Carbon stock, density, and biomass of seagrass in South Bangka, Indonesia

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Abstract. *Supratman O, Farhaby AM, Henri, Septiyati MU, Adi W. 2024. Carbon stock, density, and biomass of seagrass in South Bangka, Indonesia. Biodiversitas 25: 1736-1742.* As a component of the carbon ecosystem, seagrass meadows play a crucial role in preventing climatic change. The execution of Indonesian programs pertaining to carbon economic value, carbon trading, and other endeavors aimed at attaining the Nationally Determined Contribution (NDC) requires estimated data on seagrass carbon stocks. The present study investigates the seagrass density, vegetation carbon stock, and sediment carbon stock of South Bangka, Indonesia. The investigation is carried out in the following stages: i) data collection on-site, ii) laboratory sample analysis, and iii) data analysis. The accumulation of data on-site utilizes a square transect method, which includes the gathering of sediment, sample biomass, and density information. The carbon composition of sediment and seagrass vegetation is ascertained through laboratory analysis employing the Loss of Ignition (LOI) method. The investigation uncovered eight species of seagrass in South Bangka. *Cymondocea rotundata, Enhalus acoroides, Halophila ovalis, Halodule pinifolia, Halodule uninervis, Oceana serrulata, Siringodium isotifolium,* and *Thalassia Hemprichii* are the identified species of seagrass. In South Bangka, the combined carbon stock of seagrass (above and below ground carbon) varies between 0.049 ± 0.057 and 1.323 ± 1.581 Mg C Ha^{-1}. The range of sediment carbon is 110.53 ± 42.07 Mg Corg Ha^{-1} extrapolated to a depth of 1 m. The results of this study suggest that the seagrass meadows in South Bangka are characterized by a significant species diversity and effectively sequester carbon in the form of biomass and sediment. This supports the National Climate Change Mitigation Program for Blue Carbon Ecosystems, an initiative that seeks to mitigate the adverse effects of climate change by utilizing the carbon sequestration capabilities of mangrove forests, seagrass meadows, and tidal marshes.

Keywords: Seagrass biomass, seagrass ecosystem, sediment carbon stock, vegetation carbon stock

INTRODUCTION

Seagrass meadow is a high-level plant that occupies coastal or inter-tidal areas. Seagrass meadow offers many ecosystem services, including fish habitat, sediment traps, coastal protection, and pharmaceutical needs (Ambo-Rappe et al. 2013; Nordlund et al. 2016; McKenzie et al. 2021) . In addition, it can keep and absorb carbon (Wahyudi et al. 2020; Heckwolf et al. 2021). Therefore, the seagrass meadow ecosystem becomes an important part of the blue carbon ecosystem. Blue Carbon refers to organic carbon captured and kept by the ocean and coastal ecosystems, particularly vegetating coastal ecosystems, including seagrass, tidal marsh, and mangrove forest (Macreadie et al. 2019; Bulmer et al. 2020). This carbon comprises soil surface living biomass (leaves, branches, trunks), underground living biomass (root and rhizome), and non-living biomass (litter and dead woods) (Howard et al. 2014). The blue carbon ecosystem is important in aquatic carbon dynamics and significantly reduces global climatic change's impact (Bulmer et al. 2020; Stankovic et al. 2023).

Indonesia possesses the capacity to sequester carbon amounting to 3.4 gigatons, which is equivalent to roughly 17% of the blue carbon produced worldwide (Alongi et al. 2016). According to the findings of Wahyudi et al. (2020), the potential carbon stock of the seagrass ecosystem in Indonesia is estimated to be between 0.94 and 1.15 tons C ha^{-1} for vegetation and 558.35 tons C ha^{-1} for sediment. According to (Stankovic et al. 2021), the seagrass meadows in Indonesia have the capacity to emit 262.86-403.81Gg CO^2 annually, which is valued at an approximated $2.63-4.03 ($10^6$ US dollars). Furthermore, in contrast to terrestrial ecosystems, the carbon present in the sediment may persist within the seagrass meadow ecosystem indefinitely, spanning centuries to even millennia (Macreadie et al. 2019). Consequently, the seagrass meadow ecosystem is crucial for potential climate change mitigation carbon absorption. Regrettably, human activities have led to a significant degradation of the seagrass meadow ecosystem (Waycott et al. 2009; Murphy et al. 2022).

