy technologies (USGS, 2024).

Table 1. Indonesia's Nickel Reserves and Consumption by Sector

Year	Nickel Reserves (Tonnes)	Stainless Steel	Batteries	Others
2021	21 million	±70%	±7–8%	±22–23%
2022	21 million	65%	15%	20%
2023	55 million	±65%	16%	±19%
2024	55 million	64%	17%	±19%
2025	62 million	65%	14–15%	20–21%

Sumber: U.S. Geological Survey, Mineral Commodity Summaries 2021-2025: Nickel (Christel Bories et al., 2025)

This position has become increasingly strategic alongside rising demand for nickel in the steel, energy storage, and electric vehicle industries. These circumstances have prompted Indonesia to reduce its reliance on raw ore exports and boost value-added through downstreaming policies. The government implemented a total ban on nickel ore exports starting in January 2020 to strengthen domestic processing capacity, enhance the commodity's economic value, and drive job creation and national industrial development (ESDM, 2019). The policy shows that nickel downstreaming is not merely a trade policy; it is also part of the government's effort to transform Indonesia's economic structure from a raw material exporter into a nation with processing capabilities and mineral-based industries (Asyono et al., 2026). Nickel downstreaming in Indonesia is developing as part of an economic transformation strategy aimed at shifting export orientation from raw ore to higher value-added products. This policy gained significant momentum through the ban on nickel ore exports, which has been in effect since January 2020. The government implemented this policy to encourage domestic nickel processing and strengthen the availability of raw materials for the national industry (IEA, 2024b).

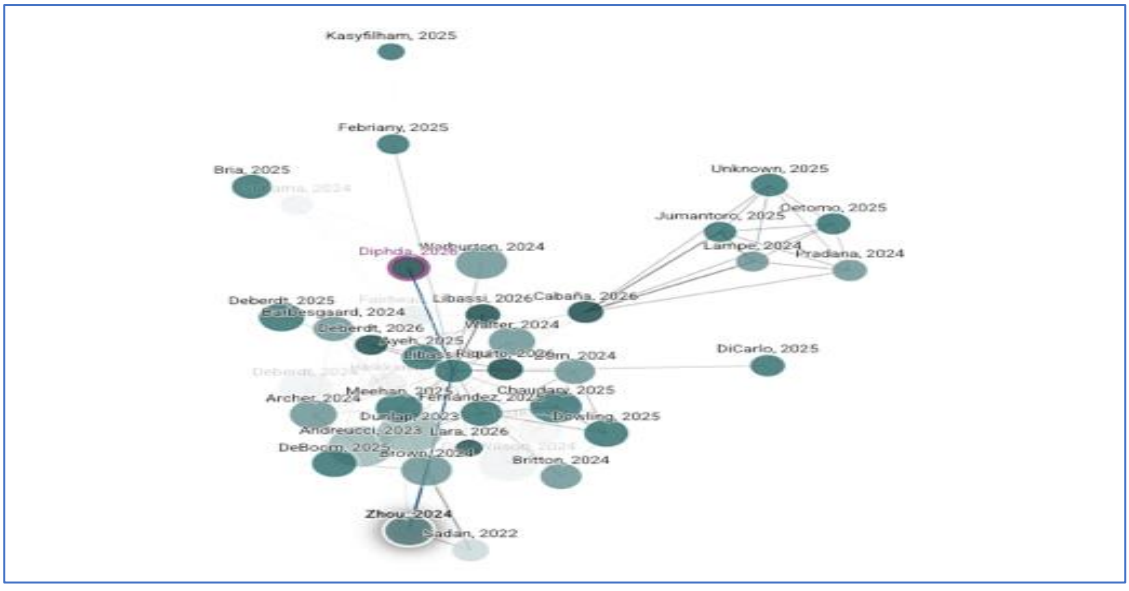
The export ban policy subsequently drove increased investment in and the construction of nickel processing facilities, particularly within industrial estates. These developments strengthened Indonesia's integration into global value chains, including in the stainless steel industry and the development of the electric vehicle battery ecosystem (Warburton, 2024). From an economic development perspective, the government positions downstreaming as a strategy to increase the value added of natural resources, strengthen industrialization, create jobs, and drive structural economic transformation (Lahadalia et al., 2024). Thus, nickel downstreaming is not merely a matter of mineral trade policy; it is also part of the national development agenda and Indonesia's strategy to elevate its position within the global value chain. However, expanding the nickel industry also raises questions

about how economic benefits are distributed, as well as the social and ecological impacts in nickel-producing regions (Muhyiddin, 2026). Therefore, discussions on downstreaming must consider not only increased investment and economic value but also its impacts on society and the environment.

The expansion of nickel downstreaming not only boosts industrial capacity and economic value-added but also brings about social and ecological changes in nickel-producing regions. A study of 7,721 villages in Sulawesi reveals that deforestation rates in villages with nickel mining activities nearly doubled between 2011 and 2018 (Lo et al., 2024). The same research indicates that, at a certain stage, mining activities can improve infrastructure, living standards, health, and community social ties. However, environmental conditions continue to deteriorate, particularly in areas with higher poverty levels.

Ecological impacts also include forest degradation, water pollution, coastal sedimentation, and ecosystem pressure (Nasution et al., 2024). From a social perspective, the expansion of the nickel industry can alter local communities' livelihood structures and living spaces. Some community members are shifting from agriculture and fisheries to employment in the mining sector and in services that support industrial operations (Lampe et al., 2025). These changes indicate that the economic benefits of downstream processing do not always align with the impacts experienced by local communities and the environment. Consequently, the expansion of nickel downstreaming reveals a tension between increased economic gains and emerging socio-ecological burdens in nickel-producing regions. Examining this situation is crucial, as the success of downstreaming cannot be measured solely by increases in investment, production, or export value, but also by the policy's ability to manage environmental impacts and ensure a more equitable distribution of benefits.

Figure 1. Research Network on Nickel Downstreaming in Indonesia



Sourse: Connected Paper

Studies on nickel downstreaming in Indonesia reveal a shift in focus - from discussions regarding industrial development to broader analyses of political dimensions and power

relations Lahadalia et al. (2024) view downstreaming as a new form of the developmental state, positioning the state as a key actor in driving industrialization and the development of the electric vehicle industry. This policy demonstrates the state's active role in steering the transformation of natural resource-based industries. However, the process entails various social and environmental externalities that must be addressed during its implementation (Warburton, 2024). A more critical perspective through the concept of "nationalist enclaves" shows that while expanding the nickel industry can drive economic growth, the benefits are not always evenly distributed. This industrial expansion also creates negative externalities that affect the surrounding environment and local communities. These conditions highlight the tension between the goal of increasing economic value through downstream processing and the resulting local-level impacts.

