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From Failure To Anticipation: Rethinking Hydrometeorological Flood Governance In Aceh Tamiang

Sitti Hafsa Sara Bitu
Department of Public Administration, NIPA School of Administration Jakarta, Indonesia
Nurlia Nurdin
Institute Governance of Home Affairs

Corresponding Author: sittihafsah16@gmail.com

Abstract

This study analyzes the failure of hydrometeorological disaster governance in the case of recurrent floods in Aceh Tamiang District in November–December 2025, which caused extensive inundation, severe infrastructure damage, and the displacement of tens of thousands of people. The research departs from the gap between technical capacity for flood risk modelling and documented vulnerability of the Krueng Tamiang watershed, and policy practice dominated by reactive crisis management. The anticipatory governance framework—comprising future readiness, innovation, endurance, long-term perspective, and direction, alongside enabling factors like leadership support, competencies, observation of trends, participatory processes, and structures—is used to evaluate how spatial and disaster data are converted into anticipatory policy decisions. The study employs a qualitative single-case study design with data drawn from scientific publications, policy documents, disaster statistics, and humanitarian reports, analyzed through theory-driven thematic analysis based on this framework. The results show that core weaknesses do not lie in data availability, but in a weak authorising environment, limited institutional capacity, and the dominance of extractive interests over land and coastal ecosystems, which hinder internalising anticipatory dimensions into spatial policy. The paper proposes strengthening the foresight function in local planning agencies, applying foresight impact assessment to major infrastructure projects, establishing a cross-actor disaster intelligence alliance, and enhancing risk data transparency to institutionalise anticipatory flood governance in Aceh Tamiang

Keywords: Aceh Tamiang, anticipatory governance, disaster governance, FIELD–SCOPES, flood governance

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INTRODUCTION

At the national level, floods and flash floods are the most frequent types of hydrometeorological disasters, and official statistics indicate an increasing trend in recent years. The series of flash floods in Sumatra in November–December 2025 caused hundreds of deaths and displaced more than nine hundred thousand people in Aceh, North Sumatra, and West Sumatra, indicating a scale of disruption that exceeds normal seasonal flooding patterns. Aceh was among the provinces most affected by the 2025 flash floods, with widespread flooding and landslides in several districts, including Aceh Tamiang. In Aceh Tamiang, the flash flood peaked in late November 2025 and caused severe damage to settlements, basic infrastructure, schools, and public services. The district education office reported that hundreds of school buildings were damaged, ranging from light to severe, disrupting learning activities and forcing many students to study from home or in temporary learning spaces.

Table 1. Flood Incidents in Aceh Tamiang (2020–2025)

Year	Number of Incidents	Fatalities	Displaced People	Housing Damage
2020	1	0	0	0
2021	1	0	0	0
2022	1	0	157,117	7,700 inundated
2025	1	57	262,087	3,043 damaged

Source: BNPB (2025), processed by author (2026)

The recurrent flood pattern in Aceh Tamiang indicates a structural governance problem rather than isolated hydrometeorological events. The increasing number of displaced people and infrastructure damage demonstrates that flood impacts continue to escalate despite the availability of flood risk studies and hazard mapping. Consequently, recurrent flood disasters should be understood as manifestations of governance failure rather than solely natural events (Tierney, 2012)

Table 2. Regional Expenditure and Unexpected Expenditure Allocation in Aceh Tamiang (2023–2025)

Year	Total Regional Expenditure (Rp)	Unexpected Expenditure/BTT (Rp)	Percentage of BTT
2023	1,206,005,362,023	5,000,000,000	0,41%

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2024	1,405,399,771,949	4,000,000,000	0,28%
2025	1,258,764,471,657	3,000,000,000	0,24%

Source: Directorate General of Fiscal Balance (DJPK), processed by author (2026).

The fiscal structure of Aceh Tamiang also reflects a reactive disaster governance orientation. Between 2023 and 2025, the allocation for unexpected expenditure (Belanja Tidak Terduga/BTT) remained below 0.5% of total regional expenditure. This indicates limited institutional preparedness and insufficient fiscal prioritisation for anticipatory disaster mitigation.

Two-dimensional hydrodynamic modelling in the Krueng Tamiang watershed had previously identified the potential for extensive flooding across various return periods (Maulina et al., 2023). Other studies also showed low soil infiltration capacity and high surface runoff during the rainy season. Studies further identified increasing runoff coefficients and flood volume due to land use change (Cut Azizah et al., 2025). Flood vulnerability mapping using geographic information systems was also conducted to delineate zones from low to very high risk in Aceh Tamiang (Nur Alifa et al., 2025). However, the flash floods in late November 2025 still caused major damage, indicating a serious gap between technical risk mapping capacity and the disaster governance practices that were actually implemented.

