

# IDENTIFICATION OF AREAS AND HOUSING CONDITIONS IN TORNADO-PRONE AREAS IN SERDANG BEDAGAI REGENCY

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## ABSTRACT

The tornado disaster is one of the natural disasters that often occur in Indonesia, including in Serdang Bedagai Regency. Therefore, research is needed that aims to analyze areas prone to tornado disasters and the level of house damage caused as a basis for reference for rehabilitation and reconstruction of disaster victims' houses in Serdang Bedagai Regency. The methodology used is qualitative methods and quantitative methods through field survey approaches, geographical mapping, and data sources belonging to the Regional Disaster Management Agency of Serdang Bedagai Regency and even interviews with local residents. The results of the identification in this study show that the occurrence of tornado natural disasters from 2021 to 2024 has occurred 43 times at 124 different points and affected 1,020 housing units, which are predominantly occurring in Sei Bamban and Tanjung Beringin Districts because they are lowland and open, namely rice fields and near-coastal areas. The results of this study are expected to be a reference for local governments in disaster mitigation planning.

**Keywords:** Tornado, House Damage Rate, Serdang Bedagai, Regional Planning, Disaster Mitigation

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## I. INTRODUCTION

Indonesia is a country that has a vulnerability to natural disasters. This is because the Indonesian archipelago is located between two oceans, namely the Pacific Ocean and the Indian Ocean, as well as two continents, namely the Asian continent and the Australian continent. Consequently, Indonesia has a high intensity and frequency of plate movement, which affects various landscapes in Indonesia ranging from mountains to coasts. The types of natural disasters are in the form of earthquakes, tsunamis, volcanic eruptions, floods, droughts, tornadoes, droughts, and landslides. This natural disaster has resulted in many losses that have a direct or indirect impact such as casualties, damage to facilities and infrastructure, loss of valuables, damage to the environment, as well as the psychology of disaster victims.

According to Law Number 24 of 2011 in (Razikin et al., 2017). A disaster is an event or series of events that threaten and disrupt people's lives and livelihoods, resulting in human casualties, environmental damage, property losses, and psychological impacts. There are 3 types of disasters, namely natural disasters, non-natural disasters, and social disasters. Natural disasters are disasters caused by natural events. Non-natural disasters are disasters caused by events or a series of non-natural events which include technological failures, modernization failures, epidemics, and disease outbreaks. Social disasters are disasters caused by events or a series of events caused by humans which include social conflicts between groups or between communities, people, and terror.

One of the natural disasters that often occur in Indonesia is tornadoes. Literally, a tornado is a name

for a tornado that crosses waters. This wind is generally formed from thunderstorms that roll and move in a circle (Wahyudi, 2021). Tornado disasters are disasters with a relatively high incidence rate, from BNPB data it is stated that tornadoes contribute 21% of all disasters in Indonesia. The formation of tornadoes often occurs when entering the pancaroba season, generally in the afternoon or evening. Tornadoes can occur due to friction between hot and cold air. Furthermore, we can see the map of the distribution of tornado events according to BNPB data in 2024 and 2023.

Figure 1.1 Tornado Disaster Data in Indonesia in 2024



Source : Indonesian Disaster Information Data National Disaster Management Agency

