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THE COST OF INDONESIA'S NICKEL BOOM: ENVIRONMENTAL JUSTICE, SACRIFICE ZONES, AND SLOW VIOLENCE IN KABAENA AND HALMAHERA

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Abstract
This paper investigates how nickel mining has affected local communities in Kabaena Island, Southeast Sulawesi, and Halmahera Island, North Maluku. Drawing on a qualitative comparative case study based on secondary evidence from peer-reviewed literature and investigative journalism, the study analyzes the cases through the integrated lenses of Environmental Justice, Sacrifice Zones, and Slow Violence. The findings indicate that the benefits and burdens of Indonesia's nickel boom are distributed unevenly. Local communities experience declining livelihoods, environmental degradation, adverse health outcomes, and limited participation in decision-making, while the economic gains accrue primarily to industrial actors and the state. Kabaena and Halmahera both exhibit similar patterns of environmental degradation, livelihood disruption, governance exclusion, and cumulative health risks, reflecting structural environmental injustice characterized by spatial concentration of environmental risks, procedural exclusion, and cumulative socio-ecological harm. Rather than treating environmental degradation as an inevitable consequence of economic development, the study demonstrates how governance failures and unequal power relations contribute to the creation of localized sacrifice zones within the global green transition. The paper contributes to the literature on environmental justice and sustainable resource governance by proposing an integrated conceptual framework linking environmental justice, sacrifice zones, and slow violence in the context of critical mineral extraction.
Keywords: *Environmental Justice, Indonesia, Nickel Boom, Sacrifice Zones, Slow Violence.*

Introduction

The global transition toward low-carbon energy systems has significantly increased demand for critical minerals, particularly nickel, which is an essential component of lithium-ion batteries used in electric vehicles and renewable energy storage systems (Stewart, 2025). As the world's largest holder of nickel reserves, accounting for approximately 42% of global reserves, Indonesia has positioned itself as a strategic supplier in the emerging green economy (Stewart, 2025; Sunuhadi et al., 2024). Since the Indonesian government prohibited the export of raw nickel ore in 2020, downstream industrialisation has accelerated rapidly, contributing substantially to national economic growth and attracting large-scale foreign investment, particularly from China (Sasongko, 2024). Nickel has consequently become a cornerstone of Indonesia's industrial development strategy and its ambition to become a global hub for electric vehicle battery production.

Despite these macroeconomic achievements, concerns have emerged regarding the uneven distribution of the costs and benefits of Indonesia's nickel boom. While the expansion of nickel extraction has generated employment, exports, and government revenue, numerous studies have documented serious environmental degradation, declining livelihoods, health risks, and social conflicts in mining regions (Astuti et al., 2025; Fünfgeld & Kammler, 2025). These impacts are particularly evident in Kabaena Island, Southeast Sulawesi, and Halmahera Island, North Maluku, where rapid mining expansion has transformed landscapes and disrupted the lives of Indigenous and local communities. Reports describe deteriorating water quality, marine ecosystem degradation, respiratory illnesses, reduced agricultural and fisheries income, and increasing restrictions on community participation in decisions affecting their environment (Gokkon, 2025; Jacobson, 2025; Jong, 2025).

These developments reveal an important paradox. The global energy transition is widely promoted as a pathway toward environmental sustainability, yet the extraction of minerals required to support this transition may generate significant environmental and social burdens for communities

located at the beginning of global supply chains. This paradox has attracted increasing scholarly attention under the concepts of just transition and environmental justice, which argue that the benefits and burdens of environmental policies should be distributed fairly and that affected communities should meaningfully participate in decision-making (Mohai et al., 2009; Owen & Kemp, 2014). However, existing studies on Indonesia's nickel sector have primarily focused on environmental impacts, industrial policy, or economic development (Astuti et al., 2025; Lahadalia et al., 2024; Sunuhadi et al., 2024), while comparatively little attention has been devoted to understanding how environmental injustice is produced through the interaction of unequal power relations, governance failures, and the gradual accumulation of environmental harm.

To address this gap, this paper integrates three complementary theoretical perspectives: Environmental Justice, Sacrifice Zones, and Slow Violence. Environmental Justice explains how environmental risks and benefits are distributed unequally among different social groups (Mohai et al., 2009). The concept of Sacrifice Zones highlights the spatial concentration of environmental degradation in places whose residents possess limited political and economic power (Juskus, 2023). Meanwhile, Nixon's (2011) concept of Slow Violence emphasises the cumulative and often invisible nature of environmental harm that unfolds gradually over time. Taken together, these perspectives provide a comprehensive framework for understanding not only where environmental burdens are concentrated, but also why they persist and how they progressively undermine community well-being.

This study investigates the cases of Kabaena and Halmahera to examine how Indonesia's nickel expansion has affected Indigenous and local communities. Specifically, it asks: (1) How has nickel mining transformed the environmental and socio-economic conditions of local communities in Kabaena and Halmahera? (2) To what extent can these mining regions be understood as environmental sacrifice zones? (3) How do environmental injustice and slow violence help explain the unequal distribution of the costs and benefits of Indonesia's nickel-driven development?

Using a qualitative comparative case study based on secondary evidence from peer-reviewed publications, government reports, NGO reports, and investigative journalism, this paper argues that the environmental and social consequences experienced by communities in Kabaena and Halmahera are not merely unintended externalities of industrial development. Rather, they reflect broader patterns of environmental injustice characterised by procedural exclusion, unequal exposure to environmental risks, and the gradual erosion of livelihoods and ecological systems. By integrating Environmental Justice, Sacrifice Zones, and Slow Violence into a single analytical framework, this study contributes to emerging debates on sustainable resource governance and the governance challenges associated with critical mineral extraction in the Global South.

