Research Article

Adaptive Capacity of Local Government in Mitigating Environmental Health Impacts if Nickel Industrialization In Morowali

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Abstract

Introduction: Downstream nickel industrialization in Morowali Regency has triggered a sharp rise in Acute Respiratory Infection (ARI) cases, from 67,732 in 2023 to 81,261 in 2025, in step with a surge of migrant workers and dense settlement growth around the mining ring. This article analyzes the adaptive capacity of the Morowali local government in mitigating this environmental health impact using Clarvis and Engle's (2015) four-dimensional adaptive capacity framework: networking, flexibility, knowledge, and integration. The study used a qualitative case study design, involving informants from the Health Office, the Regional Environmental Agency, community health centers (PUSKESMAS), sub-district and village officials, the corporation (PT Indonesia Morowali Industrial Park), and affected residents, through observation, semi-structured interviews, and document analysis, verified through source and method triangulation. The findings show that the health bureaucracy has demonstrated fairly strong adaptive capacity in networking, flexibility, and knowledge, reflected in cross-sector collaboration, streamlined emergency procedures, quickly disbursed corporate social responsibility (CSR) funding, and digitalized medical records and emission monitoring. However, the integration dimension fails at its most fundamental point: spatial planning. The absence of an ecological buffer zone between settlements and factories means that the gains achieved in the other three dimensions have not translated into a meaningful reduction in ARI cases. The article recommends revising the industrial spatial plan, establishing a joint task force with binding decision-making authority, and redirecting CSR funds from curative activities toward structural pollution prevention.

Keywords: Adaptive Capacity, Environmental Health, Acute Respiratory Infection, Nickel Industrialization, Local Governance.

1 Introduction

Modern public administration requires government organizations not merely to enforce rigid procedures, but also to learn and adjust to constantly shifting environmental pressures. This idea is rooted in resilience theory and the complex adaptive systems approach, both of which originated in ecological studies before being adopted into governance research. Folke (2006) explains that a resilient system does not mean a system free of problems, but one able to learn from disturbances and adjust its way of working in order to keep functioning. From this foundation emerges the concept of adaptive capacity: the ability of a system to maintain its core function while reducing the risks that arise from environmental change. This concept has become an important framework for assessing bureaucratic performance when confronting an environmental health crisis.

This issue is highly relevant in Morowali Regency, Central Sulawesi, home to PT Indonesia Morowali Industrial Park (IMIP), the largest nickel processing estate in Southeast Asia. Nickel downstreaming has significantly boosted the regional economy, but it has also produced two interlinked problems: an explosion in migrant population mobility and a decline in air quality. Data from the Morowali Regency Health Office recorded a sharp increase in Acute Respiratory Infection (ARI) cases, from 67,732 in 2023 to 80,713 in 2024, and 81,261 in 2025. Bahodopi Sub-district, the core location of the industrial estate, accounted for the largest share, with 55,527 cases in 2023 and a still-high 64,998 cases in 2025, while referrals of ARI patients to Morowali Regional Hospital jumped from zero in 2023 to 892 cases in 2025.

These field findings are consistent with broader independent reports. Central Sulawesi Province as a whole recorded a 26 percent rise in respiratory infection cases within a single year, from 262,160 cases in 2023 to 305,191 cases in 2024, with the IMIP estate in Morowali alone accounting for 57,190 diagnoses in 2024

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(EnviroLink Network, 2026; Mongabay, 2026). Indonesia's National Commission on Human Rights (Komnas HAM) has also stressed that communities living around mining and smelting areas face higher risk due to exposure to dust and production emissions (Mongabay, 2026). Air quality testing conducted by a local university in 2024 likewise found particulate concentrations exceeding national safety standards (National Public Radio [NPR], 2026). This body of evidence reinforces the argument that the environmental health crisis in Morowali is not merely a local administrative issue, but part of a wider national pattern in Indonesia's extractive nickel industrialization (Climate Rights International, 2025).

