Coastal Buffer Zone Management in Banten Province Coastal Region During The December 2018 Tsunami Waves in The Sunda Strait

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Abstract. Natural disasters in coastal areas and small islands in Indonesia occurred several times in the last decade. Banten Province coastal region was directly affected by the tsunami waves last December 2018 due to the Anak Krakatau Volcano's activities, covering Pandeglang and Serang Regencies. Regional and spatial planning in a coastal buffer zone is mandated by laws and regulations, both central and local, but still sometimes neglected. The spatial analysis was carried out by identifying land use/cover in Banten Province coastal area using high and medium resolution images acquired from the Google Earth website. The results of the land use/cover map observations, which validated with field data, showed that the built-up area from the tourism sector in the form of buildings, facilities, and infrastructures dominate the coastal buffer zone, both in Pandeglang and Serang Regencies, especially in Anyer District (22.3 ha), Carita District (10.7 ha), and Cinangka District (7.2 ha). Moreover, human settlements and supporting public facilities also contribute and dominate the built-up area on the coastal buffer zone in Panimbang District (15.8 ha) and Sumur District (6.4 ha). Implementation of a coastal buffer zone in a vulnerable area such as Banten Province should be evaluated to minimize the impact in the future.

1. Introduction
Indonesia is known as the largest archipelago country in the world with more than 17,000 islands, has the 2nd longest coastline after Canada [1]. Coastal areas are dynamic and are influenced by the land, sea, and air [2], also a center of people activities that depend a lot, mostly on the coastal resources [3]. Several main factors that caused tsunamis, including volcanic eruptions [4], coastal subsidence due to earthquakes [5], or those caused by the tectonic plates movement or friction [6]. The last tsunami in Sunda Strait occurred on 22 December 2018 due to the activity of Anak Krakatau volcano inducing a landslide on one side towards the sea [7], specifically the flank collapse toward the southwest direction [8]. The flank collapse was previously estimated using numerical modeling [9]. Although the tsunami disaster on the Sunda Strait coast repeatedly occurred, it still had a significant impact in casualties, moral and material losses, social and economic, and infrastructure. The low level of community preparedness for disasters in coastal areas needs to be improved to minimize losses through disaster mitigation-based regional spatial planning and management [10].

Regional planning is one of the development process stages that aims to develop and increase the productivity of the community, government, and the environment by utilizing various existing resources and being oriented as a whole but still adhering to the principle of priority [3]. One of the appropriate methods to support tsunami disaster mitigation in coastal areas is the arrangement and management of coastal space by the implementation of coastal buffer zone. According to the Presidential Regulation No.51/2016 concerning Coastal Boundaries, the coastal management is integrated with Regional Spatial Planning (RSP). Regulations related to coastal boundaries have been
exist for a long time, but the implementation and application are often overlooked and underestimated by the central and regional governments and stakeholders on the coast (Table 1).

**Table 1. History of coastal boundaries regulations**

| Legal Basis                          | Regarding                  | Land Status     |
|--------------------------------------|-----------------------------|-----------------|
| Presidential Decree No.32/1990       | Protected Area Management   | Protected Area  |
| Act No.24./1992                      | Spatial Management          | Protected Area  |
| Act No.26/2007                       | Spatial Management          | Protected Area  |
| Act No.27/2007                       | Coastal & Small Island Management | Public Area     |
| Presidential Regulation No.51/2016   | Coastal Buffer Zone         | Public Area     |
| Ministerial Regulation of MMAF No.21/2018 | Coastal Buffer Zone Assessment | Public Area     |

Source: various sources

Local Government posses the highest authorization in determining coastal boundaries by adjusting to the topographic, biophysical, coastal hydro-oceanographic characteristics, economic and cultural needs, and other provisions. Local governments are also obliged to accommodate coastal boundaries in the Provincial/Regency/City Regional Spatial Planning (RSP) based on Presidential Decree No.51/2016. In terms of regional and spatial planning, regional governments with authority must synchronize their spatial planning with Government Regulation No.13/2017 in conjunction with Government Regulation No.26/2008 concerning the National Spatial Planning to avoid overlapping implementation in the field. Based on Act No.23/2014 regarding Local Government, regional and spatial planning is mandated to regency/city governments, including coastal protection infrastructure, rehabilitation, and settlement relocation for casualties and disaster management. This regulation is reinforced in the Presidential Regulation No.51/2016 emphasizing on Provincial Governments' obligation that has coastal boundaries to regulate, direct and determine coastal boundaries. The regulation is also outlined in Regional Regulations concerning Provincial Spatial Planning. Integrated Coastal Zone Management is urgently needed to increase awareness in the coastal region, combined with educational programs, integrated research project initiation, and data center services implemented in Pekalongan, Central Java [11].

