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THE POTENTIAL OF CARBON STOCKS IN SEAGRASS MEADOW IN THE WATERS OF MRICAN BEACH, BATULAWANG BEACH AND LAENDRA BEACH, KEMUJAN ISLAND, KARIMUNJAWA ISLANDS

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ABSTRACT
Seagrass meadows in coastal ecosystems can absorb CO2 through photosynthesis. The results of carbon biomass absorption from the photosynthesis process of seagrass are stored in leaf, root, and rhizome tissues. This research aimed to determine the composition of seagrasses, determine the area of seagrass meadow which is useful for estimating the total carbon storage and the ability of seagrass meadow to absorb carbon at Mrican Beach, Batulawang Beach, Laendra Beach, Kemujan Island, Karimunjawa National Park. The research was conducted in September 2021. Data were collected at Mrican Beach (Stations 1 and 2), Batu Lawang Beach (Stations 3 and 4), and Laendra Beach (Stations 5 and 6), Kemujan Island. The 2017 seagrass meadow monitoring guide from LIPI was used as a reference for the seagrass data collection method and the Loss of Ignition (LOI) method was used to analyze carbon in seagrass. The results showed that three species of seagrass were found in the waters of Kemujan Island, namely Enhalus acoroides, Thalassia hemprichii, and Cymodocea rotundata. Seagrass density ranged from 167-490 Ind/m2. The carbon content at the research site ranged from 9.36-143.88 at the bottom of the substrate and 4.99-71.91 at the top of the substrate. Seagrass species E. acoroides had the highest carbon content of 310.79 gC/m2. Total seagrass carbon was around 26.66 MgC/Ha with a total seagrass area of 303.099 m2. The extent of carbon storage in seagrass could be used to support efforts to manage coastal ecosystems, especially seagrass meadows on Kemujan Island, Karimunjawa Islands.

KEY WORDS
Carbon, seagrass, Kemujan Island, Loss of Ignition (LOI).

Blue Carbon is carbon stored in coastal and marine ecosystems with the ability to absorb and store large amounts of carbon, one of which is found in the seagrass meadow ecosystem (Sidik and Krisnawati, 2017). Plants such as seagrass play an important role in the CO_2 reduction process through photosynthesis, where CO_2 is absorbed and converted into carbon in the form of biomass. Plants in shallow marine waters such as seagrass have a high potential for CO_2 absorption (Budiarto et al., 2021). Carbon biomass is absorbed from photosynthesis and stored in seagrass tissues (rhizome, roots, and leaves) (Ansari et al., 2020).

Seagrass biomass is a unit weight (dry weight or ash weight) of seagrass on plant parts above the substrate (leaves, sheath, fruit, and flowers) and/or below the substrate (roots and rhizomes) expressed in grams of dry weight per m^2 (gbk/m^2). The carbon in this biomass will be stored as long as the seagrass is still alive (Graha et al., 2016). According to Githaiga et al. (2017), seagrass meadow has the potential to absorb and store carbon around 4.88 tons/ha/year. The contribution of seagrass vegetation to carbon sequestration starts from the photosynthesis process which is then stored as biomass. Seagrass meadow is expected to provide a role as a CO_2 absorber in relation to reducing carbon emissions in the atmosphere. In addition, the condition of the seagrass meadow is relatively good, with a fairly high level of density and species diversity, and has great potential for carbon sequestration in the sea (Riniatsih and Endrawati, 2013).

Several studies on seagrass carbon in Karimunjawa Island have been carried out by

Hartati et al. (2018), Aji et al. (2020), Ratnasari et al. (2020). Karimunjawa waters contain 8 species of seagrass including E. acoroides, C. rotundata, and T. hemprichii. Considering the role of seagrasses for carbon sequestration is very important for the environment, so information on the ability of seagrasses in carbon absorption is very needed because the potential for seagrasses at the bottom of the substrate (rhizomes and roots) in carbon absorption will be stored longer and will continue to increase when the ecosystem is still intact. protected from natural and non-natural damage, while the upper part of the substrate (leaves) will usually be utilized in the food chain cycle (Ganefiani et al., 2019).

Based on this explanation, the objective of this research was to measure the type of seagrass found, the ability of each type of seagrass to absorb carbon, and determined the area of seagrass meadow used to estimate the total carbon stock in a seagrass meadow in the waters of Batulawang Beach and Mrican Beach, Kemujan Island. Karimunjawa Islands, Jepara Regency. The significance of this research is expected to be a reference to add scientific information about seagrass meadows and the role of seagrasses as carbon sinks in the waters of Kemujan Island. In addition, it can be used as a reference for future research related to seagrass meadow and their carbon stocks.