Population density is a critical variable that worsens the spread of ARI. Data from the Central Statistics Agency of Morowali Regency show that the population of Bahodopi Sub-district surged from 39,733 people in 2023 to 47,160 in 2025, far outpacing the relatively normal growth of other sub-districts. The uncontrolled influx of mine workers has produced dense settlements that fall short of basic habitability standards; a single boarding room measuring 4 by 4 meters is often occupied by up to six people. This condition accelerates the transmission of respiratory disease and places heavy pressure on primary health facilities, particularly Bahodopi Community Health Center, which must serve patient volumes far beyond the available ratio of medical staff.

An emergency of this scale demands that the local health bureaucracy move beyond routine, procedural patterns of work. The New Public Service paradigm insists that bureaucracy must be flexible in serving citizens as rights holders, not merely as users of administrative services (Denhardt & Denhardt, 2003). In practice, however, health bureaucracies in many regions remain constrained by rigid organizational structures, weak inter-agency coordination, and excessive dependence on formal procedure (Osborne, 2010). Previous studies on the adaptive capacity of Indonesian bureaucracy have so far focused mainly on digital service innovation (Cahyani, 2022) and institutional governance in newly formed autonomous regions (Hutagalung & Hermawan, 2018), while research on non-health sectors such as water resource management and disaster response is comparatively more advanced (Sufianti et al., 2021; Widener et al., 2017). Studies that specifically examine the adaptive capacity of local health bureaucracies in responding to the impacts of extractive industrialization, particularly the handling of ARI in mining regions, remain very limited, leaving an important research gap to be addressed.

Building on this background, this article aims to analyze how the adaptive capacity of the Morowali local government functions in mitigating environmental health impacts through ARI management in the industrial zone, examined across four dimensions: (1) networking or cross-sector collaboration, (2) flexibility of policy and procedure, (3) knowledge or organizational learning and epidemiological information, and (4) integration of resources and programs. More specifically, this research seeks to answer four questions: first, how is cross-sector networking built in the handling of ARI in the Morowali industrial zone; second, to what extent does the bureaucracy demonstrate policy and procedural flexibility when facing surges in caseload; third, how are knowledge and epidemiological data managed as a basis for policy decisions; and fourth, to what extent are inter-agency programs and resources integrated into one coherent mitigation framework.

This article makes two contributions. Empirically, it offers a concrete picture of how a health bureaucracy in a mining downstreaming region adapts to an environmental health crisis, while updating the evidence base on the impacts of nickel industrialization, a topic more often discussed from an economic or labor perspective. Theoretically, it tests whether Clarvis and Engle's (2015) adaptive capacity framework can explain why strong performance in three dimensions fails to translate into a meaningful decline in morbidity when a fourth dimension, spatial integration, is not met. In doing so, this article does not merely document conditions in a single regency, but also offers a re-reading of the assumption that the four dimensions of adaptive capacity are equally weighted and mutually substitutable.

LITERATURE REVIEW

Adaptive Capacity as an Analytical Framework

Adaptive capacity is an important derivative of resilience theory. Folke (2006) defines it as the ability of a system to survive through adjustment and restructuring of its internal structure without losing its core function when facing pressure. Smit and Wandel (2006) extend this definition to the capacity of a system to adjust in order to reduce harm while taking advantage of opportunities that arise amid uncertainty. Birkmann et al. (2010) argue that adaptation is not merely a temporary survival strategy, but a long-term process of change that keeps bureaucracy relevant to social and demographic shifts.

Gupta et al. (2010) operationalize this concept through the Adaptive Capacity Wheel, which places organizational learning, distribution of authority, leadership, and resource management as key determinants of

institutional adaptive capacity. Clarvis and Engle (2015) subsequently developed a more applied framework for institutional public governance, comprising four dimensions: networking, flexibility, knowledge, and integration. This framework serves as the main analytical lens in this article because it was specifically designed to examine bureaucracies that work in a sectoral manner and respond slowly to changing field conditions, a condition highly relevant to the context of the health bureaucracy in Morowali.

