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Measurement of Carbon and Carbondioxide Fmu Argomulyo using Biomass Approach in Community Forests, Sundul Village and Banjar Panjang, Magetan Regency

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***Keywords*— Biomass, Carbon Content, C02 Absorption, Inventory,**

***Abstract*— *The existence of community forests today has provided real benefits, especially the economic value of communities around the forest and a real contribution to environmental services with the ability to reduce greenhouse gas emissions in the context of mitigation and adaptation to climate change. Sustainable Forest Management facilitates efforts to reduce emissions in the forestry sector more economically than other sectors, which later became the forerunner to the birth of the concept of REDD+. This study aims to calculate the potential for standing stands in the villages of Sundul and Bandarpanjang Forest Management Unit. (FMU) Argomulyo, Magetan regency, looking at the ability of the forest to produce biomass, carbon content and the ability to absorb C02 content, including an allometric estimation model, by means of an inventory, for the potential destructive sampling method on samples of tree species to be measured Biomass, stored carbon and carbon dioxide uptake. The results showed that the average standing potential was 54.25 m3/ha, or a total volume of 26.732.831 m3, the average forest biomass content per ha was 955.32 tons or total of 1.944.178 tons. The average carbon content is 467.80 tons C/ha or the total available is 913.763 tons Carbon The ability to absorb carbon dioxide (C02) is 1,716.82 tons C/Ha, with an area of community forest management capable of absorbing C02 content of 3,353.512 tons C02.*

I. INTRODUCTION

Forest is an ecosystem unit in the form of a stretch of land containing biological natural resources which are dominated by trees in their natural environment which cannot be separated from one another. Based on the land status, it is divided into two types, namely state forest and private forest. One example of a private forest is a private forest where the forest is located on land that is encumbered with common property rights Annonymous (1999).

The function of community forests is one of the alternative solutions to the problem of pressure on forest resources/forest areas. In its development, it has provided many positive benefits, both directly and indirectly, among them for the owner, namely being able to provide forest products obtained directly, either in the form of a source of wood tools, firewood, food, animal feed

The positive benefits of community forests indirectly are the maintenance of hydrological, climatological, aesthetic and other functions which are the basic needs of the community (Dako, 2019)

The role of forests is very important in human life, in terms of products, forests produce three groups of products: wood, non-timber forest products and environmental services. The environmental benefits of forests are indirect and difficult to measure in value but are easy to feel in their absence due to damage. Another environmental benefit is that forests protect and at the same time serve as a source of biodiversity, both flora and fauna. Puspitojati Triono M. et al, (2014)

Forest is an ecosystem unit in the form of a stretch of land containing biological natural resources which are dominated by trees in their natural environment which cannot be separated from one another. An example of a private forest is a private forest where the forest is located on land that is encumbered with common property rights Annonymous (1999). One of the roles of community forests in environmental services is the ecological pressure of forest resources. Natural disasters and global warming occur partly because of the destruction of forests. The pressure on high carbon dioxide gas emissions has made the forest sector play a strategic role, including community forests.

Reducing emissions in the forestry sector has a high selling price compared to other sectors, which became the forerunner to the birth of the concept of REDD+ (Reducing Emissions from Deforestation and Forest Degradation plus). Forests are the main determinant of global climate change mitigation. Making forestry a part of world politics. from the perspective of global climate change Stern (2007).

The agenda for sustainable forest management has become a major global issue in the context of climate change. The role of forests in mitigating and adapting to climate change. priority on mitigation in developing countries. Sustainable Forest Management is evolving to facilitate the concept and implementation of REDD+. play a role in mitigating climate change and increasing adaptation to climate change. as well as, function for carbon conservation, sequestration and substitution. REDD as carbon conservation has its main role in carbon sequestration. Sustainable forest management is intended to increase carpentry and construction wood products or tools as well as carbon storage outside the forest. Purbawiyatna, et al (2012) Adaptation of sustainable forest management is used to reduce the openness of forest communities to the effects of climate change, as well as reduce sensitivity and increase community adaptive capacity.

Increasing forest development as a material for increasing CO2 absorption can be carried out in state forest areas or private forests, including community forests. Darusman and Suharjito (1998), the high potential of community forests both in terms of tree population and species will result in a large accumulation of CO2 absorption. However, with the high rate of forest degradation and deforestation, CO2 absorption has decreased. Degraded forests will gradually lose their function as CO2 absorbers Junaedi, (2008).

The aim of the study was to calculate the above-ground biomass in community forests, Sudul and Bandar Panjang villages, FMU Argomulyo, Magetan Regency, to estimate the potential for carbon content (C) and carbon dioxide Absroption (CO2). The benefits of this research can provide scientific information, and become a reference for local government policies in regional development and conservation plans, and can become data and information that can be a reference for further research. The issue of global warming has become the hottest discussion from the 20th decade until now, the main cause is the increase in greenhouse gases such as CO2, CH4, N2O, and CF4. (IPPC 2001) which has an impact on increasing global temperatures and changes in rainfall IPPC. (2007). Carbon dioxide gas is the biggest problem where the main cause of Greenhouse Gases.

Forests with tree components can absorb atmospheric carbon (carbon sequestration), converted into biomass (carbon sinks) as well as stored in the system as carbon stocks or carbon stocks Hairiah and Rahayu, (2007). The more trees there are, the more carbon dioxide is absorbed. If Indonesia's forest development is increased, Indonesia has helped reduce CO2 concentrations. The absorptive capacity of tree stands in the forest is influenced by tree physiology, such as the rate of photosynthesis which is influenced by atmospheric CO2 concentration, air temperature, air humidity, chlorophyll content, and stomata. The content of chlorophyll and the number of stomata per leaf area can determine the rate of photosynthesis. Thus, the larger the leaf area per unit of land, the greater the CO2 absorbed. However, leaf area will increase in line with the age of the stand, therefore it can be assumed that the age of the stand will affect CO2 absorption. However, leaf area will increase in line with the age of the stand, therefore it can be assumed that the age of the stand will affect CO2 absorption. .

Half of the biomass in forests is made up of carbon. So that currently the main function of forests is important, especially related to global warming, especially forests have a role as a source of emissions and absorption Brown (1997). Emission reduction from forests is carried out through 2 main stages, namely increasing carbon sequestration and forest carbon conservation. Carbon calculations can also be used to support forestry policies both at the national and regional levels, especially Community Forests. Where the amount of carbon from forest stands is determined by the right policy direction for sustainable forestry development.

Carbon accounting is also an effort to find out the real condition of forests in Indonesia, which is very wide and diverse. For this reason, it is recommended that carbon calculations be carried out with a combination of ground survey and remote sensing activities. in order to maintain the accuracy of the numbers and the efficiency of carbon calculations. one of which has been stated in the application to calculate emission reductions through the IPCC (GL) application, IPCC (2003)

The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

II. MATERIALS AND METHODS

A. Inventory of Community Forest Stands

Inventory of community forest stands of the Argomulyo FMU group was carried out by determining Measurement Plots in 2 village locations, namely Sundul Village and Banjarpanjang Village. Each village was determined to measure 16 plots with a size of 25 x 25 m, so that the area of each Measurement Plot is 1 hectare. The steps for data collection on each Measurement Plot, Measurement Plot Plan and Unit can be seen in the following figure-1. and figure-2.

