

CARBON STORED ON SEAGRASS BEDS IN GILI MARINGKIK, LOMBOK, INDONESIA

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Received 2 July 2022/Accepted 18 February 2023

ABSTRACT

Seagrass are among important vegetation as carbon mitigation in coastal areas as an effort to reduce the impact of global warming. This study aims to determine the composition of seagrass species, density, coverage percentage, biomass content of seagrass species, C-organic content of seagrass and C-organic content of sediments found under stands of seagrass ecosystems. The research was conducted in the small island of Gili Maringkik, Lombok, Indonesia. The research included observation of seagrass species composition. The samples were collected from 0.5 × 0.5 m plot area. The total plot area was 25 arranged on five lanes with 25 m space between plots and 100 m between lanes on the research area of 31.82 ha. Our research found eight seagrass species (two families, six genera) namely: *Cymodocea rotundata*, *Cymodocea serrulata*, *Enhalus acoroides*, *Halodule pinifolia*, *Halophila minor*, *Halophila spinulosa*, *Syringodium isoetifolium*, and *Thalassia hemprichii*. The highest density value (stand/m²) was found in *C. rotundata* (506.40 ± 187.809) and the lowest was found in *C. serrulata* (6.24 ± 5.401). The highest cover percentage value (%) was found in *T. hemprichii* (36.52 ± 30.004) and the lowest was found in *H. pinifolia* (0.28 ± 4.766). The total biomass content (g DW/m²) of Gili Maringkik seagrass was 1081.85 g DW/m² with the highest total biomass content was found in *E. acoroides* (463.41) and the lowest was found in *H. pinifolia* (12.41). The carbon stock of the seagrass beds was found to be 483.86 g C/m², while the range of carbon stock in substrate of the seagrass beds ecosystem was 0.09 – 0.49 or with an average of 0.30 ± 0.108%. The estimated total carbon stock of Gili Maringkik seagrass ecosystem in the area of 31.82 ha was 153.96 ton C or was equivalent to 4.84 ton C/ha.

Keywords: biomass, carbon sink, carbon stores, seagrass beds, substrate

INTRODUCTION

Industrial revolution, which happens in the last few decades, causes the increase of greenhouse gases emissions, such as carbon dioxide (CO₂), methane (CH₄), nitrogen dioxide (NO₂) and Chlorofluorocarbons (CFC). The increased emissions contribute to global warming which has an adverse impact on environment, among others are the increase of earth temperatures earth, the rise of sea level rise, drought, changes in hydrological cycle, and climate change (Irawan 2017; Rivera-Monroy *et al.*

al. 2017; Rahman *et al.* 2019; Jannah *et al.* 2021; Rahman & Hadi 2021). This condition is further exacerbated by the minimum efforts of forest conservation, although forest conservation plays an important role in the development of carbon mitigation areas as an alternative to absorb emissions in the atmosphere.

The development of carbon mitigation area in Indonesia is still focused on terrestrial forests and mangrove forests, while the potential utilization of seagrass ecosystems, also known as blue carbon, has not been widely studied (Murdiyarso *et al.* 2015; Alongi *et al.* 2016; Mazarrasa *et al.* 2018; Rahman *et al.* 2019; Costa *et al.* 2019; Hilyana & Rahman 2022), especially

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on the potential of seagrass beds in small-island areas in Indonesia.

The use of seagrass beds as carbon sinks and carbon storage can be done through the mechanism of photosynthesis. Results of photosynthesis can be stored as biomass that can last for thousands of years (Miyajima *et al.* 2015; Phang *et al.* 2015; Jiang *et al.* 2017; Ricart *et al.* 2017; Sophianto *et al.* 2020; Monnier *et al.* 2021, 2022; Codur *et al.* 2022). The photosynthesis results make seagrass beds become one of the richest carbon sinks and carbon storage in the biosphere, which average capacity of carbon storage in seagrass is greater (4 tons/ha/yr) compared to the total average carbon storage of terrestrial forests (1.8 - 2.7 tons/ha/yr) (Lewis *et al.* 2009; Murray *et al.* 2011; Alongi 2014; Marbà *et al.* 2018).

Meanwhile, information on carbon stocks of seagrass beds found in the coastal ecosystems of small Indonesian islands is still lacking, especially on Lombok Island, West Nusa Tenggara Province. Several previous studies in the coastal area of Lombok Island are still focused on the interaction of seagrass beds with marine biota, distribution and diversity of seagrass species, seagrass conservation status

and analysis of seagrass damage (Rahman *et al.* 2018; Syukur *et al.* 2020; Syukur *et al.* 2021; Zulkifli *et al.* 2021).