- **The Four Dimensions of Adaptive Capacity in the Context of ARI in Morowali**

Following Clarvis and Engle's (2015) framework, the networking dimension assesses a bureaucracy's ability to build cross-sector partnerships beyond formal institutional boundaries, relevant to examining how the Health Office, the Regional Environmental Agency, Puskesmas, and private corporations unite their response to ARI. This dimension builds on the leadership and resource availability indicators in Gupta et al.'s (2010) Adaptive Capacity Wheel, and also reflects the importance of social capital and inter-organizational trust as the foundation of a resilient system (Folke, 2006). The flexibility dimension assesses the pliability of procedure and budget in responding to an epidemiological emergency without being hindered by standard bureaucratic rigidity, drawing on Gupta et al.'s (2010) notion of room for autonomous change.

The knowledge dimension assesses an organization's ability to use epidemiological and air quality data for continuous learning (Pahl-Wostl, 2009), emphasizing iterative learning that turns previous crisis experience into a basis for subsequent policy improvement. The integration dimension assesses the alignment of regulation, budget, and cross-sector interests into one coherent policy system, including its link to bureaucratic legitimacy in producing public value in the form of a healthy environment (Moore, 1995). This dimension was specifically designed to address the policy fragmentation that Clarvis and Engle (2015) criticized, namely the tendency of bureaucracies to work in sectoral silos without a clear alignment of interests across institutions.

It is important to note that, in its original formulation, the framework assumes that the four dimensions operate in a complementary manner, meaning that weakness in one dimension can ideally be partly compensated by strength in another. However, a number of recent studies question this assumption of substitutability, particularly in the context of environmental crises rooted in physical spatial conditions. Baehler and Biddle (2018), for instance, argue that adaptive capacity in public administration is highly sector-dependent: in sectors where the root cause is spatial and physical, the integration dimension tends to become a precondition rather than merely one dimension among equals. This argument is tested empirically in the results and discussion section of this article by tracing all four dimensions in sequence within the context of ARI management in Morowali's industrial zone.

2. METHOD

This study used a qualitative approach with a case study design (Creswell, 2014; Yin, 2018). This approach was chosen because the focus of the research is not on the statistical measurement of clinical success, but on a deep understanding of the process of organizational adaptation, patterns of inter-actor coordination, and mechanisms of emergency decision making in ARI management in an industrial zone. The system for mitigating and managing environmental health impacts in Morowali Regency is positioned as a bounded system, with clear boundaries in terms of institutional scope (the Health Office, the Regional Environmental Agency, and the Puskesmas network), spatial location (the Morowali Industrial Zone, particularly Bahodopi Sub-district), and the actors directly involved in the epidemiological emergency at the local level.

Informants were selected using purposive sampling, based on institutional authority and direct involvement in mitigating environmental health impacts. Informants consisted of: (1) leadership of the Health Office or the Head of the Disease Prevention and Control Division; (2) leadership of the Regional Environmental Agency or a functional official in charge of environmental control; (3) heads of Puskesmas in the industrial ring, including Puskesmas Bahodopi; (4) health workers directly handling ARI patients; (5) representatives of the Health, Safety, and Environment (HSE) and Corporate Social Responsibility (CSR) divisions of PT IMIP; (6) sub-district and village officials in the industrial ring; and (7) local residents or ARI patients as recipients of services and as directly affected parties.

Data were collected through three techniques: direct observation of the medical response process at Puskesmas facilities in the mining ring and the actual condition of air pollution exposure; semi-structured interviews that allowed flexibility to probe the dynamics of coordination, emergency regulatory flexibility, and structural obstacles; and document study, covering spatial planning and environmental impact assessment documents, environmental health program reports, monthly ARI epidemiological databases, budget documents for pollution mitigation, and Air Pollution Standard Index (ISPU) monitoring data.

Data analysis followed the interactive model of Miles, Huberman, and Saldana (2014), consisting of data collection, data condensation (selection, focusing, and simplification of raw data into themes related to the four dimensions of adaptive capacity), data display in the form of descriptive narrative and actor network matrices, and conclusion drawing and verification, carried out progressively from the beginning of data collection through the completion of the entire analysis. At the condensation stage, the researcher applied strict selection to informant statements relevant to the four dimensions of adaptive capacity, then grouped them into themes and patterns related to networking, flexibility, knowledge, and integration for each actor group: local government (the Health Office and the Regional Environmental Agency), health service facilities (Puskesmas and medical staff), sub-district and village government together with the local community, and the corporation.

