D3-Turnitin-SJE-Carbon Storage Estimation In Mangrove Sediment At Payung Island

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Carbon Storage Estimation In Mangrove Sediment At Payung Island, South Sumatra

Septi Hermialingga[1]*, Rujito Agus Suwignyo[2], Tengku Zia Ulqodry[3]

[1]*Environmental Management, Postgraduate Program, Sriwijaya University*
[2] *Department of Agriculture, Faculty of Agriculture, Sriwijaya University*
[3]*Marine Science, Faculty of Mathematics and Natural Sciences, Sriwijaya University*
**Corresponding author e-mail : shermialingga@gmail.com*

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Abstract: Mangrove is a plant generally located in tropical regions. It grows many in areas with salinated to fresh water and affected by tidal along with anaerobic soil conditions which filled with mud that contain organic material. In the process of photosynthesis, mangrove captures carbon in the atmosphere and are stored in biomass and sediment. Sediment can store carbon greater than biomass and rich of organic matter. Research regarding carbon storage in mangrove sediment on Payung Island has never been carried out which made this research aimed to estimate carbon storage in mangrove sediment on Payung Island. This research was conducted in October 2020 at Payung Island, South Sumatra. The sediment samples were analyzed by the Walkley-Black oxidation method and the sediment texture was analyzed by the Shepard triangle method. The calculation results show the dominant sediment texture was in the clay category, the average value at each station for % C organic is 5.04% and % organic matter is 8.18% and carbon deposits in sediment are 129.6 tonC/ha.
Keywords : *Mangrove, Sediment Carbon Storage, Walkley-Black Method*

Abstrak: Mangrove merupakan tumbuhan yang umumnya terdapat di wilayah tropis. Tumbuh di daerah air bersalinitas hingga tawar dan dipengaruhi oleh pasang surut air laut dengan keadaan tanah yang anaerobik, dimana banyak tumbuh di daerah-daerah yang di penuhi lumpur dan banyaknya akumulasi bahan organik. Proses fotosintesis pada mangrove menangkap karbon di atmosfer dan disimpan dalam biomassa dan sedimen. Sedimen dapat menyimpan karbon lebih besar dari biomassa dan kaya akan bahan organik. Penelitan mengenai simpanan karbon di sedimen mangrove di Pulau Payung belum pernah dilakukan sehingga penelitian ini bertujuan untuk mengestimasi simpanan karbon di sedimen mangrove di Pulau Payung. Penelitian ini dilakukan pada Oktober 2020 di Pulau Payung, Sumatera Selatan dan sampel sedimen dianalisis dengan metode oksidasi basah Walkley-Black serta tekstur sedimen dianalisis dengan metode segitiga shepard. Hasil perhitungan menunjukkan tekstur sedimen dominan dalam kategori lempung, nilai rata-rata di setiap stasiun untuk % C organik adalah 5,04% dan % bahan organik adalah 8,18% serta simpanan karbon dalam sedimen adalah 129,6 tonC/ha.
Kata kunci : *Mangrove, Simpanan Karbon Sedimen, Metode Walkley-Black*

1. Introduction

Mangrove forests are plants that can live well in areas with a muddy soil and affected by tides [1]. Mangrove forests are generally more abundant in the tropical coastal regions with coordinates between 30° North to 30° South [2]. Ecological functions of mangrove forests in addition to spawning sites, breeding sites, feeding grounds for biota and others can also absorb CO_2 in the atmosphere and store it in tree biomass such as leaves, twigs, stems, roots and sediment [3]. Carbon sequestration and storage can play a role in reducing global warming [4].

Payung Island is located at Musi River's estuary which closes to the land and the activities could contribute to sediment concentration. Sediment can become a gathering place for various chemical compounds carried by waters, therefore the concentration of phosphate and organic carbon at the bottom of the waters have a greater concentration than surface. However, in marine physics activities such as tides and currents, both cause the release of chemical compounds where originally at the bottom of the sediment into the waters [5].

Organic material in waters which carried by river flow will be decomposed into inorganic material in the form of important nutrients by decomposer organisms. Several factors that can cause organic material at the bottom of the sediment are being released back to the body of water are influenced by water conditions such as tides, currents, dissolved oxygen and sediment texture [6]. The existence of organic matter as nutrients is very important for the development and growth of mangroves. Organic materials are contained in the sediment mangrove ecosystem generated from the influence of the entry of leaf litter, twigs, etc. as well as detritus from decomposition. Litter and detritus are the biggest contributors to organic matter content. The entry of leaf litter drop in the sediment will be decomposed by decomposers then gradually settle into nutrient-rich sediment [7].

