(16) Carbon absorbtion of Anthocephalus macrophyllus and Switenia macrophylla King. Gorontalo

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Submission date: 03-May-2021 08:46AM (UTC+0700)
Submission ID: 1576252368
File name: phalus_macrophyllus_and_Switenia_macrophylla_King._Gorontalo.pdf (436.25K)
Word count: 3569
Character count: 17128

INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 16, No. 5, p. 24-30, 2020
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Carbon absorbtion of *Anthocephalus macrophyllus* and *Swietenia macrophylla*. King in Gorontalo, Indonesia

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Article published on May 24, 2020

Key words: Carbon, Absorbtion, *A. macrophyllus, S. Macrophylla*, Gorontalo

Abstract

Community forests Gorontalo are widely planted and maintained by Gorontalo people where the area is not too large which only ranges from 1ha. This type is good for carbon absorption, as for this type of Mahogany (*Swetenia macrophylla*), Jabon (*Anthocephalus macrophyllus*). *A. macrophyllus* (A) 660 trees13.07m^3 ha^{-1} year^{-1},7.67 tons ha^{-1} year^{-1} biomass, carbon sequestration, 3.53 tons ha^{-1} year^{-1}. In *A.macrophyllus* (B) at the same age of 4 years the number of trees 604 trees amounted to 14.29m^3 ha^{-1} year^{-1}, biomassa 8.38 tons ha^{-1} year^{-1} with Carbon 3.86 tons ha^{-1} year^{-1}. *S.macrophylla* (C) 413 trees, aged 20 years has an average volume of ha^{-1} year^{-1} 6.96m^3, Biomassa 5.94 tons ha^{-1} year^{-1} and carbon absorbtion 2.73 tons ha^{-1} years^{-1} while *S.macrophylla* (D) 419 trees, age 35 years has average volume at the rate of 12.60m^3 ha^{-1} year^{-1}, a biomassa of 10.75 tons ha^{-1} year^{-1} with carbon sequestration of 4.95 tons ha^{-1} year^{-1}. The relationship of tree height affects the carbon absorbtion R^2 = 0.985, the age of a tree is very influential on carbon uptake where R^2 = 0.895. The most significant relationship between the age, height and diameter of the tree is the diameter of R^2 = 0.895.

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Introduction

Jabon plants grow in tropical natural forests, with a height reaching 45 m and a diameter of about 100 cm to 160 cm have cylindrical stems, making it suitable for use as raw material for the Playwood industry and can be harvested at the age of 8-10 years this is what causes Jabon as one of the types of wood that can be considered as industrial raw materials. This plant was known in 1970, because of the development of exploitation in natural forests so that this wood is increasingly scarce. This species is very suitable to be developed as a conservation plant where carbon sequestration is large. Mahogany can be found growing wild in teak forests and urban areas, left and right of the road or planted as a protective tree. This plant, originally from the West Indies, can flourish if it grows near the coast. Tree. Height 5-25m, rooted riding, rounded stems, many branches and wood gummy. The leaves even pinnate compound leaves, leaf strands are ovoid, pointed tip and base, flat edges, pinnate bones, length 3-15. Flat seeds, Mahogany is a tree producing hardwood.

The purpose of this study is to find out how much carbon uptake of the two types is Jabon and Mahogany so that it can be developed as a greening plant or conservation where growth is fast, which will affect more carbon sequestration to reduce global heat. This is what drives us to conduct research this.

Plantation in the number of trees will decrease with increasing age. Natural reduction (natural mortality) occurs due to competition between trees, so that only trees that are strong enough to compete will continue to grow and live. As an example of the development of the number of trees in an stand of Scot pine species near Moscow (Carsnowski, 1982. in Forest Growth Science, Ruchaeni, 2013).

A.macrophyllus one type of local Indonesia plants, is know as populerplants for forest plantation. *A. macrophyllus* trees can grow very rapidly with straight stands and its wood is qualified as one of the best raw materialsin forestry industries such plywood, furniture, pulp, paper, board and matches (Mansur and Tuheteru 2011).

