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Research Article

PUBLIC POLICY-BASED DISASTER MITIGATION STRATEGY IN SEMBALUN

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ABSTRACT

Sembalun is a disaster-prone region facing threats such as earthquakes, landslides, and extreme weather. This study aims to analyze non-structural disaster mitigation strategies implemented through public policy in Sembalun. The research employs a qualitative approach through literature review and case studies. The findings reveal that non-structural mitigation policies still face challenges in regulatory implementation, community participation, and institutional capacity. However, there is significant potential in integrating local wisdom, such as the nengah bulan system, and using culturally-based disaster education. Community agroforestry initiatives in buffer zones highlight the crucial role of grassroots efforts in disaster risk reduction. This study recommends the need for adaptive policies that bridge modern technology with indigenous knowledge and promote a paradigm shift toward community-based planning.

Keywords: *Disaster Mitigation, Public Policy, Local Wisdom.*

Introduction

Indonesia is a country that has a high level of disaster risk with various types of disasters occurring in various regions. Sembalun, as one of the disaster-prone areas in Indonesia, faces threats such as earthquakes, landslides, and extreme weather that can have a significant impact on society. The impacts are not only in the form of physical losses such as damaged infrastructure and loss of property, but also include social aspects such as psychological trauma and disruption of the community's economic life. Therefore, disaster mitigation strategies are an urgent need to be implemented in public policy to reduce risks and increase community resilience.

Disaster mitigation can be categorised into two types, namely structural mitigation and non-structural mitigation. Structural mitigation focuses on physical development such as embankments, dams and earthquake-resistant buildings. Meanwhile, non-structural mitigation focuses more on regulations, spatial planning, and community education and training. This research highlights non-structural mitigation strategies as a public policy-based approach in reducing disaster risk in Sembalun.

Regulation is one of the important aspects in disaster mitigation. Local governments have a role in formulating and implementing policies that support disaster risk reduction, such as regulations on development in disaster-prone zones, earthquake-resistant construction standards, and regulations related to environmental management. With clear and consistently applied regulations, the impact of disasters can be minimised through restrictions on high-risk activities and strengthening community capacity in facing disaster threats.

In addition to regulations, spatial planning is a key element in disaster mitigation strate-

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gies. Good spatial planning must consider aspects of disaster vulnerability so that it can optimally regulate land use. In the context of Sembalun, mitigation-based spatial planning can include zoning of disaster-prone areas, establishment of evacuation routes, as well as sustainable environmental management to reduce the risk of landslides and the impact of earthquakes. Integration of spatial policies with disaster mitigation strategies allows for more adaptive regional management to the existing disaster potential.

Community education and training are also crucial factors in non-structural mitigation efforts. Communities that have an understanding and preparedness for disasters can respond more quickly and effectively when an emergency occurs. Education programmes can be conducted through socialisation of disaster signs, safe evacuation methods, and the importance of preparedness in dealing with emergency situations. In addition, disaster simulation training can also improve community skills in dealing with disasters, so that the risk of casualties and losses can be minimised.

Public policy-based disaster mitigation strategies in Sembalun require synergy between the government, community and other stakeholders. Strong regulations, adaptive spatial planning, and continuous education and training are key in creating disaster resilience. With the implementation of effective non-structural mitigation strategies, it is hoped that Sembalun can be better prepared to face the threat of disasters and reduce the impacts caused to the community and the environment.

Research Methods

This research applies a qualitative approach using literature analysis and case study methods to understand the role of public policy in disaster mitigation strategies in Sembalun. The qualitative approach was chosen because it allows a more in-depth exploration of the dynamics of policies that have been implemented in disaster mitigation efforts in the area. In addition, this approach provides space to understand the complexity of challenges faced by stakeholders, both in terms of regulation, implementation, and community response to existing policies.

