

Co-Production in Maritime Disaster Risk Management Based on Coastal Community Participation in Pesisir Selatan Regency

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Abstract. Maritime disaster risk management in coastal areas continues to face challenges related to the limited involvement of local communities in disaster governance systems, particularly in relation to tidal flood risks. This study aims to analyse co-production practices in tidal flood risk management based on coastal community participation in Pesisir Selatan Regency, with an empirical focus on Nagari Kapuh. This study employed a descriptive qualitative approach using a grounded theory analysis strategy. Data were collected through in-depth interviews, field observations, and documentation involving 17 informants, consisting of representatives from the Regional Disaster Management Agency, subdistrict government, nagari government, kampung heads, and coastal communities affected by tidal flooding. Data analysis was conducted through the stages of open coding, axial coding, and selective coding. The findings show that co-production practices have emerged through community-based local knowledge in identifying signs of tidal flooding, tiered reporting to kampung heads and the nagari government, mutual cooperation in local response efforts, and the articulation of coastal protection needs. However, these practices remain suboptimal because coordination is still reactive, local preparedness institutions have not functioned continuously, and follow-up actions on proposed breakwater development have not been fully realised. This study formulates the Theory of Adaptive Co-Production of Coastal Communities in Tidal Flood Risk Management as a substantive theory. In conclusion, strengthening co-production should be directed towards institutionalising community participation, activating local preparedness institutions, improving risk data, and integrating community aspirations into coastal protection policies.

Keywords: Co- Production; Disaster Management; Community Participation

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INTRODUCTION

Maritime disaster risk in coastal areas has become a major issue in disaster governance because coastal communities are directly exposed to tidal fluctuations, high waves, shoreline changes, coastal abrasion, and seawater intrusion into land areas. One form of maritime disaster risk that is closely connected to the daily lives of coastal communities is tidal flooding. Tidal flooding occurs when seawater inundates land areas due to maximum tides, sea-level rise, ocean waves, and the limited drainage capacity of coastal settlements. Its impacts are not limited to physical inundation, but also disrupt settlements, community mobility, fishing activities, coastal livelihoods, and local socio-economic resilience. Therefore, tidal flooding should be understood not only as a hydrometeorological event, but also as a matter of public governance, institutional

capacity, coastal area management, and coastal community participation (Noviantoro et al., 2022; Ogra et al., 2021).

The urgency of this study is reinforced by information issued by the Indonesian Agency for Meteorology, Climatology, and Geophysics through the Directorate of Maritime Meteorology. In its release dated 25 May 2026, BMKG stated that the full moon phenomenon on 31 May 2026 had the potential to increase maximum sea levels and trigger coastal flooding in several regions of Indonesia. In West Sumatra, areas with potential exposure to coastal flooding during the period of 28–31 May 2026 included the coastal areas of Padang City, Padang Pariaman Regency, Pesisir Selatan Regency, Agam Regency, West Pasaman Regency, and the Mentawai Islands (Direktorat Meteorologi Maritim, 2026). BMKG also explained that coastal flooding may affect port activities, coastal settlements, salt ponds, and inland fisheries. These data indicate that Pesisir Selatan Regency is one of the areas officially identified as needing heightened vigilance against tidal flood risk.

Pesisir Selatan Regency has geographical and administrative characteristics that are highly relevant to the study of coastal disaster risk. The regency consists of 15 subdistricts and 182 nagari, is located on the western coast of West Sumatra Province, covers an area of approximately 5,749.89 km², and has a coastline of around 234 km (Pemerintah Kabupaten Pesisir Selatan, 2017, 2024). These conditions indicate the high exposure of Pesisir Selatan to tidal surges, high waves, coastal abrasion, and tidal flooding. Koto XI Tarusan Subdistrict, as the research site, covers approximately 425.63 km², or 7.7% of the total area of Pesisir Selatan Regency, lies between 100°19'–100°34.7' East Longitude and 0°59'–1°17.30' South Latitude, and consists of 23 nagari and 51 kampung (Badan Pusat Statistik Kabupaten Pesisir Selatan, 2025; Banda Sapuluh, 2021). Nagari Kapuh, as the focal research location, covers approximately 12.20 km², or 2.87% of the area of Koto XI Tarusan Subdistrict, with the Wali Nagari Office located around 4 km from the subdistrict capital, 16 km from Painan, and 61 km from Padang City (Langgam.id, 2020). Based on field data, Nagari Kapuh consists of two kampung, namely Kampung Kapuh and Kampung Gurun Panjang.

