



# Regulatory Gaps in Coastal Zone Management: Legal Assessment of Flooding and Abrasion in Loireng Village, Demak

Supriyadi Supriyadi <sup>1,a)</sup>, Endah Pujiastuti <sup>1,b)</sup>, Putri Haliza Yuniar <sup>1,c)</sup>

<sup>1</sup>*Faculty of Law, Universitas Semarang, Semarang, Indonesia*

a) Corresponding author: [supriyadi@usm.ac.id](mailto:supriyadi@usm.ac.id)

b) [endah.pujiastuti@usm.ac.id](mailto:endah.pujiastuti@usm.ac.id)

c) [putrihalizayuniar01@gmail.com](mailto:putrihalizayuniar01@gmail.com)

**Abstract.** This study examines regulatory gaps in coastal zone management using the case study of Loireng Village, Demak, which has experienced severe abrasion, chronic flooding, and ecosystem degradation due to a combination of ecological pressures and weak legal governance. The findings show that various legal instruments, such as the Coastal Zone Management Law, spatial planning regulations, environmental impact assessment (EIA) provisions, and sustainable drainage technical guidelines, are not consistently implemented. The construction of the Sayung Semarang toll road has been shown to alter water flow patterns and exacerbate flooding, while the loss of more than 40 hectares of mangroves and industrial waste pollution have accelerated coastal degradation due to weak supervision and law enforcement. The lack of synchronization between regulations, minimal coordination between agencies, and the failure to apply the principle of public participation have resulted in coastal management policies that are fragmented and unresponsive to ecological risks. This study confirms that the damage to the Loireng coast is a direct result of systemic failures in regulatory harmonization and environmental law enforcement. Therefore, coastal governance reforms must focus on regulatory integration, strengthened oversight, and the application of ecological justice principles to ensure ecosystem protection and the fulfillment of people's rights to a good and healthy environment.

**Keywords :** ecosystem degradation, environmental law enforcement, mangrove degradation,

## 1 INTRODUCTION

Coastal regions are among the most dynamic and vulnerable spaces in the world, functioning simultaneously as ecological buffers, centers of human settlement, and hubs of economic activity. Rapid urbanization, infrastructure expansion, and industrial growth increasingly intersect with climate-related hazards such as sea-level rise, tidal flooding, and coastal erosion.[1] In many developing countries, these pressures accumulate in ways that expose structural weaknesses in environmental governance and legal enforcement. Rather than being managed as integrated socio-ecological systems, coastal zones are often governed through fragmented regulations and sectoral policies that fail to capture cumulative impacts.[2] This disjuncture creates a critical governance gap between ambitious environmental norms on paper and the reality of environmental degradation on the ground.

Indonesia, as an archipelagic state with extensive coastlines, illustrates these tensions in a particularly acute manner. Coastal communities are at the frontline of climate variability, land subsidence, and unsustainable land-use practices, while at the same time being targets of large-scale infrastructure and industrial projects.[3] National laws on coastal zone management, spatial planning, environmental protection, and disaster risk reduction provide a formal framework for sustainable development. However, the implementation of these instruments is often constrained by limited institutional capacity, overlapping mandates, and political-economic interests that prioritize short-term growth over long-term ecological resilience. As a result, coastal degradation persists despite the existence of seemingly robust legal arrangements.

Demak Regency in Central Java stands out as one of the most emblematic examples of this paradox. Once characterized by extensive mangrove belts and productive fishing grounds, the area has gradually transformed into a zone of chronic tidal flooding, shoreline retreat, and socio-economic vulnerability.[4] Land subsidence, changes in hydrological patterns, and the conversion of coastal ecosystems into ponds, settlements, and industrial areas have

collectively undermined coastal stability. For local communities, these changes are not abstract environmental phenomena but everyday realities manifested in flooded homes, lost livelihoods, and displacement. The Demak case therefore provides a strategic entry point to interrogate how coastal regulation operates in practice.

Within Demak, Loireng Village has become a critical site for observing the intersection between ecological pressure and governance failure. The village has experienced severe abrasion, repeated inundation, and significant loss of coastal land over the past years. Residents have witnessed the shoreline recede, agricultural and residential areas disappear, and critical infrastructure become increasingly exposed to tidal and storm events. These dynamics have deepened local vulnerability by eroding livelihood bases and amplifying uncertainty about the future. At the same time, the ongoing degradation of Loireng's coastal ecosystem raises fundamental questions about the effectiveness of existing legal and policy instruments.