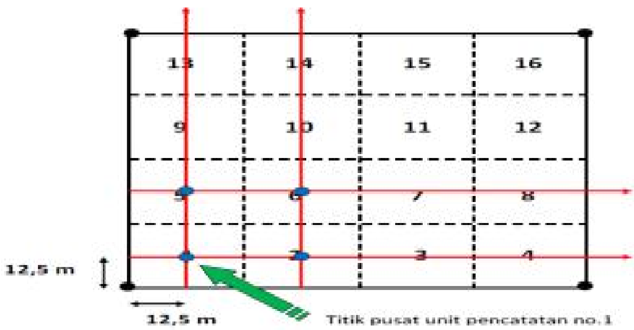


Fig. 1: Making a stand inventory plot

Caption Figure 1:

..

= recording unit center point = the outer boundary of the sample plot

= sample plot angle sign = inner limit between recording units

Fig. 2: Measuring sample Plot and Recording Unit

Caption Figure 2:

A: Inventory Plot Sample,

B : Measuring Deameter at Breast High (dbh),

C : Measuring High Tree,

D : Destructife Sample tree,

E : Measuring total leaf,

F : Measurng total root and

G : Measuring total Branch

Determination of the volume of each tree included in the PU, based on the results of measurements of height and diameter, then determined the volume. Determination of tree volume using the formula.

The measurement of standing trees is done by the formula:

$V = \frac{1}{4} \pi \times d2 \times t \times f \times n$ ………...........…..(1)

V = volume standing stock

π = phi (22/7)

d = diameter breast hight (dbh)

t = tree height

n = number of trees per hectare (n/ha)

Actual Trunk Volume

From the basic formula above, it is reduced to:

$V = \pi/8 \, (Dp2 + Du2).\, p$ ……….................... (2)

Dp = Average base diameter

Du = Average end diameter

p = Segment length

B. Measurement of the Biomass

Calculation of biomass Biomass above ground (above ground) Sach Village Sundul and Banjaar Long done by destructive sampling of the entire organ tree (roots, trunk, branches and leaves) the model used to extrapolate a snapshot of data to wider area. Mathematically, it is done allometrically. Standard allometric equations that have been published are often used, but because the coefficients of this allometric equation vary for each location and species, it is necessary to make a special equation that is significant in estimating the biomass of a vegetation (Heiskanen, 2006).

C. Tree Organ Biomass (BOP)

Lukito Martin (2020) said the calculation of plant tree organ biomassabove ground isknown based on formula:

Tree Organ = $BOP = \frac{BKS}{BBS} x\ BOt$ = ………..........…..(4)

Biomass BOP= Tree organ biomass (g, kg)

BKS = Dry weight of sample (g,kg)

BBS = Wet weight of sample (g,kg)

BBT = wet weight total organ trees (g, kg)

Measurement every dry weight carried by drying the samples taken from the field using an oven at 103 ± 2 0C to obtain a constant weight (Nelson etal,1999, in Losi, 2003). Biomass total trees can be calculated by adding up all the tree component biomass. The formula used

Wt = Ws + WL + WB + Wt...................................(5)

Wt = above ground (total weight)

Ws = Stem weight

WL = leaf weight)

WB = branch weight

D. Carbon Measurement

Source of greenhouse gases in the forestry sector and land change is carbon dioxide. Forest Carbon Stocks are stored in vegetation, namely in stems, shoots and roots, other biomass and in the soil Dharmawan, et al (2013) The carbon content obtained from each tree organ multiplies the biomass of each plant organ by the weight percentage of the total carbon content

Ct = Wt X % carbon content (CC).........................(6)

Ct = Weight of carbon content of tree organs (g, kg)

wt = weight biomass of plant organs (g, kg)

% CC = Total carbon content (C total %)

Guidelines for calculating carbon are available including the national standard for calculating carbon (SNI 7724/7725 of 2011). used as an understanding and implementation of carbon measurement and calculation, supporting climate change mitigation in the forestry sector. Carbon content was calculated by multiplying the biomass of trees, necromas, litter and undergrowth by 47% (Annonymous, 2011).

Absorption COabsorption2 through conversion of C and O Atomic Masses. Comparison of CO2 Atomic Mass to C (Carbon)= 3.67. The potential of forests to absorb CO2 from the atmosphere varies according to the type, age and level of plant density (Heriansyah, 2005). Approach to the calculation of absorption of CO2 can be approached by the formula:

WCO2 = Wtc X 3.67 .... (7)

WCO2 = amount of CO2 absorbed (tons / ha)

Wtc = the total weight of carbon stand a certain type and age (t / ha)

3.67 = Score equivalence / conversion element carbon (C) to CO2

Measurement of the ability to absorb carbon dioxide by multiplying the value of stored carbon by a constant with a large value of C and O atoms of 3.67, so that the value of forest carbon dioxide absorption can be known. Manuri et al (2011).

E. Allometric Equations

Data from such felling, tree height, dbh, sought correlation with fresh weight of plant organs, biomass, carbon dioxide, as well as CO2 sequestration order was made in an allometric equation regression model. From the regression models that have been developed in Indonesia, tree biomass estimation models are generally presented in rank (Krisnawati Haruni, et al, 2012)

Y = aXb..(8)

X = Independent Variable (Diameter, Height)

Y = Independent Variable (biomass)

a = Coefficient of allometric model

b = exponent of allometric model

Selection of the regression model based on the value of the coefficient of determination (R2),the highest as well as the sum of squared errors (residual sum of square) is the smallest. In addition, the significance test of the resulting equation was also carried out. Thenumber of deviations residual error minimum indicates the level of regression error that occurs is also getting smaller (Walpole, 1995).

III. RESULTS AND DISCUSSION

A. Community Forest Stands

Inventory of community forest stands of the Argomulyo FMU group was carried out by determining Measurement Plots in 2 village locations, namely Sundul Village and Banjarpanjang Village. One Plot Measurement is 1 hectare. The steps for data collection on each Measurement Plot, Measurement Plot Plan and Unit can be seen in the following figure-3.