The availability of official regional data also strengthens the empirical foundation of this study. The publication Kecamatan Koto XI Tarusan dalam Angka 2025 provides data on geography, government administration, population, social conditions, public welfare, agriculture, tourism, transportation, information, and telecommunications, most of which are derived from Village Potential Data Collection and the administrative records of government agencies (Badan Pusat Statistik Kabupaten Pesisir Selatan, 2025). In addition, Kabupaten Pesisir Selatan dalam

Angka 2026 provides official data on geography, government administration, population and labour, social affairs, agriculture, industry and trade, transportation and communication, finance and prices, regional income, and supplementary data (Badan Pusat Statistik Kabupaten Pesisir Selatan, 2026). Accordingly, the study of tidal flood risk management in Pesisir Selatan Regency is supported by formally documented social, geographical, economic, and institutional evidence.

Normatively, disaster risk management in Indonesia is supported by a strong legal foundation. Law of the Republic of Indonesia Number 24 of 2007 concerning Disaster Management affirms that disaster management is the responsibility of the central government and regional governments and must be implemented in a planned, integrated, coordinated, and comprehensive manner. Article 26 regulates the rights of communities to obtain social protection, security, education, training, policy information, participation in decision-making, and supervision of disaster management. Article 27 affirms the obligations of communities to maintain harmonious social life, preserve environmental sustainability, and participate in disaster management activities (Undang-Undang Republik Indonesia Nomor 24 Tahun 2007 Tentang Penanggulangan Bencana, 2007). These provisions show that communities are not positioned merely as victims or aid recipients, but also as important actors in disaster risk reduction.

This legal foundation is further strengthened by Government Regulation of the Republic of Indonesia Number 21 of 2008 concerning the Implementation of Disaster Management, which regulates prevention, mitigation, preparedness, emergency response, rehabilitation, and reconstruction (Peraturan Pemerintah Republik Indonesia Nomor 21 Tahun 2008 Tentang Penyelenggaraan Penanggulangan Bencana, 2008). The management of tidal flooding is also related to Law of the Republic of Indonesia Number 27 of 2007 concerning the Management of Coastal Areas and Small Islands and Law of the Republic of Indonesia Number 1 of 2014, which strengthen community rights to obtain access, propose traditional fishing areas, propose areas for customary law communities, and obtain information on coastal area management (Undang-Undang Republik Indonesia Nomor 1 Tahun 2014 Tentang Perubahan Atas Undang-Undang Nomor 27 Tahun 2007 Tentang Pengelolaan Wilayah Pesisir Dan Pulau-Pulau Kecil, 2014; Undang-Undang Republik Indonesia Nomor 27 Tahun 2007 Tentang Pengelolaan Wilayah Pesisir Dan Pulau-Pulau Kecil, 2007)(Undang-Undang Republik Indonesia Nomor 1 Tahun 2014 Tentang Perubahan Atas Undang-Undang Nomor 27 Tahun 2007 Tentang Pengelolaan Wilayah Pesisir Dan Pulau-Pulau Kecil, 2014; Undang-Undang Republik Indonesia Nomor 24 Tahun 2007 Tentang Penanggulangan Bencana, 2007). At the national policy level, Presidential Regulation of the Republic of Indonesia Number 87 of 2020 concerning the Disaster Management Master Plan

for 2020–2044 serves as a long-term reference for ministries and agencies, regional governments, the Indonesian National Armed Forces, the Indonesian National Police, and other stakeholders in disaster management (Peraturan Presiden Republik Indonesia Nomor 87 Tahun 2020 Tentang Rencana Induk Penanggulangan Bencana Tahun 2020–2044, 2020). At the regional level, Pesisir Selatan Regency has also enacted Regional Regulation of Pesisir Selatan Regency Number 4 of 2025 concerning the Establishment, Functions, Duties, Organisational Structure, and Work Procedures of the Regional Disaster Management Agency, stipulated on 19 August 2025 to strengthen the institutional capacity of the regional BPBD (Peraturan Daerah Kabupaten Pesisir Selatan Nomor 4 Tahun 2025 Tentang Pembentukan, Fungsi, Tugas, Struktur Organisasi, Dan Tata Kerja Badan Penanggulangan Bencana Daerah, 2025).

The urgency of this study is also supported by the results of a bibliometric analysis using VOSviewer on 1,608 Scopus-indexed publications from 2020 to 2025. The network visualisation shows that global research on disaster risk, governance, climate change, capacity, and knowledge production remains fragmented into several main clusters. The red cluster is dominated by the themes of governance, disaster, disaster risk governance, and risk management; the light blue cluster includes climate change, climate change action, and human health; the green cluster relates to capacity, resilience, and adaptation; the orange cluster includes production, waste, wastewater, and co-digestion; while the purple cluster centres on the keyword review. Node size indicates the frequency of keyword occurrence, while connecting lines indicate the strength of relationships or co-occurrence among keywords. These findings indicate that the relationships among governance, disaster risk governance, maritime, capacity, resilience, and co-production have not yet formed a strong and integrated cluster. Thus, global scholarship still tends to be oriented towards institutional and policy approaches, while the integration of local coastal community capacity with co-production-based maritime disaster risk management has not been systematically developed.