From an ecological perspective, the degradation of Loireng's coastline is closely linked to the disruption of natural protective systems, particularly mangrove forests. Mangroves perform multiple functions: they dissipate wave energy, stabilize sediments, support biodiversity, and sustain fisheries. The loss of more than 40 hectares of mangrove cover in and around Loireng has significantly reduced the capacity of the coast to absorb hydrodynamic forces. This ecological simplification has not only accelerated abrasion and flooding but also weakened the overall resilience of the coastal system. Yet, the reduction of mangrove areas has occurred despite legal norms that promote conservation, rehabilitation, and sustainable use of coastal ecosystems.[5]

At the same time, the construction and expansion of large-scale infrastructure projects have introduced new pressures on the fragile coastal environment. One of the most consequential developments near Loireng is the Sayung-Semarang toll road, which has altered water flow patterns and land-use configurations. By changing drainage pathways and surface runoff characteristics, the project has contributed to more frequent and prolonged flooding in adjacent low-lying areas. In principle, such projects should be governed by rigorous environmental impact assessment (EIA) processes, spatial planning rules, and technical guidelines for sustainable drainage. In practice, however, these instruments appear insufficiently applied or inadequately enforced in the Loireng context.

The industrialization of the broader coastal corridor has further intensified environmental stress. Industrial waste, whether from formal factories or informal activities, has contributed to the pollution of coastal waters and sediment.[6] This pollution undermines the ecological functions of remaining mangroves and aquatic habitats, reduces water quality, and threatens public health.[7] Although environmental regulations and pollution control standards exist, weak supervision and limited sanctions have allowed non-compliance to persist. The Loireng case thus reveals how the absence of credible monitoring and enforcement mechanisms can render environmental norms largely symbolic.

These ecological impacts are tightly intertwined with legal and institutional dynamics. Indonesia's regulatory framework for coastal management involves multiple layers of legislation, including the Coastal Zone and Small Island Management Law, spatial planning laws, environmental protection and management laws, and various technical regulations and guidelines. Ideally, these instruments should operate in a coordinated manner to ensure integrated coastal zone management. However, in Loireng, the lack of synchronization between different regulatory regimes has produced gaps, overlaps, and contradictions. Sectoral agencies often act according to their own mandates, with limited horizontal or vertical coordination.

The fragmentation of authority across national, provincial, and district levels further complicates coastal governance. Spatial plans, coastal zoning plans, and development agendas are prepared by different institutions that may have divergent priorities. When strategic infrastructure projects are framed as drivers of regional economic development, environmental safeguards can become secondary or procedural. In such a context, the implementation of EIA, coastal setback regulations, and mangrove protection initiatives is frequently negotiated rather than strictly applied. Loireng's experience illustrates how institutional fragmentation can diminish the coherence and effectiveness of coastal regulation.

Public participation represents another critical dimension of these governance failures. Environmental law and coastal management frameworks often emphasize the importance of involving local communities in planning, decision-making, and monitoring.[8] In principle, participatory processes should help articulate local knowledge, identify risks, and ensure that development projects align with community needs and environmental limits. Yet, in Loireng, mechanisms for meaningful participation appear weak or underutilized. Local residents are frequently informed after decisions have been made rather than being engaged in shaping those decisions. This exclusion undermines both the legitimacy and the quality of coastal governance.

These conditions point to a deeper problem: the disconnect between the normative aspirations of environmental law and the realities of implementation.[9] On paper, the legal framework aspires to provide protection for coastal ecosystems and guarantee citizens' rights to a good and healthy environment. In practice, however, institutional capacity constraints, political-economic interests, and fragmented governance structures impede the realization of

these rights. Loireng's coastal degradation thus cannot be explained solely by natural forces or local behavior; it must be understood as a manifestation of systemic regulatory failure.

Conceptually, this study is situated at the intersection of environmental governance, regulatory studies, and ecological justice. Environmental governance literature highlights the need for integrated, multi-level approaches that align legal instruments, institutional arrangements, and social practices. Regulatory studies draw attention to issues of regulatory design, enforcement, and compliance, emphasizing that rules alone do not guarantee desired outcomes. Ecological justice, meanwhile, extends the notion of justice beyond human-centered distributions to include the protection of ecological systems and the rights of affected communities. By combining these perspectives, the study seeks to illuminate how regulatory gaps and enforcement deficits translate into concrete ecological and social harms.

Within this broad framework, coastal zone management serves as a critical test of the state's capacity to operationalize sustainable development principles. Integrated coastal zone management (ICZM) approaches stress the importance of addressing land-sea interactions, cumulative impacts, and cross-sectoral coordination. In Indonesia, ICZM principles have been formally adopted but unevenly implemented. Loireng provides a concrete case where the failure to integrate coastal, spatial, and environmental regulations has produced a fragmented and reactive style of governance. The village thus functions as a microcosm for examining the broader challenges of implementing ICZM in practice.

