Estimation of Bruguiera’s Carbon Stock In Berbak and Sembilang National Park Banyuasin South Sumatera

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Estimation of Bruguiera's Carbon Stock In Berbak and Sembilang National Park Banyuasin South Sumatera

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Abstract *:*

The potential for the carbon content of mangrove forests is four times greater than other forest, this important information needs to be measured to determine the value of carbon stocks at a given time and their changes. The research was done in November 2018-March 2019 in Berbak and Sembilang National Park, Banyuasin, South Sumatra, in each location three transect lines were determined perpendicular to the land as far as 100 m and made 5 plots of 10 x10 m with a distance between plots of 10 m on each transect. The aims are to determine species richness, biomass value, estimated stored carbon reserves, and CO2 uptake in Bruguiera spp. stands. Analysis of comparison of the results of data using descriptive statistical analysis. Based on the results of the study found 4 types of Bruguiera spp. that is Bruguiera cylindrica, Bruguiera parviflora, Bruguiera gymnorrhiza, and Bruguiera sexangula. The total value of the biomass of 410,01 ton/ha, carbon stocks estimation of 189,02 ton C/ha, and the CO2 uptake of 693,69 ton CO2/ha. The results of a statistic descriptive analysis of estimated carbon stocks and CO2 uptake, in Barong Kecil river where of the most areas has been deforested into ponds, have the lowest value than the other research locations like Solok Buntu and Bungin river, with sequential carbon values of 11,51 ton C/ha in Barong Kecil river, 227,66 ton C/ha in Bungin river, and 327,88 ton C/ha in Solok Buntu river, and CO2 uptake of 42,23 ton CO2/ha in Barong Kecil river, 835,52 ton CO2/ha in Bungin river, and 1.203,33 ton CO2/ha in Solok Buntu river.

Keywords: Biomass; Bruguiera; Carbon Stocks; Mangrove; TNBS

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1. Introduction

One of problems in cultivating rice in non-tidal Forest biomass is very relevant to the issue of climate change. Forest biomass plays an important role in the biogeochemical cycle, especially in the carbon cycle. Carbon compounds found in forests, about 50% of them are stored in forest vegetation. As a consequence, if there is forest destruction, fire, logging and so on will increase the amount of carbon in the atmosphere.

Mangrove forest area is an area that is very important for the ecosystem because it can function as a bridge between the ocean and the land and various other functions. Mangrove forests have the ability to absorb carbon more than other types of forests. Based on the research of [1];[2] secondary mangrove forests can store carbon 54.1-182.5 tons C / ha and secondary highland forests can store carbon of 39.48 tons C / ha.

South Sumatra has a mangrove forest in the Berbak and Sembilang National Park (TNBS) located in Banyuasin, South Sumatra, a mangrove forest area designated as a permanent forest area with a conservation forest function as a National Park based on Minister of Forestry Decree No. 95 / Kpts-II / 2003 on March 19, 2003 [3].

According to [13], mangrove forest deforestation that occurred in BBSNP over a period of 6 years (2003-2009) caused a decrease in mangrove area of 8,232.29 ha or around 9.86%. The change in mangrove area is due to the activity of land clearing for settlement as well as the conversion of some mangrove land into ponds.

TNBS area which is still natural and no ponds are found, one of which is the Bungin River. The existence of ponds are found around the Barong Kecil River and Solok Buntu River which are still in the greenbelt region. According to [15], the area of ponds in the National Park area is around 930 ha, while the area of ponds in the greenbelt area is 238 ha.

the Bruguiera cylindrica biomass found in the TNBS area, especially in the Barong River Estuary is 1.11 tons / ha with a carbon stock value of 0.51 tons C / ha [4]. The value of biomass and stored carbon content varies in different ecosystems, depending on the diversity and density of existing plants, soil types, and how to manage these ecosystems.

2. Materials and Methods

The research was conducted in October 2018 until March 2019, including data collection activities in the field and data analysis. The study was conducted in TNBS, Banyuasin Regency, South Sumatra Province, precisely in the area of the Barong Kecil River, Solok Buntu River and Bungin River. Data processing was carried out at the Ecology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Sriwijaya University.

Location determination is based on the purposive sampling method, which is to determine the research location intentionally by considering and considering the accessibility of the research area. Observation location I was on the Barong Kecil River and observation site II was on the Solok Buntu River which is an area adjacent to the pond while location III was the Bungin River which is an unspoiled area (Figure 1).