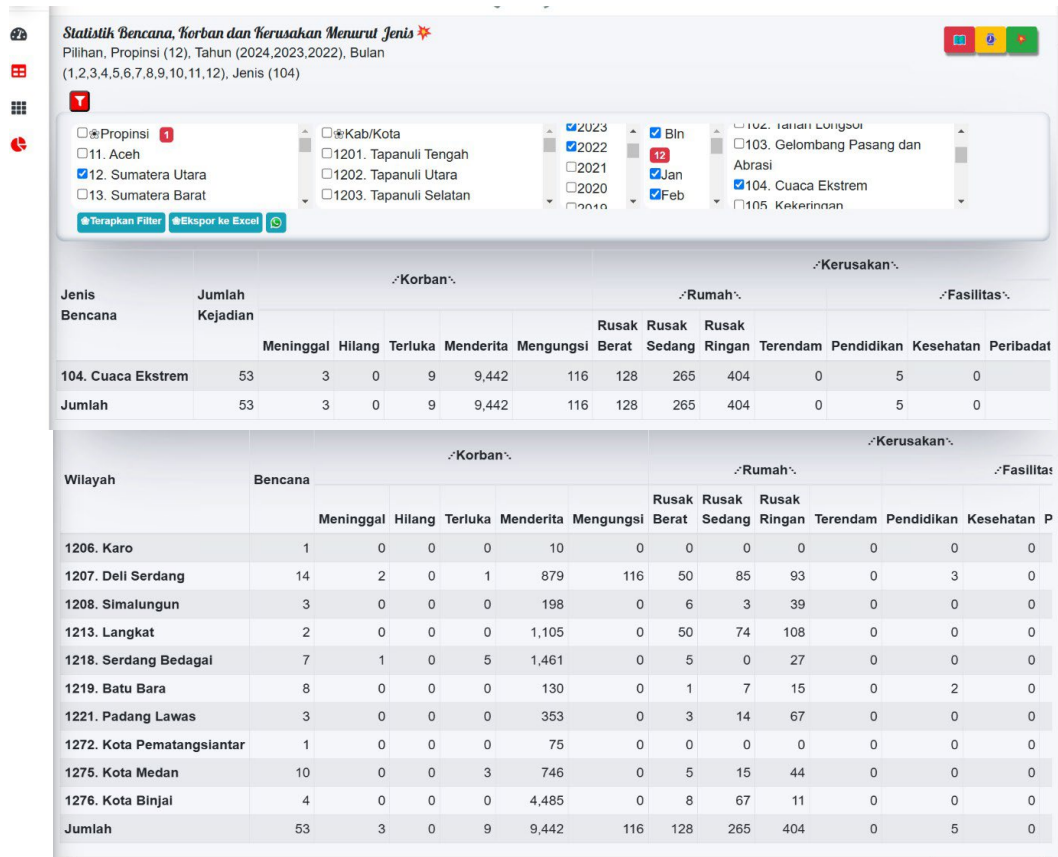
Figure 1.2 Tornado Disaster Data in Indonesia in 2023



Source : Indonesian Disaster Information Data National Disaster Management Agency

Referring to the Indonesian Disaster Information Data, the National Disaster Management Agency in 2023 detected 5,400 tornadoes throughout Indonesia, but decreased in 2024 to 1,478 disasters. Although there was a decrease, there was an increase in the number of deaths. Meanwhile, more than 45 thousand people's houses are affected by the tornado disaster every year. Tornado disaster information data is also presented on the digital page of the Central Statistics Agency of North Sumatra for 3 consecutive years which is shown in the following figure.

Figure 1.3 Statistical Data on Tornado Natural Disasters in North Sumatra in 2022-2024



Source : Information Data of the Central Statistics Agency of North Sumatra Province

Based on data from the Central Statistics Agency of North Sumatra, in 2021 the number of natural disasters – extreme weather (tornadoes) in North Sumatra was 54 incidents in districts/cities. It is in 2nd place after floods (83 cases). In 2022, the number of natural disasters – extreme weather (tornadoes) in North Sumatra was 28 incidents in districts/cities and is still in 2nd place after floods. In 2023, the number of natural disasters – extreme weather (tornadoes) in North Sumatra is 48 incidents summarized from several districts/cities such as Serdang Bedagai Regency.

Serdang Bedagai Regency is one of the districts located in the East Coast of North Sumatra. Located at 20 57" – 30 16" North Latitude and 980 33" – 990 27" East Longitude, it has regional boundaries including the Strait of Malacca to the North, Simalungun Regency to the South, Batubara and Simalungun Regencies to the East and the Snake River and the Crocodile River to the West. This area of 1,999.22 km<sup>2</sup>, administratively consists of 17 sub-districts covering 243 definitive villages/sub-districts, the center of government is located in Sei Rampah. Serdang Bedagai Regency has The population is 682,918 people, of which 343,862 are males and 339,056 are females.

Serdang Bedagai Regency is one of the areas affected by this tornado. Based on data from the Central Statistics Agency of North Sumatra Province for the last 3 years, the incidence rate in 2021 was 2 incidents, in 2022 there were 4 incidents, and in 2023 there were 3 incidents.

The occurrence of tornado natural disasters did not cause many deaths, but based on the initial observations of the people in the field, it showed that there were not a few material losses experienced by the community. Even until now, some victims have not been able to live their lives as usual because the damage caused by the tornado disaster has not fully returned to normal, and the distribution of disaster assistance has not been maximized.

