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MORALITY BEFORE KNOWLEDGE

Contesting the green transition: Nickel downstreaming, structural inequality, and the paradoxes of green extractivism

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ABSTRACT

Background: Indonesia, home to some of the world's largest nickel reserves, has emerged as a central hub in the global electric vehicle supply chain under initiatives of nickel downstreaming. This study aims to examine how nickel industrialization intersects with social, ecological, and spatial inequalities, revealing the paradoxes of green economic growth. **Methods:** Drawing on theories of political ecology framework, it integrates theories of the resource curse, and green extractivism, to understand the uneven realities of Indonesia's green transition, a mixed-methods approach was employed, integrating statistical data from the Indonesian Central Bureau of Statistics, deforestation records, health indicators, and civil society reports. The analytical process involves visualizing longitudinal datasets (2019–2024) to detect regional inequalities, which are then linked to qualitative reports to identify patterns of structural neglect and environmental injustice. **Findings:** The findings indicate that nickel-led industrial growth boosts regional GDP while welfare improvements remain stagnant, inequality persists, and access to healthcare and ecological quality are unevenly distributed across nickel-producing provinces. Deforestation, limited infrastructure, and the dominance of foreign investment reinforce patterns of structural neglect and embed Indonesia within global resource dependency networks. **Conclusion:** The study concludes that current circular economy policies risk serving as technocratic tools that legitimize extractive industrialism rather than foster genuine sustainability. Achieving meaningful circularity requires prioritizing ecological restoration, community participation, and redistributive justice to ensure that the green transition does not reinforce pre-existing inequalities. **Novelty/Originality of this article:** This research contributes a novel perspective by linking nickel industrialization with environmental justice, green colonialism, and spatial inequality in Indonesia's low-carbon development agenda.

KEYWORDS: nickel; green extractivism; circular economy; resource curse; political ecology.

1. Introduction

The accelerating climate crisis has changed not only how we speak but also what we prioritize. What used to be cautiously called "climate change" is now widely described as a "climate crisis," a term that conveying urgency and an existential threat (Carrington, 2019). The Intergovernmental Panel on Climate Change (IPCC, 2023) warns that avoiding catastrophic warming beyond 1.5 °C requires rapid, far-reaching, and unprecedented transitions in energy, industry, and transport. In response, governments worldwide have pledged ambitious emission-reduction targets under the Paris Agreement, which

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Indonesia ratified through Law No. 16/2016. However, pledges alone are not enough. Real progress depends on the material foundations of low-carbon transitions—especially the extraction and processing of critical minerals.

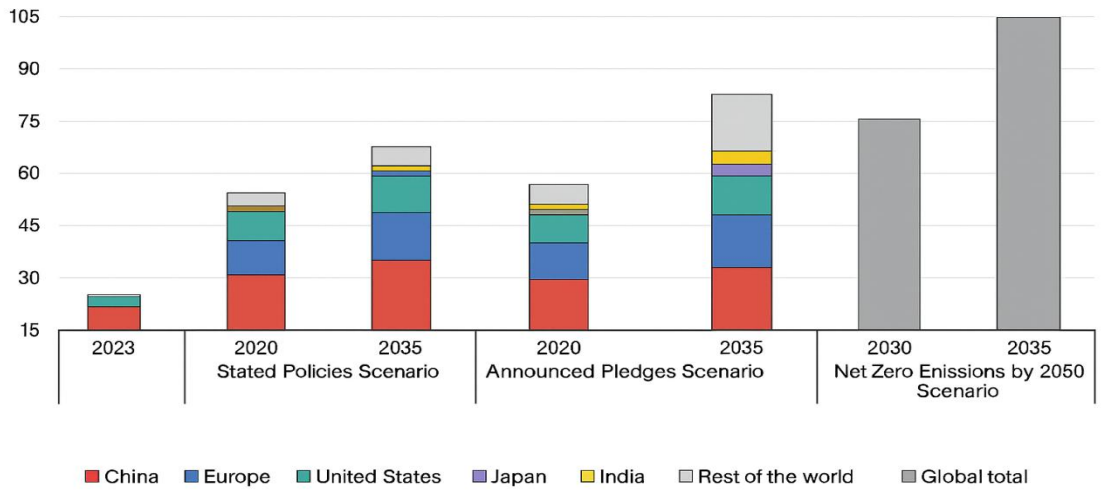

Fig. 1. Electric vehicle by region and scenario 2030 and 2035
(EV Boosters, 2024)

Global electric vehicle (EV) adoption is expected to grow five- to tenfold by 2035 under all IEA scenarios, driving up demand for critical minerals like nickel, lithium, and cobalt (IEA, 2024). The rapid expansion of EVs lies at the heart of global decarbonization strategies. According to the IEA, the global EV stock could reach between 525 and 790 million by 2035—more than a quarter of all vehicles on the road (IEA, 2024). This trend puts enormous pressure on battery technologies and mineral supply chains. Nickel is particularly strategic: it enhances energy density in batteries, allowing longer driving ranges and better performance (Nickel Institute, 2024).

As a signatory to the Paris Agreement, Indonesia continues to face a deep structural dependence on fossil fuels. Despite ongoing initiatives in reducing emissions in line with its Nationally Determined Contributions (NDCs), recent evidence indicates that overall emissions remain persistently high. The transportation sector, which accounts for a substantial share of the country's greenhouse gas emissions, represents both the greatest challenge and the greatest opportunity to achieve net-zero emissions by 2050. CO_2 emissions from transportation reached approximately 202 million tonnes in 2024, contributing around 25% of Indonesia's total emissions. Although the annual growth rate has slowed to about 2% since the Paris Agreement, the overall trend remains upward—driven by increasing mobility and vehicle ownership—underscoring the urgent need for transformational policy action (IESR, Indonesia Sustainable Mobility Outlook 2025*:* Driving Transport Decarbonization). While renewable energy deployment has expanded, Indonesia's transport sector remains overwhelmingly dependent on fossil fuels, posing a significant barrier to its decarbonization goals.

To address this, the Indonesian government has created electric vehicles (EVs) a key part of its plan to cut transport emissions and strengthen national energy security. According to Dadan Kusdiana, Secretary General of the Ministry of Energy and Mineral Resources/*Kementerian Energi dan Sumber Daya Mineral (Kementrian ESDM)*, Indonesia aims to have 2 million electric cars and 13 million electric two-wheelers on the road by 2030. In achieving this goal, the government has introduced fiscal incentives, expanded public EV charging networks/*stasiun pengisian kendaraan listrik umum (SPKLU)*, and promoted the creation of an integrated domestic battery ecosystem. These commitments were reaffirmed during the High-Level Closed-Door Ministerial Discussion at the International Energy Agency's (IEA) 9th Global Conference on Energy Efficiency in Nairobi, Kenya, on May 22, 2024 (Itsnaini, 2024).