The impact of anthropogenic activity has caused a degrading ecosystem of seagrass meadow of about 5% per year, with an estimated reduction of seagrass area in Indonesia of approximately 24.702,27 Ha per year (Waycott et al. 2009; Stankovic et al. 2021). Particularly in the Bangka Belitung Islands, specifically in South Bangka, tin mining activity in the sea has contributed to massive

destruction and degradation of seagrass meadow, subsequently triggering a reduced function of seagrass as carbon storage (Dahl et al. 2016; Sari 2019). The seagrass meadow ecosystem is important in carbon storage and climate change mitigation (Serrano et al. 2021). Nevertheless, there is currently a scarcity of studies on the estimated carbon stored in seagrass meadows, in contrast to the extensive studies undertaken on mangrove ecosystems (Chen et al. 2017; Mazarrasa et al. 2018; Stankovic et al. 2023). Several researches on mangrove carbon in Bangka Belitung have been conducted in almost all Bangka Belitung regions with many different research themes (Utami and Mahardika 2019; Sari et al. 2023; Henri et al. 2024). The only reported research on estimated carbon stock in Bangka Belitung was conducted by Sartini et al. (2021). However, these researches have limited coverage and do not discuss the carbon stocks of vegetation, carbon per seagrass species, and seagrass sediments.

The data on estimated seagrass carbon stock is particularly important to support Indonesian programs for carbon economic value, carbon trading, and any other activities to achieve Nationally Determined Contribution (NDC). In addition to one of the Indonesian government's efforts to achieve targeted Folu Net Sink 2030 through dioxide carbon absorption from the atmosphere in net amount including seagrass blue carbon ecosystem. By calculating the carbon stock in the seagrass ecosystem, it is possible to assess the carbon sequestration potential and track its contribution to carbon sequestration targets in the seagrass ecosystem. Therefore, it is important to perform research on density, biomass, and carbon stock of seagrass especially in Bangka Belitung.

MATERIALS AND METHODS

Study area and period

The research is conducted from March 2023 to December 2023 in South Bangka District, Bangka Belitung Islands, Indonesia. The research location encompasses Kumbung (2.9010 S; 106.7877 E), Penutuk (2.9941 S; 06.7639 E), Puding (2.9919 S; 106.6846 E), Tanjung Kerasak (3.0716 S; 106.7343 E), Tanjung Labu (2.9415 S; 106.9080 E), Tanjung Ru (3.0183 S; 106.7400 E), Tanjung Sangkar (2.8958 S; 106.7897 E), and Tukak (2.9708 S;106.6540 E). The research location is determined based on the distribution of the seagrass ecosystem in South Bangka. The map of research location is provided in Figure 1.

Data collection procedure

Seagrass density

The seagrass density is taken using the square transect method. The square used for *enhalus* species is 50 x 50 cm. Non-*enhalus* species adopt 25 x 25 cm square (Rahmawati et al. 2019). Sample seagrass density collection is conducted by calculating the number of seagrass stands per species in the observation square. Seagrass density collection is conducted in plots 0 m, 30 m, 60 m, and 90 m on each line transect (Figure 2), and the detailed collection of seagrass density data is based on a reference from Rahmawati et al. (2019). The identification of seagrass species is done by comparing the morphological characteristics of seagrasses with identification guides Rahmawati et al. (2017).