This gap reflects a broader challenge identified in flood governance studies, where the availability of scientific knowledge and risk assessments does not automatically translate into effective policy implementation or risk reduction measures (Alexander et al., 2016; Kaufmann et al., 2016).

Technical studies on floods in Aceh Tamiang and other parts of Aceh mainly focus on hydrology, inundation modelling, and the impact of land use change on runoff and flood volume. These studies show, for example, low infiltration capacity, increasing runoff coefficients, and significant mangrove loss that weaken the buffering capacity of coastal ecosystems. Other work uses geographic information systems to map flood-prone areas and highlights the combined effects of slope, soil type, rainfall, and land use on flood vulnerability. However, these technical findings have rarely been explicitly linked to anticipatory governance frameworks that examine how scientific evidence and forward looking intelligence are integrated into the public policy cycle.

Existing studies on flooding in Aceh Tamiang have predominantly focused on hydrological modelling, flood inundation scenarios, watershed dynamics, land-use change, and spatial vulnerability mapping. Although these studies provide valuable technical insights into flood hazards and environmental change, they offer limited explanations regarding why available

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scientific evidence has not been translated into effective anticipatory policy interventions. Consequently, the institutional and governance dimensions of flood risk management remain insufficiently explored. Furthermore, the application of anticipatory governance frameworks, particularly the FIELD–SCOPES framework, has received little attention in the context of local disaster governance in Indonesia. This study seeks to address this gap by examining recurrent flood governance failures in Aceh Tamiang through an anticipatory governance perspective.

This study asks how the absence of anticipatory governance contributed to recurrent flood governance failure in Aceh Tamiang, arguing that scientific evidence alone is insufficient without structures and procedures that internalise risks into policy decisions. The first objective of this study is to analyse the failure of flood policy responses in Aceh Tamiang during the November–December 2025 flash floods using the FIELD dimensions of the anticipatory governance framework. The second objective is to formulate a new institutional design at the Aceh Tamiang district level by utilising the SCOPES enabling factors to support the transition from reactive to anticipatory disaster governance. By achieving these objectives, this research contributes by providing concrete institutional recommendations—such as establishing foresight functions, applying foresight impact assessments to infrastructure, and creating disaster intelligence alliances—to overcome the dominance of extractive interests and successfully institutionalise anticipatory flood governance.

Beyond its empirical contribution to understanding recurrent flooding in Aceh Tamiang, this study contributes theoretically by demonstrating how the FIELD–SCOPES framework can be applied to analyse governance failures in subnational disaster management settings within developing countries.

LITERATURE REVIEW

From Crisis Management to Anticipatory Governance

Conventional disaster management remains focused on crisis management, that is, on emergency response and post disaster recovery based on historical patterns of events. In the flood context, this is reflected in the reliance on historical rainfall and river discharge data as the basis for planning, while changing climate trends and land use patterns that alter risk profiles are not fully incorporated. Anticipatory governance was developed as a response to the limits of past oriented approaches and emphasises the integration of foresight, innovation, and experimentation into public sector governance. It stresses the ability to act on the future by using data, scenarios, and weak signals to influence present decisions, rather than merely producing

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forecasts that are not internalised into policy.

Anticipatory governance has emerged as an alternative paradigm that seeks to integrate foresight, long-term thinking, and strategic intelligence into public decision-making processes. Rather than responding to crises after they occur, anticipatory governance encourages institutions to identify emerging risks and act before adverse impacts materialise (Fuerth & Faber, 2012; Guston, 2014)

In the context of climate-related disasters, anticipatory governance is increasingly recognised as a critical approach for addressing uncertainty, complexity, and the long-term consequences of environmental change (Muiderman et al., 2020). Such an approach is particularly relevant for flood-prone regions where future climate variability may intensify existing vulnerabilities.

While conventional disaster management primarily focuses on emergency response and post-disaster recovery, disaster risk reduction (DRR) seeks to minimise potential losses through prevention, mitigation, and preparedness measures. Anticipatory governance goes one step further by systematically incorporating foresight, scenario building, and strategic intelligence into decision-making processes before risks fully materialise. In this sense, anticipatory governance complements disaster risk reduction by strengthening the capacity of institutions to recognise emerging threats and act proactively under conditions of uncertainty (Djalante et al., 2011; Muiderman et al., 2020).

