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The Industry–Settlement–Environment Nexus in a Nickel-Based Industrial Zone: DPSIR Analysis and Spatial Planning Policy Implications in Morowali Regency, Indonesia

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Abstract

The Morowali Industrial Park managed by PT Indonesia Morowali Industrial Park (IMIP) ranks among the world's largest nickel-based industrial zones and has been designated as a National Strategic Project (NSP) within Indonesia's mineral downstream processing policy framework. IMIP's presence has triggered rapid spatial growth in Bahodopi District, Morowali Regency, Central Sulawesi, yet without adequate preparation in spatial planning, infrastructure provision, or environmental carrying capacity. This article analyses the causal dynamics among three interconnected ecosystems—industrial, settlement, and environmental—identifies strategic issues across spatial scales, and evaluates the existing spatial planning policy responses. Drawing on a mixed-methods approach that integrates the DPSIR (Driving Force–Pressure–State–Impact–Response) framework, a multi-level policy synthesis of 26 regulatory documents spanning national to local levels, environmental carrying capacity and assimilation analysis (ECC), and a SWOT matrix, this study finds that the dynamics of the three ecosystems in the IMIP zone are characterised by mutually reinforcing feedback loops between industrial growth and urbanisation, while the environmental ecosystem faces cumulative pressures that exceed the capacity of existing policy responses. Six strategic issues are identified across macro–meso–micro spatial scales: regulatory vacuum in spatial governance; urban settlement infrastructure deficits; environmental quality degradation; low accessibility and connectivity; weak human resource capacity and mono-economic dependency; and high disaster vulnerability. Policy synthesis reveals a significant implementation gap between the national downstream processing policy and local governance capacity. This article argues that extractive industrial zones in developing countries require anticipatory, ecosystem-integrated planning approaches rather than reactive and piecemeal responses. The IMIP case study offers policy lessons relevant to resource-based industrialisation in developing countries worldwide.

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1. Introduction

1.1 Context: Nickel Downstream Processing and the Dynamics of the Morowali Industrial Zone

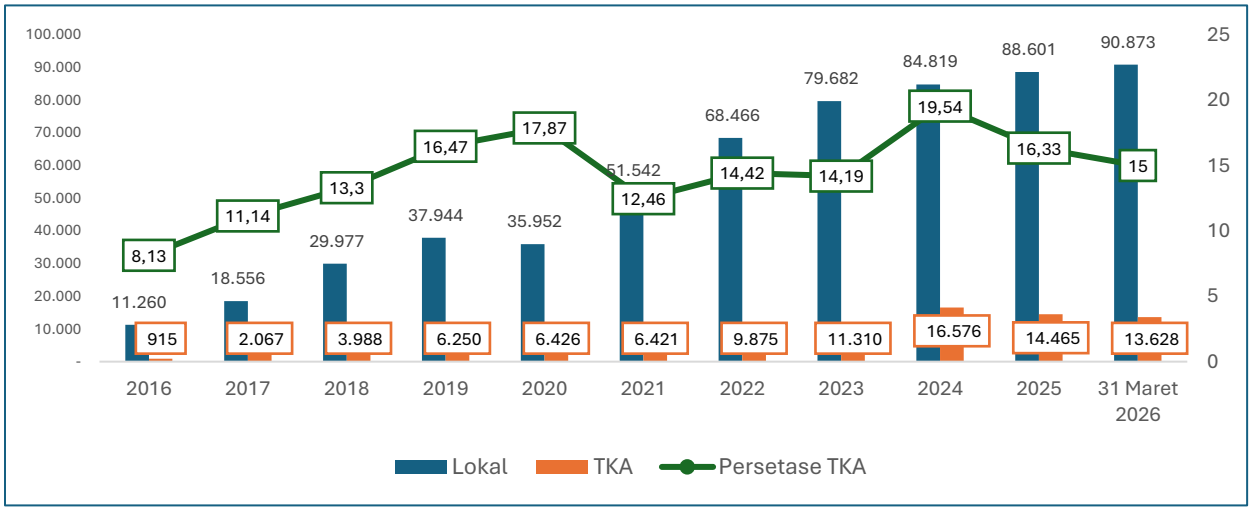
Indonesia holds the world's largest nickel reserves, with estimated deposits exceeding 21 million tonnes (USGS, 2023). The mineral downstream processing policy enshrined in Law No. 4 of 2009 on Mineral and Coal Mining—subsequently revised by Law No. 3 of 2020—has driven the transformation of Indonesia's nickel industry from the export of raw ores towards domestic processing and refining. This policy was reinforced by the designation of the

Morowali Industrial Park as one of nine National Priority Industrial Zones under the 2020–2024 National Medium-Term Development Plan (RPJMN) through Presidential Regulation No. 18 of 2020.

PT Indonesia Morowali Industrial Park (IMIP), located in Bahodopi District, Morowali Regency, Central Sulawesi, has emerged as one of the main epicentres of Indonesia's nickel downstreaming policy. Since commencing operations in 2013, the area has expanded rapidly into a globally significant integrated nickel industrial complex. Its industrial ecosystem comprises ferronickel smelters, nickel matte smelters, battery-material processing facilities, power plants, port infrastructure, and a range of supporting industries interconnected within a single production chain. The scale of this expansion is reflected in the sharp increase in IMIP's direct workforce, from 12,175 workers in 2016 to 104,501 workers as of 31 March 2026. This figure consists of 90,873 domestic workers and 13,628 foreign workers, with foreign workers accounting for approximately 15 percent of the domestic workforce.

The trajectory of employment growth in IMIP indicates a strong, albeit non-linear, pattern of acceleration. The number of domestic workers increased from 11,260 in 2016 to 79,682 in 2023, and continued to rise to 88,601 in 2025 and 90,873 by the end of March 2026. Meanwhile, the number of foreign workers grew from 915 in 2016 to 11,310 in 2023, peaked at 16,576 in 2024, and subsequently declined to 13,628 in March 2026. In relative terms, the ratio of foreign to domestic workers fluctuated from 8.13 percent in 2016, reached its highest level at 19.54 percent in 2024, and then fell to around 15 percent in March 2026. This pattern suggests that IMIP's expansion has generated substantial labour demand while also requiring specific technical competencies, some of which continue to be supplied through foreign labour.

Figure 1. Development of the number of workers in the IMIP Morowali area



Source: PT IMIP per 22 April 2026

The geographical composition of domestic workers further demonstrates that IMIP has become a major magnet for interregional labour mobility. According to PT IMIP data as of March 2026, only 17.9 percent of domestic workers originated from Morowali Regency. A further 31.8 percent came from Central Sulawesi Province, 42.2 percent from other parts of Sulawesi, and 8.1 percent from outside Sulawesi. Thus, although the majority of workers still originate from Sulawesi, IMIP's labour base can no longer be understood as local in the narrow administrative sense of Morowali Regency. Rather, the industrial estate has evolved into a regional employment hub that attracts workers from multiple areas, particularly across Sulawesi.

However, the rapid acceleration of industrial growth has not been fully matched by the readiness of spatial planning instruments, urban infrastructure capacity, or environmental carrying capacity. The large inflow of workers into Bahodopi has significantly increased demand for housing, clean water, sanitation, transport, health services, education, and other social facilities. In this context, Bahodopi is experiencing a form of urbanisation pressure characteristic of extractive industrial zones, where industrialisation proceeds faster than the surrounding area's capacity to provide

infrastructure and urban governance. As a result, residential expansion, informal economic activities, and pressures on local living spaces have developed in a fragmented and sporadic manner, while land-use control instruments have not yet been able to steer the area's transformation in a planned and coordinated way.

The IMIP case therefore reveals a fundamental paradox in the development of resource-based industrial estates. On the one hand, IMIP has succeeded in becoming a major engine of economic growth, employment creation, and Indonesia's integration into the global nickel supply chain. On the other hand, large-scale industrial concentration has generated new pressures on spatial governance, infrastructure provision, public services, and local ecosystems. Accordingly, the central challenge facing Bahodopi is no longer merely how to attract industrial investment, but how to transform rapid industrial growth into a more orderly, inclusive, and sustainable process of regional development.

1.2 Research Gap

The resource boomtown phenomenon—areas experiencing rapid growth driven by natural resource extraction—has been the subject of well-developed scholarship in regional planning and rural sociology literature in advanced economies (Freudenburg, 1981; Jacquet & Kay, 2014; Ruddell et al., 2014). These studies consistently identify recurring patterns: rapid population surges, infrastructure pressures, social conflicts between migrants and local residents, and long-term economic instability. However, the majority of this literature was developed in the context of developed countries with considerably stronger governance capacity.

In the Indonesian context, scholarship on the impacts of extractive industrial zones on regional spatial planning remains very limited and tends to be fragmented—addressing environmental impacts, socioeconomic impacts or spatial planning aspects in isolation. No study has comprehensively integrated a three-ecosystem nexus analysis using the DPSIR framework in the context of Indonesian nickel industrial zones, particularly one examining the gap between national downstream processing policy and local governance implementation capacity—the central gap this article addresses.