Meanwhile, Jordy (2025) analyzes the Indonesia Morowali Industrial Park (IMIP) as a growth machine that brings together the government, industrial area managers, and foreign investors to encourage downstream nickel processing. This collaboration strengthens IMIP's position as a nickel industry development center and an important part of Indonesia's downstream strategy. From a security and political policy perspective, Nugraha et al. (2025) show that the government frames nickel as an issue of economic and geopolitical security to legitimize its policies, including the ban on raw ore exports. The literature shows that downstreaming involves the state, corporations, foreign capital, economic interests, and the construction of national interests, rather than merely an instrument for increasing value-added.

Another perspective situates nickel downstreaming within socio-ecological changes linked to the energy transition agenda. Lo et al. (2024), through analysis of 7,721 villages in Sulawesi, show that nickel mining activities are associated with increased forest cover loss. On the other hand, mining's impact on community welfare is multidimensional and not entirely positive. These findings show that increasing economic activity through nickel mining can go hand in hand with environmental pressure and changes in social conditions. Muhyiddin (2026) demonstrates that nickel industrialization through the IMIP has driven structural transformation and strengthened the industrialization process at the regional level. However, this development also faces challenges such as technological dependence, limited local government fiscal capacity, environmental degradation, and the risk of a midstream trap. These findings indicate that increased industrial activity does not automatically result in technological self-reliance or equitable development benefits at the regional level. Meanwhile, Diphda & Reza Triarda (2026), explicitly employ the perspective of "green extractivism" to explain how narratives surrounding the climate crisis, energy transition, ESG, and decarbonization can legitimize the expansion of extractive industries in the IMIP area. This perspective demonstrates that the energy transition agenda can proceed alongside the expansion of extractive activities. Conversely, the social and ecological impacts of these activities continue to accumulate in the areas surrounding the industrial complex.

The literature on nickel downstreaming in Indonesia has examined this issue from various perspectives. Lahadalia et al. (2024) discuss downstreaming within the frameworks of the developmental state and industrialization. Warburton (2024) examines the formation of "nationalist enclaves," while Jordy (2025) situates the topic within a political economy perspective. Nugraha et al. (2025) analyze downstreaming through the concept of securitization. Muhyiddin (2026) links downstreaming to resource nationalism and global

value chains, whereas Diphda and Triarda (2026) discuss it in the context of green extractivism. Meanwhile, Lo et al. (2024) highlight the ecological impacts of nickel mining on deforestation and community well-being. Despite these significant contributions, the literature tends to address political-economic dimensions, strategic discourses, and socio-ecological impacts in isolation. This gap creates an opportunity to examine the interconnections among the discourse on downstreaming, national interests, and socio-ecological consequences within a single analytical framework. This study positions political discourse as the primary focus.

Literature on nickel in Indonesia has evolved to cover various distinct aspects. However, there remains scope to integrate narratives regarding development and energy transition, the legitimation of downstreaming, and the distribution of benefits and socio-ecological impacts within a single analytical framework. Consequently, the research gap lies in the limited number of studies linking development and energy transition to the legitimation of downstreaming expansion and the distribution of benefits and socio-ecological consequences. Meanwhile, this study's novelty lies in integrating discourse analysis, green extractivism, and an environmental justice perspective to explain how narratives, framing, and legitimation practices function as discursive data.

Green Extractivism is a perspective that critiques the transition to a low-carbon economy, noting that the drive for green technologies often triggers increased natural resource extraction. This study uses this perspective to examine how rising demand for nickel, driven by low-carbon technologies, justifies expanding mining and downstream processing activities, even as the resulting socio-ecological impacts remain concentrated in the regions where the resource is produced. Meanwhile, "Just Transition" emphasizes the importance of social equity in the shift toward a low-carbon economic system; it is used here to analyze whether the benefits of nickel downstreaming, environmental risks, and decision-making processes are distributed equitably (Andreucci et al., 2023).

This study analyzes the interconnections between nickel downstreaming, the green transition, and the reproduction of extractive logic, while identifying implications for the socio-ecological justice of communities in production areas. It contributes to the study of green transitions by linking political-economic, socio-ecological, and environmental justice dimensions to understand nickel downstreaming in Indonesia. Consequently, the study asks: How does Indonesia's nickel downstreaming, within the framework of the green transition, reproduce the logic of "green extractivism" and result in an unequal distribution of benefits and socio-ecological burdens?

METHOD

This study uses a qualitative, descriptive-analytical approach to explore the linkages between nickel downstreaming in Indonesia, the green transition, "green extractivism," and the socio-ecological changes resulting from nickel production. The literature base for this analysis came from transcripts of official speeches by President Joko Widodo between 2014 and 2024, identified through specific keywords and then filtered using inclusion and exclusion criteria. The author utilized 16 documents, categorized as follows:

1. Database: Websites of the Cabinet Secretariat of the Republic of Indonesia, the Press, Media, and Information Bureau of the Presidential Secretariat, the Ministry of State Secretariat of the Republic of Indonesia, and mass media outlets (Detik News and Tirto).

2. Keywords: Nickel downstreaming, raw materials, export bans, nickel/bauxite/copper, economic sovereignty, middle-income trap.
3. Timeframe: 2014–2019 (first term) and 2020–2024 (second term) of Joko Widodo's administration..
4. Inclusion and exclusion criteria:
    - Inclusion: (1) Speeches or remarks delivered personally by Joko Widodo. (2) Content addressing nickel downstreaming and the prohibition of raw material exports. (3) Transcripts available on credible platforms. (4) Documents falling within the study's specified timeframe.
    - Exclusion: (1) Speeches that do not contain narratives regarding downstreaming, export bans, or economic sovereignty. (2) News reports, opinion pieces, or media summaries that do not provide the full text of a speech. (3) Documents consisting only of links or brief excerpts without sufficient text for analysis. Number of sources: 16 speech documents were used-5 from the 2014–2019 period and 11 from the 2020–2024 period.
5. Basis for source selection: Presidential speeches were chosen as they serve as primary sources that directly demonstrate how the downstreaming policy is framed, justified, and defended by policymakers. Official government platforms were used as the primary reference, as they provide authoritative and verifiable transcripts.

Data were analyzed using Norman Fairclough's (1992, 1995) three-dimensional model of Critical Discourse Analysis (CDA). The analysis was conducted across three dimensions:

1. Textual dimension
   The author analyzed linguistic elements within each speech, including vocabulary choices, metaphors and imagery, and references to achievement figures used to legitimize.
2. Discursive practice dimension
   The author examined how the texts were produced, distributed, and consumed, considering the type of forum (e.g., state addresses, inauguration speeches, investment and financial forums), the intended audience, and intertextual connections across the years.
3. Socio-cultural practice dimension
   The findings from the textual and discursive practice analyses were linked to a broader context, including power relations and economic-political interests, the ideologies of resource nationalism and developmentalism, pressures from the global trade regime, and discourses surrounding the green transition and "green extractivism."