Conservation and utilization of seagrass surrounding Lombok Island (2,313.2 ha) is important for implementing the Indonesian blue carbon concept. Therefore, information on the carbon stock of Gili Maringkik seagrass beds can be used as comparison data with seagrass ecosystems in Indonesia and other tropical coastal areas in the world at different characteristics and locations. This study aims to determine seagrass species, density, coverage percentage, biomass, C-organic content of seagrass beds, C-organic content of seagrass ecosystem substrates, and estimation of carbon stock of seagrass ecosystems in Gili Maringkik, Lombok, Indonesia.

MATERIALS AND METHODS

Geographically, Gili Maringkik is a small island in the southern part of East Lombok and located at 116°37' - 116°45' E and 8°17' - 8°18' S. The island has 31.82 ha potential seagrass ecosystem (Fig 1).

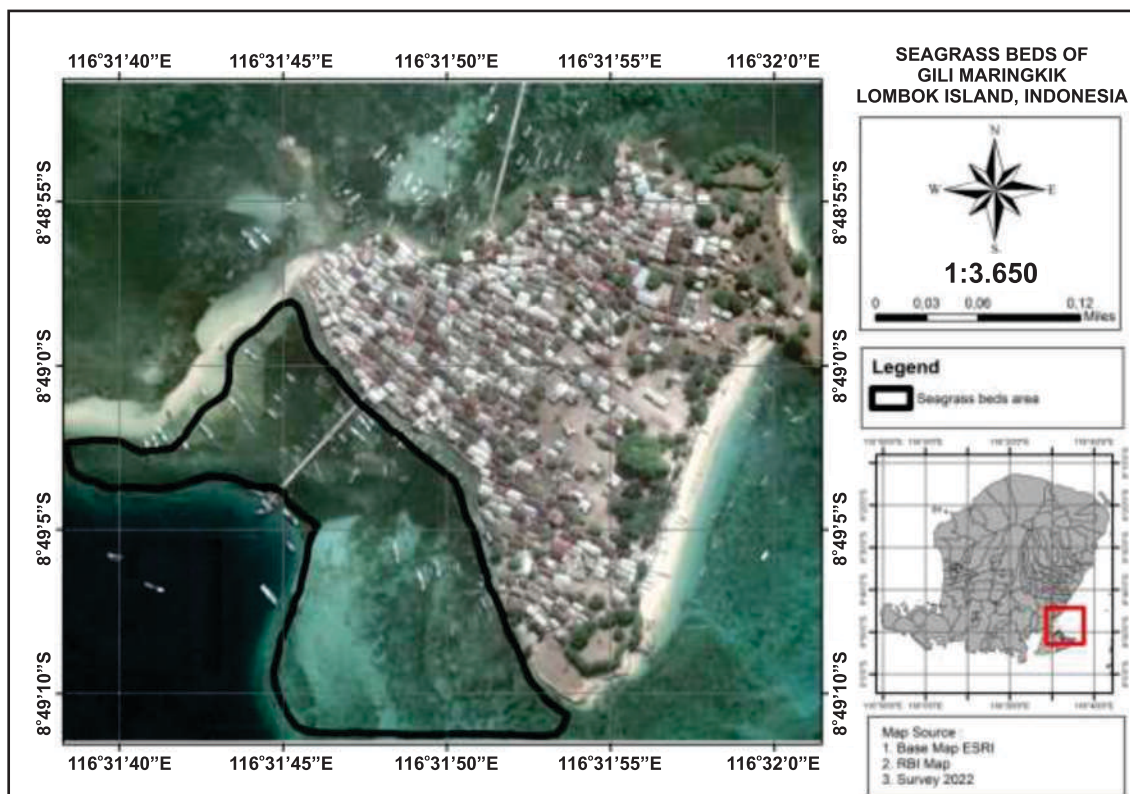


Figure 1 Seagrass ecosystem surrounding Gili Maringkik Island, East Lombok, Indonesia

Sampling Strategy

The research was carried out through field observation and laboratory analysis. Field research included seagrass species identification (Azkab 1999; Hartog & Kuo 2006) and determining the seagrass coverage percentage by using the Seagrass Watch Standard Guidances for Seagrass Covering (McKenzie *et al.* 2001). Within the 31.82 ha seagrass bed, the samples were collected from 0.5 × 0.5 m plot area. The total plot area was 25 arranged on five lanes with 25 m space between plots and 100 m between lanes.