This study aims to illustrate and evaluate the implementation of spatial planning regulation related to the natural disaster in Indonesia, especially in the small island and coastal region due to tsunami wave, and provide policy recommendation as a mitigation action to the stakeholders.

### 2. Methodology

The research was conducted in August 2020, continuing the rapid assessment activities in January 2019 regarding the impact of The Sunda Strait Tsunami in 2018 in Banten Province, particularly in the impacted area from two regencies (Pandeglang and Serang Regency) as shown by figure 2.
High-resolution images from the Google Earth Pro in the selected area were acquired, combined with the Indonesia basic map taken from The Indonesian Geospatial Information Agency (BIG). Manual digitation was carried out to create the recent coastline in the study site using Geographic Information Application (ArcGIS) and buffered 100 meters landward as the minimum requirement for a coastal buffer zone. Land use and land cover identification executed utilizing the high-resolution images from the Google Earth and ground-truthing using Global Positioning System (GPS) during the fieldwork. Land use and Land Cover identification are divided into three categories, namely: 1. Built area (infrastructures, buildings, and settlements) 2. Open area/empty area (vegetation, bare land, lakes, rivers), and 3. Utilized area (ponds, agriculture, horticulture). Lastly, the land use and land cover identification map overlayed with the coastal buffer zone map resulted in the main issue that needs to be addressed.

3. Results and Discussion
Banten Province and Lampung Province are the areas that were directly affected by the tsunami at the end of December 2018, with casualties of 437 death, ten missing, and more than 31,000 people wounded [12]. Based on the regional planning contained in Government Regulation No.13/2017 in conjunction Government Regulation No.26/2008 concerning the National Spatial Plan (NSP), the land use in the coastal areas of Pandeglang Regency and Serang Regency is dominated by cultivation, protected areas (conservation forest and protected forest), and agriculture, which can change its functions in another detailed spatial planning for every five years (Figure 2).
3.1 Legal Aspect

Based on Government Regulation No.13/2017 in conjunction with the Government Regulation No.26/2008 concerning the National Spatial Plan (NSP), the area arrangement in almost all of the region in Pandeglang Regency and Serang Regency dominated by cultivation areas and food crop agriculture in a wet or dry land, but its designation can still switch functions in a more detailed spatial plan. More detailed arrangements were described in the Provincial Government's Regional Spatial Planning (RSP) through Banten Provincial Regulation No.5/2017 concerning Banten Provincial Spatial Planning 2010-2030, where the designation of coastal buffer zone has been allocated 100 meters from the high-tide point towards the land.
Based on the digital map of the coastal buffer zone in Pandeglang and Serang Regencies, several areas in the planning still do not meet the minimum requirements for the coastline width as far as 100 m from the high-tide point (Figure 3). The width of the coastal buffer zone in areas close to the popular tourism sectors such as Karangbolong Beach, Marina, Sambolo, Pasir Putih, and others in Anyer District (Figure 3a) did not follow the minimum distance requirements that have been determined where the width of the coastline along the area is about 50 meters from the high-tide point. The coastal buffer zones adjacent to other non-tourism designated areas (residential, industrial, forestry, and agrarian), have generally met the minimum requirements for the coastal buffer zone's width. Not only in Anyer District, but the implementation of the coastal buffer zone in the tourism area in Cinangka District also faces almost the same problems, especially in the Sirih White Sand Beach area (Figure 3b), Florida, Batu Saung Jangkung, and Tumaritis. Likewise, this also happened in other districts such as Carita District (Figure 3c) and Labuan District. Unlike the Districts in the northern part, the Districts in the south including Cigeulis, Pagelaran, Panimbang, and Sumur (Figure 3d) are dominated by open space (vegetation, open land, fields, shrubs, and others) and utilized land (agriculture, plantation, fishing, aquaculture, and others). The coastal areas have a coastal buffer zone in accordance with the minimum requirement as far as 100 meters from the high-tide point.

