Spending More, Fewer Casualties? Leveraging Governance in Local Disaster Management

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ABSTRACT

Research Originality: This research introduces a quantitative framework for evaluating the effectiveness of local government disaster management strategies in Indonesia, specifically during the pre-disaster and emergency response stages—an area previously underexplored in existing qualitative-focused literature.

Research Objectives: This study evaluates the effectiveness of disaster management in reducing losses from natural disasters, focusing on two main stages: the pre-disaster and emergency response stages. Pre-disaster is measured by the documented availability of the Disaster Management Plan and the emergency response aspect through emergency spending.

Research Methods: This study employs fixed-effect estimation using panel data from districts and cities across Indonesia spanning 15 years, from 2008 to 2022.

Empirical Results: The study's results indicate that RPB effectively reduces the death rate from natural disasters, whereas the realization of BTT shows the opposite result.

Implications: These findings indicate that local governments should improve the quality of their RPBs and regularly prepare them to mitigate disaster risk effectively. Additionally, the government needs to assess and improve the flexibility of the BTT implementation mechanism, enabling its immediate use during the initial emergency response stage and thereby reducing death rates from natural disasters.

Keywords:
emergency spending; disaster management plan; death rate; natural disaster; local government policy

INTRODUCTION

Natural disasters represent a critical challenge, leading to substantial casualties, affecting a significant portion of the population, and generating significant social, economic, and long-term development losses. Meanwhile, Indonesia is the country with the second-highest disaster risk based on the report (Institute for International Law of Peace and Armed Conflict (IFHV), 2023). These disaster risks encompass the occurrence of extreme natural disasters and the negative impacts of climate change. Due to Indonesia's location and topography, earthquakes, tsunamis, and volcanic eruptions are inevitable.

Casualties, especially those who died, are the most detrimental impact of natural disasters because the loss of life not only has a direct effect on the victims' families but also shakes the social and economic stability of the community. The death of a relative can cause deep grief and temporary cognitive disorganization, which can potentially damage family structure and reduce labor productivity (Bonanno et al., 2010). Elevated mortality rates often reflect inadequate disaster mitigation, underscoring the need for enhanced planning and response to reduce risks and equip communities to withstand disasters. Preparedness and mitigation measures, along with effective evacuation, can reduce deaths due to natural disasters (Paul, 2011). Accordingly, disaster deaths are widely regarded as a key indicator to assess the efficacy of disaster risk management strategies in mitigating the impact of natural disasters (Green et al., 2019).
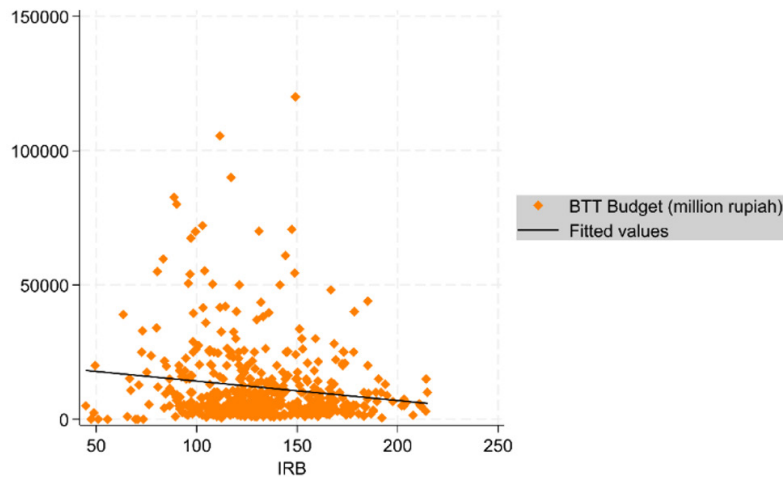
The effectiveness of disaster management plays a critical role in addressing the elevated risk of natural disasters. In the Indonesian context, disaster risk can be mitigated by reducing vulnerability levels and enhancing people's ability to cope with potential hazards. For instance, we can implement this by improving infrastructure and early warning systems, offering disaster education, and promoting active community involvement in disaster planning and mitigation. Although natural hazards such as earthquakes or volcanic eruptions cannot be entirely avoided, their impacts can be mitigated by reducing vulnerability and increasing capacity.

Pre-disaster activities within the disaster management implementation framework include risk reduction through vulnerability reduction and capacity building. In accordance with Law No. 24/2007, the Government of Indonesia mandates that the pre-disaster stage of disaster management begins with the preparation of a disaster management plan (RPB). The matters listed in the RPB include threat assessment, understanding community vulnerability, disaster impact analysis, selection of risk reduction actions, determination of preparedness mechanisms, and allocation of tasks, authority, and resources. Subsequently, central and local governments incorporate elements of the RPB into their development planning. However, despite the mandate established under Law 24/2007, only 247 districts, or around 48% of Indonesia's 514 districts, had RPB documents as of 2023.

District governments contribute to preparing RPB and play a crucial role during the emergency response stage following natural disasters. In emergency response, district governments coordinate among parties to assess needs, organize communication, allocate resources, and coordinate activities during response/evacuation in disasters. District

governments hold jurisdiction over the allocation of disaster management budgets within their respective regions. As the coordinator of regional disaster management, the Regional Disaster Management Agency allocates a portion of its budget to routine expenditures, which remain substantially lower than the local government's total budget (Oktari et al., 2017). Notably, up to 50% of local governments in Indonesia allocate disaster mitigation budgets that fall short of the actual needs, highlighting this condition (Dartanto et al., 2017).

