Analysis of biomass estimation and carbon stock on puspa (schimma wallichii korth.) in Talaga Bodas Nature Reserve Garut

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Abstract. This study aimed to find out the estimation of Biomass and Carbon Stock on Puspa (Schimma wallichii Korth.) in Talaga Bodas Nature Reserve Garut. The uses of this study were to give information about the estimation of Biomass and Carbon Stock on Puspa Stands in Talaga Bodas Nature Reserve Garut and become a consideration in supporting the implementation of carbon trading and its effects on global warming. Descriptive quantitative was used as a method in this study with systematic sampling with a random start as a sampling technique. The making of the plot line using the line plots method that was to make a stub line 100 meters in length and on the stub line a plot of 20 x 20 meters, was made in 3 replications. Related to research on estimating biomass in Puspa stands using allometric equations obtained results of 105.741 tons/Ha. Carbon estimation using carbon fraction formula yielded 49,765.8 ton/Ha. The results of the calculation of the Puspa stand density Using the density formula (number of Puspa/area) obtained a result of 328 Puspa/Ha.

1. Introduction
Global warming is an issue that is currently hotly discussed among the world community. Global warming is caused by the increasing amount of greenhouse gases released into the Earth's atmosphere. Land use changes and changes in the land cover through forest conversion and the increasing number of heavy industries make the environment damaged and cause air pollution which has an impact on the global climate. Air pollution by emission gases such as CO₂, NO₂, and CH₄ in the atmosphere which is industrial exhaust gases and originating from deforestation is a contributing factor to global warming. Forests have a very important role in reducing emissions of greenhouse gases because forests are able to fix carbon and store it in vegetation known as carbon sinks. Forest vegetation has the ability to absorb CO₂ through photosynthesis. The photosynthesis results are generally stored in root, stem, branch and twig biomass [1] which makes forest vegetation grow larger and higher. High-density forest vegetation can absorb more CO₂ than forest vegetation with low density.

Indonesia's forest resources have high potential in terms of biodiversity and potential in carbon sequestration [2]. It is estimated that in the 1990-1994 period Indonesia's forests covering an area of around 120.4 million hectares were able to absorb and store carbon around 15.05 billion tons of carbon. The magnitude of the potential of the forest as a carbon sink and storage provides a great opportunity for Indonesia to be involved in the carbon trading mechanism that was initiated internationally since the Kyoto Protocol was approved in 1997. One of Indonesia's forests that have carbon stock potential is the Talaga Bodas Nature Reserve Forest in Garut Regency. This can be seen
from the potential of stands which are dominated by woody plants with a relatively old age and consist of different types of vegetation.

The Talaga Bodas Nature Reserve area is designated as a conservation area based on the Decree of the Minister of Agriculture number: 680 / Kpts / Um / 1979 and the establishment of the CA Talaga Bodas's area with a decree number: SK. Minister of Forestry No. 226 / Kpts-II / 1990, Decree of the Minister of Forestry No. SK.483 / MENHUT-II / 2010 dated 30 August 2010 concerning the determination of the Talaga Bodas Nature Reserve Forest covering an area of 258,050 Ha located in the Garut Regency, West Java Province. This area is a hilly area that has a wavy topography with a slope angle of 30-70% with a height of 1,700 m above sea level [3].

Puspa tree (Schimma wallichii Korth.) belongs to the Theaceae family. In other regions of Indonesia known as simartolu (Batak); Medang Seru, Seru (Bangka); Kemetru (Lampung), Huru Batu, Huru Manuk, Puspa (Sunda); Puspa (Java); Penaga (Ketapang). In Malaysia known as Gegat, MedangGatal, while in Thailand it is known as Ta-lo [4]. Puspa grows on dry soil and does not choose the state of soil texture and fertility, so it is good for reforestation of alang-alang grasslands, shrubs, and critical soil. This type requires a wet to somewhat dry climate with an A-C rainfall type, in the lowlands to mountainous areas with altitudes of up to 1000 masl [5].

