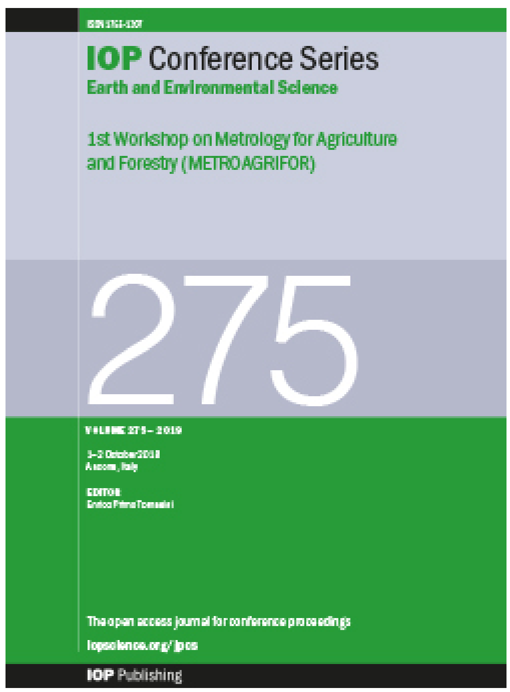
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Preface

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PREFACE

On behalf of the Organizing Committee, I would like to extend our warmest regards to all participants of the International Conference on Tropical and Coastal Region Eco-Development (ICTCRED) 2019. This annual conference is the fifth event at Semarang, Central Java, Indonesia that is organized by the Faculty of Fisheries, Universitas Diponegoro. This year we brought an essential global topic the ***Integrated Coastal Zone Management for Sustainable Development.*** The conference aims to provide a forum to exchange ideas and their current achievements for researchers, academicians, professionals, and industries to expose and exchange innovative ideas, methods, and experiences in the areas related to tropical life sciences and coastal development.

We have accepted 156 abstracts for oral and poster presentations coming from different universities and research centers from many countries, which were consisted of 13 big interests. Besides, we have cordially invited five highly respected researchers as keynote speakers with different fields to share their knowledge and expertise. I am grateful for each one of them for setting aside their valuable time to participate in this conference.

The committee extent very kind thank all participants for the success of the conference. They were Rector of Universitas Diponegoro, Dean of Faculty of Fisheries and Marine Science, the keynote speakers. I also would like to acknowledge the Institute of Physics (IOP) for the collaboration in publishing the conference proceedings, our sponsors the Bionesia**,** Faculty of Law, Universitas Diponegoro, COREM Undip, and Deltares.

Finally, we proudly present some selected papers in IOP Conference Series: Earth and Environmental Science. I do hope that the 5th ICTCRED 2019 event brings a fruitful knowledge and be a memorable event not only from the scientific perspective but also in the joy of meeting with other scientists for mutual collaboration.

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Peer review statement

All papers published in this volume of *IOP Conference Series: Earth and Environmental Science* have been peer reviewed through processes administered by the proceedings Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

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The potential stocks and carbon uptake by seagrass meadows at Pari Island, Kepulauan Seribu, Indonesia

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The potential stocks and carbon uptake by seagrass meadows at Pari Island, Kepulauan Seribu, Indonesia

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Abstract. The development of human civilization during the last century has increased carbon dioxide content in nature that will contribute to global climate change. However, ocean water will reduce this increase by absorbing CO_2. The increasing CO_2 content in the ocean could decrease pH and carbonate ion, which will have negative impacts on the life of marine organisms, food production and human life. Seagrass meadows through photosynthetic processes could absorb CO_2 and store carbon in large amounts for an extended period. This process could be the strategic way of resolving global climate change. The purpose of this research was to identify the species of seagrass, quantify the density and coverage of seagrass, and calculate biomass and carbon stock in seagrass meadows at Pari Island, Kepulauan Seribu. The research was carried out in February 2019. This research used quantitative field observation with the purposive sampling method. Samples were collected from 3 locations with nine stations. The obtained samples were analyzed at the Laboratory of Faculty of Fisheries and Marine Science, Diponegoro University. Carbon and sediment samples were analyzed using Loss in the Ignition (LOI) method. The results showed that there are three species of seagrass in Pari Island, i.e. *Enhalus acoroides*, *Thalassia hemprichii*, and *Cymodocea rotundata.* Total density value was 129.19 individual m^{-2} and total coverage value was 62.59%. Total stock potential of carbon value in Pari Island was 87.80 ton per ha with total area of seagrass meadows of 3.48 ha. Silty-sands mainly dominated sediment textures. It can be concluded that seagrass meadows are potential habitats to control CO_2 concentration in coastal waters and to hold the rate of climate change.