RESULT

Nickel Downstreaming as a Green Transition

The global energy transition has heightened the strategic importance of critical minerals in the shift toward a low-carbon economy. The growth of electric vehicles (EVs), energy storage, renewable energy, and economic electrification requires a range of minerals, including lithium, cobalt, graphite, copper, and nickel. The International Energy Agency (IEA) indicates that demand for minerals used in clean energy technologies continues to rise alongside the expansion of low-carbon technologies; global electric vehicle sales reached nearly 14 million units in 2023, up about 35% from the previous year. During the same

period, demand for nickel, cobalt, and graphite rose by about 8% to 10% (IEA, 2023). Under the Announced Pledges Scenario (APS), nickel demand for clean energy technologies is projected to rise from approximately 240,000 tonnes in 2021 to 1.953 million tonnes in 2030 and 3.381 million tonnes in 2040. These projections indicate that the demand for nickel will increase alongside the development of clean energy technologies (IEA, 2024). Thus, the energy transition not only transforms the global energy system but also increases demand for regions and countries with strategic mineral reserves.

Table 2. Nickel Demand Projections for Clean Energy Technologies

Years	Nickel Demand for Cleantech (Thousand Tonnes)
2021	240
2023	478
2030	1.953
2040	3.381

Source: IEA | Global Critical Minerals

These developments place Indonesia in a strategic position within the global nickel supply chain, given its substantial reserves and production capacity. USGS data indicates that Indonesia's nickel production reached approximately 2.03 million tons in 2023 and rose to around 2.2 million tons in 2024. This increase further reinforces Indonesia's role as a major global nickel supplier. That figure accounts for approximately 59% of global nickel production, according to data from the Mineral Commodity Summaries 2025. Indonesia holds approximately 55 million tons of nickel reserves, representing around 42% of the global total. The magnitude of these reserves positions Indonesia as a key player in the global critical mineral supply chain not merely as a supplier of raw materials, but also as a nation instrumental to the development of the nickel processing industry.

Table 3. Indonesia's Position in Global Nickel Production

Indicator	2023	2024
Indonesia's Nickel Production	2,03 juta ton	2,20 juta ton
Global Nickel Production	3,75 juta ton	3,70 juta ton
Indonesia's share	±54%	±59%
Indonesia's Reserves	-	55 juta ton
Global Reserve Share	-	±42%

Source: USGS Mineral Commodity Summaries 2025

The Indonesian government has leveraged this strategic position through a downstreaming policy, shifting the mineral economy from raw material exports to domestic processing and value-added products. The downstreaming value chain extends from nickel ore mining to processing and smelting facilities that produce intermediate products such as

nickel pig iron (NPI), ferronickel, and battery raw materials, thereby supporting the development of battery cells and the electric vehicle ecosystem (Lahadalia et al., 2024). It characterizes this downstreaming strategy as a new form of the developmental state, marked by the state's active role in driving structural transformation and strengthening Indonesia's position in the electric vehicle industry. This strategy is also linked to ESG agendas, the SDGs, sustainable development, and the energy transition. However, the research also highlights social and environmental externalities that must be managed during downstreaming implementation.

This development narrative is being realized through the development of an electric vehicle battery ecosystem. In 2024, the government announced that HLI Green Power would begin commercial EV battery production in Karawang. This project is part of the development of an electric vehicle battery ecosystem, with an investment value of approximately USD 9.8 billion (Lo et al., 2024). In this context, downstreaming is no longer merely a mineral management policy, but also a green industrialization strategy and an effort by Indonesia to strengthen its integration into the future global energy economy.

However, a fundamental paradox arises here. The shift from exporting raw ore to processing industries does not automatically signal the end of the logic of extraction. On the contrary, rising global demand for critical minerals could expand mining activities to meet downstream industries' needs. In other words, the green transition creates new incentives to accelerate mineral extraction. This paradox is supported by empirical findings from Lo et al., 2024 in a study published in One Earth. Based on an analysis of 7,721 villages in Sulawesi, the research shows that nickel mining activities accelerate deforestation. Between 2011 and 2018, forest cover in nickel mining villages declined by 4.4 percentage points, a greater reduction than the 2.4 percentage point drop observed in villages without mining activities (Lo et al., 2024). Thus, deforestation in nickel mining areas was nearly twice as high as in control areas. The impact of mining on community well-being is also uneven; mining activities can improve infrastructure and living standards, yet simultaneously significantly diminish environmental well-being. These impacts are particularly evident during advanced stages of production and in areas with high initial poverty levels.

These findings challenge the assumption that shifting a mineral's intended use automatically alters the socio-ecological character of its extraction. Nickel, previously extracted for conventional industrial needs, is now increasingly positioned as a strategic material for electric vehicle batteries and low-carbon technologies. However, mineral production still entails land clearing, resource exploitation, industrial infrastructure development, and energy-intensive processing. Consequently, nickel downstreaming can be understood as a manifestation of the "green transition" paradox. While the transition to low-carbon technologies indeed requires minerals like nickel and opens up industrialization opportunities for Indonesia, it also entails these persistent socio-ecological impacts.

Socio-Ecological Transformation of Downstreaming

Landscape Transformation

The expansion of Indonesia's nickel mining and processing industry has altered the landscape across various nickel-producing regions. These changes include land clearing for mining operations, road and infrastructure construction, the development of industrial estates and settlements, and the establishment of mineral processing facilities. Nickel mining in Indonesia is estimated to involve a land transformation factor of 0.7 ± 0.1 m² per ton of nickel ore produced (Heijlen & Duhayon, 2024). Furthermore, nickel mining in

Indonesia also reduces carbon stocks (Atika, Werner, & Matsubae, 2026). The ecological impacts of downstream processing extend well beyond the immediate mining sites. Removing vegetation and altering the land surface can accelerate erosion, sending sediment into rivers and coastal areas.

Studies in the North Morowali nickel mining region indicate that mining-related changes to land structure increase erosion and sedimentation risk. Moreover, sediment accumulation can reduce the capacity of settling ponds and increase the risk of turbid water runoff into the surrounding environment (Lidman et al., 2023). Consequently, landscape degradation in upstream areas can affect downstream aquatic ecosystem quality. This impact poses an even greater risk to mining operations located near the sea. Erosion carries sediment into the water, increasing total suspended solids (TSS) and reducing water clarity. Such conditions can impede light penetration and diminish the productivity of coastal ecosystems.