Borders Village	Sundul Village	Banjarpanjang village
North	Bandarr Panjang Village	Banjarejo Village
East	Giripurno Village	Giripurno Village
South	Krowe Village	Sundul Village
West	Krajan Village	Banyudono Village
Geographical Position	Sundul Village	Banjarpanjang Village
North	70 42'12.46" S, 1110 22'24.42" E	70 41' 11.15" S, 1110 21'36.4" E
East	70 42' 38.84" S, 1110 22'59.95" E	70 41' 42.25" S, 1110 22'34.46" E
South	70 45' 7.78" S, 1110 21'59.83" E	70 42'13.79" S, 1110 22' 26.4" E
West	70 42' 4.59" S, 1110 21'51.12" E	70 46'8.92" S, 1110 21' 19.4" E

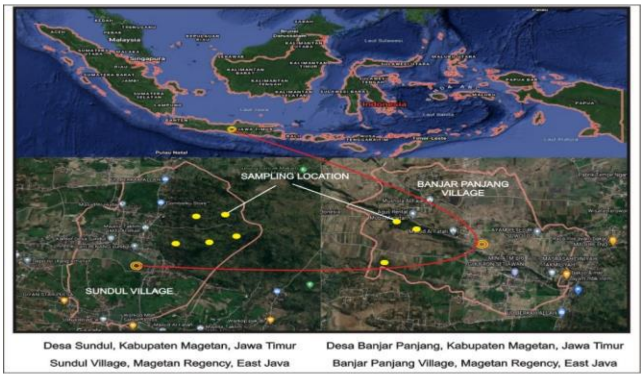


Fig. 3: Location of the sample plots in the villages of Sundul and Bandar Panjang, Argomulyo FMU, Magetan Regency

Sundul Village is 310,435 Ha with a combination showing varying conditions, namely sloping conditions to mountainous conditions, in terms of soil depth, the effective dominance of soil is less than 30 cm located in Parang, Lembeyan, Kawedanan, The type of soil in the village of Sundul consists of grumosol, latosol, mediteran, and andosol. enter the mountainous region of western Bancak. Parang and Ngariboyo sub-districts have a C climate type, the altitude is between 300-1,100 above sea level, with an average rainfall of 1,453 mm/year with a hilly topograph.

Forest Management Unit Argomulyo is a combination of community forest management organizations (OPHR) consisting of seven (7) villages namely Balerejo Village, Garon, Giripurno, Ngentep, Tladan sub-district. Kawedanan, Banjar Panjang Village, Ngariboyo District and Sundul Village, District. Magetan Regency Parang. FMU "Argomulyo" Kawedanan District Magetan Regency was established on June 24, 2010.

B. FMU Argomulyo Working Area

In accordance with the agreement of the members of the Argomulyo FMU, that the working area of the Argomulyo FMU is 966,251 Ha, including 199,144 Ha in the Banjarpanjang and Sundul Village areas as presented in Table 1:

Table.1: Recaptulation of Community Forest Area of Sundul Village and Bandar Panjang FMU Argomulyo, Magetan Regency

NO	Village/Distric	Village	Area of community forest (HA)			Number of Members
			Yard	Moor	Total	
1	BanJar Panjang	Panjang	7,800	35,734	43,533	202
	Ngariboyo district	Pulutan		50,166	50,166	131
	Total-1		7,800	85,900	93,699	333
2	Sundul	Sundul I	0,07	0,515	0,585	12

	Parang District	Sundul II	5,242	59,989	65,231	227
		jambu	3,418	32,239	35,657	109
		Sulurejo	0,721		0,721	8
		Brumbung	3,25		3,25	24
	Total-2		12,701	92,743	105,444	380
	Total 1+2		20,501	178,643	199,144	613

Inventory stands in the community forest of the villages of Sundul and Banjar Panjang in the Argomulyo FMU area, the average potential of community forest per ha forstands is Acacia auricuriformis 16 trees with a standing stock volume of 5.706 m3, Swietenia mahagoni is 8.825 m3 with an average of 46 trees per ha, Tectona grandis Lf is 186 trees with a standing stock volume of 153.98 m3, and the potential for Dalbergia latifolia roxb is 1.229 M3 with an average of 10 trees per Ha. As seen in Table 2, Table 3. and Table 4:

Table. 2: Inventory of Stands at Pole Level per Ha Community Forest of Sundul and Banjar Panjang Villages FMU Argomulyo Magetan Regency

Village	Pole level									
	Acacia auricuriformis		Swietenia mahagoni		Tectona grandis Lf		Dalbergia latifolia roxb		Total	
PU	N	V	N	V	N	V	N	V	N	V
Sundul	22	2,774	101	12,635	306	40,067	25	2,5827	454	58,058
Bandar panjang	20	3,280	43	5,248	274	29,598			337	38,125
Total	42	6,054	144	17,882	580	69,665	25	2,5827	791	96,184
Per Ha	11	1,513	36	4,471	145	17,416	6	0,6457	197,75	24,046

Caption = N= Number of Trees, V= Volume

Source: Primary data processed in 2021

Table. 3: Inventory of Stands Tree Level per Ha Community Forest of Sundul and Banjar Panjang Village FMU Argomulyo Magetan Regency

Desa	Tree Level									
	Acacia auricuriformis		Swietenia mahagoni		Tectona grandis Lf		Dalbergia latifolia roxb		Total	
PU	N	V	N	V	N	V	N	V	N	V
Sundul	10	5,03	34	14,778	119	60,709	15	3,0228	178	83,54
Bandar panjang	13	14,064	6	2,639	43	23,608			62	40,311
Total	23	19,094	40	17,417	162	84,317	15	3,0228	240	123,85
Per Ha	6	4,7735	10	4,354	41	21,079	4	0,7557	60	30,963

Caption = N= Number of Trees, V= Volume

Source: Primary data processed in 2021

Table.4: Inventory of Community Forest Stands per Ha in Sundul Village and Banjar Panjang FMU Argomulyo Magetan Regency

Village	Total number									
	Acasia *Acacia auricuriformis*		Swietenia mahagoni		Tectona grandis Lf		Dalbergia latifolia roxb		Total	
PU	N	V	N	V	N	V	N	V	N	V
Sundul	32	7,804	135	27,413	425	100,78	40	4,917	632	141,6
Bandar panjang	33	15,018	49	7,887	317	53,206			399	78,437
Total	65	22,822	184	35,299	742	153,98	40	4,917	1.031	220,03
Per Ha	16	5,706	46	8,825	186	38,495	10	1,229	258	55,009

Caption = N= Number of Trees, V= Volume

Source: Primary data processed in 2021

Table.5: Number of trees Inventory of Community Forest Stands in Sundul and Banjar Panjang Villages, Argomulyo FMU, Magetan Regency

Village	District	Area (Ha)	*Acacia auricuriformis*	Swietenia mahagoni	Tectona grandis Lf	Dalbergia latifolia roxb	Total
			N	N	N	N	N
Banjar Panjang	Ngariboyo	20,501	677	1.005	6.499		8.180
Sundul	Parang	178,643	5.717	24.117	75.923	7.146	112.902
jumlah total		*199,144*	*6.393*	*25.121*	*82.422*	*7.146*	*121.082*

Caption = N= Number of Trees

Source: Primary data processed in 2021

Table. 6: Volume Total Inventory of Community Forest Stands in Sundul and Banjar Panjang Villages, Argomulyo FMU, Magetan Regency

Village	District	Area (Ha)	*Acacia auricuriformis*	Swietenia mahagoni	Tectona grandis Lf	Dalbergia latifolia roxb	Total
			Volume	Volume	Volume	Volume	Volume
Banjar Panjang	Ngariboyo	20,501	307,890	161,681	1.090,781		1.560,353
Sundul	Parang	178,643	1.394,163	4.897,107	18.002,856	878,334	25.172,460
Total Number		*199,144*	*1.702,053*	*5.058,789*	*19.093,638*	*878,334*	*26.732,813*

Source: Primary data processed in 2021

C. Potential Biomass of Community Forest Stands

Amount of forest biomass is carried out for all parts Trees consist of above-ground biomass including stem organs, branches, and leaves, and below-ground biomass including tree roots. The results of the inventory per segment are presented in Table 7 as follows:

Table. 7: Biomass (kg) Per Segment of Community Forests in Sundul Village and Bandar Panjang FMU Argomulyo Magetan Regency

Type	Dbh (cm)	H (m)	Vol (M3)	Wet Weight (Kg)				Total (KG)
				Root	Stem	Branch	Leaf	
Acasia auricuriformis	15,037	16,65	0,014	31,329	47,323	10,300	8,869	97,821
Swietenia mahagoni	17,957	19,75	0,020	27,169	75,848	14,706	11,273	128,996
Tectona grandis Lf	20,203	19,57	0,022	50,921	95,221	12,020	10,083	168,245
Dalbergia latifolia roxb	13,630	15,63	0,012	31,329	47,323	9,585	8,869	97,106
Average	16,707	17,90	0,017	35,187	66,429	11,653	9,774	123,042

Source: Primary data processed in 2021

The average weight per tree for the Acacia auricuriformis species was 97.821 kg/tree, the Swietenia mohagoni species was 128.996 kg/tree and the Tectona grandis lf species was 168.245 kg/tree and Dalbergia latifolia roxb 97.106 kg/tree. the average wet weight in the villages of Sundul and Bandar Panjang is 123,042 kg/tree. The average biomass per ha is for Acacia auricuriformis 148.41 tons/ha, Swietenia mahagoni is 213.87 tons/ha and for Tectona grandis Lf is 611.56 tons/ha and Dalbergia latifolia roxb of 21.48 tons/ha, the average biomass per ha of 995.32 tons ha. The Biomass Potential of Community Forests in Sundul and Banjar Panjang Villages in the Argomulyo FMU Management Area is presented in Table 8, figure-4

Table. 8: Biomass Potential Per Ha in Sundul Village and Bandar Panjang Management Area of FMU Argomulyo Magetan Regency

Average per Ha	Total Biomass Total per Hectare Type						
	N	V (M3)	Root	Stem	Branch	Leaf	Total (Ton)
Acacia auricuriformis	16	5,706	46.199,66	72.627,07	16.132,75	13.450,99	148,41
Swietenia mahagoni	46	8,825	64.779,76	121.014,74	15.479,50	12.596,20	213,87
Tectona grandis Lf	186	38,474	132.647,90	351.388,35	73.523,74	53.997,32	611,56
Dalbergia latifolia roxb	10	1,229	6.735,66	10.588,63	2.191,68	1.961,08	21,48
Total	258	54,234	250.362,98	555.618,79	107.327,68	82.005,60	995,32

Caption = N= Number of Trees, V= Volume

Source: Primary data processed in 2021

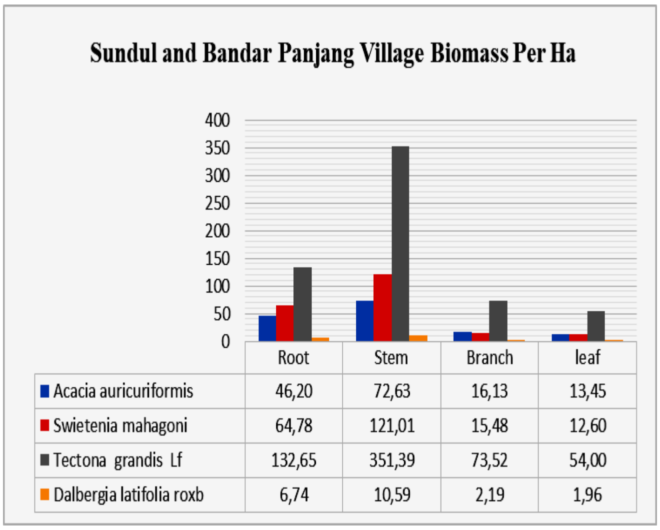


Fig. 4: Biomass Potential Per ha of Community Forests in Sundul Village and Bandar Panjang FMU Argomulyo Kec. Kawedanan, Magetan Regency

The village community forest area Sundul and Banjar length within the territory of the region manage FMU Argomulyo covering an area of 199,144 ha, the distribution of species and potential based on the type of Tectona grandis Lf looks very dominant in the area of community forest and is almost evenly distributed in every village in the management area, namely 82,422 trees with a total volume of standing stock of stands Tectona grandis Lf of 19,093,638 m3, species Swieteniamahogany amounting to 25.121 trees 5.058,789 m3is also almost evenly, the type of *Acaciaauricuriformis* tree of 6393 with a total volume of standing stock amounted to 1702.053 M3, the kind Dalbergia lati Folia Roxb of 7.146 trees (878.334 m3) is only found in the village Sundul Table 5 and Table 6.

Image above shows that 75% of the tree biomass in the study is accumulated above ground. This study noted that the average ratio between aboveground and belowground tree biomass in the study was 4:1 where the amount of above-ground biomass was much higher than below ground. Which is consistently similar to studies conducted in different forest areas (Mendoza-Ponce and Galicia 2010; Ekoungoulou et al. 2015; Nam et al. (2016)

Table. 9: Total Biomass Potential of Sundul Village and Bandar Panjang Management Area of FMU Argomulyo Magetan Regency

Village/Type	Total Biomass per species (Kg)/Ton						
	N	V (M3)	Root	Stem	Branch	Leaf	Total (Ton)
Sundul Village							
Acacia auriculiformis	5.717	1.394,163	87.677,10	137.830,69	30.616,52	25.527,12	281,651
Swietenia mahagoni	24.117	4.897,107	127.079,76	238.131,22	30.093,08	24.470,43	419,77
Tectona grandis Lf	75.923	18.002,856	250.162,64	662.688,49	138.659,52	101.834,34	1.153,34
Dalbergia latifolia roxb	7.146	878,334	13.471,31	21.177,26	4.383,37	3.922,16	42,95
Total-1 (Ton)	**112.902**	**25.172,460**	**478,39**	**1.059,83**	**203,75**	**155,75**	**1.897,72**
Bandar Panjang Village							
Acacia auriculiformis	677	307,890	4.722,22	7.423,45	1.648,98	1.374,87	15
Swietenia mahagoni	1.005	161,681	2.479,76	3.898,25	865,92	721,98	8
Tectona grandis Lf	6.499	1.089,052	15.133,16	40.088,21	8.387,97	6.160,29	70
Total-2 (Ton)	**8.180**	**1.558,624**	**22,34**	**51,41**	**10,90**	**8,26**	**92,91**
Total Number	**121.082**	**26.731,084**	**500,73**	**1.111,24**	**214,66**	**164,01**	**1.990,63**
Average	**116.992**	**25.951,772**	**489,56**	**1.085,53**	**209,20**	**159,88**	**1.944,18**