At the local level, preliminary interview findings indicate that the people of Nagari Kapuh understand tidal flooding as the movement of seawater onto land caused by high tides and large waves. Tidal flooding disrupts fishing activities, raises concerns over seawater entering residential areas, interferes with water flow, and damages the coastal environment. Community members also expressed the need for coastal area protection through the construction of breakwaters to prevent large waves from directly entering the shoreline area. These preliminary findings show that tidal flooding is a concrete socio-ecological experience for coastal communities, rather than merely a technical issue in disaster management.

Field data also show that coastal communities play a role in risk management. Community members are usually the first to identify signs of high tides, large waves, and changes in coastal conditions. This information is conveyed to the kampung head and then forwarded to the nagari government, subdistrict authorities, or relevant agencies. Community members are also involved in mutual cooperation, drainage cleaning, assistance among residents, and the submission of proposals for coastal area protection. However, local preparedness institutions have not functioned optimally because the Disaster Preparedness Group existed around 2017–2018 but has not remained active on a continuous basis. This condition indicates the presence of community participation at the local level, although its institutionalisation within the disaster preparedness system remains weak.

From the perspective of public administration, such community involvement is relevant for analysis through the concept of co-production. Co-production positions communities not as passive recipients of public services, but as government partners in the planning, implementation, and evaluation of public services (Khine et al., 2021; Scupola & Mergel, 2022). This principle aligns with tidal flood risk management because coastal communities possess local knowledge of tidal signs, vulnerable locations, wave patterns, drainage channels, and coastal protection needs. Within this framework, the government acts as a policy maker, coordination facilitator, provider of institutional support, and connector of response programmes, while the community acts as a provider of local information, implementer of collective action, and proposer of mitigation needs.

The concept of co-production is also related to disaster risk management and community-based mitigation. Disaster risk management emphasises the importance of hazard identification, vulnerability assessment, capacity strengthening, institutional development, and the integration of risk reduction policies into development planning (Ogra et al., 2021). Meanwhile, community-based disaster risk reduction positions communities as key actors in risk identification, planning, mitigation action, and evaluation of disaster risk reduction activities (Hadlos et al., 2022; Trogrlić et al., 2022). The integration of local knowledge and scientific knowledge is considered capable of strengthening preparedness, improving response effectiveness, and producing mitigation strategies that are more adaptive to local conditions (Hadlos et al., 2022; Vasileiou et al., 2022). Thus, co-production serves as a conceptual bridge between government governance and community participation in tidal flood risk management.

Previous studies show that co-production has been widely discussed in public administration studies, particularly in relation to public value creation, service quality improvement, and citizen involvement in public service delivery (Khine et al., 2021; Scupola &

Mergel, 2022). In disaster studies, community participation has often been examined through approaches such as community-based disaster risk reduction, local knowledge integration, community resilience, and participatory risk assessment (Hadlos et al., 2022; Islam et al., 2022; Marasco et al., 2021; Satizábal et al., 2022; Trogrlić et al., 2022). Other studies show that flood risk management requires the integration of data, institutional capacity, and community participation because flood risk is associated with physical hazards, social vulnerability, and local response capacity (Amatebelle et al., 2025; Ogra et al., 2021; Chan et al., 2022). In the study of tidal flooding, Aksa & Afrian (2022) showed that coastal communities have adaptation strategies for tidal flooding, although perceptions of hazard may differ among residents.

Nevertheless, previous studies still have several limitations. First, research on co-production in public services has mostly discussed public service delivery in general and has not specifically examined tidal flooding as a maritime disaster risk experienced by coastal communities (Khine et al., 2021; Scupola & Mergel, 2022). Second, studies on community-based disaster risk reduction tend to emphasise community capacity and local knowledge, but have not sufficiently explained the reciprocal relationships among communities, kampung heads, nagari government, subdistrict authorities, and BPBD in tidal flood risk management (Hadlos et al., 2022; Trogrlić et al., 2022; Vasileiou et al., 2022). Third, research on flooding has more commonly focused on vulnerability mapping, spatial analysis, or technical approaches, whereas the role of coastal communities as co-producers in tidal flood risk governance remains underexplored (Amatebelle et al., 2025; Ogra et al., 2021; Chan et al., 2022).

