



The Influence of Urban Morphology of Tarutung on The Resilience of Cities Following An Earthquake

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Abstract. Tarutung City is the capital of North Tapanuli Regency, North Sumatra Province. Tarutung City is an earthquake-prone city, this is caused by the city's geotectonic and geological conditions which are traversed by active fault lines, namely the active Toru fault. This study aims to look at the influence of the morphology of Tarutung City on disaster response urban planning. Tarutung City is considered to have started implementing a disaster response city, but several aspects still need to be improved.

Keywords: disaster settlements, earthquake, evacuation routes

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1 Introduction

Tarutung City is a sub-district town and is the capital of North Tapanuli Regency, North Sumatra Province. Geographically, Tarutung City is located at 1o20'-2o41' NL and 98o05'-99o16' EL [1]. Tarutung City is a district that has the smallest area but has the highest population density in North Tapanuli Regency [2]. Tarutung city is a city prone to earthquakes, this is caused by the geotectonic and geological conditions of the city which are traversed by active fault lines, namely the active Toru fault [3]. Recently, an earthquake occurred again on October 7th, 2022 at 03.00 WIB. Based on data from the Meteorology, Climatology and Geophysics Agency (BMKG), the earthquake was centered on land and was at coordinates 2.02o North Latitude and 99.01o East Longitude [4]. This study aims to identify the influence of the morphology of Tarutung City on the resilience of the city after the earthquake.

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2 Methodology

In this study, the research method used is descriptive research. Sukmadinata (2006) explains that the definition of research using descriptive methods is the characteristics of research that specifically reveal various social and natural phenomena that exist in people's lives.

2.1 Research Locations

This research is located in Tarutung City, North Tapanuli. It can be seen on this map (Figure 1) that the city of Tarutung has a density along the Aek Sigeaon River, the Sumatran causeway, SM. Raja Street, Ferdinan Lumbantobing Street and Mayjend D.I. Panjaitan Street.



Figure 1 Maps of Tarutung City [5]

2.2 The History of Tarutung City

Tarutung used to be visited by lots of people around for trade transactions who came from the Silindung, Humbang, Samosir, Toba, and Dairi areas, including from the south such as Pahae, Sipirok also Sibolga, and Barus. Initially, these traditional trading transactions were carried out in a village location centered under a shady banyan tree called Onan Sitaru (exchange market) in the present Saitnihuta village [6].

During the turmoil of Bonjol's civil war called the Padri War (1816 - 1833), trading activities in this traditional market stopped. The departure of the Padri troops from Silindung was not solely

due to the response to the attack by the kings in Silindung, but they leave on their own because many of them died without knowing the cause. Upon the return of the Padri troop from Silindung, the Silindung area is like an uninhabited ghost area. Gradually the people came down from the mountains to re-open their villages on the ruins of the destruction or open new settlements. But at the same time, the Batak Lands began to be controlled by the Dutch Army, especially after the handover of West Sumatra by the British government to the Dutch Colonial government. So the Dutch also set foot in Silindung and established their headquarters right in the center of Tarutung City, now called as Tangsi. The traditional trade that previously had developed in Onan Sitaru Saitnihuta began to show its activity, but it had become a Tangsi area controlled under the Dutch, and around it stood a village called Hutatoruan. The area became an official trading place and the Dutch planted a sign tree, namely durian tree which in 1877 the Batak people called as tarutung. After about 60 years, traditional market activities were re-opened under the tarutung tree which later developed into a city called Tarutung City [6].

3 Literature Review

In disaster-prone areas, spatial and regional planning is urgently needed which takes into account minimizing the impact of natural disasters. This spatial planning becomes the basis for making decisions on submitting development plans in the area. Several aspects need to be understood in the concept of disaster response environmental planning, namely:

3.1 Evacuation Rescue Route (Escape Route)

In planning earthquake-resistant buildings, what is needed is to minimize the impact of the disaster. To minimize the impact of a disaster, an evacuation route for disaster victims is needed. Evacuation route planning is divided into 2 types, namely evacuation routes in buildings and evacuation routes in residential areas [7].

3.1.1 Evacuation Routes in Buildings

In buildings/buildings, especially those with lots of floors, the planning of an escape route that must be provided is an emergency ladder or a list that can go directly to the outside room [7]. Emergency stairs are usually placed on the side of the building or in the middle of the building. This is intended to facilitate access in and out of the building. An evacuation plan is an evacuation guide to the outside of the building that is used by users and visitors of the building, and also for the evacuation officers during a disaster or other emergency [8].

3.1.2 Evacuation Routes in Residential/Settlement Environments

In planning a settlement, consideration should be given to the service route planning system or environmental services to make it easier for service vehicles to enter the environment. This is very important because if one day a disaster occurs, rescue vehicles can immediately go to the

location without obstacles. There are several escape routes in the environment, namely (1) Evacuation routes to higher ground, (2) Evacuation routes in the city environment, (3) Evacuation routes to rescue hills [7].