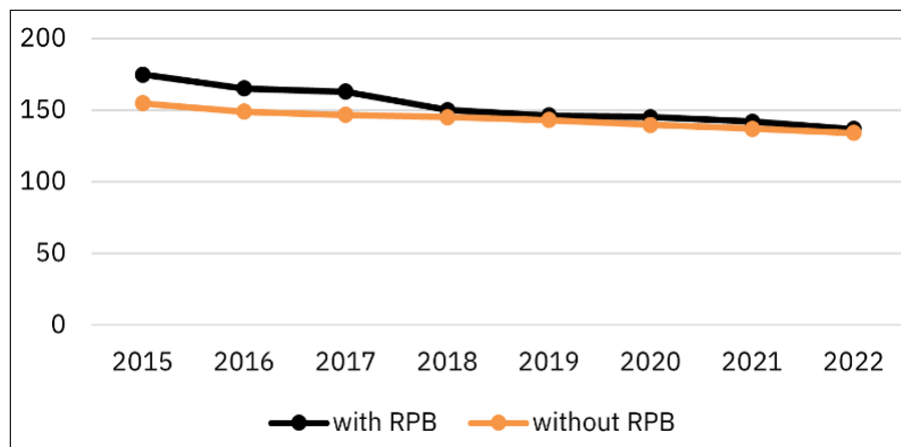**Figure 1. Relationship between the BTT budget and the IRB at the district government in 2023**

Source: BNPB and Ministry of Finance (processed by authors)

In the emergency response stage, district governments allocate emergency spending (BTT) within the Regional Revenue and Expenditure Budget (APBD). According to the Ministry of Internal Affairs Regulation (Permendagri 77/ 2020), BTT is designated to finance urgent disaster response activities, including search and rescue of disaster victims, emergency response assistance, evacuation of disaster victims, clean water and sanitation needs, food, clothing, health services, shelters, and temporary houses. Dartanto et al. (2017a) observed that as disaster risk intensifies, budget allocations for disaster mitigation tend to decline, reflecting perceived uncertainty and the limited effectiveness of such investments in reducing damage and losses. Under these conditions, ideally, areas with a high disaster risk index (IRB) should focus on the emergency response stage by increasing BTT allocations to reduce disaster impact. However, empirical findings from 2023 reveal a negative relationship between the BTT budgets and IRB (Figure 1). This data shows that the district government has not allocated BTT in accordance with the regional IRB's provisions. The BTT budget continues to decline as the regional IRB grows.

Furthermore, when examining compliance with disaster management governance during the pre-disaster stage, an additional noteworthy finding emerges. Figure 2 revealed that regions with RPB documents, on average, scored higher on IRB than those without. These findings suggest that areas with a high IRB exhibit greater awareness of the risks in their areas and commitment to managing disaster risk through systematic planning. Figure 3 indicates that areas with RPB have comparatively lower budgets than those without
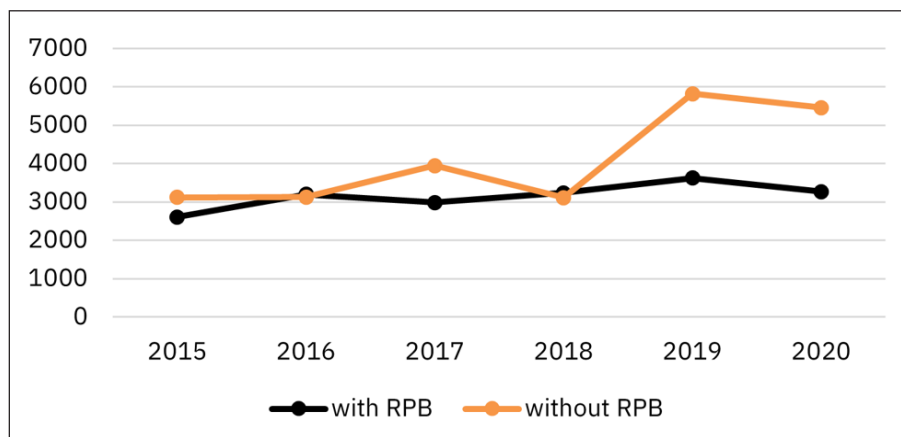
RPB. This may reflect more mature, structured planning in regions with RPB, enabling them to optimize budgets and reduce BTT funding during emergencies. Furthermore, Figure 4 reveals that areas with RPB achieve slightly higher BTT than those without RPB. This condition aligns with the potential for enhanced disaster management, given that the area has an IRB score higher than those without RPB.

Figure 2. IRB districts with and without RPB in 2015-2022

Source: BNPB (processed by authors)

Figure 3. BTT budget (million rupiah) districts with and without RPB in 2015-2020
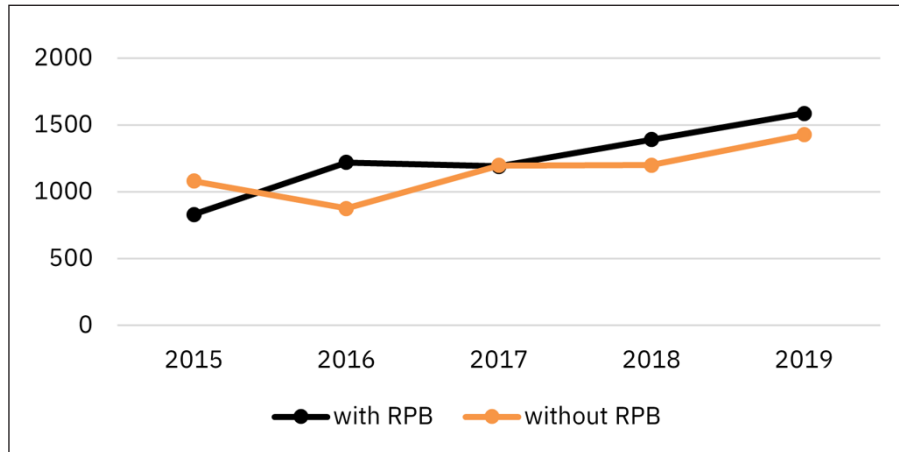

Note: This graph does not include 2021–2022, as management of the COVID-19 pandemic led to a significant spike in the BTT budget in that period.