Figure 1. Map of research location

The tools and materials used in the study are stationery, GPS, hand-refractometer, camera, tape, roll meter, and soil tester. The material used in the form of stands of Bruguiera spp. with a stem diameter of ≥ 5 cm. Field observations were made by recording names and counting the number of stands of Bruguiera spp. and mangrove species other than Bruguiera spp. encountered at the study site.

Each observation location, namely Barong Kecil River, Solok Buntu River and Bungin River has 3 transect lines drawn perpendicularly from the river direction to the mainland as far as 100 m with an unspecified distance between transects using the Line Transect method. Each transect has a number of plots that adjust to the length of the transect, as many as 5 plots with a plot size of 10 × 10 m, with a distance between plots of 10 m.

Conversion of the value of the surrounding stem of the Bruguiera stand. to the diameter of the stem, using the following formula:

$$D = \frac{K}{\pi}$$

Note: D = Diameter; K = circumference; π = 3.14

The results of the conversion of the circumference of the mangrove stem to the diameter of the mangrove stem are included in the allometric equation (Table 1).

Table 1. Allometric equations for Bruguiera stand biomass calculations.

Biomass	Allometric model	Source
Above biomass (SB)	$B = 0{,}251 \times \rho \times D^{2.46}$	[14]
Root biomass (RB)	$B = 0{,}199 \times \rho^{0.899} \times D^{2.22}$	
Total Biomassa (X)	$B = SB + RB$ (ton/ha)	

Note: B = Biomass (tons / ha); D = Diameter (cm); ρ = wood specific gravity (gr / cm3); The value of ρ for Bruguiera gymnorrhiza is 0.8683 [5]; The value of ρ for Bruguiera cylindrica is 0.8100 [5]; The ρ value for the Bruguiera sexangula is 0.8300 [5]; The value of ρ for Bruguiera parviflora is 0.8427 [5].

Convert biomass values from gr / cm2 to tons / ha

$$Bn = \frac{Bx}{1.000.000} \times \frac{100.000.000}{Luas\ plot}$$

Note: Bn = biomass per hectare (ton / ha); Bx = biomass in each plot (gr / cm2)

Convert the value of biomass into carbon stock using the following formula:

$$C = B \times 46\%$$

Note: C = Carbon Reserves (tons C / ha); B = Biomass (ton / ha)

Convert carbon stock values to carbon sequestration using the following formula:

$$\text{uptake of carbon dioxide} = 3{,}67 \times C$$

Note: CO2 uptake = (tons of CO2 / ha); C = Carbon Reserves (ton C / ha)

Comparative analysis of Bruguiera carbon stock values

Data from the calculation of carbon stock values were analyzed by descriptive statistical analysis using the SPSS 25.0 application. to compare carbon stock values and CO2 uptake values in the three study sites.

3. Results And Discussion

3.1 Bruguiera Standing Biomass

Based on research conducted to estimate the magnitude of biomass and carbon stocks in the Barong Kecil River, Bungin River and Solok Buntu River, TNBS, the following results were obtained (Table 2.)

Bruguiera types found in the Barong Kecil River, Bungin River and Solok Buntu River are Bruguiera cylindrica, Bruguiera parviflora, Bruguiera sexangula, Bruguiera gymnorrhiza. Trees with older age tend to have a larger diameter, so biomass deposits will be higher than trees with a younger age. According by [6], trees which have an older age have a diameter, height and specific gravity of trees that are of greater value compared to trees of a younger age. Information about the biomass content stored in each tree with different levels / age classes is needed in order to become one of the considerations in mangrove forest management.

The difference in the value of density causes a difference in the calculation of the value of biomass, which will affect the value of carbon stocks. One of the largest carbon stock values at the Solok Buntu River station is influenced by the species found in the form of Bruguiera gymnorrhiza and Bruguiera parviflora which have density values of 0.8683 gr / cm3 and 0.8427 gr / cm3, greater than Bruguiera species the other. According by [7], the carbon content for each type of mangrove vegetation will differ from one another, depending on the density of wood. The higher the density of wood, the more biomass content. The greater the biomass content, the stored carbon content will be even greater.