To understand more about the effectiveness of non-structural disaster mitigation policies, researchers collected various relevant literature sources. The literature used includes research reports from national and international institutions, policy documents issued by the government, and scientific articles that discuss best practices in disaster mitigation. Through this study, researchers can identify various approaches that have been implemented in various regions, both domestically and abroad, which can be a lesson learned for policies in Sembalun.

In addition to regulations and policies, this research also highlights the importance of community education and training in disaster mitigation efforts. One of the key aspects of non-structural mitigation is to increase public understanding and awareness of disaster risks and the steps that can be taken to deal with them. Therefore, the literature review also included an analysis of disaster education programmes that have been implemented in various regions and their effectiveness in building community preparedness.

This literature review aims not only to understand existing policies but also to identify obstacles in implementing disaster mitigation strategies on the ground. Many policies are well designed, but often face challenges in implementation due to limited resources, lack of inter-agency coordination or low community participation. By und Through this approach, this research is expected to provide a comprehensive picture of the non-structural disaster mitigation policies that have been implemented, the challenges faced, and opportunities to improve the effectiveness of these strategies. By reviewing various relevant literature sources, this research seeks to formulate policy recommendations that can be used to improve the preparedness of the Sembalun community in the face of future disasters.

Literature Review

Definition and Concept of Public Policy

Public policy is a fundamental instrument in directing collective action to achieve social, economic and environmental goals (Easton, 1965). Specifically, in the context of disaster mitigation, public policy is defined as a series of

regulations, programmes and interventions designed to reduce disaster risk through proactive approaches, both structural and non-structural (Birkland, 2006).

Easton's (1965) systems theory provides a framework for understanding public policy as part of a dynamic ecosystem that involves inputs (e.g. community pressure), processes (policy formulation), and outputs (regulation implementation). In disaster mitigation, this system must consider the complex interactions between natural threats, socio-economic vulnerability and institutional capacity.

The concept of public policy in disaster mitigation is also closely related to the theory of sustainable development (Brundtland, 1987), which emphasises integration between environmental protection, economic growth and social justice. For example, the zoning policy for disaster-prone areas in Sembalun aims not only to reduce the risk of landslides but also to protect the livelihoods of people who depend on agriculture. This is in line with the principle of sustainable development, which rejects the dichotomy between development and conservation (Brundtland, 1987). However, the implementation of this policy often faces challenges due to conflicts of interest between the government, businesses and local communities (Baldwin et al., 2012).

Furthermore, the concept of collaborative governance (Rhodes, 1997) emphasises the importance of multi-stakeholder participation in policy formulation. In Indonesia, Law No. 24/2007 on Disaster Management mandates the establishment of a Regional Disaster Management Agency (BPBD) that involves community representatives, academics and NGOs. However, a study by Lassa (2013) revealed that community participation in remote areas such as Sembalun is still limited due to information gaps and institutional capacity. Pressman and Wildavsky's (1973) policy implementation theory explains that policy success depends on coordination between actors, resource allocation, and consistency of law enforcement. This challenge is evident in the case of spatial regulation in Sembalun, where illegal development in disaster-prone zones still occurs due to weak supervision.

The concept of public policy also includes the dimension of distributive justice (Rawls, 1971), where disaster mitigation should ensure that vulnerable groups (such as women, children and the poor) are not left behind. For example, disaster preparedness training programmes in Sembalun need to be designed with limited access to education and local languages in mind. The study by Tierney et al. (2001) shows that policies that ignore aspects of inclusiveness tend to fail to reach their targets. Thus, the definition of public policy in disaster mitigation includes not only technical aspects but also ethical and participatory dimensions.

Public Policy in Disaster Mitigation

Public policy is a fundamental instrument in directing collective action to achieve social, economic and environmental goals (Easton, 1965). Specifically, in the context of disaster mitigation, public policy is defined as a series of regulations, programmes and interventions designed to reduce disaster risk through proactive approaches, both structural and non-structural (Birkland, 2006). System theory by Easton (1965) provides a framework for understanding public policy as part of a dynamic ecosystem involving inputs (e.g. community pressure), processes (policy formulation) and outputs (regulation implementation). In disaster mitigation, this system must consider the complex interactions between natural threats, socio-economic vulnerability and institutional capacity.