Along with the formation of all levels of districts, sub-districts, villages, neighborhoods in Gorontalo Province, all of which require the use of timber for development, so that the desire of the people to find a way to plant crops that have good wood such as *A.macrophyllus* , and *S.macrophylla*. This plant grows in natural forests. This plant grows to a height of 45m and a diameter of about 100cm to 160cm has cylindrical stem so it is suitable for use as raw material for Playwood industry and can be harvested at the age of 8-10 years which causes Jabon to be wrong one type of wood that can be considered as raw material for industry. This plant was known in 1970, because of the development of exploitation in natural forests so that the wood is increasingly stepping. *A. macrophyllus* is classified as a pioneer plant and can grow on clay, brown podsolic clay, or rocky soils. Local designation: Mahagoni, maoni, moni Synonym= *Swietenia macrophylla*, King. *Swietenia mahagoni*, Bl., Jacq. Familia: Meliaceae. Another result that people don't take into account is carbon sequestration.

This research was conducted to find out how much carbon sequestration of these two types, which carried out an inventory of trees in the field and measurement of trees, especially tree diameter and height, to get the volume of each tree. As for future research, how different carbon sequestration is at each height from sea level, different age and growth in each different soil conditions.

Materials and methods

Plants in 4 (four) locations of this study

Materials

Jabon and Mahogany tree species inventory is carried out to find out how many trees and each tree is measured around the diameter so that the diameter can be calculated and height, both of these parameters to calculate volume (m^3) will be converted into dry weight after being multiplied by specific gravity (volume x dry weight) of tree species.

Methods

The method used is a census (100% intensity) where every tree is measured all measured in each block, there are 4 (four blocks) with an area of 1ha / block. Measuring lines are made along 100m, line width is 20m and the number of lanes is 5. The measured plot area is 100 m x 20 m = 2.000 m^2 x 5 lanes so that the area is 10.000m^2 (1ha).

Data collection

The procedures were carried out in plantations to collect data or measure tree circumference and tall tree coverings using christenmeters. Jabon at the age of 4 years, North Gorontalo District is the same in Delumo Village with the type of *A. Macrophyllus (*A) material as well as Boalemo Village with 35 years *S. macrophylla* (D) type, and Molontadu with Jabon (B) size with 4 years tree age Bongohulawa *S. macrophylla* (C) 20 years old this place has an area of 1ha each so the total area is 4ha Time of implementation in October 2016 to February 2017. Can be reached from the City as far as 30km and 60km. Coordinates: B.$0^0$41'35 "and N.$122^0$28 ' 13 "

The object to be studied is *A. macrophyllus* and *S. macrophylla* trees, in each location where plants grow.The ingredients used are *A. macrophyllus* and *S. macrophylla* stands. Tools such as: meters, tally sheets, pencils, pens, calculators, computers, tree labels, and markers. Data retrieval in the field with a census method where all trees are measured by a track system where each track has a width of 20m and trees that have been measured around it (*LIPI, Dept. Forest.* 2003, in (Sandalayuk *et al*., 2011), which measures circumference to get the area of the base (LBDS) is labeled or registered by each tree where the tree species is recorded on the list, the team consists of 5 people, with the duty of one rope holder, 2 left and right tree registrars, 1 compass holder and 1 giver tree label.

The number of locations measured: *Anthocephalus macrophyllus* block (A)of 660 trees covering an area of 1ha with a age of 4 years, Block (B) *A.macrophyllus*. All trees measured (census) 100%. *A.macrophyllus* as many as 604 trees covering 1ha with age 4 years, Block (C) *S. macrophylla* as many as 413 trees covering 1ha with age 20 years and block (D) type *S. macrophylla* 35 years old 419 To measure trees with 20m track width.

Data Analysis

Plants are calculated by tree volume, using the following general formula.