Table 2. Bruguiera Biomass Values in Berbak and Sembilang National Parks

Location of Observation	Transek	Species	Number of Individuals (Ind)	Tree Diameter (cm)		Biomassa (gr/cm^2)			Biomassa (ton/ha)
				The range	Average	Above ground biomass	Root biomass	Total	
Barong Kecil River	I		0	0	0	0	0	0	0
	II	*Bc*	6	5,10-11,78	6,91	164,48	80,66	375,22	75,04
		Bs	1	11,78	11,78	89,90	40,18		
	III		0	0	0	0	0	0	-
Total			7	5,10-11,78	7,60	254,38	120,84	375,22	25,01
Solok Buntu River	I	*Bp*	12	5,09-20,70	8,76	850,07	363,61	3.302,57	660,51
		Bg	3	5,40-36,31	16,66	1.553,05	535,84		
	II	*Bp*	6	7,00-8,92	8,24	230,60	111,73	342,33	68,47
	III	*Bp*	29	5,10-24,20	12,81	5.015,10	2.012,91	7.046,97	1.409,39
		Bg	1	5,15	5,15	12,29	6,67		
Total			51	5,09-36,31	11,40	7.661,11	3.030,76	10.691,87	712,79
Bungin River	I		0	0	0	0	0	0	-
	II	*Bg*	1	9,30	9,30	52,58	24,76	77,34	15,47
	III	*Bg*	30	5,10-33,51	13,28	5.252,40	2.094,02	7.346,42	1.469,28
Total			31	5,10-33,51	13,15	5.304,98	2.118,78	7.423,76	494,92
Total			89	5,10-33,51	11,71	13.220,47	5.270,38	18.490,85	410,91

Information: Bc = Bruguiera cylindrica, Bp = Bruguiera parviflora, Bs = Bruguiera sexangula, Bg = Bruguiera gymnorrhiza

The average diameter of the largest tree in the location of the Bungin River is 13.15 cm, the location of the Solok Buntu River is 11.40 cm, while the smallest average diameter is at the location of the Barong Kecil River which is 7.60 cm. This difference in diameter size is due to individual trees in the Bungin River location having an older stand age value compared to the age of individual tree stands in the Barong Kecil River. Stated that biomass will increase along with increasing plant age, this is because the diameter of the tree grows through continuous cell division and slower at a certain age. The growth occurs in the cambium so that new cells are formed which will increase the diameter of the tree trunks obtained [8].

Based on the analysis of aboveground biomass data, the value is greater than the results of data analysis for root biomass, the total value of above biomass is 13,220.47 gr / cm2 and the total value for root biomass is 5,270.38 gr / cm2. This difference in value is influenced by the number of parts of the tree included in it, for the upper biomass part includes the leaves, twigs, branches, and also the trunk, while for root biomass only includes the root section. These results are in accordance with the research [9] that the distribution of biomass in each tree component illustrates the magnitude of the distribution of photosynthetic products stored by plants. The largest distribution of photosynthesis is in the stem.

Diverse canopy structure and the number of tree stands in a location have a big influence on the value of the biomass content, the more the number and size of individuals in a location, the greater the amount of biomass produced. It is known that the location of the Solok Buntu River has a biomass of 712.79 tons / ha and in the Bungin River of 494.92 tons / ha, while the location of the Barong Kecil River has a significant difference in value with a biomass value of 25.01 tons / ha, this is because at the location of the Little Barong River has a young stand age can be seen from the average diameter of the tree, and based on observations at the location there are still many individuals who are still in the form of seedlings. The total amount of biomass contained in the TNBS area is 410.91 tons / ha.

In general the biomass of plant parts is positively correlated with the total diameter and height of the tree. The positive correlation of tree part biomass is greater in relation to the diameter of the tree compared to the total height. The positive correlation that occurs can be interpreted that an increase in plant diameter or total plant height will also be followed by an increase in biomass in each of the plant parts [10].

3.2 Estimation of Carbon Reserves and Bruguiera Carbon Dioxide Uptake

Based on Table 3. and the results of descriptive analysis the average stored carbon stock of Bruguiera stands highest at the location of the Solok Buntu River at 327.88 tons C / ha and the smallest average carbon stock is at the Barong Kecil River at 11.51 tons C / ha. In line with the amount of biomass found at each station, the greater the biomass, the greater the carbon stock in the area. According by [11], that the size of the leaves, the size of the tree diameter, and the most important is the number of individuals and the size of individuals at a greater tree level produces a large amount of biomass and carbon, carbon stock is positively correlated with the amount of biomass, which means greater biomass savings then the carbon stock will be higher so that the potential for CO2 absorption is also increasing.

The value of carbon stock stored at each location varies depending on the size of the stem diameter, age, number, and species differences that affect the value of its density. State that the age of a stand is thought to affect the biomass and the amount of carbon stored in a stand [12].

