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Carbon storage in seagrass meadow of Teluk Bakau – Bintan Island

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Abstract. Seagrass has the ability to store carbon through photosynthesis. The ability is influenced by environmental factors. This study was aimed to examine the diversity of seagrass and investigate the carbon storage in seagrass' biomass in two stations at Teluk Bakau Village, Bintan Island. This research was conducted at two stations including Beralas Pasir Island (small island) and Teluk Bakau Village Beach (mainland). Measure of seagrass biomass with dried seagrass sample was carried out at 60°C temperature. The analysis of carbon content was carried out on the biomass of the four dominant seagrass species found in the Teluk Bakau Village namely *Cymodocea rotundata*, *Enhalus acoroides*, *Syringodium isoetifolium*, *Thalassia hemprichii*. The results show that the carbon storage on seagrass has a correlation with seagrass biomass. *Enhalus acoroides* has the highest carbon content compared to the other three seagrass species. In general, seagrass located in Teluk Bakau Village Beach have higher biomass than seagrass located in Beralas Pasir Island, and it means that they have high carbon storage. This is expected to occur considering that the area of Teluk Bakau Village Beach is close to the mainland, where there is a high nutrient input support for the growth of seagrass biomass.

Keywords: Bintan Island, biomass, carbon, ecology, seagrass

1. Introduction

The seagrass ecosystem is a part of coastal ecosystems that has very high productivity. Seagrass ecosystems composed by seagrasses which are flowering plants that are able to live submerged under sea water. The ability of seagrasses to carry out photosynthetic activities makes seagrass ecosystems a source of productivity and habitat for other marine biota. The existence of various types of marine biota in seagrass ecosystems makes them a source of life for coastal communities and they have a significant economic value [1].

Thirteen of 69 seagrass species in the world can be found in Indonesia [2]. Based on data mapped until 2017, seagrass ecosystem area in Indonesia is 150,693.16 Ha, with 4,409.48 Ha in western Indonesia and 146,283.68 Ha in Central and Eastern Indonesia [2]. One of the seagrass ecosystems in western Indonesia which has high seagrass diversity is found on Bintan Island, where 10 species of seagrass are found [3].



The existence of a seagrass ecosystem in Bintan Island has a very important ecological function. One of the important ecological functions is carbon storage from the atmosphere. The ability of seagrasses in storing carbon is one form of coastal ecosystem mitigation to increase the concentration of carbon gas in the atmosphere [4]. In seagrass ecosystems, carbon from the atmosphere will be stored in seagrass biomass and in the substrate [4]. This study was aimed to examine the diversity of seagrass and investigate the carbon storage in seagrass biomass in Teluk Bakau Village at Bintan Island.

2. Materials and Methods

2.1. Study area

This research was conducted in July 2018, in a seagrass ecosystem located in Teluk Bakau Village, Bintan Island. There are two stations in this research (figure 1), the first station is located on the beach of the Teluk Bakau Village (mainland) and the second station is Beralas Pasir Island.