Estimation of sediment carbon storage can be done by burning method (*Lost On Ignition*) and method of Walkley and Black [8]. In this study, carbon storage in sediment was analyzed using the Walkley-Black method. The advantages of the Walkley-Black method can be used easily, simply and require little equipment while the weakness of the Walkley-Black method can not oxidize all organic carbon such as Cl^-, MnO_2, and Fe^{2+} [9].

The study was conducted on Payung Island where mangrove vegetate throughout the area but information about carbon storage in Payung Island mangrove sediment is still very limited. According to [3] states that the amount of carbon stored in forests within tree and soil biomass ranges around 2500 Gt. Therefore, the role of vegetation in reducing CO_2 emissions is needed. The purpose of this study was to estimate carbon storage in mangrove sediment. The results of the study in the form of estimated data on mangrove sediment carbon storage on Payung Island are expected to help provide information.

2. Material and Methods

The study was conducted in October 2019 on Payung Island, Banyuasin Regency, South Sumatra Province at 8 observation locations (Figure 1). The coordinates of the 8 observation stations can be seen in Table 1. Furthermore, carbon storage analysis (C) in sediment was carried out at the Oceanography Laboratory, Marine Science, Faculty of Mathematics and Natural Sciences, Sriwijaya University.

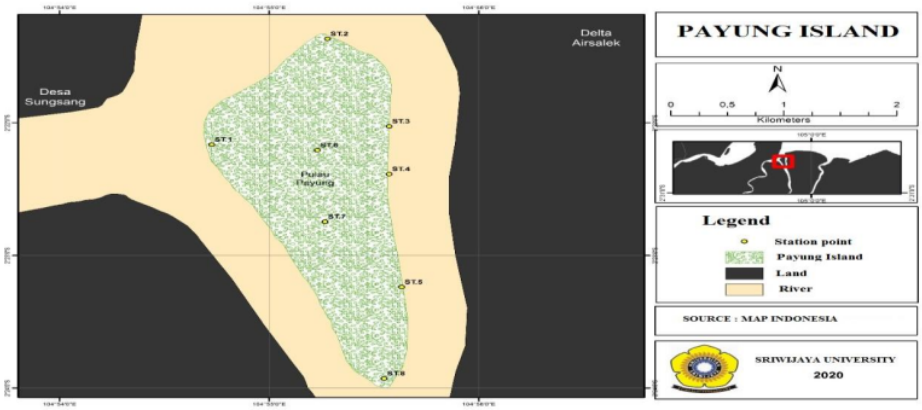

Figure 1. Research Location Map

Table 1. Coordinate of Observation 8 Stations on Payung Island

Station	Latitude	Longitude
1.	-2.3694	104.9121
2.	-2.3560	104.9213
3.	-2.367	104.9261
4.	-2.373	104.9261
5.	-2.3873	104.9271
6.	-2.3705	104.9205
7.	-2.3795	104.921
8.	-2.3991	104.9264

2.1 *Methods and Field Data Processing*

The sediment sampling method is carried out using a sediment core at each station as deep as 0-30 cm. Afterward, the sediment sample is homogenized because usually litter falls have not been fully decomposed. The carbon storage analysis method of sediment samples used the Walkley-Black method and the type of sediment was analyzed by using Shepard triangle method.

Analysis of organic carbon sediment samples used the wet oxidation method from Walkley and Black (1934). The principle of the Walkley-Black method is reducing Cr^{6+} (originally orange color) into Cr^{3+} (signing green color). The sample 0.5 g has been mixed with 10 ml of $K_2Cr_2O_7$ solution, 10 ml H_2SO_4 solution, 100 ml aquadest, 5 ml of H_3PO_4 solution, 2.5 ml of NaF 4% solution and 1 ml of diphenyl amine. Then sample is titrated using ferrous sulfate solution till its changes to green color. Finally, the difference between titrations number of the sample solution and blank are calculated. Finally % C can be calculated (Equation 1) [11] :

$$\% \text{ Corg} = (b\text{-}t) \times N \times \left(\frac{3}{w}\right) \times \left(\frac{100}{77}\right) \quad (1)$$

Note :
b = Blank
t = Titration
N = Ferrous Normality
w = Sample Weight

Afterward, the content of organic matter was determined (Equation 2):

$$\% \text{ BO} = \text{Corg} \times 1{,}724 \quad (2)$$

Note :
Corg = C-organik (%)
BO = Organic matter (%)

Calculation of soil organic carbon content used (Equation 3) [12] as follows :

$$Ct = Kd \times \rho \times \% \text{ Corg} \quad (3)$$

Note :
Ct = Soil organic carbon (g / cm^2)
Kd = Depth soil (cm)
ρ = Soil density (g / cm^3)
% Corg = Organic carbon (%) or **0.47**

After the calculation of soil carbon (g/cm2), then it was converted to units of tons per hectare (ton/ha) (Equation 4) :

$$C_{soil} = Ct \times 100 \quad (4)$$

Note :
C_{soil} = Soil organic carbon (ton / ha);
Ct = Soil organic carbon (g / cm^2)

Determination of sediment type is classified based on the Shepard triangle diagram (1954) (Figure 2).