Source: BNPB and Ministry of Finance (processed by authors)

Given the disaster management conditions in Indonesia as explained above, how effective is the response system in reducing losses from natural disasters? Theoretically, local governments are better positioned than the central government to deliver public goods and services aligned with their communities' preferences and needs, given their more immediate and comprehensive access to regional information. As Oates (1993) contends, this allows them to provide more effective public services Click or tap here to enter text.. Governments at the regional level are also more responsive to the needs of

the majority of local communities (Bardhan, 2002). It is anticipated that adjusting local government expenditure policies through regional budget instruments will harmonize the availability and allocation of resources.

Figure 4. Realization of BTT (million rupiah) districts with and without RPB in 2015-2019

Note: The graph does not display the years 2020–2022, as management of the COVID-19 pandemic during those years led to a notable increase in the realization of BTT.

Source: BNPB and Ministry of Finance (processed by authors)

Governments encounter a persistent dilemma in allocating resources for disaster management. In disaster relief, budgeting for disaster management programs is challenging, marked by uncertainty and potential dilemmas. The timing and scale of financial allocations remain indeterminate because they depend on the unpredictable occurrence of disasters (Goodisman, 1983). The government needs to allocate several budgets for disaster management to protect the community's safety from the impacts of natural disasters. On the other hand, the government also needs to encourage development that supports productivity.
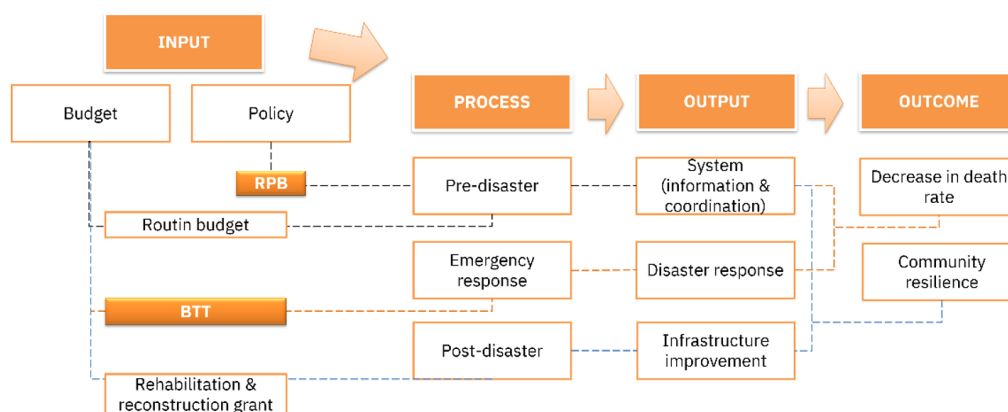
The Arrow-Lind paradigm posits that the government maintains a neutral stance towards risk, diversifying risks across various programs to mitigate the negative impact of natural disasters. Even so, Hochrainer & Pflug (2009) resist this paradigm in disaster-prone countries, where risk dissemination and collection become difficult. In these countries, the costs and negative consequences of natural disasters can outweigh the benefits of taking risks. In such a situation, avoiding risks by allocating an adequate budget for disaster management may be more appropriate than taking risks or remaining neutral, with negative consequences if the event occurs. However, this condition will impose an opportunity cost on other sectors. The budget allocated to disaster management may be diverted from other important sectors, such as education, infrastructure development, and poverty alleviation.

The next question pertains to the effectiveness of the allocated disaster management budget in achieving its intended outcomes. As previously mentioned, disaster deaths serve as the primary indicator of the effectiveness of disaster risk management strategies in mitigating the impact of natural disasters. In this scenario, the intended consequences of negative natural disasters, like death, are irreversible and irreparable. Disaster deaths serve

as the primary outcome indicator, reflecting the effectiveness of the disaster in mitigating its impact (Green et al., 2019). Mortality figures are widely used in the literature due to their comprehensive and reliable collection (Anbarci et al., 2005; Escaleras & Register, 2012; Kahn et al., 2005; Yamamura, 2012; Raschky & Schwindt, 2016). The extent to which fiscal allocations have successfully reduced disaster-related deaths through integrated mitigation, preparedness, and emergency response efforts demonstrates the effectiveness of the budget and governance in this case.

The existing literature on the implementation and efficacy of disaster management strategies, including their budget allocation, remains underdeveloped, particularly in quantitative analysis. Previous research primarily focused on qualitatively discussing the government's efforts to enhance the effectiveness of disaster management and the challenges it faces (Butt, 2014; James, 2008), while empirical literature is mainly comprised of cross-country studies (Skidmore & Toya, 2013). Complementing prior research, this study presents a country-specific analysis of Indonesia to quantitatively assess the effectiveness of local government measures in reducing deaths from natural disasters, focusing on the pre-disaster and emergency response stages. Furthermore, this study assesses the context of local expenditures on natural disasters and governance, focusing on the adoption of regulatory and disaster management measures. To our knowledge, no study has examined local governance and spending policies related to local disaster management.