The core problem addressed in this study is the mismatch between the complexity of ecological risks in Loireng and the fragmented nature of the regulatory regime governing the area. Severe abrasion, chronic flooding, and ecosystem degradation are symptoms of deeper governance pathologies, including unsynchronized regulations, weak inter-agency coordination, and inadequate law enforcement. Without addressing these systemic issues, technical interventions such as sea walls, drainage improvements, or mangrove planting will likely have limited and temporary effects. Understanding the regulatory and institutional dimensions of the problem is therefore essential for designing more durable solutions.[10]

Accordingly, this study asks how and why existing legal instruments have failed to prevent or mitigate coastal degradation in Loireng Village. It examines the extent to which coastal zone management laws, spatial planning regulations, EIA provisions, and technical guidelines for sustainable drainage have been implemented, enforced, or circumvented. It also explores how agency coordination, political priorities, and public participation shape the trajectory of coastal management decisions. By unpacking these dynamics, the research aims to explain the causal pathways through which regulatory gaps and enforcement failures produce environmental harm.

The significance of this study is both theoretical and practical. Theoretically, it contributes to discussions on environmental rule of law by providing an empirically grounded account of how legal norms are translated or fail to be translated into practice in a specific coastal setting. It demonstrates that environmental degradation is not merely an outcome of individual non-compliance or natural processes but is deeply rooted in the design and operation of regulatory systems. Practically, the study generates insights that can inform policy reforms aimed at improving coastal governance, particularly in regions facing similar combinations of ecological vulnerability and institutional fragmentation.

For policy-makers and local governments, the Loireng case offers valuable lessons on the consequences of neglecting regulatory integration and ecological considerations in development planning. The amplification of flooding due to infrastructure projects, the unchecked loss of mangroves, and the persistence of industrial pollution underline the need for stronger oversight mechanisms.[11] Reforms that clarify institutional mandates, strengthen monitoring and enforcement, and embed ecological justice principles into decision-making processes are essential to preventing further damage and restoring public trust. The study's recommendations are therefore intended to be directly relevant for ongoing and future coastal governance initiatives.[12]

At the community level, the research underscores the importance of recognizing local residents not merely as victims of environmental degradation but as rights holders and potential co-managers of coastal resources. Enhancing public participation mechanisms, providing access to information, and creating channels for community-based monitoring can help recalibrate power relations in environmental governance. Such measures are integral to the realization of the constitutional right to a good and healthy environment and to the broader pursuit of ecological justice for marginalized coastal populations.

Methodologically, the study adopts a case-study approach that combines legal and policy analysis with empirical observations at the village level. It involves a close reading of relevant laws, regulations, and technical guidelines, as well as an assessment of their implementation in practice. This is complemented, where possible, by field-based insights into how local stakeholders experience and interpret coastal changes, regulatory interventions, and institutional responses. By integrating normative and empirical perspectives, the research aims to capture both the formal architecture and the lived reality of coastal governance in Loireng.

The scope of the study is deliberately focused on Loireng Village and its immediate coastal and regulatory context. While broader regional and national dynamics inevitably influence local outcomes, the village scale provides a manageable unit of analysis for tracing specific interactions between regulation, infrastructure development, ecosystem change, and community vulnerability. At the same time, the findings are expected to have relevance beyond Loireng, especially for other coastal areas experiencing similar patterns of abrasion, flooding, and governance challenges. The case-study approach thus balances depth of analysis with the potential for broader conceptual insights.

Finally, this introduction situates Loireng's coastal degradation within a larger conversation about the need to reform coastal governance in ways that prioritize regulatory integration, strengthened oversight, and ecological justice. The subsequent sections of the study will elaborate on the theoretical framework, describe the legal and institutional architecture of coastal management, analyze the empirical findings from Loireng, and formulate concrete recommendations for policy and practice. Through this structure, the research aims to move beyond diagnosis toward constructive pathways for ensuring both ecosystem protection and the fulfillment of the right to a good and healthy environment for coastal communities.

## 2 RESEARCH METHOD

His study employed a qualitative socio-legal research design combined with a single case-study strategy centered on Loireng Village, Demak. The socio-legal orientation was chosen to enable a simultaneous reading of formal legal norms and their actual operation within a specific ecological and social context.[13] Rather than treating law solely as a set of abstract rules, the research approached it as a living practice mediated by institutions, actors, and power relations. The case-study design provided the depth necessary to trace how regulatory gaps and enforcement failures contribute to concrete environmental outcomes such as abrasion, flooding, and ecosystem degradation.