The Government Regulation No.13/2017 in conjunction with the Government Regulation No.26/2008 concerning the National Spatial Plan (NSP), states that the area arrangement in almost all of the region in Pandeglang and Serang Regency are dominated by cultivation areas and food crop agriculture in wet or dry land, but its designation can still switch functions in a more detailed spatial plan. The more detailed arrangements are described in the Provincial Government's Regional Spatial Planning (RSP) through Banten Provincial Regulation No.5/2017 concerning Banten Provincial
Spatial Planning 2010-2030, where the designation of the coastal buffer zone has been allocated 100 meters from the high-tide point towards the mainland.

The regional spatial planning through provincial regulation already distribute the function of land use/cover based on its potency and characteristics, but sometimes it is different in the reality due to the interest and potential economic perspective. The instrument that regulates spatial planning and management in the form of laws and regulations related to coastal buffer zone has existed since 1997. This was further strengthened by other regulations related to disaster management from various technical ministries and related institutions. However, there are still many irregularities, deviations, and violations in their implementation in the field. In other words, the implementation did not follow the existing regulations.

Based on observations and rapid assessment in Banten Province regarding the Sunda Strait tsunami in February 2019 by Solihuddin et al. [10], there were so many infrastructures and buildings located in the coastal buffer zone area. Various irregularities in spatial planning and management occurred, especially land use designated for the tourism sector, residential settlements, reclamation, and other land-use types in Banten coastal region that did not meet the criteria and not in accordance with the coastal boundaries regulation based on Presidential Decree No.51/2016. The areas directly affected by the Sunda Strait Tsunami, particularly the region with heavily damaged and caused significant casualties, were scattered in Serang and Pandeglang districts, which strengthening the importance of collaboration and coordination from stakeholders especially related to tourism sector [13].

Several locations famous for their beaches, particularly in Anyer and Cinangka District in Serang Regency and Carita, Panimbang, and Sumur Districts in Pandeglang Regency. These areas were heavily damaged during the 22 December 2018 tsunami and experienced more casualties [14]. Anyer, Cinangka, Carita, and Panimbang district are well-known for their beautiful beaches, natural scenery, especially as a tourist destination in Banten Province, while Sumur District known as a region with huge potency on fisheries sectors such as fish ponds, shrimp ponds, hatchery, fisherman village, and floating net, is identical to the local-generated revenue and as a center of economic development to the local government both for regency and province.

The arrangement for land use/cover in Sumur District, and Panimbang District, which allocated for coastal buffer zone were dominated by areas for cultivation and agriculture. Carita has similar condition with Sumur and Panimbang District, but it has protection function also, where in more detail regulation contained in provincial regulations regarding regional spatial planning that the arrangement were for fisheries, plantation, agriculture and settlements. In comparison to Cinangka and Anyer District, the arrangement of land use/cover in the region destined for cultivation and agriculture, but based on the regional spatial planning it is generally for tourism purposes.

3.2 Geographical Aspect
The coastal region of Banten Province is geographically situated in the Sunda Strait and directly faces the active volcano of Anak Krakatau, stretching from the north down to south with various topography characteristics. The topography of Anyer District generally existed at a low slope of less than 15° [15] where several villages like Anyer and Cikoneng Village located in a low-lying area. These areas are vulnerable to coastal natural disasters such as rob floods, high waves, and tsunami. The similar topography with Anyer District found in Cinangka District, where the topography in the region mostly existed in a coastal region, showed by the coastline in Cinangka District that stretched through several villages (Umbul Tanjung, Pasauran, Bulakan, Karang Suraga, Cinangka, Sindanglaya, and Kamasan) with a gentle slope [16], which also potential to the natural disaster. The topography of Carita District is a little bit different from Anyer and Cinangka District, even though the coastline encompassed six villages, but most of the region are located in the medium-slope areas, except for two villages (Carita and Sukajadi) which located in the low-lying areas and prone to tsunami [17], resembling to the Carita District, most of the region in Panimbang District are dominated by low-lying areas with three of them (Panimbang Jaya, Citeureup, and Tanjung Jaya) are situated adjacent to the coastline [18] and prone to the natural disaster associated with earthquake and volcano eruption. Based on data and information
[19], the topography of Sumur District is dominated by coastal regions with low-lying areas, which also potential to natural disaster such as tidal flood, high waves, and tsunami. Despite the vulnerable Banten Province coastal region, both in Pandeglang and Serang Regency, the coasts has productive areas in supporting the community's economy and local-generated revenue to the local government, especially from the tourism sector [20]. Various productive sectors are scattered along the coast of Pandeglang and Serang Regencies such as industrial, socio-cultural tradition, tourism, cultivation, agriculture, aquaculture, plantation, fishery processing and other sectors. Based on observations and rapid assessment of the Sunda Strait tsunami in February 2019 by Solihuddin et al. [10], the community preparedness over natural disasters in both regencies were low and need improvement.

