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Total biomass, carbon stock and carbon dioxide sequestration value of kandelia candel stands on Payung Island, Banyuasin II Sub-district, Banyuasin Regency, South Sumatera

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ABSTRACT
Background: This research aims to analyze the value of biomass, carbon reserves and carbon dioxide uptake in Kandelia candel (L.) Druce stands and compare the values at both observation stations. **Methods**: Using the purposive sampling method, observation stations were determined based on the presence of K. candel with stem diameter ≥ 5 cm. Comparison of biomass values, carbon reserves and carbon dioxide uptake at the two stations was analyzed using graphic analysis. **Results**: The results of this research show that the biomass value from the two observation stations is 342.70 tons/ha with the highest biomass value found at station II, namely 193.69 tons/ha. The carbon reserve value is 157.65 C/ha, while the carbon dioxide uptake value is 571.32 tonnes CO2/ha. **Conclusion**: The values of biomass, carbon reserves and carbon dioxide uptake at the two observation stations are different due to differences in stem diameter.

KEYWORDS: biomass; carbon reserves; carbon dioxide; kandelia candel.

1. Introduction

Global climate change can be mitigated, among others, by reducing greenhouse gas emissions, namely carbon dioxide or CO2. This effort can be achieved through various activities, such as ensuring and maintaining forest sustainability, conserving carbon reserves, and increasing their reserves in forests (Djaenudin et al., 2015). Forests play an important role in this reduction effort. Donato et al. (2011) suggested that the type of forest that is able to draw carbon higher than other types is mangrove forest. This forest is able to store carbon according to its species. In Indonesia, there are various types of mangroves.

Mangrove forests can be found, among others, in the Payung Island area. This vegetation is the dominant one in the area. This is due to its position at the mouth of the Musi River, where the sea meets the river, which causes high salinity in the vicinity or is included in the type of brackish water so that there are natural mangroves that have the potential to absorb carbon (Afriani et al., 2017). In addition, this area is a coastal area with muddy substrate content and cannot be separated from the influence of sea tides. As a result, the ecosystem on this island is arguably natural.

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According to Sarno et al. (2020), Kandelia candel (K. candel) on Payung Island is at the level of trees with important value (NP), which is 30.59%. This is influenced by K. candel which can be found at the observation station because this species is suitable for habitat vegetation on the island, namely habitats containing mud substrates with a salinity of 0‰. The Berbak and Sembilang National Park in Banyuasin, South Sumatra is a mangrove forest area. This area has been designated as a permanent forest that functions as a conservation forest (national park).

This research refers to previous research conducted by Nugraha (2020). The results of Nugraha's (2020) research show that the national park has a biomass value of 44,708 tons/ha, the highest carbon stock of 20,566 tons/ha, and carbon dioxide absorption of 75,477 tons/ha. In particular, the biomass value between one observation station and another station is not the same because there are differences in the average diameter of K. candel mangrove stands. Therefore, further research is needed on carbon stocks in K. candel stands on Payung Island.

The formulation of this research problem is the amount of biomass, carbon stocks, and carbon dioxide uptake in K. candel stands. As a form of theoretical review, this research uses several concepts, namely carbon and biomass and carbon stocks in mangrove forests. The element carbon is important in human life. The existence of carbon in nature is contributed by various activities, such as daily human breathing that emits CO2, combustion, logging, industry, and motor transportation (Purnobasuki, 2012). Carbon is contained in the earth's land in the form of animals and plants, dead organisms, and sedimentary rocks or deposits, such as animal and plant fossils.

Biomass and carbon mass are inseparable from each other. Most of the constituents of biomass are carbon. The main constituent of biomass is carbohydrate; carbohydrates are formed from carbon, hydrogen, and oxygen produced through photosynthesis by plants (Suryono et al., 2018). Carbon storage indicates how much carbon a tree contains. The amount of carbon stored in a vegetation is influenced by the biomass of the tree, the absorption capacity of the vegetation, and soil fertility (Ati et al., 2014). Carbon content in plants implies how much the plant can bind CO2 from the air. Plants suck CO2 from the air, then convert it into organic matter through photosynthesis to grow.

2. Methods

The period of this research was January 2022 to April 2022 on Payung Island. The instruments used in the study were stationery, GPS (Global Positioning System), handrefractometer, multifunction environment meter, cloth meter, pH meter, camera, roll meter and soil tester. Research materials in the form of K. candel mangroves with stem diameters measuring ≥ 5 cm were measured for biomass calculations (Komiyama et al., 2005). Determination of observation stations using purposive sampling method.

