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THE ABILITY OF MANGROVE AREAS TO CONSERVES CARBON STOCK IN SEMI ARID REGION

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ABSTRACT

Above ground trees and poles biomass was estimated in Avicennie marina, Rhizophora stylosa and Sonneratia alba of mangrove forest in Oebelo, Central Kupang Regency, East Nusa Tenggara, Indonesia. The research was conducted from January 2013 to July 2013, and undestructive method was used trees and poles, which having a diameter of less than 5 cm and over. Choosing the allometric equation based on the difficulties and practicality to get variable in the field become considerations. Results shows that carbon stock pattern different between all of trees and poles, and increasing ranging of diameter will followed of biomass and carbon stock in all trees and poles. Species that contributed the largest amount of carbon was Sonneratia alba with the total carbon stored in all individuals of this species of about 59 % of the total biomass stored on the research areas. This species had high number of individuals, high average of diameter and height. At areas of research, Sonneratia alba shared a maximum of 59 % of the total biomass, while, Rhizophora stylosa and Avicennia marina shared 38 % and 3 % respectively.

Key words : above ground, biomass, allometric equation, carbon stock

BACKGROUND

Mangrove forests have a unique characteristic that differs from other forest types. One of ecological functions of mangrove forests as carbon sink become an important consideration by attempts to conserves the areas. Since, deteriorating environment has been a topic of great public interest that brings disastrous consequences in many aspects of life. Forest deforestation mad it more complex, not excepted in mangrove forests. As trees grow and their biomass increases, they absorb carbon from the atmosphere and store it the plant tissues resulting in growth of different parts. Active absorption of CO_2 from the atmosphere in photosynthetic process and its subsequent storage in the biomass of growing trees or plants is the carbon storage. In terms of atmospheric carbon reduction, trees offer the double benefit of direct carbon storage and stability of natural ecosystem with increased recycling of nutrient along with maintenance of climatic conditions by the biogeochemical processes.

Therefore, the present study is undertaken to understand mangrove community composition and estimate carbon stock stored in semi arid mangrove of Kupang. In this research we will use indirect method (non destructive method), because its very suitable for conservation needed. Directly measuring biomass is accurate but the research involving destructive sampling is time-consuming and costly, but indirect method (non destructive method) is rapid and a much larger area and number of trees can be sampled.

MATERIAL AND METHODS

Study area

The study was located at Oebelo, Central Kupang District, East Nusa Tenggara Province, Indonesia. Field sampling were conducted in four sites, that is natural mangrove and mangrove plantation areas (2004, 2007, 2008). Carbon stock assessment was carried out in the study areas from January 2013 to July 2013.

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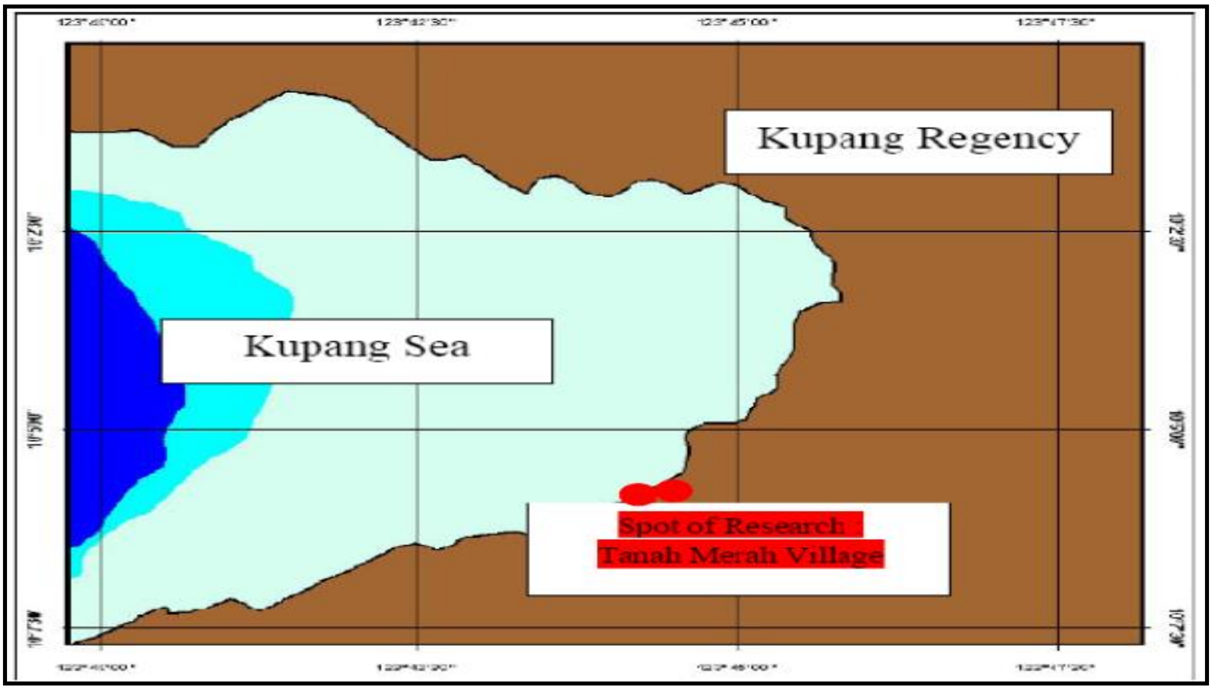

