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Study of Carbon Stock Potential and Carbon Absorption on Pamonean Land of Mentawai Community at Siberut Island

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Abstract

The amount of carbon stored in each land varies depending on the species diversity and the existing plant density, the type of soil and the form of management. Long-lived plants or trees grown in forests as well as extensive mixed gardens (agroforestry) are much larger carbon storage than other forms of management. Pamonean is an agroforestry land of indigenous people at Mentawai that have been carried out from generation to generation and are different from other land management systems in Sumatera. Research on carbon stock potential and carbon absorbtion capability in pamonean lands indigenous peoples at Mentawai was conducted in April 2018. Data collection for tree and sapling rates using non destructive methods and using allometric equations Kettering, Hairiah and Arifin. Result of analysis get total pamonean carbon stock equal to 155,66 ton/ha with capability of CO2 absorption equal to 571,27 ton/ha. The highest carbon reserves are found at the tree level of 135.05 ton/ha, the sapling rate of 20.61 tons/ha. Cultivated plants contribute the highest carbon stock of 98.35 tons/ha, while the value of wild plant carbon stocks allowed to grow by 57.31 tons/ha. The Pamonean Lands of Mentawai indigenous peoples are an important part of the world climate change mitigation efforts.

Keywords: stock carbon, absorptions, Pamonean and Mentawai

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1. Introduction

Agroforestry is a collective name for land use systems and technologies where hard-wood crops are deliberately used in the same land management unit as agricultural and / or animal crops, in some form of spatial and temporal arrangements. Agroforestry is a system of natural resource management through tree integration in agricultural landscapes, diversification of plant species for social, economic and environmental enhancement. In agroforestry land, at least meet three basic criteria, such as: a). There

are at least two species that interact biologically. b) At least one of the species is woody. c) At least one of the plant species is managed for feed sources, on an annual basis. Agroforestry systems are always more complex, for example in structure, function and economy, compared to the monoculture system [1].

The agroforestry system can help sustainable natural resource productivity by improving soil fertility, controlling erosion and improving the microclimate of the land. The agroforestry design maximizes the positive interaction between trees and other elements and minimizes negative interactions [2].

Long-lived plants or trees grown in forests or in mixed or agroforestry gardens are places where carbon stocking or storage is much larger than in annual crops. Planting trees on farms is essential to reduce excessive amounts of CO^2 in the air [3].

Siberut Island is one of the Mentawai archipelagos in West Sumatra, separated more than 500,000 years ago by seawater from mainland Asia. The process of separation has taken place since the time of Pleistocene [4]. Very long separation or isolation causes the flora and fauna of Siberut Island to experience its own evolutionary process that is different from the process that occurs on the Sumatra island. The consequences of the process lead to the formation of speciations and the appearance of endemic species.

Similarly, the land processing system implemented by the indigenous Siberut. They conduct the domestication process of several types of food plants to be planted as an effort to meet the needs of food, culture and so forth. Agricultural land cultivation system in the form of agroforestry or mixed plant pattern between useful plants and plants. The agroforestry system in Siberut's original language is called Pamonean.

The Siberut region has a long history of agroforestry, based on the needs of the community and the peculiarities of the place developed by the native agroforestry system over the years. The Siberut indigenous agroforestry system has great potential in carbon storage and sequestration, but there is not much information about carbon allocation in the region. In the global climate change mitigation efforts, it is important to conduct research on the amount of carbon content and its ability to absorb Pamonean land on the island of Siberut.

2. Materials and Methods

2.1. Times

This research takes three months. Beginning with field data retrieval in April 2018, data processing and analysis during May and June 2018.

2.2. Study area

The research was conducted in Bekemen, Bojakan Village, North Siberut District, Mentawai Islands District of West Sumatra Province, Indonesia. The location of the data collection lies in the position S = 01° 12'07.3" and E = 098° 50'40.8". Bekemen area is a former traditional village that has been abandoned. However, pamonean land that has existed in the area since the first time they still manage with traditional systems and ways. Pamonean land is along the left and right of the Bekemen river, which is a branch of the main river Sikabaluan. Bekemen area is approximately 23 km from Capital District Sikabaluan, directly adjacent to Siberut National Park. So this area is a buffer zone for Siberut National Park (Fig. 1).