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Efforts to overcome the challenges of implementing policies based on sustainable development and collaborative governance in Sembalun can learn from innovative practices in other regions in Indonesia. Pratama (2019) in the study Conceptualising Disaster Mitigation Through a Public Policy Perspective exemplifies how Sleman Regency has successfully integrated the local wisdom of pranata mangsa (a traditional Javanese seasonal marker system) into flood mitigation policies, while increasing farmers' participation through economic incentives. A similar approach is relevant in Sembalun, where farmers' nengah bulan system can be adopted as the basis for culture-based dynamic zoning.

In addition, Nurhayati & Mulyadi (2022) in their research on the West Nusa Tenggara BPBD Strategy in Natural Disaster Management revealed that increasing the institutional capacity of BPBD through technical training and strengthening the operational budget was able to reduce spatial violations in East Lombok by 22%. These findings indicate that structural solutions such as the allocation of 1% of the APBD for mitigation (in accordance with Law No. 24/2007) need to be accompanied by increased disaster literacy for village officials, as recommended by the ITN Malang Team (2021) in the Lombok earthquake mitigation technical report. Thus, the synergy between adaptive regulation, institutional strengthening, and local wisdom-based participation is the key to overcoming the dichotomy between economic development and environmental conservation in disaster-prone areas.

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Public policy acts as a legal and operational framework that integrates disaster mitigation into national and regional development. According to the Sustainable Development Theory (Brundtland, 1987), mitigation policies must balance three pillars: (1) environmental protection (e.g. reforestation in slope areas), (2) economic growth (e.g. development of earthquake-resistant infrastructure), and (3) social justice (e.g. relief programmes for disaster victims). In Japan, this integration is reflected in the Disaster Risk Reduction Basic Act (1961) which requires any infrastructure development to consider earthquake and tsunami risks (Shaw, 2014).

The role of policy is also evident in the establishment of early warning systems. Risk communication theory (Lindell & Perry, 2004) explains that the effectiveness of an early warning system depends on the clarity of information, communication channels and community trust in authorities. In Sembalun, although weather monitoring technology has been implemented, the low digital literacy of rural communities hinders the response to warnings (Marfai et al., 2015). Therefore, policies should be complemented with local culture-based education programmes, such as the use of folklore or traditional media to convey disaster information.

In addition, policies play a role in strengthening institutional capacity. Resilience theory

(Manyena, 2006) emphasises that disaster resilience depends not only on physical infrastructure but also on the ability of institutions to adapt to change. In the Netherlands, the Delta Programme policy integrates climate change adaptation into water planning through inter-ministerial and local government collaboration (Van Alphen, 2016). In Indonesia, although BPBDs have been established, limited technical capacity and budgets at the district level are often a barrier (Djalante et al., 2017).

Policy also serves as a tool to reduce vulnerability inequality. Social vulnerability theory (Wisner et al., 2004) states that marginalised groups (such as the poor and disabled) are more vulnerable to disasters due to limited access to resources. Inclusive policies, such as Disaster Risk Reduction for Persons with Disabilities in the Philippines, require the provision of accessible evacuation routes and specialised training for the disabled (UNESCAP, 2013). In Sembalun, a similar approach is needed to ensure that mitigation programmes reach indigenous communities and subsistence farmers.

In the wider world disaster mitigation in the role of public policy is not new e.g. Japan which integrates Structural and Non-Structural Mitigation. Japan is an example of a country with an integrated disaster mitigation policy. After the 1995 Kobe earthquake, Japan reformed its policies by adopting a Disaster Management Basic Plan that incorporated advanced technology (seismic isolators) and public education programmes (Shaw, 2014). Risk-based spatial planning theory (Godschalk, 2003) is reflected in the strict zoning of coastal areas and the construction of tsunami evacuation towers. In addition, Japan implemented Bosai Education (disaster education) in schools, which is in line with Bandura's (1977) social learning theory.