1.3 Research Objectives, Questions, and Contributions

This article aims to: (1) analyse the causal dynamics among three ecosystems affected by nickel industrial zone development in Morowali Regency using the DPSIR framework; (2) synthesise the multi-level policy framework bearing on spatial planning in the zone; and (3) identify strategic issues across spatial scales as a basis for sustainable spatial planning policy directions. The research questions addressed are: how do the causal dynamics among the industrial, settlement, and environmental ecosystems shape the complexity of spatial planning challenges around IMIP; what strategic issues constitute policy priorities across different spatial scales; and where do the critical gaps lie within the existing multi-level policy framework.

The article's contributions span three dimensions. Theoretically, it develops the concept of "cascading DPSIR" for analysing the industry–settlement–environment nexus in extractive industrial zones in developing countries. Empirically, it offers the IMIP case study—the world's largest nickel industrial zone, hitherto underexplored in international academic literature—as a richly documented empirical referent. From a policy standpoint, it produces recommendations for spatial planning governance reform relevant to Indonesia's mineral industrialisation context.

2. Literature Review

2.1 Resource Boomtowns and Industrial Urbanism

The concept of the resource boomtown was first systematically developed by Freudenburg (1981) to describe communities experiencing very rapid growth driven by natural resource extraction industries. Its defining characteristics include population surges dominated by in-migrants, infrastructure pressures exceeding provision capacity, cost-of-living inflation, social structure shifts, and long-term economic instability (Jacquet & Kay, 2014). Ruddell et al. (2014) updated this model to encompass unconventional energy industry contexts, demonstrating the continued relevance of the resource boomtown pattern despite changes in technology and scale. A central insight from

this literature is that rapid economic growth does not automatically translate into equitably distributed welfare gains—it frequently produces widening inequality and long-term instability.

In the developing country context, analogous phenomena are analysed through the lens of industrial urbanism—urbanisation driven by industrial activity rather than organic city growth (Anand et al., 2018). Industrial urbanism in developing countries exhibits distinctive characteristics that differentiate it from resource boomtowns in advanced economies: the dominance of the informal sector in housing and services provision, limited governance capacity, and misalignment between the pace of industrialisation and the pace of institutional development (Arboleda, 2020). The concept of the company town—whereby a single corporate entity dominates the provision of public services that ideally constitute state responsibilities (Garner, 1992)—is highly relevant to the IMIP context, given that PT IMIP has become the de facto provider of much of the zone's services and infrastructure. The resource curse thesis (Auty, 1993; Sachs & Warner, 1995) enriches this perspective by showing that resource-rich regions paradoxically often experience slower economic growth and greater social inequality through Dutch disease, commodity price volatility, and institutional failure.

2.2 The DPSIR Framework in Regional Planning

The DPSIR (Driving Force–Pressure–State–Impact–Response) framework developed by the European Environment Agency (EEA) is a systemic analytical tool linking human activities with environmental change and policy responses. Gabrielsen and Bosch (2003) emphasise that DPSIR is most effective as a communication framework between scientific knowledge and policy-making. Maxim et al. (2009) developed a more dynamic variant of DPSIR to capture feedback loops frequently overlooked in conventional applications—a development highly pertinent to complex industrial zone contexts. Applications of DPSIR to industrial zone contexts include analyses of special economic zone impacts and mining zones in Africa (Hilson & Murck, 2020). This study adapts and extends the DPSIR framework to capture simultaneous interactions among three mutually influencing ecosystems—a context underexplored in the existing DPSIR literature.

2.3 The Industry–Settlement–Environment Nexus

The nexus approach analyses the interconnections and interdependencies between two or more mutually influencing systems (Hoff, 2011). Grimm et al. (2008) developed the concept of urban ecology, emphasising that industrial zones are hybrid ecosystems in which social, economic, and biophysical components are complexly interlinked and cannot be disentangled. Alberti (2008) shows that the resilience of urban areas depends on their capacity to maintain ecosystem functions while accommodating growth in human activity—a balance that is at the core of the challenges in Bahodopi. Land use conflicts between industrial interests, settlement needs, and environmental conservation represent the concrete manifestation of this nexus (Seto et al., 2012). In extractive industrial zones, such conflicts tend to be asymmetric, as industrial and large-capital interests command far greater negotiating power than local communities and ecologically non-organised ecosystems (Watts, 2004). Environmental carrying capacity and assimilation capacity constitute a critical threshold in nexus analysis—the ecological limit whose breach triggers irreversible damage and threatens the sustainability of the entire system (Arrow et al., 1995).

2.4 Industrial Zone Governance and Indonesia's Downstream Processing Policy

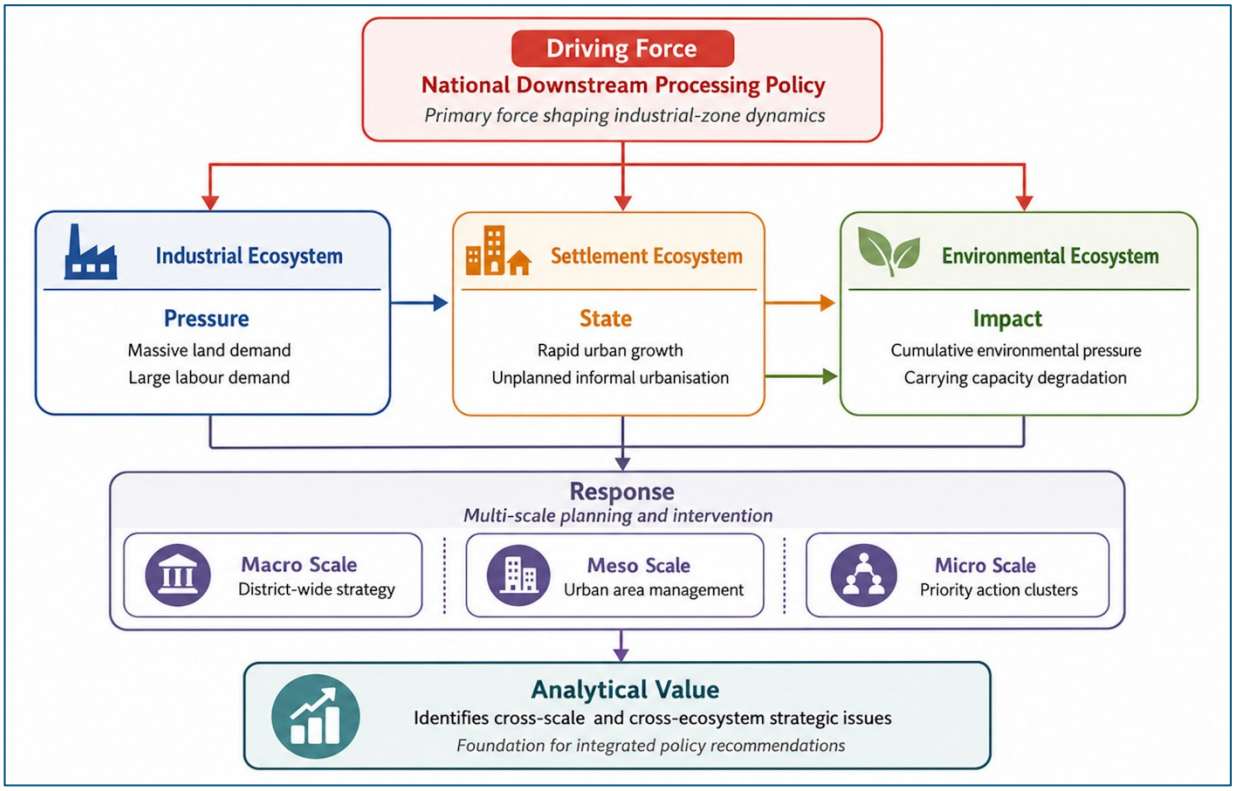
Indonesia's mineral downstream processing policy constitutes one of the most ambitious industrial interventions globally in the past decade. The ban on raw nickel ore exports implemented since 2020 has driven waves of foreign investment—primarily from China—into Indonesia's nickel processing industrial zones, generating what Warburton (2024) characterises as 'nationalist enclaves': industrial parks that advance resource-nationalist goals for a value-added extractive sector yet remain paradoxically dependent on narrow networks of foreign capital. Industrial zone governance in Indonesia involves at least three levels of government and multiple sectors, creating complex institutional fragmentation that frequently produces inconsistent or even contradictory policies (Warwick & Nolan, 2014). Environmental regulations—encompassing obligations for Environmental Impact Assessments (EIA/AMDAL), Environmental Management and Monitoring Efforts (UKL-UPL), and Environmental Management and Monitoring Plans (RKL-RPL) under Law No. 32 of 2009 as amended by Law No. 11 of 2020 and Government

Regulation No. 22 of 2021—formally establish comprehensive environmental management standards. Their implementation effectiveness, however, is heavily dependent on local government monitoring capacity. Government Regulation No. 142 of 2015 requires industrial zone companies to provide basic infrastructure within the zone, but its scope does not extend to settlement infrastructure beyond the industrial zone boundary that is nonetheless directly affected. This pattern gives rise to what this article terms the "lagged response phenomenon"—a delay in policy response that allows negative impacts to accumulate to levels that become progressively more difficult to address.