Data credibility was tested through two forms of triangulation. Source triangulation was carried out by comparing statements from various informants across institutions and interests, including officials of the Health Office, the Regional Environmental Agency, Puskesmas heads, corporate management, and affected communities, to check the consistency of data on the responsiveness of health policy in the industrial zone. Method triangulation was carried out by checking the consistency between in-depth interview results, field observation of actual air pollution exposure, and documentation of monthly ARI reports and ISPU monitoring data (Creswell, 2014; Patton, 2015). Data obtained were subsequently confirmed with relevant informants (member checking) to ensure accuracy and validity, and further strengthened with supporting sources such as scientific literature on the health impacts of mining downstreaming and environmental policy documents, before being classified and systematically analyzed to produce comprehensive and academically defensible conclusions

3. RESULTS

Networking Dimension: Strong Collaboration in Service Delivery, Fragile in Negotiation

The findings show that pressure from population mobility forced Dinas Lingkungan Hidup Daerah (DLHD) to move beyond a sectoral pattern of work. The Health Office built partnerships with dozens of private health facilities, independent medical practices, and internal company clinics around the mine, requiring all partners to report ARI patient data every month so that service burdens could be more evenly distributed. On the environmental oversight side, the DLHD, which does not yet have its own industrial laboratory, built vertical partnerships with central government ministries and signed memorandums of understanding with accredited environmental laboratories, so that the air quality data used for policymaking would have a legitimate legal basis.

At the direct service level, Puskesmas Bahodopi expanded its network down to the community level, establishing communication with neighborhood heads, village officials, and boarding house owners to build an early reporting system, enabling medical staff to respond to disease clusters before they spread further. PT IMIP, through its HSE and CSR divisions, also integrated its internal clinics into the Puskesmas reporting system and regularly sent medical teams to provide free treatment in villages within the industrial ring.

This strength of networking at the operational level is also evident at the lowest tier of government. Facing piles of waste and declining sanitation caused by the population influx, sub-district and village governments partnered with Puskesmas staff, the corporation, security forces, youth groups, and migrant worker associations to organize mass community clean-up drives and set up watch posts at illegal dumping sites. This pattern shows that the capacity to build networks is not the monopoly of the regency-level bureaucracy, but also grows organically at the level of government closest to the community, in line with Gupta et al.'s (2010) argument that the distribution of leadership across multiple layers of government is a marker of an adaptive institution.

However, the strength of this network becomes uneven when it shifts from the sphere of medical service and environmental cleanliness toward the more fundamental sphere of negotiating environmental disputes. Residents who sought to build communication channels with village heads, sub-district heads, and even company leadership reported that the corporation almost never sent its directors or top management to negotiation forums; the company tended to send only public relations staff who lacked the authority to approve compensation claims. This pattern is not unique to Morowali. A report by Climate Rights International (2025), based on interviews with 93 residents across three of Indonesia's main nickel hubs (Southeast Sulawesi, Central Sulawesi, and North Maluku), documents a similar pattern: limited access to public information, an unequal bargaining position in compensation negotiations, and slow handling of environmental complaints by companies. Vinesh et al. (2025) further confirm that overlapping authority among institutions in industrial zones often leaves dispute resolution mechanisms unclear. The networking dimension in Morowali is therefore strong

in its medical and operational function but weak in its function of representing and enforcing residents' interests, a gap that, if left unaddressed, will continue to leave the root cause of pollution unresolved. This pattern of relations reveals a layered network of varying quality: networks among bureaucratic agencies, and between bureaucracy and the corporation at the technical level, function fluidly and with mutual trust, whereas the network between the community and the corporation's top decision makers remains blocked by a corporate hierarchy reluctant to grant direct access. This situation demonstrates that expanding the number of actors in a network does not automatically improve the quality of that network if the actors who genuinely hold decision-making power remain out of residents' reach.

