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NATURAL LANDSCAPE PLANNING AS TSUNAMI DISASTER MITIGATION:A CASE IN ULEU LHEUE, BANDA ACEH, INDONESIA

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Abstract

Tsunami has changed the landscape of the area, the environmental order (spatial planning), and the structure of the Ulee Lheue Coastal area. The tsunami threat is substantial since the site's position is very close to the source of the disaster. The shape of the area is flat and does not have any protection (both natural and structural) to protect the land. Planning criteria in tsunami areas are essential to know and learn from previous disasters. Tsunami disasters have different characteristics in each site; thus, planning is mismanaged and ineffectively conducted. Planning is performed by applying the tsunami mitigation approach and the theory of landscape connectivity. One of the mitigation plans is planning a natural landscape in the form of vegetation. The vegetation in the research case study is in the coastal area of Uleu Lheue, which was still lacking after the tsunami hit this area in 2004. There are only mangroves in some areas, sea pine, tamarind trees, and low shrubs. Therefore, in planning a mitigation-based site, it is necessary to arrange vegetation to reduce the impact of a tsunami and condition the environment around the area. This research aims to integrate natural landscape planning based on tsunami mitigation and find natural vegetation or natural protection as a tsunami disaster mitigation and as a criterion in planning a coastal area based on tsunami disaster mitigation. From the results of the tsunami study, it is recommended that the case study area be freed from new development and mitigation strategies with buffers in the form of using vegetation zones (mangroves and the like). The planning applied using vegetation indicated to reduce the effects of the tsunami that hit the design area, among others, the tree category: Pandanus Odoratissimus, Casuarina equisetifolia, Hibiscus Tiliaceus, Tamarindus indica, Anacardium occidentale, bakau, nypah and waru.

Keywords: natural landscape; vegetation; tsunami mitigation; planning

Introduction

The uniqueness of the coastal area is also followed by its potential for natural disasters, such as the devastating tsunami that hit coastal areas on the 24 December 2004 has destroyed the coastal areas of Ulee Lheue and other areas. The tsunami has also changed the regional landscape, environmental structure (spatial planning), and the structure of the Banda Aceh city area, such as dense settlements into empty expanses. Mitigation efforts are needed to reduce the risk of a tsunami disaster that is able to support multi-sectors such as the concept of spatial use with multi-function assimilation (buffer zone, settlements, agricultural/ cultivation areas, and ecotourism). Disaster risk, when viewed in terms of spatial planning and physical environment, can be reduced through land use planning, site planning, and building design. The momentum for the realignment of the area is a valuable opportunity for planning so that it can minimize casualties and damage due to the disaster itself. So, the problem statement in this research is mitigation efforts are needed to reduce the risk of tsunami disasters in favour of multi sectors, such as the concept of spatial use with multi-function assimilation (buffer zone, settlements, agricultural/ cultivation areas, and ecotourism). Disaster risk, when viewed from the aspect of spatial planning and physical environment, can be reduced through land use planning, site and building planning. This research aims to determine whether natural vegetation or natural protection is tsunami mitigation and as criteria in planning and designing coastal alley areas based on tsunami mitigation.

Planning and protection of natural beaches can be used as solutions to physical and environmental research problems formulated previously in coastal areas, which are also tourism areas. The conclusion of this theoretical study on green open space is that open space with natural functions that are very important for security, safety, comfort, and sustainability must be prioritized, especially in land use. Even some experts suggest the conversion of the function of the area that has been built into a natural environment again (Eisner, 2005; Dahdouh et al., 2005). From the above study, several types of vegetation can be used in Ulee Lheue landscape planning, including the type of mangrove vegetation Rhizopora apiculate, Rhizopora mucronata, and Pandanus odoratissimus. This is reinforced by research that has been carried out by (Arikawa et al., 2010) in several Asian areas affected by the tsunami; in part directly adjacent to the sea, the landscape can be dominated by mangrove vegetation, which can be divided into two zones to reduce the risk of a tsunami (Dahdouh et al, 2005; Eisner,2005; Paris et al, 2009).