Table 2. Land use/cover in several districts in Pandeglang and Serang Regency

| Land Use/Cover       | District (ha) |
|----------------------|---------------|
|                      | Anyer | Cinangka | Carita | Panimbang | Sumur |
| Hotel/Villa/Resort   | 22.33 | 7.25     | 10.77  | 8.78      | 1.04  |
| Industry             | -     | 0.87     | 2.65   | 0.18      | 1.67  |
| Settlements          | 8.91  | 4.47     | 8.61   | 15.87     | 6.37  |
| Public Facility      | 3.17  | 0.02     | 6.03   | 8.75      | 5.02  |
| Open Area            | 80.81 | 159.87   | 146.80 | 303.16    | 258.64|
| Utilized Area        | 0.77  | 0.92     | 13.54  | 27.07     | 33.98 |
| Coastal Structure    | 0.48  | 3.41     | 1.64   | 0.36      | -     |
| Culture Heritage     | 0.10  | -        | 0.13   | -         | -     |
| Total Extent         | 116.57| 177.11   | 190.18 | 364.18    | 306.72|

Based on the land use/cover analysis as shown in table 2, the land use/cover in Banten Province Coastal Region is dominated by empty area (open area). The smallest open area is in Anyer District with an extent of around 80.8 ha (69.3% of total extent), while the largest is in Cinangka District with 159.9 ha (90.1% from total extent). These conditions are supported by the portion of other land use/cover types such as public facilities, settlements, and utilized area, where Anyer District have a higher portion on the public facilities, tourism infrastructure, and human settlements, concluding the development focus and the characteristics of both districts in coastal management. The districts of Anyer, Carita, and Cinangka are famous for their beaches, where several locations are chosen as the main tourism destination, both domestic and overseas visitors. The portion of tourism infrastructure and its supporting facilities in the coastal region placed Anyer District as the highest district to allocate tourism infrastructure in their coastal region with 22.3 ha (19% from total extent), followed by Carita District with 10.8 ha (5.7% from total extent). In comparison, Cinangka District allocates 7.3 ha (4.1% from total extent) for tourism infrastructure. Even though Panimbang District allocates 8.8 ha, where Special Economic Zone Tanjung Lesung is located in this region, the percentage of tourism infrastructure is quite small (2.4%) compared to the total extent of about 364.2 ha. Sumur District is different, the region has a significant portion of the utilized area as shown by the massive existence of fisheries sectors such as shrimp ponds, fish ponds, and hatchery, particularly in the coastal buffer zone. The people livelihood in Sumur District mainly worked as a fisherman, and most of them lived adjacent to the coastal region by building a fisherman community and create a fisherman village. Most of the region's activities are associated with the fisheries and coastal areas, which proved and highly vulnerable based on natural disasters, especially Tsunami.

The challenges faced in implementing the arrangement and management of the coastal buffer zone in coastal areas often come from conflicts of interest that arise between stakeholders. Investment considerations to boost a region's economy from productive sectors such as industry and tourism are not balanced with the compliance to the applicable laws and regulations, potentially detrimental when a disaster occurs. Tourism infrastructure in the forms of hotels, cottages, bungalows, resorts, and other
infrastructure often makes the beachside (coastline area) a selling point or promotion value of the area, which violates the minimum buffer zone of the coastal area even with a minimum scenario (100 meters from the high-tide point towards land). This condition is exacerbated by settlements and their supporting public facilities, making the area more vulnerable to natural disasters. Conflicts of interest between stakeholders potentially occurred and continue in planning, drafting, and discussing regulations mandated by law to the respective local governments according to their respective regions' interests and characteristics. The conflict of interest often results in a tug of war and ends up in a deadlock situation resulting in delays or even the cancellation of the draft proposed regulations.