A qualitative approach was deemed most appropriate because the main research interest lies in understanding meanings, interpretations, and practices surrounding coastal regulation, rather than measuring variables statistically. Coastal degradation in Loireng is not only a physical process but also a governance phenomenon shaped by discretionary decisions, institutional routines, and contested interpretations of legal obligations. Qualitative methods allow these dimensions to be explored in detail through textual analysis, field observations, and narratives from affected stakeholders.[14] This approach enables the study to capture the complexity of regulatory implementation that would be difficult to grasp through purely quantitative techniques.

Loireng Village was purposively selected as the empirical site because it represents an extreme yet informative case of coastal degradation linked to combined ecological and regulatory pressures. The area has experienced severe abrasion, chronic flooding, and significant mangrove loss, while also being affected by major infrastructure development such as the Sayung-Semarang toll road. These conditions make Loireng a strategic location for examining the interaction between formal regulatory frameworks and on-the-ground decision-making. The village's experience is also indicative of broader patterns in Indonesia's northern Java coast, thereby enhancing the analytical relevance of the case.

The unit of analysis in this research comprises both the regulatory regime governing Loireng's coastal zone and the local governance practices that emerge from it. At the macro level, the study examines the architecture of coastal, environmental, spatial, and infrastructure-related regulations that formally apply to the area. At the micro level, it investigates how local authorities, project proponents, and communities interpret and enact these regulations in everyday coastal management decisions. This dual focus allows the research to bridge the gap between legal texts and socio-ecological outcomes.

Data collection began with an extensive doctrinal analysis of legal and policy instruments relevant to coastal management in Loireng. These included national laws on coastal zone and small island management, environmental protection and management, spatial planning, and disaster risk reduction, as well as implementing regulations, government decrees, and ministerial regulations. Technical guidelines on sustainable drainage, mangrove management, and infrastructure development in coastal areas were also examined. The selection of instruments was guided by their formal applicability to Loireng's jurisdiction and their relevance to issues of abrasion, flooding, and ecosystem protection.[15]

In addition to the core legal texts, the study analyzed a wide range of official documents and secondary materials to understand how regulations were interpreted and operationalized. These sources included regional spatial plans, coastal zoning plans, environmental impact assessment (EIA) documents for major projects such as the toll road, environmental monitoring reports, and institutional work plans from relevant agencies. The research also drew on academic studies, NGO reports, media coverage, and publicly available maps and satellite imagery to reconstruct the

history of coastal change and governance responses in Loireng. Documentary data were organized chronologically and thematically to trace policy trajectories and regulatory turning points.

Fieldwork in Loireng complemented the doctrinal and documentary analysis by providing empirical insights into lived experiences and local governance practices. The field component relied primarily on semi-structured interviews and non-participant observations conducted in and around the village. Semi-structured interviews were chosen because they balance the need for comparability across respondents with flexibility to explore unanticipated issues. Observations focused on visible signs of environmental change, protective infrastructure, drainage systems, and sites of community interaction related to coastal management.

A purposive sampling strategy was used to identify key informants who possessed relevant knowledge or were directly affected by coastal governance decisions. The sample included village leaders, fisherfolk, pond farmers, and residents living in high-risk areas, as well as representatives from local government agencies responsible for environment, public works, spatial planning, and coastal management. Where feasible, interviews were also sought with individuals associated with the implementation of the toll road and industrial activities in the surrounding area. Snowball sampling was employed to reach additional respondents who were recommended by initial informants as having important perspectives on regulatory implementation or environmental impacts.

Semi-structured interviews followed an interview guide organized around several thematic clusters. These clusters covered perceptions of coastal change and its causes, experiences with flooding and abrasion, interactions with government agencies, knowledge of relevant regulations, involvement in planning or consultation processes, and views on law enforcement and accountability. Interviews were conducted in a conversational manner to encourage respondents to narrate their experiences and interpretations freely. With the informed consent of participants, interviews were audio-recorded and later transcribed; when recording was not possible, detailed notes were taken during and immediately after the conversation.

Non-participant observations were undertaken to document the physical and social landscape of Loireng's coastal zone. The researcher visited areas affected by abrasion and flooding, remaining mangrove stands, drainage channels, and sections of the toll road and related infrastructure. Observations focused on the condition of protective structures, patterns of land use, evidence of informal adaptations by residents, and signs of pollution such as industrial waste. Field notes were compiled systematically, describing locations, conditions, and relevant interactions, and were supplemented by photographs where appropriate, while respecting privacy and ethical considerations.