The scientific novelty of this article lies in the use of a co-production perspective to analyse tidal flood risk management as part of maritime disaster risk management. Although the article title uses the term maritime disaster risk management as a broader framework, the empirical focus of this study is limited to tidal flooding as one of the forms of maritime disaster risk most closely connected to the lived experiences of coastal communities in Pesisir Selatan Regency. This article explains how coastal communities act as co-producers through local knowledge, risk reporting, mutual cooperation, and the articulation of coastal protection needs, while the government plays a role in coordination, field verification, documentation, planning, and policy follow-up.

Based on the discussion above, the research problem addressed in this article is the suboptimal implementation of co-production in tidal flood risk management based on coastal community participation in Pesisir Selatan Regency. Although communities possess local knowledge and are involved in initial response efforts, coordination mechanisms still tend to be

reactive, local preparedness institutions have not operated continuously, and community proposals related to coastal protection have not been fully realised. Therefore, this article aims to analyse co-production practices in tidal flood risk management as part of maritime disaster risk management in Pesisir Selatan Regency. Specifically, this article examines the division of roles between the government and coastal communities in identifying risks, reporting tidal flood events, carrying out local responses, and articulating the need for coastal area protection.

METHODS

This study employed a descriptive qualitative approach with a grounded theory analysis strategy to examine co-production practices in tidal flood risk management based on coastal community participation in Pesisir Selatan Regency. A qualitative approach was used because this study focuses on an in-depth understanding of coastal communities' experiences, the role of government, reporting mechanisms, institutional coordination, mutual cooperation, and local strategies in responding to tidal flood risk. Grounded theory was applied to develop concepts, categories, and themes based on field data through a systematic coding process. Thus, this study not only describes the phenomenon but also identifies patterns of relationships among actors in maritime disaster risk management (Akkaya, 2023; Liu, 2022).

The study was conducted in Nagari Kapuh, Koto XI Tarusan Subdistrict, Pesisir Selatan Regency, in 2026. Research informants were selected using purposive sampling, namely the selection of informants based on their knowledge, experience, authority, and direct involvement in tidal flood risk management. This technique is appropriate for qualitative research because it enables researchers to obtain rich, in-depth, and relevant data in line with the focus of the study (Ahmad & Wilkins, 2025; Czernek-Marszałek & McCabe, 2024). The study involved 17 informants, consisting of one informant from BPBD, two informants from the subdistrict government, one informant from the nagari government, one kampung head, and 12 informants from coastal communities affected by tidal flooding. This number was considered sufficient because the data had shown recurring patterns related to local knowledge, incident reporting, mutual cooperation, government–community coordination, disruptions to fishing activities, the need for breakwaters, and local preparedness institutions.

Data were collected through in-depth interviews, observation, and documentation. Interviews were used to explore coastal communities' experiences in dealing with tidal flooding, reporting mechanisms to kampung heads and the nagari government, coordination between subdistrict authorities and BPBD, forms of community mutual cooperation, and proposals for coastal area protection. Observation was used to examine coastal area conditions, drainage

channels, settlement areas, and the shoreline environment. Documentation was used to supplement the data through field photographs, supporting documents, interview notes, statistical data, and institutional information.

Data analysis was conducted through three main stages in grounded theory, namely open coding, axial coding, and selective coding. In the open coding stage, the data were broken down into initial codes, such as tidal surges, high waves, community reports, mutual cooperation, blocked drainage channels, disruption to fishing activities, proposed breakwater development, subdistrict coordination, the role of BPBD, and local preparedness institutions. In the axial coding stage, these codes were grouped into major categories, such as local knowledge of coastal communities, community participation, government–community coordination, the socio-economic impacts of tidal flooding, coastal protection needs, and institutional barriers. In the selective coding stage, all categories were integrated into the core theme of adaptive co-production in tidal flood risk management based on coastal community participation (Akkaya, 2023; Liu, 2022).