The remainder of the paper is organised as follows. The next section reviews the literature and develops the conceptual framework. This is followed by the research methodology, the comparative analysis of the two mining regions, a discussion of the theoretical and policy implications, and concluding remarks on achieving a more just and sustainable governance of Indonesia's nickel industry.

Literature Review and Conceptual Framework

Environmental Justice and critical mineral extraction

The accelerating global transition toward low-carbon technologies has intensified demand for critical minerals, raising new questions about the social and environmental consequences of resource extraction. Although the green transition is intended to mitigate climate change, its benefits and burdens are often distributed unevenly across regions and social groups. Countries rich in critical minerals increasingly bear the environmental costs of extraction, while the benefits of clean energy are largely enjoyed by consumers and industries elsewhere. This unequal distribution has brought the concept of *Environmental Justice (EJ)* to the forefront of sustainability debates.

Environmental Justice originated in the United States during the civil rights movement in response to the disproportionate concentration of hazardous waste facilities in low-income and minority communities (Cutter, 1995; Mohai et al., 2009). Since then, the concept has evolved beyond questions of environmental protection to encompass the fairness of environmental decision-making and access to environmental benefits. Contemporary EJ scholarship generally identifies three interrelated dimensions. *Distributive justice* concerns the equitable distribution of environmental benefits and burdens. *Procedural justice* focuses on meaningful participation in environmental decision-making. *Recognition*

justice emphasises respect for the identities, cultures, knowledge systems, and rights of affected communities (Schlosberg, 2007).

These dimensions are particularly relevant to extractive industries in the Global South. Mining projects frequently generate substantial national economic benefits while imposing environmental degradation, health risks, and livelihood losses on nearby communities (Bebbington et al., 2008). Consequently, environmental justice has become an important framework for evaluating whether mineral-based development contributes to genuinely sustainable development or merely redistributes environmental risks to politically and economically marginalised populations.

Recent studies on Indonesia's nickel industry similarly demonstrate tensions between industrial development and community well-being. While downstream industrialisation has strengthened Indonesia's economic position in global battery supply chains, mining expansion has also generated increasing concerns regarding pollution, land-use change, community displacement, and unequal participation in environmental governance (Astuti et al., 2025; Lahadalia et al., 2024; Sunuhadi et al., 2024). These studies provide important evidence of environmental impacts but pay comparatively less attention to how these impacts become institutionalised through broader structures of power and governance.

Sacrifice Zones and unequal development

The concept of *Sacrifice Zones* provides a spatial perspective on environmental injustice by explaining why environmental degradation becomes concentrated in particular places. Originally associated with areas exposed to intensive industrial pollution in the United States, sacrifice zones describe locations where environmental destruction is considered an acceptable cost of achieving broader economic or political objectives (Juskus, 2023).

Sacrifice zones are not simply environmentally degraded areas. Rather, they emerge where particular communities possess insufficient political, economic, or institutional power to resist environmentally harmful development. Decisions regarding industrial expansion therefore become embedded in unequal relationships between governments, corporations, and local communities. Environmental harm is effectively normalised because those bearing the greatest costs have the least influence over decision-making.

The concept has increasingly been applied beyond North America to examine extractive industries, hazardous waste disposal, and fossil-fuel development in the Global South (Auerochs, 2025). In these contexts, sacrifice zones frequently coincide with Indigenous territories or economically marginalised regions where communities experience limited access to legal protection, environmental information, and political representation. The concept therefore extends Environmental Justice by highlighting the geographical concentration of environmental risks within unequal systems of development.

In Indonesia, rapid nickel expansion raises similar concerns. Mining activities have increasingly transformed small islands and ecologically sensitive regions into centres of mineral extraction. The resulting environmental degradation raises important questions regarding whether these landscapes have effectively become sacrifice zones within the global transition toward renewable energy.

Slow Violence and environmental change

While *Environmental Justice* explains unequal outcomes and *Sacrifice Zones* identify their spatial concentration, these perspectives provide less insight into how environmental harm unfolds over time. Rob Nixon's (2011) concept of *Slow Violence* addresses this temporal dimension.

Slow violence refers to environmental destruction that occurs gradually, often invisibly, and accumulates over extended periods. Unlike spectacular forms of violence that receive immediate public attention, slow violence progresses incrementally through pollution, ecosystem degradation, declining health, and the gradual erosion of livelihoods. Its cumulative nature frequently obscures causal relationships between industrial activities and long-term human suffering.

This perspective is particularly relevant to mining industries because many environmental impacts emerge only after years of continuous extraction. Water contamination, biodiversity loss, declining agricultural productivity, chronic respiratory diseases, and cultural disruption rarely occur as isolated events. Instead, they accumulate gradually, progressively reducing the resilience of affected communities while remaining politically and socially under-recognised.

Nixon's framework therefore complements Environmental Justice by demonstrating how environmental inequalities become embedded within everyday life through cumulative ecological degradation rather than sudden disasters. It also explains why communities may remain trapped in environmentally hazardous conditions despite continuing evidence of environmental decline.