Therefore, this incident is a concern of the government in implementing disaster management to minimize the number of losses caused by tornadoes. According to Abdi Sugiarto, starting disaster management in the early stages of rehabilitation and reconstruction is the first step to recover and rebuild areas affected by disasters (Abdi Sugiarto et al., 2024). The study is in line with the government's efforts such as the National Action Plan for Post-Disaster Rehabilitation and Reconstruction through the implementation of Minimum Service Standards in the Public Housing Sector. From the explanation of the background and description of the problem above, the author found the purpose of the research on how to implement or the initial stages in the management of the tornado disaster by the Housing and Settlement Areas Office in Serdang Bedagai Regency which includes:

1. Identify the areas most vulnerable to tornado damage. This aims to ensure that every community in tornado-prone areas can improve and pay attention to the location in building housing.
2. Analysis of factors that affect the level of house damage in Serdang Bedagai Regency so that it is necessary to evaluate the preparation, provision, and maintenance of houses in accordance with applicable regulations.
3. Knowing the types of basic services for the provision and rehabilitation of livable houses for disaster victims so that facilities and infrastructure can be fulfilled.
4. Recommendations for regional planning and urban planning that are more resilient to tornado disasters.

## **II. LITERATURE REVIEW**

### **2.1 Tornado Natural Disasters and Efforts to Minimize Losses**

North Sumatra has the potential to be affected by natural disasters, one of which is a tornado. A tornado is a strong wind that appears suddenly, it has a center and moves in a circle like a spiral until it touches the surface of the earth. The global warming factor is a supporter of changes in wind direction patterns that are irregular and difficult to predict and the time of occurrence tends to be short. A way is needed to identify areas prone to tornadoes to take actions that can reduce losses (Rizky Syahrul Ramadhan, et al. 2019). According to Ridho Darman (2019), one of the efforts that can be made to minimize losses due to tornadoes in Indonesia is to make a mapping of tornado-prone zones. Historical data on tornado events and the factors that affect them are used to create a map of the distribution of tornado events in Indonesia.

### **2.2 Disaster Threat to Community Sustainability**

According to Abdi Sugiarto in a book entitled Regional Development Planning, natural disasters that often occur are one of the main factors that cause spatial planning crises, To overcome it, Indonesia needs to take strategic steps in spatial planning to face and reduce the impact of disasters. The goal is not only to eliminate or at least minimize the risk of future disasters, but also to lower the level of vulnerability and potential losses. Indonesia must switch from a conventional approach to the use of spatial planning tools.

## **III. METHOD APPROACH**

According to Sugiyono (2019), research methods are a scientific way to obtain data with specific purposes and uses. Research Methods are closely related to the procedures, techniques, tools and research designs used. The research methods that will be used in this study are qualitative and quantitative methods that aim to summarize and organize data systematically so that it can be understood and interpreted more easily (Yin in Sugiarto et al, 2023; Nuraini et al, 2023). Qualitative research is research that intends to understand phenomena about what the research subject experiences, for example behavior, perception, motivation, action and others (Moleong, 2018). Meanwhile, the quantitative research method is a research method with a more complicated level of variation, because it examines a larger sample, but quantitative research is more systematic in conducting research from beginning to end (Syafri Hafnir Sahir, 2021). The data collection techniques are carried out through:

1. The field survey was carried out using a questionnaire to assess the level of house damage in several villages in Serdang Bedagai Regency that were affected by the tornado.
2. Data source from the Regional Disaster Management Agency in Serdang Bedagai Regency.
3. GIS mapping is useful for mapping the areas most vulnerable to tornado disasters.
4. Interviews with village officials and local residents. This is necessary to gain perspective on the direct

impact of the disaster and the community's response to the disaster.

In the implementation of data collection, several things that need to be considered include the implementer of data collection, data types, and data collection methods according to the following table;

Table 3.1 Variables of House Damage Level Data Collection

It	Activities	Data Type	Method	Time Implementation
1	Data Collection of House Damage Level	<ul style="list-style-type: none"> <li>• Number of Houses Affected by Natural Disasters</li> <li>Number of RTs, KKs and Victims' Souls</li> <li>His house was affected by the disaster.</li> <li>• Logging Damage to the house (Forms A and B).</li> <li>• Recapitulation of house damage data and the number of candidates SPM service recipients.</li> </ul>	Rapid data collection is coordinated by the BPBD Task Force Team together with the Technical OPD Task Force Team in the field of Housing and local communities.	Implementation on no later than 3 (three) months after the emergency response period.