The FIELD and SCOPES Framework

The FIELD framework defines five outcome dimensions: future readiness, innovation, endurance, long-term perspective, and direction, which are used to assess how prepared a public organisation is for long-term uncertainty. Future readiness refers to the capacity of policies to respond to future trends and signals, innovation to the ability to develop and test new approaches, and endurance to the robustness of policies and infrastructures under shocks and contextual changes. Long-term perspective concerns the extent to which policies look beyond electoral cycles, while direction reflects the clarity of a shared long-term vision.

The emphasis on future readiness and long-term orientation aligns with resilience thinking, which stresses the importance of preparing institutions and communities to absorb shocks, adapt to changing conditions, and transform when existing governance arrangements become inadequate (Folke et al., 2005; Walker et al., 2004).

The SCOPES framework specifies six enabling factors: support from leadership,

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competencies, observation of trends and signals, participatory processes, exchange of intelligence and good practices, and structures and procedures. These factors are considered institutional prerequisites for operationalising the FIELD dimensions in public organisations at both national and subnational levels. Evidence from various applications suggests that data and analysis alone are insufficient without leadership support, institutional structures, and participatory processes that make anticipatory action feasible.

Previous studies suggest that anticipatory governance is most effective when supported by strong leadership, collaborative learning processes, and institutional mechanisms capable of translating foresight into policy action (Boyd et al., 2015).

The FIELD–SCOPES framework is particularly relevant for local governments because many disaster risk management decisions, including spatial planning, infrastructure development, ecosystem management, and emergency preparedness, are implemented at the subnational level. By combining outcome-oriented dimensions (FIELD) with institutional enabling factors (SCOPES), the framework provides a practical analytical tool for assessing not only whether governments are prepared for future risks, but also whether they possess the organisational capacities necessary to translate foresight into policy action. This makes the framework especially suitable for examining flood governance challenges in districts such as Aceh Tamiang, where technical risk information is available but has not consistently informed long-term policy decisions.

Compared with conventional disaster management frameworks that primarily assess preparedness and response capacities, the FIELD–SCOPES framework offers a more comprehensive perspective by explicitly incorporating future-oriented thinking, institutional learning, and long-term adaptation. The framework therefore enables researchers to examine not only how governments respond to existing risks but also how they anticipate emerging challenges and integrate foresight into policy processes. This characteristic makes FIELD–SCOPES particularly suitable for analysing flood governance in the context of increasing climate uncertainty

Political Economy of Disasters and Extractive Oligarchy

Political economy literature on disasters stresses that disaster risk and impact are shaped not only by natural factors but also by power relations, interests, and resource governance. Studies in Aceh show that the expansion of non forest land, including settlements, open land, and other uses, increases runoff and flood volume in certain watersheds. Land-use change is widely recognised as one of the most significant drivers of environmental degradation and increased disaster risk. Expansion of agriculture, settlements, and extractive economic activities often alters

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hydrological systems and reduces ecosystem services that naturally mitigate flood hazards (Lambin et al., 2003).

In Aceh Tamiang, significant mangrove loss due to conversion to aquaculture and plantations reflects the dominance of short term economic interests over long-term ecological functions that are crucial for coastal protection and flood mitigation. In such contexts, attempts to institutionalise anticipatory governance that require land use restrictions or ecosystem restoration face structural resistance from actors who benefit from unsustainable resource exploitation. The degradation of mangrove ecosystems is particularly problematic because mangroves play a critical role in regulating coastal hydrology, reducing erosion, and buffering flood impacts. Across Southeast Asia, mangrove loss has been strongly associated with aquaculture expansion and commercial land conversion (Richards & Friess, 2016).

METHODOLOGY

Research Design

This study uses a qualitative single case study design focusing on Aceh Tamiang District. The single case design enables an in depth exploration of the interactions between scientific data, policy processes, and political economy in the November–December 2025 flash floods.

Research Sample / Data Sources

Data sources include scientific publications on hydrology and flooding in the Krueng Tamiang watershed, studies on mangrove dynamics and land use change in Aceh Tamiang and other relevant watersheds, official disaster data from national and provincial disaster management agencies, credible media reports on the impact on education and infrastructure, and documents on the FIELD–SCOPES framework and its implementation guidance. The study analysed a purposive sample of approximately 25 documents published between 2023 and 2026. These consisted of peer-reviewed journal articles, government policy documents, disaster statistics, humanitarian situation reports, and media publications related to the November–December 2025 floods in Aceh Tamiang.