An integrated conceptual framework

Although Environmental Justice, Sacrifice Zones, and Slow Violence have developed as distinct theoretical traditions, they are highly complementary for analysing contemporary critical mineral extraction. This study integrates these perspectives into a single conceptual framework. Environmental Justice provides the normative framework for evaluating whether environmental costs and benefits are distributed fairly and whether affected communities participate meaningfully in decision-making. Sacrifice Zones explain the spatial concentration of environmental burdens in politically and economically marginalised regions. Slow Violence explains the temporal processes through which cumulative environmental degradation progressively undermines livelihoods, health, and ecological resilience. Taken together, these perspectives suggest that environmental injustice is not simply the consequence of isolated pollution incidents. Rather, it emerges through interactions between governance arrangements, unequal power relations, spatial concentration of environmental risks, and cumulative environmental degradation.

Accordingly, this paper proposes that Indonesia's nickel expansion can be understood as a governance process in which industrial development generates geographically concentrated environmental burdens that accumulate over time and disproportionately affect communities with limited political influence. This integrated framework guides the subsequent comparative analysis of Kabaena and Halmahera by examining three analytical questions:

1) How are the environmental costs and economic benefits of nickel mining distributed?
2) To what extent have Kabaena and Halmahera become environmental sacrifice zones?
3) How does cumulative environmental degradation contribute to slow violence and the erosion of community livelihoods?

These questions provide the analytical bridge between theory and the empirical findings presented in the following sections. This study argues that environmental injustice in Indonesia's nickel industry is best understood as the interaction of distributive inequality, governance asymmetry, and cumulative socio-environmental degradation.

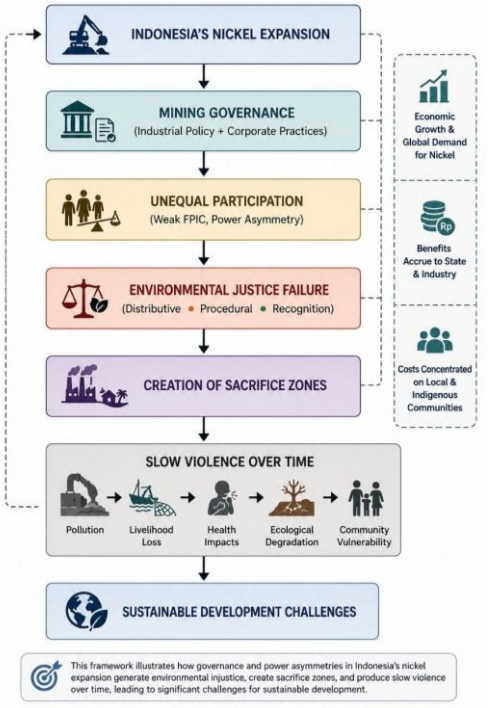


Figure 1. Proposed Conceptual Framework

Research Methodology

This study adopts a qualitative comparative case study to examine the socio-environmental impacts of nickel mining on Indigenous and local communities in Kabaena Island (Southeast Sulawesi) and Halmahera Island (North Maluku). These two islands were selected because they represent two of Indonesia's most rapidly expanding nickel mining regions, where large-scale industrial development has generated widespread concerns over environmental degradation, declining livelihoods, and conflicts involving Indigenous and local communities (Astuti et al., 2025; Gokkon, 2025; Jacobson, 2025; Jong, 2025). A comparative case study is appropriate because it enables an in-depth analysis of how similar processes of resource extraction produce comparable patterns of environmental injustice across different geographical settings (Yin, 2018).