1. Introduction

Carbon dioxide (CO_2), which has increased in nature since the industrial revolution, accompanied by the development of human civilization is a result of increased emissions, mainly from burning fuel and biomass [1]. Carbon dioxide content is thousands of times more than the pre-industrial era 200 years ago (before the increase in fossil fuels burning). The higher CO_2 partial pressure in the atmosphere indicates the large amount of carbon dioxide in marine waters [2]. This condition has contributed to changes in weather patterns, food production and human life [3].

Carbon can be absorbed by plants and stored at a specific time. Therefore, the role of plants becomes essential in dealing with climate change. Previous studies only focused on the role of soil plants such as forests and gardens in carbon sequestration and ruled out the role of marine ecosystems [4]. UNEP, FAO, IPCC, and UNESCO have introduced the concept of blue carbon by emphasizing the importance of marine and coastal ecosystems as controllers of climate change, concerning carbon uptake by marine ecosystems, namely: mangroves, seagrasses and brackish swamps [5]. These ecosystems have carbon potential of around 300 to 900 metric tones of CO_2 annually, which is equivalent to 7 to 20% of annual emissions resulting from global deforestation and forest degradation [6]. Therefore, the knowledge of the role of natural ecosystems in capturing CO_2 becomes necessary for developing strategies in dealing with climate change [7].

Pari Island has a reasonably good seagrass ecosystem. It was stated that there are seven species of seagrass on Pari Island, i.e., *Thalassia hemprichii*, *Enhalus acoroides*, *Cymodocea rotundata*, *Halophila ovalis*, *Halodule uninervis*, *Cymodocea serrulata* on the southern coast and *Enhalus* *acoroides* on the western coast. The Enhalus-Thalassia seagrass community on Pari Island has carbon reserves of 200.5 g C m^{-2} or equivalent to 2.005 tons C ha^{-1} while the total carbon stock is 67.21 tons C [8].

The vital role of seagrass in carbon storage, mitigation, and adaptation to climate change needs to be studied; further, this research will examine the potential carbon stocks and uptake by seagrass meadows.

2. Methodology

2.1. Study Site

The research was carried out at Pari Island, Kepulauan Seribu, Indonesia. Geographically, Pari Island is located on the coordinates 5° 50’ 20” to 5° 50’ 25” S and 106° 34’ 30” to 106° 38’ 20” E (Figure 1). The determination of sampling points was based on the distribution of seagrass in Pari Island, and sampling activities were carried out in a representative manner that it was expected to represent all conditions of the study area. There were three research locations that were divided into nine stations and 27 points.