Samples of seagrass species included leaves, rhizomes, roots and substrates for each species in each quadrant of observation. The samples were taken as material for further testing in the laboratory.

Seagrass biomass content was determined by using the oven method at a temperature of 60 °C until dry weight was stable. The c-organic content of seagrass on the top of the substrate (leaf sheaths and blades) and bottom substrate (rhizoma and roots) was determined based on the Loss On Ignition method.

In addition, sampling of the substrate as a test material for the carbon content of the substrate were carried out using the curd method. The samples were carried out in each quadrant with a sample depth of up to 30 cm and a slope of 30° using a pipe with a diameter of 5 cm and a length of 35 cm.

Data Analysis

Density

Seagrass density is the sum of all seagrass individuals per unit area. Value of seagrass ecosystem density was calculated by using the following formula (Brower & Zar 1977):

$$D = \frac{Ni}{A}$$

where:

- D = density of segrass, species i (stands/m²)
 Ni = number of seagrass with species i (stand)
 A = area of observation plot (m²)

Biomass

Biomass is an organic material produced through photosynthesis process, either the primary product or waste. Seagrass standing biomass is a result of oven drying method which

was calculated by using the following formula (Helrich 1990):

$$\text{Biomass (g DW/m}^2\text{)} = \frac{\text{Dry weight (g DW)}}{\text{Observation area (m}^2\text{)}}$$

Seagrass Carbon

Seagrass standing carbon was calculated by using the following formula (Helrich 1990):

$$\text{Ash content (\%)} = \frac{c - a}{b - a} \times 100\%$$

where:

- a = cup weight
 b = cup weight + dry weight of seagrass sample
 c = cup weight + ash weight of seagrass sample

Organic Material Content

Organic material as a result of weight reduction while digestion process was calculated by using the following formula (Helrich 1990):

$$\text{Organic material content (\%)} = \frac{[(b - a) - (c - a)]}{(b - a)} \times 100\%$$

where:

- a = cup weight
 b = cup weight + dry weight of seagrass sample
 c = cup weight + ash weight of seagrass sample

Carbon Content

Value of carbon content of seagrass was calculated from the Organic Material Content divided by a constant value of organic material (1.724), using the following formula:

$$\text{Carbon content (\% C)} = \frac{\text{Organic material content (\%)}}{1.724}$$

where:

- 1.724 = constant value of organic material

Substrate Carbon

Substrate carbon content was calculated by using the following formula (Sulaeman *et al.* 2005):

$$\text{Substrate carbon} = \frac{\text{ppm curve} \times 10}{500 \times \text{correction factor}}$$

where:

- ppm curve = sample content obtained from the relationship curve between standard series content and the reading after corrected by the curve form

$$\text{Correction factor} = 100 / (100 - \% \text{ water content})$$

Total of Carbon Stock Area

The calculation of carbon content (g C/m²) of seagrass was performed using the approach of seagrass biomass weight (g DW/m²) by using the following formula (Barrón *et al.* 2004):

$$\text{Carbon stored (g C/m}^2\text{)} = \frac{\text{Carbon contained (\% C) x Biomass of species (g DW/m}^2\text{)}}{100}$$

Then, the estimation of total carbon stock area was calculated by using the following formula (Sulaeman *et al.* 2005):

$$C_t = \sum (L_i \times C_i)$$

where:

C_t = total carbon (ton C)

L_i = area of seagrass bed ecosystem (ha)

C_i = the average of seagrass carbon content (g C/m²)

RESULTS AND DISCUSSION

Seagrass Species

Eight species of seagrass were found in Gili Maringkik (two families and six genera) (Table 1). The total composition of seagrass species in Gili Maringkik represents 61.54% of the total 13 species of seagrass found growing in Indonesian marine waters. Species composition in each research path was different. The richest species composition was found in lanes 3 (three) and 5 (five) with the number of seagrass growing as many as five species, which is presumably because the substrate consisted of small diameter sand substrate is suitable for the growth of the 5 species. Overall, *Cymodocea rotundata* and *Enbalus acoroides* could be found in all lines of observation. On the other hand, *Cymodocea serrulata* and *Halophila spinulosa* were found only in one line with a low number of distributions.