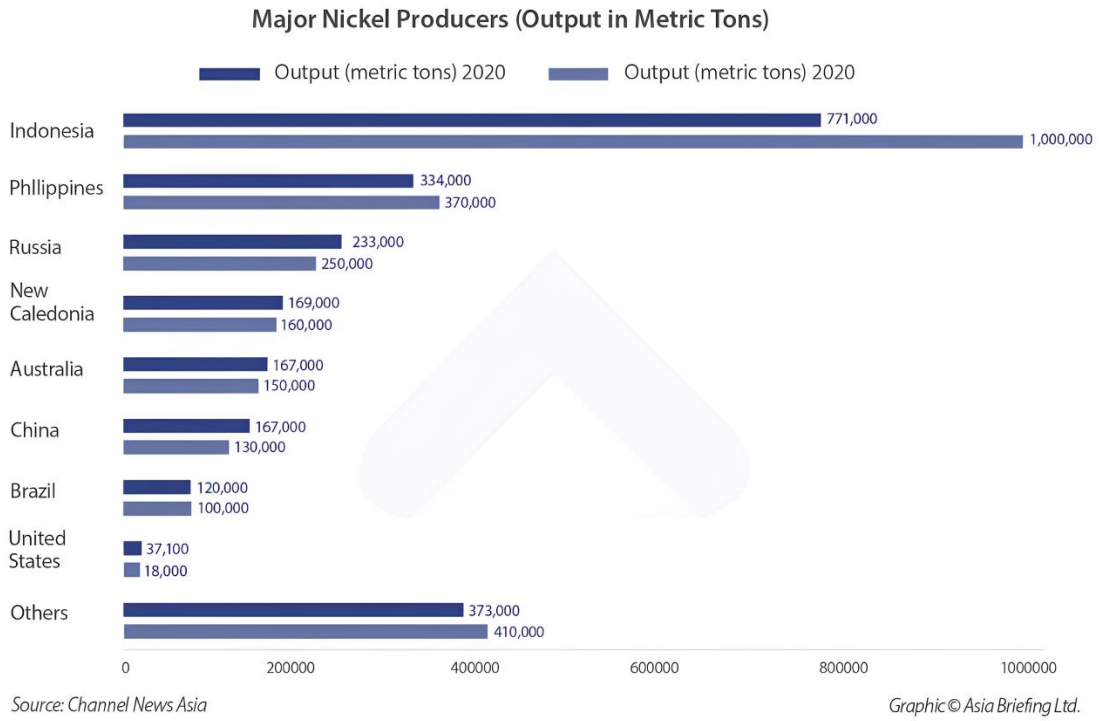

Fig. 2. Major nickel producers
(Medina, 2023)

As shown in Figure 2, Indonesia has quickly become a pivotal player in the global EV supply chain. The country holds more than half of the world's nickel reserves, mainly in Sulawesi and North Maluku, and promotes itself as a strategic hub for battery and EV industries. However, most of Indonesia's nickel production still goes to the steel industry, primarily as ferronickel and nickel pig iron (NPI) for stainless steel. In 2019, only about 5 percent of global nickel use went into batteries, though that share is expected to reach nearly 25 percent by 2030 as electric mobility grows (Guberman, 2022). To seize this opportunity, Indonesia has pushed for *hilirisasi* (downstream industrialization), focusing on domestic processing of battery-grade nickel to strengthen its position as a global supplier for the EV sector. This dual path highlights the tension between Indonesia's long-standing role in traditional steel production and its new ambitions in low-carbon industrial transformation.

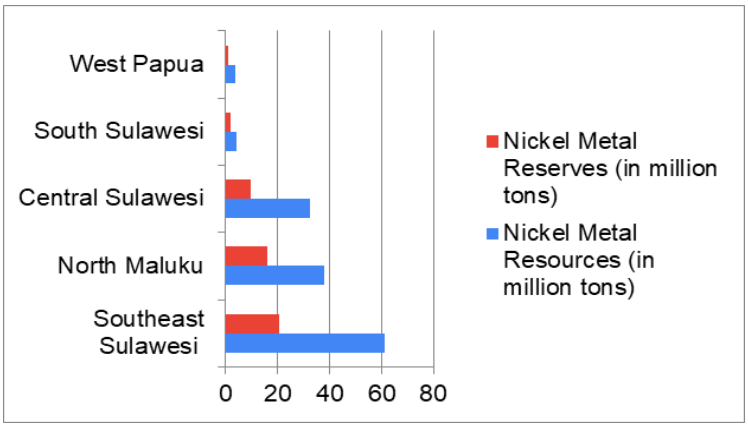

Fig. 3. Provinces with the largest nickel resources
(Coordinating Ministry for Maritime Affairs and Investment, 2024)

According to the Coordinating Ministry for Maritime Affairs and Investment (2024) in Figure 3, Southeast Asia's largest nickel reserves lie within Indonesia. The nickel boom has

expanded strongly in eastern regions—Southeast Sulawesi, North Maluku, Central Sulawesi, South Sulawesi, and West Papua—areas rich in nickel. However, marked by poverty, limited health infrastructure, and ecological degradation. From a political ecology perspective, so-called "green transitions" are not neutral or uniform processes; they are spatially uneven and often reproduce existing power hierarchies. As Avelino et al. (2024) emphasize, sustainability transitions are deeply political—shaped by unequal distributions of power, recognition, and representation across social and spatial divides. Peripherality in such transitions often corresponds to limited participation, institutional exclusion, and the dominance of centralized policy agendas. In this way, resource frontiers in peripheral regions—especially in the Global South—bear much of the cost, while administrative centers capture most of the benefits.

Since the 2020 export ban on raw ores, the Indonesian government has accelerated its *hilirisasi* agenda. Law No. 3 of 2020, which amended Law No. 4 of 2009 on Mineral and Coal Mining, mandates that mining permit holders process minerals domestically into value-added products rather than export raw materials. Official narratives frame this as a pillar of "green growth"—a policy promising economic development, industrial upgrading, and global relevance in the energy transition. The results have been striking according to BPS (2024), nickel exports (HS 75) reached USD 3.45 billion between January and July 2023—five times higher than in 2015 (USD 806 million) (Rachman, 2023). Tax revenues also jumped from IDR 1.66 trillion in 2016 to IDR 17.96 trillion in 2022, driven by expanding smelter operations and value-added processing. These numbers show how *hilirisasi* has turned nickel into one of Indonesia's most profitable export commodities.

However, behind these achievements lies a troubling paradox. Empirical evidence from Morowali, Obi Island, and other nickel-producing regions reveal widespread deforestation, pollution, displacement, and rising inequality. These patterns illustrate what scholars describe as green extractivism—a process where climate goals are used to justify even more extraction rather than reducing harm (Dunlap et al., 2024). As they explain, green extractivism is "a system of extractive development that harnesses climate change and other socioecological crises as profit-generating and re-branding opportunities." Indonesia's nickel boom, though wrapped in the language of decarbonization, often reinforces extractive hierarchies and spatial injustices.

This raises a fundamental question: whose green transition is it? While governments and corporations enjoy industrial and fiscal benefits, local communities bear the social and environmental costs—facing pollution, land loss, and poor access to health and welfare services. Recent scholarship emphasizes that sustainability transitions are inherently political processes shaped by power asymmetries and the redistribution of authority among actors (Williams et al., 2025). In Indonesia's nickel sector, investigations by Climate Rights International highlight weak environmental oversight, poor regulatory transparency, and limited mechanisms for benefit-sharing at the local level (Climate Rights International, 2024).

Current research on this topic remains fragmented. Global studies focus on geopolitical supply chains and "decarbonization by dispossession" (Andreucci et al., 2023; Barbesgaard & Whitmore, 2025), while national-level studies often examine environmental or fiscal impacts in isolation (Wahyono et al., 2024). Few have combined welfare indicators—such as economic growth, inequality, poverty, stunting, or respiratory illness—with ecological and political factors like deforestation or Indigenous land conflicts across nickel-rich provinces.

As Grubb (2014) reminds us, reducing vulnerability to the intertwined economic and environmental risks of fossil fuel dependence is central to sustainable development. But the climate crisis pushes us to think beyond carbon metrics. It forces us to ask: how do low-carbon pathways, such as the global shift to EVs, reshape inequality? Sovacool et al. (2019) warn that unless equity is placed at the center, low-carbon transitions risk reproducing or even deepening existing injustices. Ultimately, this is not just a technological or economic issue—it's a question of energy justice, political ecology, and human dignity.

This study bridges political ecology and resource-curse frameworks to examine how Indonesia's nickel boom affects economic growth, inequality, health, environment, and Indigenous rights in five major producing provinces—North Maluku, Central Sulawesi, Southeast Sulawesi, South Sulawesi, and West Papua—from 2019 to 2025. By connecting global theories of green extractivism with local welfare and environmental data, it seeks to uncover how the so-called green transition in Indonesia distributes its benefits and burdens—and whether it represents genuine inclusion or simply a rebranded form of extractive inequality.

2. Methods

2.1 Data sources and analytical scope

The type of data used in this study is secondary data, which is time series data in the last six years years. This study employs a descriptive–interpretive mixed-methods approach that integrates quantitative provincial-level indicators with qualitative interpretive insights under a political ecology framework. The empirical scope focuses on five major nickel-producing provinces in eastern Indonesia—North Maluku, Central Sulawesi, Southeast Sulawesi, South Sulawesi, and West Papua. These provinces were selected based on their centrality in Indonesia's *hilirisasi nikel* (nickel downstreaming) policy and their strategic relevance in global supply chains for electric vehicle (EV) batteries and renewable energy infrastructure.