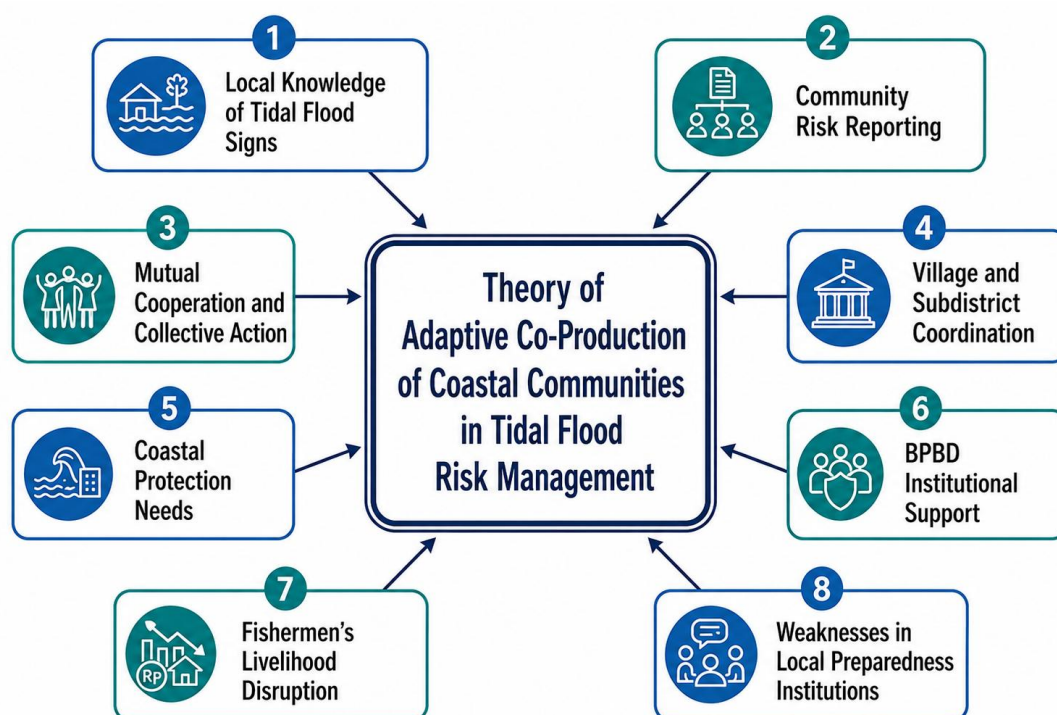
RESULTS AND DISCUSSION

In this section, tidal flooding is positioned as the main empirical case of maritime disaster risk management because this risk is the most dominant issue reflected in the lived experiences of coastal communities in Nagari Kapuh. The findings show that co-production in tidal flood risk management has emerged through local community practices and government responses, although it has not yet been fully institutionalised within a sustainable disaster governance system. Based on interviews with 17 informants, a recurring pattern was identified: tidal flood risk management operates through four main mechanisms, namely community recognition of tidal flood indicators, incident reporting to kampung heads and the nagari government, local response through mutual cooperation, and the submission of coastal protection proposals to the government. These findings indicate that coastal communities are not merely affected groups, but also act as co-producers in maritime disaster risk management (Khine et al., 2021; Scupola & Mergel, 2022).

Grounded Theory Process and the Formation of a Substantive Theory

Data analysis was conducted through three stages of grounded theory, namely open coding, axial coding, and selective coding. In the open coding stage, interview, observation, and documentation data were broken down into initial codes, such as tidal surges, high waves, seawater intrusion into land areas, community reports, kampung heads as intermediaries, mutual cooperation, blocked drainage channels, disruption to fishing activities, proposed breakwater development, subdistrict coordination, the role of BPBD, and inactive local preparedness

institutions. In the axial coding stage, these codes were grouped into the categories of community local knowledge, community-based risk reporting, collective action, institutional coordination, coastal protection needs, socio-economic impacts, and weaknesses in local preparedness institutions. In the selective coding stage, all categories were integrated into the core theme, namely the Theory of Adaptive Co-Production of Coastal Communities in Tidal Flood Risk Management. This theory emerged from recurring patterns in the field data and explains the adaptive relationship between coastal communities and the government in tidal flood risk management (Akkaya, 2023; Liu, 2022).



Pictures 2. Theory Memo of Adaptive Co-Production of Coastal Communities in Tidal Flood Risk Management

Source: Elaborated by the authors, 2026.

Picture 1 shows eight main dimensions of the substantive theory, namely local knowledge of tidal flood signs, community risk reporting, mutual cooperation and collective action, village and subdistrict coordination, BPBD institutional support, coastal protection needs, fishermen's livelihood disruption, and weaknesses in local preparedness institutions. These eight dimensions are the result of integrating initial codes, axial categories, and the core theme. Thus, adaptive co-production is formed not only through government–community collaboration, but also through the relationships among local knowledge, risk reporting, cooperation, institutional coordination, coastal protection needs, fishermen's economic impacts, and weaknesses in local preparedness.