- **Flexibility Dimension: Rapid Response in Clinical Spaces, Constrained in Production Spaces**

The flexibility of Morowali's health bureaucracy is most evident in budgeting and clinical procedure. Recognizing that disbursement of Anggaran Pendapatan dan Belanja Daerah (APBD) involves a lengthy approval process ill-suited to the speed of a rising caseload, the Health Office made rapid use of corporate CSR funds to finance emergency response programs such as GESER ISPA (Gerakan Edukasi Serentak Infeksi Saluran Pernapasan Akut). A similar pattern occurs at the village level, where the Village Budget (APBDesa) includes a contingency fund that can be disbursed immediately when an environmental health crisis emerges.

In the service space, Puskesmas Bahodopi applies a fast-track procedure for emergency patients: those arriving with severe shortness of breath do not need to go through conventional registration counters and are immediately given nebulizer therapy without being hindered by incomplete residency documents, a policy highly relevant given that many migrant workers lack a local identity card or health insurance. Medical staff schedules are also adjusted dynamically, including extending emergency services to a full 24 hours on days when pollution worsens. On the environmental oversight side, the limited number of DLHD personnel, only five officers to monitor the entire industrial zone, is addressed through a risk-based approach: prioritizing the locations most frequently reported by residents and supplementing this with indirect oversight by reviewing companies' routine compliance reports.

The corporation likewise shows operational flexibility by converting routine CSR programs into emergency mask distribution when air quality worsens, and by tracing pollution sources whenever sensors detect a sharp decline in air quality. However, this flexibility collides with internal pressure to meet production targets. A company informant acknowledged that the fast pace of operations often means production facilities are built before environmental permitting is complete, a pattern consistent with the concept of institutional inertia in environmental governance (Luqito & Firmansyah, 2023), in which production interests tend to dominate pollution prevention interests.

Flexibility also appears at the household level, but in a problematic form: residents keep doors and windows shut all day and wear masks even inside their own homes to keep out factory dust. This behavior is technically a form of adaptation, but in fact reflects the loss of residents' right to clean air in their own homes, a form of forced coping rather than a structural solution. This kind of flexibility is itself an indicator of a larger systemic failure: when the only remaining form of adaptability available to residents is confining themselves indoors, it signals that the space for adjustment that should have been provided through spatial planning and emission control policy has instead been shifted onto residents as an individual burden.

Sub-district officials also demonstrate flexibility through the willingness to clear industrial trucks parked haphazardly, keeping village roads, including access for ambulances, unobstructed, a small but concrete step in maintaining the mobility of emergency services amid dense industrial traffic. Overall, the flexibility of Morowali's health bureaucracy is fairly strong in responding to clinical emergencies and short-term financing needs, but it has not yet reached the flexibility needed at the source of the problem, namely the regulation of industrial production operations itself. This gap shows that flexibility as a form of adaptive capacity is asymmetric: bureaucracy and residents are required to be highly adaptable, while the corporation, as the source of environmental pressure, remains relatively shielded from a comparable demand for flexibility.

Knowledge Dimension: Abundant Data, Lagging Physical Follow-up

The surge of migrant workers reluctant to register their place of residence created a data blindness regarding population figures, complicating the mapping of vulnerable groups. The health bureaucracy responded with full digitalization: patient records at Puskesmas shifted from paper to an Electronic Medical Record (RME) system that captures specific disease type, home address, and workplace location, then connects automatically to the central computer at the Regency Health Office. This data is discussed in monthly meetings (mini-workshops at Puskesmas) to map the areas with the highest morbidity rates, so that education campaigns and mask distribution can be directed precisely.

On the environmental side, the DLHD conducts direct air quality measurements within the industrial zone, while PT IMIP operates a Continuous Emission Monitoring System (CEMS) on factory chimneys, connected in real time to the database of the Ministry of Environment and Forestry, enabling early detection of emission spikes above the quality standard threshold. The local government also draws on an Environmental Health Risk Assessment study from the central government, which projects that children living around the industrial zone face a risk of lung and heart damage within nine years, used as a basis for protective policy.

These field-level data are consistent with broader external findings. Air quality testing by a local university in 2024 found dangerous particulate concentrations exceeding national safety standards (NPR, 2026; KERA News, 2026), while a Dialogue Earth (2025) report recorded coal ash found in school classrooms in Labota Village, only a few hundred meters from the IMIP plant, triggering coughing and shortness of breath among a number of students. The convergence of local data (RME and CEMS) with these independent findings strengthens the validity of the knowledge base built by the Morowali bureaucracy.