Natural coastal protection is necessary for tsunami mitigation efforts because it includes all activities related to reducing tsunami wave energy in coastal areas so that the tsunami wave energy run-up towards the mainland can be minimized. The type of plant that has been proven effective in helping reduce tsunami waves is mangroves. Besides the vegetation characteristics such as density, the age of the tree, and species, the scale of tsunami height plays a role. Based on model simulations in laboratory studies conducted by several researchers related to tsunami mitigation with vegetation, mangroves with a thickness of about 150 m with a density of 4 m can reduce tsunami wave heights by up to 35 % (Hiraishi & Harada, 2003; Thuy et al., 2010a). Several vegetation types can also be selected to assist the tsunami disaster mitigation system, including Rhizophora apiculate, Rhizophora mucronata (type R. apiculata), and Pandanus odoratissimus, a plant that grows in sand, which is effective in protecting against tsunami damage due to its complex aerial structure. (Thuy et al, 2010a).

There are two layers of vegetation of vertically structured plants with Odoratissimus and Casuarina equisetifolia, and plants with large and small diameter horizontal structures are also essential to increase the catch area of current-borne objects such as broken branches, damaged houses, etc. plants with a vertical design as well as providing an effective soft landing for humans who were swept away by the tsunami or fled when the tsunami struck. In addition, the water flow between the mangroves and the space between vegetation C. equisetifolia is predicted to dampen the waves from the Tsunami (Celik, 2015). Based on the literature, it is known that the impact of the tsunami disaster can be reduced by the presence of landscape fortifications that resist the tsunami wave rate. Adequate vegetation as a fortress against tsunami waves has deep and strong roots.

The development of Banda Aceh must be planned based on disaster mitigation, one of which is tsunami disaster mitigation. A tsunami is a tidal wave caused by an earthquake or landslide on the seabed slopes. This tidal wave can hit coastal areas up to tens of meters high and hundreds to thousands of meters away from the coast, thus sweeping and destroying everything on the beach and the land. Therefore, tsunami disaster mitigation aims to reduce the tsunami disaster risk in the city of Banda Aceh, which is carried out by considering the sustainability aspects and the participation of all relevant parties (Sumarto, 2010; Fuady, 2015).

METHODS

The data collection method in this research was conducted through literature study, observation, and interviews with experts. The study's planning location is in the Ulee Lheue area, Banda Aceh. From the map below, it is known that the planning location has a high tsunami inundation potential (0-2 m above sea level) (Bappeda Department, 2014). Therefore, a particular approach is needed in planning to respond to disaster vulnerability in the physical condition of the design location with a natural planning approach based on tsunami mitigation.

1. Preparation and survey stage

Figure 1. Ulee Lheue Area before and after Tsunami (Source: Fuady, 2017).

This study's research design is qualitative to examine the condition of natural objects. The primary and secondary data obtained were then analyzed inductively/qualitatively. This research was conducted in the coastal area of Ulee Lheue Village, Meuraxa sub-district in Banda Aceh, with a case study approach, namely observing and identifying natural vegetation as a barrier to tsunami mitigation in the coastal area of Ulee Lheue village.

2. Data analysis stage

In this study, data were obtained from the object under study in primary data from field observations, interviews with experts and the community, and an examination of maps related to green governance as tsunami mitigation. The secondary data was obtained from literature studies and scientific publications that have been previously researched related to green governance in coastal areas.

3. Data synthesis stage

The interactive model manages and analyses the research data through interrelated processes: data reduction, data presentation, and conclusion drawing. Raw data in the form of data collected related to the observed phenomena. The data is contained in documentation divided into two separate collections: those sourced from evidence (primary data) and those sourced from reports such as articles, reports, or books/documents (secondary data). Primary and secondary data were analysed in stages: primary data from interviews recorded via cell phone then written in transcripts, and secondary data made a resume containing important things (Hay, 2010). Next, the author reads the entire raw data.

4. Landscape planning stage

It is recommended that for the design of the coastal area, a greenbelt system is made, namely by creating a fort of plants/trees before the residential area to reduce the strength of the water flow when a tsunami disaster occurs. The existence of a defense system using plants will decline the risk/impact of a tsunami; plants will function to reduce tsunami velocity. Apart from being an environmental defence system, the presence of plants and trees helps reduce temperatures, reduce CO2 levels and maintain air humidity in a tropical climate, which will add to the beauty of the coastal area.

Figure 2. The green belt as a barrier at Ulee Lheue Area (Source: Personal Documentation, 2021).