Figure 1. Location of research

Measurement of carbon stock and estimating the biomass

The research method consists of the following stages:

(1) Dividing areas as follows:

(a) Plantation areas of mangrove (2004, 2007, 2008) and (b) virgin mangrove

(2) Measuring the carbon stock aboveground by using World Agroforestry Center (2007) as

a guide (Hairiah and Rahayu, 2007).

The biomass calculation is measured using allometric equations ($W = 0{,}11\rho D^{2{,}62}$) (Ketterings *et al*, 2001 in Almulqu, 2011). Carbon concentration (C) in organic ingredients is usually 50%, thus carbon stock can be calculated by multiplying the total of its mass weight with 0.50. The plant diversity calculation uses ecological index that includes the following parameter of basal area: $\pi r^2 (m^2\ ha^{-1})$, relative basal area (%) = (Species basal area/total basal area) x 100%, where, r is radius and diameter measurement of breast height.

Estimation of carbon stock is calculated on its 2 areas, they are plantation areas of mangrove (2004, 2007, 2008) and virgin mangrove. The carbon stock average obtained from allometric equations is each multiplied by the zone width, therefore, the information about the ability of supporting carbon from research areas is achieved in unit of tons C.

Result and Discussion

The results show that within the research areas, there were three species with the basal area around 0,002 – 0,125. Table 1 presents dominant species with the basal area of individuals in each area of research.

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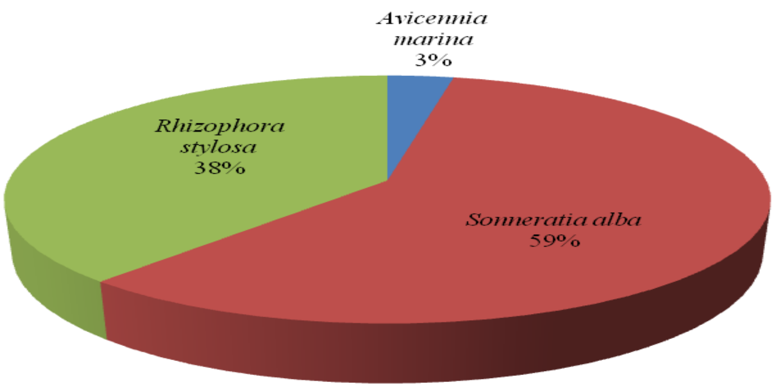
Table 1. Biomass potency from each areas of research

