ESTIMATION OF CARBON CONTENT OF MAHONI TREES (*Swietenia mahagoni (L) Jacq*) SVLK CERTIFIED COMMUNITY FOREST (WIMBER LEGALITY VERIFICATION SYSTEM)
(Case Study at KTH Lestari Makmur, Ngranget Village, Dagangan District, Madiun Regency Indonesia)

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Abstract: Community forest development is a concrete form of climate change mitigation that community forest farmers have carried out. Community forests are essential in reducing greenhouse gas emissions because forests can absorb carbon dioxide in the air, stored in trees. Measuring the amount of C stored in plant bodies (biomass) in community forests can describe the amount of CO absorbed by plants in the atmosphere. The research aims to estimate the carbon reserves of mahogany trees in SVLK (Timber Legality Verification System) certified community forests. The method used is the creation of allometric equations using the destruction method for mahogany tree species. The research location is in a community forest area managed by the Forest Farmers Group (KTH) Lestari Makmur, Ngranget Village, Dagangan District, Madiun Regency. With a land area of 14,3808 hectares owned by 63 farmer group members, it received a certificate from the SVLK Certification Agency PT Sarby International Certification (SIC) on October 4, 2021. The percentage of biomass per tree part is the stem, 49.73%; branches and twigs, 19.41%; roots, 18.41 %; last leaves, 12.45%. The model equation to estimate the total carbon content of mahogany wood Y = 169.3739 d $^{2.290}$ (with diameter in cm and carbon in grams).

Keywords: carbon content; mahogany; community forestry; Legality of wood

1. INTRODUCTION

One way to control climate change is to reduce greenhouse gas emissions (CO, CH, NO) by maintaining the integrity of natural forests and increasing the population density of trees outside the forest. Plants inside and outside the forest area absorb charcoal acid gas (CO) from the air through photosynthesis, which is then converted into carbohydrates, distributed throughout the plant body, and finally stored in the plant body. The process of storing carbon (C) in the bodies of living plants is called (C-).

Based on Presidential Decree 61/2011 concerning the National Action Plan for Reducing Greenhouse Gas Emissions, the forestry sector occupies a strategic position that plays a vital role in efforts to reduce Greenhouse Gases until 2020. According to Pustanling data, 2011, the forestry sector's action plan for reducing Greenhouse Gas emissions is directed at controlling forest and land fires, managing water networks and systems, forest and land rehabilitation, developing Industrial Plantation Forests (HTI), building Community Forests (HR), eradicating illegal logging, preventing deforestation, and community empowerment. (1).

Community forest development is a concrete form of climate change mitigation that community forest farmers have carried out. Community forests are essential in reducing greenhouse gas emissions because forests can absorb carbon dioxide in the air, stored in trees. However, most community forest farmers need to realize the importance of community forests in mitigating climate change. Most community forest farmers need to learn how much carbon dioxide their forests have absorbed. In a broader context, only a few people understand various global warming and climate change terms. (2)

Community forests grow on community land, either in yards (around residential houses), upland (dry land usually planted with crops other than rice), or in rice fields. (3)

The Timber Verification and Legality System (SVLK) is a multi-stakeholder tracking system that ensures the legality of circulating and trading timber sources in Indonesia. The Timber Legality Verification System (SVLK) was developed to encourage the implementation of applicable government regulations related to trade and distribution. SVLK is Indonesia's effort to provide legal guarantees that wood and wood products originating from Indonesia are sourced from legal raw materials and come from sustainably managed forests, so every wood product whose raw materials come from imports must also come from legal sources. And produced without violating the country's laws where the product trees are harvested. (4)

The taxonomy of mahogany plants (Swietenia mahagoni (L.) Jacq) is classified as follows: (5, 6)
Kingdom : Plantae (plants)
Division : Magnoliophyta (flowering plants)
Class : Magnoliopsida (two pieces/dicots)
Order : Sapindales
Family : Meliaceae
Genus : Swietenia
Species : *Swietenia mahagoni* (L.) Jacq.
Synonyms : *Swietenia mahogoni* Lam., *Swietenia mahogani* C. DC., *Swietenia mahagoni* var. praecociflora Hemsl., *Swietenia acutifolia* Stokes, *Cedrela mahagoni* L.