Caption = N= Number of Trees, V= Volume

Source: Primary data processed in 2021

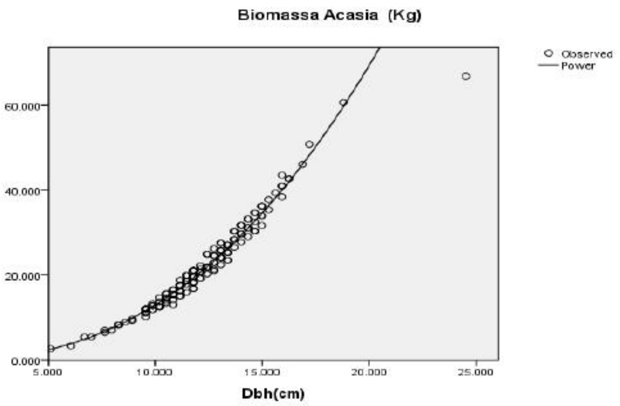
Lukito Martin, Rohmatiah, 2013 Plant Biomass JUN (Jati Unggul Nusantara) Krowe Village Kab. Magetan averages 183.870 kg/tree. The total potential biomass content of JUN stands is 27.30 tons per hectare, Lukito Martin, Romatiah (2014) Potential biomass of JUN stands in Trosono Village. Magetan regency amounted to 56.2 tons. Or 17,295 tons per hectare. Judging from the potential for biomass in community forests around the Magetan district, Madiun Regency Rohmatiah, Lukito martin, 2015. The amount of biomass potential of JUN stands in Dungus Village, Kab. Madiun averages 27.30 tons per hectare, or a total of 121.1 tons in an area of 131.4 ha Rohmatiah, Lukito Martin, 2015. Estimated volume, biomass and carbon of the community forest of Jati Unggul Nusantara Kare Village. Madiun regency. JUN's biomass content is 168.35 tons per ha. Total of 6,462.67 Tons.

D. Biomass estimation model

The model for estimating the biomass of Community Forest species on the diameter at breast height (Dbh) in the villages of Sundul and Bandar Panjang FMU Argomulyo, Magetan Regency is described in the form of a scatter plot, presented in Table 10 and Figure -5 as follows:

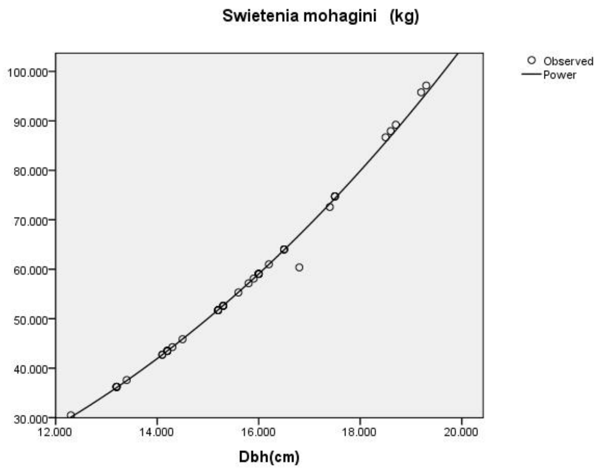
Table. 10: Biomass Allometry Model for Community Forests in Sundul and Bandar Panjang Villages, Argomulyo FMU, Magetan Regency

No.	Tyepe	Model	Equation	R^2	RSS	Std Error
1.	*Acacia auriculiformis*	Power	Y = 0,50 *dbh* ^{2,416}	0,977	1.108	0,070
2	*Swietenia mahagoni*	Power	Y = 0,092 *dbh* ^{2,565}	0,997	0.007	0,016
3	*Tectona grandis lf*	Power	Y = 0,092 *dbh* ^{2,565}	0,997	0.007	0,016
4	*Dalbergia latifolia roxb*	Power	Y = 0,115 *dbh* ^{2,065}	0,792	1.456	0,204
5	Biomass	Power	Y = 0,048 *dbh* ^{2,442}	0,979	1.121	0,064



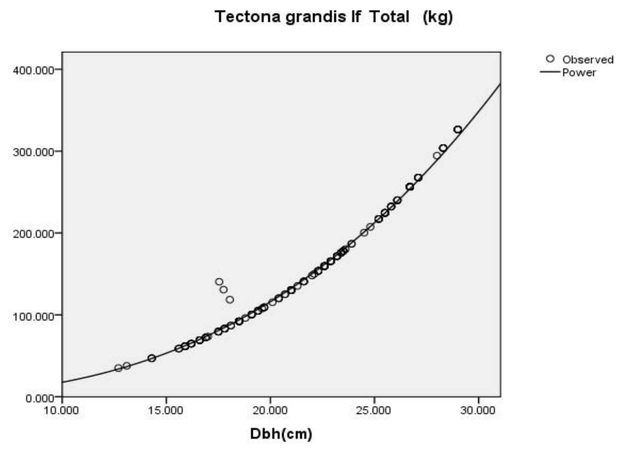
Biomass *Acacia auriculiformis*. Power Y = 0,50 *dbh* ^{2,416} R^2 = 0,977, RSS 1.108, Std Error 0,07

Fig. 5a: Estimation Model of Content (kg) of Community Forest Segments in Sundul Village and Bandar Panjang FMU Argomulyo, Magetan Regency



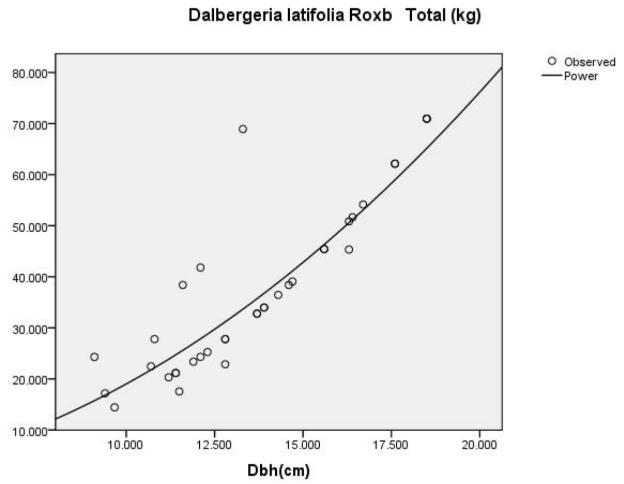
Carbon *Swietenia mahagoni*. Power Y = 0,048 *dbh* ^{2564} R^2 = 0,917, RSS=0,022, Std Error 0,0213

Fig. 5b: Estimation Model of Content (kg) of Community Forest Segments in Sundul Village and Bandar Panjang FMU Argomulyo, Magetan Regency



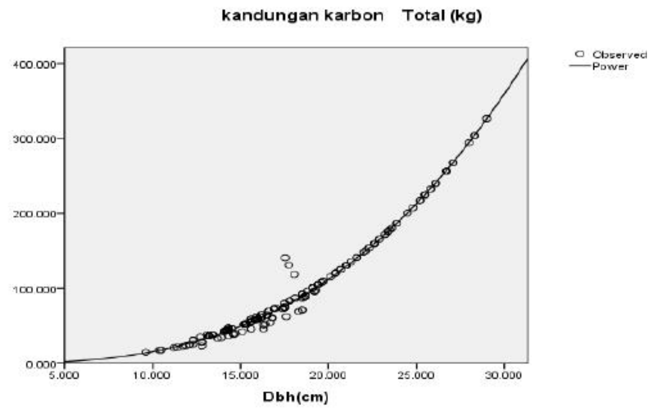
Carbon *Tectona grandis lf*. Power Y = 0,035 *dbh* ^{2710} R^2 = 0,987, RSS = 0,062, Std Error 0,058