One of the important parts of this research is the discovery of seagrass *Halophila spinulosa* in Gili Maringkik Waters. Previous studies reported that *Halophila spinulosa* was found only in Mangrove Bay (Riau Islands), Anyer Sea (Java

Island), North Baluran Sea and Irian Sea (Kiswara & Hutomo 1985; Priosambodo 2007); Waters of Hiri Islands, Ternate, Maitara and Tidore, North Maluku (Ramili *et al.* 2018); and Lungkak Waters, East Lombok (Syukur *et al.* 2020). Our study showed that *Halophila spinulosa* was found in Gili Maringkik Waters.

Seagrass Density and Coverage Percentage

The highest species density values were observed for *Cymodocea rotundata* (506.40 ± 187.809 stands/m²) and *Thalassia hemprichii* (273.28 ± 77.151 stands/m²). The high value of species density for *C. rotundata* proved that the research location was still categorized as natural environment, while *T. hemprichii* with the second highest species density value proved that the species was well adapted to the surrounding environment (Larkum *et al.* 1989).

At the research location, *T. hemprichii* was associated with *Enbalus acoroides* at the coastal area of Gili Maringkik. The coastal topography of Gili Maringkik is shallow and clear, so that light penetrates the seagrass habitat to support the seagrass photosynthesis process.

Seagrass density value and coverage percentage are influenced by seagrass abundance and size. Having species density value of 115.20 ± 62.471 stands/m², *Halophila minor* has small size with large number of stands in each quadrant. Therefore, *H. minor* required smaller space for each stand compared to larger-sized seagrass, such as *Enbalus acoroides* which has low number of stands in each quadrant (Table 2).

The highest coverage percentage were observed in *T. hemprichii* (36.52 ± 30.004%) and *C. rotundata* (31.36 ± 33.747%) stands. The main factor causing the lower coverage percentage of *C. rotundata* compared with that of *T. hemprichii* was the low distribution rate of *C. rotundata*, although the density of *C. rotundata* was higher than that of *T. hemprichii*. Larger-size seagrass, such as *E. acoroides*, provided the third highest coverage percentage (18.84 ± 20.922%), although it had a low number of stands (Rahman *et al.* 2018).

Table 1 Seagrass species found at Gili Maringkik Waters, Lombok, Indonesia

No	Family	Seagrass species	Lanes				
			1	2	3	4	5
1	<i>Potamogetonaceae</i>	<i>Cymodocea rotundata</i>	+	+	+	+	+
		<i>Cymodocea serrulata</i>	-	-	+	-	-
		<i>Syringodium isoetifolium</i>	+	-	+	-	+
		<i>Halodule pinifolia</i>	-	+	-	+	+
2	<i>Hydrocaritaceae</i>	<i>Enbalus acoroides</i>	+	+	+	+	+
		<i>Halophila minor</i>	+	-	+	+	+
		<i>Halophila spinulosa</i>	-	-	-	-	+
		<i>Thalassia bempriichii</i>	+	+	+	+	-

Notes: + = found; - = not found.

Table 2 Density and seagrass coverage at Gili Maringkik Waters, Lombok, Indonesia

No	Seagrass species	Density (stands/m ²)	Coverage percentage (%)
1	<i>Cymodocea rotundata</i>	506.40 ± 187.809	31.36 ± 33.747
2	<i>Cymodocea serrulata</i>	6.24 ± 5.401	0.79 ± 1.976
3	<i>Enbalus acoroides</i>	57.36 ± 40.243	18.84 ± 20.922
4	<i>Halodule pinifolia</i>	44.80 ± 49.943	0.28 ± 4.766
5	<i>Halophila minor</i>	115.20 ± 62.471	4.84 ± 8.286
6	<i>Halophila spinulosa</i>	23.20 ± 22.807	0.75 ± 2.113
7	<i>Syringodium isoetifolium</i>	107.20 ± 60.258	6.63 ± 11.893
8	<i>Thalassia bempriichii</i>	273.28 ± 77.151	36.52 ± 30.004

High species density and coverage percentage of seagrass beds provide benefits for the survival of marine biota due to the multi-function of seagrass as food source, spawning area, coastal buffer and source of organic carbon in the substrate (Arkham *et al.* 2015; Rahman & Hadi 2021). The density of seagrass beds in coastal areas increases the diversity and abundance of fish as an economic source for coastal communities (Arkham *et al.* 2016). Seagrass habitat has a strong relationship with the abundance of fish species. This statement is supported by the study conducted by Wahyudin *et al.* (2018), in which there were 118 fish species found in seagrass habitat in the waters of Bintan Island.