2.5 Conceptual Framework

This article develops a conceptual framework that integrates DPSIR with multi-ecosystem and multi-scale analysis. The framework positions the National Downstream Processing Policy as the primary Driving Force propelling all dynamics within the zone. At the ecosystem level, three systems are analysed simultaneously: the Industrial Ecosystem (Pressure: massive land and labour demands); the Settlement Ecosystem (State: rapid, unplanned informal urbanisation); and the Environmental Ecosystem (Impact: cumulative carrying capacity degradation). Response is then analysed at three spatial scales: macro (the entire district), meso (the urban area), and micro (priority action clusters). This framework enables the identification of strategic issues that are cross-scale and cross-ecosystem in character, providing the foundation for integrated policy recommendations.

Figure 2. Conceptual/Analytical Framework: DPSIR Framework for the Three-Ecosystem Nexus of the Morowali Industrial Zone



Source: Adapted from Master Plan for Development and Spatial Management of the Surrounding Area of the Morowali Industrial Zone (Bappenas,2023.

3. Methodology

3.1 Research Approach and Design

This study employs a mixed-methods approach with an explanatory case study design (Yin, 2018). This approach was chosen because the phenomena under investigation are contextual and complex, involving interactions among policy,

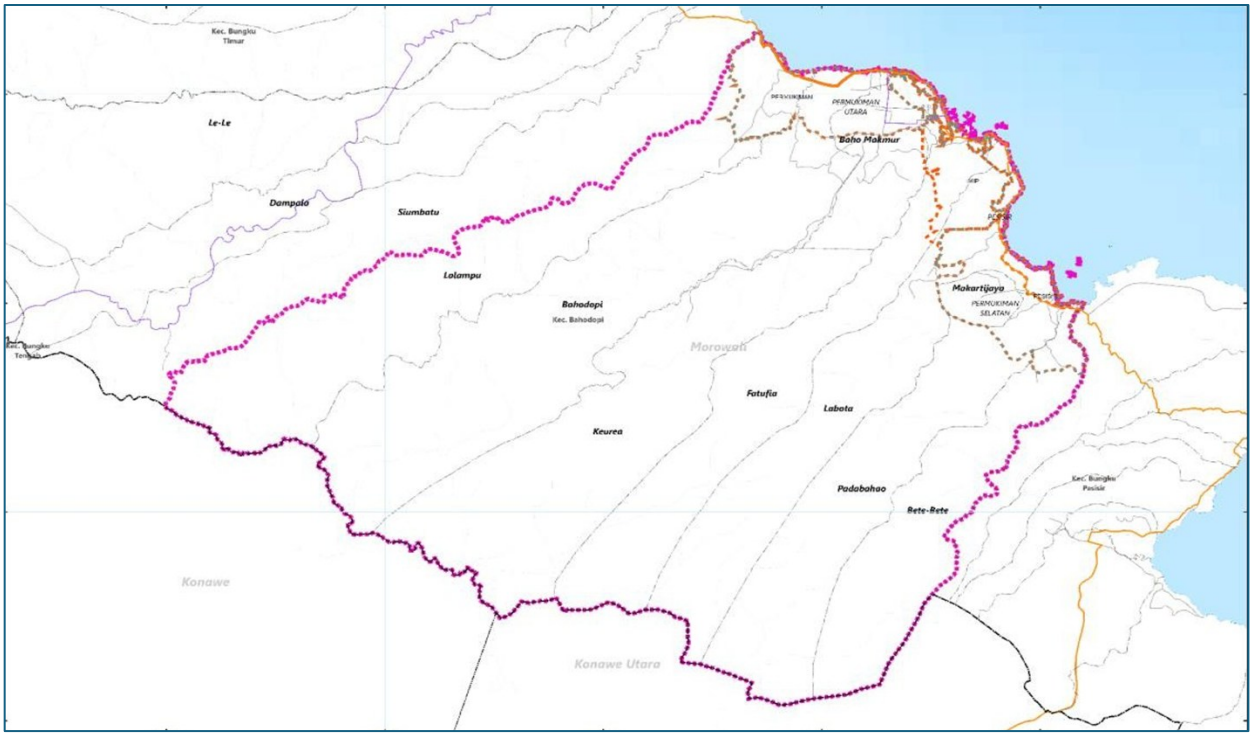
spatial dynamics, and ecological conditions that cannot be adequately understood through a single methodological approach. The unit of analysis is the Morowali Industrial Zone and its surrounding area in Bahodopi District, Morowali Regency, Central Sulawesi, with an observation period spanning 2009–2023. Bahodopi District was selected as the study site because it: hosts IMIP, which has been designated a National Strategic Project; has undergone the most dramatic spatial and demographic transformation; presents the most complex concentration of problems in terms of spatial planning, infrastructure, and the environment; and represents a case of high relevance to Indonesia's national mineral industrialisation policy.

3.2 Spatial Delineation of the Planning Area

The planning area was delineated across three tiers reflecting the depth of analysis and intervention required, taking into account PT IMIP's development plans, the distribution of worker settlement concentrations, the distribution of Mining Business Licences (IUPs), the urban service centre system, and the physical-environmental conditions of the area requiring protection.

The macro-scale area encompasses the entire administrative territory of nine villages in Bahodopi District—including the industrial zone, mining areas, settlements, and protected areas—and constitutes the context for environmental carrying capacity analysis and multi-level policy synthesis. The meso-scale area covers the Bahodopi Urban Settlement Area, that is, the area outside the boundaries of the industrial and mining zones that constitutes the effective area for urban development; analysis at this scale focuses on urban infrastructure, settlement patterns, and environmental quality. The micro-scale area comprises four priority action clusters: the Southern Settlement Cluster (Fatufia Village and surroundings, the largest concentration of IMIP worker housing); the Northern Settlement Cluster (Bahomakmur and Keurea Villages, which experienced the most rapid settlement growth from 2017 onwards); the Mining Cluster (the transition area between the industrial zone and active mining areas where land use conflicts are most intense); and the Coastal Cluster (the Tolo Bay coastal area, vulnerable to marine pollution, coastal erosion, and upstream mining sedimentation impacts).

Figure 3. Macro-Scale Planning Area Delineation: Bahodopi District, Morowali Regency.



Source: Master Plan for Development and Spatial Management of the Surrounding Area of the Morowali Industrial Zone (Bappenas, 2023).

3.3 Data and Sources

Primary data were collected through field observations of the physical condition of the zone; in-depth interviews with key stakeholders (Morowali Regency Government officials, the National Development Planning Agency/Bappenas, the Ministry of Environment and Forestry, IMIP management, and village heads in Bahodopi District); and Focus Group Discussions with community groups, local business actors, and industrial workers. Secondary data encompass 26 policy documents spanning national to district levels—including the National Spatial Plan (RTRWN), Central Sulawesi Provincial Spatial Plan (RTRW), Morowali Regency Spatial Plan (RTRW), the National Long-Term Development Plan (RPJPN), the 2020–2024 National Medium-Term Development Plan (RPJMN), Provincial and Regency Medium-Term Development Plans (RPJMD), and various sectoral regulations in the fields of mining, industry, environment, and transportation—supplemented by spatial data in the form of satellite imagery from 2009–2022, Statistics Indonesia data, and Environmental Impact Assessment documents and Mining Business Licence data.

3.4 Analytical Methods

DPSIR and Causal Loop Analysis involved identifying D–P–S–I–R components for each ecosystem, mapping reinforcing and balancing causal links, and identifying policy intervention points. Multi-Level Policy Synthesis was conducted through a systematic review of 26 policy documents, focusing on vertical consistency across government levels, horizontal consistency across sectors, and identification of regulatory gaps and conflicts. Environmental Carrying Capacity and Assimilation Analysis (ECC) was conducted following the methodology of Ministry of Environment and Forestry Regulation No. P.17/MENLHK/SETJEN/KUM.1/2/2017, encompassing food carrying capacity analysis, water carrying capacity analysis, and ecosystem service performance analysis. SWOT Analysis involved identifying Strengths, Weaknesses, Opportunities, and Threats based on the integration of all data, then constructing SO, ST, WO, and WT strategies as the basis for strategic issue formulation across the three spatial scales.