Fig. 5c: Estimation Model of Content (kg) of Community Forest Segments in Sundul Village and Bandar Panjang FMU Argomulyo, Magetan Regency



Carbon *Dalbergia latifolia roxb*. Power Y = 0,190 *dbh* ^{2001} R^2 = 0,767, RSS= 1,586, Std Error 0,216

Fig. 5d: Estimation Model of Content (kg) of Community Forest Segments in Sundul Village and Bandar Panjang FMU Argomulyo, Magetan Regency



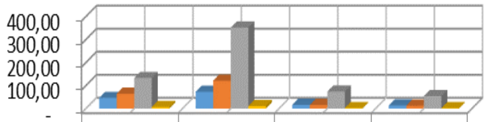
Carbon Total . Power Y = 0,021 *dbh* ^{2873} R^2 = 0,971, RSS1.876, Std Error 0,093

Fig. 5e: Estimation Model of Content (kg) of Community Forest Segments in Sundul Village and Bandar Panjang FMU Argomulyo, Magetan Regency

Table 11. Carbon Content (kg) Per Segment of Community Forests in Sundul Village and Bandar Panjang FMU Argomulyo Magetan Regency

Average Per Ha	Carbon (Kg)				
	Root	Stem	Branch	Leaf	Total (Ton)
Acacia auricuriformis	43.427,68	68.269,45	15.164,78	12.643,93	139,51
Swietenia mahagoni	60.892,98	113.753,85	14.550,73	11.840,43	201,04
Tectona grandis Lf	124.689,03	330.305,05	69.112,32	50.757,48	574,86
Dalbergia latifolia roxb	6.331,52	9.953,31	2.060,18	1.843,42	20,19
Total	235.341,20	522.281,66	100.888,02	77.085,26	935,60

Source: Primary data processed in 2021



	Root	Stem	Branch	leaf
Acacia auricuriformis	46,20	72,63	16,13	13,45
Swietenia mahagoni	64,78	121,01	15,48	12,60
Tectona grandis Lf	132,65	351,39	73,52	54,00
Dalbergia latifolia roxb	6,74	10,59	2,19	1,96

Fig. 6. Carbon Content (kg) Per Segment of Community Forests in the Villages of Sundul and Bandar Panjang FMU Argomulyo Magetan Regency

E. Carbon Potential

Research on the carbon content of community forest stands is limited to living plants. The measurement method used, the carbon value is calculated by multiplying the tree biomass, 47% (Annonymous, 2011). The results of the calculation of the carbon content are presented in Table 11 as follows:

Table 11 shows the highest carbon content per ha for Tectona grandis Lf was 574 tons/ha (61.44%), Swietenia mahagoni 21.48%, Acacia auricuriformis 14.91% and Dalbergia latifolia roxb 2.15%. With an average percentage of carbon (C organic) content of 47%. Based on the carbon content per organ of community forest plants for stem organs it is 55.82%, for root organs it is 25.15% for branch organs 10.78 % and for leaf organs 8.25% as shown in Figure 6.

The average carbon content of community forest plant organs in the villages of Sundul and Bandar Panjang FMU Argomulyo is 47.12%. the need to calculate total community forest carbon depends on the needs and ease of data collection, the average percentage of carbon content (organic C) is 47% Ravindranath, et al, 2008. The total carbon content of the community forest stands of Sundul Village and Bandar Panjang FMU Argomulyo Magetan Regency is 57.983 tons/ha. The area of community forest management area of FMU Argomulyo Kec. Kawedanan Magetan Regency is 199.144 Ha by looking at the types of stands that are in the management area, the carbon content is 46,130.7 tons. Where Sundul has the greatest potential 52.24%. As seen in Table 12:

Table 12. Total Carbon Content (Tons) of Community Forest FMU Argomulyo Magetan Regency

Village/type	Total of Carbon dioxide per species (Kg)						
	N	V (M3)	Root	Stem	Branch	Leaf	Total (Ton)
Sundul Village							
Acacia auricuriformis	5.717	1.394,163	41.208,24	64.780,43	14.389,76	11.997,75	132,38
Swietenia mahagoni	24.117	4.897,107	59.727,49	111.921,67	14.143,75	11.501,10	197,29
Tectona grandis Lf	75.923	18.002,856	117.576,44	311.463,59	65.169,97	47.862,14	542,07
Dalbergia latifolia roxb	7.146	878,334	6.331,52	9.953,31	2.060,18	1.843,42	20,19
Total-1 (Ton)	**112.902**	**25.172,460**	**224,84**	**498,12**	**95,76**	**73,20**	**891,93**
Bandar Panjang Village							
Acacia auricuriformis	677	307,890	2.219,44	3.489,02	775,02	646,19	7,13
Swietenia mahagoni	1.005	161,681	1.165,49	1.832,18	406,98	339,33	3,74
Tectona grandis Lf	6.499	1.089,052	7.112,59	18.841,46	3.942,35	2.895,34	32,79
Total-2 (Ton)	**8.180**	**1.558,624**	**10,50**	**24,16**	**5,12**	**3,88**	**43,67**
Total Number	**121.082**	**26.731,084**	**235,34**	**522,28**	**100,89**	**77,09**	**935,60**
Average	**116.992**	**25.951,772**	**230,09**	**510,20**	**98,33**	**75,14**	**913,76**

Source: Primary data processed in 2021

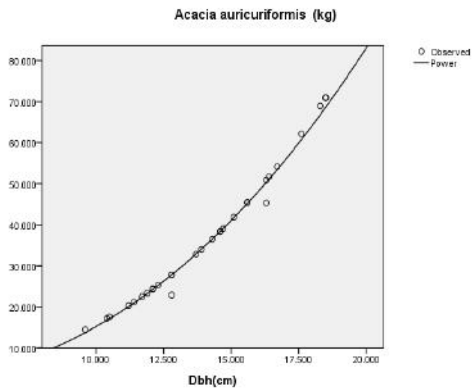
The carbon content of stands Jun Krowe Village, Magetan Regency averaged 13.65 tons Ca/Ha, Lukito Martin, Rohmatiah, 2013. The carbon potential of Jati Unggul Nusantara Trosono Village, Magetan Regency was 8.73 tons carbon/ha. The total is 26.1 tons. Rohmatiah, Lukito Martin, 2015 said the total potential carbon content of the JUN (Jati Unggul Nusantara) stands of Dungus Village, District. Madiun amounted to 46.61 tons of carbon. volume per hectare 12.45 – 13.65 tons of carbon per hectare, Rohmatiah, Lukito Martin, 2015 said the total potential carbon content of the JUN stands of the community forest of Kare Village, Madiun Regency is 3,180.71 tons of carbon. Per hectare is around 84.175 tons. The carbon content of the UPHR Kare Lestari community forest covering an area of 625.82 hectares totaling 48,709.92 tons or an average of 77.833 tons carbon/ha. Setiahadi, et al (2014).