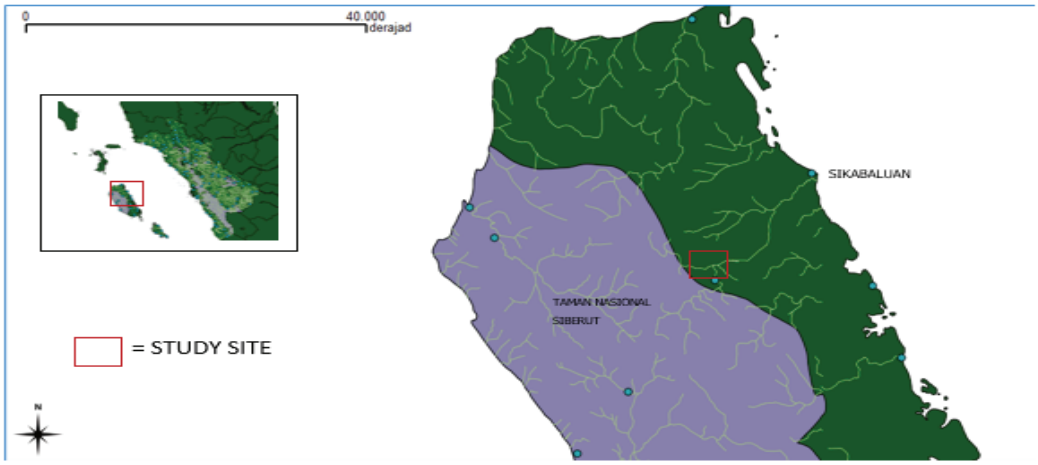

Figure 1: Map of Research Locations.

2.3. Methodology

The study of carbon stock measurement on pamonean land uses non destructive method, considering that the pamonean land is active land that is still managed by traditional society. In plots 25 plots are made in two transects that extend from the river bank to the end of the pamonean, perpendicular to the contour lines. Plots were made each measuring 10x10 meters for tree data collection (dbh> 10 cm) and 5x5 meters for sapling data retrieval (dbh 2 - 10 cm). The data parameters taken were plant species, stem diameter (1.3 m) and total height of stem. In this study the data of nekromas and litter were not taken because the land was always cleaned by the land owner. The plant species obtained were collected and identified at the Herbarium Universitas Andalas (ANDA) using manuals such as Flora Malesiana [5]; [6]; [7]; [8]; [9], Tree Flora of Malaya [10]; [11], The collection and Illustration of Tropical Plant [12].

2.4. Data analysis

Pamonean land is covered by various types of plants with different habits. To obtain data on biomass, each type of plant used three allometric equations, namely:

1. For branched timber trees used the formula Ketterings, 2001:Biomass = 0.11.p.D2, 62

2. For the branchless wood trees used the formula Hairiah et al., 1999:Biomass = π.p.H.D^2 / 40

3. For banana trees used the formula Arifin, 2001:

Biomass = 0,030.D2,13

Where:

p = Plant Species Weight

H = Tree Height

D = Trunk Diameter

The amount of stored carbon is calculated using the formula:

C = Biomass x 0.46

Carbon uptake capability:

Absorption = C x 3.67

3. Results and Discussions

A total of 25 plots that have been made each for trees and sapling, obtained 150 individual tree levels and 51 individuals for sapling levels. In general, the density of plants in the pamonean field in Bekemen is 600 individuals / ha for the tree level and 816 individuals / ha for the sapling level with a total of 1,416 individuals / ha of land.

The results of identification get as many as 37 species of plants that are incorporated in 13 families. Most species of plants from the families Euphorbiaceae and Palmae were found the most. Of the 37 species found, 16 species are cultivated plants, the rest are wild plants (Table 1) that are allowed to grow in pamonean land because it has functions for buildings, medicines, cultural rituals and so on.

From the results of the analysis of carbon content, it was found that the total carbon content stored in the pamonean land in the Bekemen area was 155.66 tons / ha and the ability of land carbon uptake was 571.27 tons / ha. The highest carbon stocks are at the tree level of 135.05 tons / ha and the lowest at the sapling level of 20.61 tons / ha. Likewise, the highest carbon uptake at the tree level is 495.64 tons / ha and the lowest carbon uptake at the sapling level is 75.63 tons / ha. Therefore, see table 2 for more detail of the carbon stock for each species.

Based on the origin of plants in the pamonean field, cultivated plants have higher carbon content than wild plants. Cultivation plants have carbon reserves of 79.68 tons/ha at the tree level and 18.67 tons / ha at the sapling level. The smallest carbon stock is found in wild plants at a sapling rate of 1.94 tones / ha. The same thing is also found in the value of carbon uptake capability, tree-level cultivated plants have the highest

Table 1: The species of plants obtained at Pamonean Land in Bekemen Area.