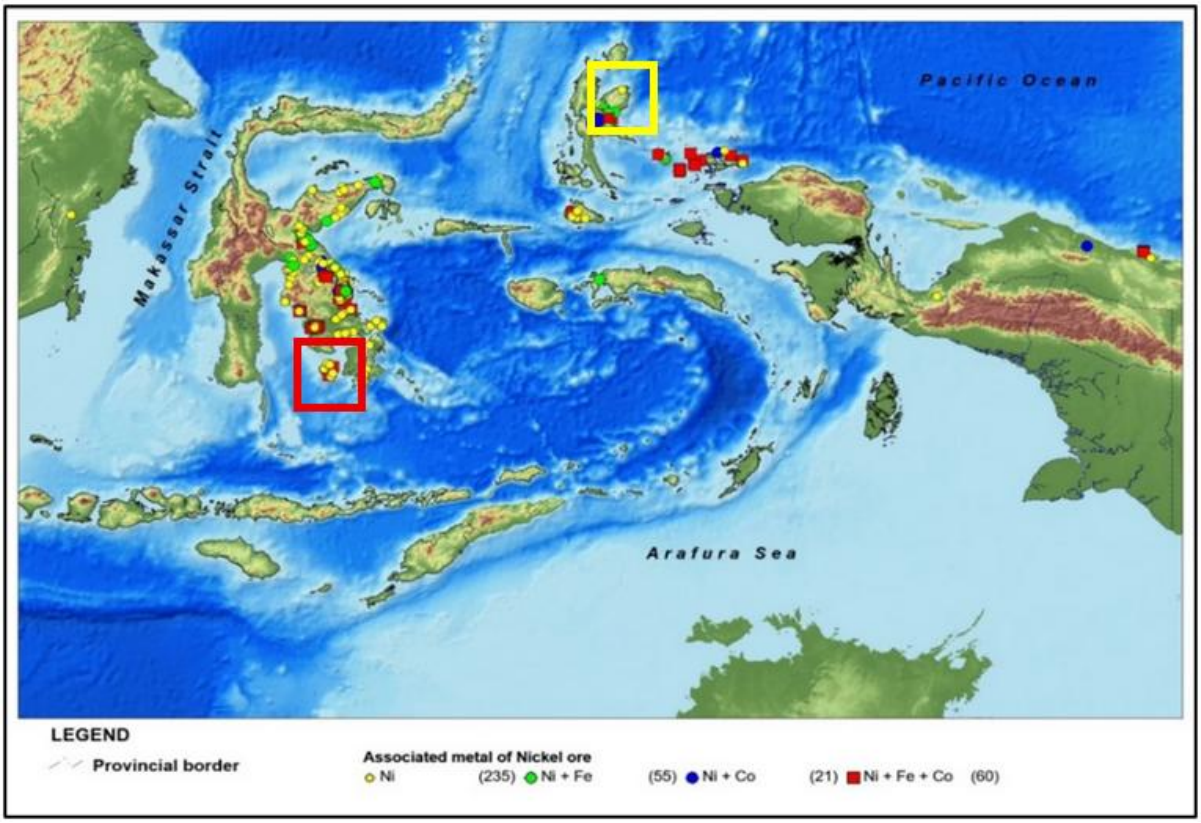


Figure 2. The location of the two cases studied:
Kabaena Southeast Sulawesi *(left)* and *Halmahera,* North Maluku *(right)* (Sunuhadi et al. 2024)

The analysis is based exclusively on secondary data collected from multiple sources to enhance the credibility of the findings through data triangulation (Creswell & Poth, 2018). These sources include peer-reviewed journal articles, Indonesian government publications, reports from non-governmental organizations, policy documents, and investigative journalism published by reputable media outlets such as *Mongabay*. The selected documents provide evidence on environmental conditions, health impacts, livelihood changes, governance practices, and community responses to nickel mining in both study areas.

The collected data were analysed using thematic analysis (Braun & Clarke, 2006). Guided by the integrated conceptual framework developed in the previous section, the analysis focused on identifying recurring themes related to environmental degradation, livelihood transformation, health impacts, community participation, and governance. These themes were subsequently interpreted through the lenses of Environmental Justice, Sacrifice Zones, and Slow Violence to understand how environmental risks and development benefits are distributed across different stakeholders.

This methodological approach does not seek to establish causal relationships in a statistical sense. Rather, it aims to generate an analytically rich understanding of how environmental injustice is experienced and reproduced within Indonesia's expanding nickel industry. By systematically synthesising evidence from diverse sources, the study provides a comprehensive interpretation of the

socio-environmental consequences of nickel extraction in two of Indonesia's most rapidly developing mining regions. Yet, because this study relies on secondary evidence, its findings should be interpreted as an analytical synthesis rather than direct observations from fieldwork.

Research Findings

The comparative analysis reveals that nickel mining has generated remarkably similar socio-environmental consequences in Kabaena and Halmahera despite differences in geography, industrial configuration, and local livelihoods. In both cases, rapid mining expansion has transformed landscapes, altered local economies, increased environmental and health risks, and intensified tensions between industrial development and community well-being. While Indonesia's nickel industry has become a key driver of national economic growth and the global energy transition, the empirical evidence indicates that the benefits and burdens of this development have been distributed unevenly. National economic gains and industrial investment have expanded considerably, whereas the environmental and social costs have been borne primarily by Indigenous and local communities living closest to mining and processing operations.

Transformation of landscapes and ecosystems

The first and most visible finding concerns the rapid transformation of natural landscapes. Both Kabaena and Halmahera have experienced extensive environmental change following the expansion of nickel extraction, although the forms of degradation differ according to their ecological characteristics. Kabaena, a relatively small island in Southeast Sulawesi, has undergone extensive land conversion as mining concessions expanded across the island. Recent investigations estimate that approximately 73–75% of the island has been allocated for nickel mining activities (Jong, 2025). Large-scale vegetation clearing has accelerated soil erosion, increasing sediment runoff into rivers and coastal waters. Communities report that formerly clear coastal waters have become reddish-brown, particularly after rainfall, reflecting heavy sedimentation associated with mining activities (Astuti et al., 2025; Gokkon, 2025; Jong, 2025). The deterioration of marine water quality has reduced the ecological productivity of coastal ecosystems that support fisheries and seaweed cultivation, resulting in declining seaweed quality, lower harvests, and substantial income losses for coastal households (Astuti et al., 2025; Gokkon, 2025; Jong, 2025).

In Halmahera, environmental transformation has occurred on a larger industrial scale, driven by the rapid expansion of nickel mining and downstream processing industries (Astuti et al., 2025; Fünfgeld & Kammler, 2025). The rapid development of the Indonesia Weda Bay Industrial Park (IWIP) has required extensive land clearing, industrial infrastructure, transportation networks, and energy production facilities (Fünfgeld & Kammler, 2025; Jacobson, 2025). More than 5,000 hectares of tropical forest have reportedly been converted into mining and industrial areas, accompanied by expanding coal-fired power generation to support nickel smelting (Jacobson, 2025). While Kabaena illustrates the ecological consequences of open-pit mining on a small island ecosystem, Halmahera demonstrates the cumulative environmental impacts of vertically integrated mining and processing industries (Astuti et al., 2025; Fünfgeld & Kammler, 2025).

Despite these contextual differences, the two cases reveal similar ecological trajectories. Mining expansion has altered terrestrial and marine ecosystems, reduced biodiversity, and increased the vulnerability of communities that depend directly on environmental resources. Environmental degradation is therefore not confined to mining sites but extends across broader ecological systems that sustain local livelihoods.