Seagrass Biomass

The total biomass content stored in the seagrass ecosystem of Gili Maringkik was 1,081.85 g DW/m² with *Enbalus acoroides* as the species with the highest biomass value (463.41 g DW/m²). The highest value of *E. acoroides* was caused by the size of this species of seagrass compared with the other seven seagrass species found in the Gili Maringkik Waters.

This findings are in line with the the results of previous study conducted by Rustam *et al.*

(2015) in the coastal waters of Miskam Bay, Tanjung Lesung, Banten; Indriani *et al.* (2017) in the coastal seagrass ecosystem of Bintan Island, Riau Islands; Githaiga *et al.* (2017) in the seagrass ecosystem of Kenya Gazhi; and Rahman *et al.* (2018) in the Poton Bako seagrass ecosystem, East Lombok Regency, West Nusa Tenggara.

Our study also discovered that the standing biomass of *Halodule pinifolia* (12.41 g DW/m²) was lower than that of *Halophila minor* (24.28 g DW/m²), although the size of *Halodule pinifolia* is larger than that of *Halophila minor*. This result could have been caused by the lower species density value of *Halodule pinifolia* compared to that of *Halophila minor*, which affected the total species biomass in our research area.

The seagrass biomass content in Gili Maringkik Waters seemed to be not only influenced by the seagrass size but can also by the species density, which contributes to the total dry weight of the seagrass samples (Githaiga *et al.* 2017; Azizah *et al.* 2017).

Comparison of biomass content of each part of seagrass (leaf sheaths and blades, rhizomes and roots) resulted in different biomass content values. Biomass contents of seagrass rhizomes and leaves were higher than those of seagrass roots, with a total ratio of overall biomass as 5 : 4 : 1 or was equivalent to 510.14 g DW/m² in

rhizome, 382.57 g DW/m² in leaves and 189.13 g DW/m² in roots.

The highest rhizome biomass was shown in *Enbalus acoroides*, *Cymodocea serrulata*, *Halophila minor* and *Halodule pinifolia*, while the highest leaf biomass was shown in *Thalassia hemprichii*, *Cymodocea rotundata*, *Syringodium isoetifolium* and *Halophila spinulosa* (Table 3).

Total biomass of the bottom substrate (rhizomes and roots) in Gili Maringkik Waters was greater than that of the upper substrate (leaf sheaths and blades). This results were similar with the reports of Tasabaramo and Kawaroe (2015) and Wahyudi *et al.* (2016) which stated that biomass of the bottom substrate material is greater than that of the upper substrate material because the material of the bottom substrate is denser compared with material of the upper substrate.

Additionally, material of the bottom substrate comes from the root-absorbed nutrients and

organic materials resulting from photosynthesis, which is mostly stored in rhizomes. The bottom substrate material is suitable for seagrass as blue carbon. The biomass contained in the bottom substrate (rhizome and roots) is stored for a long time, as oppose to the biomass contained in the upper substrate (leaf sheaths and blades) which can be wiped-out by water currents and human activities, which release carbon in the form of wastes.

Seagrass Carbon

The highest carbon content (% C) was found in the rhizome with an average of 45.37 ± 3.633 compared to roots (42.22 ± 9.542) and leaf (22.08 ± 25.132). In terms of seagrass species, *Enbalus acoroides* and *Cymodocea serrulata* showed the highest carbon content (both species had the same carbon content of 142.09), followed by *Cymodocea rotundata* (139.25), and lastly *Halophila minor* (79.04) (Table 4).