F. Carbon Estimation Model

The carbon estimation model for Sundul and Bandar Panjang villages in the Argomulyo FMU area, Magetan district for the total carbon of community forest species against diameter at Breast height (Dbh) is presented in Table 13, and the scatter plot is shown in Figure 7:

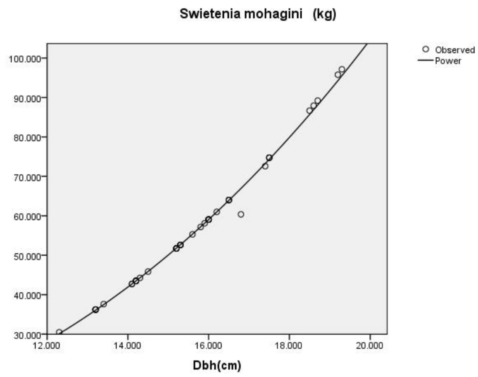
Table 13. Carbon Allometry Model for Community Forests in Sundul and Bandar Panjang Villages, Argomulyo FMU, District. Magetan

No	Type	Model	Equation	R^2	RSS	Std Error
1	*Acacia auriculiformis*	Power	Y = 0,0540 *dbh* ^{2,416}	0,990	0,057	0,045
2	*Swietenia mahagoni*	Power	Y = 0,048 *dbh* ^{2,564}	0,917	0.022	0,021
3	*Tectona grandis lf*	Power	Y = 0,035 *dbh* ^{2,710}	0,987	0.062	0,058
4	*Dalbergia latifolia roxb*	Power	Y = 0,190 *dbh* ^{2,001}	0,767	1.586	0,216
5	Carbon	Power	Y = 0,021 *dbh* ^{2873}	0,971	1.876	0,093



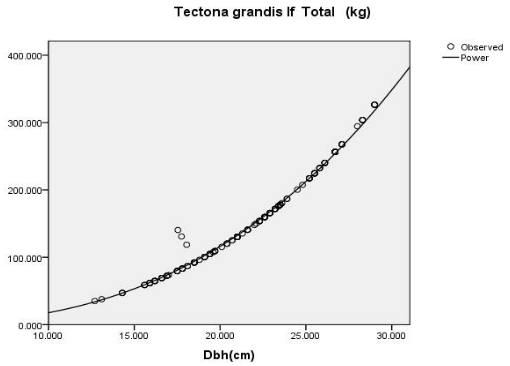
Carbon *Acacia auriculiformis*. Power Y = 0,0540 *dbh* ^{2,416} R^2 = 0,990, RSS 0,057, Std Error

Fig. 6a: Estimation Model of Content (kg) of Community Forest Segments in Sundul Village and Bandar Panjang FMU Argomulyo, Magetan Regency



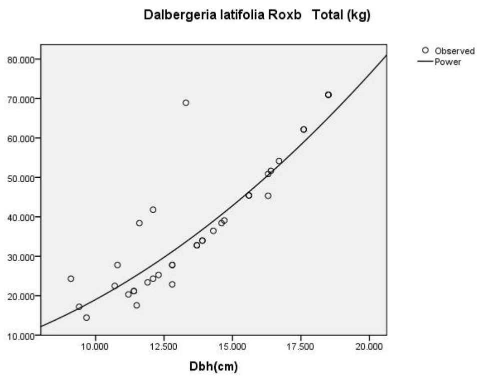
Carbon *Swietenia mahagoni*. Power Y = 0,048 *dbh* ^{2564} R^2 = 0,917, RSS=0,022, Std Error 0,0213

Fig. 6b: Estimation Model of Content (kg) of Community Forest Segments in Sundul Village and Bandar Panjang FMU Argomulyo, Magetan Regency



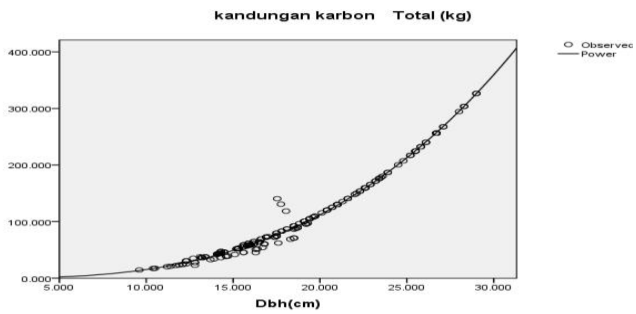
Carbon *Tectona grandis lf*. Power Y = 0,035 *dbh* ^{2710} R^2 = 0,987, RSS = 0,062, Std Error 0,058

Fig. 6c: Estimation Model of Content (kg) of Community Forest Segments in Sundul Village and Bandar Panjang FMU Argomulyo, Magetan Regency



Carbon *Dalbergia latifolia roxb*. Power Y = 0,190 *dbh* ^{2001} R^2 = 0,767, RSS= 1,586, Std Error 0,216

Fig. 6d: Estimation Model of Content (kg) of Community Forest Segments in Sundul Village and Bandar Panjang FMU Argomulyo, Magetan Regency



Carbon Total . Power Y = 0,021 *dbh* ^{2873} R^2 = 0,971, RSS1.876, Std Error 0,093

Fig. 6d: Estimation Model of Content (kg) of Community Forest Segments in Sundul Village and Bandar Panjang FMU Argomulyo, Magetan Regency

IV. CONCLUSION

1. Average standing stock of 54.25 m^3/ha with a total volume of 26,732,831 m^3 consisting of *Acacia auriculiformis* stands potential of 5,706 m^3/ha, total volume of 1,702,053 m^3, *Swietenia mahagoni* of 8,825 m^3/ha, total volume of 5,508,789 m^3, *Tectona grandis Lf* of 38,495 m^3/ha total volume of 19,093,638 m^3, and *Dalbergia latifolia roxb* of 1,229 m^3/ha total volume of 878,334 m^3
2. Biomass content per hectare is 955.32 tons/ha, during from Acacia auriculiformis is 148.41 tons/ha, Swietenia mahagoni is 213.87 tons/ha, Tectona grandis Lf is 611.56 tons/ha, and Dalbergia latifolia roxb of 21.48 tons/ha. Total Biomass based on Community forest area 1,944,178 tons.
3. The average carbon content is 467.80 tons C/ha with an area of 199.44 ha, so the potential available carbon dioxide is 913,763 tons of carbon.
4. The carbon absorption capacity of the community forests of Sundul Village and Bandar Panjang FMU Argomulyo to absorb carbon dioxide is 1,716.82 tons C/ha, or is able to absorb CO2 content of 3,353.512 tons C.
5. Relationship of Biomass, Carbon, and Carbon Uptake with Variable Diameter at Breast height (Dbh) Allometric power model with model:

Model Equation	Allometrik	R^2	RSS
Biomass Allometry	WT = 0,048 Dbh ^{2,442}	0,979	0,064
Carbon Allometry	WT = 0,021 Dbh ^{2,873}	0,971	0,093
CO2 absorption allometry	WT = 0,021 Dbh ^{2,6358}	0,973	0,086

Caption: WT = Total Wight, Dbh = Diameter Brigt High, R = Koef Diterminasi ,RSS = Residual Some Of Square

Measurement of carbon potential in people's forests, when this research was carried out only used the above and bellows ground methods. In the future, it is necessary to measure all aspects (trees, soil, necro-mass, litter) and carbon analysis using all organs/variables with the creation of a comprehensive allometric model.