Data Collection Tools and Procedure

Documents were selected based on three criteria: (1) relevance to flood risk, hydrometeorological disasters, or anticipatory governance; (2) direct relation to Aceh Tamiang or comparable governance contexts; and (3) availability of empirical information concerning disaster

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impacts, policy responses, or institutional arrangements

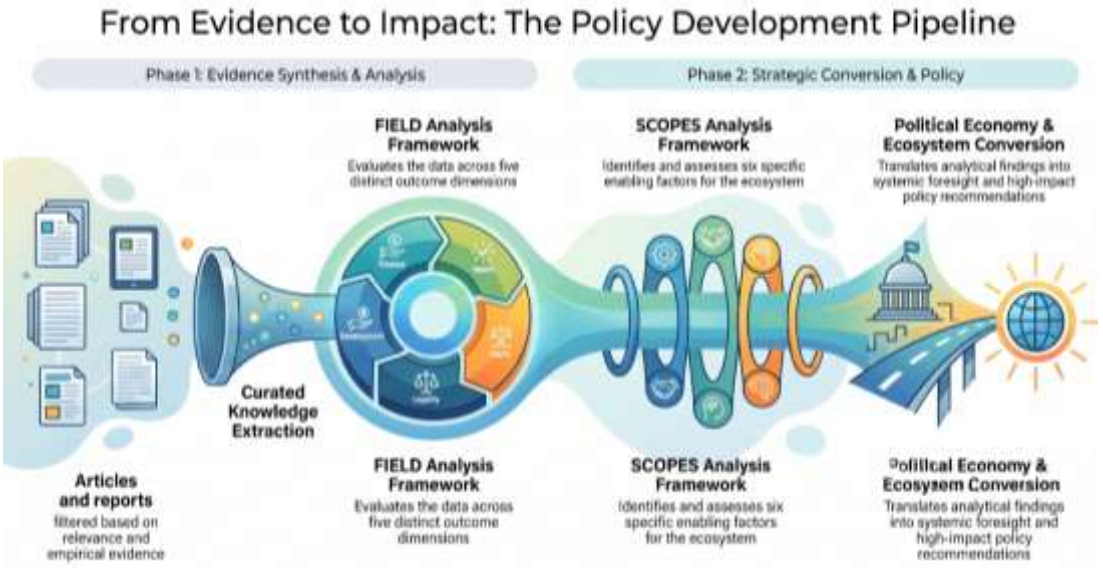


Figure 1. Research Flow Diagram of the Study
Source: Developed by author based on FIELD–SCOPES framework (2026).

Data Analysis

Data are analysed using theory driven thematic analysis with FIELD–SCOPES as the main coding framework. In the first step, information on flood impacts, damage, and policy responses is coded under the five FIELD dimensions to assess the levels of future readiness, innovation, endurance, long-term perspective, and direction of governance in Aceh Tamiang. In the second step, the SCOPES factors are used to identify barriers and opportunities for institutionalising anticipatory governance, including leadership support, competencies, trend observation mechanisms, participatory processes, intelligence exchange, and organisational structures and procedures. In the third step, these findings are interpreted through a disaster political economy lens by linking them to evidence on land use change and mangrove dynamics that reflect extractive pressures. To enhance analytical rigour, data triangulation was applied by comparing findings across multiple sources, including scientific studies, official government reports, humanitarian assessments, and media coverage. This approach enabled the identification of consistent patterns and reduced the risk of relying on a single source of evidence. The use of multiple data sources also strengthened the credibility of interpretations regarding governance failures and institutional barriers to anticipatory action.

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Ethical Considerations

Since this study relied exclusively on publicly accessible policy documents, published research, and official secondary statistical data, direct primary human participant interaction was not involved. All referenced materials were accurately cited in accordance with academic integrity guidelines.

RESULTS AND DISCUSSION

FIELD Diagnostic: Why Aceh Tamiang Failed to Anticipate the 2025 Floods

Table 3. FIELD Assessment of Flood Governance in Aceh Tamiang

FIELD Dimension	Assessment	Evidence
Future Readiness	Low	Flood risk studies and modelling existed but were not translated into anticipatory policy action
Innovation	Low	Responses remained focused on emergency relief and recovery measures
Endurance	Low	Significant damage to infrastructure, housing, and education facilities
Long-Term Perspective	Low	Continued mangrove degradation and land-use conversion despite known flood risks
Direction	Moderate	Flood risk recognised in policy documents, but weak alignment with development policies

Source: Author's analysis based on FIELD–SCOPES framework (2026).