Biomass and carbon of seagrass vegetation

Seagrass biomass sample is taken in square observation plots 0 m, 30 m, 60 m, and 90 m in each transect (Rahmawati et al. 2019) (Figure 2). The seagrass biomass comprises two parts: above substrate comprising leaf sheaths and strands and below substrate comprising roots and rhizomes. The seagrass biomass sample from the field is cleaned of substrate and attaching organisms. The cleaned sample seagrass is separated between upper and lower biomass and weighted to obtain the biomass value. The seagrass vegetation carbon is determined based on the biomass result and conducted using the Loss of Ignition (LOI) method (Howard et al. 2014; Rahmawati et al. 2019), a method principally aimed at removing organic materials through an ignition process in a furnace.
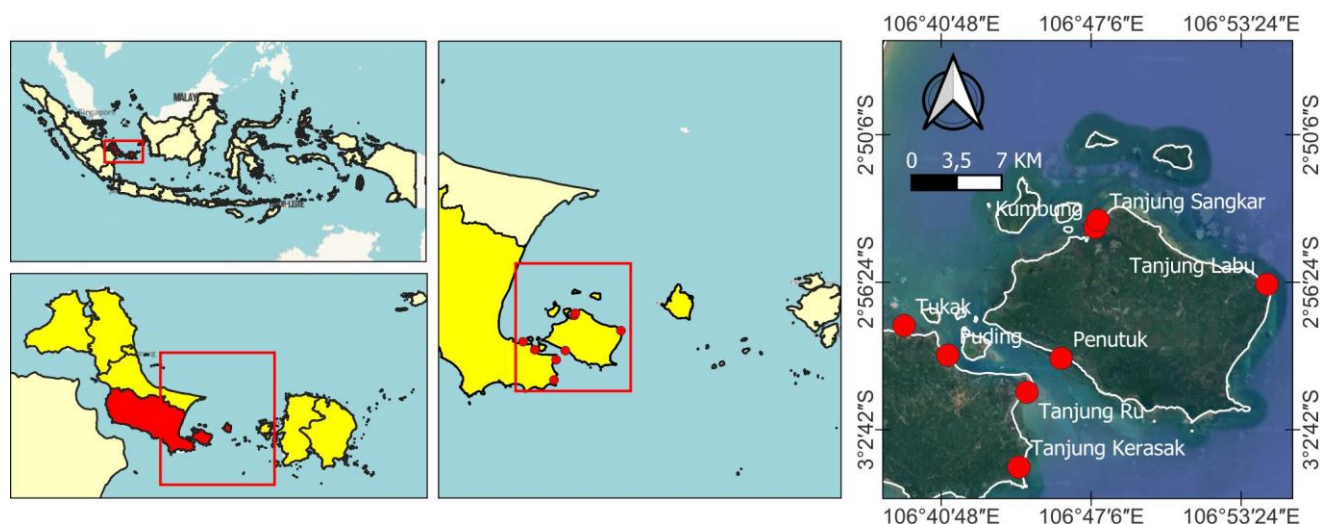
Figure 1. Seagrass research location in South Bangka, Bangka Belitung Islands, Indonesia

Sediment carbon

A tool used to collect the sediment sample is the sediment core. The sediment core is made of iron with 100 cm of length with 2.54 cm of diameter. The sample sediment is collected in plots 0 m, 50 m, and 100 m on each line (Rahmawati et al. 2019). The sample carbon collection in the sediment is performed based on the reference from Howard et al. (2014).The sample sediment is collected by putting the sediment core into the substrate through the maximum limit. The sample collected is divided by 5 cm and kept in a sample plastic for laboratory analysis. The sample sediment is dried in the laboratory, weighted for dry bulk, and burnt in a furnace to calculate the percentage of organic using the LOI method (Howard et al. 2014; Rahmawati et al. 2019).

