

DISASTER MITIGATION APPROACH OF URBAN GREEN STRUCTURE CONCEPT IN COASTAL SETTLEMENT

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ABSTRACT

Coastal settlement of Banda Aceh in the north of Sumatera Island has high potential risk of tsunami disaster. In the year 2004, half of Banda Aceh city has been destroyed by tsunami disaster, especially its coastal settlement area. Based on this experience, the approach of disaster mitigation concept for coastal settlement with vision of environment represent wise choice on planning sustainable Banda Aceh for future generation. This qualitative research try to explore the role of green open space as green structure of the city by considering aspect of tsunami disaster mitigation for coastal settlement of Banda Aceh. This research will evaluate the existence of green open space and post disaster reconstruction of coastal settlement area. Result of this research is green structure concept in coastal settlement of Banda Aceh based on tsunami disaster mitigation and expected to contribute ideas for disaster mitigation in other coastal settlement areas.

Keywords: Disaster mitigation; coastal settlement; green open space; tsunami.

INTRODUCTION

Banda Aceh is located at the coastal tip of Sumatra Island and adjacent to the Indian Ocean. This location is disaster vulnerable because its close to meeting point of the Indo-Australian and Euro-Asia plates which if collide could potentially cause tsunami waves. In 2004, tsunami had destroyed many settlements and infrastructures of Banda Aceh from areas near the coast to most of the downtown area (BRR, 2005). Based on bitter experienced, future settlement planning should be responsive and adaptable to the possibility of disaster. Therefore, environmentally sustainable approach in settlement planning by considering aspects of disaster mitigation is a wise choice.

Coastal settlements of Banda Aceh is the location of the most damage caused by tsunami, so the future settlement planning must be responsive to the possibility of disaster. This is in line with Sukawi (2008), which declared disaster should be used as momentum to perform realignment of a residential neighborhood, so that people can re-build the cultural, economic and social life. Realignment efforts should not only to minimize the risk of disasters but also to prevent or avoid the cause of the damage caused by the disaster.

In connection with the arrangement of post disaster settlements, Pratiwi and Koerniawan (2008) stated the importance of considering aspects of disaster mitigation to be applied in structuring settlements so that (a) it can minimize the risk and

impact of disaster-prone areas in residential areas, public facilities and infrastructure, (b) new development cannot be carried out in disaster-prone locations without adequate precautions, (c) restore the land in disaster-prone areas to be productive land, (d) help secure public and private investment, and (e) prepare the location and circulation for evacuation in case of subsequent disaster.

In line with the development of sustainable coastal settlements, the construction should be done properly and in balance between physical development and the maintenance of ecological functions of the environment. According to Chen (2004), Pauliet and Kaliszuk (2005), green open spaces as urban green structures act to support sustainable urban life, hence the existence of the natural environment and green open spaces are important to consider in order to continue to support human needs and urban development in the future. Similarly, according to Irwan (2005) and Purnomohadi (2006), the presence of green space is important in controlling and maintaining the integrity and quality of the environment.

As a structural component of environmentally sustainable city concept, the existence of open green spaces are important element supporting the creation of sustainable settlements. This research try to explore the role of green open space as green structure of the city by considering aspect of tsunami disaster mitigation for coastal settlement of Banda Aceh. This research will evaluate the existence of green open spaces and post disaster development of coastal settlement areas. Result of this research is green

structure concept in coastal settlement of Banda Aceh based on tsunami disaster mitigation and expected to contribute ideas for disaster mitigation in other coastal settlement areas. The benefits and contribution of this study is to provide recommendations to the city regarding the green structure concept for coastal settlement of Banda Aceh based on tsunami disaster mitigation, so it can be a consideration material in planning future coastal settlements of Banda Aceh.