Beyond altering the physical landscape, nickel expansion also poses ecological risks. Weak governance during the rapid growth of Indonesia's nickel sector has been linked to deforestation, coastal sedimentation, water pollution, and declining fisheries yields. This suggests that nickel expansion affects not only terrestrial environments but also coastal ecosystems and local livelihoods (Kadir et al., 2026). It demonstrates that ecological impacts spanning mining areas, forests, water bodies, and coastal zones are closely interconnected. Mining expansion triggers a series of linked ecological changes: forest conversion alters land cover, increases erosion, promotes sedimentation, degrades water quality, and intensifies pressure on coastal ecosystems. Although nickel is positioned as a strategic mineral for low-carbon technologies, its supply chain processes still require significant spatial transformation and intensive ecosystem exploitation. Consequently, shifting from raw material extraction to downstream industrial activities does not automatically eliminate ecological pressures; in fact, increased production capacity may further expand landscape transformation.

This study's environmental justice analysis uses three dimensions: distributive justice (the allocation of burdens and benefits), procedural justice (access to decision-making processes), and recognition justice (acknowledgment of the identities, knowledge, and living spaces of affected groups) (Schlosberg, 2007).

First, distributive justice: The ecological burden of nickel downstreaming is concentrated at mining sites, along the coast, and in surrounding waters. Within the Weda Bay Nickel concession in Halmahera, Climate Rights International (CRI) estimates that approximately 1,400 hectares of forest have been lost. At the same time, Eramet reports that about 2,000 hectares have been exploited out of a 45,000-hectare concession (Anya & Gorbiano, 2024). Water quality tests conducted by several NGOs between 2023 and 2024 revealed extremely high levels of nickel and hexavalent chromium (AFP, 2025). Land cover mapping in Halmahera indicates that the island's forest cover declined from 83.0% in 2014 to 82.1% in 2024. In North Maluku, sediment runoff threatens the fishing grounds used by local fisherss (Yusuf & Asuhadi, 2026), In Raja Ampat, nickel concessions cover about 22,000 hectares of a total area of 3.66 million hectares (Uli, 2025). A furnace explosion at the Indonesia Morowali Industrial Park (IMIP) in December 2023 resulted in the deaths of 21 workers. One accident database records 96 incidents and 97 fatalities at nickel smelters between 2019 and 2024, while Trend Asia has tallied 114 deaths across the industry from 2015 through June 2024, 40 of which occurred at the IMIP (Rachman, 2025).

Second, procedural justice: Legally, the scope for participation in environmental impact assessments (EIA) has narrowed following the enactment of the Job Creation Law. EIA preparation now involves only directly affected communities; the inclusion of broader community representatives in the assessment team has been restricted, and provisions for lodging objections have been removed. The weakened EIA process and centralized regulations have constrained meaningful participation (Yusuf & Asuhadi, 2026). In practice, CRI has documented inadequate public consultation, failure to obtain Free, Prior, and Informed Consent (FPIC), and non-disclosure of environmental studies (CRI, 2025a). Residents have reported an inability to negotiate fairly during land sales. Other reports note allegations of coerced sales of customary land, reportedly backed by security forces. The space for raising objections has been further restricted through criminalization; for instance, eleven residents of Maba Sangaji, East Halmahera, faced charges after a traditional ritual protest in May 2025, a case JATAM described as a SLAPP (Strategic Lawsuit Against Public Participation) (Uli, 2025).

Third, recognition justice: In the case of the Hongana Manyawa people in Halmahera, a tribe estimated to number around 3,000, including approximately 500 individuals who remain in voluntary isolation, the lack of formal land titles makes it difficult for them to assert claims over forest areas that overlap with the Weda Bay concession (AFP, 2025). Survival International argues that groups living in voluntary isolation cannot provide FPIC, noting that mining operations began in 2019 even though the company was aware that the area overlapped with the tribe's territory. Furthermore, the government only formally acknowledged the existence of this isolated group in 2025 (AFP, 2025). This belated, contentious recognition reflects an imbalance in acknowledgment. Recognition also pertains to cultural practices and livelihoods. Authorities have treated protests in the form of traditional rituals as criminal offenses, while residents worry about contamination of the water used to process sago (Uli, 2025). Other vulnerable groups include migrant workers; between 2016 and 2024, 77 deaths and 120 injuries were recorded at Chinese-invested nickel plants, alongside instances of passport confiscation and the withholding of wages (Feng & Nindita, 2025). Legal recognition of specific living spaces also remains inconsistent. Although the law prohibits mining on small islands such as Gag, Kawe, and Manuran (AFP, 2025) a protection upheld by the courts in 2024, permits continue to be issued.

These three dimensions show that while downstreaming (industrial value-addition) shifts where value is created, it does not change who holds decision-making power or who receives recognition. The socio-ecological burden continues to fall upon communities living near mines; opportunities for participation remain restricted, and the claims of Indigenous groups have yet to be adequately acknowledged. The absence of these considerations indicates that the discourse surrounding downstreaming treats environmental justice as a secondary concern.

Livelihood Transformation

Nickel industrialization has altered not only ecological conditions but also the livelihoods and living spaces of communities around industrial zones. These changes are analysed through the three dimensions of environmental justice adopted in this study: distributive, procedural, and recognition justice (Schlosberg, 2007).

Distributive justice. Before the expansion, some people in nickel-producing regions relied on farming, fishing, and subsistence activities. The development of the Indonesia Weda Bay Industrial Park (IWIP) moved many farmers and fishers into industrial work

(Pasha, 2025). Industrial activity generated an annual economic impact of IDR 2.55 trillion and a local income multiplier of 1.19, alongside a shift from agriculture and fisheries to mining-related activities (Munzila et al., 2026). However, employment elasticity was only 0.115, even though the share of formal employment rose by more than 14 percentage points (Muhyiddin M et al., 2026) This favours residents with industry-relevant skills and migrant workers. Around IWIP, the settlement area grew from 39.3 ha in 2012 to 82.2 ha in 2022, the industrial workforce rose from 650 in 2018 to 29,800 in 2022, and land prices in Lelilef Sawai climbed from about Rp50,000/m² to Rp277,000/m² (Husni et al., 2025). Benefits are real but uneven, while pressure on housing, water, sanitation, health, and education falls on surrounding communities.

Procedural justice. Communities' role in decisions has narrowed even as the industry has grown. After the Job Creation Law, EIA preparation involves only directly affected communities, and the provisions for lodging objections were removed. A weakened EIA process and centralised regulation further constrain meaningful participation (Yusuf & Asuhadi, 2026). In practice, residents report being unable to negotiate fairly in land sales. Consultation and access to information have also been inadequate: CRI has documented insufficient public consultation and the non-disclosure of environmental studies (CRI, 2024), residents say EIA consultation was ignored before land clearing (Cultural Survival, 2026), and the dense network of actors makes it hard for them to identify which company is responsible for harm (JATAM, 2024). Avenues for objection are equally limited. Complaints to local authorities reportedly brought no change (Cultural Survival, 2026).