V = ¼ x 3.14 x d^2 x h x f

d = K /π

In which V = Tree Volume (m^3), d = Tree Diameter (cm), h = Tree Height (m), f = Tree shape factor (assumed to be 0.8), d = Diameter, K = Around, π = (22/7) = 3.14. Determination of tree biomass using the formula (LIPI, Dept.Hut, 2003, in (Sandalayuk *et al*., 2011)

To calculate the biomassa, the formula is used:

B = (4/3) .V.p

In which B = tree biomassa (tons), P = Timber density (anonymous, 2003). About half of the amount of tree biomassa is carbon biomassa so that in this calculation it is used (*economic journal*, 2003), and (Subekti., 2007. in (Sandalayuk *et al*., 2011) The formula used :

C = 0.46 x B

In which C = Carbon content (tons), B = Tree biomassa (tons)

Results

The intensity of waterloging and drought are predicated to increase in dry and rainy season due to climate change (Tong *et al*., 2016) and potentially effects on initial growth and successfull forest and land rehabilitation activities. Forest plantation of *A.macrophyllus* produced biomass and carbon sequestration of 81,90 ton ha^1 and 39.31 ton ha^{-1} , respectively at the age of 8 year. However, the amount of biomass and carbon in another plot of *A.macrophyllus* trees was 96.85 ton ha^{-1} and 46.49 ton ha^{-1} respectively (Agus *et al*., 2017).

Reseach and operational experience show that total plantation biomassa productivity exeeding 22 Mg ha^{-1} y^{-1} green weight basis with rotations less than 25 years are biologically possible, financially atactive and enviromenttally sustainable (John. F, Thomas R Fox, 2010).

The planting distance on *S.macrophylla* is 4m x 4m in Bongohulawa Village (Block C) at the age of 20 years with the location of the corrugated planting site being measured while *S.macrophylla* on D block is hilly with a slope of 15° with a measured planting area of 1ha so that it is 2ha as attached (Table 1).

Table 1. Amount of Volume and Average Volume of *A.macrophyllus* Tree Age 4, and *S.macrophylla* 20 years and 35 Years.

No	Type	Number of trees	Diameter (cm)	T (m)	Volume	Av /v/tree (m^3)
1	*Anthocephalus macrophyllus*	A (4 years) 660	14.54	5.66	52.28	0.079
2	*Anthocephalus macrophyllus*	B (4 years) 604	15.28	5.06	57.14	0.095
3	*Swietenia macrophylla*	C (20 years) 413	27.45	7.67	139.16	0.340
4	*Swietenia macrophylla*	D (35 years) 419	11.17	11.70	441.05	0.900__

In which D = diameter (cm), T = Free branch hight (m) V= Volume (m^3) Av=Average (m^3)

Table (1) above is obtained after processing the primary measurement results so that it is obtained, after calculating the volume of each tree in each *A.macrophyllus* (A) block of 52.28m^3/ha at 4 years of age, *A.macrophyllus* (B) 57.14m^3/ha age 4 years, *S.macrophylla* (C) 139.16 m^3/ha age 20 years and *S.macrophylla* (D) 441.05 m^3/ha at age 35 years.

Table 2. Biomassa and carbon absorbtion.

No.	Species	BD		Volum ha^{-1} (m^3)	Biomassa = B	C = 0,46 x B
1	*A. macrophyllus*	A (4)	0.44	52.28	30.6709	14.1086
2	*A. macrophyllus*	B (4)	0.44	57.14	33.5221	15.4202
3	*S. macrophylla*	C(20)	0.64	139.16	118.7499	54.6249
4	S. *macrophylla*	D (35)	0.64	441.06	376.3627	173.2805_

In which BD = specific grafity, B = Biomassa (tons), C = Carbon (tons)

Table (2) above biomass is calculated by the formula B = (4/3) .Vp. Where the biomass in Jabon block (A) is 30.67 tons, Jabon (B) 33.52 tons, Mahogany block (C) 118.75 tons and Mahogany (D) 376.36 tons.

Table 3. Average Volume, Biomassa and Carbon Absorbtion ha^{-1} year^{-1}.