Table 3. Carbon stock values and carbon dioxide uptake of Bruguiera stands in BBSNP

Location of Observation	Transect	Species	Carbon Reserves (ton C / ha)	Absorption of Carbon Dioxide (CO2 tons / ha)
Barong Kecil River	I		0	0
	II	*Bc* *Bs*	34,52	126,69
	III		0	0
Total			11,51	42,23
Solok Buntu River	I	*Bp* *Bg*	303,84	1.115,08
	II	*Bp*	31,49	115,58
	III	*Bp* *Bg*	648,32	2.379,34
Total			327,88	1.203,33
Bungin River	I		0	0
	II	*Bg*	7,12	26,11
	III	*Bg*	675,87	2.480,45
Total			227,66	835,52
Total			189,02	693,69

The amount of forest biomass and carbon stock is also very dependent on the physiological process of plants, namely photosynthesis. The magnitude of the photosynthetic rate of the stand is related to the condition of the canopy structure, canopy cover, total leaf area, chlorophyll content, number of stomata per unit leaf area, and stand age. The greater the area of stand leaves per unit of land, the more CO2 will be absorbed by the stands. The total leaf area will increase in line with the age of the stand because the tree canopy will be wider, so it can be assumed that the age of the stand will affect the biomass and the amount of carbon stored in a stand [12].

Based on data and statistical descriptive analysis results it is known that the Bruguiera stand which has the highest absorption value of carbon dioxide (CO2) is the location of the Solok Buntu River with a value of 1,203.33 tons CO2 / ha, and the smallest is 42.23 tons CO2 / ha. The CO2 absorption value is influenced by the amount of carbon stock stored in a plant. The greater the value of carbon stocks, the value of CO2 absorption will also be even greater [13].

The lowest average CO2 absorption is found in the Barong Kecil River. This is caused by several factors such as the small number of stands, age of stands, diameter size, species found so that competition occurs between plants in the region. Bruguiera found at the Small Barong River location is Bruguiera cylindrica which has a tree habitus that is smaller than other Bruguiera species that only reaches 20 m, based on herbaria 7-9 it has the smallest leaves measuring 8-9.6 x 4-4.9 cm thinner than other types, and Bruguiera sexangula with leaf size based on specimens 10-12 ie 8.5-10.5 x 2.5-5 cm. The smaller the size of habitus and leaf area, the ability of CO2 absorption will decrease [14].

The total value of CO2 uptake in the TNBS area of 693.69 tons CO2 / ha indicates that the Bruguiera stand in TNBS has the potential to reduce CO2 levels in the air so that it can reduce CO2 levels in the atmosphere, and reduce its impact on living creatures and as a means of mitigating change climate. Mangrove ecosystems play an important role in the carbon cycle in the world. Mangroves have an ecological function as carbon sinks and depositors. Mangroves absorb CO2 compounds during photosynthesis, then convert them into carbohydrates by storing them in the form of biomass in roots, trees and leaves [15].

The results showed that the Barong Kecil River area had the smallest Bruguiera carbon stock compared to the other two locations namely the Bungin River and the Solok Buntu River. This is presumably because the Barong Kecil River area is the area closest to the sea so that it has the highest salinity that affects the growth of Bruguiera and is the area that has the most deforestation due to the presence of ponds, which cause disturbance to the mangrove natural habitat in the area. This shows that deforestation in an area causes a decrease in the region's ability to store C and absorb CO2 in the air. Based on the results of the study the value of Bruguiera biomass at the three research sites in Banyuasin National Park South Sumatra is 410 tons / ha, the estimated value of carbon stocks is 189.02 tons C / ha, and the CO2 absorption value is 693.69 tons of CO2 / ha. The results showed a higher number compared to the results of research by [16] in Kubu Raya, West Kalimantan. 55 tons CO2 / ha, this shows that Bruguiera in the TNBS area has greater potential to absorb and store carbon.

4. Conclusions

Bruguiera species richness in the TNBS area includes: Bruguiera cylindrica, Bruguiera parviflora, Bruguiera gymnorrhiza, and Bruguiera sexangula; The potential of biomass in the Bruguiera stand in the TNBS area has a value of 410.91 tons / ha. Descriptive analysis results estimation of carbon stocks and CO2 uptake in the Barong Kecil River area that experienced deforestation into the most extensive ponds have the smallest value compared to the locations of the Bungin River and Solok Buntu River, with sequential carbon values of 11.51 tons C / ha, 227, 66 tons C / ha, and 327.88 tons C / ha, and CO2 absorption values of 42.23 tons CO2 / ha, 835.52 tons CO2 / ha, and 1,203.33 tons CO2 / ha. The existence of a pond affects the amount of carbon stock and CO2 uptake in the BBSNP area. Periodic research needs to be done so that changes in the ability of Bruguiera stands in the BBSNP area as a store of carbon stocks are continuously monitored and further research is carried out on the estimation of other types of stored carbon stocks so that activities in the context of climate change mitigation become more optimal.

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