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CALCULATION OF ENVIRONMENTAL SERVICES FOR THE FOREST ADOPTION PLOT OF PT BIO FARMA (PERSERO) IN TAMAN BURU MASIGIT KAREUMBI, WEST JAVA

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ABSTRACT

Climate change or global warming has always been a hot topic of discussion and a global issue. Forests, as one of the largest carbon sinks, play a crucial role in addressing the problem of global warming. Forests have direct benefits that can be felt by humans, as well as indirect benefits that are not directly experienced by humans. One of the indirect benefits felt by humans is the absorption of CO_2 and the production of O_2. Taman Buru Masigit Kareumbi (TBMK) is a conservation area that plays an important role in the absorption of CO_2 and the production of O_2. Taman Buru Masigit Kareumbi does not have a buffer zone, which creates significant pressure on the area, especially social pressure. The significant pressure on the area has led to the emergence of the Forest Adoption program there. This program is aimed at the care and protection of forest areas through an adoption scheme. PT Bio Farma (Persero) actively participates in this program. The Forest Adoption plot of PT Bio Farma (Persero) has a carbon reserve of 134,095 tons, a CO_2 absorption value of 418,464 tons/hectare/year, and an O_2 production value of 358,033 tons/hectare/year. When evaluated, the Forest Adoption plot of PT Bio Farma (Persero) has a carbon absorption value of Rp. 28,318,422 (twenty-eight million three hundred eighteen thousand four hundred twenty-two Indonesian rupiah).

Keywords; Economic Value; Carbon Sink; Eviron Service; Forest Adoption; TMBK

INTRODUCTION

Climate change or global warming is a topic that is always hotly discussed and becomes a world problem. Global warming can occur due to high levels of Greenhouse Gas (GHG) emissions. Carbon Dioxide Gas (CO_2) is one of the major influences in climate change in the world (Rinjani et al., 2016). Forests have an important role in the absorption of CO_2 gas during the process of photosynthesis. Some efforts to reduce greenhouse gases are by reducing emissions from the source and increasing absorption ability (Adinugroho, 2010). One of the largest carbon sinks is in forest areas.

Forests provide very meaningful benefits, such as direct benefits (tangible) and indirect benefits (intangible). All the benefits of the forest can be felt by humans if the forest is in optimal condition and maintained (Zainuddin & Tahnur, 2018). Some of the direct benefits of forests that can be felt by humans are natural medicines and wood. While the indirect benefits felt are hydrological functions and carbon sequestration. Maintaining, caring for, and increasing forest areas is very meaningful to reduce greenhouse gas emissions.

A conservation area is a forest area that has certain characteristics with the main function of preserving the diversity of plants and animals and their ecosystems. Buru Park is one of the conservation areas that has the main function as a place for regular hunting (hunting tourism) (Andrian, 2020). Taman Buru Masigit Kareumbi is the only hunting park on the island of Java-Bali. TBMK is also the largest catchment area in the eastern area of Bandung.

The Forest Adoption Program is one of the programs launched by Wanadri (West Java Conservation Trust Fund) in Taman Buru Masigit Kareumbi. The Forest Adoption Program is a program to adopt a forest area with tree stands that have grown in a unified area of square meters for one year. This program is based on a lot of pressure on the area and minimal regional security costs. Human pressure on forests leads to deforestation and degradation of existing forests. A decrease in the number and quality of forests can lead to a reduction in carbon stocks, the release

of carbon emissions into the atmosphere, and a reduction in carbon sequestration by forests (Manuri et al., 2011).

Economic assessment of natural resources and the environment is considered necessary to give an idea to the general public how valuable these natural resources are.

RESEARCH METHOD

Data Retrival

The study was conducted in Taman Buru Masigit Kareumbi (TBMK), precisely in the forest adoption plot of PT Bio Farma (Persero) covering an area of 1 hectare (Figure 1) using the census method. The data taken includes DBH and the height of all woody plants in the plot.