The coastal buffer zone's management and spatial planning in the Regional Spatial Planning still refer to the Presidential Regulation No.56/2016 with a minimum distance of 100 meters from the high-tide point towards the mainland. At the same time, based on the technical guidelines for determining coastal buffer zone issued through Ministerial Decree Minister of Marine Affairs and Fisheries, Republic of Indonesia No.21/2018 concerning Procedures for Determining Coastal Boundaries where some several criteria and factors need to be considered in appointing the coastal buffer zone, especially for areas that have a high potential threat and vulnerability index. The challenge in itself for Banten Province is related to the discussion of a regional regulation regarding the Zoning Plan for Coastal Areas and Small Islands (RZWP3K) mandated by the central government, which is still in the process of submitting to the Regional House of Representative (RHR) where coastal areas in the administrative area of the sub-district are the scope of the discussion of RZWP3K.

Reflecting on the tsunami wave disaster that hit Aceh (Indonesia) and the surrounding area, Sri Lanka, which was also directly affected by the tsunami wave, has several methods to improve the arrangement and management of space in its coastal area where the coastal buffer zone is implemented through regulations as far as 100 meters in the south and 200 meters in the north and east [21]. The infrastructure in the coastal border zone that is not damaged is still allowed to stand and be used, while infrastructure with damage below 40% is still allowed to be renovated and used. With population density and land use on the coast, other problems arise because the reconstruction scenario is hampered by the scarcity of replacement space/land, but the economic development considering the existing condition should be accommodated through integrated spatial planning involving all stakeholders.

Even though natural disasters in the form of tsunami waves have repeatedly hit the coastal area of the Pandeglang Regency, this does not have a deterrent effect on the surrounding community from neglecting laws and regulations governing the arrangement and management of coastal buffer zone. Lacking regulations socialization from the in-charge authorities and the low level of public awareness and preparedness regarding the threat and vulnerability of the coastal areas of an area impact the lack of preparedness of coastal communities, which resulted in large losses and fatal damage caused by the tsunami waves. The implementation of spatial planning and management in the coastal buffer zone requires all parties to appropriately perform the laws and regulations according to what has been mutually agreed.

4. Conclusion
Spatial planning and management in Pandeglang Regency and Serang Regency still need a massive improvement, where in the field there were so much land use that is not in accordance with the spatial planning regulation, especially in the area affected by the Tsunami in the year 2018 ago. These areas were very vulnerable to the tsunami waves due to their position facing directly to the active volcano Anak Krakatau, which still frequently occurs eruptive activity and tremors. Besides, the Sunda Strait location, which is directly connected to the Indian Ocean, further adds potential threat in the form of earthquakes generated by the movement of continental plates.

Several steps can be taken in implementing the spatial planning management of coastal region as follows:

- A moratorium on permits for constructing facilities, infrastructure, settlements, and other land uses in the coastal buffer zone.
- Review the existence of facilities, infrastructure, settlements, and other land use in the coastal buffer zone related to the socio-economic, safety, and comfort aspects of stakeholders.
- Relocating facilities, infrastructure, settlements, and other land uses in the coastal border area.
- Education-based socialization massively related to the existence of coastal buffer zone to the stakeholders in areas with high potential threat and vulnerability risk factors to increase coastal communities' preparedness dealing with natural disasters, particularly tsunami waves.
- Review the rules and regulations related to the coastal buffer zone, both the central and regional levels, rearrange the regional spatial planning according to the reality on the ground, and accommodate the potency and opportunities based on the existing economic perspectives infrastructure.
- Detailed planning related to spatial planning and management into a more specific scale such as the Detailed Spatial Plan (DSP) scale of 1: 5,000, to minimize public area exploitation and so that in the future it is expected to suppress the exploitation of public space and minimize the impact of natural disasters.
- Supervision and field inspection in curbing land use that is not in accordance with its land use designation.

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