Mahogany plants are a type of plant that can survive even in arid land. Even if it is not watered for months, mahogany can still survive. Location requirements for mahogany cultivation include a maximum land height of 1,500 meters above sea level, rainfall of 1,524-5,085 mm/year, and air temperature of 11-36 ^{0} C. The Swietenia genus, also known as broadleaf mahogany, is a type of tropical tree endemic to Central America and South America. Which has a wide natural distribution, stretching from Mexico to Bolivia and Central Brazil. This mahogany species is also grown in Southeast Asia and the Pacific, including India, Indonesia, the Philippines, and Sri Lanka—the natural development of 11 MAHONI (Swietenia mahagoni (L.) Jacq) Herbs for diabetes. Swietenia's optimum is in dry tropical forest conditions with an annual rainfall of 1000-2000 mm, an average yearly temperature of 24 ^{0} C, and a potential evapotranspiration ratio of 1-2. In Indonesia, Swietenia grows at altitudes from 0 - 1500 meters above sea level in areas with average annual temperatures from 20-28 ^{0}C. (7, 6)

Mahogany is a plant or plant originating from tropical areas in the West Indies. This plant usually grows wild as a shade tree in various teak forests, beaches, and roadsides (7). The quality of the wood is hard and perfect for furniture, carved items, and handicrafts. Rulers are also often made because they are not easily changed. The quality of mahogany wood is slightly below teak wood, so it is often called the second favorite in the wood market. Another use of the mahogany plant is the skin, used to dye clothes. The cloth boiled with mahogany skin will turn yellow and not fade quickly.

Meanwhile, mahogany sap, also called blendok, can be used as a raw material for glue and mahogany leaves for animal feed. Mahoni (Swietenia mahagoni (L.) Jacq) Herbs for Diabetes Mahogany tree seed extract can also be used as a botanical pesticide to control pests in cabbage plantations, namely Plutella xylostella and Crocidolomia binonalis, especially when the pests are in the larval stage (8, 6).

This research aims to measure carbon reserves from mahogany trees by destroying them (destructive method) and then creating an allometric formula, which is a component of community forests in SVLK-certified community forests, especially in the research area.

2. RESEARCH METHODS

This research was carried out in 3 (three) hamlets, namely Kepuh, Ngranget, and Talunrejo hamlets, which are located in community forest areas managed by KTH (Forest Farmers Group) Lestari Makmur, Ngranget Village, Dagangan District, Madiun Regency.

Field research was carried out for 2 (two) months.

The material for this research is land owned by KTH Lestari Makmur, Ngranget Village, Dagangan District, and Madiun Regency members. Meanwhile, the tools used in this research are a chainsaw, hoe, pick, machete, hanging scale, ohus scale, meter tape, plastic rope, opener, wrapping paper, camera, and stationery.

Making allometric equations was carried out using a destructive method, namely felling selected sample trees from 3 (three) hamlets which are part of the Ngranget Village area, Dagangan sub-district, Madiun district, where there are community forest farmers who are members of KTH Lestari Makmur. Meanwhile, the trees cut down were mahogany trees, where each village cut down 10 (ten) trees; this was done by harvesting all parts of the plant, including the roots, drying them, weighing the wet and dry weight, and then looking for the biomass.
In estimating the potential carbon mass of a stand without taking into account the type of biomass and age of the stand, the carbon mass is considered to be equal to 50% of the biomass or the conversion factor = 0.5 (9,10,11).