Figure 5. Framework of RPB and BTT from Input, Process, Output, and Outcome Channels

Source: Authors

Appropriate policies and adequate budget allocations enable governments to reduce negative impacts and enhance the resilience of communities and ecosystems (Limariana et al., 2024; Wurarah & Mulyanto, 2024). Using the number of deaths as an outcome, this study focuses on implementing disaster management in the pre-disaster stage and during emergency response (Figure 5). During emergency response, local governments, per *Permendagri* 77/2020, provide BTT to address emergencies, including natural, non-natural, and social ones; search-and-rescue operations; and damage to facilities that disrupt public services. Local governments use these funds for evacuation, victim rescue, clean water, sanitation, food, clothing, health services, and shelters. The use of BTT is valid from

the time the emergency response is established until the end of the phase. Flexible access to emergency spending is essential to support rescue operations and facilitate the rapid evacuation of trapped or injured victims (Wang et al., 2018). Several Regional Apparatus Organizations (OPD), including the Environment and Forestry Service, the Public Works and Spatial Planning Office, and the Health Service, receive funding for pre-disaster activities. Various OPDs distribute a relatively small budget for pre-disaster activities. The BPBD, acting as the region's disaster management coordinator, allocates a relatively small portion to pre-disaster activities, primarily focusing on routine spending and maintenance (Dartanto et al., 2017; Oktari et al., 2017). This study uses the availability of RPB documents to provide an overview of pre-disaster activities carried out by local governments, while accounting for the complexity of pre-disaster budget allocation. Every five years, the BPBD coordinates the preparation of the RPB document, which involves other related OPDs. The RPB document includes disaster management mechanisms, resource allocation, and disaster risk reduction action plans. Establishing a coordination structure and system and preparing comprehensive policies and action plans in the RPB document illustrate the government's commitment and preparedness (Dariagan et al., 2021).

This study poses two questions. The first question concerns the effectiveness of BTT in reducing the death rate from natural disasters. A higher level of BTT indicates that the local government is better prepared and more committed to emergency response, thereby reducing the death rate from natural disasters. The second question examines the effectiveness of local governments with RPB documents in reducing death rates from natural disasters. Local governments prioritize delivering public services to enhance community welfare. Their performance is assessed through a multidimensional approach using Minimum Service Standards (SPM). Within this framework, RPB is classified as a basic service in the SPM. These services ensure that the quality and type of services are in accordance with the set standards, impacting direct service implementation. These RPBs are a form of decentralized policy, and existing cross-country studies show that local government policies on natural disasters are associated with improvements in casualty management (Sjöstedt & Povitkina, 2017; Skidmore & Toya, 2013). Thus, we expect local governments with RPBs to demonstrate a more substantial commitment to disaster preparedness and enhance regional capacity to lower the death rate from natural disasters.

This study focuses on the analysis from 2008 to 2022. We selected the sample year from 2008, considering the issuance of PP 21/2008, which mandates local governments to prepare RPBs. These RPBs are integrated into the broader development planning process, drawing upon the results of disaster risk analysis and activities outlined in the disaster management activity program. This study employs a fixed-effects estimation method to assess the correlation between RPB and BTT implementation and natural disaster mortality rates. The study is structured into four sections. The introduction explains the context, objectives, and scientific contributions. The second part discusses the methodology for calculating the correlation between BTT and RPB regarding natural disaster mortality rates. The third part presents the findings and discussion of the estimation. The final section offers concluding remarks and policy recommendations.

METHODS

This study analyzes secondary data, covering districts and municipalities in Indonesia from 2008 to 2022. The data were obtained from various sources, including the BNPB, Ministry of Finance, and Central Bureau of Statistics (BPS). The selected data sources were chosen for their comprehensiveness and relative consistency of the data they provide each year. Table 1 presents more detailed information on the operational variables used in the study.

This study employs a fixed effect method, presuming a correlation between the independent variables and unobserved heterogeneity. This method considers that each local government may have unique characteristics that affect the relationship between the realization of unexpected spending and disaster risk reduction. This approach can manage the effects of constant variables across regions and time developments, resulting in a more precise estimate of the correlation between disaster spending and the death rate from natural disasters. This reduces any potential endogeneity issue.

This study examines the effectiveness of regional disaster management spending and governance in reducing deaths and losses from natural disasters by estimating the following model:

$$DR_{it} = \beta_0 + \beta_1 BTT_{it} + \beta_2 RPB_{it} + \beta_3 GRDPC_{it} + \beta_4 HDI_{it} + \beta_5 POPDENS_{it} +$$
$$\beta_6 VULNPOP_{it} + \sum_{j=1}^{n} \gamma_j DISFREQ_{j,it} + \theta_i + \varepsilon_{it} \tag{1}$$

The description of each variable in equation (1) is explained in Table 1. As a result of disaster management, DR represents the total number of deaths due to natural disasters in a district, divided by the district's population, within a year of the disaster. Following the guidelines of (Escaleras & Register, 2012), several adjustments were made to the calculation of DR. Firstly, the ratio is interpreted per 100,000 population because of its small size. Second, the model transformed this variable using a logarithm due to the significant variation in deaths. Finally, to account for disasters with zero fatalities, one death was added to each observation. Accordingly, DR is the result of $\ln((1 + \text{number of deaths})/(\text{population}/100,000))$.