LITERATURE REVIEW

Green Open Spaces as Urban Green Structure

Green open spaces can be interpreted as spaces in the city or the wider region in the form of area or region as well as in the form of elongated area or path which is more open in its use and without buildings. Green open spaces can present as city parks, urban forests, sports fields and recreation areas, funerals, green belts and green fields (DPU, 2008). According to Purnomohadi (2006) urban green open spaces can also form as protected forests, green belts and green lanes of river banks and beaches.

The presence of green spaces in the city helped shape the structure of city. This opinion is in line with Sinulingga (1999), where the structure of urban space is an arrangement of settlements, network of infrastructure systems and facilities. The elements that make up the structure of urban space consisting of (a) a collection of services including trade, finance, government which tend to distribute in groups in the service center, (b) collection of secondary industry (manufacturing), warehouses and wholesale trade which tend to congregate in one place, (c) residences and green spaces, and (d) transport network connecting the three places above.

Meanwhile Hastuti (2011), reveals the environment of coastal settlements have distinctive characteristics, where green open spaces planning in coastal settlements should be able to maintain balance and harmony between built up spaces and open spaces. The balance between city structure and the natural environment are able to mitigate some of the negative impact of environmental degradation and maintain balance, sustainability, health, comfort and increase the quality of the city environment. In general, the green structure of the coastal settlements can be green forest or non-forest such as park, green belt, yard and garden. Besides the presence as green structure, green open spaces in coastal settlements can also serve as ecological, hydrological, climatological, protective, social, cultural and aesthetic.

In connection with the presence of green open space in coastal areas, Tjallingii (2005), suggested a complementary relationship between green structure and water bodies in the city. Green structure will control water such as floods and rains. Similarly, water bodies will support fertility and beauty of the green areas in the settlements. The existence of water and green structure is needed not only on the natural environment, but also on other city areas such as housing, recreation areas, they will act to support the sustainability of the city.

Associated with the concept of sustainable development of coastal settlements, Dahuri (2003) stated the importance of considering aspects of (a) ecological sustainability of the natural environment, in improving the capacity and quality of ecosystems as the main focus, it will not pass its carrying capacity and (b) socio economic sustainability, which implies the development of coastal settlements must consider the sustainability of society welfare.

Disaster Mitigation

Disaster mitigation is a series of efforts to reduce the risk of an event or series of events that threaten and disrupt the lives and livelihoods. Mitigation can be done through physical development, awareness and capacity building to face the threat of disaster. The disasters as events that threaten, disrupt lives and can result in human casualties, environmental damage, loss of property, as well as the psychological impact can be caused by natural factors or human factors (HSEM, 2009 and TDMRC, 2010).

Coastal settlements as residential areas are located in the waterfront areas which is very prone to tsunami. Therefore it needs strategic steps to protect residents with disaster relief starts from before, during and after a disaster occurs. One of the efforts made at the time prior to the occurrence of disasters is prevention and mitigation, which is an effort to reduce or minimize the impact of loss or damage that can be caused by disaster (Bakornas, 2002).

According to Usman (2009), the tsunami disaster mitigation efforts can be grouped into two main parts, namely: (a) structural mitigation in the form of technical effort that aims to reduce wave energy in coastal areas. Structural efforts can be distinguished naturally by planting mangrove forests as green belt and the efforts made by the construction of breakwaters, sea walls, dykes, as well as strengthen the design of buildings and houses and other infrastructure to be resilient to disasters, (b) non structural mitigation in the form of non technical efforts related to the adjustment and regulation of

human activities and land use policies to be consistent and in accordance with structural mitigation measures and other efforts. Non-structural efforts also include, among others: the standardization of building settlements and infrastructures, public economic activities, disaster mitigation simulation also early warning system of danger.

Research on disaster mitigation in disaster prone settlements have been made by several researchers. Samsirina, Poerbo and Syahyudesrina (2008), reveal important aspects of environmental regulation such as the environment and green open spaces. Neighborhood road in good connection is important for people to be able to escape to the higher and safer location. Shape of the road will determine how the layout of the housing will be created and can be elements of the environment that can increase alertness to residents in time of disaster. Characteristics of the road width and perpendicular to the shore, will help residents to see the arrival of tsunami waves from far away so that they can immediately run towards safer place.