No.	Family	Species	Vern Name	Sources	
				Cultivated	Wild
1	Anacardiaceae	*Mangifera indica*	Tambojo	+	-
2	Annonaceae	*Polyalthia sp*	Tengleu	-	+
3	Bombacaceae	*Durio zibethinus*	Doriat	+	-
4	Bombacaceae	*Durio carinatus*	Tok tuk	+	-
5	Bombacaceae	*Durio laccensis*	Kinoso	+	-
6	Dipterocarpaceae	*Hopea sangal*	Karai	-	+
7	Euphorbiaceae	*Baccaurea sp1*	Kapundung	+	-
8	Euphorbiaceae	*Baccaurea sp2*	Elak Mata	+	-
9	Euphorbiaceae	*Baccaurea sp3*	Ongang	-	+
10	Euphorbiaceae	*Baccaurea parvifolia*	Ololosit	-	+
11	Euphorbiaceae	*Hancea griffithiana*	Ungla	-	+
12	Euphorbiaceae	*Endospermum sp*	Bag bag	-	+
13	Gnetaceae	*Gnetum gnemon*	Bake	+	-
14	Guttiferae	*Garcinia sp*	Sangkla	-	+
15	Lauraceae	*Litsea sp*	Mamagri	-	+
16	Melliaceae	*Lansium sp1*	Mabulu	+	-
17	Melliaceae	*Lansium sp2*	Tolu Gokgok	+	-
18	Moraceae	*Artocarpus integer*	Peigu	+	-
19	Moraceae	*Artocarpus elasticus*	Baiko	-	+
20	Moraceae	*Artocarpus sp*	Tapeiki	-	+
21	Moraceae	*Ficus variegata*	Karamangra	-	+
22	Moraceae	*Ficus sp*	Tepu Tepuk	-	+
23	Myristicaceae	*Myristica sp*	Onam	-	+
24	Myristicaceae	*Horsfieldia sp*	Roan	-	+
25	Myrtaceae	*Eugenia sp*	Kalumajak	-	+
26	Myrtaceae	*Eugenia cymosa*	Rimbu	-	+
27	Musaceae	*Musa paradisiaca*	Bago	+	-
28	Palmae	*Areca catechu*	Pinang	+	-
29	Palmae	*Areca sp*	Nempeu	-	+
30	Palmae	*Arenga obtusifolia*	Poula	-	+
31	Palmae	*Coccos nucifera*	Toitet	+	-
32	Palmae	*Metroxylon sagu*	Sagu	+	-
33	Palmae	*Oncosperma sp*	Ariribuk	-	+
34	Phyllanthaceae	*Aporosa sp*	Sipuloi	-	+
35	Sapindaceae	*Nephelium cuspidatum*	Bailongkan	+	-
36	Sapindaceae	*Nephelium sp*	Para Batti	-	+
37	Thymelaeaceae	*Aquilaria malaccensis*	Simoitek	+	-

Table 2: The carbon stock of each species at Pamonean Land in Bekemen Area.