Legal and policy documents were analyzed using a doctrinal and interpretive approach. The analysis scrutinized the content, structure, and hierarchy of relevant norms, examining how key principles such as prevention, precaution, polluter-pays, public participation, and ecological justice were articulated. Particular attention was paid to the consistency between different legal instruments, their institutional allocation of responsibilities, and the presence or absence of clear enforcement mechanisms. The doctrinal analysis also considered how the regulatory framework conceptualized coastal risks, ecosystem protection, and community rights, and whether these conceptions were internally coherent.

Empirical data from interviews and observations were analyzed through qualitative thematic analysis. The process began with an initial round of open coding, in which transcripts and field notes were read line by line to identify meaningful segments related to regulatory implementation, institutional coordination, community experiences, and perceived causes of environmental degradation. These initial codes were then grouped into broader categories such as "regulatory gaps," "weak enforcement," "infrastructure impacts," "mangrove loss," "participation deficit," and "adaptive practices." Through iterative refinement, these categories were developed into themes that captured recurring patterns and contradictions in the data.[16]

To integrate doctrinal and empirical insights, the study employed an analytical matrix linking legal provisions, institutional practices, and observed ecological outcomes. For each major regulatory domain coastal management, spatial planning, EIA, and drainage the matrix juxtaposed what the law formally required, how agencies and project proponents reported implementing those requirements, and how local communities experienced the consequences. This comparative approach made it possible to identify specific types of regulatory gaps, such as non-implementation, selective enforcement, conflicting mandates, or procedural compliance without substantive environmental protection. The matrix also helped clarify causal pathways from regulatory failure to coastal degradation.

Triangulation was a key strategy for enhancing the credibility of the findings. Information derived from legal texts was cross-checked against official documents, interview accounts, and field observations to identify consistencies and discrepancies. For instance, claims about the adequacy of EIA processes or public consultation were evaluated by comparing formal procedures with community narratives and observational evidence. Divergent accounts were not treated as errors to be eliminated but as indicators of underlying conflicts and power asymmetries in coastal

governance. This triangulated analysis strengthened the robustness of conclusions regarding systemic regulatory failures.

Ethical considerations were central to the research process, particularly given the vulnerability of affected communities. Prior to each interview, participants were informed about the purpose of the study, the voluntary nature of their involvement, and their right to decline answering any question or withdraw at any time. Anonymity was ensured by omitting identifying details from transcripts and reports, and by using pseudonyms or generic role descriptions when citing interview material. Audio files, transcripts, and field notes were stored securely and accessed only by the researcher. The study also sought to avoid raising unrealistic expectations by clearly explaining that it did not have direct decision-making authority over coastal management policies.

Reflexivity was practiced throughout the research to acknowledge and mitigate potential biases stemming from the researcher's positionality. The researcher maintained an analytic memo log in which reflections on field interactions, emotional responses, and emerging interpretations were recorded. These memos were used to question taken-for-granted assumptions, consider alternative explanations, and remain attentive to whose voices were being amplified or marginalized in the analysis. Reflexive practice helped ensure that the study's account of regulatory gaps and governance failures remained grounded in the empirical material rather than in preconceived narratives.

Finally, the methodological choices in this study inevitably entail certain limitations. The focus on a single village limits the statistical generalizability of the findings, although the depth of analysis enhances their analytical and conceptual transferability to similar coastal contexts. The research does not include quantitative hydrodynamic modeling or large-scale surveys, which could provide additional insights into physical processes or broader public perceptions. Nonetheless, the combined use of doctrinal analysis, documentary review, interviews, and observations provides a sufficiently rich evidentiary base to address the research questions. These methods are well-suited to uncovering how systemic failures in regulatory harmonization and environmental law enforcement contribute to the ongoing degradation of the Loireng coast.

### 3 RESEARCH RESULTS

The findings of this study are organized around four interrelated dimensions: the materialization of coastal degradation in Loireng, the performance of the regulatory framework in practice, the dynamics of institutional coordination and enforcement, and the implications for ecological justice and the right to a healthy environment. Taken together, these dimensions reveal that the environmental crisis in Loireng cannot be reduced to natural processes alone, but is deeply rooted in systemic failures of regulation and governance. What appears locally as "normal" flooding and erosion is, in fact, the cumulative outcome of choices about how laws are written, interpreted, and enforced.