However, this sophisticated knowledge capacity has not yet translated into physical environmental improvement felt by residents. Community members report fatigue from repeated surveys and data collection by both health and corporate officials, without ever seeing a tangible change in air quality in their surroundings. This gap between data availability and corrective action is consistent with findings from cross-country studies showing that strong public health governance capacity requires a combined configuration of technological, organizational, and environmental factors simultaneously; monitoring technology alone, without changes in organizational and environmental factors, is not sufficient to produce meaningful public health improvement (Frontiers in Public Health, 2025). In other words, the knowledge dimension in Morowali excels in data collection and processing, but is weak in closing the feedback loop toward environmental improvements that residents can directly experience.

This gap is also evident at the level of residents' own knowledge. Unlike the bureaucracy, which relies on digital instruments, local communities build their understanding of environmental damage from daily lived experience: a sulfur-like odor noticeable every night, and zinc roofing that rusts and leaks within less than a year due to chemical exposure. This experience-based knowledge is in fact a rich, real-time form of qualitative data, but it has not yet been positioned as equal to the quantitative RME and ISPU data in policy decision making. Yet pairing formal knowledge (digital government and corporate data) with residents' experience-based knowledge could accelerate the early detection of critical pollution hotspots not yet captured by fixed sensors. The failure to combine these two forms of knowledge is one reason residents feel that repeated data collection has not produced tangible results: the knowledge instruments used by government and industry tend to be technocratic and one-directional, rather than dialogic and participatory.

Integration Dimension: Aligned on Paper, Fractured in Spatial Planning

At the regulatory level, policy alignment in Morowali is fairly well structured. The Health Office ensures that environmental health programs are aligned with Rencana Pembangunan Jangka Menengah Daerah (RPJMD), while pollution control targets are linked to the corporation's Environmental Impact Assessment (AMDAL) and its Environmental Management and Monitoring Plan (RKL-RPL). At the village level, residents' health complaints are discussed regularly in the Village Development Planning Deliberation (Musrenbangdes), ensuring they become a priority in the following year's health budget. Clinical-preventive integration also functions fairly well at Puskesmas: ARI patients receive not only medication but also direct counseling, followed up by sanitarian visits to patients' residences to check ventilation and occupancy density. At the corporate level, coordination across the Production, HSE, and CSR divisions runs actively, including automatic adjustment of the company's environmental action plan whenever regulations are updated.

Even so, all these achievements in administrative integration collapse at one critical point: spatial planning. There is no ecological buffer zone separating residential settlements from the smelting area. Boarding houses and rented rooms for migrant workers have been built pressed tightly together, in some cases directly abutting the industrial zone's perimeter wall and the routes used by heavy vehicles hauling mining material. As a result, no matter how good the treatment provided by Puskesmas, patients always return to a living environment directly exposed to factory dust and emissions, so the cycle of respiratory illness continues to repeat.

The dual impact of this spatial integration failure is also felt in livelihoods. Coastal residents who previously relied on fishing have lost their source of income as waters turned murky and warm from waste discharge, while at the same time their respiratory health continues to be eroded by air pollution. This dual loss, of livelihood and of health, demonstrates that the consequences of failed spatial integration are multidimensional, not confined to the health sector alone, and therefore cannot be resolved through partial measures.

This failure of spatial integration is not an isolated case in Morowali, but a pattern that recurs across Indonesia's nickel downstreaming regions more broadly. A Climate Rights International (2025) report documents land grabbing, forced relocation without adequate compensation, and destroyed fishing livelihoods due to water pollution across Indonesia's three main nickel hubs. Dialogue Earth (2025) additionally records the added risk of tailings waste accumulation, projected to grow more than fourfold by 2026, along with earthquake risk in the surrounding area that has not yet been matched by adequate spatial planning and disaster mitigation. These findings reinforce the argument that policy integration cannot stop at aligning documents and administrative budgets; genuine integration must extend to the physical arrangement of space between the source of pollution and residential settlements, the aspect hardest to achieve because it directly touches industrial economic interests and land scarcity.