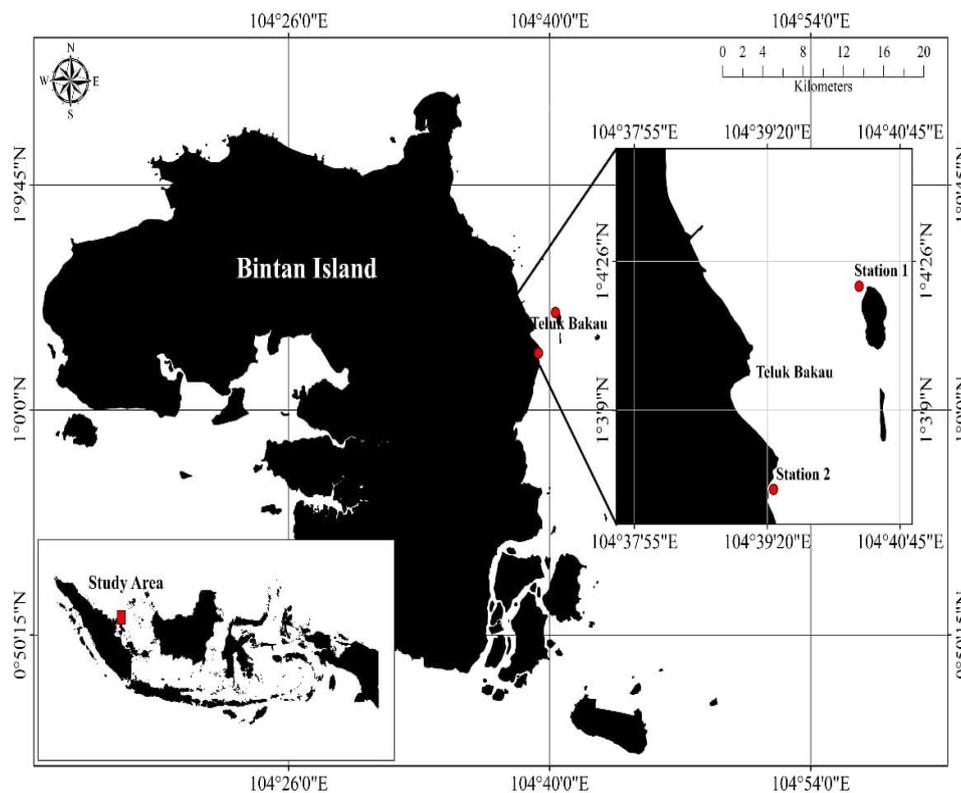


Figure 1. Research location in Teluk Bakau Village, Bintan Island. Station 1 located in Teluk Bakau Beach (mainland) and station 2 located in Beralas Pasir Island (small island).

2.2. Data collection

Seagrass data collection was carried out at each station using the line transect method [5]. Each station consists of 3 line transects with a transect line length of 100 meters for seagrass percent coverage observation. The observation of seagrass percent coverage on each transect line was done by using square size 0.5x0.5 m. Each square in transect lines was placed at a distance of 10 m [figure 2].

2.3. Biomass and carbon storage

Measurement of biomass and carbon content was carried out on seagrass species with high percent coverage. Seagrass species observed were *Enhalus acoroides* (Ea), *Thalassia hemprichii* (Th), *Cymodocea rotundata* (Cr), *Cymodocea serrulata* (Cs) and *Syringodium isoetifolium* (Si). Samples of seagrasses were cleaned to remove the attached epiphytes, then the samples were dried using an oven with a temperature of 60°C for 72 hours or until the weight remained constant, then the dry weight

was weighed and expressed as biomass in grams dry weight (g DW). Carbon storage was calculated by multiplying the seagrass biomass value with the percentage of carbon content, 40.9% for *E. acoroides*, 36.6% for *T. hemprichii*, 33% for *C. serrulata*, 40.9% for *T. hemprichii* and 34% for *S. isoetifolium* [6, 7].