Empirical observations and community accounts show that Loireng has undergone a dramatic transformation from a relatively stable coastal settlement into a landscape of chronic inundation and shoreline retreat.[17] Residents describe how areas that were once used for rice fields, ponds, or housing have been progressively claimed by the sea. Field visits revealed collapsed embankments, dead tree stumps where mangroves used to stand, and houses that now sit only a few meters from the waterline. Seasonal high tides that were previously manageable have increasingly turned into events that disrupt daily life, damage property, and force temporary displacement.

Documentary reconstruction of the coastline's evolution corroborates these narratives. Local government reports and spatial planning documents indicate that coastal retreat and land loss have accelerated over the past decade, coinciding with intensified infrastructure development and land conversion in the broader Demak-Semarang corridor.[18] Maps and satellite imagery show a gradual thinning and fragmentation of mangrove belts along the shoreline, followed by the eventual disappearance of some stands. While natural processes such as sea-level rise and land subsidence are present, the timing and spatial pattern of degradation suggest strong interaction with human-made changes in land use and hydrology.

From the perspective of local residents, the causes of abrasion and flooding are understood as a combination of natural forces and human actions, with the latter increasingly emphasized. Interviewees repeatedly referred to the construction of the toll road, the loss of mangroves, and the discharge of waste into coastal waters as key drivers that "make the sea angrier" or "stop the water from flowing where it used to." At the same time, some residents framed these changes as inevitable consequences of "development" that lies beyond their control. This ambivalence reflects both a recognition of human agency and a sense of powerlessness in influencing decisions that shape their environment.

A central empirical finding concerns the hydrological impacts of the Sayung–Semarang toll road on Loireng and its surroundings. Observations and informant testimonies indicate that the road and associated embankments have altered natural drainage paths, creating barriers that slow the outflow of rainwater and tidal backflow from inland areas. In several locations, drainage outlets appear undersized, poorly maintained, or misaligned with local topography, resulting in water accumulating for longer durations in low-lying settlements. Residents contrasted the shorter, more predictable inundations of the past with the current pattern of prolonged standing water after heavy rain or high tides, which they associate with the new infrastructure.

Despite the magnitude of these changes, the environmental impact assessment (EIA) processes associated with major projects near Loireng appear to have operated in a predominantly procedural and technocratic manner. Review of available EIA documents suggests that coastal and hydrological risks were framed as manageable through standard mitigation measures such as drainage channels, retention ponds, or embankment design, without fully accounting for cumulative impacts on a already vulnerable coastline. Interview data indicate that local communities were largely unfamiliar with the contents of these assessments, and several respondents recalled consultation meetings as brief, one-directional presentations rather than genuine opportunities to influence project design.

A similar pattern emerges in the implementation of spatial planning regulations. On paper, regional spatial plans and coastal zoning instruments designate certain areas for protection, controlled development, or infrastructure. In practice, land use in and around Loireng has evolved in ways that diverge from these designations, with new constructions and industrial activities appearing in zones that were formally intended to maintain ecological functions. Local officials acknowledged that spatial plans are often revised or selectively interpreted to accommodate strategic projects, while enforcement against incompatible land uses is weak. This disjuncture between planned and actual land use undermines the coherence of spatial regulation as a tool for risk reduction.

The analysis of the legal framework reveals that multiple regulatory instruments formally apply to Loireng's coastal zone: laws on coastal management, environmental protection, spatial planning, disaster risk reduction, and sectoral regulations on infrastructure and drainage. However, their implementation is partial and uneven. Key principles such as preventive action, ecosystem protection, and public participation are articulated at a general level but are often diluted at the stage of implementing regulations or left to the discretionary judgment of local agencies. As a result, there is no single, clearly enforced regime that ensures integrated and anticipatory management of coastal risks in Loireng.

One of the clearest manifestations of regulatory gaps concerns mangrove protection and restoration. Although national and regional policies recognize mangroves as critical coastal buffers and encourage their conservation and rehabilitation, the loss of more than 40 hectares of mangroves in and around Loireng has occurred with minimal formal sanction. Interviews suggest that mangrove areas have been gradually converted into ponds, settlements, or infrastructure corridors, sometimes with informal tolerance by authorities and sometimes under formal permits that prioritize economic use over ecological function.[19] Where replanting initiatives have been undertaken, they have tended to be small-scale, project-based, and insufficient to offset ongoing losses.

The weakness of enforcement mechanisms is evident across several domains. Environmental officials reported limited human and financial resources for regular monitoring, particularly in remote or dispersed coastal locations. Sanctions for non-compliance with environmental obligations, when applied, often take the form of warnings or requests for administrative correction rather than substantive penalties that would deter harmful practices. Community members, for their part, perceived that larger actors such as companies or project proponents are rarely held accountable for environmental damage, whereas smaller-scale infractions are more likely to be targeted. This perceived asymmetry erodes trust in the fairness and effectiveness of environmental law enforcement.