Local Knowledge, Risk Reporting, and Tiered Coordination

The first finding shows that coastal communities possess local knowledge in recognising the signs of tidal flooding. Community informants explained that tidal flooding occurs when the tide rises, and seawater enters land areas (MSR-01). Another informant stated that the signs of tidal flooding are recognised through tidal movements and previous experience (MSR-10), while residents living near the shoreline feel more concerned when high tides and large waves occur (MSR-07). The data pattern from MSR-01, MSR-07, and MSR-10 indicates that community knowledge of tidal flooding is empirical and based on lived experience in coastal areas. This finding aligns with (Hadlos et al. (2022), Trogrlić et al. (2022), and Vasileiou et al. (2022), who emphasise that local knowledge can strengthen disaster risk reduction when integrated with institutional systems and scientific knowledge.

The second finding shows that risk reporting takes place through a tiered mechanism. Community members convey information to the kampung head, who then forwards it to the nagari government, subdistrict authorities, and relevant agencies. The kampung head explained that community members usually report to the kampung head, after which the information is forwarded to the nagari government or subdistrict authorities (KPG-01). The nagari government also inspects the location, collects documentation, and reports the incident to the subdistrict authorities (PNG-01). At the subdistrict level, KEC-01 plays a role in issuing public advisories and assisting the nagari, while KEC-02 is involved in planning, reporting, and administrative coordination. This pattern indicates the joint production of disaster-related information between the community and the government. However, coordination still tends to be reactive because institutional actions more often emerge after community reports are received or after impacts become visible in the field (Ogra et al., 2021; Satizábal et al., 2022).

Mutual Cooperation, Socio-Economic Impacts, and Coastal Protection Needs

The third finding shows that mutual cooperation is the most visible form of community participation in dealing with tidal flooding. Community members help clean drainage channels when water begins to rise or when the channels become blocked (MSR-04). The kampung head also emphasised that mutual cooperation is carried out to clear blocked water flows (KPG-01), while another community informant stated that residents help one another when water rises or when the surrounding environment is affected (MSR-09). Mutual cooperation reflects the social capital of coastal communities, but it remains more dominant as a spontaneous action and has not yet been fully institutionalised within a tidal flood preparedness system (Hadlos et al., 2022; Islam et al., 2022; Trogrlić et al., 2022).

The fourth finding shows that tidal flooding directly affects the socio-economic activities of coastal communities, particularly fishermen. When high waves occur, fishermen cannot immediately go to sea and must wait until conditions are safe (MSR-02). Tidal flooding also disrupts community activities because some residents work as fishermen (MSR-08), while communities continue to require government attention because tidal flooding recurs and disrupts coastal life (MSR-12). This finding indicates that tidal flooding affects not only the physical environment but also the daily economy of the community. Therefore, tidal flood risk management needs to consider livelihood protection and the reduction of socio-economic vulnerability among coastal communities (Marasco et al., 2021; Ogra et al., 2021).

The fifth finding shows that communities have a strong need for breakwater construction as a form of coastal area protection. Community members expect the construction of breakwaters so that waves do not directly enter the shoreline area (MSR-06), while another informant stated that community proposals had previously been submitted but had not all been followed up (MSR-11). The kampung head also stated that proposals for coastal protection emerged from community concerns about large waves and seawater entering the shoreline area (KPG-01). From a co-production perspective, the proposed breakwater represents a form of community contribution to formulating policy needs. However, when such proposals have not been fully followed up, a gap emerges between community participation and policy realisation (Satizábal et al., 2022).