Data analysis

The seagrass density is determined based on the number of stands per species divided by the number of observation plots (Rahman et al. 2018; Rahmawati et al. 2019). The seagrass biomass is calculated per species of seagrass found in the research location. The biomass is calculated by dividing the dry weight with the number of seagrass stands per species which is determined based on the reference from Rahmawati et al. (2019). Seagrass vegetation carbon is determined using the LOI method. The LOI method measures the organic material lost due to high-temperature combustion. The LOI results are then determined by the % Corg value using the equation from Howard et al. (2014). The sediment carbon is calculated based on the result of the guide and equation from (Howard et al. 2014). The sediment carbon is determined based on the Dry Bulk Density (DBD) value, % Corg and depth interval (Rahayu et al. 2023). Total sediment carbon of one core is determined by summing up all sediment carbons in each interval, then converted, and uniformed through the depth of 1 meter.

inter-tidal areas to the highest points of reefs. They also exhibit a great tolerance to fluctuations in salt levels, as observed by Fitrian et al. (2017). The *H. pinifolia* species exhibits the highest density in comparison to other species. Simultaneously, the species with low density is *E. acoroides*; the substantial size of its physical characteristics contributes to the low density of this species, thereby limiting the number of stands that occupy the area. Nevertheless, this particular seagrass possesses a substantial amount of biomass.

Biomass refers to the total mass of living matter in plants, which can be assessed by measuring the weight of plants after they have been dried (Rahmawati et al. 2019). The seagrass biomass is determined based on both Above-Ground Biomass (AGB) and Below-Ground Biomass (BGB). The above-ground biomass comprises leaf blades and petioles, while the below-ground biomass includes rhizomes and roots. The value of above-ground biomass in seagrass ranges from 3.67 ± 2.77 to 111.44 ± 89.15g DW m^{-2}. On the other hand, the below-ground biomass ranges from 11.36 ± 8.85 to 340.17 ± 165.08 g DW m^{-2}. The result indicates that the value of the below-ground biomass is higher than that of the above-ground biomass. This is the same as the research result Fourqurean et al. (2012), showing that two-thirds of seagrass biomass is buried in rhizome and root sediment. High below-ground biomass is caused by the seagrass rhizome and root spreading with extensive coverage. The total value of biomass resulting from summing up the above-groundand below-ground biomass is in the range from 15.04 ± 11.63 to 440.27 ± 268.27g DW m^{-2}. The highest value of biomass is found in Penutuk with 440.27 ± 268.27g DW m^{-2}, followed by Tanjung Sangkar (406.26 ± 202.61g DW m^{-2}), and the lowest biomass in Puding with value of 15.40 ± 11.63g DW m^{-2} (Table 1). The results of the anova test of seagrass biomass at the study location showed no significant difference (*p = 0.59*).

RESULTS AND DISCUSSION

Seagrass density and biomass

The research shows that eight species of seagrass are found in South Bangka. The species of seagrass found includes *Cymondocea rotundata* (Cr), *Enhalus acoroides* (Ea), *Halophila ovalis* (Ho), *Halodule pinifolia* (Hp), *Halodule uninervis* (Hu), *Oceana serrulata* (Os), *Siringodium isotifolium (Si)*, and *Thalassia Hemprichii (Th)*. The species of seagrass with the highest density include *C. rotundata* and *H. ovalis* (Figure 3). Meanwhile, the species with the lowest density includes *E. acoroides*, reaching 25.6 ± 23.9 shoot m^{-2}. Factors determining the density difference in each seagrass species include seagrass morphology, adaptation ability, substrate texture, water transparency, and water depth.

The abundance of *H. pinifolia* species is attributed to its compact form, which allows for a greater number of individuals to occupy a given space in comparison to larger species. Furthermore, the *H. pinifolia* species can be found in a wide range of environments, ranging from muddy
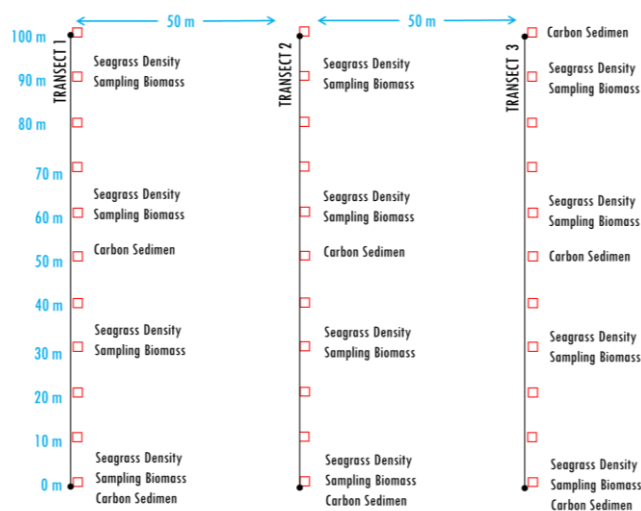