MATERIALS AND METHODS

The research was conducted in September 2021 at Mrican Beach, Batulawang Beach, and Laendra Beach, Kemujan Island, Karimunjawa Islands. The materials used in this research were samples of seagrass vegetation found on Mrican Beach (Stations 1 and 2) and Batulawang Beach (Stations 3 and 4) and Laendra Beach (Stations 5 and 6) Kemujan Island, Karimunjawa Archipelago (Figure 1). The data needed in this research included the type of seagrass, seagrass stands, seagrass meadow area, biomass value, and carbon content value contained in seagrass vegetation. The reference for collecting data on seagrass vegetation at the observation site used the 2017 LIPI Seagrass Monitoring Guide (Rahmawati et al., 2017). The area of the seagrass meadow was used to convert the total value of seagrass carbon stocks at the research location obtained through remote sensing using the Sentinel 2-A satellite image projection.

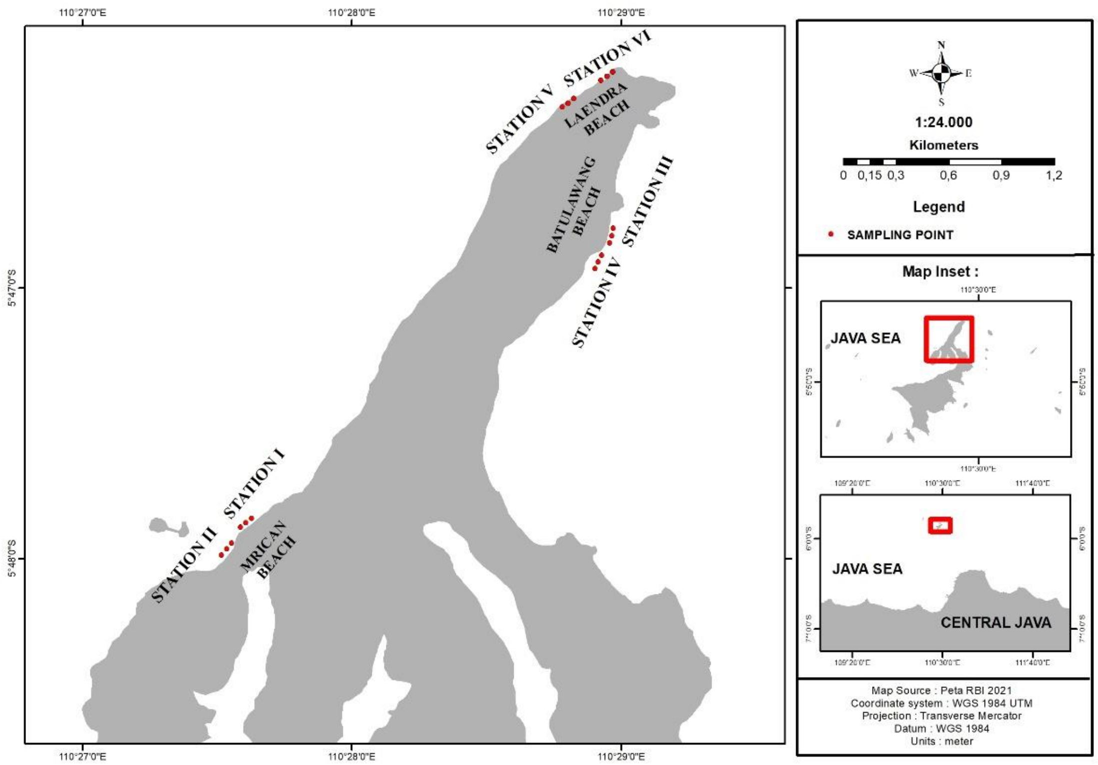

Figure 1 – Research Location Map

An analysis of seagrass samples was conducted at the Agricultural Technology Research Center (BPTP) Ungaran, Central Java, to determine the carbon value of the grass. Data collection was carried out directly by identifying seagrass species and counting seagrass stands (Rahmawati et al., 2017). Seagrass samples were collected using the coring method and will be used in the carbon content analysis (Samper-Villarreal et al., 2017). Measurement of biomass was carried out after drying of leaves, rhizomes, and roots of seagrass by using an oven at a constant temperature of 60°C for 4-5 hours (Supriadi et al., 2014). The biomass value was obtained using the equation of Graha et al., (2016). Carbon analysis using the LOI (Loss on Ignition) method on samples of leaves, rhizomes, and roots of seagrasses was used to remove organic matter content. Calculation of the value of ash content, the value of the organic matter, and the value of carbon content in seagrass tissue was calculated using the Helrich (1990) equation. Analysis of seagrass samples to determine the carbon value of seagrass was carried out at the Laboratory of the Agricultural Technology Research Center (BPTP) Ungaran, Central Java. The results of the calculation of the total converted carbon stock were then averaged in gC/m² units and multiplied by the area of the seagrass meadow at the observation site (Howwards et al., 2014).