BPBD Support and Weaknesses in Local Preparedness Institutions

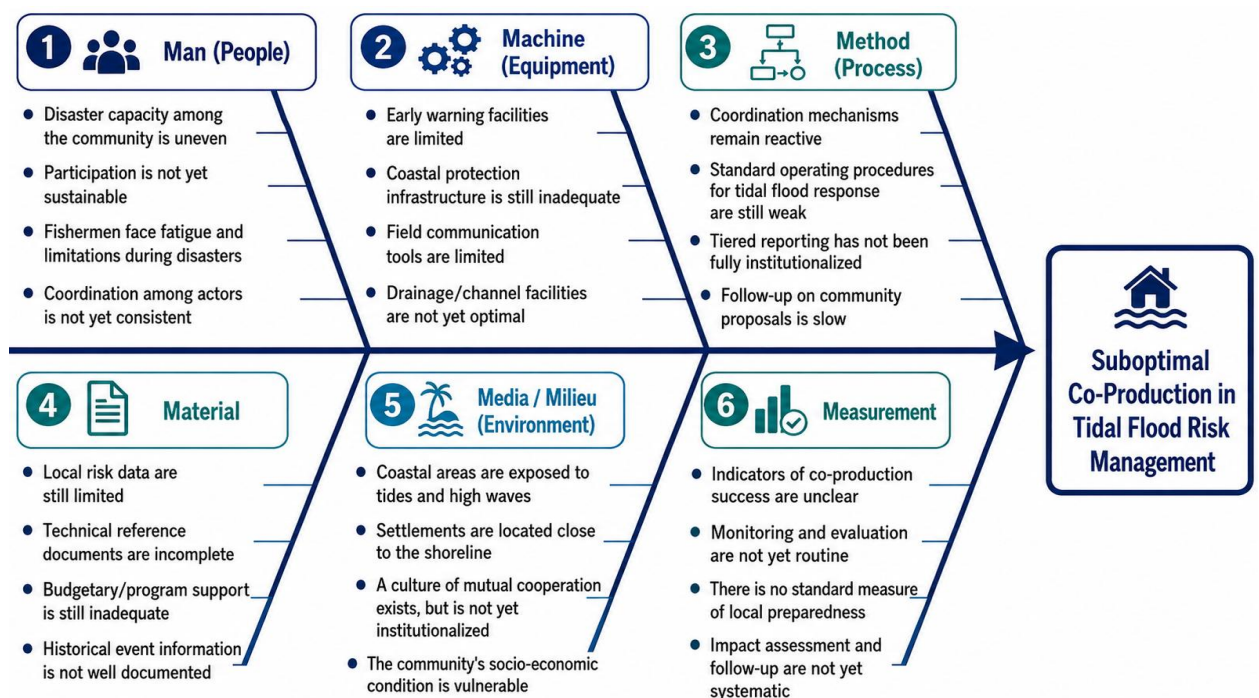
The sixth finding shows that BPBD plays an important role in the regional disaster management system. BPBD prepares strategies, policies, and disaster management formulations before disasters occur (BPBD-01). During disasters, BPBD also plays a role in evacuating victims and meeting the basic needs of affected communities (BPBD-01). However, BPBD's institutional support has not been fully connected to local preparedness institutions. The nagari government explained that the Disaster Preparedness Group existed around 2017–2018, but it is no longer active (PNG-01). This condition shows that the main barrier does not lie in low community awareness, but in the weakness of local institutions capable of managing knowledge, training, reporting, and collective action on a continuous basis (Islam et al., 2022; Satizábal et al., 2022).

Normatively, the importance of community involvement also aligns with Law of the Republic of Indonesia Number 24 of 2007, which affirms the rights of communities to obtain protection, information, education, training, and participation in decision-making, as well as their obligation to engage in disaster management activities. In addition, Government Regulation of the Republic of Indonesia Number 21 of 2008 positions disaster management as a series of activities that

includes prevention, mitigation, preparedness, emergency response, rehabilitation, and reconstruction. Thus, the reactivation of local preparedness institutions is important so that the principle of community participation does not remain merely a legal norm, but operates in the practice of tidal flood risk management.

Root Cause Analysis Using the 6M Fishbone Approach

To clarify the factors causing the suboptimal implementation of co-production in tidal flood risk management, this study used Fishbone or Ishikawa analysis with the 6M approach, namely Man, Machine, Method, Material, Media/Milieu, and Measurement. This analysis was used to systematically map the root causes based on field findings.



Pictures 2. Fishbone Analysis of the Root Causes of Co-Production Gaps in Tidal Flood Risk Management

Source: Developed by the authors, 2026

Picture 2 shows that the suboptimal implementation of co-production is influenced by six groups of factors. The Man factor includes uneven disaster capacity among community members, participation that has not been sustained, fishermen's limitations during disasters, and inconsistent coordination among actors. The Machine factor includes limited early warning facilities, coastal protection infrastructure, field communication tools, and drainage facilities. The Method factor includes coordination mechanisms that remain reactive, weak standard operating procedures for tidal flood response, tiered reporting that has not been fully institutionalised, and slow follow-up on community proposals. The Material factor includes limited local risk data,

incomplete technical reference documents, inadequate budget support, and insufficient historical documentation of events. The Media/Milieu factor includes coastal exposure to tides and high waves, settlements located close to the shoreline, a culture of cooperation that has not been institutionalised, and vulnerable socio-economic conditions among communities. The Measurement factor includes unclear indicators for the success of co-production, irregular monitoring and evaluation, the absence of standard measures for local preparedness, and the lack of a systematic approach to impact assessment and follow-up.

Based on the 6M Fishbone analysis, strengthening co-production should be directed towards improving community capacity, providing early warning facilities, strengthening coastal protection infrastructure, preparing standard operating procedures for tidal flood reporting, improving local risk data, documenting historical events, institutionalising cooperation, and developing indicators for the success of co-production. Thus, the Fishbone analysis functions not only as a tool for mapping root causes, but also as a basis for formulating improvements in tidal flood risk governance (Amatebelle et al., 2025; Ogra et al., 2021; Chan et al., 2022).