Recognition justice. This dimension concerns whose knowledge, identity, and living spaces are acknowledged. The Hongana Manyawa lack formal land titles, and the government only acknowledged isolated groups in 2025 (AFP, 2025). Residents also fear contamination of the water used for sago processing (Uli, 2025). Local knowledge and customary claims have likewise gone unrecognised in decisions: residents describe how rivers turn murky after upstream rain (Cultural Survival, 2026), and land cultivated for decades is claimed as state land (JATAM, 2024). Vulnerable groups bear particular risks. Fishers have become vulnerable to marginalisation amid the influx of newcomers in North Morowali (Lampe et al., 2025), and migrant workers face safety risks (Feng & Nindita, 2025). Overall, downstreaming is a process of social transformation. It creates economic opportunities while producing new vulnerabilities and inequalities across all three dimensions.

Distribution of Benefits and Burdens

Nickel downstreaming creates a distributional paradox: while industrial growth offers tangible economic benefits, these gains are not equitably shared across all groups and regions - particularly among those facing social and ecological impacts. At both macro and regional levels, investment in the industrial sector drives increased economic activity, labor absorption, and production capacity. The workforce and labor pool expanded by more than 50% between 2013 and 2025, accompanied by a decline in unemployment and a rise in formal employment (Dio Rhiza Amrizal et al., 2026). However, economic development has outpaced social and institutional progress. Industrial growth has created visible disparities based on location, human resource capabilities, and access to the labor market.

This inequality is also evident at the inter-regional level. An analysis of Indonesia's 34 provinces between 2015 and 2024 shows that implementing downstreaming policies directly increased the per capita Gross Regional Domestic Product (GRDP) of provinces that

served as hubs for these activities. However, the spillover effects on surrounding areas were detrimental. These results indicate a "backwash effect", a phenomenon in which economic growth in a central hub draws resources away from surrounding regions, preventing the equitable distribution of development benefits. Furthermore, income inequality in the provinces hosting these downstreaming activities also increased significantly (Iqbal Anugerah & Selma Fajic, 2026). Growth resulting from downstreaming can accumulate in specific industrial zones, automatically fostering inclusive development in the surrounding areas.

The distribution of burdens is also evident in the daily lives of communities in industrial areas. The construction of a nickel processing plant in Morowali demonstrates that rapid industrial development has coincided with limited access to clean water, sanitation, housing, education, and healthcare services. The study also identified issues regarding air pollution, social conflict between local and foreign workers, and low levels of public participation and protection for vulnerable groups (Taufik et al., 2025). Consequently, regions serving as hubs for this development may face strain regarding social capacity and public facilities if industrial expansion is not matched by adequate social infrastructure development. Downstreaming cannot be measured solely by investment scale or industrial output. Economic benefits typically accrue to the state, investors, corporations, highly skilled workers, and industrial sites. In contrast, the social and ecological impacts are largely borne by communities living near extraction and industrial areas.

DISCUSSION

Nickel Downstreaming as a Green Transition Strategy

The environmental transition entails shifts in economic structures, technologies, and energy systems, moving away from reliance on high-emission energy sources toward lower-carbon systems. This transformation involves not only developing renewable energy sources but also changing industrial sectors and the material supply chains that support eco-friendly technologies. Electric vehicles, batteries, energy storage systems, power grids, and various clean energy technologies require specific minerals classified as "critical minerals." In this context, nickel plays a pivotal role as an essential material for lithium-ion battery production, particularly for battery technologies utilizing nickel-manganese-cobalt (NMC) compositions (Andreucci et al., 2023). Consequently, global efforts to reduce carbon emissions have indirectly increased focus on countries with nickel reserves and production capacity.

Indonesia plays a crucial role in this transformation, given its abundant nickel reserves and status as one of the world's leading nickel producers. The surge in demand for minerals used in green technologies offers Indonesia an opportunity to move beyond supplying raw materials in the global value chain. The government has launched a downstreaming policy that encourages domestic nickel processing by building processing plants and downstream industries. Fundamentally, this policy shifts Indonesian nickel from a commodity exported as ore to a component in a broader industrial production chain.

In the context of a sustainable transition, nickel downstreaming is linked to two main mechanisms. First, downstreaming provides materials for environmentally friendly technology. Rising demand for electric vehicles and energy storage systems is increasing the need for battery minerals. Therefore, increasing nickel processing capacity in Indonesia can be seen as a response to shifts in global demand driven by the electrification of

transportation. Nickel laterite from Indonesia is directly linked to the need for materials for the energy transition, while advances in the domestic processing industry strengthen Indonesia's position in the mineral supply chain for new energy technologies (Heijlen & Duhayon, 2024). Secondly, downstreaming serves as an industrialization strategy to generate value-added from commodities essential for the energy transition. When Indonesia functioned primarily as an ore exporter, most of the economic value from processing and production was captured abroad. Through policies that ban ore exports and promote local processing facilities, the government aims to shift most value-added activities domestically. Reclassifying nickel as a critical transition mineral aligns with Indonesia's national agenda to build downstream industries and strengthen state control over resources (Warburton, 2024). This policy has driven rapid growth in the nickel industry and increased revenue from exports of processed products.

The link between downstream industrialization and the green transition extends beyond nickel's use in electric vehicles; it is also reflected in nickel's shifting strategic value in the global economy. Once primarily viewed as a mining commodity and raw material for the iron industry, nickel has taken on new significance as a critical mineral essential to electrification. This shift has created fresh momentum for producing nations to ramp up output, attract investment, establish processing facilities, and integrate their mineral resources into low-carbon technology value chains (Tilley, 2026). However, this relationship also reveals a contradiction. The goal of the green transition is to reduce reliance on fossil fuels, yet the technologies deployed to achieve it still require extracting vast amounts of natural resources (Andreucci et al., 2023). For nickel, global demand for battery materials could drive mining operations and expand processing industrial zones in producing countries. Consequently, the transition from a fossil-based economy to a low-emission economy does not automatically eliminate the extractive relationship between the global industry and mineral-producing regions.