RESULTS AND DISCUSSION

Based on observations, it found 3 types of seagrasses in the two research locations, namely: *E. acoroides*, *C. rotundata*, and *T. hemprichii*. Characteristics found in three types of seagrasses at the observation site were located on the coast to the sea with different distributions of seagrass. The results of these observations had similarities with the results of research from Wicaksono et al. (2012) and Dewi et al. (2021,) which state that the types of seagrasses that are often found in the waters of Karimunjawa Island are *E. acoroides*, *T. hemprichii* and *C. Rotundata*.

Seagrass density is the number of individuals occupying a certain area or area. The number of stands (ind) in one quadrant area is expressed in units (ind/m2). *T. hemprichii* had the highest density of 490 Ind/m^2 and *E. acoroides* had the lowest density with a value of 169 Ind/m^2 (Figure 2). Seagrass species that generally had large morphology such as *E. acoroides* tended to have a low-density level compared to seagrass species with a small morphology such as *C. rotundata* and *T. hemprichii* (Sumbayak et al., 2021). The species of *T. hemprichii* had a good adaptation strategy to its environment where the plant had fibrous roots that were able to colonize more densely in shallow habitats compared to other types of seagrasses (Suryanti et al., 2014). According to Ruswahyuni et al. (2013), *T. hemprichii* can live in all types of substrates that vary from coral fragments to soft substrates even in liquid mud, but is more dominant on hard substrates and can form a single community on coarse sand. Therefore, the seagrass species of Thalassia hemprichii had the highest number of stands because the substrate in the waters of Kemujan Island was coarse sand.

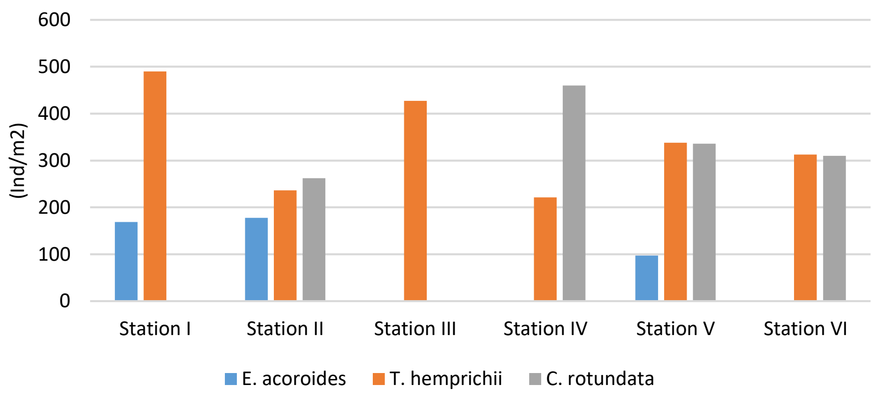

Figure 2 – Seagrass Density at Four Research Stations on Kemujan Island, Karimunjawa Island

Biomass is the total amount of living matter on the surface of a plant or tree and in some types of plants, biomass can be calculated by the dry weight of the plant (Supriadi et al., 2014). The obtained biomass values are grouped by tissue (leaves, rhizomes, and roots) as presented in Figure 3.