The first independent variable is BTT, which represents each district government's actual emergency spending. BTT is allocated for spending during emergencies, including natural disasters, non-natural disasters, social issues, search and rescue operations, and damage to facilities or infrastructure that disrupt public services. Although its application extends beyond natural disasters, BTT remains unavailable to the public. Consequently, this study uses the overall BTT realization as a variable, which constitutes a limitation. The next independent variable is RPB, a dummy variable. A value of 1 indicates that the district has an RPB document, while 0 suggests otherwise. The local government prepares the RPB for five years and should periodically update it. However, if the local government has updated the RPB, the previous version will be used as a reference when preparing the development plan.

To account for regional characteristics and socio-economic heterogeneity, this study incorporates control variables such as the real Gross Regional Domestic Product per capita (GRDPC), the Human Development Index (HDI), population density (POPDENS),

and vulnerable population groups, including toddlers and the elderly (VULNPOP). It is hypothesized that GRDPC and HDI variables negatively impact mortality rates. Regions with high GRDP contribute to reducing the impact of natural disasters (Escaleras & Register, 2012). Higher-income areas are more likely to provide high-quality infrastructure and emergency services to protect communities from disaster deaths (Kahn et al., 2005).

Table 1. Description of Variables and Sources of Data Used in The Study

Variable name	Brief description	Source of data
Death Rate (DR)	The death toll from natural disasters is calculated by: ln((1+number of deaths)/ (population/100,000))	BNPB & BPS
Emergency spending (BTT)	Realization of BTT (rupiah)	Ministry of Finance
Disaster Management Plan (RPB)	Dummy variable: Valued at 1, if there is an RPB document; 0 if otherwise.	BNPB
Income per capita (GRDPC)	Real gross regional domestic product per capita	BPS
Human Development Index (HDI)	Human development achievements are based on several basic components of quality of life.	BPS
Population Density (POPDENS)	The total population divided by the area (populations/km^2)	BPS
Vulnerable group population (VULNPOP)	The percentage of the population is under 5 years old and over 64 years old (%)	BPS
Frequency of floods and landslides (DF1)	Number of flood and landslide disaster events (times)	BNPB
Frequency of earthquake disasters (DF2)	Number of earthquake disaster events (times)	BNPB
Frequency of tsunami disasters (DF3)	Number of tsunami disaster events (times)	BNPB
Frequency of other disasters (eruptions, extreme weather, forest and land fires, droughts) (DF4)	Number of eruptions, extreme weather, forest and land fires, drought disaster events (times)	BNPB

Meanwhile, regions with high HDI scores tend to exhibit elevated literacy and education levels. These conditions enable residents to make informed decisions about safe construction practices, residence locations, and disaster protection strategies, reducing disaster-related deaths (Toya & Skidmore, 2007). Meanwhile, other variables, such as population density (POPDENS) and vulnerable population groups (VULNPOP), are believed to influence mortality rates positively. The more people in a densely populated area, the more deaths will occur in the event of a natural disaster (Padli et al., 2018). Vulnerable groups, such as toddlers and the elderly, exhibit reduced mobility and a limited capacity for self-evacuation when a disaster occurs. Furthermore, a weak immune system will be more susceptible to increased health risks during a natural disaster, which can increase mortality.

Meanwhile, disaster frequency (DISFREQ) refers to the number of natural disasters separated for each type. Each type of disaster can have a distinct impact on mortality rates. This study is divided into four disaster groups: floods and landslides, earthquakes, tsunamis, and other disasters (volcanic eruptions, extreme weather, forest fires, and

droughts). Furthermore, θ_i denotes a fixed effect vector, ε indicates the error term, i represents the district, and t is the year.

In equation (1), if $\beta_1 < 0$ with a significant value, it will confirm that the emergency spending can effectively reduce the death rate as an outcome of disaster management. Meanwhile, if $\beta_1 > 0$ with a significant value, the opposite Interpretation arises, namely that the allocation of unexpected spending has not been managed effectively in reducing the number of deaths. The local government's reliance on central government bailout funds may reduce the effectiveness of unexpected expenditure allocation in implementing disaster management in the region. Furthermore, if $\beta_2 < 0$ with a significant value, it indicates that local governments with RPB documents can be more effective at reducing disaster-related death rates than those without RPB documents. Conversely, if $\beta_2 > 0$, given their significant value, local governments with RPB documents are not yet as effective in implementing disaster management as those without RPB documents.

RESULTS AND DISCUSSION

The unit of observation in this study consists of annual data from each of the 443 districts from 2008 to 2022. The analysis was restricted to districts with complete data for all variables throughout the research period. Descriptive statistics and details of the variable employed in the analysis are presented in Table 2. The death rate ranged from 0.026 to 647.115, reflecting significant variation in mortality rates across regions. BTT also showed considerable variability, ranging from 0 to 394,034 million rupiah. This shows that some regions do not recognize BTT and instead rely on allocating emergency funds, grants, or assistance from the provincial and/or central governments for natural disaster response. Furthermore, the availability of RPB varied across regions, with an average score of 0.154, indicating limited adoption of formal disaster planning documents in many districts.

Table 3 presents the results of the fixed-effect estimation, both with and without control variables, to assess the consistency of the main independent variable coefficients, namely the BTT and RPB realizations. In the table, without adding control variables (column 1) and with them added (columns 2 and 3), the RPB coefficient remains negative and statistically significant. In contrast, the BTT coefficient is statistically significant and positive.

Table 3 reveals a negative correlation between the presence of the RPB and the death rate due to natural disasters. Controlling for all other variables, regions with RPB have an average mortality rate from natural disasters that is 6.1 percentage points lower than those without RPB. This finding aligns with Tay et al. (2022), who emphasize that the preparedness phase determines the operations to be carried out before a disaster strikes to support emergency response efforts effectively. Preparedness-related elements are outlined in the RPB. In this context, risk awareness is crucial for implementing operational plans and strategies, helping governments and communities prepare more effectively for disasters.