This study operates transects with the Line Transect method, which is a method that combines the path method with a plot line. Data collection was carried out using a sampling method without harvesting (Sutaryo, 2009). Data processing using MS excel application then continued to find out the comparison of Kandelia candel carbon stock values at the two research stations.

3. Results and Discussion

This study found that the values of biomass, carbon stocks, and carbon dioxide uptake in K. candel on Payung Island are as follows.

Table 1. Biomass, carbon stock and carbon dioxide uptake values of Kandelia candel (L.) Druce on Payung Island

Observation Station	Number of individuals	Mean tree diamete (cm)	Biomass (ton/ha)	Carbon Reserve (ton C/ha)	CO_2 Uptake (tonCO_2/ha)
Station I	58	9,81	149,01	68,54	251,28
Station II	51	11,04	193,69	89,11	320,04
Total	109		342,70	157,65	571,32

Kandelia candel on Payung Island was found at observation stations I and II. Kandelia candel is commonly found at both stations. According to the results of research by Sarno et al., (2020), Kandelia candel dominates naturally and grows well in the Payung Island area at observation stations I and II with an important value index of 30.59%. This is due to the fact that this type of mangrove can grow in brackish water ecosystems and in addition, the condition of the island which is peat soil or swamp filled with fresh water.

Table 1 shows that the highest biomass value of Kandelia candel on Payung Island is at observation station II, which is 193.69 tons/ha. Meanwhile, station I only has a value of 149.01 tons/ha. The value is known from the value of the diameter of the plant's stem. The value of biomass, one of which, is determined by the size of the diameter. Suwardi et al. (2017) suggested that the level of influence of stem diameter on increasing tree biomass is 97.1%. This shows that the biomass value will be greater in a plant if the diameter size is also large.

The largest number of individual trees was indeed at station I. However, the largest biomass value was found at station II. This is due to the diameter of the trunk on trees at station II is much larger than station I. This is in line with the results of research by Mandari et al. (2016) that the highest tree density value is owned by the biomass value of plot III, but the highest biomass value at station II because the average diameter is greater than other plots. the biomass value in plot II is 47.55 tons/ha, while plot III with the highest tree density has a lower biomass value, which is 40.87 tons/ha.

Stem diameter has a positive correlation with biomass value; larger stem diameter, more biomass value, and vice versa, smaller stem diameter, less biomass value. According to Agustin et al. (2014), this is because stem diameter is positively correlated with root diameter, so the only way to measure root biomass value is by measuring stem diameter.

The results of research by Mandari et al. (2016) are consistent with the research findings. At station I, there were 58 trees with a biomass value of 149.01 tons/ha, which was lower than station II, which had 51 trees and a biomass value of 193.69 tons/ha. The average tree diameter at station II was larger than that at station I. Therefore, the seeds at station II were larger than the seeds at station I. Therefore, the magnitude of the diameter value has a stronger influence on the magnitude of the biomass value.

Table 1 shows that the highest carbon stock value of K. candel is found at observation station II, which is 89.11 tons C/ha, while at station I it is 68.54 tons C/ha. This is in accordance with the diameter at breast height that the larger, the higher the biomass value in the plant. Hariah and Rahayu (2007) explained that the size of the stem diameter is proportional to the biomass value. The high DBH implies that the trees are older and have more carbon reserves. The amount of forest biomass and carbon stocks is strongly influenced by photosynthesis as a physiological process in plants. The amount of photosynthesis rate of a stand is related to chlorophyll, number of stomata, age, canopy cover, and canopy structure. The larger the leaf area per unit of land, the greater the CO2 absorbed by the stand (Lukito and Rohmatiah, 2013). The more leaves a tree has, the older it is and the greater its biomass potential and ability to store carbon. Thus, age affects the value of biomass and carbon stocks in a stand.

Differences in carbon stock values at the two observation stations may occur due to different stem diameter sizes in K. candel. Hairiah et al. (2011) suggested that the difference in the amount of carbon stocks between the two observation stations is also influenced by plant density and substrate type. In a field, carbon storage will be greater if the soil is fertile because tree biomass increases. In other words, carbon stocks or above-ground plant biomass are influenced by the amount of soil organic matter or carbon in the soil. Thus, it is necessary to measure the number of trees on the land as well.