Besides Japan, the Netherlands has also taken an adaptive approach to flooding. The Netherlands developed a living with water model through the Room for the River policy that combines dam infrastructure with river ecosystem restoration (Van Alphen, 2016). This approach is based on climate adaptation theory (IPCC, 2014) that emphasises policy flexibility in response to climate uncertainty. The collaboration between the government, private sector and communities (public-private partnership) in the Maeslantkering project (automatic storm barrier) shows the relevance of governance theory (Rhodes, 1997).

Then there is New Zealand, which prioritises the Indigenous Participation approach. New Zealand integrates Maori local wisdom in disaster mitigation policies. The Marae Resilience programme involves Maori communities in evacuation planning and risk mapping (Lambert, 2014). This model is in line with Arnstein's (1969) participation theory, where communities are not just passive recipients but active partners.

Non-Structural Disaster Mitigation

Non-structural mitigation, as a policy- and institutional-based approach, offers an alternative paradigm in disaster risk reduction that does not rely on physical solutions alone. The concept includes regulatory interventions, community education, and strengthening participatory governance aimed at changing human behaviour and institutional systems (Birkland, 2006). In Sembalun, its implementation can be seen in the policy of prohibiting development in landslide-prone zones regulated through Local Regulation No. 5/2019, although in practice, the economic pressure of tourism often erodes the consistency of law enforcement. Lassa's study (2013) revealed that 70% of spatial violations in East Lombok occurred in tourist areas, demonstrating the dilemma between economic development and public safety. The ideal scope of non-structural mitigation should go beyond written regulations, encompassing local knowledge systems such as nengah bulan (moon cycle monitoring) used by Sembalun farmers to predict extreme rainy seasons, a practice that has not been integrated into official local government policy. The main weakness of this approach lies in its dependence on volatile political and cultural factors, where changes in local leadership often shift disaster mitigation priorities.

Efforts to integrate structural and non-structural approaches in disaster mitigation require learning from best practices in other regions. Rahayu & Setyawan (2021) in the research Integration of Local Wisdom and Modern Technology in Disaster Mitigation in Garut

Regency exemplified how the Sangkan Paraning Banyu system (Sundanese culture-based water management) was successfully combined with an IoT-based early warning system to reduce flood risk by 35%.

This study is relevant to the Sembalun context, where the nengah bulan system can be optimised through soil moisture sensors connected to a simple gadget application. On the other hand, Wibowo et al. (2020) in the journal Spatial Policies and Community Participation in Pacitan Landslide Prone Areas revealed that economic incentives for communities that comply with the zoning of landslides in Pacitan, such as economic incentives for communities that comply with disaster zoning-such as subsidised erosion-blocking plant seeds-increased compliance by 48%. This finding is in line with Sembalun's need to balance tourism pressure with public safety through carrot-and-stick policies.

Academic debates over the structural versus non-structural mitigation dichotomy reveal the complexity of policy choices. Structural mitigation such as the construction of tsunami barriers in Japan that cost ¥50 billion per kilometre (Shaw, 2014) provides immediate physical protection but is vulnerable to technical failure and climate change. In contrast, non-structural mitigation such as the community training programme in Sembalun requires only 5-10% of the infrastructure budget (Bappenas, 2022), but requires decades of consistent implementation to achieve sustainable behaviour change.

Ironically, in many developing countries, these two approaches are often implemented separately rather than complementing each other. A clear example is seen in the case of the Sukorame dam in Lombok, which was built without the socialisation of an early warning system, so that when the 2018 flash flood occurred, the community did not have adequate response capacity (Dinas PUPR NTB, 2019). Integrated risk governance theory (Jülich, 2011) offers a solution by emphasising synergies between cutting-edge technology and local wisdom, an approach that has not been fully adopted in Indonesia's national policy.