Figure 2. Seagrass condition and carbon stock observation design

Some factors, including density, coverage, seagrass species, habitat characteristics, substrate texture, water transparency, and nutrients, influence seagrass biomass in each research location. The density of seagrass has a direct impact on its biomass, since a higher density results in a greater amount of seagrass biomass (Cabaço et al. 2013; Maulita et al. 2023). The biomass is calculated by multiplying the dry weight of the seagrass by its density. However, according to the findings shown in Table 1, it is evident that not all areas with high population density are accompanied with high density. The seagrass biomass is determined by the morphological size. The seagrass species with the largest morphology is *E. acoroides*. The biomass will also be greater when compared to seagrass species with a tiny morphology, such as *H. pinifolia*, *H. ovalis*, and *C. rotundata*. The maximum density may be noticed in Kumbung, surpassing that of Tukak, Penutuk, Tanjung Kerasak, Tanjung Sangkar, and Tanjung Labu. Nevertheless, the overall amount of seagrass biomass is comparatively lower in relation to the locations mentioned in Table 1. The reason for this is that the prevailing species in Kumbung is *C. rotundata*, which has a smaller physical stature.

The seagrass biomass significantly influences the carbon stock in the ecosystem of the seagrass meadow. The higher the biomass is, the higher the carbon stock of seagrass will be. The data on seagrass biomass is particularly important because this is used to calculate and determine the carbon stock in the seagrass vegetation (Howard et al. 2014; Rahmawati et al. 2019). In addition, the seagrass biomass data can be used to determine the carbon stock on sediment, above-ground, and below-ground using the equation developed by Wahyudi et al. (2020). However, this research determines the parameter using the LOI method commonly used in previous research (Samper-Villarreal et al. 2016; Bañolas et al. 2020; Maulita et al. 2023). Therefore, with biomass data, the determination of seagrass carbon stock may be a consideration in upcoming research because the execution is faster and cheaper without the laboratory analysis compared to the LOI method. According to Rahmawati et al. (2019), the allometric method with equations is the last alternative for calculating seagrass carbon stock. This is because this method is less accurate than the LOI or CHN (Carbon, Hydrogen, Nitrogen) analyzer method.

Organic carbon content in seagrass

The organic carbon content shows seagrass's ability to bind CO_2 from the air. The bigger the carbon stock value in an ecosystem, the better it will be because it can significantly contribute to mitigating climate change. The carbon content may be interpreted as the amount of carbon that the seagrass can absorb in the form of biomass. The analysis shows that the total carbon stock (above-ground and below-ground carbons) of seagrass in the above portion ranges from 0.049 ± 0.057 to 1.323 ± 1.581 Mg C Ha^{-1} (Table 2). The research result indicates that the carbon content in the below-ground substrate is higher due to accumulated and locked carbon in the sediment. The high carbon stores below-ground are caused by seagrass biomass storage systems, where most seagrass species tend to store more biomass below-ground when compared to above-ground (Watiniasih et al. 2021). In addition, the parts of seagrass below ground have slow growth and turnover and are more resistant to decay, thereby contributing to higher carbon sediments over time (Dahl et al. 2016; Husodo et al. 2017).