The trunk has the largest carbon stock value. This is because it is made up of 40-56% cellulose. Cellulose in the stem is built by carbon, so the higher the cellulose, the higher the carbon content (Manafe et al., 2016). Cellulose, which is abundant in the stem, becomes the main wall that strongly encloses plant cells, making the content higher. As a result, the value of carbon reserves will also be high. In addition, the larger the diameter, the more cellulose is found in the tree trunk.

Based on Table 1, the carbon dioxide uptake value at observation station I is 251.28 tons CO2/ha, while observation station II is 320.04 tons CO2/ha. Station II has a high biomass value and carbon reserves so that the absorption value is also high. This is in line with the explanation of Heriyanto and Subiandono (2012) that carbon dioxide absorption is related to stand biomass. The amount of biomass in mangrove areas can be known from the production and absorption by measuring the diameter, height, and specific gravity of trees and soil fertility.

According to Iswandar et al. (2017), the amount of carbon sequestration in mangrove species is related to the diameter and height of the tree because the larger the tree increases the potential for carbon sequestration. Carbon dioxide is absorbed by trees through roots, stems, twigs, and leaves, then photosynthesized through leaves, then converted into organic carbon stored in the form of biomass in stems, roots, twigs, branches, and leaves.

The value of carbon storage affects the carbon dioxide uptake value obtained. This reserve makes the greater the value of carbon uptake. According to Yaqin et al. (2022), the ability of mangroves to absorb carbon dioxide cannot be separated from one factor, namely the estimation of carbon reserves contained in the stand.

Different mangrove composition can also be caused by conditions in each mangrove area. According to Ulqodry et al. (2014), mangroves are C3 plants, which means that different environmental conditions and different species will create differences in terms of sensitivity and photosynthetic ability. These environmental differences include light intensity, salinity, tides and temperature, among others. Therefore, this research also found the results of K. candel's environmental parameters as shown in the following table.

Table 2. Environmental parameters of Kandelia candel (L.) Drucedi Payung Island

Parameters	Research Location	
	Station I	**Station II**
Water Salinity (°/◦◦)	0	0
Sediment pH	7,0	7,0
Air Temperature (˚C)	24˚ C	28˚ C
Air Humidity (%)	90,0	91,1
Light Intensity (lux)	0,25	0,28
Substrate Type	Clay	Sandy clay

Based on the table above, observation station I has a salinity of 0°/° with a temperature of 25°C, while the salinity at station II is II 0°/° with a temperature of 28°C.

Both stations have good salinity values that are suitable for mangrove growth, which can then increase the value of biomass, carbon dioxide uptake, and carbon stocks. Photosynthesis, among others, is influenced by temperature. The results of research by Hutasoit et al. (2017) showed that a good temperature range for photosynthesizing mangroves is 20-30 °C. The temperature on Payung Island is 25-28 ° C so it is good to support mangrove growth because these plants get enough sunlight.

The salinity measurement value in Table 2. shows that the salinity value is 0/°°. This means that Payung Island has waters that tend to be fresh. According to Matatula et al. (2019), salinity is one of the important factors in mangrove growth, endurance and zonation. In general, mangroves live in salty or brackish areas.

Freshwater and seawater greatly affect high and low salinity levels. Noor et al. (2006) stated that mangrove composition is strongly influenced by salinity conditions. These salinity levels are faced by different types of mangroves in different ways. Certain species can absorb salt from the growing medium, while other species can remove it through certain glands on the leaves. Air humidity at station I 90.0% and station II 91.1%, respectively, showed a positive correlation with carbon stock biomass and carbon dioxide uptake values.

The light intensity at station I was 0.25 lux and at station II was 0.28 lux. In the process of photosynthesis, it is needed to absorb carbon dioxide, which will then be converted into organic carbon to be stored as biomass (Sutaryo, 2009). The results of photosynthesis are needed by plants to grow vertically and horizontally, which can be seen from the increase in height and diameter. According to Syam'ani et al. (2012), plants collect CO_2 through the help of sunlight, then converted as organic compounds or carbohydrates.

Observation stations I and II have a soil pH of 7.0. This value indicates the acidity of the soil. According to Ariani et al. (2016) mangroves can develop well in waters that have acidity with a pH range of 6.0 - 9.0. Therefore, these two stations become a good place for mangrove growth.

4. Conclusions

The results of this study show that the value of biomass stored in Kandelia candel (L.) Druce stands on Payung Island is 342.70 tons/ha, the value of carbon reserves stored is 157.65 tons/ha and the value of carbon dioxide absorption is 571.32 tons CO_2/ha.

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