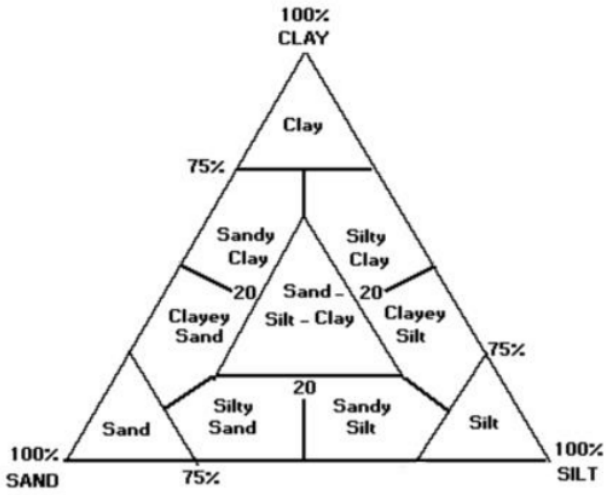

Figure 2. Diagram of Percentage and Type of Sediment [13]

3. Results and Discussion

The fine coarse texture of the soil is known through the comparison between the size of the grains of sand, clay, and mud. Based on the type of sediment classification each station has a differing type. Classification of sediment types on Payung Island based on grain size can be seen in Table 1. Based on the results of the classification of sediment types in Table 1, the percentage values of gravel, sand, mud and clay fractions at stations 1 to 8 are 73.46-94.8 %. In this study, the type of sediment obtained is predominantly clay type. Clay substrate is very suitable for the growth of mangrove species *Rhizophora* spp., *Brugueira spp., Avicennia spp, N. fruticans,* and *S. caseolaris* [14].

Table 1. Classification of Sediment Types

Station	Fraction (%)				Type
	Gravel	Sand	Mud	Clay	
1	0	8.25	2.48	89.28	Clay
2	0	16.08	2.58	81.33	Clay
3	0	8.28	3.26	88.47	Clay
4	0	4.27	3.88	91.86	Clay
5	0	2.24	3.44	94.32	Clay
6	0	24.30	2.25	73.46	Clay Sandy
7	0	7.88	3.44	88.69	Clay
8	0	1.34	3.86	94.8	Clay

Carbon and organic material of sediment samples were analyzed using the Walkley-Black method. Organic carbon is one of the compilers of organic material in sediment that important to improve the quality of sediment then mangroves can be used as a source of nutrients [15]. Organic material comes from leaf litter, twigs, decomposition of animals and plants which accumulated gradually in sediment [16]. The results of the calculation of organic carbon and mangrove sediment organic material can be seen in Figure 3.

Station 1 has the highest value for carbon storage 8.18% and the value of sediment organic matter is 14.11%. While station 8 has the lowest value for carbon storage 2.34% and sediment organic matter value 4.03%. The high level of organic carbon and sediment organic material at station 1 are caused by the large input of organism remains from animals and plants. Even though they both face airflow, this can be related to the dominant mangrove species, especially their root system. Station 1 is dominated by true mangrove species that have a root system that traps sediment and nutrient, while station 8 is dominated by *Nypa fruticans*, which hold very low sediment and litter, because it has not true root. The mangrove which getting older then more organic matter will decompose and accumulate in the sediment [17]. In addition, the high level of organic carbon is due to the ability of sediment textures to bind organic carbon. According to [18] that sediment containing sludge is generally rich in organic matter compared to sandy sediment. Based on the results of the study of organic carbon and organic material on Payung Island, it can be seen that increasing value of organic material along with organic carbon deposit at each station.

The average percentage value of organic sediment carbon and the average value of sediment organic matter were 5.04% and 8.69% respectively. The percentage value of organic carbon in this study when compared with the study by [18] in Miskam Bay, Tanjung Lesung showed a larger mangrove sediment carbon storage value around 0.78-9.51%. On the other hand, the percentage value of carbon is smaller than the research conducted by [19] in Ujung Piring Jepara, where the average sediment carbon deposit 43.38% and research by [15] 10.57 C% ± 4.87.