In addition, it is necessary to pay attention to evacuation routes in buildings (emergency stairs and elevators) and residential areas (settlement design) that considers environmental service/service route planning, construction of rescue buildings, and well-organized settlement patterns. [9]

3.2 Protected Area

Included in protected areas are (1) Safe zones in residential areas, (2) Planning for protective structures (retaining embankments, mangroves and others), (3) Productive protective zones (ponds, rice fields and others), (4) Layered green lanes as a filter for debris or garbage in the event of a disaster, (5) Conservation of nature or forests as protective areas [7].

3.3 Safe Zone

In planning residential areas, the building layout plan and its environment must be considered. This is intended to create a clear mapping of land use. The important thing that must be provided in a disaster response residential area is a disaster safe zone. Disaster safe zones can be open spaces in residential areas, which can actually function as fields or parks [7].

3.4 Open Space

Open space can also be used as a city emergency room. The city's emergency room must be equipped with the needs of clean water, toilets, communication equipment, and warehouses that can store food and medicine for 2 days, before aid arrives. Realizing a disaster responsive city can be done by increasing city parks and city park vegetation [7].

3.5 Public Facilities in Disaster Response Settlements

Arrangement of public facilities (commercial, school, hospital, open space and others) in residential areas to be placed at a safe distance and central position from residential areas so that they are easily accessible. City polycentric (multi-center) layouts can reduce the distance between zones of main functions (commercial, government centers, etc.) within the city [7].

4 Results and Discussion

Tarutung City is one of the sub-districts in North Tapanuli Regency which is located in the highlands of North Sumatra at an altitude of between 150-1,700 meters above sea level [1]. Tarutung City is one of the cities prone to earthquakes, this is caused by the geotectonic and geological conditions of the city which is traversed by an active fault line, namely the active

Toru fault [3]. The influence of tarutung city morphology on the city's resilience after the earthquake based on several aspects as follows :

4.1 Evacuation Rescue Route (Escape Route)

To minimize the resulting impact by disaster, basically the city of Tarutung must have an evacuation route planning. There are 2 types of evacuation route planning, namely evacuation routes in buildings and evacuation routes in residential/settlement environments.

4.1.1 Evacuation Routes in Buildings

The buildings in Tarutung City are low-rise buildings, It can be seen on figure 2. Low-rise buildings are buildings with several floors around 1-3 floors, height < 10m based on Mulyono in 2000 [10].



Figure 2 View of Tarutung City [11] [12] [13]

For low-rise buildings, the evacuation facility that must be provided are: (1) Hazard warning system, (2) Emergency exit door, (3) Evacuation route, and (4) Provision of emergency stairs [8].

Evacuation Route Requirements are: (1) Evacuation routes must be free of objects that could interfere with the smooth evacuation and easy to reach, (2) Corridors, tunnels, and staircases must be temporarily safe areas from fire, smoke, and gas hazards, (3) The placement of

emergency exits must be arranged in such a way that any occupant can reach the exit, (4) Corridors and exits must be non-slippery, free of obstacles, and have a minimum width of 1.2 m for corridors and 2 m for exits, (5) Evacuation routes must be provided with adequate lighting and not depend on the main source, (6) Directions to the exit must be posted with clear instructions, and (7) Emergency exits must be marked with writing [8].

4.1.2 Evacuation Routes in Residential/Settlement Environments

A. Evacuation Route To Higher Ground

In Tarutung City, the pedestrian path is above the city drainage and has unfavorable conditions because the pedestrian path is used for parking, trading, and other functions, thus disrupting evacuation routes (Figure 3).



Figure 3 Street View of Tarutung City [14]

B. Evacuation Routes In Urban Environments

Tarutung City is split in two by the Aek Sigeon River so the evacuation route is also divided into 2 parts, namely to the east and west of Tarutung City, this can be seen in the figure 4.



Figure 4 Rute Maps of Tarutung City Evacuation [5]

C. Evacuation Route To Rescue Hill

In the figure 4, it can be seen that the evacuation route is divided into two, namely east and west, and each route leads to the rescue hill.

4.2 Protected Area

Tarutung city is split in two by the Aek Sigeaon River. To anticipate an overflowing disaster due to floods or earthquakes, a retaining embankment is made along the Aek Sigeaon River (Figure 5).



Figure 5 Levee of Aek Sigeaon River on Tarutung City [14]

4.3 Safe Zone

The Tarutung City Center has a safe zone in the form of a green open space, namely the Tarutung Multipurpose Field, a green open space near the Tarutung Market, and the Tarutung Tangsi Ball Field (Figure 6).