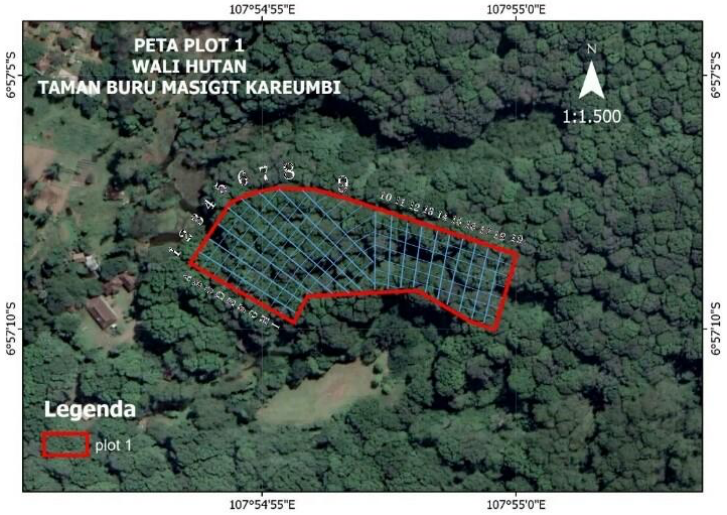

Figure 1 Map of PT Bio Farma Persero's Forest Adoption Area in 2022

Tree Species Identification

Trees found will be recorded on *tally sheets*, identified and searched for specific gravity using secondary data. If the specific gravity of a particular tree cannot be found in the secondary data, the specific gravity of its closest relative (genus or family) will be used.

Tree Circumference Measurement

The circumference of the tree is calculated using a tape measure with a height at breast height (DBH). DBH measurements are commonly used to compare dimensions and calculations of carbon storage in trees. DBH measurement methods vary from tree to tree with the principles as shown in Figure 2

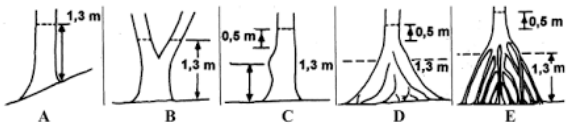

Figure 2 DBH Measurement Method

Tree Height Measurement

The measurement of the height of the tree is carried out with a measuring stick as shown in Figure 3.

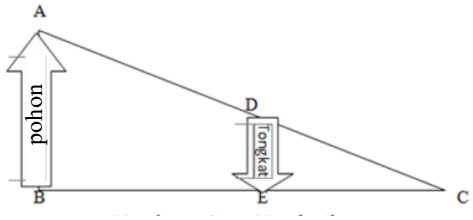

Figure 3 Tree Height Measurement Using a Measuring Stick

Measuring tree height using a measuring stick using the triangular principle with the following calculations: $Tree\ Height = \frac{BC}{EC} \times Stick\ Height$

Tree Volume Calculation

The calculation of the volume of the tree uses the following formula:

$$V = \frac{1}{4}\pi \times DBH^2 \times H \times f$$

Description: V = tree volume (m^3)
$\pi = 3{,}14$
DBH = diameter of the tree at chest height
H = total tree height (m)
f = form factor (0.6)

Calculation of Biomass above Ground Level

The calculation of biomass above ground level uses the formula of SNI Agency number 7724 (2011) as follows: (Badan Standar Nasional Indonesia, 2011)

$$B_{ap} = V \times BJ \times BEF$$

Description: B_{ap} = aboveground biomass (Kg)
V = tree volume (m^3)
BJ = specific gravity of wood (Kg/m^3)
BEF = Biomass Expansion Factor

Subsurface Biomass Calculation

The calculation of biomass above ground level uses the formula of SNI Agency number 7724 (2011) as follows: (Badan Standar Nasional Indonesia, 2011)

$$B_{bp} = NAP \times Bap$$

Description: B_{bp} = subsurface biomass (Kg)
NAP = root shoots ratio value
Bap = aboveground biomass (Kg)