Trees and vegetation in green open spaces in the form of natural or artificial forests can be designed to slow down and hold currents and waves which carried debris. According to Thuy (2008), tsunami reduction behind the coastal forest depends not only on vegetation specie, vegetation characteristics but also on arrangement of vegetation. As the same of vegetation characteristics, the vegetation arrangement has a significant influence on current velocity and hydraulics force behind the coastal forest.

Meanwhile Nasution (2005), in research on tsunami prone areas on the west coast of Aceh confirms 7 principles in dealing with the tsunami disaster mitigation, namely (a) identify the tsunami risk at the site, (b) avoid new development in tsunami inundation areas to reduce victims in the future, (c) set a new development in tsunami inundation areas to minimize future losses, (d) design and build new structures that can reduce the damage, (e) protect existing development from tsunami losses by rebuilding, planning and utilization, (f) take special precautions in managing and designing infrastructure and facilities, to reduce the damage and (g) make evacuation plan.

METHODOLOGY

This study used qualitative approach in assessing the role of green spaces as the urban green structure by considering aspects of disaster mitigation to coastal settlements of Banda Aceh which are prone to tsunami. This study will evaluate the presence of green open spaces and the development of post

disaster coastal settlements. Evaluation begins with an analysis of space utilization plan in Master plan of Banda Aceh 2009-2029. Aspects which reviewed in this study include settlement development plan, road development plan and also the plan of green open space in coastal settlements and protected areas. By analyzing the development plans, its expected to be basis in formulating the concept of green structure in coastal settlements of Banda Aceh.

Supporting material used in this study as secondary data collected from several government offices such Master plan of Banda Aceh in 2009-2029 by Bappeda, Banda Aceh in figure 2011 by BPS, coastal settlement planning after disaster from the Rehabilitation and Reconstruction Agency (BRR) and document of green open space management from the Department of Hygiene and Beauty (DKK) of the city of Banda Aceh. It also made direct observations of the use of spaces in coastal settlements which include recording images as the primary data. Other secondary data also had been collected from a variety of other related literatures.

RESULT and DISCUSSION

Green Open Spaces in Coastal Settlements

In the Master plan of Banda Aceh 2009-2029, it mentioned the provision of green open spaces in the city of Banda Aceh is specifically aimed at ecological functions, economic and aesthetic. Lands designated for urban green spaces will not be developed as built up areas. Green open spaces to be developed in the city of Banda Aceh, among others, are as follows:

- a. Riparian green spaces developed on the northern limit of the loop line on the north and south with a width of 8-10 m.
- b. Coastal border of green open spaces set 100 m from the high tide along the coast.
- c. Green open spaces along the road network.
- d. Green open spaces for funeral.
- e. Green open spaces for urban park developed in the Old Town Center in Peunayong, New Town Center in Lamdom/Batoh, Sub City Centre Keutapang, and Sub City Center Ulee Kareng and in the centre of neighborhood.

In general, the plan is continue the previous green open spaces plan and try to incorporate disaster mitigation considerations. This is especially noticeable with the affirmation of the limits specified coastal border 100 m of high tide along the coast. This effort also to make green open spaces as protective green belts on the coast.

In particular, Master plan of Banda Aceh 2009-2029, also established green open spaces in the form of natural spaces, namely the development of mangrove forests. The mangrove forest areas serves as buffer zones for the surrounding area to govern water, flood prevention and erosion, also maintain soil fertility. In addition, this region also has a function to minimize the potential tsunami hazard for the surrounding area. Mangrove forest areas is directed at northern coastal city of Banda Aceh. Locations are included in this category is the location of the coastal zone that could potentially be developed mangroves and other coastal plants. Development of this area ranging from Ulee Pata area in Jaya Baru district extending to the coastal area of Alue Naga in Syiah Kuala district.

