Seagrass existence after Sunda Strait tsunami 2018: Evidence in Tanjung Lesung region

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Abstract. The volcanic tsunami occurred at the Sunda strait at the end of 2018. Tanjung Lesung is one of the affected areas, and the seagrass ecosystem allegedly affected too. This research aims to determine seagrass existence in Tanjung Lesung after the tsunami 2018. This research was conducted from June until July 2019 with the same area as the previous study (before tsunami). Observation method using 20 x 0.5 m belt transect sized 50 x 50 cm quadrat. The transect was made perpendicular to the beach line. Seagrass species that were found outside transect also noted. This research found six seagrass species in Tanjung Lesung after tsunami 2018; there were Enhalus acoroides, Cymodocea rotundata, C. serrulata, Syringodium isoetifolium, Halophila ovalis, and Thalassia hemprichii. The most significant impact of tsunami 2018 for seagrass existence sighted in the west part of the cape. Seagrass in the previous observation point has already disappeared and replaced with rock, dead coral, and macro-algae.

1. Introduction
The seagrass ecosystem has an essential contribution to the ecological and social systems of the coastal area. In an ecological system, seagrass contributed as a feeding ground, spawning ground, nursery ground, sediment trap, beach protector, nutrient regulator, blue carbon, and many more [1-3]. Whereas, in the social system perspective, seagrass habitat has utilized by small-scale fishermen as fishing area [4] and support marine tourism activities [5-6].

One of the seagrass habitats that have an important role as a social-ecological system is the seagrass ecosystem in Tanjung Lesung Coastal. In there, seven seagrass species was found [3], namely Enhalus acoroides, Cymodocea rotundata, C. serrulata, Syringodium isoetifolium, Halophila ovalis, Thalassia hemprichii, and Halodule uninervis.

However, a volcanic tsunami occurred in Sunda Strait as an effect from the landslide of Anak Krakatau Mountain because of eruption activities at the end of 2018. The tsunami did coastal damage around Sunda Strait, including the seagrass ecosystem. Tsunami 2004 also destroyed the seagrass
ecosystem in Andaman [7, 8] and tsunami 2011 destroyed the seagrass ecosystem in Shizugawa Bay [9]. Therefore, this research aim is to invent the seagrass species in Tanjung Lesung after the Sunda Strait tsunami.

2. Method
This research was conducted in June until July 2019 at Tanjung Lesung Coastal, Pandeglang District, Banten Province. Observation of this research was conducted in the same area with a previous study [3] as before the tsunami condition (Figure 1). Observation method using 20 x 0.5 m belt transect, with 50 x 50 cm transect quadrat. This transect is a modification from Irving et al. [10] that used for observing seagrass habitat structure. This transect was made perpendicular to beach line. Seagrass species that was found outside transect also noted. Seagrass identification used the Seagrass-watch standard [11].

![Figure 1. Observation area.](image)

3. Result and discussion
This research found six seagrass species in Tanjung Lesung coastal, namely *Enhalus acoroides*, *Cymodocea rotundata*, *C. serrulata*, *Syringodium isoetifolium*, *Halophila ovalis*, and *Thalassia hemprichii*. The results show the difference from the previous study before a tsunami with seven species (Table 1) [3].
Table 1. Comparison of seagrass species before and after tsunami at Tanjung Lesung region.

| Seagrass Species      | Area A | Area B | Area C | Area D |
|-----------------------|--------|--------|--------|--------|
|                        | 2      | 3      | A      | 1      | B      | 4      | C      | 5      | D     | E     |
| Enhalus acoroides     | +      | +      | +      | +      | +      |        |        |        |       |  +   |
| Thalassia hemprichii  |        |        |        | +      | +      | +      |        |        |        |       |
| Cymodocea rotundata   |        |        |        | +      | +      |        |        |        |        |       |
| C. serrulata          | +      | +      |        | +      | +      |        |        |        |        |       |
| Syringodium isoetifolium | +   |        |        |        |        |        |        |        |        |   +   |
| Halophila ovalis      |        |        |        |        |        |        | +      | +      | +      | +    |
| Halodule uninervis    |        |        |        |        |        |        |        |        |        | +    |

Note: 1, 2, 3, 4 and 5: Station before tsunami; A, B, C, D and E: Station after the tsunami.