The carbon content in seagrass depends on the species of seagrass (Watiniasih et al. 2021; Samper-Villarreal et al. 2022). Each species of seagrass typically has a different ratio of carbon content (Stankovic et al. 2017). In addition to biomass in calculating organic carbon content using this equation model, the density and coverage become a variable affecting seagrass carbon content's value. The high value of density and coverage in almost all observation stations impacts the high carbon content in the research location. The density and coverage of seagrass are high because most observation stations are still natural and have little human activity encroachment. Therefore, the seagrass ecosystem in this region is more sustainable, resulting in no difference in total carbon content value.
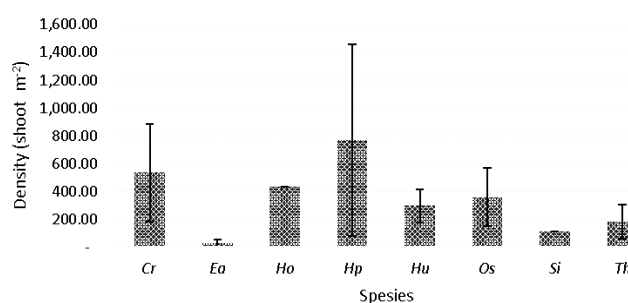

Figure 3. Seagrass density per species in South Bangka, Indonesia

Table 1. Density andseagrass biomass in South Bangka, Indonesia (means± SD)

Location	Density (Shoot m^{-1})	Above-Ground Biomass (g DW m^{-2})	Below-Groundbiomass (g DW m^{-2})	Total Seagrass Biomass (g DW m^{-2})
Kumbung	674.09±337,12	62.40 ± 24.41	47.60±31.11	110.01±55.52
Penutuk	139.64±170.21	111.44 ± 89.15	328.82±179.12	440.27±268.27
Puding	5.33±2.07	3.67 ± 2.77	11.36±8.85	15.04±11.63
Tanjung Kerasak	628.57±470.70	50.16 ± 11.25	126.7±49.89	176.86±61.15
Tanjung Labu	165.00±168.21	58.78 ± 27.96	236.02±201.42	294.81±229.38
Tanjung Ru	8.00±3.58	8.30±8.83	52.88±25.16	61.18±34.00
Tanjung Sangkar	122.25±148.93	66.08±37.533	340.17±165.081	406.26±202.61
Tukak	123.11±131.12	47.47±18.051	182.83±118.60	230.31±136.65

The value of carbon stock in the observation stations, the difference in condition, and aquatic characteristics or differences in seagrass meadow ecosystem condition in the observation stations will affect the value of carbon stock belonging to a location. The species of seagrass with the highest value of carbon content includes *C. rotundata* with 22.83 Mg Corg Ha^{-1}, and the species with the lowest value are *H. ovalis* with (0.33 Mg Corg Ha^{-1}) and *S. isotifolium* (0.43 Mg Corg Ha^{-1}) (Figure 4). The high carbon content of *C. rotundata* is caused by the high density owned by this species. In addition, the plants' morphology and seagrass meadows' characteristics may become important factors in organic carbon accumulation (Stankovic et al. 2017; Samper-Villarreal et al. 2022). Seagrass morphology has a greater ability to store carbon in vegetation and sediments (Stankovic et al. 2017).

The seagrass carbon stock in South Bangka is still lower than the global carbon stock, which reaches 2.52 ± 0.48 Mg Corg ha^{-1} (Fourqurean et al. 2012). The range of carbon stock in Indonesia is between 0.94-1.15 Mg Corg ha^{-1} and 0.57 Mg Corg Ha^{-1} in Bangka Belitung (Wahyudi et al. 2020, 2022). The very low vegetation carbon stock in South Bangka falls within Puding and Tanjung Ru; the low stock of vegetation carbon in these locations is influenced by low seagrass density (Table 1). The density and coverage particularly determine the carbon content of seagrass because the vegetation carbon stock originates from the biomass of plants that live in the upper or lower biomass of the plant. The vegetation carbon content in Puding and Tanjung Ru is the lowest, but the sediment's carbon stock is relatively high compared to other locations (Table 3). This might be caused by seagrass degradation in these locations, making the seagrass die and subsequently accumulate in the substrate, forming organic materials and carbon. Sando et al. (2022) revealed seagrass stand in Tanjung Ru ranges from 41.61 to 98.87 shoot m^{-2} and coverage of 5.6 to 27.37%; therefore, compared to this research at the same location in Tanjung Ru, the seagrass density was only 8.00 ± 3.58 shoot m^{-2} (Table 1). During the previous research, the seagrass condition in Puding Beach has a density of 233.9 shoot m^{-2} and coverage of 31.39% (Supratman and Adi 2018). This research shows that the stand is only 5.33 ± 2.07 shoot m^{-2} at Puding (Table 1). In addition, Tanjung Ru and Puding's observation result indicates very high sedimentation with very muddy substrate. However, further study is required to investigate the seagrass damage resulting from sedimentation. Furthermore, according to Reyes et al. (2022), the obstructed locations will impact the seagrass vegetation and carbon content on either biomass or lower biomass.