Source : Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 29/PRT/M/2018 concerning Technical Standards for Minimum Service Standards for Public Works and Public Housing

Meanwhile, the determination of the level of damage to houses due to disasters can use the criteria in the following table according to existing norms, standards, procedures and criteria.

Table 3.2 Criteria for Damage to House Buildings

It	Categories Damage		Criterion Damage	Description
1	Minor Damage	Class A	<p>The building is still standing.</p> <p>Some nonstructural components and architecturally damaged.</p>	<ol style="list-style-type: none"> <li>1. Most of the roof and ceiling coverings are loose.</li> <li>2. Cracks in the stucco of the beam columns, and the walls/plank walls are broken/damaged.</li> <li>3. Loose/peeled floor covering.</li> <li>4. Part of the installation was damaged.</li> </ol>

		Class B	Damage Rate between 5 to 30%	<ol style="list-style-type: none"> <li>1. A small portion of the roof cover is off.</li> <li>2. A small number of cracks in the stucco of the columns, walls and stucco, and the walls of the boards came off.</li> <li>3. Some of the stucco peeled off.</li> <li>4. A small part of the antenna is damaged</li> </ol>
		Class C		<ol style="list-style-type: none"> <li>1. Small cracks in the walls.</li> <li>2. Some of the stucco peeled off.</li> <li>3. A small portion of the doors/windows and hinges are damaged</li> </ol>
2	Moderately damaged		The building is still standing, Some structural components are broken and non-structural components broken	<ol style="list-style-type: none"> <li>1. The building is still standing</li> <li>2. Part of the atappatah framework</li> <li>3. Partially broken column beams</li> <li>4. A small part of the wall, door / window frame collapsed / collapsed</li> <li>5. Part of the sky is loose</li> <li>6. Most electrical installations are damaged/disconnected</li> </ol>
3	Heavy Damage		Collapsed or partially collapsed buildings Large structural components damaged	<ol style="list-style-type: none"> <li>1. The building collapsed completely.</li> <li>2. The roof fell.</li> <li>3. Beams, columns, floor plates are broken.</li> <li>4. Walls, doors/windows most collapsed/collapsed.</li> <li>5. Most of the ceiling collapsed.</li> <li>6. The electrical installation was completely damaged.</li> </ol>

*Source : Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 29/PRT/M/2018 concerning Technical Standards for Minimum Service Standards for Public Works and Public Housing*

## IV. DISCUSSION

### 1.1. Remediation Disaster Wind Nipple Adze by Regional Disaster Management Agency in Serdang Bedagai Regency.

Based on the results of the research obtained by the researcher, the Regional Disaster Management Agency in Serdang Bedagai Regency has made efforts in managing the tornado disaster. The efforts made are the implementation of emergency response and the distribution of disaster assistance to affected communities. Starting from providing basic food assistance, providing building materials to cleaning roads covered by fallen trees. These efforts are considered to be quite good and in accordance with policy objectives.

### 1.2. Tornado Disaster Management by the Housing and Settlement Areas Office in Serdang Bedagai Regency.

The housing problem is a crucial issue faced by many countries, including Indonesia. Governments often take steps that focus on providing access to affordable and decent housing for low-income people. (Nuraini et al., 2024). In an effort to realize livable houses for the victims of the tornado disaster in accordance with the Minimum Service Standards for the Public Housing Sector, the Housing and Settlement Areas Office in Serdang Bedagai Regency needs to have basic services for the provision and rehabilitation of livable houses for disaster victims in the post-disaster period. Basic services for the provision and rehabilitation of livable houses for disaster victims in the district include home rehabilitation for disaster victims, reconstruction of houses for disaster victims, new construction in new locations/relocation for disaster victims and assistance for access to livable rental houses for disaster victims. The efforts that have been made by the Housing and Settlement Areas Office of Serdang Bedagai Regency which is the initial stage in implementing the Minimum Service Standards for the Public Housing Sector, namely the identification of housing in disaster-prone locations. The implementation of housing identification activities in disaster-prone locations is carried out by collecting data on the level of damage, the number and addresses of families affected by the tornado disaster which focuses on the Decree of the Regent of Serdang Bedagai

Number 395/18.35/Year 2022 concerning the Determination of the Emergency Status of Tornado Natural Disasters in Sei Bamban, Teluk Mengkudu, Serbajadi Tanjung Beringin, Tebing Tinggi, Dolok Masihul, Sipispis and Bandar Khalifah, Serdang Bedagai Regency.