Table 2. Descriptive statistics

Variable	Obs.	Average	St. Dev.	Min.	Max.
DR (per 100,000 persons)	6645	1.176	13.528	0.026	647.115
BTT (million rupiah)	6645	5019.909	17667.319	0	394034
RPB (million rupiah)	6645	0.154	0.361	0	1
GRDPC (million rupiah)	6645	31.776	43.183	0.713	1045.988
HDI	6645	68.636	5.988	35.45	87.69
POPDENS	6645	1002.432	2175.478	0.41	15643
VULNPOP (%)	6645	14.574	1.951	2.096	21.372
DF_flood	6645	1.931	3.243	0	72
DF_landslide	6645	1.35	6.791	0	361
DF_earthquake	6645	0.07	0.311	0	7
DF_tsunami	6645	0.003	0.056	0	2
DF_eruptions	6645	0.022	0.4	0	24
DF_extremeweather	6645	1.765	6.352	0	327
DF_forestlandfire	6645	0.493	2.403	0	51
DF_drought	6645	0.177	0.648	0	28

Notes: In the estimation, disasters are divided into four groups, namely floods and landslides, earthquakes, tsunamis, and other disasters (volcanic eruptions, extreme weather, forest fires, and drought).
Source: BPS, BNPB, Ministry of Finance (processed by authors)

The importance of preparedness is further underscored by evidence that elevated exposure levels, when not accompanied by adequate readiness, significantly increase the risk and impact of disasters. Accordingly, emergency planning and preparedness remain critical—particularly in developing contingency plans, conducting emergency response simulations, and fostering cross-sector coordination among governments, communities, and security institutions (Geddam & Raj Kiran, 2024). Given prevailing conditions in the field, where the majority of districts remain without a formal RPB, there is a significant preparedness gap that urgently needs to be addressed. This observation is corroborated by a study conducted in Kuwait by (Al-Husain, 2023) , identifying key areas for improvement in organizational preparedness and resilience against disasters and crises. The study further highlights the need for continuous training programs, infrastructure investment, and supply chain sustainability to build a robust and sustainable disaster management system.

Conversely, Table 3 indicates that the realization of BTT did not correspond with a reduction in the death rate from natural disasters. The analysis reveals that a one percentage point increase in BTT realization is associated with a 0.9 percentage point increase in the mortality rate, holding all other variables constant. These findings highlight that pre-disaster management, as outlined in RPB, has demonstrated greater efficacy in reducing disaster-related mortality than reactive expenditures like BTT. The observed positive correlation with BTT suggests that this type of spending has not functioned as an effective instrument for reducing casualties from natural disasters.

Table 3. Estimation results with the fixed effect method

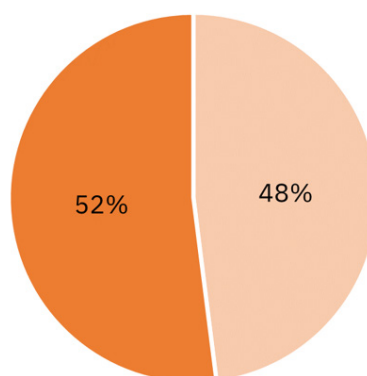|	(1)	(2)	(3)
BTT	0.005** (0.003)	0.005* (0.003)	0.009*** (0.003)
RPB	-0.105*** (0.029)	-0.131*** (0.03)	-0.061* (0.034)
GRDPC			0.046* (0.026)
HDI			-0.03*** (0.004)
POPDENS			-0.188*** (0.046)
VULNPOP			0.009 (0.009)
DF1		0.003 (0.004)	0.004 (0.004)
DF2		0.283*** (0.049)	0.297*** (0.049)
DF3		1.476*** (0.39)	1.427*** (0.399)
DF4		-0.007 (0.014)	-0.008 (0.014)
Constant	-0.898*** (0.015)	-0.924*** (0.018)	1.836*** (0.375)
N	6.645	6.645	6.645
R2	0,003	0,040	0,061

Note: * $p < .10$, ** $p < .05$, *** $p < .01$

Disaster risk reduction and mitigation are vital for public welfare and sustainable development. Although emergency expenditures during disasters are often necessary, relying solely on reactive spending without proper investment assessment may compromise long-term economic resilience. Thus, governments must adopt a more integrated and forward-looking approach—allocating funds for immediate response and pre-disaster mitigation, considering both direct and indirect losses through a holistic framework. This holistic investment approach improves the cost-effectiveness of disaster response and enhances community resilience by reducing exposure and vulnerability before disasters occur. Strategic funding in early warning systems, emergency preparedness programs, and health infrastructure has demonstrated efficacy in reducing mortality and economic disruption. In particular, pre-disaster investment can significantly reduce the strain on public finances during emergencies and ensure faster recovery and the continuity of essential services. Reinforcing these systems is especially critical in regions with high disaster exposure and limited institutional capacity. Persistently high mortality rates remain a substantial impediment to development, underscoring the urgency of improving early warning mechanisms, emergency preparedness, and healthcare systems as part of a long-term disaster risk governance strategy (Kyne & Kyei, 2024).