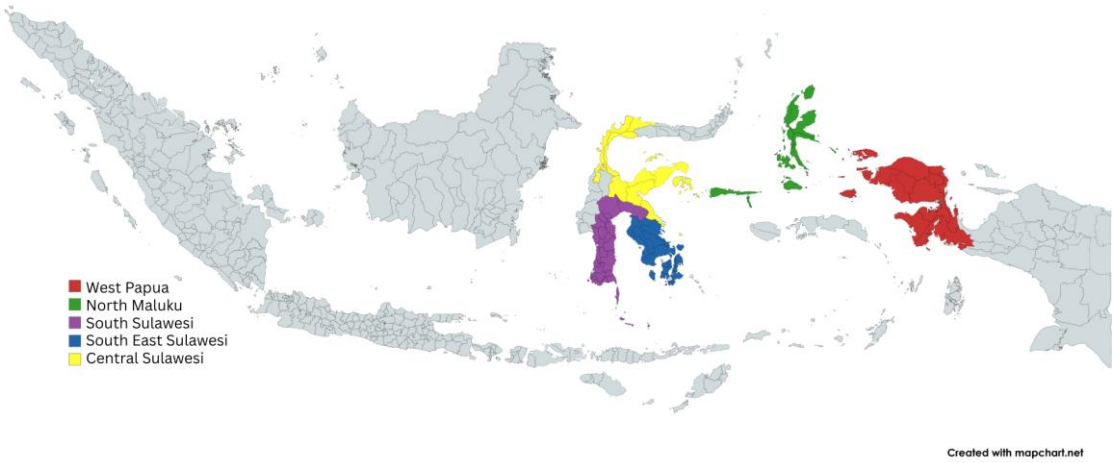

Fig. 4. Research location: maps of five major nickel-producing provinces in eastern Indonesia: North Maluku, Central Sulawesi, Southeast Sulawesi, South Sulawesi, and West Papua

Quantitative data were compiled from official national datasets published by the Central Statistics Agency/*Badan Pusat Statistik (BPS)*, the Ministry of Health/*Kementerian Kesehatan (Kemenkes)*, and the Ministry of Environment and Forestry/*Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia (KLHK).* The variables include economic growth rate, poverty rate, Gini ratio, Human Development Index (HDI), stunting prevalence, and forest loss (2019–2024). All numerical data were processed and visualized using Microsoft Excel, which served as the primary analytical tool for detecting provincial-level trends, disparities, and correlations across socio-economic and environmental dimensions.

Complementary qualitative materials were drawn from civil society and non-governmental organization (NGO) reports, including Amnesty International and Climate Rights International (CRI), Greenpeace published in 2024-2025. These reports provided valuable narratives and empirical observations concerning socio-environmental conflicts, policy contestations, and local experiences of ecological degradation within nickel mining frontiers. The study's analytical framework synthesizes three key theoretical perspectives:

the political ecology (Robbins, 2020), green extractivism (Dunlap et al., 2024), and resource curse (Narh, 2023). This combination allows for an examination of how Indonesia's "green industrialization" simultaneously produces economic concentration, environmental harm, and uneven development across its resource peripheries.

2.2 Methodological approach and rationale

The decision to employ a descriptive–interpretive mixed-method design reflects both practical constraints and epistemological commitments. Quantitative environmental data in Indonesia's extractive regions are notably fragmented, with limited availability of verified information on air quality, water pollution, or industrial waste at the provincial or district level. Instead of treating this absence as a mere data limitation, the study conceptualizes it as part of the political ecology of knowledge itself—called epistemic injustice and its extensions in Global South contexts (Kaur et al., 2023).

Under this lens, the scarcity and opacity of environmental data are seen as manifestations of extractive power, where the ability to produce and circulate knowledge is unevenly distributed. As such, data gaps—particularly in provinces like North Maluku and Central Sulawesi—become analytically meaningful, revealing structural neglect and the marginalization of affected communities within dominant narratives of economic progress. To address these challenges, this study employs proxy indicators to approximate key socio-environmental dimensions. Forest loss (hectares, 2019–2024) serves as a proxy for deforestation and land-use change, derived from KLHK, Auriga Nusantara, and Global Forest Watch. Stunting prevalence (%) represents chronic undernutrition and public health inequality (BPS; Ministry of Health). The number of villages per health facility reflects institutional neglect and spatial inequality in state investment (BPS). The Human Development Index (HDI, 2024) measures overall welfare disparity (BPS). Recorded land and customary conflicts act as proxies for ecological dispossession and socio-political tension (Amnesty International, 2025; Climate Rights International, 2024; Greenpeace Indonesia, 2025).

Additionally, national policy documents—such as Indonesia Circular Economy Roadmap 2025–2045 (Bappenas, 2025a), and Indonesia Nickel Industry Decarbonization Roadmap (Bappenas, 2025b)—are used to contextualize the political framing of sustainability in Indonesia's industrial transition. By combining these quantitative proxies with interpretive qualitative insights, the analysis identifies patterns of socio-environmental inequality across Indonesia's nickel frontiers. The use of Excel-based visualization supports transparent, replicable analysis, while the interpretive layer ensures that the findings remain theoretically grounded. Ultimately, this methodological configuration is not aimed at producing predictive models but at illuminating the contradictions of Indonesia's green transition—where the rhetoric of sustainability coexists with deepening territorial and class-based inequalities. This hybrid method thus embodies an epistemological stance aligned with political ecology: that knowledge about the environment is always political, situated, and shaped by power

3. Results and Discussion

3.1 Growth, welfare, and the nickel boom in five provinces with the largest nickel resources

Economic growth is often perceived as a sign of progress. In public discourse and policy narratives, a rising GDP is frequently equated with social advancement. However, in Indonesia, this relationship is not always straightforward. While economic expansion may reduce poverty, studies show that sustainable welfare gains depend on simultaneous improvements in education, health, and infrastructure. As Gaukroger (2022) notes, GDP was never intended to measure wellbeing—it omits essential dimensions such as inequality and environmental degradation.

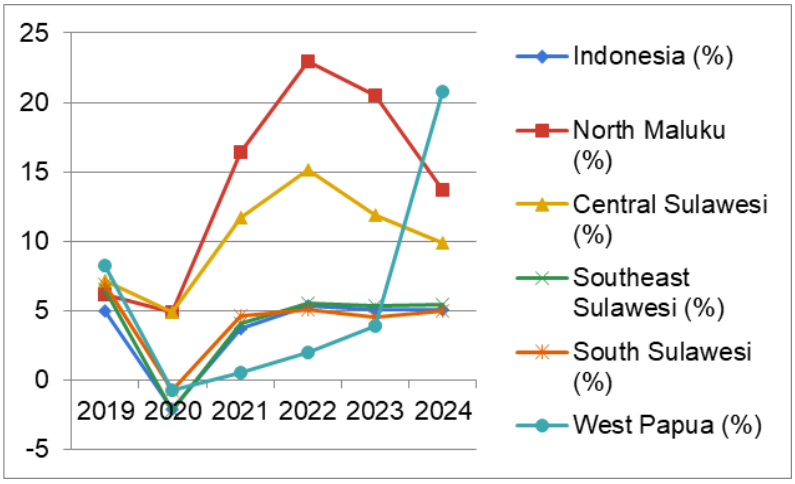

Fig. 5. Economic growth in Indonesia and five provinces with the largest nickel resources (BPS, 2019–2024)

Between 2019 and 2024, Indonesia's overall economic growth remained stable at around 5% per year. In contrast, two nickel-rich provinces—North Maluku and Central Sulawesi—experienced significantly higher growth, driven by the rapid expansion of the nickel downstreaming (*hilirisasi*) industry. North Maluku's economy grew by 22.94% in 2022 and remained above 13% in 2024, while Central Sulawesi recorded 15.17% in 2022 and 9.89% in 2024. These figures highlight a widening gap between national averages and resource-based regions, showing how Indonesia's industrial expansion has become spatially concentrated in areas tied to energy-transition policies. However, this impressive growth raises a critical question: to what extent do these gains benefit local communities? While the mining sector can stimulate growth and raise incomes, its benefits depend on whether investments strengthen social services and infrastructure (Azubuike et al., 2023).