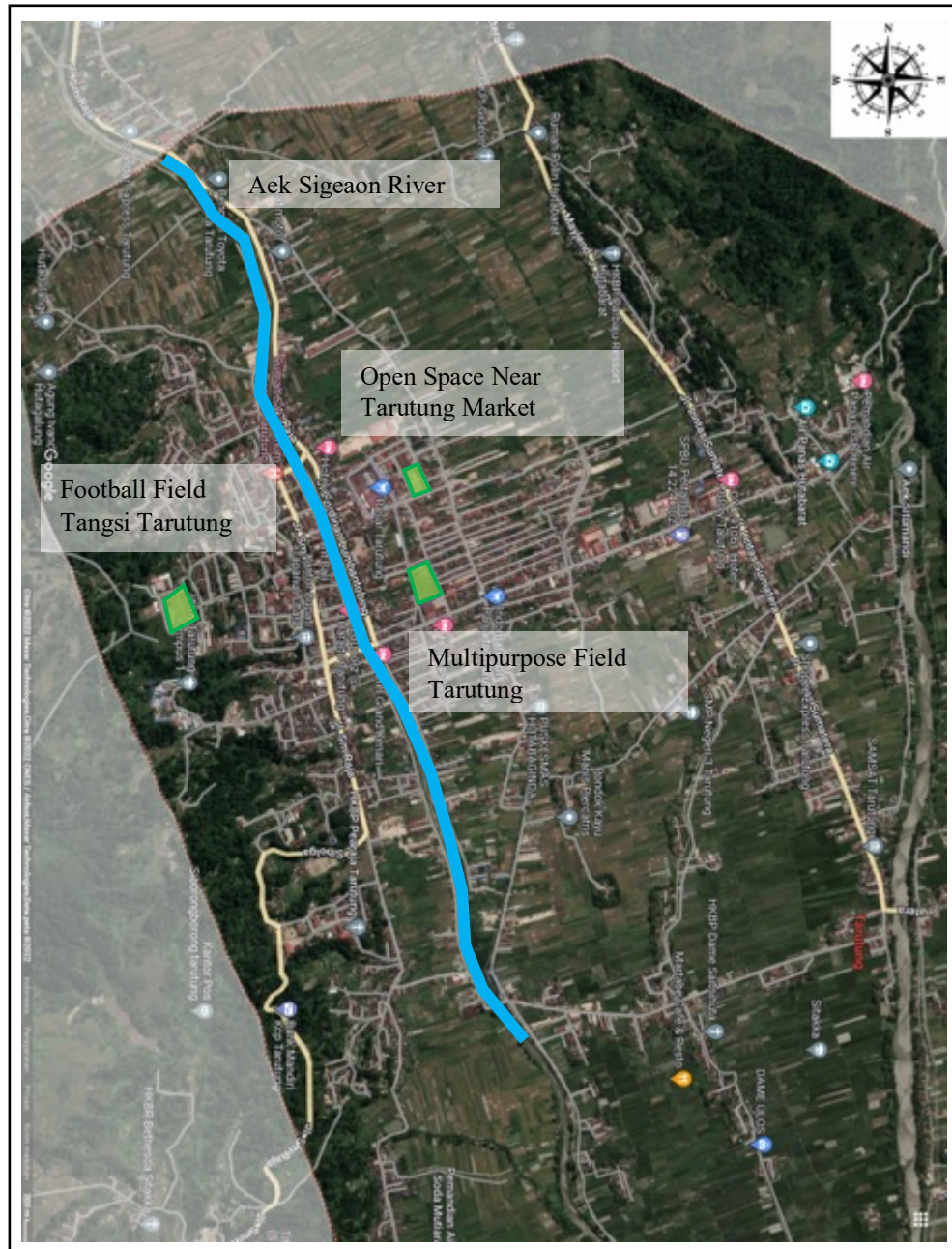


Figure 6 Tarutung City Safe Zone Map [5]

4.4 Open Space

Open space that can be used as city emergency rooms is the Tarutung Multipurpose Field and the Tarutung Tangsi Ball Field (Figure 7). The Tarutung Multipurpose Field and the Tarutung Tangsi Ball Field are equipped with the necessary clean water, toilets, and storage facilities.



Figure 7 Tarutung Multipurpose Field Tarutung City (a) [15] and Tarutung Tangsi Ball Field Tarutung City (b) [15]

4.5 Public Facilities in Disaster Response Settlements

Most public facilities are located in zone A, this can be seen from the figure 8. The trade center for Tarutung City is Tarutung Market which is in zone B. The government center for Tarutung City is the Office of the North Tapanuli Regent in zone A. And the health center for Tarutung City is the Tarutung Regional General Hospital in zone A.



Figure 8 Tarutung City Public Facilities Map [5]

5 Conclusion

Disaster-responsive urban planning is still an unfinished task for both government and society. Awareness of disaster response will increase the chances of survival when a disaster occurs. In this scientific work the case study is Tarutung City. Tarutung City already has a disaster response city structure but there are still deficiencies, namely pedestrian evacuation routes that are not feasible enough which can hinder the evacuation, and the signage (evacuation routes, gathering points) still hasn't existed yet. It can cause people not knowing the safe evacuation routes. The structure of a disaster response city is a city that provides good evacuation routes, has protective areas, provides safe zones, provides open spaces, and is close to public facilities.

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