Among the control variables, HDI and population density showed negative effects. A higher HDI, which reflects better living standards and welfare, is linked to fewer disaster-related deaths. This suggests that people in more developed areas can make safer choices—such as building stronger houses, choosing safer locations, and understanding how to protect themselves—thereby reducing fatalities. Interestingly, areas with higher population density also tend to have lower death rates. This may be because densely populated, urban areas often have better disaster preparedness and response systems (Irajifar et al., 2016). While GDP per capita was expected to reduce mortality, it actually showed a positive, significant relationship. In some cases, rising GDP per capita may be accompanied by greater income inequality, limiting poorer groups' access to health services and increasing their mortality. The proportion of vulnerable populations did not significantly affect death rates. Meanwhile, the frequency of earthquakes and tsunamis had a significant positive impact on mortality. In contrast, the frequency of floods, landslides, and other disasters was not significant, given their relatively low average death tolls.

Although central and local governments engage in multiple dimensions of emergency planning and response, local governments bear the primary responsibility for emergency management. This is because local officials, such as firefighters, police, and emergency medical personnel, are the first to arrive at the scene and initiate emergency response efforts as soon as possible (Henstra, 2010). The effectiveness of local governments in coordinating disaster response efforts depends heavily on the quality of prior planning. In this context, local governments are expected to fulfill a fundamental governance role by creating a disaster management plan, which serves as the foundation for developing regional work plans, particularly those related to disaster management. Only about 48% of districts and cities (247 out of 514) have RPB. The estimates show that RPB availability significantly reduces disaster losses, particularly the death rate.

Figure 6. DSP transfer to districts in 2021 (natural disasters)

Source: BNPB (processed by authors)

The study's results revealed that BTT was ineffective at reducing death rates from natural disasters. The BTT realization mechanism may lack flexibility, making it challenging for local governments to directly intervene in the early stages of natural disaster emergency

response by carrying out evacuations. Allegations have emerged that the inefficacy of local governments' emergency spending is attributable to their continued reliance on central government financial assistance (Miao et al., 2021). The BNPB annually allocates ready-to-use funds (DSP), sourced from the State Budget (APBN) by the central government. The Ministry of Finance retains the authority to augment BNPB's allocation at any time, based on the amount requested, making it "infinite" and always available. These funds are distributed to various areas that require disaster management, particularly in the emergency response stage. Conversely, the DSP data from 2021 indicates that these funds primarily focus on managing the transition from emergency to recovery. This situation suggests that Indonesia's emergency spending, both at the central and regional levels, may still face effectiveness issues, as the share of spending on emergency response operations is not dominant (see Figure 6).

Under current conditions, the utilization of BTT in the initial stages of emergency evacuation remains operationally constrained and has yet to reach optimal effectiveness. Interestingly, the findings suggest a concurrent increase in both mortality rates and BTT realization. This relationship may arise from the frequent deployment of BTT during the recovery phase, particularly in operations involving the retrieval of deceased victims. Consequently, higher BTT realization may reflect improved identification and recovery of victims, thereby reducing the number of individuals classified as missing. If this interpretation is empirically valid, it indicates that BTT's effectiveness is improving, as it enhances the capacity to locate and identify victims during evacuation and recovery. In this sense, the number of victims recovered may serve as an indirect indicator of BTT's operational success in supporting emergency response and post-disaster recovery. Nevertheless, further empirical investigation is required to comprehensively assess BTT's effectiveness in minimizing unaccounted-for casualties and to distinguish its impacts across the phases of rescue and recovery operations.

CONCLUSION

This study found that Regional Disaster Management Plans (RPB) are associated with lower mortality rates from natural disasters. Regions with well-implemented RPBs tend to experience fewer disaster-related deaths. In contrast, the use of local emergency funds (BTT) has not been effective in reducing fatalities. In fact, larger BTT allocations are correlated with higher death rates. This may be due to the limited flexibility of BTT disbursement mechanisms or the reliance on central government assistance, which often delays early emergency responses.

These findings suggest that local governments' policy effectiveness is achieved through regional planning and institutional improvements in disaster management rather than through the size of local emergency spending. Therefore, local governments in Indonesia should enhance the quality of their RPBs and regularly prepare them to mitigate disaster risk effectively. Furthermore, the government should evaluate and enhance the flexibility of the BTT implementation mechanism to ensure its timely deployment during the initial emergency response stage, thereby reducing death rates from natural disasters.

REFERENCES

Al-Husain, R. (2023). Promoting Sustainability in Kuwait: An Exploratory Study of Disaster Management Preparedness and Resilience in State Organizations. *Sustainability*, *15*(13), 1–24. https://doi.org/10.3390/su151310066.

Anbarci, N., Escaleras, M., & Register, C. A. (2005). Earthquake Fatalities: The Interaction of Nature and Political Economy. *Journal of Public Economics*, *89*, 1907–1933.

Bardhan, P. (2002). Decentralization of Governance and Development. *Journal of Economic Perspectives*, *16*(4), 185–205. https://doi.org/10.4324/9781315703527-19.

Bonanno, G. A., Brewin, C. R., Kaniasty, K., & La Greca, A. M. (2010). Weighing the Costs of Disaster: Consequences, Risks, and Resilience in Individuals, Families, and Communities. *Psychological Science in the Public Interest*, *11*(1), 1–49.

Butt, S. (2014). Disaster Management Law in Indonesia: From Response to Preparedness? In. Butt, S., Nasu, H., & Nottage, L. (Eds). *Asia-Pacific Disaster Management: Comparative and Socio-Legal Perspectives*. Berlin: Springer.

Dariagan, J. D., Atando, R. B., & Asis, J. L. B. (2021). Disaster Preparedness of Local Governments in Panay Island, Philippines. *Natural Hazards*, *105*(2), 1923–1944.