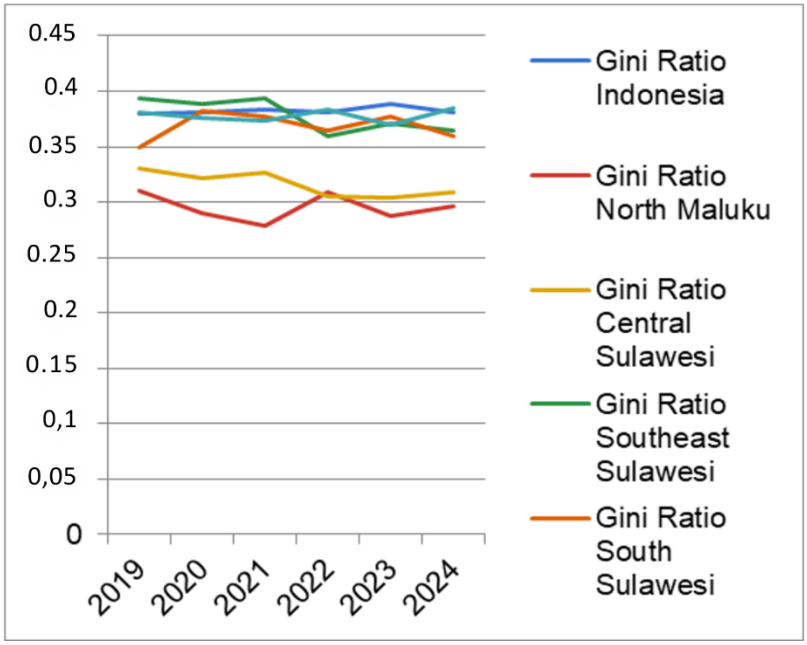

Fig. 6. Gini ratio in Indonesia and five provinces with the largest nickel resources, 2019–2024 (BPS, 2019–2024)

Despite rapid economic expansion, inequality persists. The national Gini ratio remained around 0.38 between 2019 and 2024, showing minimal structural change. In North Maluku and Central Sulawesi—the fastest-growing provinces—Gini ratios even increased slightly after 2020, reaching 0.296 and 0.309 respectively in 2024. These data suggest that industrial profits are unevenly distributed. Economic gains primarily accrue

to state and corporate actors, while local communities receive marginal benefits. This pattern demonstrates how extractive-led industrialization can reinforce existing social hierarchies rather than dismantle them.

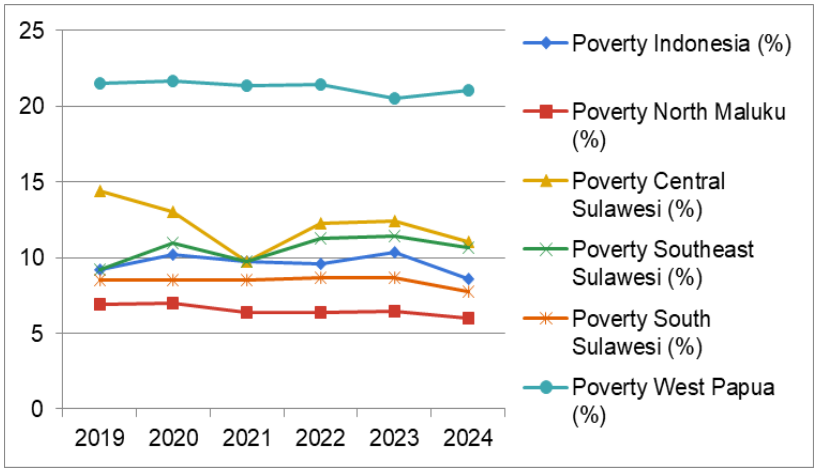

Fig. 7. Poverty rate in Indonesia and five provinces with the largest nickel resources, 2019–2024 (BPS, 2019–2024)

At the national level, Indonesia's poverty rate declined modestly—from 9.22% in 2019 to 8.57% in 2024. However, in several nickel-dependent provinces, the decline was slower or even reversed. In 2024, Central Sulawesi's poverty rate stood at 11.04%, while Southeast Sulawesi and West Papua recorded 10.63% and 21.09%, respectively. Only North Maluku experienced a notable reduction to 6.03%. This evidence confirms that economic growth has not consistently translated into poverty reduction. The benefits of downstreaming remain spatially and socially uneven, with limited trickle-down effects on household welfare.

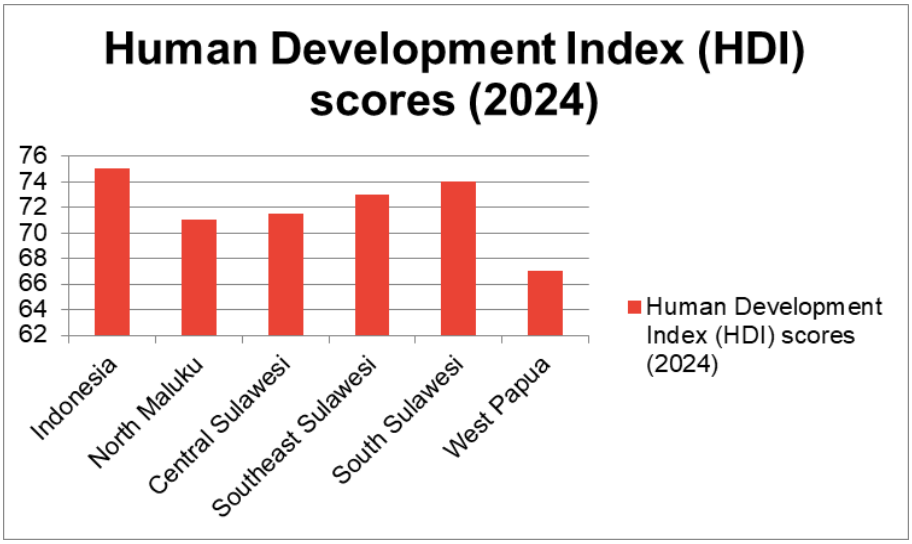

Fig. 8. Human Development Index (HDI) in Indonesia and five provinces with the largest nickel resources, 2024
(BPS, 2024a)

Human Development Index (HDI) data reveal similar disparities. Indonesia's national HDI reached 75.02 in 2024, but major nickel-producing provinces lagged behind—North Maluku (71.03), Central Sulawesi (71.56), and West Papua (67.02). These gaps demonstrate that economic growth alone does not guarantee improved education, health, or living standards. Taken together, the data expose a clear paradox: Indonesia's mineral-led growth, particularly through nickel downstreaming, has driven rapid GDP expansion but produced uneven social outcomes. The national narrative celebrates high growth as

evidence of progress, however indicators of inequality, poverty, and human development tell a more complex and troubling story.

Continuous investment flows have primarily targeted industrial capacity and export value rather than community development. As Bishoge & Mvile (2020) caution, resource exploitation does not automatically lead to poverty reduction. Where governance and redistribution mechanisms are weak, resource-rich countries often fail to capture the full benefits of extraction or meet community needs. In such cases, the mining sector may deepen pre-existing inequalities rather than alleviate them.

This dynamic exemplifies green extractivism—a development model in which resource-driven industrialization supports the global green transition while perpetuating domestic inequalities. Profits from nickel extraction are concentrated in corporate and urban centers, leaving nearby communities to shoulder the social and environmental costs. For Indonesia's energy transition to be genuinely sustainable, economic growth must be accompanied by robust social welfare policies. Without such integration, the green transition risks reproducing the very extractive logic it seeks to overcome: growth without inclusion, and prosperity without justice.

3.2 Spatial inequality and green extractivism

The persistence of public health disparities across Indonesia's nickel-rich provinces reflects a well-known paradox of the resource curse—a condition where resource abundance coexists with social and developmental stagnation (Narh, 2023). Provinces such as North Maluku, Central Sulawesi, Southeast Sulawesi, South Sulawesi, and West Papua exemplify this contradiction. Although these regions play a vital role in the global green transition through nickel mining for electric vehicle (EV) batteries, they continue to experience chronic underdevelopment in health infrastructure and social welfare.