The flow of research implementation is as shown below:

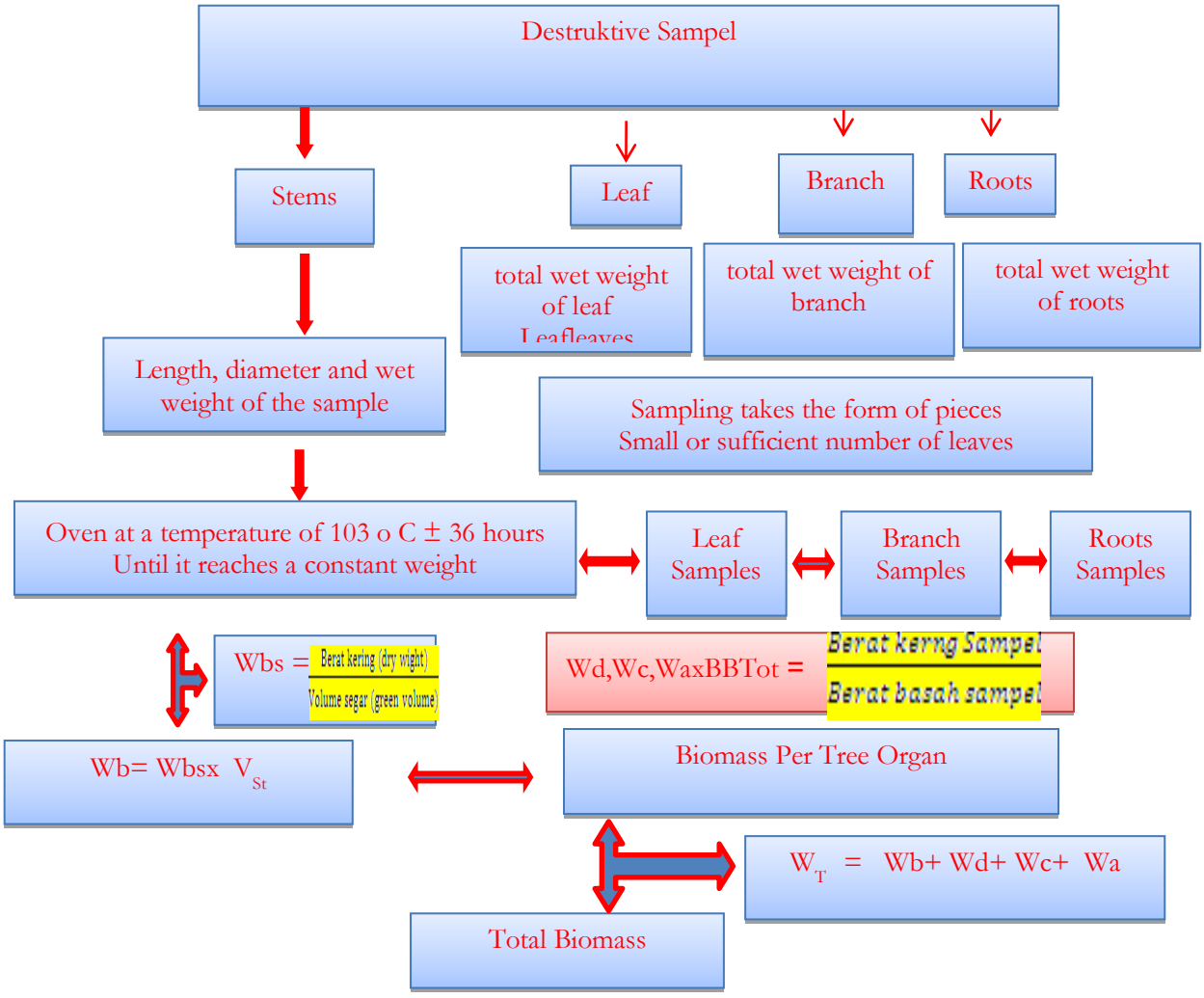

Figure 1. Destructive method research flow

The carbon content data that has been obtained is then made into an allometric equation with a regression model. Making a regression model aims to estimate or assess the magnitude of the quantitative effect of one parameter on another. In general, the regression model has the form of a regression equation, and its transformation is presented in Table 1 as follows (12).