No.	Family	Species	Vern Name	Carbon Stock (Ton/ha)	
				Cultivated	Wild
1.	Anacardiaceae	*Mangifera indica*	Tambojo	0.1434081	
2.	Annonaceae	*Polyalthia* sp	Tengleu		0.0290967
3.	Bombacaceae	*Durio zibethinus*	Doriat	8.0318201	
4.	Bombacaceae	*Durio carinatus*	Tok tuk	32.9881956	
5.	Bombacaceae	*Durio laccensis*	Kinoso	7.8111269	
6.	Dipterocarpaceae	*Hopea sangal*	Karai		0.7912951
7.	Euphorbiaceae	*Baccaurea* sp1	Kapundung	5.7212405	
8.	Euphorbiaceae	*Baccaurea* sp2	Elak Mata	0.8539109	
9.	Euphorbiaceae	*Baccaurea* sp3	Ongang		0.0110834
10.	Euphorbiaceae	*Baccaurea parvifolia*	Ololosit		0.3779925
11.	Euphorbiaceae	*Hancea griffithiana*	Ungla		0.0441938
12.	Euphorbiaceae	*Endospermum* sp	Bag bag		0.3519244
13.	Gnetaceae	*Gnetum gnemon*	Bake	0.6002072	
14.	Guttiferae	*Garcinia* sp	Sangkla		0.1095400
15.	Lauraceae	*Litsea* sp	Mamagri		0.1491960
16.	Melliaceae	*Lansium* sp1	Mabulu	1.2705121	
17.	Melliaceae	*Lansium* sp2	Tolu Gokgok	0.1256587	
18.	Moraceae	*Artocarpus integer*	Peigu	5.2852048	
19.	Moraceae	*Artocarpus elasticus*	Baiko		0.4773447
20.	Moraceae	*Artocarpus* sp	Tapeiki		1.8273014
21.	Moraceae	*Ficus variegata*	Karamangra		0.0964812
22.	Moraceae	*Ficus* sp	Tepu Tepuk		0.0116265
23.	Myristicaceae	*Myristica* sp	Onam		0.4104589
24.	Myristicaceae	*Horsfieldia* sp	Roan		2.4933015
25.	Myrtaceae	*Eugenia* sp	Kalumajak		0.2623793
26.	Myrtaceae	*Eugenia cymosa*	Rimbu		0.0710939
27.	Musaceae	*Musa paradisiaca*	Bago	1.0353652	
28.	Palmae	*Areca catechu*	Pinang	0.2718060	
29.	Palmae	*Areca* sp	Nempeu		0.1421382
30.	Palmae	*Arenga obtusifolia*	Poula		5.1853601
31.	Palmae	*Coccos nucifera*	Toitet	3.2276124	
32.	Palmae	*Metroxylon sagu*	Sagu	19.5684916	
33.	Palmae	*Oncosperma* sp	Ariribuk		20.3690607
34.	Phyllanthaceae	*Aporosa* sp	Sipuloi		0.4394423
35.	Sapindaceae	*Nephelium cuspidatum*	Bailongkan	10.8815497	
36.	Sapindaceae	*Nephelium* sp	Para Batti		8.8904573
37.	Thymelaeaceae	*Aquilaria malaccensis*	Simoitek	0.8062434	

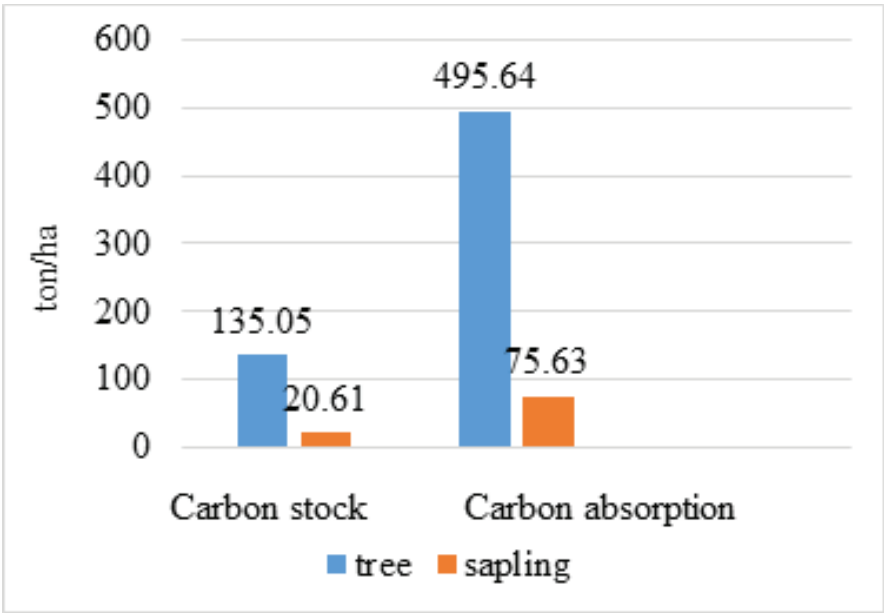

Figure 2: Graph of Carbon Stock and carbon absorption of Pamonean Land of Bekemen.

uptake, namely 292.42 tons /ha smallest amount of sapling in wild plants, which is 7.1 tons / ha (Fig. 3).