Research examining the benefits of the Talaga Bodas nature reserve forest as a provider of environmental services such as carbon sequestration and storage has not been carried out. Therefore, "Analysis of Estimated Bound Biomass and Carbon on the Puspa (Schimma wallichii Korth.) Stand in the Talaga Bodas Nature Reserve in Garut Regency" is needed to find out how much carbon is stored and biomass to determine the potential for consideration in supporting the implementation of carbon trading (carbon trading) and its influence on global warming.

Based on the description, the purpose of this study is to find out:
1. The estimated value of biomass and carbon is bound to the Puspa (Schimma wallichii Korth.) Stands in the TalagaBodas Nature Reserve area of Garut Regency.
2. The density of the Puspa stands (Schimma wallichii Korth.) in the Talaga Bodas Nature Reserve area of Garut Regency.

The results of the study are expected to become informed and be taken into consideration in supporting the implementation of carbon trading and its effects on global warming.

2. Methods
The research was carried out in the TalagaBodas Nature Reserve area, Garut Regency, and was carried out in August - September 2018. The sample in this study werePuspa plants (Schimma wallichii Korth.) which were in the research plot. Determination of the sampling location is carried out by systematic sampling with a random start (systematic sampling with initial randomization) [6].

To obtain the data used systematic sampling with a random start technique (systematic sampling with initial randomization). Sample plots are taken systematically according to certain rules or patterns with the first sample plot chosen randomly from the population. The making of the pilot line using the line-line method, which is to make a stub line 100 meters long and on the stub line a plot of 20 x 20 meters is made in 3 replications. Each test is given a distance of 10 meters. While the number of plots used is 10% of the area to be studied. Determination of sampling intensity is 2% for forest area 1,000-10,000 Ha, and 10% for forest area less than 1,000 Ha [7]. The parameters measured consisted of Puspa Biomass, Carbon Bound to Puspa and Puspa density. Thus calculated:

a. The number of individuals is the total of individuals at the research location.
b. The diameter of the Puspa tree stem (Schimma wallichii Korth.) Was measured using phiband. The diameter of the tree trunk measured is the diameter at the breast height, then recorded on the tally sheet.

\[
\begin{align*}
D &= 2r \\
K &= \frac{D}{2r} \\
\pi &= 3.14
\end{align*}
\]

Information: \( D \) = Diameter, \( K \) = Around, \( r \) = radius, \( \pi \) = 3.14
Measurement of stand biomass is based on the diameter data obtained. The diameter data is then entered into the Puspa stand allometric formula [1]. The Puspa stand allometric formula used is:

$$W = 0.4594D^{1.9978}$$

Information: $W =$ Total biomass (kg), $D =$ Diameter at breast height (dbh) (m), $0.4594 =$ Constanta, $1.9978 =$ Constanta

d. Measurement of the amount of carbon stock is based on the calculation of stand biomass in each age group. The biomass data is then included in the formula for calculating the number of carbon stocks. Based on the results of the IPCC (the Intergovernmental Panel on Climate Change) [6], the carbon fraction of the above-ground forest biomass is 0.47 so to determine the potential of carbon (ton C/Ha) in the forest can be estimated by multiplying biomass with the carbon fraction.

$$C = W \times 0.47$$

Information: $C =$ Carbon (ton), $W =$ biomass (kg/pohon), $0.47 =$ tree fraction

e. Density is the total number of individuals found during observation. Density index gives an overview of species composition in a community [8]. To find out the density of Puspa (*Schimma wallichii* Korth.), the following formula is used:

$$P_i = \frac{\sum Puspa}{Area}$$

Information: $P_i =$ Density, $\sum Puspa =$The total number of Puspa, $Area =$ Area of sample area