Table 1. Regression Equations and Transformations:

Form Mode	Equation	Form Linier
Linear	$Y = a + bX$	$Y = a + bX$
Qudratic	$Y = a + bX + cX^2$	$Y = a + bX + cX^2$
Cubic	$Y = a + bX + cX^2 + dX^3$	$Y = a + bX + cX^2 + dX^3$
Logarithm	$Y = a + b \ln X$	$Y = a + b \ln X$
Inverse	$Y = a + b/X$	$Y = a + b/X$
Compound	$Y = ab^x$	$\ln Y = \ln a + X \ln b$
Power	$Y = a X^b$	$\ln Y = \ln a \, b \ln X$
Sigmoid	$Y = e^{a + b/t}$	$\ln Y = a + b/t$
Growth	$Y = e^{a + bx}$	$\ln Y = a + bx$
Eksponensial	$Y = a (e^{bx})$	$\ln Y = \ln a + bx$
Logistic	$Y = (1/u + ab^2)^{-1}$	$\ln (1/Y - 1/u) = \ln a + \ln b$

The regression model selection is based on the highest value of the coefficient of determination (R2) and the smallest residual sum of squares. The regression model was also tested using the variance test (ANOVA) to determine the significance level of each resulting equation. Data processing uses SPSS Statistics 18.

3. RESULTS AND DISCUSSION

Biomass Calculation

The results of calculating the average biomass of mahagony trees per tree section are as in table 2 below:

Table 2. Calculation results of average mahogany tree biomass per tree section

No	Tree	Part Biomass									
		Leaf		branches		Roots		Stems		Total	
		gram	procent	gram	procent	gram	procent	gram	procent	gram	procent
1.	Mahoni	24531,17	12,45	39840,28	19,41	34650,98	18,41	101748,31	49,73	200770,74	100,00

Source : field data processing

Meanwhile, the distribution of biomass per tree section is as shown in the diagram below

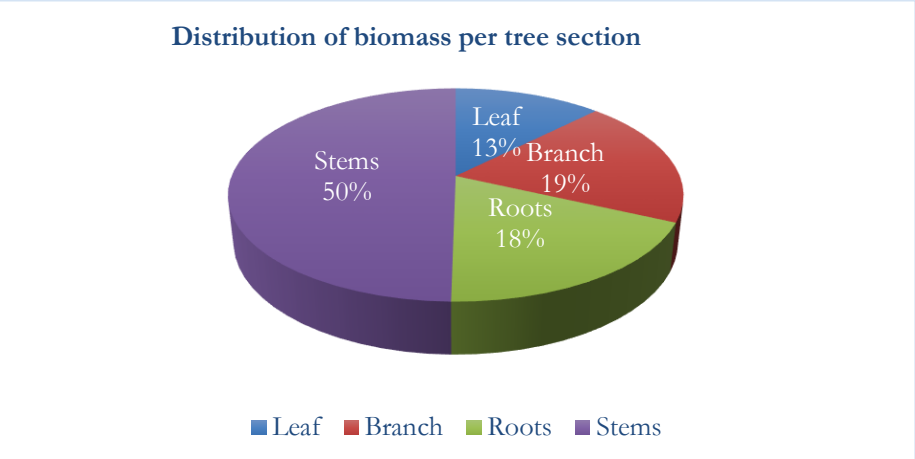

Figure 2. Biomass distribution per tree section

Based on Figure 2 above, it can be seen that the trunk part is the part that has the highest biomass percentage value (49.73%), this is in accordance with research from (13) that the main tree trunk part generally has more wood constituents (xylem tissue). compared to other tree parts (branches and twigs), the high carbon content in the trunk is due to carbon being the dominant element in wood. Wood is composed of cellulose, hemicellulose, lignin, and extractive substances which are mostly composed of the element carbon. The second order is the branches and twigs (19 .41 %), only roots (18.41 %) and lastly leaves (12.45 %) The low carbon content in leaves is because the leaves contain a lot of thin-walled parenchymal tissue and the walls of this tissue do not only consist of cellulose, but There are also almost no pectin and lignin materials, and the products of photosynthesis in the leaves are immediately translocated to all parts of the tree to undergo further metabolic processes (assimilation, biosynthesis, etc.). Meanwhile, in roots, apart from xylem (wood) tissue, there is also a lot of phloem and parenchyma tissue. Both phloem and parenchyma tissue have thin walls and almost no lignin (14).
Estimation of Carbon Content

The results of calculating the biomass of each type of tree then estimate how much carbon content it has according to (9 , 10 , 11) which states that carbon mass is considered equal to 50% of biomass or the conversion factor = 0.5 in estimating the potential carbon mass of a stand without taking into account the type of biomass and age of the stand. The results of the carbon estimation were made into an allometric equation model using SPSS statistics 18 and the appropriate equation model was selected based on the largest R2 value and the smallest and most significant residual sum of squares.