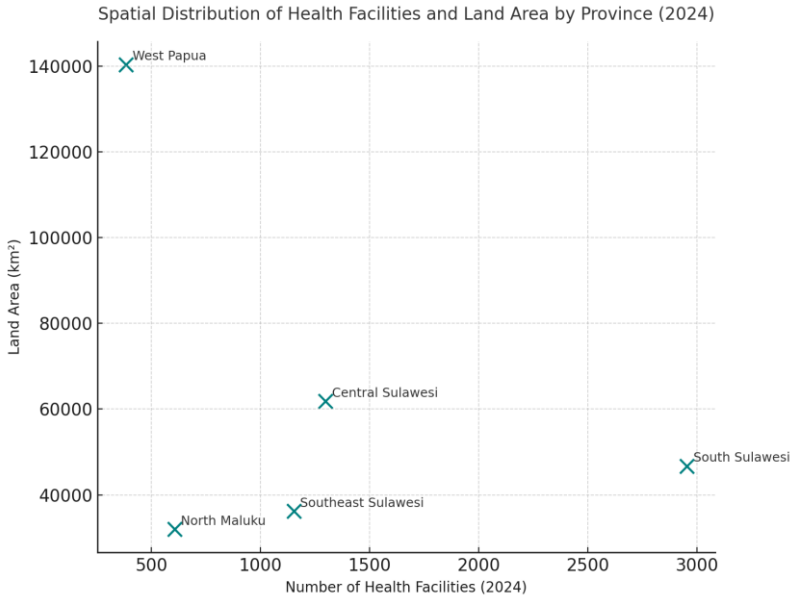

Fig. 9. Spatial distribution of health facilities and land area by province, 2024 (BPS, 2024b)

Figure 9 (BPS, 2024b) illustrates the spatial distribution of healthcare facilities relative to land area across the five provinces. Each data point represents the total number of health facilities plotted against provincial land area, offering insight into geographic disparities in healthcare accessibility. The pattern reveals a clear imbalance: provinces with larger territories do not necessarily possess more health facilities, highlighting persistent spatial inequality in public health provision.

South Sulawesi stands out as an outlier, hosting the highest number of health facilities—approximately 2,955 across 46,717 km^2—indicating relatively dense and accessible coverage. In contrast, West Papua lies at the opposite extreme: an extensive land area of roughly 140,000 km^2 served by only 382 facilities. Each facility in West Papua thus covers an area nearly three times greater than its counterparts elsewhere, underscoring its severe infrastructural deficit. North Maluku, Central Sulawesi, and Southeast Sulawesi fall in between but remain below the national benchmark in facility density.

The spatial gap visualized in the scatter plot reflects a broader structural condition—uneven development across Indonesia's resource-dependent peripheries. Despite their growing contribution to national GDP through nickel exports, these provinces continue to face logistical and fiscal barriers that hinder equitable access to basic services. This uneven geography of welfare exemplifies the enduring logic of the resource curse: the expansion of extractive industries rarely coincides with proportional improvements in public service delivery.

As noted by the Natural Resource Governance Institute (2015), elites in resource-rich economies often prioritize rent-seeking and rent-seizing over productive investment, resulting in institutional fragility and weak governance. Consequently, regions endowed with abundant resources experience economic growth in extractive sectors without corresponding social progress—deepening spatial inequalities across the archipelago. The outcome is a fragmented welfare landscape where economic extraction outpaces social investment.

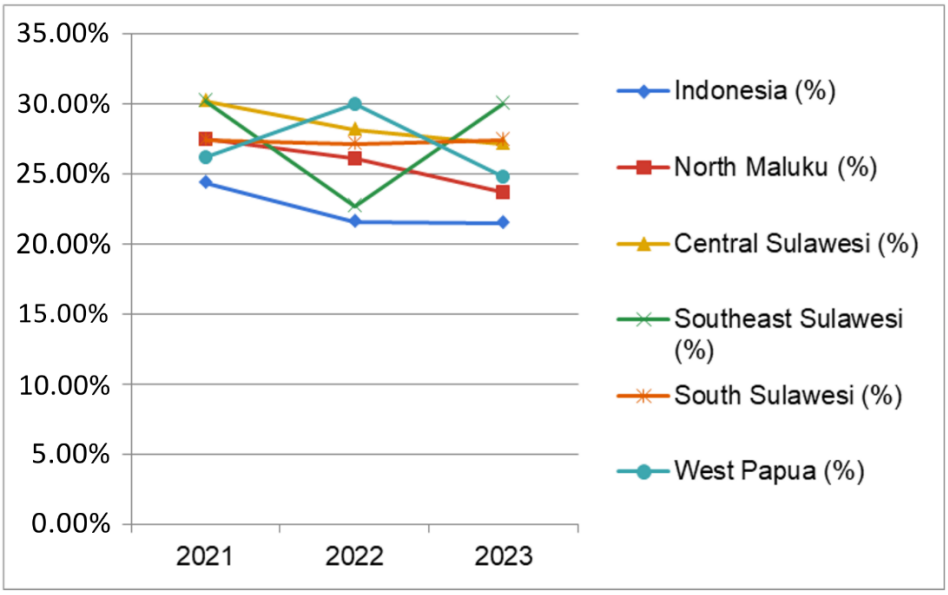

Fig. 10. Stunting Rate by Province, 2021-2023
(Kementerian Kesehatan Republik Indonesia, 2021-2023)

As shown in Figure 10, this structural disparity extends beyond infrastructure to public health outcomes, particularly stunting—a key indicator of chronic child malnutrition. While Indonesia's national stunting rate declined from 24.4% in 2021 to 21.5% in 2023, nickel-producing provinces remain above the national average. Central Sulawesi recorded 27.2% in 2023, down only slightly from 30.2% in 2021. Southeast Sulawesi remained stagnant at 30.0%, while West Papua improved from 30.0% to 24.8% but still trails behind. Even North Maluku, at 23.7%, exceeds the national rate. These figures underscore that extractive investment alone has not translated into tangible improvements in social or health outcomes for local populations.

This contradiction epitomizes what scholars' term green extractivism—a new phase of resource exploitation legitimized by the global transition to renewable energy (Gudynas, 2020). In Indonesia, nickel mining—often celebrated as a pillar of the "green

economy"—has instead intensified socio-spatial inequality. The wealth generated from mineral exports seldom circulates locally. Nearby communities face environmental degradation, disrupted livelihoods, and persistent deficits in public health and welfare. This dynamic mirrors the logic of green colonialism, where economic and ecological dependencies are reproduced under the banner of sustainability and decarbonization (Manahan, 2023).

The government's nickel downstreaming (*hilirisasi*) policy vividly illustrates this paradox. While the initiative has attracted major investment and boosted export revenues, most of its benefits accrue to state and corporate elites rather than local communities. The uneven spatial distribution of hospitals and clinics—combined with persistently high stunting rates—demonstrates how "green growth" can reproduce extractive inequalities rather than resolve them. From an environmental justice perspective (Schlosberg, as cited in Cannavó, 2008), this situation reflects a systemic failure to ensure fair distribution of both environmental risks and economic gains across Indonesia's extractive peripheries.

Ultimately, data from 2021–2023 reveal a consistent pattern: Indonesia's nickel-rich provinces, despite their strategic global value, remain structurally deprived. Health infrastructure lags, and child malnutrition remains alarmingly high. The country's extractive-led growth has yet to yield inclusive or equitable outcomes. Moving forward, policies for the energy transition must extend beyond economic efficiency toward a multidimensional framework that emphasizes social inclusion, equitable benefit-sharing, and public health. Expanding healthcare access, reforming local revenue mechanisms, and ensuring participatory governance are essential steps toward breaking the persistent link between resource abundance and social deprivation. Only through such an integrative approach can Indonesia's green transition embody true sustainability—not only environmentally, but also socially and humanly.