Livelihood disruption and declining household resilience

The second major finding concerns the transformation of local livelihoods. Across both islands, environmental degradation has translated directly into declining household income and increasing economic vulnerability.

The Bajau communities of Kabaena provide one of the clearest illustrations of this process. Traditionally dependent upon fishing, seaweed cultivation, and small-scale coastal resource management, these communities rely heavily on healthy marine ecosystems (Astuti et al., 2025; Gokkon, 2025). As sedimentation and pollution have degraded coastal waters, seaweed production has declined substantially (Gokkon, 2025; Jong, 2025). Farmers report not only lower production volumes

but also poorer product quality, leading to dramatic reductions in market prices. According to recent field investigations, household income from seaweed farming has fallen by nearly 70% in several villages, including Kokoe, Liwu Lampona, Telaga Besar, and Wulu (Jong, 2025). Many households have consequently been forced either to seek alternative employment or to depend upon increasingly uncertain fishing activities (Astuti et al., 2025; Gokkon, 2025).

Livelihood disruption in Halmahera follows a comparable pattern although through different mechanisms. Industrial expansion has reduced community access to forests, agricultural land, and coastal resources while simultaneously increasing environmental pollution (Astuti et al., 2025; Fünfgeld & Kammler, 2025). Traditional economic activities have become increasingly difficult as mining infrastructure occupies former agricultural areas and environmental degradation affects fisheries and water resources (Fünfgeld & Kammler, 2025; Jacobson, 2025). Although industrialisation has generated employment opportunities, these jobs are unevenly distributed and frequently require technical skills unavailable to many local residents (Astuti et al., 2025; Fünfgeld & Kammler, 2025). Consequently, while industrialisation has created new employment opportunities, the benefits have been distributed unevenly, with many local households continuing to experience declining access to traditional livelihood resources (Astuti et al., 2025; Fünfgeld & Kammler, 2025).

Across both cases, livelihood decline extends beyond reduced income. The evidence suggests a broader erosion of household resilience. Communities that previously diversified livelihoods through fishing, farming, and forest products have become increasingly dependent upon uncertain labour markets or declining natural resources. Environmental degradation therefore produces not only immediate economic losses but also reduces the long-term adaptive capacity of local communities.

Environmental health risks

The third finding concerns growing public health risks associated with mining expansion. Although the available evidence is derived primarily from health reports, environmental monitoring, and investigative journalism rather than epidemiological research, multiple independent sources consistently identify deteriorating health conditions in both study areas.

In Halmahera, rapid expansion of nickel processing has been accompanied by increasing air pollution associated with coal-fired power plants and industrial emissions (Astuti et al., 2025; Fünfgeld & Kammler, 2025). Residents describe persistent dust settling on houses, schools, and public facilities, while local health data indicate a substantial increase in respiratory diseases during the period of industrial expansion (Jacobson, 2025). Investigations also report growing community concerns regarding deteriorating air quality and prolonged exposure to industrial emissions surrounding the Indonesia Weda Bay Industrial Park (Fünfgeld & Kammler, 2025; Jacobson, 2025). Although multiple factors may influence public health outcomes, the temporal coincidence between rapid industrial growth and worsening air quality has generated widespread concern among local communities and environmental researchers (Astuti et al., 2025; Jacobson, 2025).

In Kabaena, health concerns are associated primarily with water pollution resulting from mining runoff and sedimentation (Astuti et al., 2025; Gokkon, 2025). Communities report skin irritation following contact with contaminated seawater, while environmental investigations have detected elevated concentrations of heavy metals, including nickel, cadmium, and lead, in water and sediment samples collected from coastal areas (Gokkon, 2025). Declining water quality has affected not only marine ecosystems but also the safety of water used for daily household activities and seaweed cultivation (Gokkon, 2025; Jong, 2025). These findings have heightened community concerns regarding long-term exposure to environmental contaminants and their potential implications for human health (Astuti et al., 2025; Gokkon, 2025).

Taken together, the evidence from both islands suggests that environmental degradation produces cumulative health risks rather than isolated environmental incidents. Pollution affects daily activities, including fishing, farming, bathing, and household water use, thereby increasing the frequency with which communities encounter contaminated environments (Astuti et al., 2025; Jacobson, 2025). Consistent with the environmental justice literature, prolonged exposure to environmental hazards disproportionately affects communities with limited economic resources and restricted access to healthcare and environmental protection (Cutter et al., 2003; Mohai et al., 2009). These health impacts reinforce existing livelihood vulnerabilities by increasing household expenditures, reducing labour productivity, and contributing to long-term social insecurity (Astuti et al., 2025; Cutter et al., 2003).

Governance, participation, and unequal decision-making

Beyond environmental and economic impacts, the comparative analysis highlights significant governance challenges associated with Indonesia's nickel expansion. Both case studies reveal limited participation of Indigenous and local communities in decisions concerning mining development, environmental management, and land-use planning. These findings are consistent with broader studies of extractive industries, which show that environmental conflicts frequently arise when local communities have limited influence over resource governance despite bearing the greatest environmental risks (Bebbington et al., 2008; Mohai et al., 2009).