Rising demand for nickel to support the low-carbon transition has spurred expansion in Indonesia's mining sector, particularly in Sulawesi, a major global hub for nickel production. A study comparing nickel-mining villages with non-mining villages in Sulawesi between 2011 and 2018 reveals that villages linked to nickel mining experienced deforestation rates approximately 2 percentage points higher than control villages during the observation period. This impact unfolded gradually: during the first three years of production, nickel-mining villages lost 1.2% more forest cover than control areas, followed by an additional loss of around 0.4% between the fourth and seventh years of production (Lo et al., 2024). Mining activities also affect community well-being beyond changes in forest cover. Welfare growth in villages linked to nickel mining lagged behind control villages by about 2.1%. During the initial mining phase, indicators related to environmental well-being, quality of life, and education declined, despite improvements in health, infrastructure, and social interaction. In fact, environmental well-being continued to deteriorate during the subsequent production phase, particularly in villages that previously had high poverty levels. Thus, nickel downstreaming in this study is interpreted as a manifestation of the green transition that embodies contradictory characteristics. Downstreaming reflects an effort to link Indonesia's mineral resources with global demands for low-carbon technology, while simultaneously serving as a vehicle for industrialization and the creation of domestic value-added. However, this focus does not automatically render the entire production process sustainable.

From Green Transition to Green Extractivism

The transition toward sustainability aims to reduce reliance on fossil fuels and build a low-carbon economy. However, this shift does not automatically diminish the need for natural resources. Electrification of transport, advances in battery technology, and the development of renewable energy are driving up demand for various minerals, including nickel. This produces what can be called a green transition paradox: efforts to curb carbon emissions can trigger greater extraction, landscape transformation, and social-ecological pressure in production regions. This article treats the paradox as the phenomenon to be explained and uses green extractivism as the explanatory perspective. Green extractivism describes a form of extractivism that gains new legitimacy through discourses of decarbonization and sustainability (Andreucci et al., 2023). The analysis therefore does not stop at the fact that nickel mining harms the environment. It asks what mechanisms allow expanded extraction to be justified within the transition agenda.

The first mechanism is reclassifying nickel's status. Previously, nickel was viewed mainly as a mineral extracted for industrial use. With advances in electric vehicles and battery technology, it has gained new recognition as a critical mineral for the energy transition, raising its strategic value and validating the push to increase production (Diphda & Reza Triarda, 2026). Demand for nickel is thus justified not only on economic grounds but also by the global need to decarbonize. The second mechanism frames increased extraction as an inevitable consequence of sustainability. In this framing, mineral demand can divert attention from ecological limits, benefit-sharing, and who bears the burden of extraction. Sulawesi illustrates the point. Deforestation rates in nickel-mining areas are nearly double those in comparable areas. In the initial stages of mining, environmental conditions, quality of life, and education declined, even though health, infrastructure, and social ties improved. In the subsequent production phase, environmental well-being continued to deteriorate, particularly in villages that previously had high poverty levels (Lo et al., 2024).

The third mechanism is the gap between the transition's goal and the supply chain that serves it. The shift to electric vehicles does not guarantee a low-carbon footprint across the entire production chain. In Indonesia, extraction and processing can still rely on fossil fuels, specifically coal. A sector supplying materials for eco-friendly technologies may thus perpetuate, or even worsen, reliance on high-emission energy within its production areas. Technologies considered part of the low-carbon economy can stem from supply chains that remain heavily dependent on energy- and resource-intensive processes. This does not mean that all nickel produced for electric vehicles automatically falls under green extractivism. The concept is more relevant where "green" objectives serve as a pretext for expanding extraction without fundamentally transforming power relations or the distribution of costs within the production process. In the Indonesian context, the crucial question is not only whether nickel is used for low-carbon technologies, but also how this demand shapes government decisions, industrial investment, land use, and relations between companies and local communities.

Nickel downstreaming in Indonesia can therefore be understood as a sphere where the national development agenda and global decarbonization efforts converge with extractive logic. On one hand, downstreaming enhances local processing capabilities and integrates Indonesia into the low-carbon technology value chain. On the other hand, the imperative to secure nickel supply can drive increased extraction, while producing regions bear the

ecological and social impacts. This is where green extractivism proves useful as an explanation, because it shows that the green transition is not simply technological change. It also concerns who controls resources, who reaps the benefits, who determines the direction of development, and who bears the social and ecological consequences.

Socio-Ecological Transformation under Nickel Downstreaming

Nickel downstreaming does more than just reshape Indonesia's industrial structure and mineral value; it also alters societal relations, settlement patterns, and the surrounding environment. The expansion of mining activities and the construction of processing facilities drive simultaneous transformations across ecological, livelihood, and social spheres, as well as in how the benefits and burdens of development are distributed. Consequently, it is crucial to understand downstreaming as a process of social and ecological change, rather than viewing it solely through the lens of industrialization's economic consequences.

Ecological and Landscape Transformation

The expansion of nickel mining directly alters land use and the geographical landscape of producing regions. Research on 7,721 villages in Sulawesi between 2011 and 2018 found that villages adjacent to nickel mining operations lost about 4.4% of their forest cover, while villages without mining activity lost 2.4%. Consequently, the deforestation rate associated with nickel mining was nearly double that of control areas. This impact also intensified over time: during the initial years of production, forest loss was about 1.2% higher, rising to approximately 1.6% in subsequent production periods (Lo et al., 2024). Landscape changes extend beyond vegetation loss. Mining activities and infrastructure development such as roads, ports, and industrial zones alter the community's interaction with an environment previously used for agriculture, fisheries, and other economic activities. Environmental well-being declines sharply during the subsequent production phase, dropping by approximately 11.3% in villages involved in nickel mining. Thus, landscape transformation is a crucial element of the nickel industrialization process.

Livelihood and Community Transformation

Environmental changes occur alongside shifts in how communities meet their livelihood needs. The growth of industrial zones creates new employment opportunities and boosts economic activity; however, it also alters the occupational structure of local communities. Research on the expansion of the nickel sector in Bahodopi indicates that industrial development has accelerated shifts in livelihood structures, social conditions, and economic interactions among communities surrounding the industrial area. Impacts on well-being are multifaceted: while infrastructure and quality of life have improved, education, social interaction, and, in particular, environmental well-being have faced strain at various stages (Lo et al., 2024).

This transformation shows that communities face not only changes in their work but also shifts in how they relate to their living environments. Villages that once relied on farming or fishing must now contend with industrial activity, labor migration, infrastructure development, and rising demand for housing and public facilities. Research on the social impact in Morowali also shows that smelters are linked to issues of access to clean water, sanitation, housing, education, and healthcare services, even as industrialization drives economic growth (Andreucci et al., 2023).

Unequal Distribution of Benefits and Burdens

This transformation demonstrates that the benefits and costs of downstream processing are not always evenly distributed. Benefits may include investment, job creation, infrastructure improvements, and economic growth, while communities in production areas may face deforestation, environmental stress, shifts in livelihoods, and rising demands on public services. Villages that initially had high poverty rates experienced far more severe impacts on well-being; during the subsequent production phase, environmental conditions in these areas declined by approximately 13.7%, accompanied by a 13% drop in health indicators (Andreucci et al., 2023).