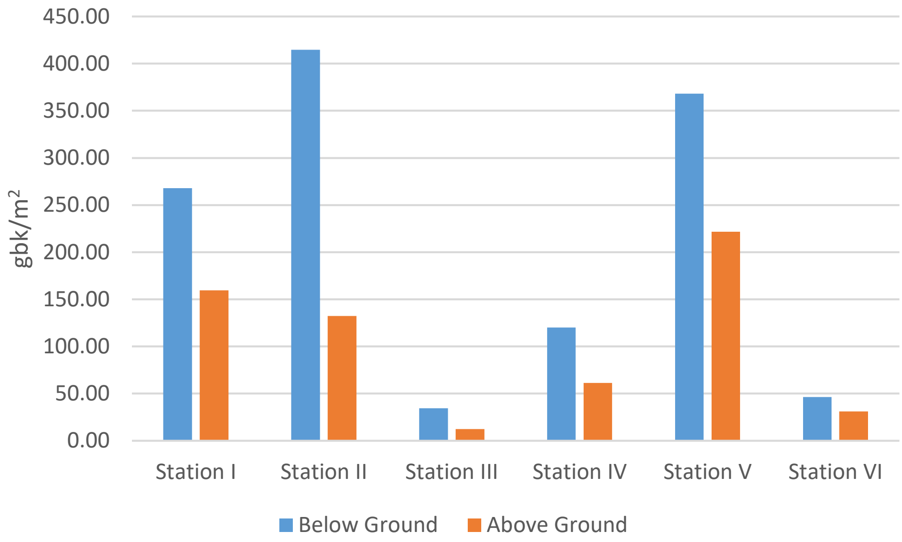

Figure 3 – Seagrass Biomass Value at Research Station on Kemujan Island, Karimunjawa Island

Based on Figure 3, the highest biomass value at the bottom of the substrate was at Station 2 at 414.63 gbk/m^2 and the lowest value was at Station 3 at 34.56 gbk/m^2. The highest biomass value at the top of the substrate was at Station V at 221.76 gbk/m^2 and the lowest value was at Station 3 at 12.26 gbk/m^2. The highest biomass values at Station 2 and Station 5 were because E. acoroides species had larger roots, rhizomes, and leaves when compared to other species. Station 3 had the lowest value because there were only T. hemprichii species.

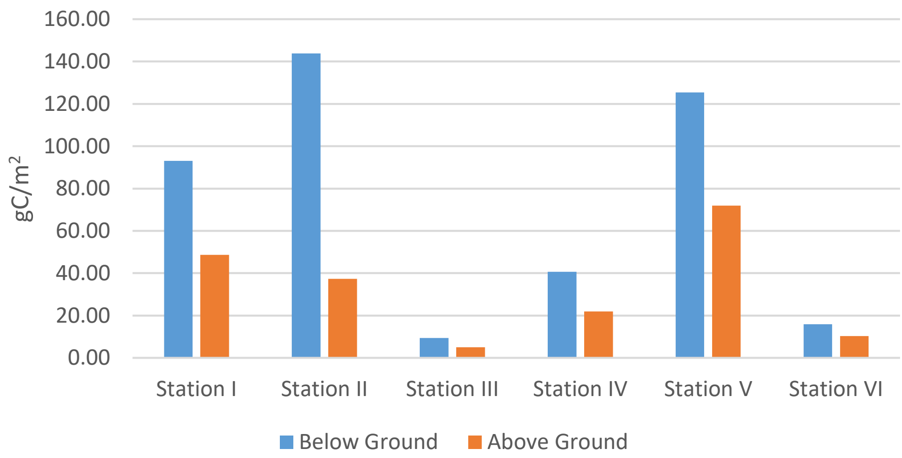

Figure 4 – Seagrass Carbon Value at Research Station on Kemujan Island, Karimunjawa Island

The above-substrate biomass value tended to be lower than the below-substrate biomass value. This was because the biomass value below the substrate was a combination of roots and rhizomes, while the biomass value above the substrate only consisted of leaves (Ganefiani et al., 2019). According to Kaya (2017), the part of the seagrass that absorbed the most nutrients from the substrate was the rhizome when compared to other parts of the seagrass organ because the rhizome contained the products of the photosynthesis process such as starch and pest elements that were stored at the bottom of the substrate. According to Indriani et al., (2017) the seagrass biomass value was influenced by the density value in a location and affected the growth rate of seagrass. The high density of seagrass from each species was directly proportional to the biomass produced, the higher the density of seagrass in water, the higher the biomass produced by the seagrass.

The carbon content of the seagrass was calculated based on the bottom tissue of the substrate (roots, rhizomes) and the top of the substrate (leaves) (Figure 4).

The carbon content of seagrass at the bottom of the substrate had the highest value at Station 2 of 143.88 gC/m^2 and the lowest value was at Station 3 with a value of 9.36 gC/m^2. The top of the substrate had the highest carbon content at Station 5 with a value of 71.91 gC/m^2 and the lowest value at Station 3 with a value of 4.99 gC/m^2. Based on the results of the calculation of the carbon content value, there was a relationship between the estimated carbon storage and seagrass biomass, so the carbon stock in the seagrass would increase in line with the increase in biomass (Indriani et al., 2017).