No.	Species	BD		V ha^{-1}year^{-1}(m^3)	B (tons)	C (tons) /year^{-1}
1	*A. macrophyllus*	A (4)	0.44	13.07	7.67	3.53
2	*A. macrophyllus*	B (4)	0.44	14.29	8.38	3.86
3	*S. macrophylla*	C (20)	0.64	6.96	5.94	2.73
4	*S. macrophylla*	D (35)	0.64	12.60	10.75	4.95

In which BD = specific grafity, V= Volume (m^3) B = Biomassa (tons), C = Carbon (tons).

Table (3) above illustrates the average carbon uptake (C) = 0.46 x B) per year, so that Jabon is obtained in block (A) of 3.53 tons, Jabon (B) 3.86 tons, Mahogany block (C) 2.73 tons and Mahogany (D) 4.95 tons.

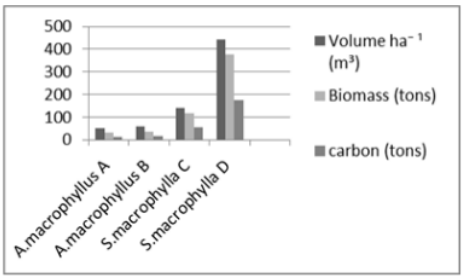


Fig. 1. Total volume, biomassa and carbon ha-1 Fig. 2. Average volume, biomassa carbon years-1 Block (A, B, C, D.) Block (A, B, C, D).

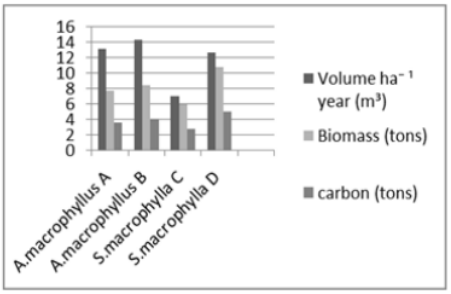
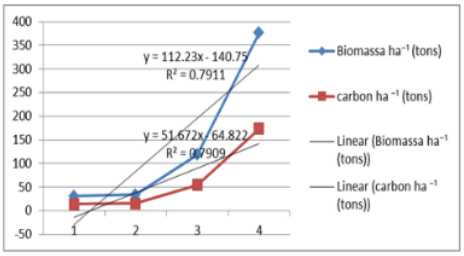


Table 2. Biomassa and carbon absorbtion.

Simple Regression analysis can be seen in the image below. 1. Effect of Biomassa on carbon uptake.



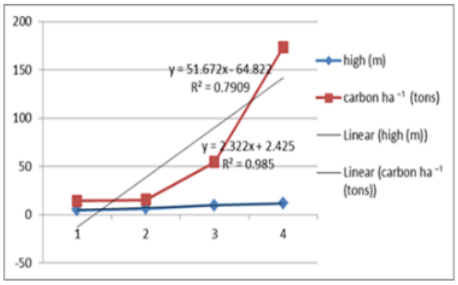


Fig. 3. The corelation between biomassa and **Fig. 4.** The corelation between carbon in ton of *A. macrophyllus* and carbon high in tons. *A.macrophyllus S.macrophylla.* King tree and *S. macrophylla*

Fig. (3). The correlation between carbon and biomass of *A.macrophyllus* tree. Relationship of carbon uptake is strongly influenced by diameter where R^2 = 0.7911, this proves that the diameter of the tree is very influential on carbon uptake so that for a large absorption of need rapid growth. In Fig. (4). The relationship of tree hight affects the carbon absorbtion R^2 = 0.985.

Discussion

Anthocephalus macrophyllus and *S. macrophylla* After making in the field by measuring the diameter and height of trees in several places, the volume of trees is obtained. In table 1 above can be seen *S.macrophylla* in (C) the number of trees is smaller and has a diameter smaller than in (D) so high the average and the volume in blocks (C) = 0.34 < (D) = 0.90 at the age of 20 and 35 years different place. The average growth in diameter and volume of trees, Mean Anual Increment (MAI) yield for total production and age, which is as a mean tree increment of all trees including trees felled in thinning (Ruchaemi, 2013)