Several studies report that communities have had limited opportunities to influence decisions regarding mining concessions, environmental monitoring, or mitigation measures (Astuti et al., 2025; Owen & Kemp, 2014). Although Indonesian regulations formally recognise community participation in environmental governance, implementation appears uneven, particularly in remote mining regions (Carona, 2025). Communities frequently report inadequate access to environmental information, limited legal assistance, and restricted opportunities to express concerns during project planning (Astuti et al., 2025; Fünfgeld & Kammler, 2025). These procedural limitations reduce the capacity of affected communities to participate effectively in decisions that directly affect their livelihoods and environments.

The principle of ***Free, Prior and Informed Consent (FPIC)***, widely recognised as an important mechanism for protecting Indigenous rights in extractive industries, also appears to have been implemented inconsistently. Existing literature suggests that consultation processes often emphasise procedural compliance rather than meaningful community participation, particularly where substantial asymmetries of information, bargaining power, and technical expertise exist between corporations and local communities (Owen & Kemp, 2014). As a consequence, affected communities may formally participate in consultation while exercising little substantive influence over development decisions. Such procedural shortcomings have been widely identified as indicators of environmental injustice because they weaken recognition of Indigenous rights and limit democratic participation in environmental governance (Cutter, 1995; Mohai et al., 2009).

Power asymmetries further reinforce these governance challenges. Mining companies generally possess greater financial resources, technical expertise, legal capacity, and political influence than local communities (Bebbington et al., 2008; Juskus, 2023). Reports also indicate that community protests have occasionally encountered legal pressure, security responses, or criminalisation, thereby reducing opportunities for constructive dialogue and independent environmental advocacy (Fünfgeld & Kammler, 2025). These governance conditions contribute to persistent inequalities between industrial actors and communities experiencing the environmental consequences of mining expansion. They also illustrate how unequal decision-making processes can reinforce the concentration of environmental burdens in politically and economically marginalised regions.

From an ESG perspective, these findings suggest that governance failures extend beyond environmental management to include inadequate stakeholder engagement, weak accountability mechanisms, and insufficient protection of Indigenous and local communities. Strengthening participatory governance and implementing FPIC more effectively are therefore essential not only for environmental justice but also for improving the social legitimacy and long-term sustainability of Indonesia's nickel industry.

Unequal distribution of benefits and burdens

The comparative evidence consistently demonstrates an uneven distribution of the benefits and burdens associated with Indonesia's nickel industry. This imbalance reflects a broader challenge in resource-dependent development, where the economic gains generated by extractive industries are frequently distributed across national and global markets, while environmental and social costs are concentrated in local mining communities (Bebbington et al., 2008; Mohai et al., 2009).

At the national level, downstream industrialisation has contributed significantly to economic growth, export earnings, foreign direct investment, and Indonesia's strategic position within global electric vehicle (EV) supply chains (Lahadalia et al., 2024; Sasongko, 2024; Sunuhadi et al., 2024). Since the implementation of the nickel export ban in 2020, the expansion of domestic processing and smelting industries has strengthened Indonesia's industrial development strategy and increased its importance in the global transition toward low-carbon technologies (Lahadalia et al., 2024; Sunuhadi

et al., 2024). These developments have positioned Indonesia as one of the world's most influential suppliers of critical minerals for the global energy transition.

At the local level, however, communities experience a markedly different reality. Environmental degradation, declining livelihoods, health risks, and social disruption are concentrated within mining regions, while many of the economic benefits are realised elsewhere (Astuti et al., 2025; Fünfgeld & Kammler, 2025). Although mining projects generate employment opportunities and stimulate local economic activity, these benefits appear unevenly distributed and are often insufficient to offset the broader environmental and social costs experienced by affected communities (Astuti et al., 2025; Bebbington et al., 2008). Existing studies further suggest that the unequal distribution of development benefits is reinforced by disparities in political influence, institutional capacity, and access to environmental decision-making, limiting the ability of Indigenous and local communities to negotiate more equitable development outcomes (Mohai et al., 2009; Owen & Kemp, 2014).

The comparative findings are summarised in Tables 1 and 2. Table 1 provides an overview of the key characteristics of the two case studies, highlighting their different ecological settings, mining configurations, and principal socio-environmental impacts. Building on this comparison, Table 2 synthesises the uneven distribution of the benefits and burdens associated with Indonesia's nickel expansion, illustrating how national economic gains contrast with the environmental, social, and governance challenges experienced by Indigenous and local communities. Together, the two tables provide a concise overview of the empirical patterns that emerge consistently across both cases.

Table 1. Profile of the Two Case Studies

Characteristic	Kabaena	Halmahera
Main mining activity	Open-pit nickel mining	Integrated mining and smelting (IWIP)
Main affected communities	Bajau and coastal villages	Indigenous and local villages
Dominant environmental impact	Marine sedimentation and water pollution	Air pollution, deforestation, industrial emissions
Main livelihood affected	Fisheries and seaweed farming	Agriculture, fisheries, and forest resources
Major health concerns	Skin irritation, heavy-metal exposure	Respiratory diseases and dust pollution
Key governance issue	Limited participation in mining decisions	Limited participation and industrial expansion

Table 2. Unequal Distribution of Benefits and Burdens in Indonesia's Nickel Expansion

Dimension	National and Industrial Benefits	Community-Level Burdens
Economic	Higher GDP growth; increased export earnings; foreign direct investment; growth of downstream industries	Declining household income; reduced fisheries and seaweed production; livelihood insecurity
Environmental	Expansion of industrial infrastructure supporting the EV supply chain	Water and air pollution; deforestation; coastal degradation; biodiversity loss
Social	Employment creation and industrial development	Respiratory and skin diseases; loss of traditional livelihoods; declining community resilience