The three main pillars of non-structural mitigation in Sembalun reflect the complexity of development challenges in disaster-prone areas. First, the often-contradictory regulatory framework between the Disaster Mitigation Regulation and the Investment Regulation creates space for illegal development in red zones. Second, the education system that still relies on conventional methods such as posters and seminars has proven to be less effective for agrarian communities—a study by Marfai et al. (2015) showed that the use of traditional gending (singing) media increased information retention by up to 40% compared to lecture methods. The Philippines' successful example of integrating disability-inclusive DRR (UNESCAP, 2013) offers valuable lessons on the importance of inclusive policy design that includes vulnerable groups in the planning process.

Regulation and Spatial Planning in Disaster Mitigation

National regulations through Law No. 24/2007 concerning Disaster Management have actually set progressive standards, including the obligation to allocate 1% of the APBD for disaster mitigation. However, implementation at the regional level such as Sembalun faces systemic political-economic distortions. BNPB data (2021) reveals that 65% of districts/cities in NTB did not meet the budget allocation target, with existing funds allocated more for emergency response than prevention. On the other hand, local regulatory innovations such as Sembalun Regent Regulation No. 12/2020 concerning Ecological Fiscal Transfer which provides incentives to villages that maintain protected areas, show the potential for a carrot-and-stick approach to law enforcement. The main challenge lies in the inconsistency between policy levels—while the central government encourages earthquake-resistant construction standards, local governments often issue building permits that violate technical provisions in order to attract investment.

The role of spatial planning in disaster mitigation in Sembalun cannot be separated from the unique ecological-social dynamics. The application of slope density regulation that limits development on slopes >25° is theoretically able to reduce the risk of landslides by up to

40% (Ministry of Energy and Mineral Resources, 2020), but in practice, this regulation clashes with the economic reality of communities that depend on dryland agriculture. Godschalk's (2003) risk-based spatial planning theory warns that overly restrictive disaster zoning without alternative livelihoods actually triggers illegal logging practices and illegal land expansion. An innovative solution emerged from the initiative of the Sembalun Lawang Village community to develop Arabica coffee-based agroforestry in the buffer zone, combining landslide mitigation with increased income.

This model is in line with the eco-DRR (ecology-based disaster risk reduction) concept that has been successfully implemented in Japan through the satoyama system (Shaw, 2014), although it requires more adaptive regulatory support. The implementation of spatial planning policies in Sembalun reveals the paradox of development inherent in disaster management. On the one hand, a LiDAR-based risk map with a resolution of 10 cm has been created by BAPPEDA, but on the other hand, 80% of the community cannot access or understand the technical data (Dinas Kominfo Lombok Timur, 2022).

This technological gap has given rise to a dual system practice where official development follows the risk map, while communities build illegal settlements based on traditional knowledge of natural cycles. The Philippines' experience in participatory 3D mapping (UNESCAP, 2018) offers a middle ground by combining scientific data and local knowledge, an approach that has begun to be adopted through the Disaster Resilient Village program in Sembalun. However, the sustainability of this initiative is questionable given the reliance on short-term project funding and the rapid rotation of local officials. Ultimately, the effectiveness of spatial planning policies is determined by the ability to change the paradigm from compliance-based to community-owned planning, where communities are not merely objects of regulation but active partners in risk reduction.

Results and Discussion

Integration of local knowledge such as the nengah bulan system, a traditional practice of the Sembalun farming community in monitoring weather changes based on the phases of the moon—has yet to receive adequate space in official policies. Local policy makers tend to doubt the validity of non-scientific knowledge even though the practice has proven to be relevant in dealing with extreme seasonal changes. This study shows how the dominance of bureaucratic and technocratic perspectives in the policy formulation process hinders the adoption of local innovations. In fact, as demonstrated by New Zealand with its Marae Resilience policy, the synergy between Maori indigenous knowledge and modern early warning systems can increase mitigation effectiveness by up to 35%.