The results of the six research stations had different values of total carbon content that vary, one of the influencing factors was the difference in morphology of seagrasses found at the location. Seagrass species E. acoroides had the highest carbon content of other species with a total carbon content of 310.79 gC/m^2. According to Runtuboi et al. (2018), the value of carbon content in E. acoroides species was higher than other species because it had a larger morphology when compared to other seagrass species. The carbon content at the four stations on Kemujan Island ranged from 2.34-130.91 gC/m^2 which was lower than the study by Dewi et al., (2021) carbon content in seagrass ranged from 138–1.696 gC/m^2 on Kemujan Island, Karimunjawa Islands. Differences in these results were thought to be influenced by several factors such as the density of seagrass meadow, seagrass morphology, and environmental conditions of the waters found in the research location.

Plant morphology and characteristics of seagrass meadows can be important factors in the accumulation of organic carbon in seagrass ecosystems (Gillis et al., 2017). According to Graha et al. (2016), differences in carbon values caused variations in the value of carbon stock content in seagrass, and differences in carbon content concentrations between species and between tissues in the same seagrass species. The potential for long-term carbon storage between seagrass meadows and other seagrass meadows was not the same. The characteristics of the seagrass habitat would greatly affect the potential for carbon storage. (Mazarrasa et al., 2018).

Environmental stress factors and physiological processes also had an impact on carbon absorption in seagrass, respiration rate, and seagrass growth (Graha et al., 2016). Turbid water conditions would have an impact on decreasing the intensity of sunlight so it interfered with the photosynthesis process in seagrass (Tasabaramo et al., 2015). According to Sumbayak et al. (2021), waters with a depth of 2 to 4 meters with brightness reaching the bottom and far from human activities caused the seagrass meadow conditions to be better. This condition was a factor in the high carbon content in these waters.

Satellite images of Sentinel 2-A were used to measure the area of the seagrass meadow. The results of the image analysis showed that the area of each seagrass meadow is presented in Table 1. The total value of seagrass carbon in the highest seagrass area was at Mrican Beach, which was around 13,081 MgC/Ha. The total carbon storage of seagrass at the research site was 26.66 MgC/Ha with a seagrass area of 303.099 m2. This value was higher than the research of Septiyani et al., (2018), which stated that the total value of seagrass carbon content at the research site was 10.58 MgC/Ha. The difference was due to the total value of seagrass carbon content which was influenced by seagrass density, biomass, and the area of the seagrass meadow. The high carbon value in seagrass vegetation was thought to come from the absorption of nutrients carried out by seagrass roots and the results of photosynthesis carried out by seagrass leaves (Fifianingrum et al., 2020). According to Aji et al., (2020), the total biomass carbon in Indonesian waters can be greater than expected because the area of seagrass in several locations or areas has not been carried out by sustainable research. The total area of a seagrass meadow in Indonesia was estimated to have shrunk by 30-40% of the total area. If the area of seagrass meadow was reduced, it can reduce the ability of coastal and marine ecosystems to absorb carbon (Setiawan et al., 2012).

Table 1 – Total Seagrass Carbon in Kemujan Island, Karimunjawa Islands

Region	Seagrass meadows Area (m^2)	Seagrass Carbon Stock (gC/m^2)	Seagrass Meadow Carbon Stock (MgC/Ha)
Mrican Beach	80,999	161,45	13,08
Batu Lawang Beach	153,300	38,45	5,89
Laendra Beach	63.800	111.75	7.69
Seagrass total area	303.099	199,90	26.66

CONCLUSION

The waters of Kemujan Island, Karimunjawa Islands have three species of seagrass found, namely E. acoroides, T. hemprichii and C. rotundata. These waters are included in the poor category because they have seagrass density values ranging from 169-490 Ind/m^2. There are carbon contents ranging from 9.36-143.88 gC/m^2 at the bottom of the substrate and 4.99-71.91 gC/m^2 at the top of the substrate at the research site. Seagrass species E. acoroides has the highest carbon content of 310.79 gC/m^2. Total seagrass carbon is around 26.66 MgC/Ha with a total seagrass area of 303.099 m^2. Seagrass density has an effect on carbon storage in the seagrass meadow. In this research, we only calculated the potential for carbon storage of seagrass based on one sampling period, so further research is needed to measure the productivity of seagrass plants in carbon sequestration and determine fluctuations that occur between periods related to seasons.

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