Table 3 summarises the assessment of flood governance performance in Aceh Tamiang using the FIELD dimensions of the anticipatory governance framework. Overall, the analysis indicates that anticipatory capacity remains weak across most dimensions, particularly future readiness, innovation, endurance, and long-term perspective. Although flood risks are recognised in official planning documents, institutional arrangements have not been sufficient to translate risk knowledge into proactive policy action.

The future readiness dimension shows that, despite a relatively strong data and modelling base, the capacity to use this information to anticipate flash floods remains weak. Prior hydrodynamic modelling had highlighted the potential extent of inundation in the Krueng Tamiang watershed and the need for spatial planning and infrastructure design that account for various

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flood scenarios, yet the November 2025 flash floods still caused extensive damage and isolated several villages. This indicates a translation gap between strategic intelligence and policy action. The inability to transform risk information into preventive action illustrates what anticipatory governance scholars describe as the implementation gap between foresight generation and policy uptake (Fuerth & Faber, 2012; Guston, 2014).

This finding is consistent with previous studies on anticipatory governance, which suggest that the existence of scientific knowledge alone is insufficient to generate policy change when institutional incentives and political support remain weak (Boyd et al., 2015; Guston, 2014). Similar implementation gaps have also been observed in flood governance systems in other regions, where risk assessments are available but remain disconnected from planning and investment decisions.

From an endurance perspective, the 2025 flash floods tested the resilience of Aceh Tamiang's policies and infrastructures and revealed significant weaknesses. Official data show large numbers of displaced people, extensive damage to housing and public facilities, and severe disruption to education services, as indicated by the destruction of hundreds of school buildings. This suggests that critical infrastructures were not designed or upgraded to withstand the intensity of the floods that occurred. From a resilience perspective, the scale of infrastructure disruption indicates limited adaptive capacity and insufficient investment in systems capable of maintaining functionality during extreme events (Adger et al., 2005; Folke et al., 2005).

The long-term perspective and direction dimensions indicate that long-term policy directions on land use and ecosystem protection have not favoured flood risk reduction. The marked decline in mangrove cover between 2000 and 2023 in Aceh Tamiang (Marfi et al., 2025) shows that spatial planning and coastal management frameworks have allowed the expansion of aquaculture and plantations rather than preserving key ecosystems as flood buffers. While disaster documents identify floods as a major hazard, sectoral development policies remain misaligned with long-term risk reduction goals. The innovation dimension appears limited because institutional responses to the 2025 flash floods largely repeated emergency routines, such as logistics mobilisation, construction of temporary shelters, and repair of damaged facilities. Proposals for temporary and permanent housing are important for recovery but do not yet reflect long-term policy experimentation, such as resettlement planning in safer zones or transformative land use changes in the watershed.

The findings suggest that governance failure was not primarily caused by a lack of information but rather by the inability of institutions to transform available knowledge into

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binding policy decisions. This indicates that the challenge lies less in technical capacity and more in the political and organisational conditions required for anticipatory action.

CONCLUSION

The November–December 2025 flash floods in Aceh Tamiang demonstrate that the availability of risk data and modelling does not automatically produce anticipatory governance when FIELD dimensions, particularly future readiness and endurance, are not internalised into spatial and infrastructure policies. The FIELD–SCOPES based analysis shows that the main obstacles lie in a weak authorising environment, limited foresight structures, and the dominance of extractive interests driving the conversion of key ecosystems such as mangroves.

This paper contributes by extending the application of the anticipatory governance framework to a district government context in a developing country and by proposing a set of institutional interventions, namely establishing a foresight function in the planning agency, adopting foresight impact assessment, forming a disaster intelligence alliance, and improving risk data transparency, as concrete steps to shift Aceh Tamiang's flood governance from reactive to anticipatory.

The findings support previous studies suggesting that resilience and disaster risk reduction cannot be achieved solely through technological improvements or hazard modelling. Effective risk governance requires institutional arrangements capable of integrating foresight, adaptive learning, and long-term environmental stewardship into development decision-making processes (Boyd et al., 2015; Folke et al., 2005; Muiderman et al., 2020). Without institutionalising anticipatory governance, recurrent flooding in Aceh Tamiang is likely to remain a predictable disaster rather than an unavoidable one.

This study has several limitations. As a qualitative single-case study relying primarily on documentary sources, the findings cannot be generalised statistically to other regions. Future research could incorporate interviews with policymakers, local communities, and disaster management officials to provide deeper insights into the institutional dynamics shaping anticipatory disaster governance. Comparative studies across multiple flood-prone districts may also help refine the applicability of the FIELD–SCOPES framework in different governance contexts.

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