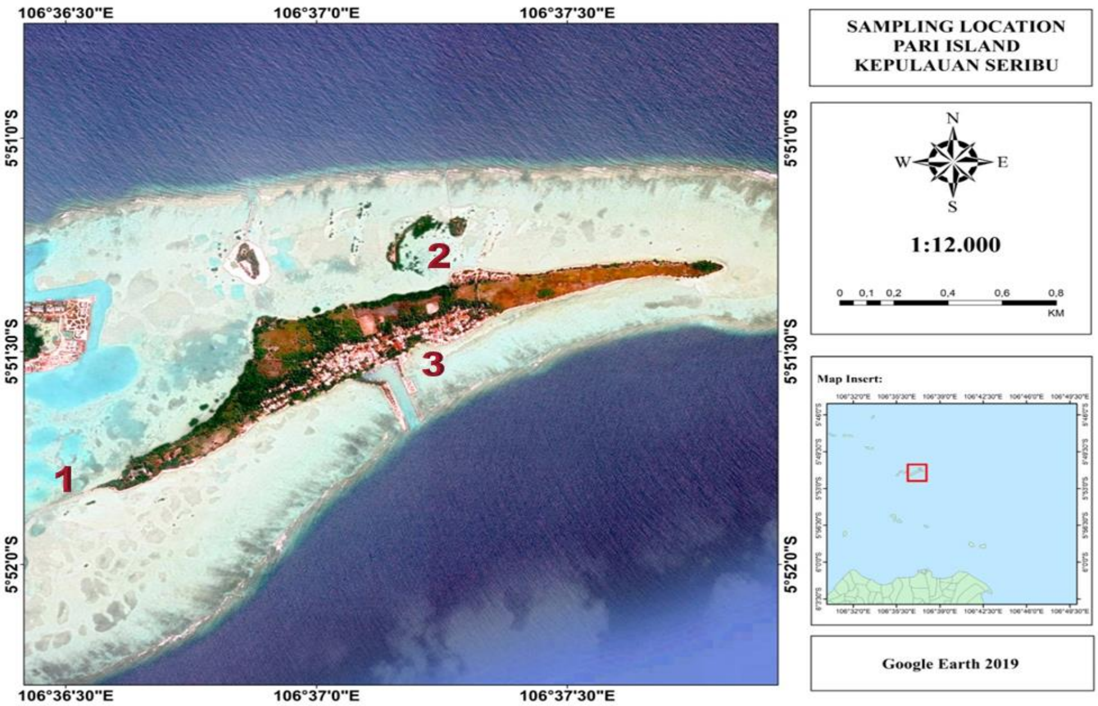

Figure 1. Map of research location

2.2. *Field Sampling*

2.2.1. Seagrass observation

Identification of species, density, and percentage of seagrass coverage was conducted through observations of seagrass. Data were collected based on the Seagrass watch method [9]. The three transects were made with length about 50 m each other and the distance between one transect and the other is 25 m. The quadrant frame was placed on the right side of the transect with the distance between one quadrant, and the other is 25 m, resulting in three quadrants on each transect (Figure 2). The starting point of the transect was placed at a distance of 0 m from the first time the seagrass was encountered (from the coast) [10].

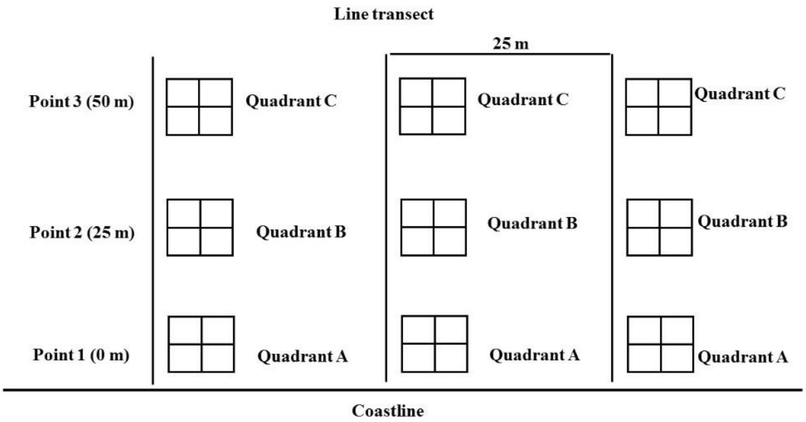

Figure 2. Quadrant transect illustration in seagrass with Seagrass watch modified

2.2.2. Seagrass sampling process

Seagrass samples were taken on each transect by sampling method which three sticks in one transect were taken. One root is defined as one bud (leaf), one segment of rhizome and root so that each root has three parts, namely leaves, rhizome, and roots. The total of root taken as a sample was recorded [11]. The samples were then cleaned of sediment and put in a sample bag and then stored in an icebox to maintain freshness. Then, seagrass samples were winded and also cut into leaves, rhizomes and roots. The samples were brought to the laboratory for analysis [4]. Seagrass samples taken were seagrasses that dominated in quadrant transect [12].

2.2.3. Sediment sampling process

Sediment sampling was conducted by taking surface sediments using sandpit. One sample was collected at each location and put into plastic zipper, therefore in total, and there were nine sediment samples from 9 points at 3 study sites. Then the samples were stored in a cool box for further analysis in the laboratory.