This failure in the integration dimension explains why strong performance in the other three dimensions, networking, flexibility, and knowledge, has failed to significantly reduce ARI cases. Within the adaptive capacity framework, all four dimensions are assumed to be complementary (Gupta et al., 2010; Clarvis & Engle, 2015); however, the findings from Morowali reveal a kind of ceiling effect: high performance in service delivery and knowledge management cannot compensate for a structural failure in spatial integration. This finding adds nuance to Clarvis and Engle's framework: in the context of an environmental health crisis caused by extractive industrialization, the integration dimension is not merely one of four equal pillars, but a structural precondition that determines the effectiveness of the other three. This argument reinforces Baehler and Biddle's (2018) view that adaptive capacity cannot be treated as a collection of standalone indicators, but as a system whose success is determined by its weakest link.

Discussion: Curative Adaptation Without Structural Change

Overall, the pattern observed in Morowali is that of a health bureaucracy highly adaptive in curative and administrative terms, but not yet adaptive in structural terms. The Health Office, the DLHD, and Puskesmas have successfully built collaborative networks, cut procedural barriers, and built a relatively sophisticated data system for a developing region. This is consistent with Kattel's (2022) and Kim and Kim's (2022) argument that the dynamic capabilities and innovation capacity of public organizations can indeed grow rapidly under crisis pressure. However, adaptation of this kind is fundamentally reactive, responding to symptoms of the illness rather than its source.

This pattern is also reflected in the power relationship between local government and the corporation. When it comes to direct health service delivery (CSR donations, free treatment, mask distribution), collaboration proceeds quickly and smoothly. But when it comes to decisions that affect production continuity, such as temporarily halting the plant during extreme pollution episodes or funding full relocation compensation for affected settlements, decision-making authority remains firmly in the hands of the corporation, and local government has not yet developed a policy instrument strong enough to enforce such decisions. This condition is consistent with Vinesh et al.'s (2025) finding on weak policy coherence caused by overlapping authority in industrial zones, as well as the broader observation that regions with high economic dependence on a single industrial sector tend to have weaker regulatory bargaining power against investors.

Comparison with contemporary adaptive governance literature reinforces this conclusion. Nzewi (2025) argues that genuine adaptive governance requires a balance between structural accountability and operational flexibility, two elements that have not yet developed equally in Morowali. Research on the integration of climate and health policy at the city level also confirms that long-term success depends on unifying spatial planning with health strategy from the earliest planning stage (ScienceDirect, 2025), rather than adding it after a health crisis has already erupted, as occurred in Morowali. Consequently, the main challenge going forward is no longer to strengthen the administrative and clinical capacity that is already relatively strong, but to build the political will and legal instruments that would allow local government to enforce spatial boundaries against the interests of large-scale extractive industry.

This finding also carries methodological implications for the future use of Clarvis and Engle's (2015) adaptive capacity framework. To date, the four dimensions of this framework have often been treated as equally weighted in institutional adaptive capacity assessments, for example through an aggregate or composite index score. The Morowali case study shows that treating the dimensions as equal in this way risks concealing a critical failure: a bureaucracy could receive a high aggregate score by excelling in three dimensions, while substantively still failing to protect residents' health because of weakness in the dimension that matters most. Therefore, assessments of adaptive capacity in the environmental health sector should not merely calculate the average score across the four dimensions, but should also identify which dimension functions as a structural

precondition, or binding constraint, for the success of the system as a whole, a reading that more closely resembles a weakest-link analysis than a simple summation of scores.

The practical implications of this finding are also relevant for other regions in Indonesia currently undergoing similar mining downstreaming processes, given that rapid nickel industry growth, accompanied by large-scale worker migration and inadequate spatial planning readiness, is not a phenomenon unique to a single regency, but rather a structural pattern in Indonesia's natural resource downstreaming policy more broadly (Climate Rights International, 2025; Dialogue Earth, 2025). This means the policy recommendations generated from the Morowali case have the potential to carry broader relevance for other mining and mineral processing regions in Indonesia facing similar challenges.