Furthermore according to the characteristics of the region and the direction of development of the city, the planned of local protected areas such as coastal border and rivers include:

- a. Coastal border region, which serves to protect coastal areas from activities that interfere with the preservation of the coast. This area is located along the banks with proportional width to the shape and physical condition of the beach that is 50-100 m from the point of the highest tide landward. Specified coastal border area along the coast that is, except the coastal areas used for public purposes, such as port/dock, open spaces, public spaces, tourism, and fishing settlements that already exist, as well as ponds that have obtained permission from the government.
- b. Riparian areas, serves to protect the river from human activities that may interfere with or damage the function of river discharge, arranged as follows: (a) the river which has a depth of no more than 3 m the river banks are a minimum of 10 m from the edge of the river, (b) river has a depth of more than 3 m to 20 m, 15 m riparian is from the edge of the river, and (c) the river that has a depth of more than 20 m, the river banks is 30 m from the river bank (source: Bappeda 2009).

Green spaces planning in the Master plan of Banda Aceh 2009-2029, has been mentioned several policies regarding the protection of natural spaces of coastal border and the river. But all this has not translated into a green open spaces planning in more detailed and specific of disaster mitigation aspects that can be realized in practice. City Spatial Detail Plan (RDTRK) for every district in the city of Banda Aceh that considers aspects of disaster mitigation is being prepared. But the plan has been delayed in completion because there are some corrections and improvements so that it has not been published yet.

The Concept of Disaster Mitigation in Coastal Settlement

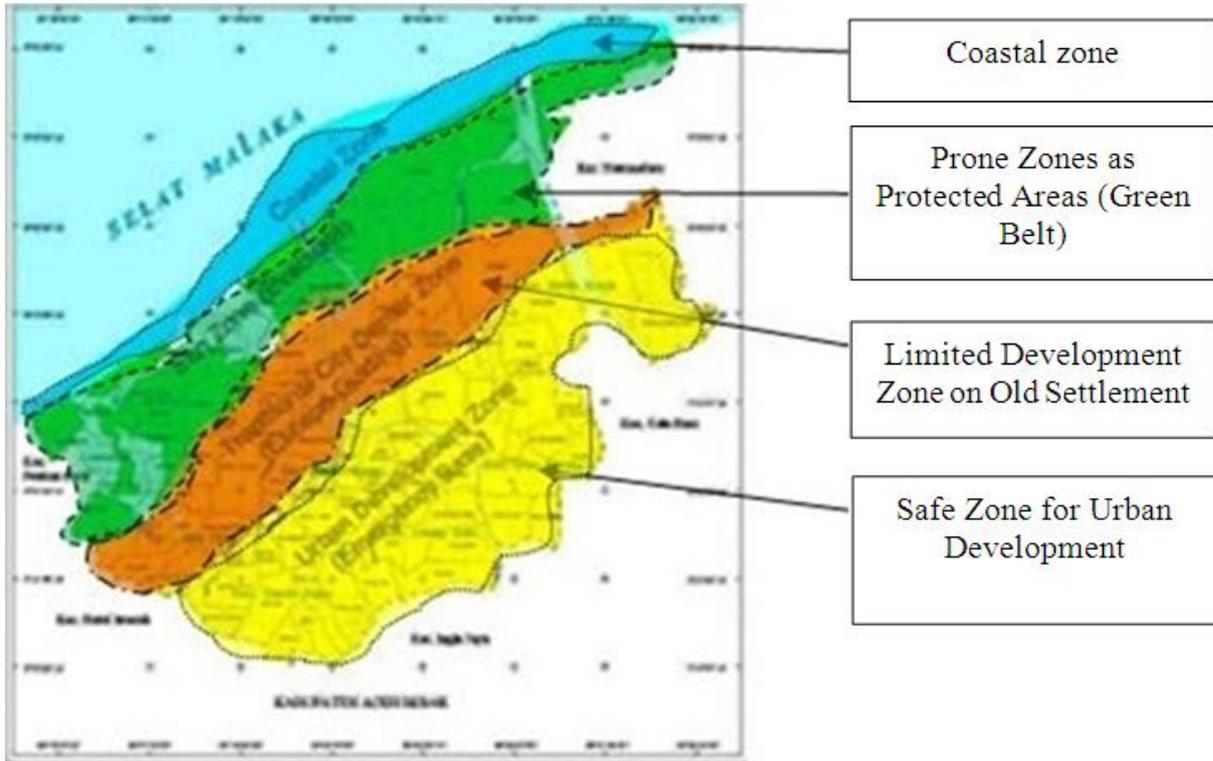
Tsunami is a tidal wave caused by an earthquake or landslide on the slope of the sea floor. Such tidal waves could hit coastal areas up to tens of meters high and hundreds to thousands of meters away from the beach, that can sweep and destroy all that is on the beach and on the mainland. Tsunami disaster mitigation has goals of tsunami disaster risk reduction in the city of Banda Aceh, which could be done with consideration for sustainability and participation of all parties concerned.