### 1.3. Housing Identification Data at the Tornado Disaster Location.

Table 4.1 Identification of Tornado Natural Disaster Events in 2021-2024

It	District	Number of Incidents	Number of Households
1	Sei Bamban	21	558
2	Sei Rampah	12	118
3	Perbaungan	12	67
4	Tanjung Beringin	20	49
5	Pegajah	9	43
6	The team was fished	5	39
7	Caliph City	6	32
8	Sipispis	4	29
9	High Cliff	13	28
10	Noni Bay	12	22
11	Serbajadi	3	22
12	Mirror Beach	6	12
13	Syahbandar Cliff	1	1
Total		124	1.020

Source : Data from the Perwankim and BPBD Serdang Bedagai Regency, 2024

Table 4.2 Data on the Identification of Housing Damage Conditions for Victims of Tornado Natural Disasters

No	Location	Number of Incidents	Number of Households	Minor Damage	Moderately damaged	Heavy Damage
1	Sei Bamban	5	16	16		
2	Sei Rampah	1	5	5		
3	Perbaungan	0	0	0		
4	Tanjung Beringin	3	5	5		
5	Pegajah	3	6	6		
6	The team was fished	0	0	0		
7	Caliph City	0	0	0		
8	Sipispis	0	0	0		
9	High Cliff	1	3	3		
10	Noni Bay	1	1	1		
11	Serbajadi	0	0	0		
12	Mirror Beach	2	6	5		1
13	Syahbandar Cliff	0	0	0		
Total		16	42	41		1

Source : Data from the Serdang Bedagai Regency Corruption Office, 2024

Based on data from the Regional Disaster Management Agency in Serdang Bedagai Regency, tornado natural disasters have been recorded in 55 different locations that have impacted 216 families with 98 units of lightly damaged houses and 118 units of severely damaged houses in 2021. Meanwhile, in 2022 there have been incidents in 41 different locations that have impacted 625 families with details of 375



housing units with minor damage and 250 housing units with severe damage. In 2023, incidents were recorded in 12 different locations that impacted 137 families, with 62 suffering severe damage and 75 experiencing minor damage.

However, since 2024, the collection of data on the level of damage to houses of victims of natural disasters has been carried out by the Housing and Settlement Areas Office of Serdang Bedagai Regency along with the implementation of the implementation of the Minimum Service Standards which refer to the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 29/PRT/M/2018 concerning Technical Standards for Minimum Service Standards for Public Works and Public Housing. From the results of data collection, 16 locations were obtained that were affected by the tornado disaster. In the span of 2024, there will be 42 housing units affected by the tornado disaster, including 41 units of lightly damaged houses and 1 unit of severely damaged houses.

Table 4.3 Percentage of Housing Damage for Victims of Tornado Natural Disasters compared to the Total Number of Housing Units in Serdang Bedagai Regency

No	Percentage		
	Minor Damage	Heavy Damage	Year
1	0.033%	0.001%	2024
2	0.060%	0.050%	2023
3	0.301%	0.201%	2022
4	0.079%	0.095%	2021

Source : Author, 2024

Housing units in Serdang Bedagai Regency reached 129,859 housing units (RP3KP Report of Serdang Bedagai Regency, 2024) consisting of independent houses, official houses and others, as well as formal houses. Most of the houses in Serdang Bedagai Regency are self-owned, reaching 118,888 units (91.55%), contracts/leases reaching 5,504 units and official houses reaching 5,467 units. In the percentage calculation in Table 4.3 Housing Damage for Victims of Tornado Natural Disasters above, the number of independent houses and contract/rental houses is used as a denominator in the calculation which amounts to 124,392 housing units.