2.3. Data Analysis

2.3.1. Measurement of seagrass biomass

Measurement of biomass was carried out by counting seagrass stands and taking seagrass samples and then biomass was counted as wet biomass. Samples that have been washed and cleaned of sediments, then sorted by type and parts, namely leaves, rhizomes and roots [9]. After that, the sample was dried in an oven at 60 ^{0}C for 24 hours to obtain a dry weight (DW) for leaves, rhizomes, and roots. Thus, the dry biomass of each species per chip can be known. Biomass per unit area was obtained by multiplying the amount of density per unit area and biomass per sample [13]. The formula used to calculate biomass is shown by the equation according to [14]:

$$B = W \times D$$

where:
B = Seagrass Biomass (gram.m^{-2})
W = Dry Weight of a Seagrass Sprout (gram.sprout^{-1})
D = Seagrass Density (shoots.m^{-2})

2.3.2. Measurement of seagrass carbon

Measurements of seagrass carbon were carried out using the Loss On Ignition (LOI) method [15], with the following procedures:

1) Wash the porcelain cup then rinse and dry;
2) Insert the cup into the furnace (electric furnace) for 2 to 3 hours with a temperature of 550 ^{0}C;
3) Cool the porcelain cup in the desiccator for 30 minutes, then weigh the cup as the weight of the empty cup;
4) Insert 1 to 2 grams of the dry sample into the porcelain cup and record the weight of the cup plus weight of the sample;
5) Porcelain cup containing dry sample is then burned in the furnace for 6 hours at a temperature of 550°C until it becomes ash which is marked by greyish-white without black spots;
6) Cool in the desiccator then weigh the cup as the weight of the cup plus the weight of ash and calculated using a greying formula.

The formula used to calculate the carbon content of seagrass with the ashing method by [16]:

$$\text{Dust concern} = \frac{c-a}{b-a}\ x\ 100\%$$

where:
a = cup weight
b = cup weight plus dry weight of seagrass tissue
c = weight of the cup plus weight of seagrass ash

Organic matter was calculated by the ashing method by reducing the weight when ashing by [16]:

$$\text{Levels of organic matter}=\frac{[(b-a)-(c-a)]}{b-a}\ x\ 100\%$$

where :
a = cup weight
b = cup weight plus sample weight
c = weight (cup plus ash)
The carbon content value of seagrass tissue is calculated:

$$\text{Carbon content} = \frac{levels\ of\ organic\ matter}{1{,}724}$$

Note : 1,724 = constant value of organic matter.
The value of the carbon content results is then averaged as the carbon content value of seagrass tissue [7].

2.3.3. Total carbon stock

Total seagrass carbon stock was calculated with formulation [17]:

$$\text{Ct} = \sum(Li\ x\ Ci)$$

where :
Ct = total carbon (tons)
Li = broad seagrass category class i (m^2)
Ci = average carbon stock of seagrass class I (gC m^{-2})

3. Result and Discussion

3.1. Results

3.1.1. Seagrass biomass

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Result of biomass c is presented in the following Figure 3. Based on the diagram above it can be seen that the percentage of biomass under the substrate is higher at 59% with a biomass value ranging from 2.28 - 186.96 gbk m^{-2} while the value of biomass on the substrate ranges between 1.68 - 111.12 gbk m^{-2}.

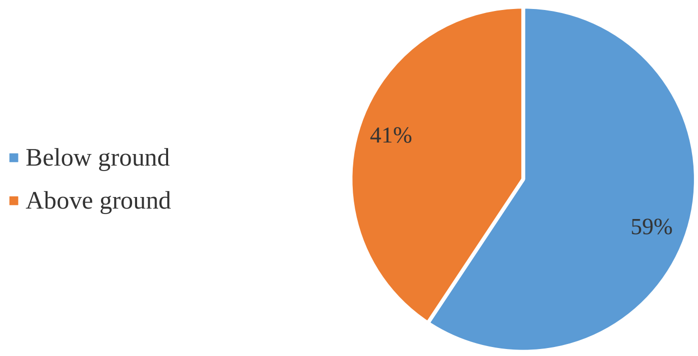

Figure 3. Percentage of carbon below ground and above-ground biomass

3.1.2. Estimation value of seagrass carbon stock
The total carbon stock obtained from the seagrass area in Pari Island is presented in Table 1. The denomination carbon g C m^{-2} is converted into ton C ha^{-2}.