5. CONCLUSION

The adaptive capacity of the Morowali local government in mitigating environmental health impacts shows an uneven pattern across dimensions. In the networking, flexibility, and knowledge dimensions, the local health bureaucracy, together with Puskesmas, sub-district and village officials, and the corporation, has shown a rapid and reasonably innovative response: cross-sector collaboration for medical service delivery, streamlined emergency procedures, agile CSR financing, digitalized medical records, and sensor-based emission monitoring. However, in the integration dimension, particularly spatial integration between the industrial zone and residential settlements, the local bureaucracy has experienced a structural failure that renders all the gains achieved in the other three dimensions insufficient to meaningfully reduce ARI cases. As long as there is no ecological buffer zone separating the source of pollution from residents' homes, the cycle of respiratory illness will continue to repeat, no matter how sophisticated the health service system built around it.

Based on these conclusions, this article proposes the following strategic recommendations. First, for the local government and legislature, it is urgent to revise the Regional Spatial Plan (RTRW) for the industrial zone by mandating an ecological buffer zone at a safe distance from settlements, accompanied by a fair relocation financing scheme for residents in high-risk zones, with mandatory joint financing from the corporation. Second, a permanent joint task force with binding authority should be established, involving corporate directors directly rather than only public relations staff, so that residents' environmental complaints can be resolved without being delayed by layered bureaucracy.

Third, for the Health Office and the DLHD, it is necessary to require the direct integration of every factory's emission monitoring system (CEMS) into the government's real-time monitoring system, so that pollution spikes can automatically trigger an early warning for Puskesmas to activate mobile health services. Fourth, for the corporation, a portion of CSR funds should be redirected from curative activities (treatment and mask distribution) toward investment in structural prevention, such as emission control technology and enclosure of material transport routes, along with an automatic mechanism to reduce production capacity whenever sensors detect pollution exceeding the safe threshold.

Fifth, for sub-district and village governments, residents' bargaining position in environmental dispute resolution forums should be strengthened by requiring the presence of top corporate management, not only public relations staff, whenever such forums address compensation claims or the temporary halting of production activities proven to be a source of pollution. Sixth, government and corporate digital data should be systematically paired with residents' experience-based knowledge, for instance through a citizen reporting mechanism integrated with the government's early warning system, so that field-level information flows not only upward from the bureaucracy but also serves as active input for policy renewal.

This set of recommendations underscores one central principle: strengthening the adaptive capacity of the health bureaucracy will accomplish little unless accompanied by the political will to enforce a clear spatial boundary between industrial interests and residents' right to a healthy environment. As long as the corporation can continue operating without a clear physical boundary from residential areas, and as long as negotiation forums remain dominated by parties without decision-making authority, the adaptive capacity so painstakingly built by the Health Office, the DLHD, and Puskesmas will continue to operate in firefighting mode, treating the symptoms of illness as they appear without ever truly extinguishing the source.

This study has a number of limitations that should be openly acknowledged. First, as a single case study focused on one industrial zone, generalization of the findings to other contexts should be made with caution, given that each industrial zone has a different institutional configuration, demographic profile, and power dynamic. Second, the qualitative approach used allows for a deep understanding of the process and mechanisms of adaptation, but has not yet been able to precisely quantify the contribution of each dimension of adaptive capacity to the decline or rise of ARI incidence. Third, limited access to certain internal corporate documents

constrains the depth of analysis regarding business decision-making processes that shape the company's environmental policy.

Given these limitations, future research is recommended to conduct comparative studies across other nickel downstreaming zones in Indonesia, such as Indonesia Weda Bay Industrial Park in North Maluku or nickel industrial zones in Southeast Sulawesi, to test the consistency of the pattern of curative adaptation without structural integration found in this study. Future research is also encouraged to adopt a mixed methods approach, combining qualitative analysis of institutional capacity with quantitative spatial epidemiological modeling, to more precisely measure the causal relationship between settlement density, distance from emission sources, and ARI incidence in extractive industrial regions. Longitudinal studies are also needed to monitor whether spatial planning policy recommendations, if adopted, genuinely succeed in reducing morbidity over the medium and long term, so that the adaptive capacity framework can continue to be tested and refined as an evaluation instrument for environmental health governance in Indonesia's extractive industrial zones.

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