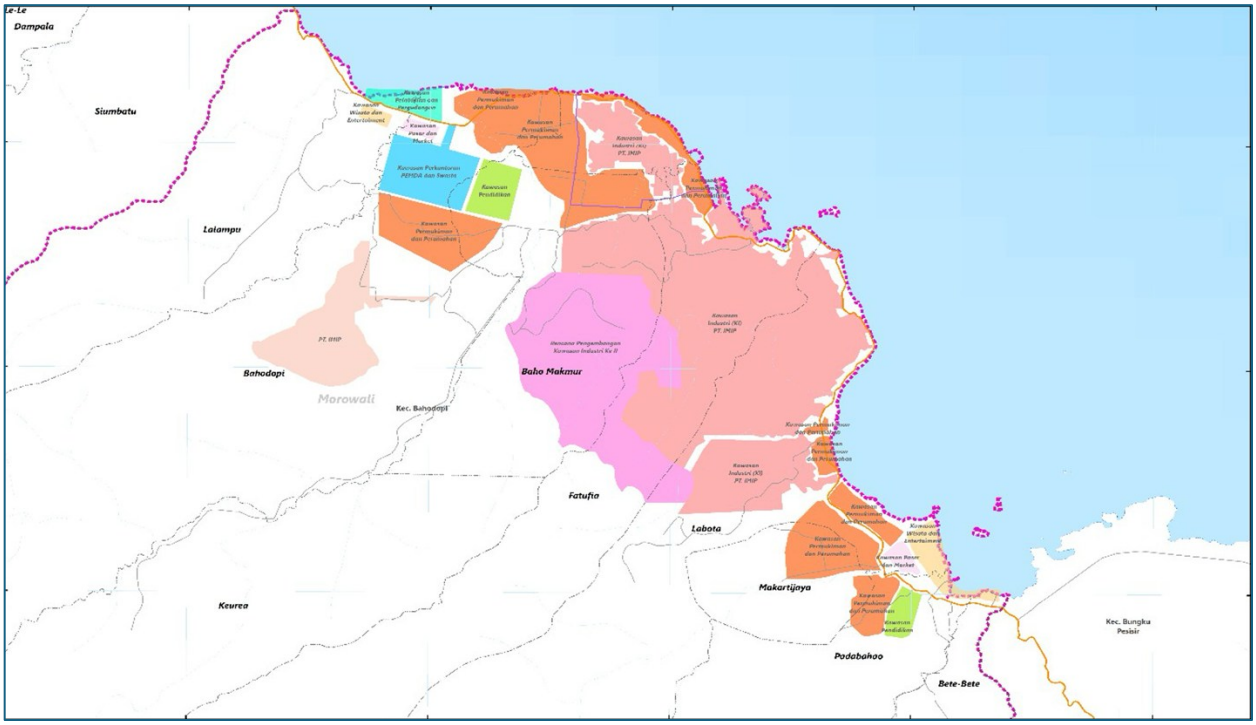
4. Results

4.1 Spatial Profile and IMIP Growth Dynamics

The Morowali Industrial Park managed by PT IMIP commenced operations in 2013 on land previously comprising agricultural areas and secondary forest on the shores of Tolo Bay, Bahodopi District. In less than a decade, this zone transformed into Southeast Asia's largest nickel processing industrial complex—encompassing ferronickel smelting, nickel matte smelting, lithium battery material processing, and various support industries. The demographic impact of IMIP's growth has been dramatic: the previously stable population of Bahodopi District has experienced exponential growth as the workforce has been drawn in from across Indonesia. The composition of the workforce, dominated by migrants—with 85% originating from outside Morowali Regency, the majority from outside Sulawesi Island—has created an intensely dynamic pattern of in-migration. Workers predominantly occupy rental housing in the form of boarding houses and rented rooms dispersed along the Trans-Sulawesi Highway and in the surrounding settlements, with the heaviest concentration in five villages: Fatufia, Bahomakmur, Keurea, Bahodopi, and Labota.

Satellite imagery analysis from 2009–2022 reveals highly significant land use changes. Settlements expanded rapidly from 2017 onwards in Bahomakmur, Keurea, Fatufia, and Bahodopi Villages, encroaching upon agricultural land, plantations, and natural vegetation. The pattern of settlement growth is highly sporadic—following existing road corridors without structured planning—indicative of the absence of effective spatial use control instruments. Industrial zones and mining lands also underwent massive expansion into surrounding protected forest and production forest areas. IMIP's presence has generated a significant economic multiplier effect: following Moretti's (2010) estimate that each manufacturing industry job potentially generates 2–5 additional jobs in the service and informal sectors, the presence of approximately 150,000 IMIP workers potentially animates hundreds of thousands of informal-sector jobs in the surrounding area, spanning food stalls, boarding house businesses, and transport services. However, this multiplier effect also carries negative consequences: sharp cost-of-living inflation; erosion of the traditional economic base of fisheries and agriculture; and widening income inequality between regularly-waged industrial workers and local residents trapped in low-income informal sector employment.

Figure 4. Map of PT IMIP Development Plans and Worker Settlement Distribution, Bahodopi District, Morowali Regency.



Source: Combined from Master Plan for Development and Spatial Management of the Surrounding Area of the Morowali Industrial Zone (Bappenas, 2023).

4.2 Causal Loop Dynamics: The Three-Ecosystem Nexus

DPSIR analysis yields a complex mapping of the causal dynamics among the three ecosystems. At the most fundamental level, the National Downstream Processing Policy as the primary Driving Force drives the development of the Industrial Ecosystem, which requires land, infrastructure, and labour at a massive scale. This labour demand becomes a secondary Driving Force generating large-scale in-migration and forming a Settlement Ecosystem that grows at great speed. Both ecosystems together exert enormous Pressure on the Environmental Ecosystem through land conversion, water exploitation, and various forms of pollution.

The Industrial Ecosystem operates through a self-reinforcing feedback loop: industrial investment creates employment, which generates an economic multiplier effect, which in turn attracts new investment and drives further industrial expansion. This loop also produces negative Pressure: upstream raw material (ore) requirements continue to increase, forest areas face ever more intense conversion pressures, and infrastructure needs exceed provision capacity. Without legally mandated environmental remediation commensurate with the pace of exploitation, pressure on the Environmental Ecosystem continues to grow exponentially.

The Settlement Ecosystem is developing in a pattern of unplanned informal urbanisation. PT IMIP provides only a very limited number of vertical residential units for a small fraction of its workforce, so the majority of migrant workers must independently secure housing through rental rooms and boarding houses of quality far below liveable standards. This uncontrolled densification produces a growing urban infrastructure deficit: severely limited coverage of adequate drinking water supply; near-zero access to adequate sanitation (0%); only approximately 16% of generated solid waste being collected and managed; a storm drainage system unable to handle increasing surface runoff; and a local road network that is narrow and of poor quality. These conditions have culminated in the proliferation of informal settlement pockets scattered across the Bahodopi urban area—a State that contrasts sharply with the image of modern industrial zones often portrayed in downstream policy narratives.

The Environmental Ecosystem receives cumulative pressure from both other ecosystems through several interacting mechanisms. First, mining activities in the upstream zone involve massive topsoil stripping that generates erosion and sedimentation into rivers flowing towards downstream and coastal areas, polluting water bodies and damaging the marine ecosystem. Second, air pollution from nickel smelting operations and heavy vehicle traffic has caused high incidence rates of Acute Respiratory Infections (ARI) in the surrounding communities—the Impact most directly experienced by residents. Third, river water contaminated by inadequately managed industrial and domestic wastewater reduces the availability of clean water and damages aquatic ecosystems. Fourth, the Tolo Bay coastal area is experiencing pollution from sedimentation and industrial waste that is seriously affecting traditional fishing activities and coral reef ecosystems downstream. A degraded environmental ecosystem in turn weakens the area's carrying capacity for human activity—a balancing loop that, left unmanaged, will threaten the sustainability of the entire system, including the continuity of industrial operations.

The critical point in this three-ecosystem nexus is the absence of adequate Response mechanisms. Existing policy instruments—EIA, RKL-RPL, and spatial planning regulations—are neither strong enough nor swift enough to keep pace with the rate of growth driven by the national downstream processing policy. This constitutes the manifestation of the "lagged response phenomenon": the delay in policy response that accumulates negative impacts to levels that become progressively more difficult to address, and that requires distinct theoretical understanding in the developing country context.

4.3 Policy Synthesis: Between Formal Consistency and Implementation Gaps

Analysis of the 26 policy documents reveals a striking paradox: a high degree of formal consistency in the direction of policy across levels coexists with a very large implementation gap between national policy and on-the-ground realities.

In terms of vertical consistency, spatial planning documents from the National Spatial Plan (RTRWN, Government Regulation No. 13/2017) through to the Morowali Regency Spatial Plan 2019–2039 consistently designate the Bahodopi area as an industrial zone and National Strategic Area. The Provincial Spatial Plan of Central Sulawesi designates Bungku as a Local Activity Centre (PKL) and Provincial Strategic Area for the Economy, while the Morowali Regency Spatial Plan designates Bahodopi as a District Service Centre (PPK) with industrial zone development directed there. Development planning documents from the 2020–2024 RPJMN through to the Morowali Regency Medium-Term Development Plan (RPJMD) align in positioning industrial zone development as a priority, with Morowali Regency's development vision having shifted from an agribusiness emphasis to industrial zone development in tandem with IMIP's growth. This formal consistency reflects good vertical policy alignment—all levels of government point in the same direction.