Industrial pollution provides a concrete example of how weak supervision contributes to coastal degradation. Residents pointed to specific canals and discharge points where water is discolored or emits strong odors, particularly near industrial clusters. While formal regulations require industries to manage and treat their waste, monitoring appears sporadic, and information on compliance is not readily accessible to the public. Some interviewees reported that complaints had been submitted to local authorities, but follow-up actions were perceived as slow, opaque, or inconclusive. The persistence of visible pollution, despite the existence of standards and permits, underscores the disconnect between regulatory design and everyday practice.

Institutionally, coastal management in Loireng is characterized by overlapping mandates and fragmented authority. Agencies responsible for environment, public works, spatial planning, disaster management, and coastal affairs all have some jurisdiction over aspects of the problem, yet their actions are not systematically coordinated. Officials described coordination mechanisms in the form of ad hoc meetings or inter-agency working groups, but these often occur in response to acute events, such as major floods, rather than as part of a sustained, integrated planning process.

This fragmentation contributes to gaps in responsibility, with each agency focusing on its own mandate while systemic issues fall between institutional boundaries.

The fragmentation is particularly evident in the management of drainage and flood risks. Public works departments focus on the construction and maintenance of drainage infrastructure, while environmental agencies emphasize water quality and ecosystem protection, and disaster management bodies concentrate on emergency response. In Loireng, these functions have not been effectively integrated into a single, coherent strategy that links land use, infrastructure design, and ecosystem-based adaptation. For example, drainage projects may be planned without fully considering their interaction with mangrove areas or coastal hydrodynamics, leading to unintended consequences such as increased inundation in certain zones.

Disaster risk reduction frameworks, which in principle should promote anticipatory, multi-hazard planning, have also been implemented in a reactive manner. Early warning systems and evacuation procedures exist on paper, but community accounts suggest that most official attention is focused on responding to extreme events rather than addressing underlying drivers of vulnerability. Post-disaster assistance, when provided, tends to be temporary and does not always translate into long-term measures such as relocation planning, livelihood diversification, or structural retrofitting. This reactive orientation limits the capacity of disaster governance to function as a bridge between environmental regulation and everyday risk management in Loireng.

Public participation emerges as a critical fault line in the governance of Loireng's coast. Formal instruments such as EIA procedures, spatial planning consultations, or public hearings nominally require community involvement. However, respondents commonly described these processes as brief, infrequent, and heavily controlled by officials or consultants. Participation often took the form of attending socialization meetings where project plans were presented, with limited opportunity to question assumptions, propose alternatives, or influence final decisions. Many residents felt that their attendance was treated as a procedural requirement to legitimize predetermined choices rather than as meaningful input.

Beyond procedural inadequacies, participation deficits manifest in deeper issues of access to information and voice. Technical documents, such as EIA reports or spatial plans, are rarely available in user-friendly formats, and local residents often rely on informal rumors or partial explanations from intermediaries. Vulnerable groups, including women, small-scale fishers, or households in the most at-risk locations, are especially likely to be excluded from deliberative spaces. In practice, decisions about large-scale projects and regulatory priorities are shaped more by bureaucratic and political considerations than by articulated community preferences. This marginalization contributes to a sense that coastal governance is something done "to" the community rather than "with" it.

In response to ongoing degradation and perceived governance failures, communities in Loireng have developed their own adaptation practices. These include constructing makeshift embankments from sandbags or waste materials, elevating house floors, modifying daily routines around tidal cycles, and engaging in small-scale mangrove planting initiatives. In some cases, residents have organized collective work days to repair or reinforce informal protective structures. Such measures demonstrate local agency and knowledge in coping with environmental stressors, and they partially mitigate immediate risks.

However, these community-based adaptations have clear limits and can even create new vulnerabilities. Informal embankments may be overtopped or collapse during extreme events, and ad hoc drainage modifications can shift water problems from one area to another. Small-scale mangrove planting efforts often lack technical support and may fail in unsuitable locations. Moreover, the financial and labor burdens of adaptation fall disproportionately on residents who are already socio-economically constrained. Without structural changes in regulatory and institutional arrangements, local coping strategies risk becoming a form of privatized resilience that obscures the responsibility of state and corporate actors.