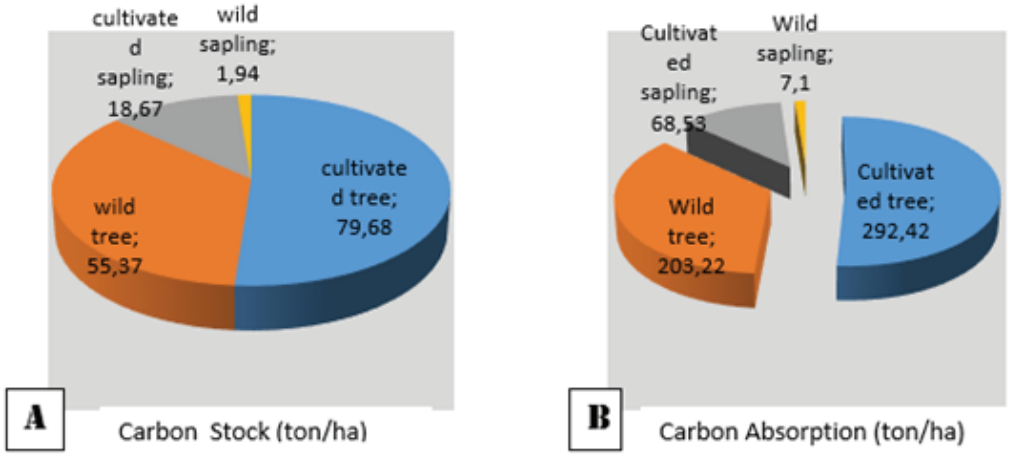

Figure 3: A. Carbon Stock Based on Plant Sources and Levels of Vegetation and B of Carbon Absorption Based on Plant Sources and Level of Vegetation on Pamonean Land Bekemen.

The value of the density of plants in pamonean in the Bekemen area was considered quite high. The density of plants is one of the factors that determine the amount of biomass and the amount of biomass that is greater will affect the carbon stock and uptake of CO_2 [13]. Carbon stock is positively correlated with biomass [14] which showed in the result trees have higher carbon stocks compared to sapling (Fig. 2). Based on Yastori et al. [15], the level of trees carbon stocks in Bukit Barisan Forest Area in the western part of Padang city is 451.26 ton/ha and sapling 4.39 ton/ha.

Indigenous Siberut people fill their pamonean land with various types of plants that are considered useful. The pamonean land management system which only cuts down trees that are considered not selectively selective and does not burn causes the plant density in the land to be high. Pamonean land is planted with cultivated plants, especially fruits and sago as staple foods. The high density of plants in the pamonean land causes the land to look like forest. This condition causes pamonean land to be protected from the threat of soil erosion of humus and landslides.

Besides planting pamonean land with cultivated plants, the community also carried out the transplanting of wild plants in the forest which they considered important to their land. With this pattern they will not look for various types of plants far into the forest if needed. The type of plant that grows the most in pamonean land besides food is for medicine.

Almost all flat land near small water niches, as well as the gentle slopes adjacent to the primary rivers in Siberut have become fields. This selection is a watery lowland cultivation strategy and is therefore naturally fertilized from soil humus landslides coming from the surrounding wooded hillsides. In the traditional economy, fields are needed to collect forest fruits, sources of vegetables, plants for medicines and building materials [16].

Pamonean is the main food source for indigenous people of Siberut island, so the cultivation as the main food source is maintained intensively so that it has bigger tree size compared to other wild plants. There are only a few types of plants that are also large in size, like plants that source wood for buildings, but will be cut down if needed. While fruit-producing plants, which are the main components in the pamonean land, will not be cut down. This causes more stored carbon stocks in cultivated plants compared with wild plants that exist in pamonean.

4. Conclusion

The density of plants in the pamonean land of the Mentawai indigenous people in the Bekemen area is 600 individuals / ha for the tree level and 816 individuals / ha for the sapling level with a total of 1,416 individuals / ha of land. The results of identification found 37 plant species incorporated in 13 families where 16 species were cultivated plants. The total carbon stored in the pamonean land in Bekemen area is 155.66 tons / ha and the ability of land carbon uptake is 571.27 tons / ha. Tree level vegetation has the highest carbon content of 135.05 tons / ha and the lowest at the sapling level of 20.61 tons / ha. The highest carbon uptake also at the tree level is 495.64 tons / ha and

the lowest is at the sapling level of 75.63 tons / ha. Cultivation plants have the highest reserves of 79.68 tons / ha at the tree level and 18.67 tons / ha at the sapling level. The same thing is also found in carbon uptake, where tree-level cultivation has the highest absorption of 292.42 tons / ha. The pamonean land of the Mentawai community on the island of Siberut has a very important role in the efforts to conserve global climate change mitigation. It can be judged by the high level of plant density, having carbon carbon reserves and high carbon uptake.

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