Location	Poles/Trees	Species	Basal Area (m^2)	Vtotal (m^3)	Biomass (ton/ha)
2004	**Poles**				
	1	*Avicennia marina*	0,015	0,055	0,321
	2	*Sonneratia alba*	0,002	0,012	0,054
	Trees				
	1	*Avicennia marina*	0,007	0,035	0,192
2006	**Poles**	-	-	-	-
	Tree				
	1	*Avicennia marina*	0,006	0,027	0,132
	2	*Sonneratia alba*	0,032	0,136	0,691
	3	*Rhizophora stylosa*	0,005	0,027	0,152
2007	**Poles**				
	1	*Rhizophora stylosa*	0,029	0,155	0,912
	Trees				
	1	*Sonneratia alba*	0,101	1,138	5,675
Natural Mangrove	**Poles**				
	1	*Sonneratia alba*	0,009	0,038	0,242
	2	*Rhizophora stylosa*	0,007	0,04	0,246
	Trees				
	1	*Rhizophora stylosa*	0,125	0,843	6,34
	2	*Sonneratia alba*	0,111	1,047	5,025

The value of biomass is influenced by several factors including the diameter, wood species density and number of individuals in an area. Species that contributed the largest amount of carbon was *Sonneratia alba* with the total carbon stored in all individuals of this species of about 59 % of the total biomass stored on the research areas. This species had high number of individuals, high average of diameter and height. At areas of research, *Sonneratia alba* shared a maximum of 59 % of the total biomass, while, *Rhizophora stylosa* and *Avicennia marina* shared 38 % and 3 % respectively (Figur 1).



Figur 1. Contribution of biomass from each species

The carbon stock was estimated using the equation developed by Ketterings *et al*. (2001) with the conversion of biomass to carbon by 50% (Brown, 1997). The carbon stock respectively for the areas plantation (2004, 2006, 2007) and natural mangrove were 0,284 ton C /ha, 0,488 ton C/ha, 3,293 ton C/ha and 5,926 ton C/ha. The total carbon stock at natural mangrove was greater (5,926 ton C/ha) than areas plantation (4,065 ton C/ha) (Table).

Our study shows that the carbon sequestration potential of *Sonneratia alba* is 20 % higher than *Rhizophora stylosa* and *Sonneratia alba* is higher than 51 % *Avicennie marina*. *Sonneratia alba* (0,417 ton/tree), *Rhizophora stylosa* (0,273 ton/tree) and *Avicennie marina* (0,040 ton/tree) captured maximum carbon per tree.

Root biomass stock contributed by four research area was 0,071 ton C/ha, 0,122 ton C/ha, 0,823 ton C/ha and 1,481 ton C/ha respectively (Table 2). Biomass of roots is strongly influenced by the carbon content of biomass because the calculation is the result of multiplying the total biomass per category roots with carbon content. The more severe root has an impact to increasing the biomass. For the largest C content is at the root of (61.09%) for C levels associated with the number of substances that potentially put them together, such as cellulose, hemicelluloses, and lignin contained in the root. The older roots in this case the large roots will be more and more also substances that are potentially up carbon. This is because the development of root structure following the age. Roots that are older than juvenile roots (medium root and fine roots) certainly have a greater carbon content.

Table 2. Potency of poles and trees in research areas as pool carbon

Location	Basal Area (m^2)	Vtotal (m^3)	Biomass (ton/ha)	Carbon Stock (ton C/ha)	Root Biomass (ton C/ha)	CO_2 Absorption Potential (ton)
2004						
Poles	0,018	0,067	0,376	0,188	0,047	0,69
Trees	0,007	0,035	0,192	0,096	0,024	0,352
Σ	*0,025*	*0,102*	*0,568*	*0,284*	*0,071*	*1,042*
2006						
Poles	0	0	0	0	0	0
Trees	0,043	0,192	0,977	0,488	0,122	1,794
Σ	*0,043*	*0,192*	*0,977*	*0,488*	*0,122*	*1,794*
2007						
Poles	0,029	0,155	0,912	0,456	0,114	1,675
Trees	0,101	1,138	5,675	2,837	0,709	10,413
Σ	*0,13*	*1,293*	*6,587*	*3,293*	*0,823*	*12,088*
Natural Mangrove						
Poles	0,016	0,078	0,488	0,244	0,061	0,896
Trees	0,236	1,891	11,365	5,682	1,42	20,856
Σ	*0,252*	*1,969*	*11,853*	*5,926*	*1,481*	*21,752*
Total Σ	**0,45**	**3,556**	**19,988**	**9,994**	**2,498**	**36,678**

Measuring the CO_2 absorbed by plants can be identified by converting the carbon content is obtained by a conversion factor of 3.67 obtained from the ratio of atomic and molecular weight. Once converted to the unit area can be known ability mangrove vegetation stand in the store total of carbon. From Table , we can note that the greater biomass and carbon reserves of natural gas reserves of CO_2 will also increase . The total number of 9,994 ton of carbon could yield the total gas reserves of CO_2 that can be absorbed by mangrove vegetation stand in Kupang of 36,678 ton and it will followed by plantation areas (Figur 2).