To avoid the danger of tsunami impact, there needs to be special spatial planning in the coastal border for tsunami wave to break down and also slow down the speed of the wave. Given policy in this regard is the establishment of coastal border of more than 100 m from the high tide line landward, and along the border created a distinctive zones consisting of mangrove zone, fishery zone land/pond and plantation zones. After the development of cultivation zones, residential zones were allowed to be developed.

In line with Usman (2009) regarding the structural efforts in disaster mitigation, from year 2005 to 2007, the government has built sea wall and breakwater in the coastal areas of Banda Aceh. This development keep the shoreline from abrasion. It also has made efforts to replant green coastal areas with the same local plant as before tsunami disaster in the form of casuarina and mangrove.

Determination of disaster prone areas in the coastal settlements and city generally performed as a tsunami disaster mitigation. Settlements located in tsunami-prone coastal areas that are vulnerable to sea tides, designated as a protected areas or green belts. The old settlement zone can be use in limited development by the provision of disaster mitigation. Similarly, zones of residential areas in the city center and safe zone far away from the coast can be develop as urban development, but still have to be set by regulation of development based on disaster mitigation (Figure 1).

In fact, despite being aware of the coastal region is prone to tsunami disasters, residents resettle in the previous coastal areas, especially people who work as fishermen. Wanting to go back to location near the beach is an ideal fit with the routine work for fish catching by boat. Therefore the arrangement of settlement in coastal areas must provides rescue access to safer place as presented by Samsirina (2008).



Source: BRR, 2005

Figure 1. Zoning of Banda Aceh

Development in the coastal zone is limited and prefer the space to support the development of zones in protected areas. If the cultivated area will be developed as the development zone it should be limited to anticipate the likely impact and the number of casualties and losses caused by the disaster. Related to disaster mitigation efforts in disaster prone areas, the development of the area should be accompanied by efforts to reduce disaster especially tidal waves and tsunami disaster with development support facilities for emergency conditions, among others:

- a. Development of road networks for rescue. The road network is useful for the rescue of runaway catastrophic events in a short time, as well as to track first aid and evacuation of casualties.
- b. Development of public facilities for evacuation. This facility is needed to rescue people or to perform collection activities and aid for victims of disaster. This facility can be shaped as building for rescue (escape building), open space and others.

][In line with Nasution (2005) regarding the principles in dealing with the tsunami disaster mitigation, the government has built three rescue buildings located in Desa Lambung, Alue Dayah Tengoh and Deah Geulumpang, and also two other buildings which can be used as rescue building which

are the Tsunami Museum and Tsunami Research Center. Ideally this number should be increased based on total area and population served, for example in Lamdingin, Jeulingke, Tibang and Lamnyong region. While the salvage pathway which is the main road that connects the villages has been equipped with the tsunami warning signs and circulation directions to a safer place.