3. Results and Discussion

3.1. Biomass Tree Puspa (*Schimma wallichii* Korth.)

The results of observations of the biomass of the Puspa Tree (*Schimma wallichii* Korth.) at the research location (Puncak Ekstra, The Talaga Bodas Nature Reserve) is presented as follows:

| Puspa Biomas In Pilot line | Ton/Ha  |
|---------------------------|---------|
| Pilot Line 1              | 5.2778  |
| Pilot Line 2              | 9.717   |
| Pilot Line 3              | 5.3767  |
| Pilot Line 4              | 12.9856 |
| Pilot Line 5              | 10.4332 |
| Pilot Line 6              | 13.6732 |
| Pilot Line 7              | 9.7351  |
| Pilot Line 8              | 13.3134 |
| Pilot Line 9              | 14.6709 |
| Pilot Line 10             | 10.5581 |
| Overall Biomass Tree      | 105.741 |
| Average Biomass Tree      | 10.5741 |

Based on Table 1, it can be seen that the results of the biomass calculation of the Puspa tree (*Schimma wallichii* Korth.) using the allometric equation formula obtained a value of 105.741 tons / Ha with an average biomass of 10.5741 tons / Ha.
3.2. **Estimation of Bound Carbon in Puspa Stand (Schimma wallichii Korth.)**

**Table 2.** Estimation of Bound Carbon in Puspa Stand

| Bound Carbon In Puspa Stand | (Ton/Ha) |
|-----------------------------|----------|
| Pilot Line 1                | 2.5480   |
| Pilot Line 2                | 4.5669   |
| Pilot Line 3                | 2.5270   |
| Pilot Line 4                | 6.1032   |
| Pilot Line 5                | 4.9037   |
| Pilot Line 6                | 6.4265   |
| Pilot Line 7                | 4.5755   |
| Pilot Line 8                | 6.2573   |
| Pilot Line 9                | 6.8953   |
| Pilot Line 10               | 4.9624   |
| Overall Carbon Tree (Ton/Ha)| 49.7658  |
| Average Carbon Tree (Ton/Ha)| 4.97658  |

Based on Table 2 it can be seen that the results of the calculation of carbon trees in the Puspa Stand (*Schimma wallichii* Korth.) using the carbon fraction formula obtained a value of 49.9765 tons /Ha with an average carbon tree of 4.97658 tons / Ha.

3.3. **The density of Puspa Trees (Schimma wallichii Korth.)**

**Table 3** Density of Tree Puspa (*Schimma wallichii* Korth.)

| Density of Puspa Trees In Pilot Line | (Puspa/Ha) |
|-------------------------------------|------------|
| Pilot Line 1                        | 35         |
| Pilot Line 2                        | 33         |
| Pilot Line 3                        | 20         |
| Pilot Line 4                        | 44         |
| Pilot Line 5                        | 26         |
| Pilot Line 6                        | 41         |
| Pilot Line 7                        | 30         |
| Pilot Line 8                        | 35         |
| Pilot Line 9                        | 38         |
| Pilot Line 10                       | 26         |
| Density Of Puspa Trees (Puspa/Ha)   | 328        |

Based on table 3 it can be seen that the results of the calculation of Puspa tree density (*Schimma wallichii* Korth.) by using the density index formula obtained a value of 328 with a total number of Puspa trees as much as 328 and a sample area of 1 Ha.

3.4. **Environmental Factors**

Based on measurements of environmental factors obtained data that the average temperature is located at temperature intervals of 17-19 °C, soil pH 5-6 which shows acidic properties, the lowest light intensity is 1060 Lux and the highest is 6973 Lux, while wind speeds range from 0.2 to 0.4 m /s.

Biomass is a photosynthetic product where the energy absorbed will be used to convert CO₂ with water into carbon, hydrogen and oxygen compounds. In terrestrial ecosystems, the value of biomass and bounded carbon is vary. The ecosystem that has the highest carbon storage is a natural forest. Natural forest is the highest carbon storage (C) place compared to agricultural land use systems because natural forests have a variety of long-lived trees and many litters. If the forest is converted into agricultural, plantation or grazing fields, the amount of stored C will decrease. The amount of organic material stored in forest biomass per unit area and per unit of time is a staple of forest...
productivity. Forest productivity is an illustration of the ability of forests to reduce CO₂ emissions in the atmosphere through their physiological activities.