Anthocephalus macrophyllus (A) has a volume of 52.28m³ with an increase in diameter per year-¹ of 4.84cm and the volume of trees-¹ year-¹ 0,0198m³. Whereas *A.macrophyllus* (B) has a volume of 57.28 m³, an increase in annual diameter of 5.09 cm and an increase in annual volume of 0.0238. MAI in *A.macrophyllus* (A) = 52.28m³: 4 (years) ha-¹ = 13.07m ³ha-¹ year-¹. MAI Jabon (B) = 57.14m³ : 4 years ha -¹ = 14.28m³ ha -¹ year -¹. *Swietenia macrophylla* (C) volume amounted to 139,16m³ with an increase in diameter per year-¹ 1.37cm and tree volume-¹ year-¹ 0.017m³. While in (D) it has a volume of 441.05 m³, an increase in diameter per year is 1.103cm and the increase in volume per year is 0.032. MAI on *S.macrophylla* (C) = 6.96m³. *S.macrophylla* MAI (D) = 12.60m³.

A.macrophyllus Forest grows easily and quickly for good carbon absorbtion. This can be a plant to improve the water system and soil conservation.

The absorbtion of Carbon *A. macrophyllus* 4 years is different, showing the following: *A. macrophyllus* (A) 660 trees, biomassa 7.67 tons ha^{-1} year^{-1}, absorbtion of carbon 3.53 tons ha^{-1} year^{-1}. At *A.macrophyllus* (B) at the same age of 4 years the number of trees is 604 trees, biomass is 8.38 tons ha^{-1} year^{-1} with carbon 3.86 tons ha^{-1} year. *S.macrophylla* (C) 20 years old has biomass 5.94 tons ha^{-1} year^{-1} and carbon absorbtion 2.73 tons ha^{-1} year^{-1} and *S. macrophylla* (D) 35 years old has a biomass of 10.75 tons ha^{-1} year^{-1} with carbon 4.95 tons ha^{1} year^{-1}. Jabon has good carbon uptake so it needs to be developed as either a conservation plant or an industrial plant. While *S. macrophylla* has a wooden pattern similar to teak for carpentry, furniture also has good carbon uptake. *A. macrophyllus* and *S. macrophylla* plants can be developed because they provide many benefits, such as industrial plants for ply wood and sawn, good carbon absorbtion.

Conclusion

Anthocephalus macrophyllus (A) in (Fig. 1,2) 660 trees13.07m^3 ha^{-1} year^{-1},7.67 tons ha^{-1} year^{-1} biomass, carbon sequestration, 3.53 tons ha^{-1} year^{-1}. In *A.macrophyllus* (B) at the same age of 4 years the number of trees 604 trees amounted to 14.29m^3 ha^{-1} year^{-1}, biomassa 8.38 tons ha^{-1} year^{-1} with Carbon 3.86 tons ha^{-1} year^{-1}. *S. macrophylla* (C) 413 trees, aged 20 years has an average volume of ha^{-1} year^{-1} 6.96m^3, Biomassa 5.94 tons ha^{-1} year^{-1} and carbon absorbtion 2.73 tons ha^{-1} years^{-1} while *S. macrophylla* (D) 419 trees, age 35 years has average volume at the rate of 12.60m^3 ha^{-1} year^{-1}, a biomassa of 10.75 tons ha^{-1} year^{-1} with carbon sequestration of 4.95 tons ha^{-1} year^{-1}.

The relationship of tree height affects the carbon absorbtion R^2 = 0.985, the age of a tree is very influential on carbon uptake where R^2 = 0.895. The most significant relationship between the age, height and diameter of the tree is the diameter of R^2 = 0.895.

Recommendations

Need to plant faster-growing plants such as *A. macrophyllus* and *S. Mgrophylla*, to help absorb carbon from the air.

Acknowledgements

Mulawarman University lecturers, Gorontalo University Chancellor Dr.Ibrahim Ahmad, SH, MH, Chair of the Gorontalo DLP Foundation, Chair of the Board of Trustees Dr. H. Rustam. Hs. Akili, SE, SH, MH. Dikti, PT. Katingan Timber. Staff of the Fahutan Unmul laboratory. Muctar Dakio team that assist in field data collection.