3.3 Environmental degradation, decarbonization, and indigenous conflict

As outlined in the methodology, environmental data from Indonesia's nickel-producing regions remain fragmented and incomplete—particularly regarding pollution, biodiversity loss, and broader socio-ecological impacts. This opacity is not a neutral gap in data collection; it reflects deeper governance failures. As Putri (2022) observes, Indonesia's Mining Law has failed to ensure public access to mining information, meaningful participation, and strong accountability mechanisms for affected communities. In short, despite official claims of transparency and decentralization, environmental and social information remains tightly controlled.

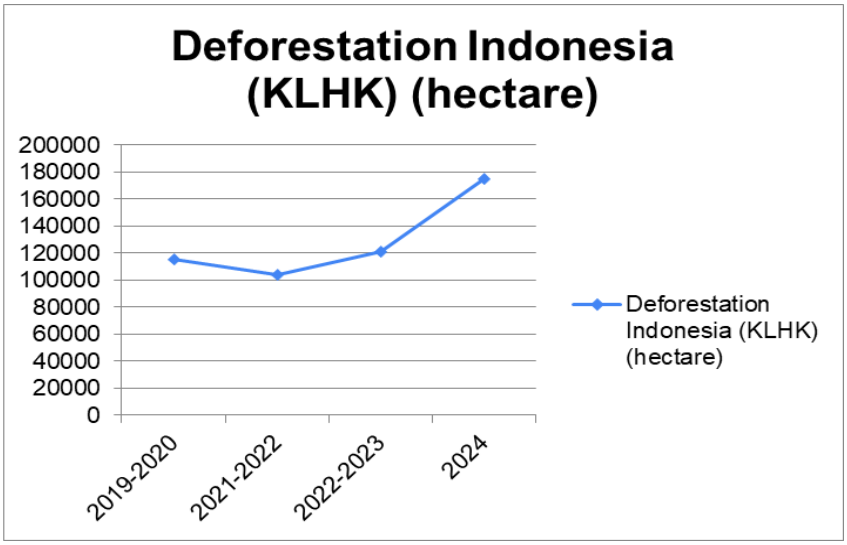

Fig. 11. Deforestation Indonesia (hectare), 2019-2024 (KLHK, 2019-2024)

Between 2019 and 2024, Indonesia's deforestation rates fluctuated sharply—from about 100,000 to over 260,000 hectares per year—depending on the reporting source (KLHK, 2024; Auriga Nusantara, 2024; Forest Watch, 2025). The Ministry of Environment and Forestry (KLHK) reported a net deforestation of 175,400 hectares in 2024, whereas Auriga Nusantara estimated over 260,000 hectares for the same year. These discrepancies illustrate how environmental data have become both contested and politicized, revealing institutional opacity and competing definitions of "accountability" in Indonesia's extractive frontier.

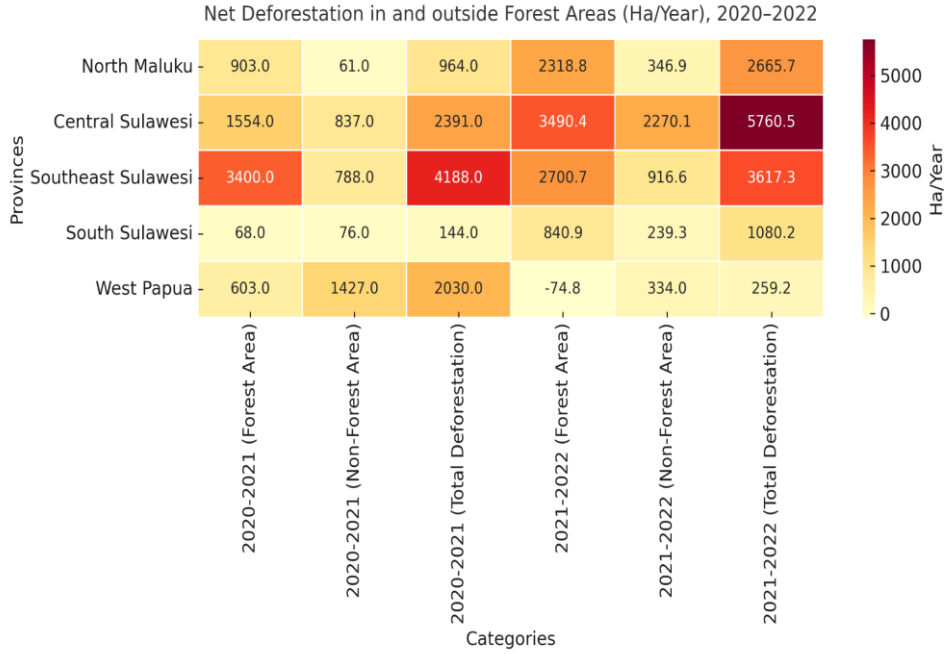

Fig. 12. Net Deforestation in and outside forest areas (Ha/Year), 2020-2022 (BPS, 2020-2022)

Provincial data follow the same pattern. Figure 12 presents net deforestation rates (hectares per year) across five key provinces—North Maluku, Central Sulawesi, Southeast Sulawesi, South Sulawesi, and West Papua—over two periods: 2020–2021 and 2021–2022. The figures are divided between forest areas (Kawasan Hutan) and non-forest areas (Areal Penggunaan Lain, APL). Overall, most provinces saw a rise in total deforestation, except for West Papua, where it dropped dramatically from 2,030 ha to just 259.2 ha. Central Sulawesi, in contrast, saw the steepest jump—from 2,391 ha to 5,760.5 ha—indicating growing land-use pressures in the province.

Across the data, forest-area deforestation consistently outpaced losses in non-forest zones. For example, Southeast Sulawesi lost 3,400 ha of forest in 2020–2021, compared to only 788 ha outside forest zones. The same pattern appeared in 2021–2022, with 2,700.7 ha cleared inside forests versus 916.6 ha outside. These numbers show that drawing legal boundaries alone does not protect forests; weak monitoring, overlapping permits, and limited transparency continue to undermine conservation. West Papua is a notable outlier: its forest-area deforestation turned negative (–74.8 ha) in 2021–2022, indicating either a slight net gain or a correction in data. However, according to the Central Bureau of Statistics (BPS, 2024a), Papua's overall forest cover—once about 85% of its landmass—has now fallen to 33.12 million hectares, or just 32.2% of Indonesia's total forest area. The region lost over 663,000 hectares to deforestation, and another 765.71 hectares were cleared in early 2024 alone, showing that its forests remain under serious threat.

The uneven pace of forest loss across provinces highlights long-standing governance failures in Indonesia's forest management. The dominance of forest-area deforestation suggests that legal protection is ineffective without open data systems, public access to

information, and genuine local participation. The continued expansion of extractive projects within or near conservation zones also exposes the contradictions of Indonesia's "green industrialization." In some areas, nickel mining has moved into protected ecosystems—including Raja Ampat, a UNESCO Global Geopark and one of the world's richest marine habitats. While the government revoked four mining permits in 2025, at least five other companies remain operational (Greenpeace Indonesia, 2025). This clash between ecological preservation and industrial ambition reflects a deeper paradox in Indonesia's energy transition: "green growth" has become a license to extend extractive activities into fragile and indigenous territories.

Beyond environmental damage, Indonesia's nickel boom has fueled social and political conflict—especially among indigenous and coastal communities living near major smelter zones. In East Halmahera, Amnesty International (2025) documented the arrest of eleven indigenous people protesting land grabs linked to nickel concessions. The O'Hongana Manyawa (Tobelo Dalam) community has also faced forced displacement and the erosion of traditional livelihoods as their customary forests were handed over for mining (Forest Watch Indonesia, 2025). Even in Raja Ampat, where indigenous councils have repeatedly rejected mining, weak enforcement and overlapping legal claims have silenced their resistance. These cases reveal a stark power imbalance: industrial projects backed by the state easily override local communities whose lands and seas sustain Indonesia's ecological balance.