DISCUSSION

Disaster Mitigation is a preventive action taken to reduce the consequences of a disaster, with the preparation before a disaster occurs and a long-term risk reduction measures action (Paris et al., 2009). Based on research conducted by TDMRC Universitas Syiah Kuala, there are ten districts/cities in Aceh with disaster alertness, one of which is the city of Banda Aceh (TDMRC, 2015). Ulee Lheue area, which is part of Banda Aceh City, is vulnerable to tsunami and earthquake disasters (Celik, 2015; Latief et al, 2000).

Natural Landscapes as Tsunami Disaster Mitigation

Green open space based on disaster mitigation is a series of efforts to organize the existence of green open space in the city to reduce the risk of events that threaten and disrupt people's lives and livelihoods. Disaster mitigation efforts can be carried out through physical development, awareness, and capacity building to deal with disaster threats. Disasters are events that threaten and disrupt lives and can result in human casualties, environmental damage, property losses, and psychological impacts that natural and human factors can caused. (Latief et al, 2000; Meutia, 2019).

Mitigation Theory in the Design of Physical and Environmental Elements

This literature review is expected to provide views of theories related to planning and protection of natural beaches to consider solutions to physical and environmental research problems that have been previously formulated in coastal areas, which are also tourist areas. In this study, open space has two aspects of the review: open space as an element of natural beach protection and open space as a rescue space.

Protection Function

A study conducted by the PU team in 2007 on the green belt in the coastal area of Sri Lanka showed that using artificial structures to mitigate tsunamis could be mitigation. However, if it is possible to use a natural approach again, then it would be the best choice (Bappeda Department, 2014).

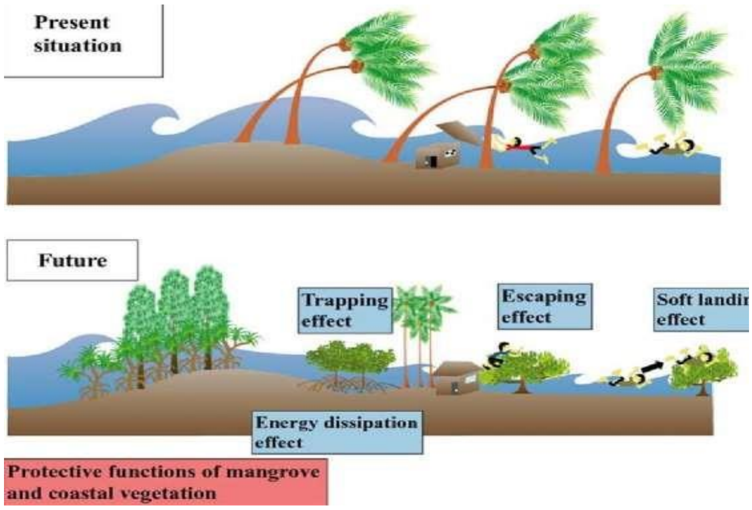


Figure 3. Coastal Forests as Disaster Mitigation (Source: Tanaka, 2009).

The picture shows that protecting natural beaches from coastal forests is essential. No matter how small the available natural coastal ecosystem is, it should be maintained and preserved. As Vitasari (2015) explained regarding the preservation of green space, one of the solutions is that land use for green space is sufficient in areas that are planned to have medium to high density, namely reducing the building footprint size. However, if a site is already very dense and does not yet have green space, it is highly recommended to free up (transfer of function) lands with the lowest priority to be used as green spaces. This theory can also be the basis for determining land use in tsunami-prone areas (Tanaka, 2009; Thuy et al., 2010a). This theoretical study on green open spaces concludes that open areas with natural functions that are very important for security, safety, comfort, and sustainability must be prioritized, especially in land use. Some experts even suggest converting the area that has been built into a natural environment again (Tanaka, 2009; Thuy et al., 2010a; Wiwik, 2011).

Coastal Protection with Vegetation

Tsunami has many impacts on human life, settlements, and infrastructure. There were also coastal zones that were not destroyed. This is due to the presence of a natural barrier that receives the impact of waves and is assumed to absorb wave or tsunami energy, thus protecting the coastal area behind it. Based on a survey conducted in Thailand, it was found that areas with dunes and coral suffered minor damage. In contrast, areas that had experienced ecological damage before the tsunami experienced severe injuries such as the tsunami's physical damage (Vermat, 2006). The protection that can be obtained from this barrier on coastal environments and populations underscores the importance of conservation and protection of this vital ecosystem.