References

Amiro BD, Barr AG, Barr JG, Black TA, Xiao J. 2010. Ecosystem carbon dioxide fluxes after disturbance in forests of North America.Journal Geophysical Research. https://doi.org/10.1029/2010JG001390. Volume 115 Issue G4 Desember 2010.

Arias D, Alvarado J, Richter DJ, Dohrenbusch A. 2011. Productivity aboveground biomassa, nutrient upta Ke and carbon content in fastgrowing tree plantations of native and introduced species in the southem region of Costa Rica. ISSN **:** 0961-9534 DOI **:** 10.1016/j.biombioe.2011.01.009 Record Number : 20113156388 Publisher : Elsevier Ltd Journal article**,** Biomass and Bioenergy 2011 Vol.35 No.5 pp.1779-1788 ref.45

Asnan H, Lahjie AM, Sardjono MA. Ruchaemi A. Agang, MW. 2O12. Optimization of forest income plant type Meranti Merah, Sengon, Pulai and Bayur in a combination of management in East Kalimantan. Journal of Tropical Forest vol. 13.ISSN 1412-4645. Volume **13,** no.2. September 2012.

Hariah K, Rahayu S. 2007. Carbon measurements stored in various types of land use ISBN.979-3198-35-4.Copyright.World Agroforestry Centre, ICRAF Southeast Asia. www.worldagroforest rycentre.org/sea.p.17.29.47.

Latifah S, Sulistiyono N. 2013. Carbon sequestration potential in aboveground biomass of hybrid eucalyptus plantation forest. J Tropical For Manag **19(1),** 54-62.

Riyanti P. 2014. Estimation of potential carbon reserves in Pinus merkusii in the Dulamayo Educational Forest , Gorontalo University, Dulamayo West Village, Gorontalo District. Gorontalo Province. (Thesis) .Gorontalo University (Unigo).

Ruchaemi A. 2013. Forest growth science. Mulawarman University Press. First Printing. ISBN.979-602- 18615-4-7.p.6-9.Maret 2013.

Ruchaemi A. 2015. Wood measurement science and standing inventory. ISBN-978-602-14754-3-0. Mulawarman University Press. First printed. January 2015. Pages.116-117.

Ruslim Y, Ruspita Sihombing, Yason Liah. 2016. Stand damage due to mono-cable winch and bulldozer yarding in a selectively logged tropical forest. Biodiversitas. ISSN.1412-033X.

Sandalayuk. D, Soedirman S, Pambudhi F. 2018. Reserves estimating carbon in forest city district village Bongohulawa Gorontalo.ISSN.2455-3689.www.ijrtem.com volume 2 issue 8. August 2018 pp 60-63.

Sandalayuk D, Lahjie AM, Simarangkir BDAS, Ruslim Y. 2019. Analysis growth and macro nutrient elements Jabon (*Anthocephalus cadamba*), Jati (*Tectona grandis*) in Gorontalo. IOP Conference Series: Earth and Environ Sci 270, 012045. **20(9),** 1-19.

Sarjono A, Lahjie AM, Simarangkir BDAS, Kristiningrum R, Ruslim Y. 2017. Carbon sequestration and growth of *Anthocephalus cadamba* plantation in North Kalimantan, Indonesia. Biodiversitas **18(4),** 1385-1393.

Sutaryo D. 2009. Calculation of biomass and introduction to the carbon study and carbon trade. Published 2009 by: Wetlands International Indonesia Programme Gogor @ wetlands international programe.

Iman W, Dicky KDS, Muhran, Lidia BJ. 2014. Influence the distance of planting on tree growth and some physical-mechanical properties of fast growing teak. Journal of JIPI V2014 vol. **19(3),** 204-210. ISSN-4217 December.

John F, Munsell, Thomas, Fox R. 2010. An analysis of the feasibility for increasing woody biomass production from pine plantations in the southem United States. Jurnal Biomass and Bioenergy edidisi 34.12 page 1631-1642.

Mansur I, Tuheteru FD. 2011. Jabon tree. Book Penebar Swadaya Jakarta (Indonesian).

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