Dimension	National and Industrial Benefits	Community-Level Burdens
Governance	Stronger national industrial competitiveness and strategic control over critical minerals	Limited community participation; weak FPIC implementation; unequal access to environmental information and legal protection
Strategic	Enhanced position in global EV battery supply chains and energy transition	Concentration of environmental risks in Indigenous and local communities

The comparison does not imply that mining development generates no local benefits or that all communities are affected equally. Rather, the evidence demonstrates a persistent imbalance in the spatial distribution of development outcomes. While national and industrial actors capture most economic gains, communities located nearest to extraction and processing activities bear a disproportionate share of environmental and social costs. This imbalance constitutes one of the central empirical findings of the study and provides the basis for interpreting the cases through the integrated framework of Environmental Justice, Sacrifice Zones, and Slow Violence in the following discussion.

Comparative synthesis of the findings

Despite differences in ecological settings, mining configurations, and local livelihood systems, Kabaena and Halmahera exhibit remarkably consistent socio-environmental trajectories. Across both islands, rapid nickel expansion has been accompanied by ecosystem degradation, declining natural resource-based livelihoods, increasing health concerns, and governance arrangements that provide limited opportunities for meaningful community participation. These impacts are mutually reinforcing. Environmental degradation reduces livelihood opportunities, declining livelihoods increase household vulnerability, and governance constraints limit communities' capacity to influence decisions affecting their environment and future development.

The comparative evidence further demonstrates that these outcomes are not isolated environmental problems but interconnected dimensions of a broader development pattern. While Indonesia's nickel industry has generated substantial national economic benefits through downstream industrialisation, export growth, and integration into global electric vehicle supply chains, the environmental and social costs remain disproportionately concentrated within mining regions. Communities located closest to extraction and processing activities bear the greatest exposure to pollution, ecosystem degradation, livelihood disruption, and health risks, despite receiving comparatively fewer long-term development benefits. This asymmetry represents the principal empirical finding of the study.

Importantly, the comparison also reveals striking similarities in governance across the two cases. In both Kabaena and Halmahera, Indigenous and local communities face limited access to environmental information, constrained participation in decision-making, and unequal bargaining power relative to mining companies and state institutions. Although the specific environmental impacts differ between the two islands, the underlying governance dynamics remain remarkably consistent. These findings suggest that the challenges observed in Kabaena and Halmahera are unlikely to be isolated local anomalies but instead reflect broader governance issues associated with Indonesia's critical mineral development.

Taken together, the comparative findings indicate that Indonesia's nickel expansion involves not only environmental change but also the redistribution of environmental risks and development opportunities across different groups and places. The following discussion interprets these empirical patterns through the integrated framework of Environmental Justice, Sacrifice Zones, and Slow Violence to explain how unequal governance, spatial concentration of environmental burdens, and cumulative socio-environmental change contribute to the human costs of Indonesia's nickel-driven development; and what these findings imply for the governance of critical mineral extraction within the global energy transition.

Discussion

The findings demonstrate that the socio-environmental impacts of Indonesia's nickel expansion extend beyond local environmental degradation to reveal broader governance challenges associated with the global energy transition. While previous studies have documented pollution, livelihood disruption, and industrial expansion in Indonesia's nickel sector (Astuti et al., 2025; Fünfgeld & Kammler, 2025), this study shows how these impacts are interconnected through patterns of unequal distribution, spatial concentration, and cumulative environmental change. By integrating Environmental Justice, Sacrifice Zones, and Slow Violence, the findings provide a more comprehensive understanding of the human costs accompanying critical mineral extraction.

From an Environmental Justice (EJ) perspective, the evidence indicates that the costs and benefits of Indonesia's nickel industry are distributed unevenly across different groups. National economic growth, export earnings, foreign investment, and industrial upgrading have strengthened Indonesia's position within global electric vehicle supply chains. In contrast, Indigenous and local communities in Kabaena and Halmahera bear disproportionate environmental and social burdens, including ecosystem degradation, declining livelihoods, health risks, and reduced environmental quality. These findings are consistent with the *distributive dimension of environmental justice*, which emphasises that environmental benefits and burdens should be shared equitably (Mohai et al., 2009; Schlosberg, 2007).

The study also highlights important issues of *procedural justice*. Across both case studies, communities reported limited opportunities to influence decisions regarding mining development despite being those most directly affected. Although Indonesia's legal framework formally recognises community participation, implementation remains inconsistent, particularly regarding Free, Prior and Informed Consent (FPIC). Existing consultation mechanisms appear to prioritise regulatory compliance over meaningful stakeholder engagement. This finding supports Owen and Kemp's (2014) argument that FPIC should be understood not merely as a legal requirement but as a governance mechanism that enables affected communities to participate effectively in decisions concerning resource extraction. Weak procedural participation therefore reinforces distributive inequalities by limiting communities' capacity to negotiate more equitable development outcomes.

The concept of Sacrifice Zones provides a complementary explanation for the spatial distribution of these environmental burdens. The comparison between Kabaena and Halmahera suggests that environmental degradation is not randomly distributed but concentrated in regions where communities possess comparatively limited political, economic, and institutional influence. Although the two islands differ in ecological characteristics and industrial configurations, both have become locations where environmental risks are disproportionately concentrated while economic benefits are largely realised elsewhere. This pattern corresponds closely with Juskus' (2023) description of sacrifice zones as places where environmental degradation becomes normalised in pursuit of broader economic objectives. Rather than viewing pollution as an unintended by-product of industrialisation, the findings suggest that governance arrangements may permit environmental burdens to accumulate disproportionately in peripheral regions that possess relatively weak bargaining power.