Sediment carbon stock in seagrass

The seagrass meadow ecosystem can accumulate organic materials from within or out of the seagrass ecosystem, forming a sediment layer. The sediment carbon content in South Bangka reaches 41.95 ± 33.66 to 110.53 ± 42.07 Mg Corg Ha^{-1} (Table 3). The depth of organic carbon collected varies according to the ability of the sediment core to go through the substrate. However, to adjust with the global or domestically conducted research, the depth of sediment carbon is converted into 1 meter (Fourqurean et al. 2012; Rahayu et al. 2023). The highest organic carbon content may be found in Tukak, with 110.53 ± 42.07 Mg Corg Ha^{-1}, Tanjung Labu (95.29 ± 40.69), and Puding (94.59 ± 49.14). On the other hand, the lowest carbon content can be found in Kumbung (41.95 ± 33.66) (Table 3). Anova test results of seagrass sediment carbon at each location there was no significant difference ($p = 5.1$).
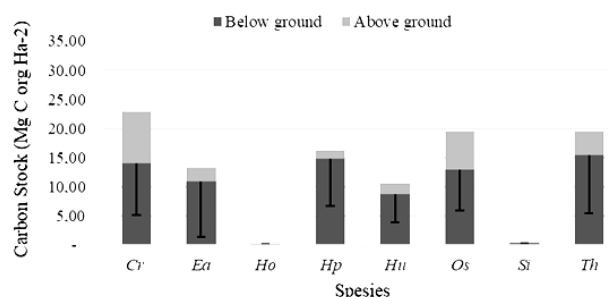

Figure 4. Carbon stok per spesies in South Bangka, Indonesia

Table 2. Total carbon content in seagrass (±SD)

Location	AGCB (Mg C Ha^{-1})	BGCB (Mg C Ha^{-1})	Total carbon content (Mg Corg ha^{-1})
Kumbung	0.199±0.084	0.159±0.101	0.358±0.442
Penutuk	0.317±0.258	1.006±0.589	1.323±1.581
Puding	0.011±0.008	0.038±0.029	0.049±0.057
Tanjung Kerasak	0.151±0.035	0.37±0.166	0.521±0.556
Tanjung Labu	0.167±0.069	0.663±0.555	0.83±0.899
Tanjung Ru	0.023±0.024	0.175±0.088	0.198±0.222
Tanjung Sangkar	0.184±0.118	1.075±0.679	1.259±1.378
Tukak	0.142±0.054	0.548±0.371	0.69±0.744

Note: AGCB: Above-ground carbon biomass, BGCB: Below-ground carbon biomass

Table 3. Total organic matter, dry bulk density and carbon stock sediment (±SD)

Location	Total organic matter (%)	Dry bulk density (gcm^{-3})	Sediment carbon stock extrapolated
Kumbung	1.45±0.82	1.17±0.2	1.95±33.66
Penutuk	2.22±0.62	1.12±0.3	74.37±32.64
Puding	2.96±1.37	1±0.15	94.59±49.14
Tanjung Kerasak	2.52±0.6	1.01±0.08	80.12±23.63
Tanjung Labu	3.56±1.4	0.8±0.16	95.29±40.69
Tanjung Ru	2.8±2.4	1.12±0.26	91.88±83.84
Tanjung Sangkar	1.91±0.94	1.14±0.16	62.72±41.98
Tukak	3.02±1.06	1.15±0.23	110.53±42.07