Table 3 Seagrass biomass content at Gili Maringkik Waters, Lombok, Indonesia

No	Seagrass species	Seagrass biomass (g DW/m ²)			
		Leaf sheath and blade	Rhizome	Root	Total biomass
1	<i>Cymodocea rotundata</i>	90.98	81.05	49.12	221.15
2	<i>Cymodocea serrulata</i>	8.08	17.72	2.96	28.76
3	<i>Enbalus acoroides</i>	138.14	277.02	48.24	463.41
4	<i>Halodule pinifolia</i>	4.42	5.27	2.72	12.41
5	<i>Halophila minor</i>	10.16	11.88	2.24	24.28
6	<i>Halophila spinulosa</i>	11.78	9.47	4.92	26.17
7	<i>Syringodium isoetifolium</i>	21.65	20.58	24.87	67.10
8	<i>Thalassia hemprichii</i>	97.36	87.15	54.06	238.57
	Average	47.82	63.77	23.64	135.23
	Standard deviation	52.562	92.095	23.467	160.815

Table 4 Percentage of carbon content in each part of seagrass observed in Gili Maringkik

No	Seagrass species	Leaf sheaths and blades carbon stored		Rhizomes carbon stored		Roots carbon stored	
		(%C)	(g C/m ²)	(%C)	(g C/m ²)	(%C)	(g C/m ²)
1	<i>Cymodocea rotundata</i>	47.94	43.62	46.49	37.68	44.82	22.02
2	<i>Cymodocea serrulata</i>	48.25	3.90	44.05	7.81	49.79	1.47
3	<i>Enbalus acoroides</i>	49.94	68.99	45.97	127.35	46.23	22.30
4	<i>Halodule pinifolia</i>	43.45	1.92	48.66	2.56	46.88	1.28
5	<i>Halophila minor</i>	41.24	4.19	19.87	2.36	17.93	0.40
6	<i>Halophila spinulosa</i>	47.36	5.58	46.65	4.42	34.80	1.71
7	<i>Syringodium isoetifolium</i>	45.05	9.75	47.49	9.77	41.13	10.23
8	<i>Thalassia hemprichii</i>	39.73	38.68	38.57	33.61	41.18	22.26
	Total	362.96	176.63	337.75	225.56	322.76	81.67

Carbon stock of seagrass beds at Gili Maringkik was found to be 483.86 g C/m². This value is higher than the carbon stock of seagrass ecosystem in Bintan Island (266.95 g C/m²) (Irawan 2017); seagrass ecosystem of Poton Bako Lombok (447.92 g C/m²) (Rahman *et al.* 2018); carbon stock of seagrass beds in Prawean (10.40 - 197.34 g C/m²) (Septiani *et al.* 2018); carbon stock of seagrass beds in Krakal Beach, Gunungkidul, Yogyakarta (30.42 ± 13.85 g C/m²) (Pramesti *et al.* 2021); carbon stock of seagrass beds in Sikka, Maumere, East Nusa Tenggara (41.95 g C/m²) (Wisnar *et al.* 2021); and the carbon stock of seagrass beds in Poteran Island, Madura, East Java (2.23 g C/m²) (Sirait *et al.* 2022).

The high and low carbon content of seagrass stocks in a coastal ecosystem could be affected by the number of species composition, the seagrass coverage area, and the percentage of carbon content in each tested species. Seagrass biomass contributes greatly to the carbon stock content, as is the case with *Enhalus acoroides* (218.64 g C/m²) which has the highest carbon stock content compared to other species. Similarly, *Halodule pinifolia* (5.76 g C/m²) and *Halophila minor* (6.95 g C/m²) are the two species with the lowest carbon stock species because they generally have small size which affect their carbon content. Carbon content is influenced by the large amount of biomass stored in leaves, rhizomes and roots.

Our study showed that carbon stock of *Cymodocea rotundata* (103.32 g C/m²) was greater than that of *Thalassia hemprichii* (94.55 g C/m²), although the size of *C. rotundata* is smaller than

that of *T. hemprichii*. The high carbon stock of *C. rotundata* was caused by its high total biomass content and species density in the entire study area (31.82 ha) which was greater than that of *T. hemprichii*.

T. hemprichii had low density values affecting its total biomass content which was influenced by unit area for sampling (Kennedy & Björk 2009; Serrano *et al.* 2014). Also, the carbon content (% C) of *C. rotundata* in leaf sheaths and blades, rhizomas and roots (139.25) was higher than that of *T. hemprichii* (119.48).

Substrate Carbon

The substrate carbon content (% C) of seagrass beds in the Gili Maringkik Waters was in the range of 0.09 - 0.49 with an average of 0.30 ± 0.108, which was less than 1% C (very low) (Fig. 2).

The levels of substrate carbon content in the seagrass beds of Gili Maringkik Waters was firstly influenced by the characteristics of the substrate types, which were sandy and coral. The low C-organic content in sandy substrates was caused by the oxidation mechanism that easily released organic matter compared with that in fine sand substrates (Serrano *et al.* 2014; Bañolas *et al.* 2020).