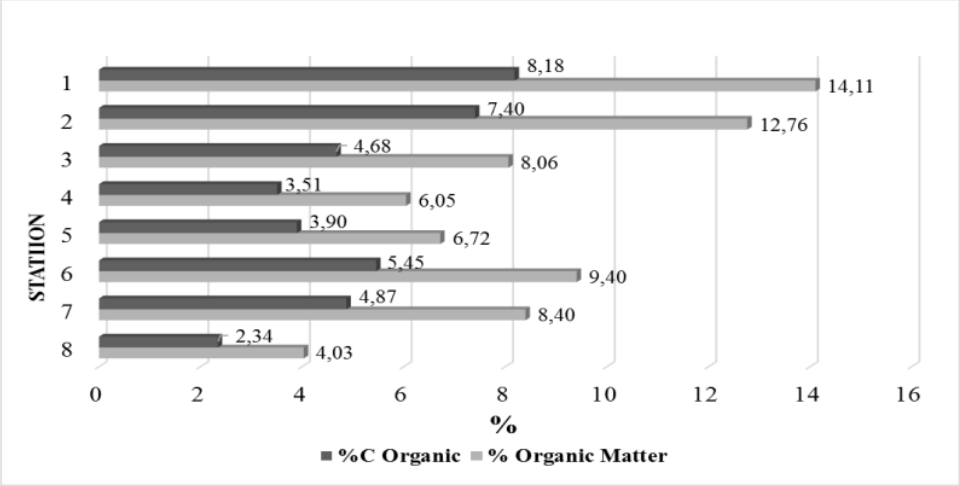

Figure 3. Percentage of Carbon and Sediment Organic Materials for Each Station

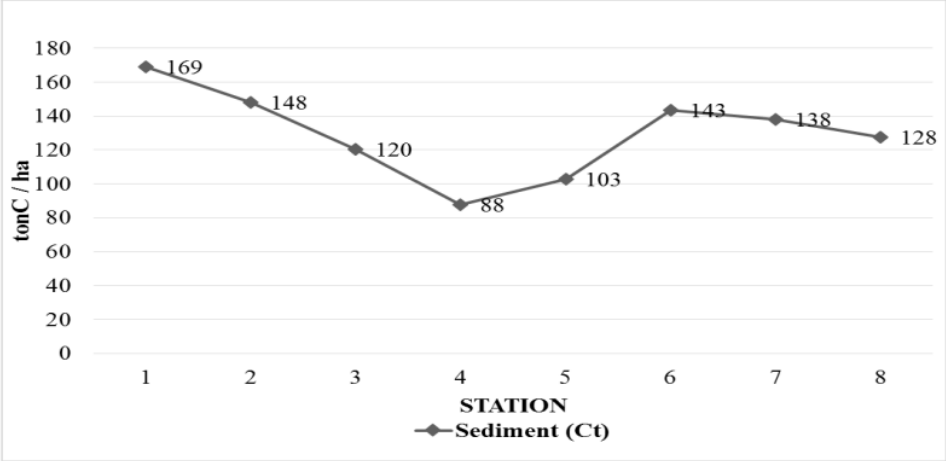

Figure 4. Sediment Organic Carbon for Each Station

Carbon content in mangrove sediment can be seen in Figure 4. The highest value of organic sediment carbon storage is 169 tonC/ha at station 1 while the lowest at station 4 is 88 tonC/ha, generally an average is 129.6 tonC/ha. The results of the average value of carbon storage of this study are greater than the research of the highest value of sedimentary carbon storage in Teluk Miskam, Tanjung Lesung by [18] 27.92 MgC/ha and smaller than research in Perancak, Bali [20] 185.96 MgC/ha. The difference in the value of sediment carbon storage are caused by differences in the value of organic matter, depth and specific soil density. The distribution of organic matter and nutrients also can be affected by tide then the stations outside the island have more dynamic value than the stastions value inside the island. The research by [21] states that deeper sediment cause higher organic carbon content in the sediment. Furthermore, higher sediment biomass content give higher the mangrove canopy cover value. In the sediment, biomass content increasing also raise the carbon content [21].

4. Conclusion

The average value of the percentage of organic carbon is 5.04% by the highest percentage of organic carbon in station 1 is 8.18%. The average value of the percentage of organic matter is 8.69 % by highest

value of organic matter being in station 1 is 14.11%. The average value of carbon storage in sediment per station is 129.6 tonC/ha.

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