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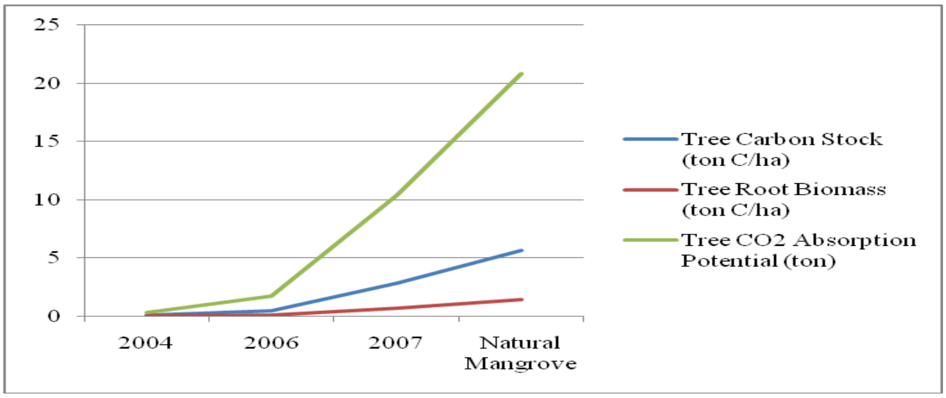
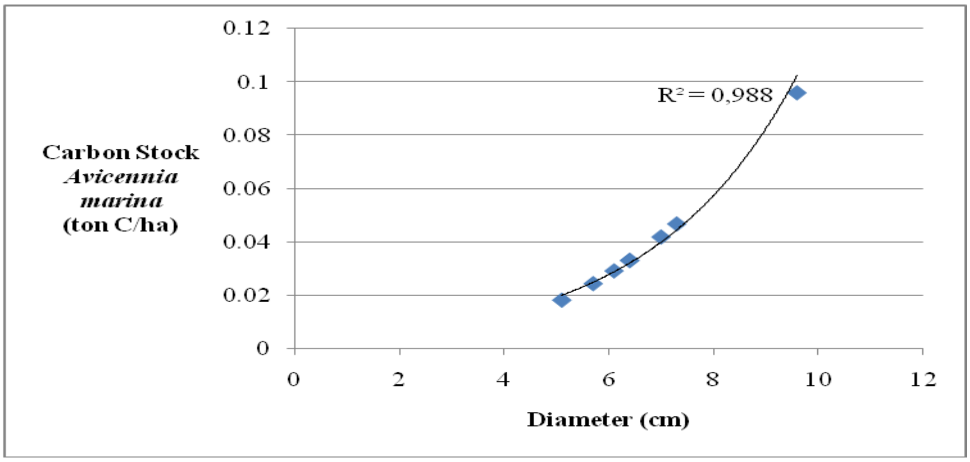
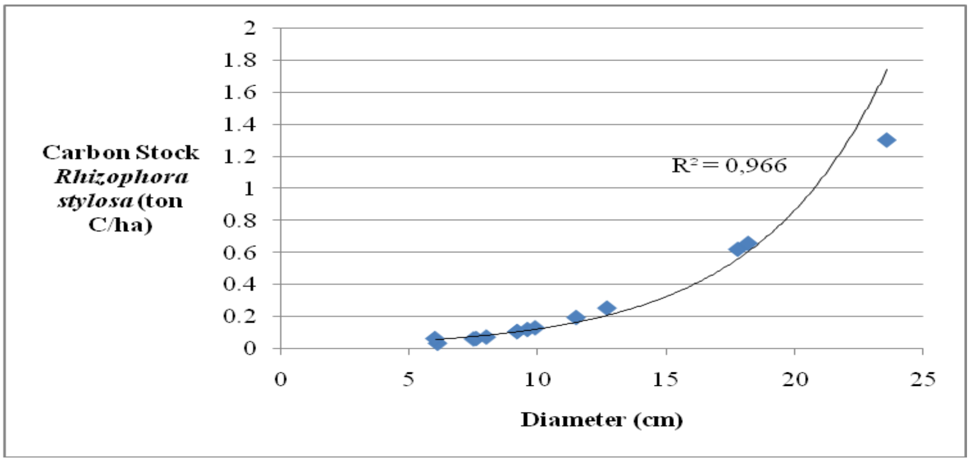