Table 1. Estimation value of seagrass carbon stock

Location	Area (ha)	Below ground (ton C ha^{-2})	Above ground (ton C ha^{-2})	Total carbon stock (ton C ha^{-2})
1. LIPI Dock	1.67	14.11	28.02	42.13
2. Perawan beach	1.13	9.55	18.96	28.51
3. Pari Island Dock	0.68	5.75	11.41	17.16
Total	3.48			87.80

This table showed that total carbon stored in Pari Island is about 87.80 ton per ha with an area of about 3.48 ha. The highest carbon stored is about 42.13 ton per ha. It was in location 1 which is seagrass meadows at LIPI Dock. While the lowest carbon stored is about 17.16 ton C ha^{-2}. It was in Pari Island Dock seagrass meadows.

3.1.3. The sediment carbon
The sediment carbon is taken from surface sediment. It was calculated to know how much carbon is stored in seagrass sediment. Sediment carbon stock was presented in Table 2.

Table 2. Sedimen carbon stock

Station	% Organic matter	Corg	Ct	C sediment (tons ha^{-2})
1	7.50	4.35	1.29	128.54
2	8.03	4.66	1.57	157.40
3	9.71	5.63	180	179.85
4	5.44	3.16	0.97	96.82
5	6.10	3.54	0.65	64.65
6	6.37	3.69	1.13	113.31

8	8.29	4.81	1.60	160.37
9	6.95	4.03	0.95	94.82

Sediment carbon content ranged between 64.65-179.85 ton C ha^{-2}. The highest carbon sediment value is in station three that 179.58 ton C ha^{-2} while the lowest value is in station five about 64.65 ton C ha^{-2}.

3.2. Discussion

3.2.1. Density and coverage

The research in Pari Island, Kepulauan Seribu showed that there are three species of seagrass: *E. acoroides, T. hemprichii,* and *C. rotundata.* The highest density is *T. hemprichii* with density of 81.03 individuals m^{-2}. While the seagrass coverage ranged from 35.83 to 83.33%. The highest cover was 83.33% at stations 3 and 4; while the lowest cover was 35.83% at station 6. Then the lowest density is *E. acoroides* with a density value of 18.37 individuals m^{-2}. Location 1 is a location with a type Homogeneous seagrass that is *E. acoroides*, although it has a low density because it has a large size the closure at this location is quite high. Seagrass beds can form single vegetation composed of one type of seagrass that grows to form dense grasslands [18].

Furthermore found that the lowest total seagrass density in Tanjung Barari because the location had a substrate with a mixture of mud making it the only station where the seagrass *Enhalus acoroides* were found [19]. The existence of this type of seagrass causes several other species of seagrass that are small in size can not grow and develop properly, due to competition in obtaining nutrients and space for life [20].

The density and coverage significantly affect the amount of biomass in a seagrass ecosystem; the amount of biomass also affects the amount of carbon stored in it. Therefore, it is necessary to calculate the density and seagrass cover as a basis for calculating the carbon content. Components of seagrass biomass that are above the soil base can be categorized as leaf stands which are generally measured in units of dry weight per unit area (g m^{-2}) related to shooting density and leaf area index [21].

3.2.2. Seagrass biomass

Calculations of seagrass biomass are separated into biomass above the substrate and below the substrate. The percentage of biomass calculated under the substrate is higher at 59% with a biomass value ranging from 2.28 to 186.96 gbk m^{-2} while the value of biomass on the substrate ranges between 1.68 to 111.12 gbk m^{-2}. The result of this study is reinforced by the statement of [22] which confirms that the potential for carbon storage at the bottom (below ground) will likely be stored longer and continues to grow if seagrass ecosystems are protected from damage.

The results of the sequestration of carbon by seagrass in the photosynthesis process are stored or flowed into several compartments, one of which is in the form of biomass, both above and below the substrate. Storage of carbon in biomass, especially the bottom of the substrate makes the seagrass role even more critical because it will be stored for a long time [23].

Location 1, which is a homogeneous seagrass, there is a type of *E. acoroides* which has a higher biomass value than locations 2 and 3. Location 2 has a high closure and density, but seen from the calculation of biomass location 2, which is dominated by *T. hemprichii* species has low biomass. The size of the seagrass *E. acoroides* which is substantial and dry weight is also significant, allows this species to have high carbon content as well. According to large seagrass species have a higher capacity to accumulate carbon due to relatively slow root and rhizome replacement [24]. However, the speed and success of carbon sequestration vary between and within seagrass types, depending on the entire set of natural processes including herbivorous activity, nutrient export and decomposes. Research also showed that the biomass of *E. acoroides* species is higher than other species, so it is suspected that *E. acoroides* is a high contributor to biomass [25].