Natural coastal protection is necessary for tsunami mitigation efforts because it includes all activities related to efforts to reduce tsunami wave energy in coastal areas so that the runoff of tsunami wave energy towards the mainland can be minimized. The types of plants that have been proven effective in helping reduce tsunami waves are mangroves. Based on model simulations in laboratory studies conducted by several researchers related to tsunami mitigation with vegetation, mangroves with a thickness of about 150 m with a density/space of 4 m can reduce tsunami wave heights up to 35% (Vermat, 2006; Yanagisawa et al, 2009). Several other types of vegetation can also be selected to assist tsunami disaster mitigation system, including Rhizophora apiculata and Rhizophora mucronata (type R. apiculata) and Pandanus odoratissimus, a plant that grows in sand, which is effective in providing protection against tsunami damage due to its aerial root structure which is complicated (Yanagisawa et al., 2009).

There are two layers of vegetation of vertically structured plants with Odoratissimus and Casuarina equisetifolia, and horizontally structured plants with large and small diameters. They are also essential to increase the catchment area of current-borne objects such as broken branches, damaged houses, and humans. Plants with a vertical structure provide an effective soft landing for humans who are carried away by the tsunami or flee when the tsunami hits. In addition, the flow of water between the mangroves and the space between the vegetation of

C. equisetifolia is predicted to dampen the waves from the tsunami (Yanagisawa et al., 2009). Based on the literature study, it is known that the impact of the tsunami disaster can be reduced by the presence of landscape fortifications that block the tsunami wave. Of course, not just any plant can be a barrier to tsunami waves; it must also have a specific minimum density. Vegetation effective as a fortress against tsunami waves has deep and strong roots. In coastal areas, vegetation that has specifications like this is a type of mangrove. In addition, there are several other types of vegetation that can be used in this disaster mitigation effort.

Figure 4. Coastal Vegetation and Mangrove Type in Asia (Source: Meutia, 2019).

From the above study, there are several types of vegetation used in the design of the Ulee Lheue Landscape, including the mangrove vegetation types, which are Rhizopora apiculate, Rhizopora mucronata, and Pandanus odoratissimus. This is corroborated by Fuady (2017) research in several Asian regions affected by the tsunami. In parts directly adjacent to the sea, the landscape can be dominated by mangrove vegetation, which can be divided into two zones to reduce tsunami risk.

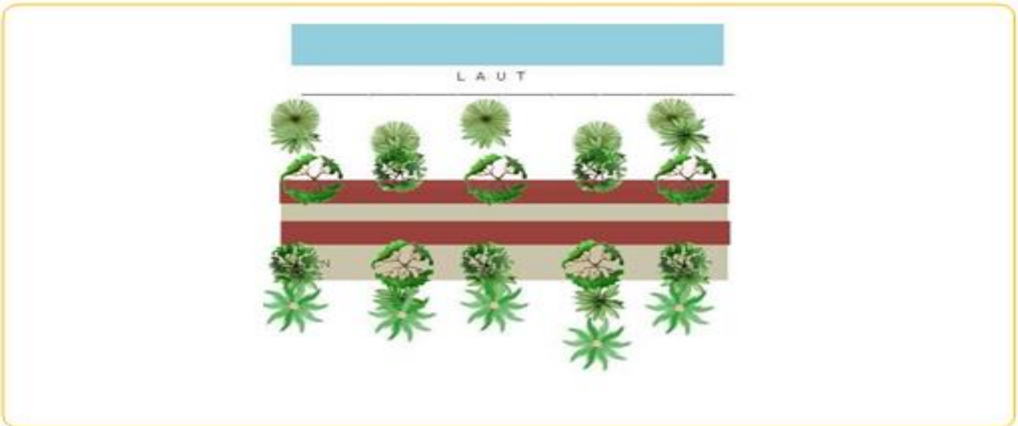
1. Zone I of the outermost mangroves are: Rhizophora mucronata (mangroves), Rhizophora apiculata (tancang), Rhizophora stylosa (slindur), Soneratia alba (Prapat), and Avicennia

alba has a height of 6-25 m and a robust root system that grips the soil and twists each other. They can reduce tsunami wave height by up to 50% depending on the composition of the mangrove forest and the size of the tsunami wave.

2. Zone II contained R. mucronata, kaboa (Aegiceras corniculata), nipah (Nypa fruticans), pidada (Sonneratia caseolaris), nirih (Xylocarpus spp), teruntum (Lumnitzera racemosa), dungun (Heritiera littoralis) and blind wood (Excoecaria agallocha). The vegetation is densely packed, so it can slow the speed of the tsunami waves.