Figur 2. Trend of carbon stock from each research areas

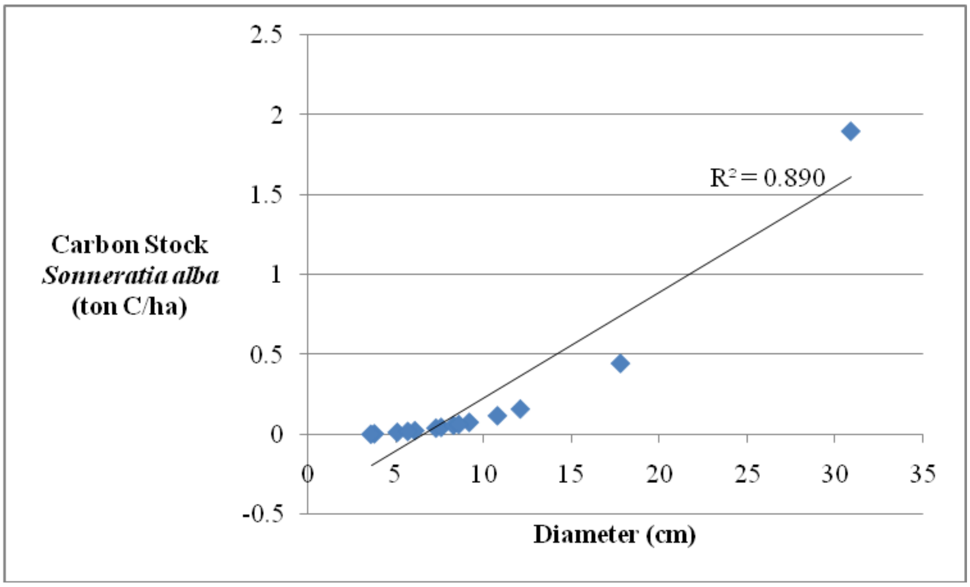
In the present study, carbon stock was positively correlated with diameter at research areas. The relationship between diameter and carbon stock in *Avicennie marina, Rhizophora stylosa* and *Sonneratia alba*, shows relatively high correlation value (R^2=0,988, R^2=0,966 and R=0,890) revealing that carbon stock increases with increase in diameter (Figur 3,4 and 5).



Figur 3. The relationship between diameter and carbon stock in *Avicennie marina*



Figur 4. The relationship between diameter and carbon stock in *Rhizophora stylosa*



Figur 5. The relationship between diameter and carbon stock in *Sonneratia alba*

This contribution of species is related with the wood density, where biomass content increasing with wood density. Because its highly correlated with the density of carbon per unit volume and is thus of direct applied importance for estimating ecosystem carbon storage and fluxes (Mani and Parthasarathy, 2007 in Almulqu, 2014). Trees play a key role in the global C cycle (Henry *et al*., 2011 in Almulqu, 2014). Trees and other forest plants remove large amounts of carbon dioxide (CO2) – a greenhouse gas (GHG) – from the atmosphere as they grow, storing the carbon in the biomass of their leaves, branches, stems, and roots. Because forests have a tremendous capacity for carbon uptake and storage, in addition to reducing GHG emissions from fossil fuels, one of the most effective ways to remove carbon from the atmosphere is through the sustainable management of forests (Walker, 2011 in Almulqu, 2014). Managing forests through agroforestry, forestry and plantation systems is seen as an important opportunity for climate change mitigation and adaptation (Henry *et al*., 2011 in Almulqu, 2014).

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