The Concept of Green Structure in Coastal Settlement

Green structures in coastal settlements should be arrangement based on disaster mitigation, emphasizes the importance of green spaces that is focused on: (a) the use for rescue that can be a field and hill in a safe area, (b) the use of green belt for protection can be included elements of coastal areas and it has direct visual so it help people run to the safe zone. In terms of utilization of coastal green belt as a protector, a combination of mangroves and coastal plants which is strong, such as coconut, casuarina, ketapang, hibiscus, tamarind, and cotton can be planted to reduce wave energy. Similarly, in each of the settlements should be protected by a row of trees in layers grown primarily along the waterfront, greenbelt, road corridor, escape roads and riverbanks (Figure 2).

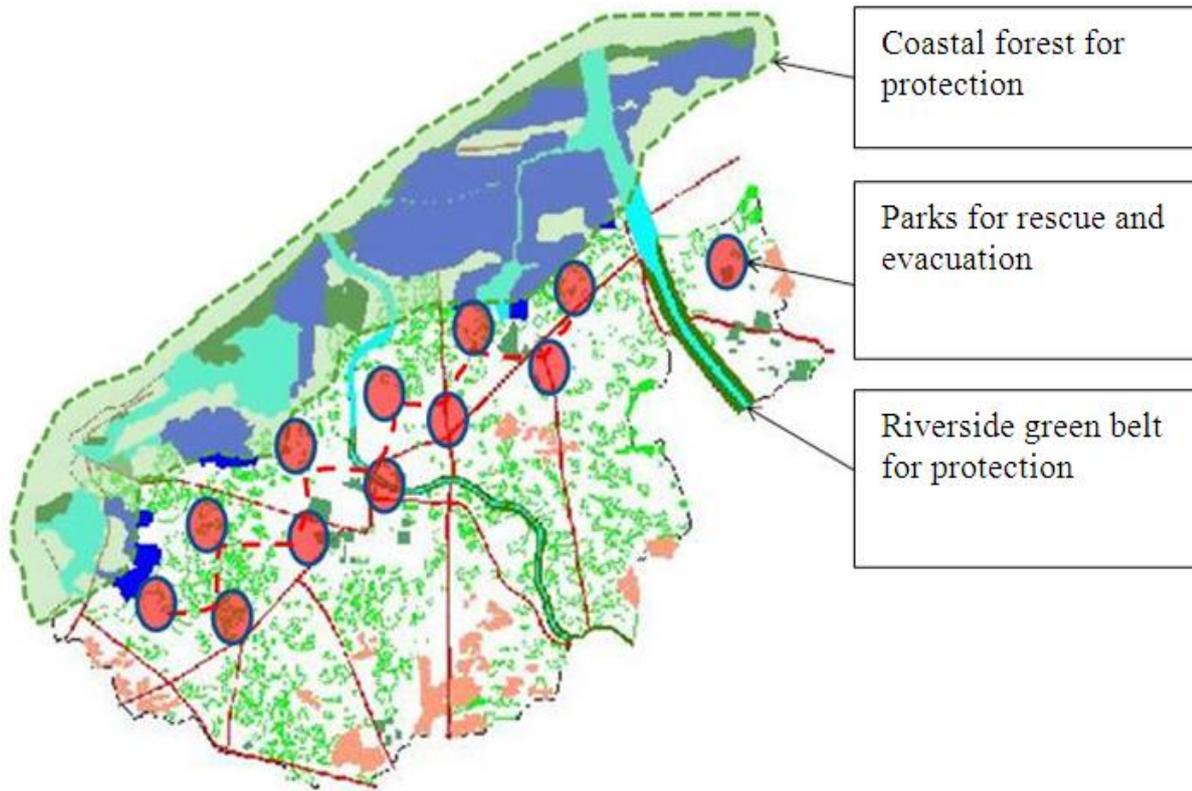


Figure 2. Green Open Space for Disaster Mitigation in the Coastal Zone

There remains, however, a pressing need to better understand the roles that ecosystems can play in defending coasts. Coastal settlement and its populations are particularly vulnerable to the impacts of extreme events such as storm, hurricane, and tsunami, and these pressures may be exacerbated through the influence of climate change and sea level rise. This is in line with McIvor (2012), coastal ecosystems such as mangrove forests are increasingly being promoted and used as a tool in coastal defence strategies. While mangrove forests are usually found on shores with little incoming wave energy, they may receive larger waves during storms, hurricanes and periods of high winds. Large wind and swell waves can cause flooding and damage to coastal infrastructure. By reducing wave energy and height, mangroves can potentially reduce associated damage.