The human rights dimension of this industrial surge was laid bare in *Nikel Dikeduk: Dampak Industri Nikel di Indonesia Pada Manusia dan Iklim* (Climate Rights International, 2024), a 124-page report based on 45 interviews around the Indonesia Weda Bay Industrial Park (IWIP). The report details widespread land grabbing, intimidation, and coercion involving company officials, police, and the military. It also shows how nickel mining and smelting cause severe deforestation, air and water pollution, and major greenhouse gas emissions through off-grid coal power plants. Despite their branding as part of the global clean energy transition, these operations have created new "sacrifice zones" where local communities bear the hidden costs of global decarbonization.

The irony is unmistakable: while electric vehicles are hailed as essential for reducing emissions, the nickel used in their batteries carries enormous ecological and human costs. IWIP alone has built at least five captive coal plants since 2018 and plans to add twelve more, generating 3.78 GW—more coal use than entire countries like Spain or Brazil (Climate Rights International, 2024). These plants emit millions of tons of CO_2 and dump toxic waste into nearby waters. Fishermen in Gemaf village report that their once-clear fishing grounds are now polluted. One fisherman shared, "Before the company came, the sea was clean. Now, we can't fish near them—if we do, we're chased away. The water's dirty, full of oil and heat. It kills the fish. Sometimes, the sea even turns red." His story captures the human side of a transition that serves global EV markets but sacrifices local survival.

These experiences point to a broader failure to uphold Free, Prior, and Informed Consent (FPIC)—a key principle of indigenous rights. Many communities say they were never properly consulted about land deals or project details (Climate Rights International, 2024). Nickel industrialization has replaced traditional livelihoods like fishing and sago farming with ecological damage and dependency. The resulting deforestation, river sedimentation, and mangrove loss have cut off access to clean water and food. As activist Adlun Fikri from Sagea puts it, "People upstream pay for the world's carbon neutrality. Western consumers enjoy electric cars, while we live with the damage." His words sum up a larger pattern of environmental injustice—where the "green transition" replicates colonial hierarchies by shifting ecological risks from the Global North to the Global South.

At a structural level, these conflicts show how weak Indonesia's environmental governance remains. Poor transparency, fragmented monitoring, and the tight bond between industrial capital and the state create conditions for impunity. Neither IWIP nor the government publishes data on air or water quality around the smelter areas, leaving nearby residents uninformed about health risks. Meanwhile, reliance on coal and the

absence of renewable integration expose the disconnect between Indonesia's climate pledges and its industrial practices. The rhetoric of "green growth" thus falls apart under scrutiny: instead of transforming extractive capitalism, the nickel boom has deepened it—embedding fossil fuels within the very industries meant to replace them.

Health infrastructure tells a similar story. Across the nickel-producing provinces, one health facility often serves four to six villages, even though these regions generate billions in export revenue. This neglect compounds environmental risks: communities exposed to pollution and deforestation lack basic healthcare, making them more vulnerable to respiratory and waterborne diseases. Strikingly, while data on smelter production and exports are updated regularly, information on air and water quality remains hidden—entrenching a deeper kind of inequality: who gets to know, and who gets to breathe.

Taken together, this dual process of ecological destruction and social marginalization embodies what Dunlap et al. (2024) call green extractivism—the continuation of extractive capitalism disguised as sustainability. Swelsen (2023) similarly shows that the global energy transition, often framed as a "just" or "clean" shift, can reproduce colonial and exploitative dynamics. Her study of the Chiloé wind farm in Chile reveals how "green" projects can still disempower local communities when they are excluded from decision-making. In this sense, Indonesia's nickel frontier is not just a production site—it is a mirror of global inequality, where the costs of decarbonization are exported southward in the name of sustainability.

This contradiction between extractive industry and environmental justice exposes the limits of Indonesia's so-called green economy. What is framed as a sustainable transition is, in practice, a rearrangement of the same extractive logic. Policies on downstream processing (*hilirisasi*) and circular economy may carry the language of "value-adding" and "decarbonization," but they remain grounded in intensive resource exploitation. The narrative of "green growth" hides a more uncomfortable truth: it does not end extraction—it simply creates it look cleaner. In conclusion, the logic of green extractivism runs deeper than environmental damage. It shapes the very policies meant to solve it. Indonesia's embrace of the circular economy represents not a break from extractive capitalism but its rebranding—a kind of green developmentalism that justifies pollution, reproduces dependency, and consolidates state-corporate power in the name of sustainability.

3.4 Circular economy and policy contradictions in Indonesia

At the heart of Indonesia's green transition lies a fundamental paradox—one that promises decarbonization while deepening extraction. This paradox is illustrated in Figure 13, which shows projected climate impacts from nickel down streaming policy in 2015-2023. Even with low-carbon initiatives, emissions continue to rise due to growing production volumes and declining ore grades. This reflects the paradox of "green growth": the effort to decarbonize while expanding the very industries that generate carbon emissions. Meyer (2025) calls this the depoliticized imaginary of climate politics—where the global fixation on carbon reduction conceals the deeper political and economic systems driving the crisis. In Indonesia's case, the pursuit of "green" industrialization remains tied to coal-powered smelters and new extractive frontiers, turning decarbonization itself into another engine of growth.

Building on this paradox, Indonesia's circular economy agenda has emerged as a key pillar in its post-extractive development narrative. The government promotes *hilirisasi industri* (industrial downstreaming) and the Indonesia Circular Economy Roadmap 2025–2045/*Peta Jalan & Rencana Aksi Nasional Ekonomi Sirkular Indonesia 2025–2045* as central strategies to enhance resource efficiency, reduce waste, and achieve carbon neutrality (Bappenas, 2025a). In principle, this roadmap casts circularity as both an ecological and economic necessity—an approach that could, at least theoretically, decouple economic growth from environmental degradation. However, realities on the ground in nickel-producing regions tell a different story. Rather than dismantling resource dependency,

Indonesia's circular economy framework risks becoming a technocratic tool that legitimizes ongoing extraction—merely rebranding it under the language of sustainability.

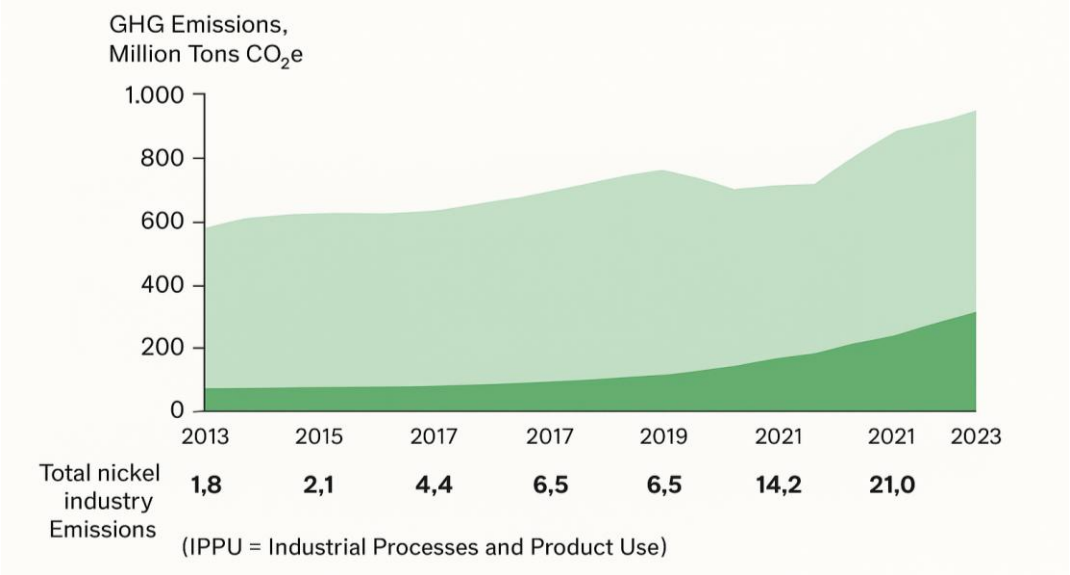

Fig. 13. Climate impact of Indonesia's Nickel downstreaming policy, 2015-2023. (Bappenas, 2024)

At its core, the circular economy (CE) promotes the idea of regenerating natural systems, recycling materials, and closing resource loops. Kirchherr et al. (2017) define it as "an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling, and recovering materials in production, distribution, and consumption processes." Ideally, CE works across different scales—from individual products and companies to cities and nations—aiming to achieve environmental quality, economic prosperity, and social equity all at once.