However, beneath this formal consistency lie five critical gaps with direct bearing on conditions in the zone. The first gap is the absence of a Detailed Spatial Plan (RDTR) and Zoning Regulations for the Bahodopi Urban Area: without these instruments, spatial use control cannot be legally enforced, meaning there is no legal mechanism to prevent construction in areas that should be protected, no buffer zone between the industrial zone and settlements, and no clear guidance for residents and investors on permitted land uses. The Bahodopi urban area grows sporadically without adequate control instruments. The second gap is a regulatory conflict between protected forest areas and industrial zone plans: within the outline of the protected forest (HL) that should be legally off-limits, a large industrial zone of 30.39 hectares and aquaculture development of 26 hectares are planned in Bahodopi District—a conflict with serious legal and environmental implications. The third gap is the imbalance between the strength of mining sector regulations and local spatial regulations: the Mining Law and its implementing regulations are far stronger and more detailed, enabling mining expansion to exceed the limits set in spatial planning documents. The fourth gap is the complete absence of any district-level regulatory document specifically governing the directions and limits of industrial zone and mining area activities to prevent negative spillover impacts on surrounding areas. The fifth gap is the lack of sectoral infrastructure master plans at the local level—no master plans for drainage, solid waste, sanitation, or drinking water supply—meaning there is no adequate technical guidance for urban infrastructure development in an area

experiencing extremely rapid growth. Existing spatial planning documents are generally normative in character without clear spatial specifications for territorial infrastructure such as water supply, waste management, drainage, or public facilities.

Table 1. Multi-Level Policy Synthesis for Development around the Morowali Industrial Zone (26 Documents Grouped in 6 Thematic Categories).

No.	Kelompok Kebijakan	Dokumen/Regulasi Utama	Arah Kebijakan Utama	Implikasi bagi Kawasan Industri Morowali
1	Tata ruang nasional dan daerah	PP No. 13 Tahun 2017 tentang RTRWN; RTRW Provinsi Sulawesi Tengah; RTRW Kabupaten Morowali	Penetapan Morowali sebagai kawasan strategis berbasis pertambangan dan industri; Bahodopi diarahkan sebagai pusat kegiatan dan kawasan industri	Memberikan dasar spasial bagi pengembangan kawasan industri, namun membutuhkan penguatan pengendalian pemanfaatan ruang, penataan permukiman, dan integrasi kawasan penyangga
2	Pembangunan nasional dan daerah	Perpres No. 18 Tahun 2020 tentang RPJMN; RPJPD dan RPJMD Provinsi Sulawesi Tengah; RPJMD Kabupaten Morowali	Pengembangan kawasan industri prioritas nasional, peningkatan investasi, pemerataan wilayah, dan transformasi ekonomi daerah	Menegaskan peran Morowali sebagai pusat pertumbuhan baru, tetapi menuntut sinkronisasi antara pertumbuhan industri, pembangunan infrastruktur, layanan dasar, dan perlindungan lingkungan
3	Pertambangan dan hilirisasi mineral	UU No. 4 Tahun 2009; UU No. 3 Tahun 2020; PP No. 1 Tahun 2017; Kepmen ESDM No. 262 Tahun 2020	Hilirisasi mineral, peningkatan nilai tambah nikel, kewajiban pengolahan dan pemurnian, reklamasi, pascatambang, serta pemberdayaan masyarakat lokal	Menjadi dasar kebijakan bagi tumbuhnya industri pengolahan nikel di Morowali, sekaligus menimbulkan kebutuhan pengawasan terhadap izin tambang, reklamasi, limbah, dan dampak sosial-ekologis
4	Perindustrian dan kawasan industri	UU No. 3 Tahun 2014; PP No. 14 Tahun 2015; PP No. 142 Tahun 2015; PP No. 28 Tahun 2021; Permenperin No. 1 Tahun 2020	Penguatan industri nasional, hilirisasi industri nikel, penyediaan infrastruktur dasar kawasan industri, serta kewajiban pengelolaan lingkungan kawasan	Memberikan legitimasi bagi pembangunan kawasan industri Morowali, termasuk kewajiban penyediaan jalan, drainase, air baku, pengolahan air limbah, RKL-RPL, dan pemantauan lingkungan secara berkala
5	Lingkungan hidup dan persampahan	UU No. 32 Tahun 2009; UU No. 18 Tahun 2008; UU No. 11 Tahun 2020; PP No. 22 Tahun 2021; Permen LHK No. 4 Tahun 2021; Permen LHK No. 5 Tahun 2021	Perlindungan dan pengelolaan lingkungan hidup, kewajiban AMDAL/UKL-UPL, persetujuan lingkungan, pengelolaan limbah, dan pengelolaan persampahan	Menjadi dasar pengendalian dampak lingkungan akibat aktivitas industri, pertambangan, dan urbanisasi; diperlukan pendekatan AMDAL kawasan serta sistem pengelolaan limbah dan persampahan yang terintegrasi
6	Transportasi dan konektivitas	UU No. 22 Tahun 2009; UU No. 17 Tahun 2008; UU No. 1 Tahun 2009; Permenhub No. 49 Tahun 2005	Pengembangan jaringan transportasi darat, laut, dan udara untuk mendukung konektivitas antarwilayah dan antarkawasan	Menjadi dasar pengembangan sistem transportasi kawasan, termasuk peningkatan jalan, pelabuhan, akses logistik, dan konektivitas antara kawasan industri, permukiman, dan pusat pelayanan

Source: Master Plan for Development and Spatial Management of the Surrounding Area of the Morowali Industrial Zone (Bappenas, 2023).

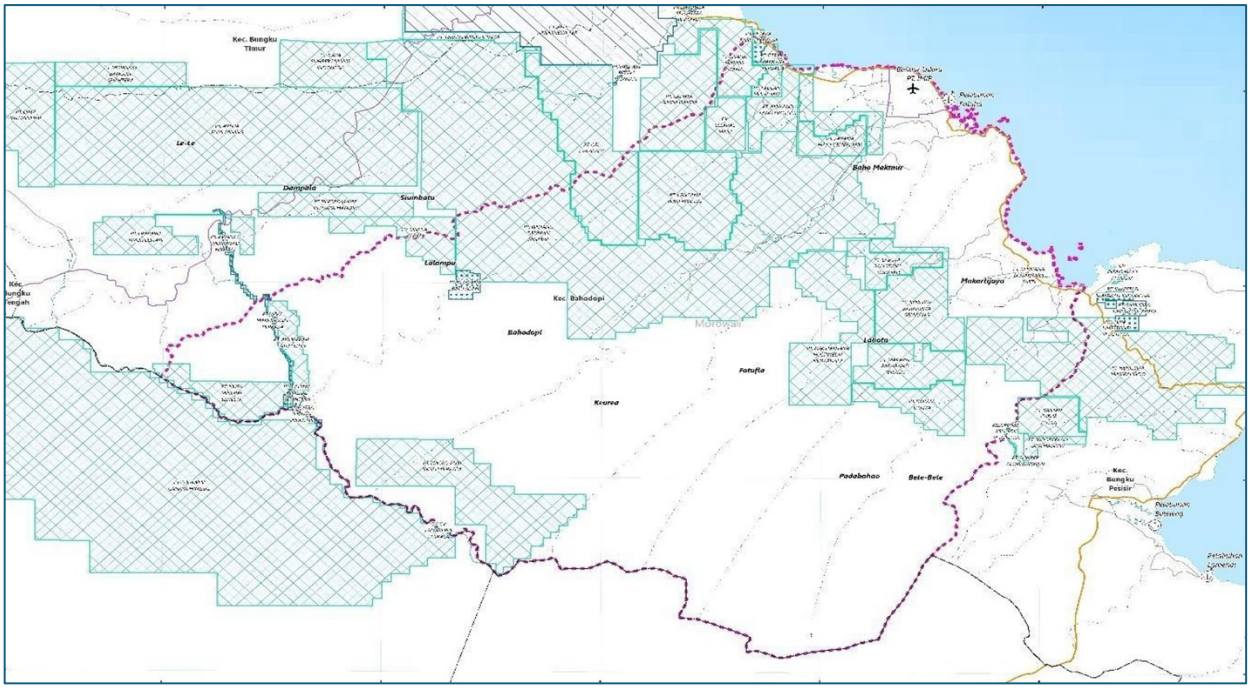
4.4 Environmental Carrying Capacity and Assimilation Analysis

ECC analysis reveals that the Bahodopi zone is experiencing increasingly serious ecological stress. Morowali Regency's food carrying capacity has been exceeded (overshoot) by 38.64%, while Bahodopi District specifically experiences an overshoot of 12.09%—reflecting the inability of local food production to meet the needs of a continuously growing population driven by massive in-migration, rendering the zone heavily dependent on food supplies from outside. Ongoing conversion of agricultural land to settlements and industrial uses will progressively worsen this situation.

Water carrying capacity presents a more alarming picture from a long-term perspective. Morowali Regency is currently overshot by 0.35%, while Bahodopi District retains a surplus of 5.27% in 2024; projections, however, indicate a dramatic decline to only 1.95% by 2045—a deeply concerning trend given continuously rising water demands from industrial and settlement expansion. Only 3,417.11 hectares, or 0.7% of the regency's total area, exhibits high to very high-water provision ecosystem service performance, while areas with "very low" water provision performance are most heavily concentrated precisely in Bahodopi District—the centre of industrial activity. This situation demands urgent strategies: increasing catchment areas through reservoir rehabilitation and construction, protecting water catchment zones, and reducing pollution loads from industrial and domestic sources.