Meanwhile, in mitigation it should emphasized the circulation and the relationship between residential zone which is dangerous to other safer zone. Characteristics of the road width and escape route should be perpendicular to the beach. The road network also features a tree-lined corridor to protect people and reduce the damage by holding the objects or demolition assets as much as possible from the wave that swept away with it so it will not hit people as well as other buildings.

The strategies that can be applied in this concept are:

- Establish a disaster-prone area delineation.
- Conserve and protect the protected beach forest areas, urban forests and mangrove forests as protective function and defense against tsunami.
- Adding and developing the green belt, escape and rescue hill in the green open spaces of the coast and coastal settlements.
- Utilizing the riverside area as one of the green belt as part of urban green structures.
- Set the density of vegetation adapted to the function of the area, the level of security against disasters and location.
- Develop existing road and add new roads as escape route.
- Develop settlements with disaster mitigation facilities.

Taking in consideration the overall implications of mitigation measures in the coastal settlement based on risk reduction such as restricting density that lead responsibility to each owner of the risk and cost they are willing to take, although in short term may be a more feasible solution, at long term may have some adverse results. The exposed population may confront greater risk, and the cost of the decreasing land value would be assumed by each owner, this would

confront social and economic sustainability of development. Building codes on its side may also present some contradictions mainly regarding urban character, uses and activities that will need special considerations to provide guidelines and flexibility to adapt to local reality.

In line with Costa (2011), major measures regarding risk avoidance in hazard areas such as the designation of a greenbelt in Special Regulation, in spite of its initial high social and economic cost of enforcing the expropriation of land, at long term may provide higher contributions to a broader community. It would also support previous community needs, would enhanced main city natural character, and most important, it would keep most exposed population out of risk, supporting issues of social, economic and environmental sustainability and contributing to further aspects of coastal settlement quality improvement.

Green open spaces as protective green structures will function effectively to mitigate tsunami wave energy if it is planned well in setting the density and type of plant, as presented by Thuy (2008). The selection of perennials such as casuarina and mangroves should be planted with appropriate density and layers, which should be placed between the coast and settlements. While in between settlements and salvage pathways toward a more secure location should not be any forest which could obstruct circulation.

CONCLUSION

In order to be sustainable, mitigation should reduce community vulnerability to tsunami risk, adopting measures that recognize ecological limits and enhance qualities of local ecosystem. Mitigation actions in coastal settlement should provide and enhance public access to the coast, promoting intensive uses in public space. Also should be concerned with improving movement and connections.

Green open space as an urban green structure in Banda Aceh play important role in tsunami disaster mitigation in coastal settlement area as protective and rescue function. Several mitigation approaches that can be used in structuring coastal settlements are as follows: (a) the areas most prone to tsunami designated as open spaces or protective green belts, (b) take over the tsunami hazard areas for open spaces functions which include buildings or hills for rescue and evacuation, (c) develop new restrictions on hazardous locations through land use regulations.

Related to disaster mitigation concept in Banda Aceh, several recommendations proposed, among others: (a) intensification of the green belts along the

coast, with a layered planting along the coast to reduce the rate of wave and destruction towards settlement areas, (b) the realignment of roads and accessibility, to the area that is relatively safe, both in quality and quantity, (c) establish coastal settlements and building regulations, so that building, house and infrastructure has specific characteristics and are not vulnerable to tsunami hazard.

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