This creates CE not just a technological framework, but also a vision for systemic change: a way to reconcile economic activity with ecological limits. However, in practice, translating these principles into policy in developing economies like Indonesia often exposes deep contradictions. The government's focus on *hilirisasi industri*, particularly in the electric vehicle (EV) and battery sectors, is portrayed as a move toward green industrialization and resource efficiency. But this policy has modernized extraction, not transformed it.

Nickel downstreaming, celebrated as a driver of domestic value addition, still depends on open-pit mining, coal-powered smelters, and extensive land conversion. These energy-intensive, linear systems continue to damage ecosystems and perpetuate inequality. As a result, Indonesia's circular economy vision risks becoming an ideological extension of extractive capitalism—where the promise of "closing the loop" hides a continued reliance on resource depletion dressed up as green progress.

The Indonesia Nickel Industry Decarbonization Roadmap by Bappenas outlines eight strategies to decarbonize the sector, including the use of biomass and improvements in smelter efficiency. On paper, these measures look ambitious, projecting up to an 81% reduction in greenhouse gas (GHG) emissions by 2045. However, the underlying logic remains tied to industrial expansion. Policies focused on "green" electricity or gas substitution don't actually reduce extraction—they just create it more efficient. Dunlap et al. (2024) describe this as green extractivism: the continuation of extractive capitalism under the label of sustainability.

Although Indonesia's circular economy discourse borrows the vocabulary of sustainability, its implementation often stops at efficiency improvements rather than true material recovery. The Circular Economy Roadmap highlights progress points—such as

Extended Producer Responsibility (EPR) systems and urban waste collection—but these efforts remain limited and heavily centralized in cities. Key circular systems like battery recycling and e-waste traceability are still underdeveloped. As of 2025, Indonesia has yet to establish a nationwide mechanism for end-of-life EV battery management, even as waste projections climb steeply (Bappenas, 2025). This gap shows how the rhetoric of circularity often diverges from the linear reality of industrial expansion.

Governance within the CE framework also reflects long-standing patterns of centralization and exclusion. Policymaking tends to be technocratic and dominated by elite actors, with little input from local governments or indigenous communities. This mirrors broader global trends where development priorities reinforce inequalities in who benefits from environmental resources and who bears the costs. As Kaiser et al. (2020) note, socio-economic hierarchies often produce unequal access to environmental goods. Elderbrock et al. (2024) similarly show that public policy tends to prioritize macroeconomic goals over community well-being. In Indonesia's nickel centers—such as Morowali, Konawe, and the Obi Islands—these dynamics are clear: local people endure ecological degradation and health risks but remain largely excluded from decision-making. The persistence of this procedural inequality reflects deeper structural issues in Indonesia's extractive governance and highlights the urgent need for justice-centered circular transitions.

The contradictions grow sharper when viewed in a global context. Despite nationalist narratives of *hilirisasi*, Indonesia's nickel industry remains heavily shaped by foreign capital, especially from China and, to a lesser extent, Europe. Investments through China's Belt and Road Initiative, combined with Indonesia's raw mineral export ban, have drawn large players like Tsingshan Group to establish smelters in Sulawesi and North Maluku (Tritto, 2023). As a result, Indonesia's circular economy is entangled within global systems of dependency (Zuo & Luo, 2024) and green colonialism (Manahan, 2023). Zuo & Luo (2024) argue that while natural resources can support growth, weak domestic governance often turns this potential into a new form of the resource curse. In Indonesia, foreign direct investment (FDI) generates jobs and revenue but also deepens reliance on external capital and technology. Ultimately, Indonesia provides "clean" materials to power the North's decarbonization, while absorbing the environmental and social costs at home—a clear example of what Manahan (2023) calls the *colonial division of sustainability*: the North decarbonizes, the South sacrifices.

To move beyond these contradictions, Indonesia needs to reimagine its circular economy not just as an efficiency project, but as a regenerative one. A truly circular transition would reduce primary extraction, strengthen recycling industries, and restore degraded ecosystems. This aligns with Hadfield et al. (2025), who argue that circular transitions in the Global South must center on justice, participation, and ecological renewal rather than technocratic optimization. Real progress would require serious investments in waste infrastructure, stronger EPR mechanisms, and the empowerment of local recycling enterprises—especially in mining regions. Governance should also become more inclusive, granting affected communities' real authority over land, industry, and benefit-sharing. Integrating indigenous knowledge systems into policy design could further align circular practices with the lived realities of people and ecosystems.

At the international level, Indonesia's role as a critical mineral supplier calls for fairer frameworks of cooperation. These could include technology-sharing agreements for battery recycling, binding environmental standards for investors, and ASEAN-based partnerships for circular innovation. Without these structural shifts, the circular economy risks becoming little more than a rhetorical device—a way to sustain extractivism under a low-carbon banner.

In essence, Indonesia's circular economy embodies the paradox of *green extractivism*: a pursuit of sustainability that never truly breaks from extraction. By prioritizing efficiency over sufficiency and industrial growth over ecological balance, the state sustains the very logic that caused the crisis it seeks to solve. Escaping this cycle requires more than modernizing extraction—it demands a post-extractive vision rooted in redistribution,

ecological repair, and community sovereignty. Until then, Indonesia's circular transition will remain circular only in name—spinning in the same loop between growth and green, progress and precarity, development and dispossession.

Indonesia's pathway toward sustainable development reveals a persistent and deep-seated paradox, one that attempts to reconcile the promise of green growth with the enduring realities of extractive capitalism. Through the lens of political ecology, green extractivism, and resource curse, this study demonstrates how the country's nickel-based industrialization and circular economy initiatives, while framed as pillars of ecological modernization, continue to reproduce environmental degradation, social inequality, and dependency on global capital.

Empirical analysis from 2019–2024 indicates that nickel downstreaming policies have contributed to rising GDP and export revenues. However, these gains are accompanied by escalating carbon emissions, deforestation, and unequal benefit distribution across regions. The socio-economic indicators examined—income inequality, poverty, and Human Development Index (HDI) trends—illustrate that industrial expansion does not automatically translate into social welfare improvement. Instead, economic growth in nickel mining provinces such as North Maluku, Central Sulawesi, Southeast Sulawesi, South Sulawesi, and West Papua often coincides with heightened ecological risks and marginalization of local communities.

At the policy level, Indonesia's Circular Economy Roadmap 2025–2045 reflects an ambitious attempt to integrate sustainability into national development planning. However, the findings reveal a mismatch between the discursive ideals of circularity and the linear logic of extractive industrialization. Policies emphasizing resource efficiency and downstreaming tend to reinforce production-oriented goals, prioritizing industrial competitiveness over ecological regeneration. The use of technocratic narratives—such as carbon neutrality, industrial decarbonization, and green investment—obscures the political and social dimensions of environmental governance, effectively depoliticizing sustainability debates.

4. Conclusions

This study underscores that Indonesia's transition remains green in discourse but extractive in practice. Despite integrating sustainability language, the governance of the nickel sector remains centralized, elite-driven, and weak in participatory inclusion. The dominance of foreign capital, particularly through China's Belt and Road Initiative, further entrenches structural dependency and perpetuates a "colonial division of sustainability," where the Global North benefits from clean energy transitions while the Global South bears the ecological burden.

To achieve a genuinely transformative transition, Indonesia must move beyond the efficiency-centered paradigm toward a regenerative and justice-oriented model of circular economy. This entails reducing primary extraction, investing in waste and recycling infrastructure, and embedding social equity into environmental governance. Strengthening community participation, recognizing indigenous knowledge systems, and decentralizing policy authority are essential to ensure that sustainability serves both people and ecosystems.

In conclusion, Indonesia's green transition will only fulfill its promise when it confronts the root contradictions of extractive development. A truly post-extractive vision must prioritize ecological repair over industrial growth, redistribution over accumulation, and community sovereignty over technocratic control. Only then can Indonesia's circular economy become a pathway not merely to decarbonization, but to environmental justice and sustainable prosperity.

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