Dartanto, T., Bastiyan, D. F., & Sofiyandi, Y. (2017). Are Local Governments in Indonesia Really Aware of Disaster Risks? *AIP Conference Proceedings*, *1857*. https://doi.org/10.1063/1.4987125.

Escaleras, M., & Register, C. A. (2012). Fiscal Decentralization and Natural Hazard Risks. *Public Choice*, *151*(1–2), 165–183. https://doi.org/10.1007/s11127-010-9740-4.

Geddam, S. M., & Raj Kiran, C. A. (2024). Enhancing Disaster Management Effectiveness: An Integrated Analysis of Key Factors and Practical Strategies Through Structural Equation Modeling (SEM) and Scopus Data Text Mining. *Geohazard Mechanics*, *2*(2), 95–107. https://doi.org/10.1016/j.ghm.2024.03.001.

Goodisman, L. D. (1983). Budgeting and Field Discretion in Disaster Relief. *Public Budgeting & Finance*, *3*(1), 138–150. https://doi.org/10.1111/1540-5850.00591.

Green, H. K., Lysaght, O., Saulnier, D. D., Blanchard, K., Humphrey, A., Fakhruddin, B., & Murray, V. (2019). Challenges with Disaster Mortality Data and Measuring Progress Towards the Implementation of the Sendai Framework. *International Journal of Disaster Risk Science*, *10*(4), 449–461. https://doi.org/10.1007/s13753-019-00237-x.

Henstra, D. (2010). Evaluating Local Government Emergency Management Programs: What Framework Should Public Managers Adopt? *Public Administration Review*, *70*(2), 236–246. https://doi.org/10.1111/j.1540-6210.2010.02130.x.

Hochrainer, S., & Pflug, G. (2009). Natural Disaster Risk Bearing Ability of Governments: Consequences of Kinked Utility. *Journal of Natural Disaster Science*, *31*(1), 11–21.

Irajifar, L., Sipe, N., & Alizadeh, T. (2016). The Impact of Urban Form on Disaster Resiliency: A Case Study of Brisbane and Ipswich, Australia. *International Journal of Disaster Resilience in the Built Environment*, *7*(3), 259–275.

James, E. (2008). Getting Ahead of the Next Disaster: Recent Preparedness Efforts in Indonesia. *Development in Practice*, *18*(3), 424–429.

Kahn, M. E., Costa, D., Gerking, S., Glaeser, E., Levinson, A., Shapiro, J., Shimshack, J., & Timmins, C. (2005). The Death Toll from Natural Disasters: The Role of Income, Geography, and Institutions. *The Review of Economics and Statistics*, *87*(2), 271–284.

Kyne, D., & Kyei, D. (2024). Understanding Associations between Disasters and Sustainability, Resilience, and Poverty: An Empirical Study of the Last Two Decades. *Sustainability*, *16*, 1–23. https://doi.org/10.3390/su16177416.

Limariana., Hidayat, B. A., & Maulana. (2024). Local Government Policy. *Jurnal Bina Praja*, 361–376. https://doi.org/10.7765/9781526110169.00008.

Miao, Q., Shi, Y., & Davlasheridze, M. (2021). Fiscal Decentralization and Natural Disaster Mitigation: Evidence from the United States. *Public Budgeting and Finance*, *41*(1), 26–50.

Oates, W. E. (1993). Fiscal Decentralization and Economic Development. *National Tax Journal*, *46*(2), 237–243. https://doi.org/10.1086/NTJ41789013.

Oktari, R. S., Fahlevi, H., & Irawati, W. (2017). Disaster Budgeting of Banda Aceh's Local Government: Trends and Analysis of Post-Tsunami Aceh 2004. *IOP Conference Series: Earth and Environmental Science*, *56*, 012024.

Padli, J., Habibullah, M. S., & Baharom, A. H. (2018). The Impact of Human Development on Natural Disaster Fatalities and Damage: Panel Data Evidence. *Economic Research-Ekonomska Istrazivanja*, *31*(1), 1557–1573.

Paul, B. K. (2011). *Environmental Hazard and Disasters*. Chichester, UK: John Wiley & Sons.

Raschky, P. A., & Schwindt, M. (2016). Aid, Catastrophes, and the Samaritan's Dilemma. *Economica*, *83*(332), 624–645. https://doi.org/10.1111/ecca.12194.

Sjöstedt, M., & Povitkina, M. (2017). Vulnerability of Small Island Developing States to Natural Disasters. *The Journal of Environment & Development*, *26*(1), 82–105.

Skidmore, M., & Toya, H. (2013). Natural Disaster Impacts and Fiscal Decentralization. *Land Economics*, *89*(1), 101–117.

Tay, H. L., Banomyong, R., Varadejsatitwong, P., & Julagasigorn, P. (2022). Mitigating Risks in the Disaster Management Cycle. *Advances in Civil Engineering*, *2022*(1), 7454760.

Toya, H., & Skidmore, M. (2007). Economic Development and the Impacts of Natural Disasters. *Economics Letters*, *94*(1), 20–25.

Wang, W., Chen, H., Xu, A., & Qu, M. (2018). Analysis of the Disaster Characteristics and Emergency Response of the Jiuzhaigou Earthquake. *Natural Hazards and Earth System Sciences*, *18*, 1771–1783.

Wurarah, R. N., & Mulyanto. (2024). Effective Government Strategies to Deal with Climate Change Impacts in the West Papua Region. *Jurnal Bina Praja*, *16*(2), 235–249.

Yamamura, E. (2012). Death Tolls From Natural Disasters: Influence of Interactions Between Fiscal Decentralization, Institutions, and Economic Development. *MPRA Paper*, *36987*.