Ecosystem service performance analysis reveals deeply concerning conditions across nearly all dimensions. Food provision ecosystem service performance at "very low" status covers 24,317 hectares in Bahodopi District. The ecosystem's capacity for landslide disaster prevention and protection at "very low" performance covers 25,062.38 hectares, while flood disaster protection capacity at "very low" performance covers 28,706.60 hectares in Bahodopi District—a very large area given the district's total extent. Water flow regulation capacity at "very low" status covers 27,350.97 hectares. These figures indicate that the majority of the zone's natural ecosystems have experienced very serious functional degradation from mining land clearance and vegetation conversion, rendering the area highly vulnerable to recurring hydrological disasters.

Figure 5. Map of Protected Areas and Mining Business Licence (IUP) Zones, Bahodopi District, Morowali Regency



Source: Master Plan for Development and Spatial Management of the Surrounding Area of the Morowali Industrial Zone, 2023.

Areas prohibited from development include: protected forest (HL) covering 99,576.41 hectares; limited production forest (HPT) covering 120,665.27 hectares; permanent production forest (HP) covering 28,280.57 hectares; convertible production forest (HPK) covering 40,207.91 hectares; protected sustainable agricultural land (LP2B) covering 6,437.33 hectares along with reserve LP2B covering 36,682.46 hectares; as well as river buffer zones, spring protection zones, coastal conservation zones, and mangrove ecosystem areas throughout the district. Disaster-prone areas that must be excluded from development include landslide hazard zones (covering parts of Bahodopi District), flood hazard zones, active fault earthqake zones, storm surge zones on coastal areas, and cultural heritage zones. All infrastructure development planning is legally prohibited from crossing these zones—a constraint that is frequently violated in practice due to the absence of effective control instruments.

4.5 SWOT Analysis and Development Strategy Formulation

The zone's principal Strengths include: the massive economic value and multiplier effect of nickel industry development; PT IMIP's active support for infrastructure and public facilities provision through Corporate Social Responsibility (CSR) funds, including the construction of a Polytechnic Institute by the Ministry of Industry and Bahodopi Hospital by PT IMIP; a very high population influx forming significant social and economic capital; and relatively good regional connectivity encompassing road (Trans-Sulawesi Highway), maritime (port), and air (airport) transportation, all available within Bahodopi District. The zone's principal Weaknesses include: large infrastructure inequality with very low coverage of drinking water, sanitation, drainage, and solid waste services; local human resource capacity and competencies insufficient to compete in mid-to-upper level labour markets; multidimensional environmental pollution problems; poor urban quality and image from informal settlement pockets and uncontrolled urban sprawl; and transportation problems from singular dependence on the Trans-Sulawesi Highway. Principal Opportunities include: national government policy support through the NSP designation, opening up possibilities for national budget funding and private investment; a surge in population as an unambiguous housing market (industrial workers with regular incomes); and substantial but untapped development potential in non-basic sectors such as maritime tourism and fisheries. Principal Threats to be anticipated include: high dependence on external regions for staple food supply; potential social conflict from exclusive treatment of migrant workers; the technological threat of sodium-ion battery development potentially substituting nickel; and irreversible environmental degradation if not addressed urgently.

Table 2. SWOT Analysis Matrix for Development around the Morowali Industrial Zone

Komponen	Isu Utama
Strengths / Kekuatan	1. Nilai ekonomi dan *multiplier effect* industri nikel sangat besar. 2. Dukungan PT IMIP dalam penyediaan infrastruktur, fasilitas sosial, dan CSR. 3. Pertumbuhan penduduk dan aktivitas ekonomi menciptakan basis pasar, tenaga kerja, dan kewirausahaan baru.
Weaknesses / Kelemahan	1. Infrastruktur dasar belum memadai, terutama air minum, sanitasi, persampahan, jalan, dan transportasi internal. 2. Kapasitas SDM lokal masih rendah sehingga belum optimal terserap pada pekerjaan menengah ke atas. 3. Tekanan lingkungan meningkat, meliputi banjir, polusi udara, pencemaran air, alih fungsi lahan, dan risiko kesehatan masyarakat. 4. Kualitas ruang perkotaan rendah akibat permukiman kumuh, *urban sprawl*, dan kebutuhan hunian MBR yang belum terpenuhi.
Opportunities / Peluang	1. Dukungan kebijakan nasional melalui penetapan kawasan industri dan PSN. 2. Konektivitas regional relatif kuat melalui jaringan darat, laut, dan udara. 3. Ketersediaan lahan dan potensi sumber air baku untuk pengembangan kawasan. 4. Peluang pengembangan sektor non-industri, seperti pertanian, perikanan, pariwisata, perdagangan, jasa, dan properti.
Threats / Tantangan	1. Ketergantungan tinggi terhadap wilayah luar dalam penyediaan kebutuhan pokok. 2. Potensi konflik sosial akibat migrasi tenaga kerja dan segregasi sosial-ekonomi. 3. Risiko perubahan teknologi baterai yang dapat menurunkan permintaan terhadap produk berbasis nikel di masa depan.

Source: Adapted from Master Plan for Development and Spatial Management of the Surrounding Area of the Morowali Industrial Zone (Bappenas, 2023).

The SWOT matrix yields four clusters of priority strategies. SO strategies (leveraging strengths to capture opportunities) include: regulatory synergies between the national government and PT IMIP in a cooperative framework for zone development and urban infrastructure provision; development of formal property sectors in new development areas with private sector participation; and fostering community entrepreneurship potential through CSR capital support. ST strategies (deploying strengths to counter threats) include: developing non-basic sectors—agriculture and fisheries—through community development and empowerment supported by PT IMIP; and promoting entrepreneurship and SME development through product innovation and market expansion in non-industrial sectors.

Table 3. Sintesys of SWOT Strategy, Including SO, ST, WO, and WT Strategies.

Strategi	Arah Strategi Utama	Rumusan Strategi
SO Memanfaatkan kekuatan untuk menangkap peluang	Penguatan kawasan industri dan ekonomi perkotaan	Mengoptimalkan dukungan kebijakan pusat, kapasitas ekonomi IMIP, dan CSR untuk mempercepat penyediaan infrastruktur, pengembangan kawasan permukiman baru, serta perluasan sektor properti, perdagangan, dan jasa.
ST Memanfaatkan kekuatan untuk mengurangi tantangan	Diversifikasi ekonomi dan penguatan kohesi sosial	Menggunakan *multiplier effect* industri dan dukungan PT IMIP untuk mengembangkan sektor pertanian, perikanan, UMKM, dan kewirausahaan lokal guna mengurangi ketergantungan pasokan dari luar serta menekan potensi konflik sosial.
WO Mengatasi kelemahan dengan memanfaatkan peluang	Perbaikan infrastruktur, SDM, dan lingkungan	Memanfaatkan dukungan APBN, kebijakan PSN, dan konektivitas regional untuk mempercepat pembangunan air bersih, sanitasi, persampahan, jaringan jalan, transportasi, perumahan MBR, pelatihan vokasi, dan pengendalian lingkungan.
WT Mengurangi kelemahan dan menghindari tantangan	Transformasi menuju kawasan industri berkelanjutan	Mendorong transformasi sosial, lingkungan, dan teknologi melalui industri hijau, penguatan partisipasi publik, perbaikan tata ruang, penyediaan infrastruktur hijau, serta peningkatan kapasitas masyarakat lokal dalam menghadapi perubahan pasar dan teknologi.

Source: Adapted from Master Plan for Development and Spatial Management of the Surrounding Area of the Morowali Industrial Zone (Bappenas, 2023).

WO strategies (overcoming weaknesses to seize opportunities) include: provision of urban infrastructure, transport networks, spatial management, and low-income community housing through national budget funding; addressing environmental and public health issues in pursuit of green industry through national government policy support; and national budget support for local human resource capacity building through training and vocational school development. WT strategies (minimising weaknesses to withstand threats) include: strengthening farmer and fishing community groups through training, working capital, and market expansion; and social and technological transformation towards green industry through regulatory support, mainstreaming public participation, and provision of green infrastructure.

4.6 Six Strategic Issues Across Spatial Scales

The synthesis of all analyses yields six strategic issues that are cross-scale and mutually interlinked. Each issue manifests differently across macro, meso, and micro spatial scales, requiring scale-sensitive policy instruments in response.

Strategic Issue 1: Spatial Governance Regulatory Vacuum. At the macro scale, land use changes driven by IUP issuance have not been accommodated in existing spatial plans; new service centres have emerged and grown rapidly but without integration into regency-wide spatial development frameworks. At the meso scale, the Bahodopi Urban Area is growing sporadically without a Detailed Spatial Plan (RDTR) and Zoning Regulations as the most operationally immediate control instruments. At the micro scale, land use conversion in high-potential areas proceeds without planning and without integration with surrounding areas. This regulatory vacuum creates an uncertain investment environment and weak spatial law enforcement, enabling construction in areas that should be legally protected.

Table 4. Strategic Issues Across Three Spatial Scales (Macro–Meso–Micro).