New Theory, Practical Implications, and Synthesis of Findings

Based on the processes of open coding, axial coding, and selective coding, this study produced a substantive theory, namely the Theory of Adaptive Co-Production of Coastal Communities in Tidal Flood Risk Management. This substantive theory emerged from field data in Nagari Kapuh; therefore, it is not intended as a universal theory, but as a conceptual explanation of how adaptive co-production is formed in tidal flood risk management among coastal communities. This theory has eight main dimensions, namely local knowledge of tidal flood signs, community risk reporting, cooperation and collective action, village and subdistrict coordination, BPBD institutional support, coastal protection needs, fishermen's livelihood disruption, and weaknesses in local preparedness institutions.

This theory is described as adaptive because the co-production practices identified in this study were not entirely built through formal procedures, but developed from repeated community experiences in dealing with tidal flooding. Communities adapt through local knowledge, reporting, cooperation, and proposals for coastal protection. The government adapts through coordination, public advisories, verification, documentation, and policy follow-up. Theoretically, these findings extend the study of co-production in public administration. While previous studies have more commonly positioned co-production within public services in general (Khine et al., 2021; Scupola & Mergel, 2022), this study shows that co-production can also be used to explain maritime disaster risk governance at the local level. In addition, this study strengthens the literature on

community-based disaster risk reduction by showing that local community capacity needs to be connected with institutional support so that participation does not remain merely a spontaneous response (Hadlos et al., 2022; Islam et al., 2022; Trogrlić et al., 2022; Vasileiou et al., 2022).

The practical implications of these findings include the need to reactivate local preparedness institutions such as KSB, strengthen standard operating procedures for tidal flood reporting from communities to BPBD, document the historical occurrence of tidal flooding, integrate proposed breakwater development into regional development planning, and formulate indicators for the success of co-production. These indicators may include reporting speed, the number of institutionalised cooperation activities, the functionality of KSB, community involvement in planning, and follow-up on coastal protection proposals.

Thus, the research objective of analysing co-production practices in tidal flood risk management has been addressed. Communities play roles in risk identification, reporting, mutual cooperation, and the articulation of coastal protection needs, while the government plays roles in coordination, verification, documentation, and policy follow-up. However, these practices remain suboptimal because they have not been institutionalised on a continuous basis. Therefore, strengthening co-production should be directed towards institutionalising community participation within a more measurable, responsive, and sustainable coastal disaster governance system.

CONCLUSION

The main findings of this study affirm that co-production in tidal flood risk management has emerged, but has not yet operated optimally. The main barriers lie in coordination that still tends to be reactive, local preparedness institutions that have not remained continuously active, limited supporting facilities, weak local risk data, and suboptimal follow-up on community proposals, particularly those related to the need for breakwaters and coastal area protection. Thus, the suboptimal management of tidal flood risk is not caused by the absence of community participation, but by the weak institutionalisation of such participation within a planned and sustainable disaster governance system.

The main contribution of this study is the formulation of the Theory of Adaptive Co-Production of Coastal Communities in Tidal Flood Risk Management as a substantive theory derived from field data. This theory explains that tidal flood risk management is formed through eight main dimensions, namely local knowledge of tidal flood signs, community risk reporting, cooperation and collective action, village and subdistrict coordination, BPBD institutional support, coastal protection needs, fishermen's livelihood disruption, and weaknesses in local preparedness institutions. This theory shows that adaptive co-production does not merely refer to

collaboration between the government and the community, but also to a process of mutual adjustment among local knowledge, collective action, institutional coordination, coastal protection needs, and policy support.

Based on these findings, this study recommends that regional, subdistrict, and nagari governments strengthen the institutionalisation of co-production in tidal flood risk management. This strengthening can be carried out by reactivating the Disaster Preparedness Group, preparing standard operating procedures for tidal flood reporting, documenting historical incidents, increasing the capacity of coastal communities, strengthening early warning systems, and integrating community proposals into regional development planning. Proposals for coastal area protection, such as breakwater construction, also need to be technically assessed and followed up gradually according to risk priorities.

Future studies are recommended to expand the research sites to other coastal nagari in Pesisir Selatan Regency or coastal areas of West Sumatra so that the substantive theory developed in this study can be tested, compared, and further refined. Future research may also combine qualitative approaches with spatial mapping, coastal vulnerability analysis, or hydrometeorological data to produce a more comprehensive, measurable, and applicable tidal flood risk management model for maritime disaster governance based on coastal community participation.

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