Secondly, substrate carbon content was affected by seagrass density. The higher the seagrass density grown on the substrate, the higher carbon content of the substrate. Thirdly, decomposed seagrass was not stored as organic matter in the substrate (Watanabe & Kuwae 2015; Marquez *et al.* 2017; Marbà *et al.* 2018; Guo *et al.* 2021; Yang *et al.* 2022).

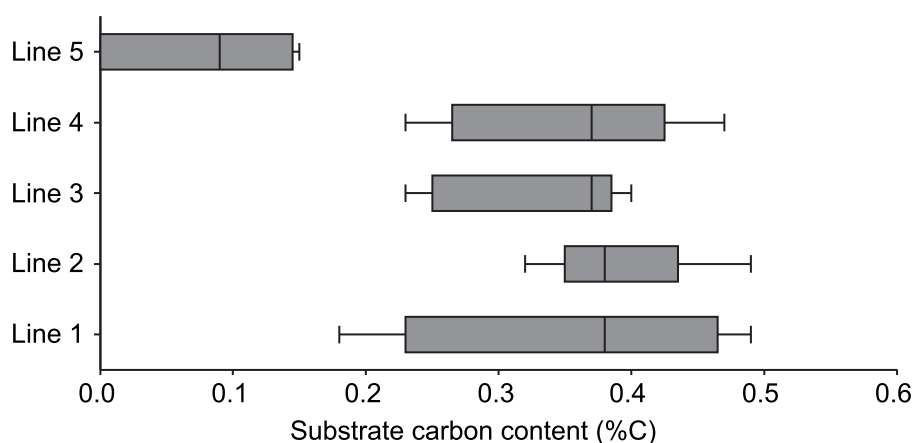


Figure 2 Substrate carbon content of seagrass beds in Gili Maringkik Waters, Lombok, Indonesia

Fourthly, there is no source of organic matter originating from the mainland due to the absence of rivers and mangrove ecosystem in Gili Maringkik Waters (Samper-Villarreal *et al.*, 2016; Prentice *et al.*, 2019; Santos *et al.*, 2019; Dahl *et al.* 2020). This finding is in line with the report by Chen *et al.* (2017) that substrate carbon content is influenced by ecosystems surrounding the seagrass habitat, such as mangrove ecosystem as a source of substrate organic matter. Fifthly, the low weathering and low mineralization mechanisms of organic matter in substrate is caused by anaerobic condition affecting the activity of decomposing organisms (Tangketasik and Narka, 2012; Delgado *et al.* 2017; Potapov *et al.* 2017; Crowther *et al.* 2019; Guo *et al.* 2021).

Carbon Sink Estimation of Seagrass Beds

The estimated total carbon stock of the Gili Maringkik seagrass ecosystem in a total area of 31.82 ha was 153.96 tonnes C or was equivalent to 4.84 tonnes C/ha. The potential carbon stocks of Gili Maringkik seagrass beds is greater than that of several locations in Indonesia. The estimated carbon stock of the seagrass beds in Sintok Island was 4.18 tonnes C/ha (Hartati *et al.* 2017); seagrass beds in Karimunjawa Island ranged from 0.50 to 0.73 tonnes C/ha (Ganefiani *et al.* 2019); seagrass beds at Tanjung Kerasak Beach, South Bangka Regency was 1.1 tonnes C/ha (Sartini *et al.* 2021). However, the carbon stock of seagrass beds in Gili Maringkik was smaller than that of seagrass ecosystem in Menjangan Kecil Island, which was 32.18 tonnes C/ha (Hartati *et al.* 2017).

CONCLUSION

Eight species of seagrass were found in Gili Maringkik Waters, namely: *Cymodocea rotundata*, *Cymodocea serrulata*, *Enhalus acoroides*, *Halodule pinifolia*, *Halophila minor*, *Halophila spinulosa*, *Syringodium isoetifolium*, and *Thalassia hemprichii*. The highest species density and coverage percentage was found in *Cymodocea rotundata*. There was a correlation between species density, total biomass and carbon content of the seagrass beds in Gili Maringkik Waters. Substrate carbon content of seagrass in Gili Maringkik was very

low (< 1%). The estimated total carbon stock of the Gili Maringkik seagrass ecosystem in an area of 31.82 ha was 153.96 tonnes C/ha or was equivalent to 4.84 tonnes C/ha.

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