Therefore, the central issue regarding downstream processing lies not only in the industry's capacity to generate growth but also in how the associated benefits and socio-ecological costs are distributed. When the economic value of nickel is integrated into national and global industrial chains while the ecological costs are concentrated on communities in extraction areas, an imbalance arises between those who reap the benefits and those who bear the burden. This situation makes it crucial to analyze nickel downstreaming through the lens of environmental justice: the transition to a green economy requires not only increased production using low-carbon technologies but also fairer benefit distribution, protection for affected communities, and recognition of people's rights to their living spaces and a healthy environment.

CONCLUSION

This study shows that Indonesia's nickel downstreaming, as part of the green transition agenda, occupies an ambivalent position. On one hand, the surge in global demand for nickel for eco-friendly technologies, particularly electric vehicle batteries, offers Indonesia an opportunity to increase mineral value-added by developing domestic processing industries. Downstreaming also strengthens Indonesia's position in the global value chain and generates benefits through investment, job creation, and infrastructure development. However, the sector's growth still depends on expanding extractive activities. Consequently, the transition to a green economy does not automatically reduce extractivism; in some cases, it can re-emerge as "green extractivism." This issue can be understood through three aspects of environmental justice.

First, distributive justice concerns how the benefits and burdens of downstreaming are distributed. Economic benefits derived from increased value-added, investment, and industrial integration can be enjoyed by the state, companies, workers, and the local economy. Conversely, communities in mining and industrial zones must contend with impacts such as changes in forest cover, environmental strain, shifts in livelihoods, and increased pressure on their living areas and public facilities. Second, procedural justice concerns communities' opportunity to engage in decision-making on mining, smelter construction, land use, and the region's development direction. If decisions are dominated by the government and industry players while local community involvement remains limited, the distribution of benefits and protection against socio-ecological impacts may fail to reflect the interests of the affected communities. Thus, the sustainability of downstreaming requires not only environmental regulations but also information transparency, substantive public consultation, and accessible mechanisms for participation and grievance redress.

Finally, the third aspect is recognition, which emphasizes whether local communities are acknowledged as active subjects in the development process rather than merely

recipients of impacts or sources of labor. Changes in mining areas can alter the communities' relationships with the land, the sea, their livelihoods, and their collective identities. If the economic value of industry dominates land-use decisions while local knowledge, the needs of vulnerable groups, and community ties to the land are disregarded, then injustices will persist across material, social, and cultural dimensions.

Consequently, the success of downstream industrialization in the context of the green transition must be viewed more broadly than increased production or economic value. A just green transition requires a more balanced distribution of benefits and burdens, meaningful community engagement, and recognition of local communities' rights, interests, and identities. These three aspects are crucial to ensuring that the decarbonization agenda does not simply shift the ecological burden from nations utilizing green technologies to the communities in mineral-producing regions.

DECLARATION OF INTEREST

The authors declare no conflicts of interest regarding the research, writing, or publication of this article.

ETHICAL CONSIDERATION

This section states that the research was conducted in accordance with research ethics principles.

REFERENCES

Andreucci, D., García López, G., Radhuber, I. M., Conde, M., Voskoboynik, D. M., Farrugia, J. D., & Zografos, C. (2023). The coloniality of green extractivism: Unearthing decarbonisation by dispossession through the case of nickel. Political Geography, 107, 102997. https://doi.org/10.1016/J.POLGEO.2023.102997

Asyono, A. H., Samputra, P. L., & Djatmiko, H. (2026). Domestic Structural Transformation in a Critical Mineral Economy: A Multisectoral Assessment of Indonesia's Nickel Downstreaming Strategy. Economies, 14(4). https://doi.org/10.3390/economies14040133

Atika, R. K., Werner, T., & Matsubae, K. (2026). Dynamics of land transformation and carbon stock loss from nickel laterite open-pit mining in Indonesia. Environmental Research Letters, Volume 21, Number 1.

Anya, A., & Gorbiano, M. (2024). Nickel hub 'apocalyptic' for uncontacted Indonesia tribe, say NGOs. Jakarta: The Jakarta Post.

AFP. (2025). Nickel rush for stainless steel, EVs guts Indonesia tribe's forest home. Agence France-Presse.

Busetto, L., Wick, W., & Gumbinger, C. (2020). How to use and assess qualitative research methods. In Neurological Research and Practice (Vol. 2, Number 1). BioMed Central Ltd. https://doi.org/10.1186/s42466-020-00059-z

Carr-Wilson, S., Pattanayak, S. K., & Weinthal, E. (2024). Critical mineral mining in the energy transition: A systematic review of environmental, social, and governance risks and opportunities. Energy Research & Social Science, 116, 103672.

Christel Bories, Simon Henochsberg, & Charles Nouel. (2025). 2025 Results Eramet.

Cultural Survival. (2026). Nickel mining threatens Bokimoruru Cave, Central Halmahera's natural treasure and Indigenous heritage. Retrieved from Cultural Survival:

https://globalvoices.org/2025/04/16/workplace-risks-loom-over-indonesias-chinese-funded-nickel-and-steel-smelters/

CRI. (2024). Nickel unearthed: The human and climate costs of Indonesia's nickel industry. Retrieved from Climate Rights International: https://cri.org/reports/nickel-unearthed/

Dio Rhiza Amrizal, M., Amirudin Akbar, F., Faza Ahmad, I., Mendatu, A., Wahyuningrat, J., & Prasetyo, A. (2026). Indonesia's New Growth Center: The IMIP Model From Industrial Boom to Social Transformation: Labour Absorption, Inequality, and Partial Integration in Bahodopi's Nickel-Based Industrialization The Indonesia Think Tank and Policy Lab. Jurnal Perencanaan Pembangunan:The Indonesian Journal of Development Planning, 4, 5. https://doi.org/10.36574/jpp.v10i1.841

Diphda, B. C., & Reza Triarda. (2026). Unraveling Green Extractivism: The Case of Nickel Downstreaming in the Indonesia Morowali Industrial Park. KARSA Journal of Social and Islamic Culture, 34(1). https://doi.org/10.19105/karsa.v34i1.23862

ESDM. (2019). Nickel Ore May No Longer Be Exported as of January 2020.

Feng, Z., & Nindita, H. (2025). Workplace risks loom over Indonesia's Chinese-funded nickel and steel smelters. Global Voices.