Table 4.4 Percentage of House Damage Rate Compared to the Total Number of Houses Affected by Tornado Natural Disasters in Serdang Bedagai Regency

No	Percentage			
	Total Number of Disaster Houses Tornado	Minor Damage	Heavy Damage	Year
1	42	97.619%	2.381%	2024
2	137	54.745%	45.255%	2023
3	625	60.000%	40.000%	2022
4	216	45.370%	54.630%	2021

Source : Author, 2024

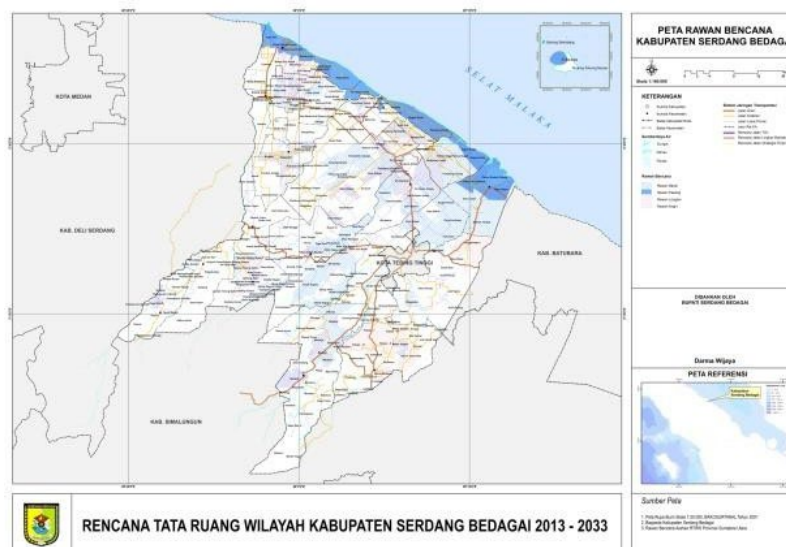
Based on data from the Housing and Settlement Areas Office and the Regional Disaster Management Agency of Serdang Bedagai Regency, from 2021 to 2024, there have been 43 tornado natural disasters in 124 different points and affected 1,020 housing units.

#### 4.4 Settlement Layout Analysis

GIS mapping shows that the most severely affected areas are in low-lying areas that are not protected by natural vegetation. In addition, irregular residential layout patterns and unplanned land use exacerbate the impact of disasters.

Figure 4.1 Map of Tornado Disaster Areas in Serdang Bedagai Regency in 2019





Source : Bappeda Serdang Bedagai Regency, 2024

## V. CONCLUSION

This study shows that the level of house damage in Serdang Bedagai Regency due to tornadoes varies based on the type of building and construction materials. The construction of houses with materials that are more resistant to wind, such as brick and concrete, should be prioritized, especially in disaster-prone areas. Non-permanent and semi-permanent homes have proven to be more susceptible to severe damage. Better area planning, including stronger use of materials and planned settlement arrangements, is essential in minimizing the impact of future disasters.

In addition, urban planning that considers disaster mitigation is very important. The use of vegetation as windbreaks, rearranging residential layouts, and implementing stricter building standards are steps that can be taken to reduce the impact of future disasters. It can be seen that the dominant tornado disaster from 2021 to 2024 occurred in Sei Bamban District and Tanjung Beringin District. This is because the area is lowland and open, making it more prone to tornadoes because there are no natural barriers to slow down wind speeds. Tornadoes are easier to form and move in flat, open areas because there are no natural obstacles such as mountains or hills. Areas that often experience strong winds blowing from certain directions tend to have a pattern of repeated tornado paths. Temperature differences between the sea and land can also trigger changes in air pressure that strengthen the wind vortex. Sei Bamban District is an area of rice fields, plantations, and large fields that are often the main path of tornadoes because the wind flow is not disturbed. Meanwhile, Tanjung Beringin District is an area near the coast or river estuary so it is vulnerable to tornadoes because it has moist air that supports the formation of local storms.

## VI. RECOMMENDATION

1. Local governments need to implement disaster-resistant building standards in tornado-prone areas.
2. It is necessary to issue derivative regulations such as Regional Regulations or Regent Regulations which contain a complete description of service standards and technical instructions on the reconstruction and rehabilitation of disaster victims' houses in Serdang Bedagai Regency.
3. Rehabilitation of settlement layouts by considering disaster risk zoning, including planting trees as a wind barrier.
4. Strengthening the socialization of disaster mitigation to the community to increase awareness and

preparedness to face disasters.

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