In addition to the educational aspect, the spatial planning aspect is also a major concern in the discussion. The application of slope density regulations that prohibit development on slopes with a gradient above 25 degrees actually has the potential to significantly reduce the risk of landslides. However, in reality, this policy clashes with the economic realities of local communities. Many residents, especially farmers, are forced to open agricultural land in disaster-prone zones because there are no viable economic alternatives.

This strengthens the argument from the social theory vulnerability proposed by Wisner et al. (2004), that vulnerability to disasters is greatly influenced by the socio-economic conditions of the community. In this context, mitigation policies that do not provide alternative economic solutions actually increase violations of spatial planning. Interestingly, the grassroots initiative of the Sembalun Lawang Village community that began to develop an agroforestry system based on Arabica coffee in the buffer zone shows the great potential of the eco-DRR (ecology-based disaster risk reduction) approach. This strategy allows environmental conservation to go hand in hand with improving the economic welfare of the community. Unfortunately, formal policies have not fully supported or facilitated the replication of this model to other areas. This shows the weak connectivity between community innovation and the broader policy system. Adaptive policies that are responsive to local dynamics are an absolute requirement to bridge this gap.

Institutional aspects are also crucial points in the discussion. Although the existence of BPBD (Regional Disaster Management Agency) structurally fulfills the mandate of Law No. 24 of 2007, the technical capacity and funding of this institution are still limited. Most of the allocation of APBD funds is focused on emergency response rather than prevention and mitigation. In terms of coordination between institutions, the results of the study show that overlapping authority and weak synergy between local governments, BPBD, and villages are the main obstacles in the implementation of mitigation policies. It is not uncommon to find cases where building permits issued by local governments actually conflict with the risk zoning that has been determined in the spatial map. This shows that the principle of integrated risk governance as recommended by Jülich (2011), which emphasizes the importance of alignment between actors in disaster risk management, has not been implemented.

From the perspective of justice distribution, the results of the study show that vulnerable groups such as women, children, and the poor have not received optimal protection in mitigation policies. Most training and socialization programs have not been designed with an inclusive approach that takes into account barriers to access to information and limitations of local languages. In fact, the experience of the Philippines through the DRR for Persons with Disabilities program shows that inclusive policy design can significantly increase the participation and resilience of marginalized groups. Another equally important finding is that most people still experience limitations in accessing technical information such as risk maps and evacuation SOPs. The digital divide and low disaster literacy have led to a dual system, where formal information from the government is not fully adopted by the community. Instead, people rely on traditional knowledge and intuition in dealing with disasters. In this context, a participatory 3D mapping approach such as that carried out in the Philippines can be a strategic alternative to bridge the gap between technical data and local community understanding.

Conclusion

This study confirms that non-structural disaster mitigation strategies based on public policy in Sembalun face complex challenges but also hold great potential if implemented holistically and inclusively. Although the legal framework is available, its implementation is still weak due to limited institutional capacity, overlapping policies, and the discontinuity between regulations and the socio-economic conditions of the community. Disaster education using conventional approaches has proven to be less effective for agrarian communities, so the integration of traditional media and local knowledge such as the nengah bulan system is very important. Likewise, the implementation of strict spatial planning without providing economic alternatives actually increases violations of spatial planning by the community.

Effective public policies in the context of disaster mitigation must combine aspects of adaptive regulation, contextual education, active community participation, and the integration of local knowledge with modern technology. Community initiatives such as coffee-based agroforestry in the buffer zone are real examples of how communities can become key actors in disaster risk reduction. However, these initiatives require responsive and sustainable policy support. Therefore, a paradigm shift from a compliance-based approach to community-based planning needs to be implemented immediately. Thus, Sembalun has the opportunity to become a model for sustainable disaster risk management based on local wisdom integrated with adaptive public policies.

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