Heijlen, W., & Duhayon, C. (2024). An empirical estimate of the land footprint of nickel from laterite mining in Indonesia. The Extractive Industries and Society, 17, 101421. https://doi.org/10.1016/J.EXIS.2024.101421

Husni, I., Islamaiya Alhadar, N., & Haris Musa, A. (2025). Spatial Transformation In Central Weda: Industrial Expansion, Land Use Change, And Settlement Dynamics In Indonesia's Nickel Frontier (Vol. 8, Number 2). http://ejournal.unkhair.ac.id/index.php/josae

IEA. (2023). Global EV Outlook 2023: Catching up with climate ambitions. www.iea.org

IEA. (2024a, March 17). Nickel Outlook for key energy transition minerals. International Energy Agency. https://www.iea.org/reports/nickel

IEA. (2024b, March 19). Prohibition of the export of nickel ore. International Energy Agency. https://www.iea.org/policies/16084-prohibition-of-the-export-of-nickel-ore

Iqbal Anugerah, & Selma Fajic. (2026). Resource Nationalism, Enclave Industrialization, and Regional Divergence: A Spatial Econometric Assessment of Indonesia's Hilirisasi Mandate. Open Access Indonesia Journal of Social Sciences, 9(1), 12–22. https://doi.org/10.37275/oaijss.v9i1.316

JATAM. (2024, August 5). The conquest and pillage of Halmahera: IWIP as the display of corporate-state's national strategic crime. Retrieved from JATAM: https://www.business-humanrights.org/en/latest-news/indonesia-jatam-report-on-the-social-ecological-risk-posed-by-iwip-on-local-population/

Jordy, J. (2025). Untangling Nickel Downstreaming: A Political Economy Analysis of Indonesia's Morowali Industrial Park. International Journal of Social and Political Sciences, 2(2), 150–161. https://doi.org/10.69812/ijsps.v2i2.136

Kadir, A., Amir, M., Hos, J., Dewa, M. J., & Suaib, E. (2026). Misaligned governance in Indonesia's nickel boom: Design and capacity failures in the Mandiodo Block. Resources Policy, 120, 106018. https://doi.org/10.1016/J.RESOURPOL.2026.106018

Lahadalia, B., Wijaya, C., Dartanto, T., & Subroto, A. (2024). Nickel Downstreaming in Indonesia: Reinventing Sustainable Industrial Policy and Developmental State in

Building the EV Industry in ASEAN. Journal of ASEAN Studies, 12(1), 79–106. https://doi.org/10.21512/jas.v12i1.11128

Lampe, I., Hendra, H., & Saputra, G. B. R. (2025). Fishermen at the Center of the Nickel Industry: Livelihoods and Corporate Social Responsibility. Jurnal Ilmu Sosial Dan Humaniora, 14(1), 101–116. https://doi.org/10.23887/jish.v14i1.87806

Lidman, J., Olid, C., Bigler, C., & Berglund, Å. M. M. (2023). Effect of past century mining activities on sediment properties and toxicity to freshwater organisms in northern Sweden. Science of the Total Environment, 872. https://doi.org/10.1016/j.scitotenv.2023.162097

Lo, M. G. Y., Morgans, C. L., Santika, T., Mumbunan, S., Winarni, N., Supriatna, J., Voigt, M., Davies, Z. G., & Struebig, M. J. (2024). Nickel mining reduced forest cover in Indonesia but had mixed outcomes for well-being. One Earth, 7(11), 2019–2033. https://doi.org/10.1016/j.oneear.2024.10.010

Muhyiddin, M. (2026). IMIP Morowali as a National Strategic Project: The Political Economy of Nickel Downstream Industrialization in Indonesia. Jurnal Perencanaan Pembangunan: The Indonesian Journal of Development Planning, 10(2), 142–158. https://doi.org/10.36574/jpp.v10i2.864

Muhyiddin M, Mendatu, A., Muhammad Dio Rhiza Amrizal, Rozikin, I. S., & Ramdan, M. R. (2026). Transformasi Struktural tanpa Ekspansi Ketenagakerjaan yang Proporsional: Bukti dari Industrialisasi Nikel di Morowali. Bappenas Working Papers, 9(3), 206–223. https://doi.org/10.47266/bwp.v9i3.608

Munzila, W. O., Falatehan, A. F., & Hidayat, N. K. (2026). Analysis of the Socioeconomic Impact of the Nickel Mining Industry on Communities Surrounding the PT Z Area. https://doi.org/10.29244/ijaree.v5i1.70554

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. In Jurnal Sylva Lestari (Vol. 12, Number 3, pp. 549–579). University of Lampung Faculty of Agriculture. https://doi.org/10.23960/jsl.v12i3.847

Nugraha, A., Madu, L., & Herry Mulyanto, I. (2025). Navigating Domestic and International Pressures: A Securitization Analysis of Indonesia's Nickel Policy. SHS Web of Conferences, 212, 04003. https://doi.org/10.1051/shsconf/202521204003

Pasha, J. A. (2025). Interaksi Dinamika Kekuasaan Kawasan Industri Weda Bay: Eksklusi Sistemik dalam Kovergensi Ekonomi. 15(2), 423–436. https://doi.org/10.33366/rfr.v%vi%i.6936

Rachman, J. (2025). Indonesia's Nickel Business Is Boosting Development and Ruining Lives. Foreign Policy.

Reich, M., & Simon, A. C. (2026). Critical Minerals. 52. https://doi.org/10.1146/annurev-earth-040523

Schlosberg, D. (2007). Defining Environmental Justice: Theories, Movements, and Nature. Oxford University Press.

Schlosberg, D. (2004). Reconceiving environmental justice: Global movements and political theories. Environmental Politics, 13(3), 517–540. https://doi.org/10.1080/0964401042000229025

Taufik, A., Tikson, D. T., & Yunus, M. (2025). Social Impact Assessment in The Development of A Nickel Smelter in Morowali District. Journal of Government and Politics, 7(2), 133–146. https://journal.ummat.ac.id/index.php/JSIP/index

Tilley, L. (2026). Indonesian nickel sovereignty and global raced finance: the value of Element 28 in an age of 'transition.' Review of International Political Economy, 33(4), 1610–1637. https://doi.org/10.1080/09692290.2026.2642935

USGS. (2024). Statistics and information on the mining industry in Indonesia. United States Geological Survey Science for a Changing World. https://www.usgs.gov/centers/national-minerals-information-center/indonesia

Uli, M. (2025). Unchecked nickel mining fuels environmental, social crises in Indonesia. Jakarta: Jakarta Post

Warburton, E. (2024). Nationalist enclaves: Industrialising the critical mineral boom in Indonesia. Extractive Industries and Society, 20. https://doi.org/10.1016/j.exis.2024.101564.

Yusuf, B., & Asuhadi, S. (2026). Analisis Kritis Kebijakan Pengendalian Pencemaran Perairan Laut akibat Ekspansi Tambang Nikel di Maluku Utara. Indonesian Journal of Public Administration Review, Vol. 3 No. 4.