In addition to the types of vegetation mentioned above, it is also important to consider planning the placement and spacing of vegetation buffers that are used to slow the rate of seawater entering the mainland to reduce the damage caused by a possible tsunami disaster (Fuady, 2015). One example is USAID's replanting in the 2006 Community Nursery and Coastal Rehabilitation activity in Aceh. Plants grown in coastal areas use a five-eye system and are multi-layered with several types of plants (Fuady, 2015), with the following details:

- Layer I planted with two rows of fir trees with a distance between trees in one row of 5 m. The distance between rows one and two is also 5 m. The position of the trees in each row is parallel, but the location of the trees in the second row is between the trees in the first row (equilateral triangle).
- Layer II: Plants of Ketapang and Waru, with a spacing of 5m x 5m, lined up 1 with the method of crossing each other or alternating.
- Layer III: will be planted with coconut trees with a spacing of 10 x 10 m.



Using a variety of local vegetation can also help in efforts to preserve the ecology of the Ulee Lheue area, as well as part of a natural disaster mitigation plan on the beach. The existence of relationships between local vegetation types is used to form a network that can ensure the ecological sustainability of the area. Landscape planning as part of this mitigation is also in line with the way of natural succession that is taking place in the post-tsunami disaster area, marked by the start of the growth of some pioneering vegetation. However, the vegetation at the design location is still minimal after the tsunami hit this area. There are only mangroves in some areas, sea pine, tamarind trees, and low shrubs. Therefore, in designing a mitigation-based tourism area, it is necessary to arrange vegetation that can reduce a tsunami's impact and also as an environmental refresher.

Figure 6. Types of *Rhizopora sp* (mangroves) (Source: Tanaka, 2009).

Mangrove forests have an important role in coastal areas and the world of fisheries. The functions of the mangrove forest (Tanaka, 2009) are as follows:

Physical function:

1. As a damper for seawater waves and storm winds, the existence of a mangrove forest consisting of tall and dense trees and leaves can break up the big waves and strong winds.
2. Coastline protection from abrasion. The robust root system of mangrove trees embedded in muddy sand can prevent beach erosion due to seawater (abrasion). This can maintain the area boundaries and the length of the coastline of an area.

Ecological function:

1. As a producer of detritus (debris), a litter that comes from fallen mangrove leaves/stalks, this detritus serves as a food source for several aquatic organisms (animals) and as an additional nutrient for the growth of the mangrove tree itself. In the mangrove ecosystem food chain, detritus acts as a producer that works as food for aquatic animals.
2. As a supplier of oxygen, mangrove forests generally have a high tree density and dense leaf mass. The thicker the mangrove forest, the more oxygen availability is produced through respiration in the leaves.

Biological Function:

1. As a spawning ground, aquatic biota, a commodity for fishermen's catches (fish, shrimp, and shellfish), breeds naturally in mangrove forests.
2. As a nursery ground, the existence of the mangrove ecosystem is a good place for the growth of small aquatic biota before the biota goes to the sea.
3. As a foraging area (feeding ground), mangrove forests are habitats for several coastal or offshore biota such as mangrove crabs, fish, shrimp, or shellfish. How to calculate the width and thickness of mangrove forests as follows:

$$dNall = \gamma \times CD\text{-}all \times bref \quad (1)$$

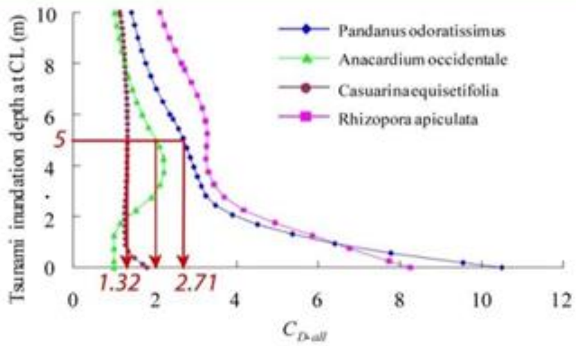


Figure 7. Vegetation calculations for tsunami (Sources: Yanagisawa et al, 2009).