Interpreted through the lens of environmental governance theory, these findings highlight a persistent gap between "law in the books" and "law in action." While Indonesia's legal framework articulates principles of sustainability, prevention, and participation, the Loireng case reveals how these principles are diluted by institutional fragmentation, weak enforcement, and infrastructure-driven development agendas. Coastal regulation operates less as a coherent system guiding decisions toward ecological resilience and more as a patchwork of instruments that can be selectively invoked or bypassed. This discrepancy explains why environmental degradation continues despite the appearance of regulatory sophistication.

From a regulatory design perspective, the study identifies several factors that contribute to this gap. Key obligations for coastal protection are often framed in general and aspirational terms, leaving wide discretion for implementing agencies. Clauses that allow exceptions or "adjustments" for projects deemed strategically important create openings for environmental safeguards to be relaxed. Enforcement provisions may lack clear triggers, timelines, or mandatory penalties, resulting in infrequent and inconsistent application. Combined with resource constraints and political

pressures, these design features reduce the capacity of the regulatory system to constrain environmentally harmful actions in places like Loireng.

The analysis of EIA and spatial planning practices further suggests that these instruments frequently function as ritualized procedures rather than as substantive tools for environmental governance. Assessments are carried out, documents are produced, and consultations are held, but the ultimate decisions often reflect pre-existing development priorities. In such a context, EIA becomes a means of legitimizing projects rather than critically evaluating their necessity, alternatives, and cumulative impacts. Spatial plans, likewise, may be revised or interpreted in ways that accommodate strategic investments, even when these investments exacerbate risks for vulnerable coastal communities.

Ecological justice offers an important framework for understanding the distributional and procedural dimensions of Loireng's environmental crisis. The burdens of abrasion, flooding, and pollution fall disproportionately on local residents who have limited capacity to relocate or negotiate with powerful actors. Meanwhile, the benefits of infrastructure and industrial development such as improved regional connectivity or economic gains are distributed more widely and often accrue to actors located outside the village. Procedurally, communities have limited influence over decisions that expose them to increasing ecological risks. This unequal distribution of harms and benefits underscores the justice implications of regulatory failure.

The constitutional right to a good and healthy environment, widely recognized in Indonesia, thus remains largely unrealized in Loireng. While this right is embedded in higher-level legal norms, the everyday experiences of residents living with recurring floods, land loss, and pollution suggest a *de facto* denial of that right. The weakness of legal remedies and accountability mechanisms means that affected communities have few effective channels to challenge harmful decisions or seek redress. This situation raises broader questions about the environmental rule of law: laws exist, but their protective function is undermined when implementation and enforcement are systematically deficient.

In light of these findings, the study argues for the urgent need to reorient coastal governance toward integrated and ecosystem-based approaches. In practical terms, this means harmonizing coastal management, spatial planning, EIA, and drainage regulations so that they operate in a mutually reinforcing manner rather than in isolation. Mangrove protection and restoration should be treated as central components of risk reduction, not peripheral conservation additions. Infrastructure design must be informed by hydrological and ecological assessments that prioritize long-term resilience over short-term expediency. Loireng's experience demonstrates that fragmented, project-by-project decision-making is ill-suited to the complex dynamics of coastal systems.

Finally, the Loireng case suggests that reforms must address not only technical and institutional aspects, but also questions of power, participation, and justice. Strengthening oversight requires clarifying mandates, enhancing monitoring capacity, and ensuring that sanctions for non-compliance are credible and consistently applied. Enhancing participation demands more than additional meetings; it requires mechanisms that give communities real influence over development options, access to information, and channels for contestation. By foregrounding regulatory integration, robust enforcement, and ecological justice, coastal governance can move closer to fulfilling its dual responsibility: protecting ecosystems and securing the rights and dignity of the people who depend on them.

#### 4 CONCLUSION

This study shows that the environmental crisis in Loireng Village is not merely the result of natural coastal dynamics, but of systemic failures in regulation and governance. Coastal management, spatial planning, EIA, and drainage regulations formally exist, yet they are implemented in a fragmented, selective, and weakly enforced manner.

The construction of the Sayung–Semarang toll road, the loss of more than 40 hectares of mangroves, and persistent industrial pollution have jointly intensified abrasion, flooding, and ecosystem degradation under conditions of inadequate oversight. Institutional fragmentation, poor coordination between agencies, and superficial public participation further widen the gap between “law in the books” and “law in action.”

Consequently, the constitutional right to a good and healthy environment in Loireng remains largely unrealized, and ecological burdens are unfairly borne by vulnerable coastal communities. To reverse this trajectory, coastal governance reforms must prioritize regulatory integration, strengthen monitoring and sanctions, and embed ecological justice as a guiding principle in every stage of decision-making and implementation.

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