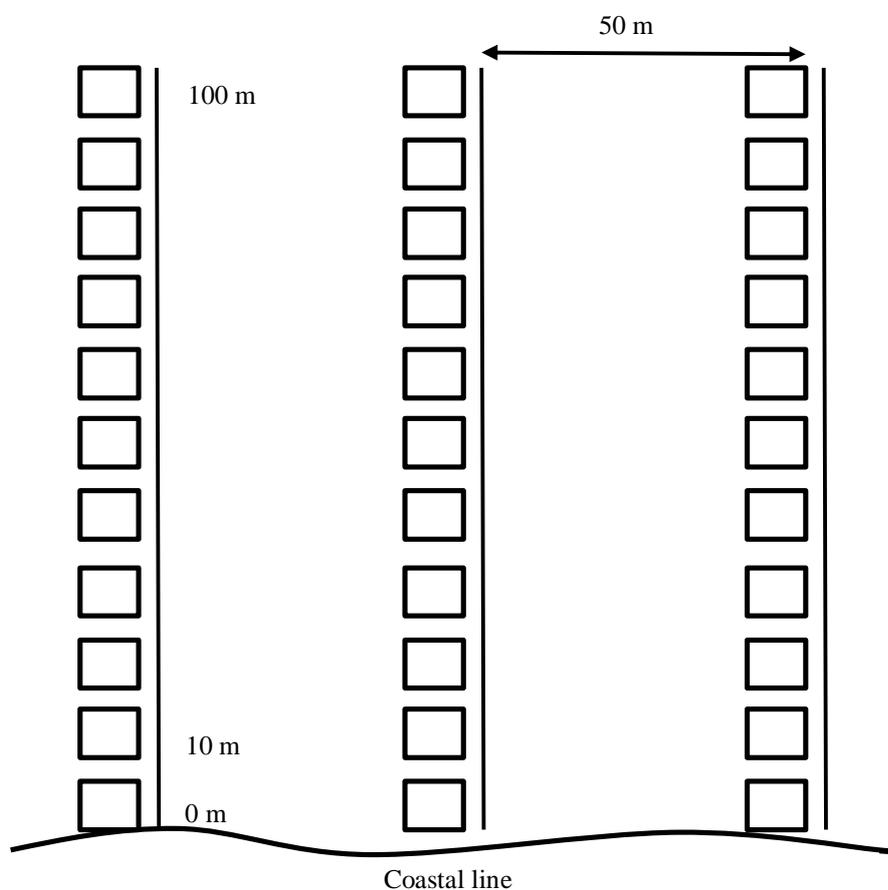


Figure 2. Illustration of seagrass observation transect.

3. Results and Discussion

3.1. Species distribution and seagrass coverage

Based on observations at two station in Teluk Bakau Village, eight seagrass species from two families were found in the seagrass ecosystem (table 1). Data in table 1 showed that seven seagrass species were found in Beralas Pasir Island and 5 seagrass species were found in Teluk Bakau Beach.

C. rotundata, *E. acoroides*, *T. hemprichii* and *S. isoetifolium* have high seagrass coverage at all stations compared to other types of pioneering seagrasses. Seagrass species with coverage at all stations are seagrasses dominate in the Indo-Pacific region [8]. *C. rotundata* has the highest seagrass percent coverage in all stations, the seagrass has a high adaptability to the environmental conditions of the waters [9]. Seagrass percent coverage at Beralas Pasir Island are 47.29% while seagrass percent coverage in Teluk Bakau beach is 29.21%. The seagrass percent coverage obtained shows that the condition of the seagrass ecosystems in all of the stations are in moderate condition [5]. Seagrass percent coverage is influenced by various factors such as topography, geography, physics, chemical water parameters and activities of people around the seagrass ecosystems [10]. Seagrass ecosystems that are close to mainland have low seagrass percent coverage, as well as seagrass percent coverage found on Teluk Bakau Beach, the large number of human activities and anthropogenic input result in a low seagrass percent coverage [3, 11].

Table 1. Distribution and coverage of seagrass species at observation stations.

| Type of seagrass | Seagrass distribution | |
|---------------------------|-----------------------|-------------------|
| | Beralas Pasir Island | Teluk Bakau Beach |
| Hydrocharitaceae | | |
| <i>E. acoroides</i> | 15.23% | 5.74% |
| <i>T. hemprichii</i> | 9.07% | 1.11% |
| <i>Halophila ovalis</i> | 0.09% | - |
| <i>Halophila minor</i> | 0.05% | - |
| Potamogetonaceae | | |
| <i>C. rotundata</i> | 15.97% | 20.60% |
| <i>C. serulata</i> | 1.48% | 1.16% |
| <i>Halodule uninervis</i> | - | 0.60% |
| <i>S. isoetifolium</i> | 5.40% | - |
| Total | 47.29% | 29.21% |

3.2. Biomass and carbon storage

The results of the measurements of biomass in each species of seagrass found at each observation station are shown in table 2.

Table 2. The values of biomass (g DW/m²) and its conversion into carbon values (g C/m²).

| Station | Type of seagrass | Above ground | | Below ground | | Total | |
|----------------------|------------------|--------------|--------|--------------|--------|--------------------------------|------------------------------|
| | | Biomass | Carbon | Biomass | Carbon | Biomass (g DW/m ²) | Carbon (g C/m ²) |
| Beralas Pasir Island | Ea | 18.85 | 7.71 | 38.50 | 15.75 | 57.35 | 23.46 |
| | Th | 7.50 | 2.75 | 4.54 | 1.66 | 12.046 | 4.41 |
| | Cr | 1.88 | 0.77 | 11.56 | 4.73 | 13.44 | 5.50 |
| | Si | 1.21 | 0.41 | 0.73 | 0.25 | 1.94 | 0.66 |
| Teluk Bakau Beach | Ea | 38.31 | 15.67 | 102.70 | 42.01 | 141.01 | 57.67 |
| | Th | 7.38 | 2.70 | 13.52 | 4.95 | 20.90 | 7.65 |
| | Cr | 12.38 | 5.06 | 33.28 | 13.61 | 45.66 | 18.67 |
| | Cs | 3.10 | 1.02 | 4.26 | 1.41 | 7.36 | 2.43 |