The temporal dimension of these findings is best understood through Nixon's (2011) concept of Slow Violence. The empirical evidence indicates that environmental harm has not occurred primarily through sudden environmental disasters but through gradual and cumulative processes. Water pollution, air pollution, declining fisheries, deteriorating public health, and livelihood insecurity have accumulated over time, progressively reducing the resilience of affected communities. Importantly, these impacts reinforce one another. Environmental degradation undermines livelihoods, declining livelihoods increase household vulnerability, and governance constraints reduce communities' ability to respond effectively. This cumulative interaction illustrates how slow violence operates not as a single event but as an incremental process through which environmental risks become embedded in everyday life.

Taken together, the three theoretical perspectives are mutually reinforcing rather than competing. Environmental Justice explains ***who*** bears the unequal distribution of benefits and burdens. Sacrifice Zones explain ***where*** environmental risks become spatially concentrated. Slow Violence explains ***how*** environmental harm accumulates over time through gradual ecological and social change. Their integration therefore provides a more comprehensive analytical framework than any single theory alone. Rather than treating pollution, governance failure, or livelihood decline as separate issues, the integrated framework demonstrates that these phenomena are interconnected dimensions of a broader socio-environmental process associated with critical mineral extraction. Their integration therefore provides

a multi-dimensional explanation of how critical mineral extraction produces persistent environmental inequalities.

These findings also have important implications for ESG and sustainable resource governance. Indonesia's success in developing downstream nickel industries has strengthened its economic competitiveness and strategic importance within global clean-energy supply chains. However, the findings suggest that the long-term sustainability of this development model depends not only on economic performance but also on governance quality, stakeholder participation, and environmental accountability. From an ESG perspective, the governance dimension extends beyond regulatory compliance to include transparent environmental management, meaningful community engagement, and effective protection of Indigenous and local rights. Without stronger governance mechanisms, environmental conflicts may undermine both the social legitimacy and long-term sustainability of Indonesia's critical mineral industry.

Several policy implications emerge from this analysis. First, FPIC should be implemented as a substantive participatory process rather than a procedural requirement, ensuring that Indigenous and local communities can influence decisions throughout the mining lifecycle. Second, environmental monitoring should become more transparent and involve independent scientific institutions together with community representatives. Third, greater attention should be given to protecting and restoring livelihoods affected by mining activities through ecological rehabilitation, fair compensation, and community development programmes. Finally, ESG frameworks adopted by mining companies and investors should incorporate environmental justice indicators that assess not only environmental performance but also the equitable distribution of development benefits and the quality of stakeholder participation.

Overall, this study demonstrates that achieving a just energy transition requires more than expanding the supply of critical minerals. It also requires governance systems capable of ensuring that the economic opportunities created by the transition do not come at the expense of the environmental rights, livelihoods, and well-being of communities located at the beginning of global supply chains.

Conclusion

Indonesia's rapid expansion of the nickel industry has become a cornerstone of the country's industrial development strategy and its contribution to the global transition toward low-carbon technologies. While this transformation has generated substantial national economic benefits, this study demonstrates that its environmental and social consequences have been distributed unevenly. Through a comparative analysis of Kabaena and Halmahera, the findings reveal that Indigenous and local communities experience disproportionate environmental degradation, declining livelihoods, increasing health risks, and limited participation in decisions affecting their environment. These impacts suggest that the human costs of Indonesia's nickel expansion are concentrated within mining regions, whereas many of the economic benefits accrue primarily at national and industrial levels.

The study contributes to the literature by integrating the perspectives of Environmental Justice, Sacrifice Zones, and Slow Violence into a single analytical framework. Rather than treating pollution, livelihood decline, or governance challenges as separate issues, the integrated framework demonstrates how unequal governance arrangements, spatial concentration of environmental burdens, and cumulative ecological change interact to produce persistent socio-environmental inequalities. Environmental Justice explains the unequal distribution of environmental costs and benefits, Sacrifice Zones illuminate the geographical concentration of these burdens, and Slow Violence reveals how their impacts accumulate gradually over time. Together, these perspectives provide a more comprehensive understanding of the human dimensions of critical mineral extraction in the Global South.

The findings also have important implications for sustainable resource governance and ESG implementation. As global demand for critical minerals continues to increase, the legitimacy of the green transition will depend not only on reducing carbon emissions but also on ensuring that its social and environmental costs are shared more equitably. Strengthening community participation, implementing Free, Prior and Informed Consent (FPIC) more substantively, improving environmental transparency, and enhancing corporate accountability are essential for building a more inclusive and sustainable mining sector. ESG frameworks should therefore extend beyond environmental performance to include meaningful stakeholder engagement, procedural justice, and the protection of Indigenous and local communities.

This study is subject to several limitations. It relies on secondary data and therefore cannot capture the full diversity of community experiences or establish causal relationships between mining activities and specific socio-environmental outcomes. Future research could build on these findings through field-based studies, longitudinal analyses, and comparative research across other nickel-producing regions in Indonesia and the Global South.

Indonesia's experience demonstrates that the success of the global energy transition should be measured not only by reductions in carbon emissions, but also by the extent to which the extraction of critical minerals respects environmental justice, protects community livelihoods, and promotes inclusive governance.

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