The estimation method used uses an indirect estimation method, which is using the allometric relationship method. Estimation of biomass with allometric equations provides the results of the alleged accuracy can be tested and accounted for, so the use of the allometric equation of a tree species that has been known to estimate the biomass potential of the same tree can produce quite accurate estimates. The value of biomass obtained from calculations can be used to calculate the potential of carbon stored in forest vegetation. Based on the results of the Intergovernmental Panel on Climate Change (IPCC) [6], the carbon fraction of above-ground forest biomass is 0.47 so to determine the potential of carbon (tons C / ha) in the forest can be estimated by multiplying biomass by the carbon fraction.

Temperature is an environmental factor that can play a direct or indirect role in living organisms. But in tropical rainforests, the temperature is not the dominant factor that determines productivity, but the length of the season grows. The presence of high and constant temperatures for most of the year can mean that the growing season for plants will last a long time, which in turn increases productivity. Temperature plays a role in controlling the enzymatic reaction in photosynthesis so that high temperatures can increase the maximum rate of photosynthesis [9].

The intensity of light and the duration of irradiation are important aspects because they act as the main controller of the ecosystem. The intensity of light in an ecosystem varies. The canopy of a vegetation will hold and absorb a certain amount of light so that it will determine the amount of light that is able to penetrate and is a certain amount of energy that can be used by basic plants [9]. The intensity of light entering the Puspa stand is relatively small. This is due to the stratification of dominating canopy plants and the fairly tight distance between plants.

Soil pH indicates soil acidity or alkalinity. The pH value indicates the amount of hydrogen ion concentration in the soil. Soil pH affects biological activity in the soil and the availability of certain minerals. Soil pH affects plant growth and development [9]. The soil pH in Puspa stands ranges from 5-6 which indicates that the pH of the soil is acidic. Generally, nutrients are easily absorbed by plant roots at a neutral soil pH of 6-7, the widening part of the pathway of each nutrient indicates the availability of nutrients which are getting bigger and the narrowing part shows the availability of nutrients that are getting smaller [9].

Factors that influence the difference in carbon storage are caused by stand density, stand age, site quality, climate, topography, soil characteristics, tree age composition, and given silvicultural treatment [10]. Stand density affects the amount of biomass and carbon capture because the denser the plants will absorb less carbon. Furthermore, the age of the stand affects the amount of carbon storage because the longer the age of the tree will store more carbon in it. The high level of carbon uptake is generally at the location of land with high fertility and sufficient rainfall. While climate, such as rainfall and air temperature affect the rate of increase in biomass and bound carbon. Because of the higher the air temperature, the lower the humidity and reduce the rate of photosynthesis.

Puspa (Schimma wallichii Korth) stand density is 328 Puspa/ha. Based on the IUCN (International Union for Conservation of Nature and Natural Resources) [11] which divides conservation status shows that Puspa is in a stable status and maintained growth. Puspa grows on dry soil and does not choose the state of soil texture and fertility, so it is good for reforestation of Alang-alang grasslands, shrubs, and critical soil. This type requires a wet to somewhat dry climate with an A-C rainfall type, in the lowlands to mountainous areas with altitudes of up to 1,000 m above sea level [4]. Thus Puspa can adapt to the Talaga Bodas Nature Reserve area which has a type of seasonal forest ecosystem with has climate type C (Schmidt and Ferguson climate type) [8].

4. Conclusion
Based on the results of research and data analysis that has been done, it can be concluded that the estimated value of biomass in the Puspa (Schimma wallichii Korth.) Stand in the Talaga Bodas Nature Reserve is 105.741 tons/ha. While the estimation of bound carbon is 49.765 tons/ha. In Addition, the value of the Puspa (Schimma wallichii Korth.) Stand density in the Talaga Bodas Nature Reserve is 328 Puspa/ha.
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