The results of SPSS 18 processing for estimating the carbon content of mahogany trees are

Table 3. Regression Equation Results using SPSS 18

Form	Equation
Linear	$Y = -74931 + 7795\ X$
Qudratic	$Y = -25033 + 2510\ X + 125\ X^2$
Cubic	$Y = 80219 + -14962\ X + 1005\ X^2 + -14\ X^3$
Logarithm	$Y = -331485 + 140526\ \ln X$
Inverse	$Y = 1999248 + -2081546 / X$
Compound	$Y = 15775{,}079\ b^{1{,}118}$
Power	$Y = 169{,}373\ X^{2{,}290}$
Sigmoid	$Y = e^{14{,}081 - 39{,}792/t}$
Growth	$Y = e^{9{,}666 + 0.111x}$
Eksponensial	$Y = 15775{,}079\ (e^{0{,}111\ x})$
Logistic	$Y = (1/u + 0{,}895^2)^{-1}$

Source: Spss data processing

Based on analysis of variance (ANOVA), the most appropriate model for mahogany trees is Y = 169.373 d $^{2.290}$, where the R Square (R2) value is the largest, namely 0.925 and the sum of squared errors (residual sum of square) is the most minor and most significant.

The relationship between diameter at breast height (dbh) and the carbon content of mahogany trees with the equation model Y = 169.373 d $^{2.290}$ is presented in Figure 3 below:

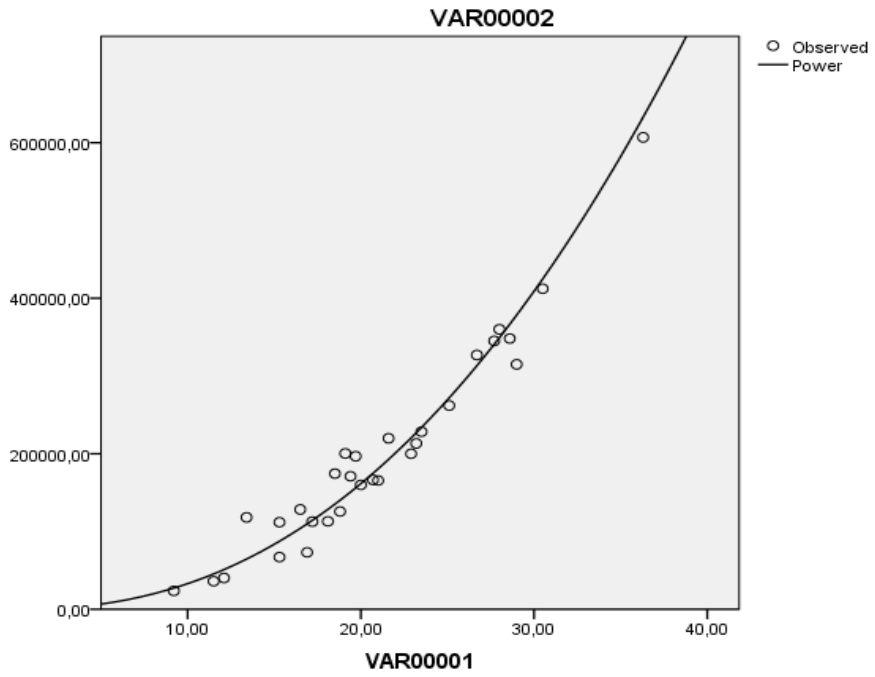

Figure 3. Relationship between diameter at chest height (dbh) and pregnancy carbon

4. CONCLUSION

Biomass per part of the mahogany tree is the stem, 49.73%; branches and twigs, 19.41%; roots, 18.41%, and leaves, 12.45%. The model equation to estimate the total carbon content of mahogany wood is Y = 169.373 d $^{2.290}$ (with diameter in cm and carbon in grams)

5. THANK-YOU NOTE

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