No.	Isu Strategis	Skala Makro	Skala Meso	Skala Mikro	Fokus Penanganan Utama
1	Belum adanya regulasi pemanfaatan dan pengendalian ruang yang adaptif terhadap percepatan hilirisasi dan pertambangan	Perubahan penggunaan lahan dan struktur ruang wilayah berlangsung cepat akibat ekspansi izin usaha pertambangan dan industri, tetapi belum sepenuhnya terakomodasi dalam rencana tata ruang kabupaten	Kawasan Perkotaan Bahodopi tumbuh sporadis tanpa RDTR dan peraturan zonasi yang efektif	Alih fungsi lahan menuju kawasan industri, pertambangan, dan permukiman belum terencana serta kurang terintegrasi dengan kawasan sekitar	Penyusunan RDTR, peraturan zonasi, pengendalian pemanfaatan ruang, dan integrasi tata ruang industri, permukiman, serta kawasan ekologis
2	Pertumbuhan permukiman perkotaan tidak diimbangi dengan infrastruktur dan hunian layak	Aktivitas tambang di wilayah hulu menurunkan daya serap air dan meningkatkan risiko banjir di wilayah hilir	Penyediaan hunian formal, air bersih, sanitasi, drainase, dan persampahan belum mampu mengikuti lonjakan penduduk	Pekerja memenuhi kebutuhan hunian secara mandiri melalui kos dan rumah sewa yang tidak terkendali, sehingga memicu permukiman padat dan kumuh	Penyediaan perumahan pekerja dan MBR, peningkatan layanan dasar perkotaan, serta integrasi infrastruktur kawasan dengan sistem perkotaan
3	Penurunan kualitas lingkungan akibat eksploitasi tambang dan aktivitas industri	Pemulihan lingkungan belum seimbang dengan intensitas eksploitasi tambang dan operasi industri	Erosi, sedimentasi, polusi udara, pencemaran sungai, pencemaran pesisir, dan penurunan kualitas lingkungan meningkat	Infrastruktur lingkungan belum memadai; pengelolaan air limbah dan persampahan masih terbatas	Penguatan pengendalian lingkungan, rehabilitasi DAS/hulu, pengelolaan limbah dan sampah terpadu, serta penerapan prinsip industri hijau
4	Rendahnya aksesibilitas dan konektivitas intra dan antarwilayah	Pergerakan kendaraan tambang masih beririsan dengan jalan umum sehingga menimbulkan perlambatan dan risiko keselamatan	Pergerakan pekerja, kendaraan pribadi, dan aktivitas masyarakat terkonsentrasi pada koridor Trans Sulawesi, sementara akses masuk kawasan industri terbatas	Jalan lingkungan berkualitas rendah, dimensi jalan terbatas, minim penerangan, minim jalur pejalan kaki, dan hambatan samping tinggi	Pemisahan jalur logistik dan mobilitas warga, peningkatan jalan lingkungan, pengembangan transportasi publik, serta manajemen lalu lintas kawasan
5	Kapasitas SDM, ekonomi lokal, dan ketahanan sosial masyarakat masih lemah	Pertumbuhan ekonomi kabupaten belum sepenuhnya meningkatkan kesejahteraan; ketergantungan terhadap industri dan tambang nikel sangat tinggi	Transformasi dari ekonomi pertanian dan perikanan menuju ekonomi industri memarginalkan sebagian masyarakat lokal; serapan tenaga kerja lokal masih dominan pada level menengah bawah	Sektor informal, jasa penunjang industri, UMKM, ruang publik, dan fasilitas sosial belum tertata dan belum cukup mendukung masyarakat lokal	Peningkatan kapasitas SDM lokal, pelatihan vokasi, pemberdayaan UMKM, penguatan ekonomi non-tambang, dan penyiapan sektor pascatambang seperti perikanan, pariwisata, serta jasa perkotaan
6	Tingginya kerawanan bencana dan masih lemahnya mitigasi serta adaptasi	Kawasan memiliki risiko banjir dan longsor, sementara edukasi dan informasi mitigasi bencana masih terbatas	Banjir berpotensi berulang karena belum adanya sistem mitigasi yang memadai, termasuk ruang evakuasi di kawasan perkotaan Bahodopi	Risiko bencana di tingkat lokal berkaitan erat dengan kerusakan lingkungan hulu dan belum ditangani secara sistematis	Penguatan mitigasi bencana berbasis tata ruang, rehabilitasi kawasan hulu, penyediaan ruang evakuasi, sistem peringatan dini, dan edukasi kebencanaan masyarakat

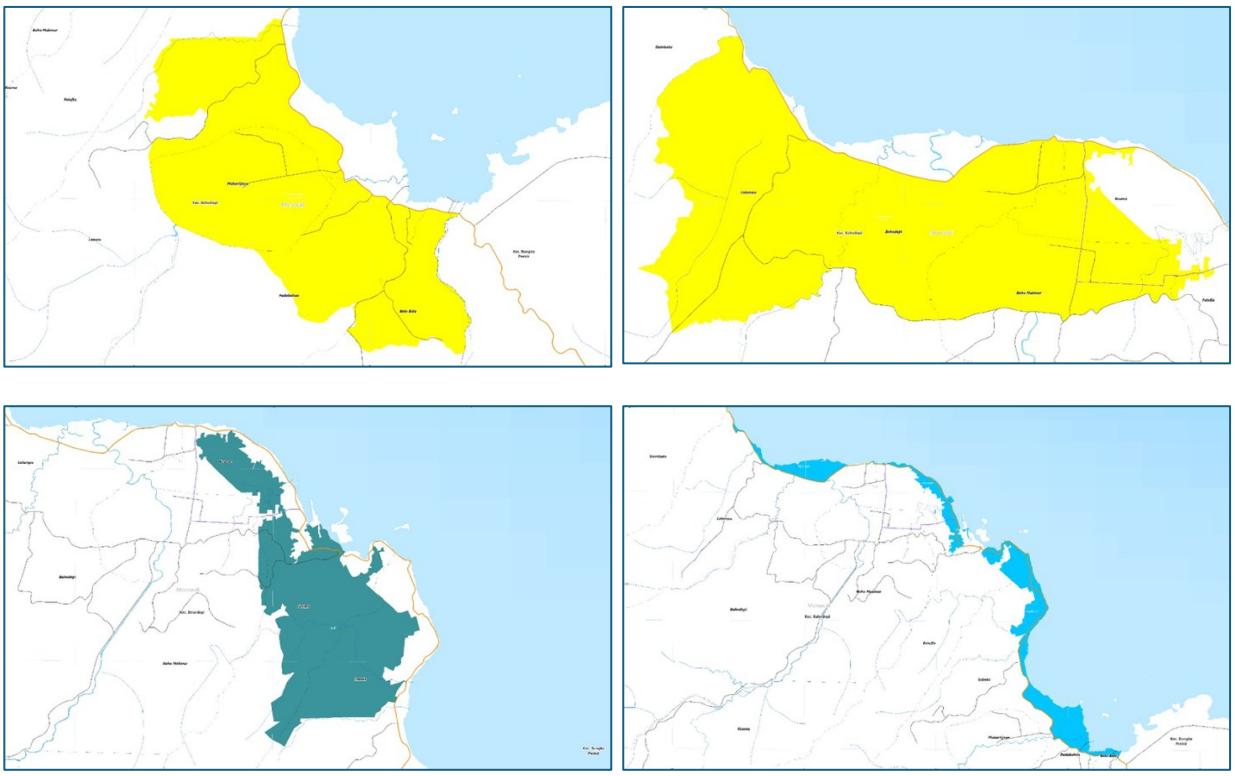
Source: Adapted Master Plan for Development and Spatial Management of the Surrounding Area of the Morowali Industrial Zone (Bappenas, 2023)

Strategic Issue 2: Urban Settlement Infrastructure Deficit. Rapid industrial development has triggered very high population growth, yet PT IMIP provides housing for only a small fraction of its workforce. At the macro scale, land restoration processes commensurate with accelerating mining exploitation have not been implemented; mining activities in upstream areas have reduced water infiltration quality, causing flooding in downstream areas. At the meso scale, urban infrastructure service quality—water supply, domestic wastewater, drainage, solid waste—is very poor as a result of exponentially growing population pressures; infrastructure provision has not been integrated into broader urban systems. At the micro scale, housing needs are left entirely to market mechanisms with minimal formal provision

from industrial zone management, leading workers to meet housing needs independently through unregulated rental accommodation of poor quality, generating informal settlement pockets.

Strategic Issue 3: Environmental Quality Degradation. Mining and industrial activities produce cumulative environmental impacts that are increasingly difficult to manage. At the macro scale, land restoration has not been implemented at a pace commensurate with accelerating mining exploitation, and upstream mining activities have degraded water absorption, causing recurrent flooding in downstream areas. At the meso scale, erosion and sedimentation from open mining areas cause sedimentation in the sea and rivers; pollution is evidenced by high air pollution levels (causing ARI), river water contaminated by industrial and domestic waste, and contamination of the coastal zone and sea. At the micro scale, zero access to domestic wastewater infrastructure and only 16% of solid waste managed reflect a systemic failure in environmental management requiring comprehensive intervention.

Figure 6. Micro-Scale Planning Area Delineation: Southern Settlement Cluster, Northern Settlement Cluster, Mining Cluster, and Coastal Cluster.