Besides the differentiation of seagrass species amount, this research also found the different distribution of several species and loss of seagrass existence. Area A has more species with the addition of species of S. isoetifolium. Area C loss of H. uninervis, but there were different species than previous that was T. hemprichii. In one station of area D, seagrass has already disappeared and changed with rock, dead coral, and macroalgae.

Area A locates in Cipanon district coastal at Tanjung Lesung. Based on the study of Rustam et al. [3], there were two species in this area (station 2 and 3), namely E. acoroides and C. serrulata. We did not observe in the same station, because this area has already changed become fisherman boat traffic. Seagrass observation was conducted in other station with information from local fisherman, where were found still many seagrasses, safe from fisherman boat, and occasionally dugong’s sighted.

The result shows that area A has turbid water, only high seagrass species, as E. acoroides, can be observed from the water surface (Figure 2). Table 1 shows that this research found three species of seagrass in area A. Two species were the same with previous study and another one different, i.e. S. isoetifolium (Figure 3).

Although the waters are turbid, small seagrass (C. serrulata and S. isoetifolium) can survive. In another place, both species can survive in turbid waters or high shading areas [12-13]. In some quadrat of transect, there was S. isoetifolium in high coverage and density. This species known as dugong’s main dietary [14-15], high density of this species causes dugong’s sighting in this area.

Figure 2. Condition of area A in Cipanon district coastal at Tanjung Lesung.
Area B still locates in Cipanlon district but have different characteristic from area A. Seagrass in this area develops monospecies beds with patchiness pattern. In area B, we only found single species that was *E. acoroides*, and the sediment was muddy (Figure 4). Besides, there were found flowers, fruits, seeds, and seedlings of *E. acoroides* (see Figure 5). Seed production related to the reproduction process, i.e. flowering, seed release, dispersal, seed germination, and seedling growth for maintaining genetic diversity [16].
Figure 5. Fruit, seeds and seedlings of *Enhalus acoroides* in area B (Cipanon district coastal at Tanjung Lesung).

Seedling was found in the no-seagrass zone between several patchy seagrasses. Dispersal of seed and growing become seedling influenced by water motion and seagrass canopies [17].

Area C is a coastal region in the east part of the bud of Tanjung Lesung. Rustam et al. [3] showed that this area has the most seagrass species in Tanjung Lesung, about six species. This research also found six species with differences in *H. uninervis* and *T. hemprichii* (Figure 6).

Figure 6. Mix-species of seagrass beds in area C in Cipanon district coastal at Tanjung Lesung.

Figure 6 shows that many epiphytes in seagrass leaf. This condition can cause decreasing of sunlight penetration to seagrass. This condition allegedly due to nutrient is in higher-level, which triggering algae epiphytes grow faster [18].
Based on information from local government and community, the east side of the cape was not significantly affected by the tsunami. While the west side of the cape was significantly affected, the most significant beach damage in Tanjung Lesung occurred in this area, and also there were found many victims. This condition showed the west side was the first place where exposed to tsunami waves and protectors for the east side.

Area D is a coastal region in the west part of the bud of Tanjung Lesung. Tsunami also affected to seagrass ecosystem. Table 1 shows that seagrass has already disappeared in area D station D. Meanwhile, a previous study found three species of seagrass in this station (station 5 in Table 1) [3]. In this station, seagrass was found changed with rock, rubble, and macro-algae (Figure 7). A tsunami can decrease coverage area, species composition, and biomass of seagrass [8-9].

Because of that, observation moved to another place in this area (Station E). In this station, four seagrass species was found (Figure 8). Seagrass in this station also did not develop extensively. Many algae and dead coral was also found in this station.

![Figure 7. Condition of area D station D in Cipanon district coastal at Tanjung Lesung.](image)

![Figure 8. Condition of area D station E in Cipanon district coastal at Tanjung Lesung.](image)

This condition showed that seagrass ecosystem recovery is happening in this area and proven by existing of Halophila as pioneer seagrass species [19] and young seagrass species. Young seagrass has several characteristics, shorter seagrass leaves and several leaves less than three leaves/shoot [20-22].

4. Conclusion
This research found six species of seagrass, a different one species from the previous study. Westside of Tanjung Lesung was the small affected area from the tsunami; changing the seagrass ecosystem is influenced by anthropogenic activity in surrounding areas. Eastside of Tanjung Lesung the big
affected area from the tsunami; some area seagrass changed with rock, dead coral, and macro-algae and the others.

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