3.2.3. Total Carbon Stock

Based on research can be known the total carbon stock value of seagrass in Pari Island is equal to 87.80 tons C ha^{-2} with a total area of seagrass 3.48 ha. The highest carbon uptake is at location 1 which is at the LIPI Dock with a total carbon stock of 42.13 tons C ha^{-2} while the lowest absorption at location 3 is around Pari Island Dock with a total carbon stock of 17. 16 tons C ha^{-2}.

The results of the study among three research sites, location 1 has the highest carbon uptake. The highest carbon uptake at location 1 is *E. acoroides* vegetation. Deposits of carbon under the high *E. acoroides* substrate are caused by large rhizoma and root size, as well as root penetration which can reach 40 cm. One function of the high storage of biomass under the substrate is to strengthen seagrass insertion [26]. Morphologically large types of seagrass tend to develop high biomass under the substrate, and therefore can accumulate higher carbon. Besides, carbon under the substrate is a place to store photosynthesis results that will support the growth of seagrass if the photosynthesis process is not running optimally [4].

Carbon stock below the substrate is higher than the above substrate mentions this because the carbon content under the substrate is less affected by physical environmental factors compared to the carbon content on the substrate which is more influenced by water factors such as temperature and others [27].

The composition of seagrass species compilers and types of substrate affect the potential of seagrass reserves in an ecosystem. The type and extent also affect the amount of CO_2 that can be absorbed by an ecosystem in a certain period. The value of seagrass carbon stocks both in vegetation and in the substrate depends on the characteristics, conditions, and extent of the seagrass ecosystem [1].

The results of carbon research on surface sediments showed high carbon content, ranging from 64.65 **-** 179.58 tons C ha^{-2}. Location 1 has a higher sediment carbon content than location 2 and 3. Type 1 substrate location is muddy sand covered with *E. acoroides* vegetation, location 2 type of substrate is fine sand which is dominated by *T. hemprichii* type but *E. acoroides* is still found even though the amount a little, whereas at the location of 3 types of sand substrate with a mixture of coral fragments overgrown by *T. hemprichii* and *C.rotundata* vegetation. [28], [26] The amount of seagrass biomass on the smaller substrate is caused by a positive effect on the nutrient absorption system, while a more substantial (coarse) substrate will decrease nutrients and organic matter [24]. Sediment in healthy seagrass ecosystems and has a seagrass biomass compilation system that has an elaborate canopy and roots and is tightly intertwined with the potential to store carbon for thousands of years.

Based on the study of the potential carbon stocks and uptake by seagrass beds in Pari Island, the Kepulaun Seribu can see the role of seagrass in storing carbon in high quantities. Seagrass ecosystems can help in climate change mitigation, besides it is seen from the ecological function of seagrass ecosystems as ecosystem stability, it is essential to hold this research and it is hoped that with this research, the public will become more aware of the need to protect the environment, one of which is to preserve seagrass ecosystems.

4. Conclusion

Based on the results of research conducted on Pari Island, Kepulauan Seribu related to the potential stock and carbon uptake by seagrass beds, the conclusions that can be drawn are as follows:

1. Types of seagrass found on Pari Island include *E. acoroides*, *T. hemprichii* and *C. rotundata*.
2. The density value of seagrass species in Pari Island is *T. hemprichii* at 81.03 individuals m^{-2}, *E. acoroides* type at 18.37 individuals m^{-2} and *C. rotundata* at 35,56 individuals m^{-2}.

3. Below ground biomass is higher than above-ground biomass. The percentage of biomass below substrate is higher at 59% with a biomass value ranging from 2.28 - 186.96 gbk m^{-2} while the biomass value of above substrate 41% ranges from 1.68 - 111.12 gbk m^{-2}. The total carbon sequestration value on Pari Island is 87.80 tons C ha^{-2} with total area of seagrass 3.48 ha. The highest carbon uptake is at location 1 which is at LIPI Dock with a total carbon stock of 42.13 tons C ha^{-2} while the lowest uptake at location 3 is around Pari Island Dock with a total carbon stock of 17. 16 tons C ha^{-2}.

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Semarang, 18th September 2019

Dean,	Chairperson,
Prof. Ir. Tri Winarni Agustini, M.Sc., Ph.D.	Dr. Pi. Aris Ismanto, S.Si., M.Si.