Source: Master Plan for Development and Spatial Management of the Surrounding Area of the Morowali Industrial Zone (Bappenas, 2023).

Strategic Issue 4: Low Accessibility and Connectivity. The use of public roads for very high-volume IMIP worker mobility causes severe traffic congestion at shift change times. Ore hauling trucks from mining areas to processing facilities cross public roads at several points, creating serious impediments. At the meso scale, the mixing of industrial worker movements and community activities on the Trans-Sulawesi Highway causes severe congestion due to limited industrial zone access gates and road network capacity; dominant private vehicle use without public transport systems exacerbates conditions. At the micro scale, local roads are of poor quality with dimensions below minimum standards; road furniture including street lighting, vegetation, and pedestrian paths are severely deficient; and road-side friction is very high from parking and informal structures that have proliferated rapidly in the Bahodopi urban area.

Strategic Issue 5: Human Resource Capacity and Mono-Economic Dependency. The very high population influx driven by industrial activity has not been matched by adequate educational, health, and recreational facilities. Macro-level economic growth in the regency has not translated into commensurate improvements in community welfare, as evidenced by persistently high poverty rates. The socioeconomic structural shift from agriculture- and fisheries-based communities towards industrial communities has marginalised those engaged in traditional sectors. Local workforce absorption is restricted to mid-to-lower employment segments, while very high dependence on nickel mining creates serious long-term vulnerability, given that nickel is a non-renewable resource. The emerging potential of sodium-ion battery technology as a nickel substitute adds a further dimension of uncertainty. No serious planning for a post-mining economic transition exists to guarantee the long-term welfare of Morowali communities.

Strategic Issue 6: High Disaster Vulnerability. The planning area is highly vulnerable to multiple natural hazard threats: flooding, landslides, earthquakes, and storm surges. Recurrent flooding in downstream areas caused by ecosystem damage in upstream zones is the most directly and frequently experienced hazard impact. At the meso scale, disaster risk communication, information dissemination, and community education are severely lacking; adequate evacuation spaces within the Bahodopi urban area are absent. At the micro scale, disaster risk is closely linked to environmental degradation in upstream areas, and systematic disaster mitigation efforts have not been undertaken, representing a serious threat to vulnerable settlement clusters.

5. Discussions

5.1 Cascading DPSIR: Theoretical Contributions

The findings of this study confirm and extend the resource boomtown concept in the developing country context. In the IMIP context, the policy response lag reflects not merely governmental ignorance or reluctance, but a structural imbalance between very powerful industrialisation forces backed by strong national interests and the far more limited institutional capacity of local government. Indonesia's national nickel downstream processing policy was designed for structural economic transformation with strong political backing. However, the implementation burden of this agenda falls disproportionately on local governments whose capacity in terms of human resources, budgets, and institutional infrastructure is far more constrained. This is the structural root of the lagged response so clearly manifest in Bahodopi.

The theoretical contribution of this article to the DPSIR literature is the development of the concept of "cascading DPSIR"—a situation in which the Impact from one DPSIR cycle becomes the Driving Force for subsequent cycles, generating complexity that compounds over time. Environmental degradation produced by the industrial ecosystem (first cycle) worsens the conditions of the settlement ecosystem through flooding, water pollution, and declining air quality (second cycle), which in turn generates social and economic pressures—rising healthcare costs, declining productivity, growing social conflict—that further drain the response capacity of local government (third cycle). This cascade mechanism explains why partial and reactive interventions are never sufficient to address the complexity of problems in extractive industrial zones, and why the systemic integrated approach proposed in this article constitutes a necessity rather than a preference.

These findings reinforce argument for systemic approaches in identifying intervention points, while critiquing overly linear DPSIR applications that neglect feedback loops as emphasised by Maxim et al. (2009). From a nexus perspective, the findings confirm Grimm et al.'s (2008) view that industrial zones are hybrid ecosystems that cannot be managed sectorally, and extend Alberti's (2008) argument on the importance of maintaining ecosystem functions in contexts of very rapid growth. The multi-scale analysis (macro–meso–micro) demonstrates that the same issue manifests through different mechanisms and causal pathways at different scales, necessitating scale-differentiated policy instruments—a dimension underexplored in existing DPSIR literature.

5.2 Policy Implications: Four Priority Recommendations

Based on the research findings, four urgent and mutually reinforcing policy recommendations are advanced.

First, acceleration of spatial planning instruments. The completion of a Detailed Spatial Plan (RDTR) and Zoning Regulations for Bahodopi District must be prioritised as the most urgent need. The revision of the Morowali Regency Spatial Plan must integrate existing IUPs and clearly establish buffer zones between the industrial zone, settlements, and protected areas. The national government must provide adequate technical and financial support to local government—the regular regulatory process that takes years cannot be awaited amid the zone's extremely rapid growth pace. Sectoral infrastructure master plans—for drainage, solid waste, sanitation, and drinking water—that the area entirely lacks must also be developed as a matter of urgency.

Second, industrial zone governance reform. PT IMIP's obligations in providing formal housing and urban infrastructure must be elevated to verifiable, legally-binding requirements rather than voluntary CSR commitments. Government Regulation No. 142 of 2015, which requires industrial zone companies to provide basic infrastructure, must be strengthened in implementation and extended in scope to encompass settlement infrastructure beyond the industrial zone boundary that is nonetheless directly affected. Post-mining land rehabilitation obligations must be implemented consistently and proportionately to the pace of exploitation.

Third, post-mining economic transition planning. Local government, with national support, must begin systematically developing post-mining economic transition plans well in advance of resource depletion. Economic diversification based on local competitive advantages—fisheries, maritime tourism, agribusiness—must be integrated as strategic pillars in the next Medium-Term Regional Development Plan (RPJMD). Specially designed human resource training and capacity-building programmes for local communities must prepare for this transition, engaging PT IMIP through more structured obligations rather than purely voluntary CSR initiatives.

Fourth, strengthening inter-governmental coordination mechanisms. The formation of an area management coordination body—analogous to a Bahodopi Development Authority—involving representatives from national, provincial, and regency governments, PT IMIP, and communities could constitute an effective institutional solution. This body must possess genuine authority—not merely a coordination forum without mandated power—and be supported by adequate funding to carry out integrated area planning, monitoring, and control functions.

5.3 Implications for National Downstream Policy and Global Mineral Supply Chains

The findings of this research have direct implications for Indonesia's broader mineral downstream processing policy. The Morowali Industrial Zone is only one of nine national priority industrial zones, and other Indonesian nickel zones—Konawe in Southeast Sulawesi, Central Halmahera in North Maluku—face analogous dynamics. Specifically, downstream processing policy should be complemented by: integrated spatial planning requirements as a prerequisite for priority industrial zone designation; dedicated budget allocations to strengthen institutional capacity in regions surrounding industrial zones; stronger benefit-sharing mechanisms to ensure local revenue commensurate with the social and environmental burdens borne locally; and an integrated monitoring and evaluation system encompassing social, environmental, and spatial dimensions—not merely economic indicators.

In the global context, the IMIP experience is also relevant to the intensifying discourse on responsible mineral supply chains amid rising nickel demand for electric vehicle batteries. If Indonesia wishes to position its nickel products as "responsible nickel" in international markets—thereby earning a premium and accessing European and North American markets with increasingly stringent Environmental, Social, and Governance (ESG) standards—then the industrial zone governance improvements recommended in this article are not only a domestic imperative but also a strategically important competitiveness agenda.

6. Conclusions

This article has demonstrated that the dynamics at the IMIP zone in Morowali Regency constitute the manifestation of a systemically embedded industrialisation paradox: a national downstream processing policy that has succeeded in driving macro-level economic growth while generating very large accumulated social and environmental costs at the local level, borne disproportionately by local communities and the ecosystems that sustain them.

DPSIR analysis reveals that the three ecosystems—industrial, settlement, and environmental—are interconnected through complex causal loops in which unplanned growth in one ecosystem generates cumulative pressures that exceed the absorptive capacity of the others. The cascading DPSIR concept developed in this article explains why partial and reactive interventions are never sufficient to address the complexity of problems in extractive industrial zones. The six strategic issues identified—spatial governance regulatory vacuum, settlement infrastructure deficit, environmental degradation, low accessibility, weak human resource capacity and mono-economic dependency, and high disaster vulnerability—are mutually interlinked and must be addressed in an integrated manner across the three spatial scales.

Policy synthesis of 26 regulatory documents demonstrates that the principal problem does not lie in the formal inconsistency of policies, but rather in the implementation gap caused by the imbalance between national policy ambition and local institutional capacity. Required reforms encompass the acceleration of spatial planning instruments, industrial zone governance reform towards structured corporate accountability, early initiation of post-mining economic transition planning, and the strengthening of inter-governmental coordination mechanisms. As the world's largest nickel industrial zone, IMIP offers lessons relevant to resource-based industrialisation policy in developing countries: that the speed of economic growth cannot be the sole measure of success if it is not accompanied by equitable benefit distribution, responsible management of environmental impacts, and the development of adequate institutional capacity.

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