Description:

γ = 1m x (width of the vegetation layer in the direction of the tsunami flow)x (trees /m²) CD-all = Coefficient of friction for all parts of the tree

Bref = diameter of the rod at a height parallel to the chest

Coastal vegetation species found in Aceh Province are Casuarina equisetifolia, Euphorbiaceae glochidion Sp., Goodeniaceae scaevola serice, Gultiferae calophyllum inophyllum, Lecythidaceae barringtonia asiatica, Leguminosae-Papilionoideae, Sago palm-palmae metroxylon sagu, Pandan fruphylon sago, Pandanaceae.

Beach plant layer:

- The coastal layer is 150 m

- Plants: Hibiscus Tiliaceous (Sea Waru), Terminalia catappa (Ketapang), Baringtonia asiatica (Butun), Pandanus Tectorius (Pandan), Calophyllum inophyllum (Nyamplung), Cocos Nucifer.

Calculating Vegetation Thickness and Flow Reduction

To calculate the potential effect of a quantitative decrease in tsunami currents, calculating dNall can be done, then comparing it with graphs showing the correlation between dNall and the degree of reduction in flow strength and time propagation delay. Although the vegetation types on the graph are limited, it is possible to use graphics for other similar plant types by allowing insertion.

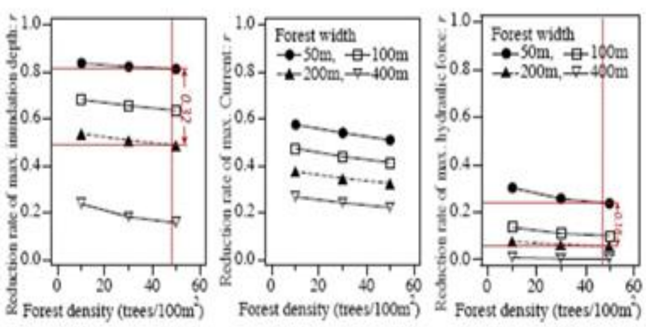


Figure 8. Coastal Layer Effectiveness (Sources: Yanagisawa et al, 2009)

From the results of the analysis above, it can be concluded that:

- Plants that can be used as protection against tsunamis are a combination of the following plants

1. Casuarina equisetifolia (Diameter 15 cm; Density of 15 trees /100m²)
2. Pandanus Odoratissimus (Diameter 15 cm; Density 36 trees /100m²)
3. Hibiscus Tiliaceus (Diameter 15 cm; Density 0.5 trees /100m²)

Each plant has its own advantages, Casuarina Tree in its height and Pandanus in its high coefficient of friction and density. At the same time, the use of Hibiscus is in its function as an endemic plant. To withstand a tsunami with a run up of <5 m, a 100 m wide coastal forest layer and an additional dike can protect most of the design area.

Green Open Space Plans for Coastal Settlements

In the (Sumarto, 2010; TDMRC, 2015), It is stated that the provision of green open space in Banda Aceh is aimed explicitly at ecological, economic, and aesthetic functions. Therefore, the area designated for green open space will not be developed as-built space. In particular, in (Zulfiyanita, 2011), green open space is also stipulated in the form of a nature reserve area, namely the development of a mangrove forest area. This mangrove forest is a buffer area for the surrounding area to regulate water management, prevent flooding and erosion and maintain soil fertility. In addition, this area also minimizes the potential tsunami hazard for the surrounding area. Furthermore, the mangrove forest area is directed to the northern coastal site of Banda Aceh city. Therefore, locations included in this category are urban coastal locations that have the potential to develop mangroves and other coastal plants.

From table 1, it can be seen that the common types of existing vegetation, namely sea pine, and mangroves, have plant growth patterns that are scattered and clustered naturally. Similarly, cropping patterns and plant density are not regular and still rare. For this reason, so that green open spaces can function to reduce wave energy, it is necessary to regulate the arrangement of cropping patterns and density and select large and robust tree sizes. In addition, the function of green open space as a protector will take place optimally if it is supported by the availability of a large enough planting area. This is so that a large number of trees can be planted with a specific pattern and density to be effective in reducing wave energy and holding back debris (Sumarto, 2010; Fuady, 2015).

Tabel 1. Types of existing vegetation.