Based on the data shown in table 2 it can be seen that, each species of seagrass has a very high biomass value below ground compared to above ground biomass, and it is in accordance with the results of previous researches [7, 12, 13]. High seagrass biomass below ground is because of the material stored below ground is denser compared to the material above ground. Besides that, seagrass biomass above ground has faster turnover and is affected by the presence of grazing activities of the biota and impacted directly by human activities [14-16].

Carbon storage in seagrass species has a positive correlation with seagrass biomass value [7]. Based on table 2 it is known that seagrasses with large size like *E. acoroides* and *T. hemprichii* have a larger carbon storage than *C. rotundata* and *S. isoetifolium*, because seagrasses with larger size can accumulate more carbon [16]. The highest carbon storage is found below ground because seagrasses below ground have higher biomass than above ground biomass. Besides that, rhizome and root as part of seagrasses below ground have a slow growth rate than above ground seagrasses, which results in below ground biomass having a high potential to storage carbon in a long time [4].

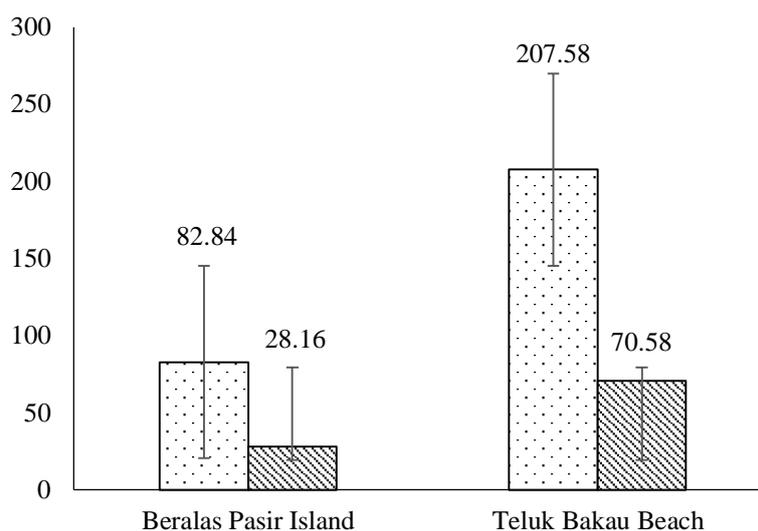


Figure 3. Total biomass and carbon storage in station observation, □ biomass (g DW/m²); ▨ carbon (g C/m²).

The estimated total seagrass biomass in Beralas Pasir Island was 84.77 g DW/m² with a total carbon storage of 34.02 g C/m², whereas in the Teluk Bakau Beach the estimated total seagrass biomass was 207.57 gr DW/m² with estimated total carbon storage of 86.43 gr C/m² [figure 3]. Teluk Bakau Beach has a greater biomass for each species compared to seagrass biomass located in Beralas Pasir Island. This affects the total biomass and carbon storage in seagrasses. The location of the Teluk Bakau station in the mainland area has a high nutrient content. Nutrients are one of the important factors that influence the amount of seagrass biomass [17].

4. Conclusion

There were eight seagrass species found in Teluk Bakau Village, which are *E. acoroides*, *T. hemprichii*, *H. ovalis*, *H. minor*, *C. rotundata*, *C. serrulata*, *H. uninervis*, and *S. isoetifolium*. Based on the percent coverage, seagrass conditions at all stations were in moderate condition. Environmental factors had a direct impact on seagrass percent coverage and seagrass carbon storage. Seagrass ecosystems in Teluk Bakau Beach (mainland) had a small percent coverage with a high seagrass carbon storage and those in Beralas Pasir Island (small island) has a high seagrass percent coverage with a low seagrass carbon storage.

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