V. ACKNOWLEDGEMENTS

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REFERENCES

[1] Basic Law of Forestry of the Republic of Indonesia No. 41 of 1999.

[2] SNI 7724:2011, National Standardization Body (BSN), "Measurement and Calculation of Carbon Stock. Field Measurement for Appraisal forest Carbon Stock (Ground Based Forest Carbon Accounting)". Book. Jakarta, 16p, 2011

[3] I. W. S. Dharmawan, N. D. Atmojo, A. Wibowo, T. Partiani, "Set Up Institutional System For Monitoring Forest Carbon Stocks in Meru Betiri National Park", Center for Climate Change and Policy Research and Development Forestry Research and Development Agency Ministry of Forestry, Indonesia, 2013.

[4] Brown, Sandra, "Estimating Biomass and Biomass Change of Tropical Forests: a Primer". (FAO Forestry Paper - 134). FAO, Rome, 1997

[5] X.F. Dako, "Design of Community Forest Development in Indonesia", Partners, Vol.1, No. 1, pp. 73-84, 2019.

[6] D. Darusman, Suharjito D, "Community Forestry: Various Patterns of Community Participation in Forest Management, Book. Bogor Agricultural Institute, Bogor, Indonesia, 1998.

[7] R. Ekoungoulou, S. Niu, J. J. Loumeto, S. A. Ifo, E. Y. Bocko, F. E. K. Mikieleko, E. D. M. Guiekisse, H. Senou, X. Lium, "Evaluating the carbon stock in above-and below ground biomass in a Moist Central African Forest", Appl Ecol Environ Sci, Vol. 3, No. 2, pp. 51-59, 2015.

[8] K. Hairiah, S. Rahayu, "Measurement of Stored Carbon in Various Land Uses", World Agroforestry Centre, ICRAF Southeast Asia Regional Office, Bogor, Indonesia, 2007.

[9] Heiskanen, "BIOMASS ECV REPORT", 2006. Twww.fao.org/GTOS/doc/ECVs/T12-biomass-standards-report-v01.doc

[10] H. Ika, "Potential of Industrial Plantation Forest in Carbon Sequester: A case study in Acacia auricuriformis and Pinus Plantation Forests", Science and Technology, Vol.3, XVII, March 2005.

[11] IPCC, "The carbon cycle and atmospheric carbon dioxide", The scientific basis, In Climate change, pp. 185 – 237, 2001.

[12] J. Penman, M. Gytarsky, T. Hiraishi, T. Krug, D. Kruger, R. Pipatti, L. Buendia, K Miwa, T Ngara, K. Tanabe, F. Wagner, "Good Practice Guidance for Land Use, Land-Use Change and Forestry", Intergovernmental Panel on Climate Change National Greenhouse Gas Inventories Programme, 2003. www.ipcc-nggip.iges.or.jp/lulucf/gpglulucf unedit.html

[13] S. Solomon, D. Qin, M. Manning, M. Marquis, K. Averyt, M. M. B. Tignor, H. L. Miller, Z. Chen, "The Physical Science Basis Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel in Climate Change", Cambridge University Press, pp. 96, 2007.

[14] A. Junaedi, "Contribution of forests as carbon dioxide sinks", Journal of Forest Info, Vol. 5, No. 1, pp.1-7, 2008.

[15] H. W. C. Krisnawati, R. Adinugroho, Imanuddin, "Monograph Allometric model for estimating tree biomass in different types of forest ecosystems in Indonesia", Center for Research and Development Conservation and Rehabilitation, Forestry Research and Development Agency, Bogor, Indonesia, 2012.

[16] C. J. Losi, G. S. Thomas, C. Richard, E. M. Juan, "Analysis of Alternative Methods for Estimating Carbon Stock in Young Tropical Plantations", Forest Ecology and Management, Vol. 184, pp. 355 – 368, 2003.

[17] M. Lukito, "Inventory of eucalyptus plantation forest (Mellaleuca cajuputi subsp cajuputi powell) in producing forest biomass and carbon: Case in eucalyptus plantation forest BKPH Sukun, KPH Madiun Perum Perhutani Unit II East Java", Thesis of Universitas Gadjah Mada, Yogyakarta, Indonesia, 2010.

[18] M. Lukito, A. Rohmatiah, "Biomass and Carbon Estimation of 5 Years Old Tectona grandis Lf Plant (Case of Plantation Forest Area of Jati Unggul Nusantara (JUN) Krowe Village, Lembeyan District, Magetan Regency)", Agri-Tek Journal Vol. 14, No. 1, March 2013.

[19] M. Lukito, A. Rohmatiah, "Biomass and Carbon Estimation Model of Community Forest Jati Unggul Nusantara Case of Community Forest Jati Unggul Nusantara (JUN) Age 5 Years Trosono Village, Parang District, Magetan Regency)", Agri-Text Journal Vol. 15, No. 1, March 2014.

[20] S. Manuri, C. A. S Putra, A. D. Saputra, "Forest Carbon Stock Estimation Techniques", Merang REDD Pilot Project,German International Cooperation – GIZ, Palembang, Indonesia, 2011.

[21] A. Mendoza-Ponce, L. Galicia, "Aboveground and belowground biomass and carbon pools in highland temperate forest landscape in Central Mexico", Forestry, Vol. 83, No. 5, pp. 497-506, 2011.

[22] V. T. Nam, M. V. Kuijk, N. P. R. Anten, "Allometric equations for aboveground and belowground biomass estimations in an evergreen forest in Vietnam", PLoS ONE, Vol. 11. No. 6, pp. e0156827, 2016.

[23] A. Purbawiyatna, F. Agung Prasetyo, H. Purnomo, "Studi Penyusunan Panduan Penyiapan Unit Pengelolaan Hutan Alam Untuk Pembangunan Program Redd+", Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Forests and Climate Change Programme (FORCLIME), Jakarta: Indonesia, 2012.

[24] Puspitojati T, Mile Y, Fauziah E and Darusman D, "Community Forests Contribution of Rural Communities for Plantation Forests", PT. Kanisius Yogyakarta, 2014.

[25] Dako XF, "Design of Community Forest Development in Indonesia", Partner, Vol. 1, No. 1, pp. 73-84, 2019.

[26] R. Setiahadi, Martono, M. Lukito, "Carbon Stock Calculation Model (Carbon Stock) Certified Community Forest SVLK (Timber Legality Verification System) for

PDD (Project Document Design) Preparation", 2014 Competitive Grant Research Report, 2014.

[27] N. H. Ravindranat, R. K. Caturverdi, I. K. Murthy, "Forest conservation afforestation and reforestation in India: Implications for forest carbon stocks", JSTORE, Vol. 95, No. 2, pp. 216-222, Jully 2008.

[28] A. Rohmatiah, M. Lukito. "Volume, Biomass and Carbon Estimation of Community Forest Tectona grandis Lf Unggul Nusantara Dungus Village, Dagangan District, Madiun Regency" in Journal of Agri-Tek, Vol. 16, No. 1, 2015

[29] N. H. Stern, "The Eonomic of Climate Change", Cambride University Press: Cambridge, England, 2007.

[30] R. E. Walpole, "Introduction to Statistics 3rd Edition", PT. Main Library Gramedia: Jakarta, Indonesia, 1995