Location	Aspect	Existing	Provision	Explanation
Meuraxa coastal Area	Type of vegetation	Generally sea fir, 8-10 m high, 30-60 cm. grows scattered and clustered naturally.	To reduce wave energy, large, strong trees are needed and in large numbers	Arrangement of planting land that is wide enough so that a large number of tress can be planted
	Density	Spacing of about five m. natural growth not a regular pattern	Planted in a regular pattern so that it can reduce energy and reduce and retain debris	The density of trees is arranged with a certain spacing with a layered pattern to dampen wave energy and reduce and retain debris

The green structure of coastal settlements based on disaster mitigation emphasizes the importance of structuring green open spaces that focus on: (a) use for rescue can be in the form of rescue fields and hills in safe areas, (b) use for protection can be in the form of green belts for coastal areas which include elements visuals that direct residents to reach the safe zone. Using coastal green belts as protection, a combination of mangrove trees and robust coastal tree species, such as coconut, sea pine, ketapang, waru, tamarind, and kapok can be planted to dampen wave energy. Likewise, every settlement must be protected by a row of multi-layered trees planted along the coast, green road corridors and rescue routes, and riverbanks.

RESULTS

From the results of the tsunami study above, this study recommends the release of new developments and mitigation strategies with defense/buffers in the form of using vegetation zones (mangroves and the like). The study of thickness of this buffer is a material that needs to be studied further. It is better for coastal area planning to make a system greenbelt by building a fort of plants/trees before the residential area to reduce the strength of the flow of water when a tsunami disaster occurs. The existence of a defense system using plants will reduce the risk/impact of a tsunami, and plants will function to reduce the speed of the tsunami. Apart from being an environmental defense system, the presence of plants and trees really helps reduce temperatures, lower CO_2 levels and maintain air humidity in a tropical climate, and it will also add to the beauty of the coastal area.

From the results of all open spaces identification in the study area that have been planned as a protection function, two of the three lands have thickness problems due to lack of land, which are the northern part of the mangrove area and the green museum. The green museum has another problem: the lack of thickness, which can only withstand ± 20% of the tsunami with the current thickness. Therefore, the condition of mangrove land arrangement as coastal protection that lacks land should be maintained, even expanded if possible. The advantage of using natural elements as protection for this area is that the Green Meuraxa concept, which prioritizes the natural environment, will become realized.

The results of inundated land identification that allow it to be used as an open space for a protection function show that this land is magnificent if it is used as a protected vegetation planting area. This land qualifies as a mangrove planting area. It has a sufficient land area, and most importantly, its position is in front of other cultivated lands. However, according to the guidelines, locations that include mangroves, coastal borders, and disaster-prone areas must be designated as protected (limited) areas. So, if possible, the transfer of land that should belong to mangroves must also be carried out. This is because of the threat of buildings in the area and the lack of protection for the area behind it. From the results of the discussion between the conditions of the open space arrangement of the Meuraxa area for protection functions with several sources of concepts, it is concluded that the right concept to overcome this problem is: Utilization and optimization of natural elements for the protection and structural protection as supporting material.

CONCLUSIONS

The concept of landscape planning and green planning should consider aspects of reforestation, fineness, control, environmental rehabilitation, and disaster mitigation (tsunami):

1. Minimizing or mitigating the impact of disasters by using fire green belts in coastal areas that can reduce water velocity in the event of a tsunami.
2. Able to strengthen the character of the village by setting patterns in planting tree species that can give and create a character in the Ulee Lheue village area.
3. Able to function as a shade in public spaces in Ulee Lheue Village.

Using green open spaces and natural elements as protection is a better action, especially in areas with a development concept based on environmental ecologies, such as Meuraxa, especially in Ulee Lheue village as the center of Meuraxa sub-district. Structural protection is still an additional function, considering the vast tsunami threat to this area. Prioritizing the development of the natural environment can also reduce land use for development little by little (limiting built-up land), especially in tsunami-prone areas. From the results of the above study and the research that has been carried out, the researcher recommends that landscape planning and green governance based on tsunami disaster mitigation should consider aspects such as reforestation, fineness, control, environmental rehabilitation, and tsunami disaster mitigation. With the existence of landscape planning based on tsunami mitigation, it can reduce the impact of disasters by using green mangrove belts on the coast. The natural landscape reinforces the village's character, planting tree species that can give their personality as a shade in the Uleeu Lheue Village Area public spaces. This study recommends the release of new developments in accordance with the rules of the coastal border that there should be no development, but in fact, several permanent buildings have been built in the field. A mitigation strategy with defense/buffering is very much needed in the form of the use of vegetation zones (mangroves and their kind).

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