This research shows that the density of seagrass, biomass, and vegetation carbon does not determine the amount of carbon in the sediment. This is because the sediment carbon in the seagrass meadow originated from seagrass plants or other dead organisms that were accumulated and kept in the sediment. In addition, unlike the terrestrial ecosystem, the carbon that is kept in the sediment remains trapped in the seagrass meadow ecosystem for centuries or thousands of years (Macreadie et al. 2019). This produces low-density and biomass locations with high sediment carbon, such as in Puding Beach and Tanjung Ru. Previously, both locations were full of seagrass meadows with relatively good density and coverage (Supratman and Adi 2018; Sando et al. 2022). Unfortunately, this research found that the density and biomass of seagrass are very low due to seagrass degradation. The deed seagrass biomass will be accumulated and kept inside the sediment fora long period, although the condition of the seagrass meadow has been degrading. The highest content of sediment carbon is found in Tukak. Since the mangrove ecosystem grows well in Tukak, the carbon content in the sediment is high. The mangrove ecosystem near the seagrass meadow has contributed to increased organic carbon materials by about 20.5% (Rahayu et al. 2023).

The research result shows that the sediment carbon in South Bangka is still lower compared to global carbon, which is 194.2 ± 20.2 Mg C Ha^{-1} (Fourqurean et al. 2012; Rahayu et al. 2023), but it still complies with the national range which is 61.38 - 104.80 Mg C Ha^{-1}(Stankovic et al. 2021). Although some locations are not included in the national range, the value is not too different. The maximum carbon content in the sediment in South Bangka (110.53 ± 42.07 Mg C Ha^{-1}) is higher than in different regions. For example, the carbon content is 71.08 Mg C Ha^{-1} in Spermonde, 103.8 Mg C Ha^{-1} in Riau Islands, 20.61 Mg C Ha^{-1} in Lembeh, and Sangihe 36.08 Mg C Ha^{-1} in Sangihe (Rahayu et al. 2023). However, this result is lower than that in the conservation area or Marine Protected Area (MPA) of Nusa Lembongan, with a carbon stock of 117.4 Mg C Ha^{-1} (Rahayu et al. 2023). The condition of seagrass beds in conservation areas is better than in non-conservation areas because the risk of ecosystem degradation due to human activities is higher in non-conservation areas. Conservation efforts have the potential to enhance the well-being of aquatic ecosystems, such as seagrass meadows (Liu et al. 2023). Hence, a robust and thriving seagrass meadow ecosystem will result in a substantial capacity for carbon absorption and storage. This syndrome has a high potential for mitigating climatic change.

The seagrass ecosystem plays a vital role in carbon sequestration by storing organic carbon, which has a large impact on the global carbon cycle. The research findings suggest that seagrass beds in South Bangka contain a significant quantity of carbon, present in both the seagrass biomass and sediments. This supports the National Climate Change Mitigation Programme for Blue Carbon Ecosystems, which seeks to utilise the carbon storage capacity of mangrove forests, seagrass beds, and tidal marshes to alleviate the effects of climate change. This programme is in line with government efforts to establish the economic value of carbon, as outlined in Presidential Regulation Number 98 of 2021. It also aligns with international agreements such as the Paris Agreement and Nationally Determined Contributions (NDC) (Taillardat et al. 2018; Arifin et al. 2023). Seagrass conditions in South Bangka are under threat from both human activities and natural reasons, leading to a decrease in their ability to operate as carbon sinks (Dahl et al. 2016; Supratman and Adi 2018). Hence, the restoration and protection of seagrass ecosystems in South Bangka can enhance efforts to mitigate climate change.

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