Calculation of Carbon Stocks above and below the Ground Surface

The calculation of carbon stocks above and below the ground surface uses references from the SNI 7724-2011 Agency with the following formula: (Badan Standar Nasional Indonesia, 2011)

$$C_{ap} = B_{ap} \times \%C\ organik$$
$$C_{bp} = B_{bp} \times \%C\ organik$$

Description: C_{ap} = carbon content of aboveground biomass (Kg)
C_{bp} = carbon content of subsurface biomass (Kg)
Bap = aboveground biomass (Kg)
Bbp = subsurface biomass (Kg)
%C organic = percentage value of carbon content, equal to 0.47

Calculation of the Total Amount of Carbon Stocks

The calculation of total carbon stocks uses the following formula:

$C_t = C_{ap} + C_{bp}$

Description: C_t = total carbon (Kg)
Cap = carbon content of aboveground biomass (Kg)
C_{bp} = carbon content of subsurface biomass (Kg)

Carbon Dioxide (CO_2) Uptake

CO_2 absorption in plants is the ability of plants to absorb CO_2 through stomatal pores that are generally on the surface of leaves in the process of photosynthesis (Salisbury & Ross, 1995). The calculation of the CO_2 absorption formula refers to the following formula : (Baharuddin et al., 2014)

$$Serapan\ CO_2 = Biomassa\ \times 1{,}4667$$

Oxygen Production (O_2)

In the process of photosynthesis, plants will absorb CO_2 and produce O_2. The calculation of the amount of Oxygen (O_2) produced refers to the following formula (Daud et al., 2015):

$Produksi\ O_2 = C \times 2{,}67$

Description: C = net carbon stock (Kg/year)

The Value of Environmental Services from Carbon Dioxide Sequestration

The value of the analysis of environmental services from carbon dioxide absorption uses the following formula: (Purnawan, 2016)

$$NJL = HJC \times C$$

Description: NJL = value of environmental services (Rp/hectare)
HJC = carbon selling price (Rp/ton, Rp67,672.33/ton)
C = carbon sequestration (ton/hectare)

RESULTS AND DISCUSSION

PT Bio Farma (Persero) Forest Adoption Plot has an area of 1 hectare, there are 733 woody plants (stakes, poles, trees) including 118 trees (diameter above 20 cm) consisting of 5 species, namely, Rasamala (Altingia excelsa), Saninten (Castanopsis argentea), Puspa (Schima wallichii), Ki Hujan (Albizia saman), and Banyan (Ficus benjamina). In the Forest Adoption plot PT Bio Farma (Persero) was dominated by Rasamala (Altingia excelsa), this was because TBMK had become a forest area managed by the Forestry and Forestry Service in 1953-1998 (Andrian, 2020).

Carbon stocks in PT Bio Farma's Forest Adoption plots amount to 134,095 tons/ha. According to Pollo et al. (Pollo et al., 2012), post-mining reclamation forests that are 5-15 years old can have carbon stocks of 247 tons / ha. Even according to Siraj (Siraj, 2019), carbon stocks in tropical forests can reach 506.7 tons / ha. The amount of biomass has a great influence on the size of carbon stocks. The growth rate of trees (biomass) is directly proportional to the level of carbon stocks, so the higher the biomass, the higher the carbon stocks (Imiliyana et al., 2012).

The amount of CO_2 absorption in the Forest Adoption plot of PT Bio Farma (Persero) amounted to 418,464 tons / hectare / year. According to Kiat et.al, (Kiat et al., 2020), tropical forests can absorb CO_2 of 143.11 tons / ha / year. Meanwhile, in Abdul Latief Forest Park, CO_2 absorption is 281.75 tons/ha/year (Sribianti et al., 2022). The high CO_2 absorption value in TBMK can be caused by the large diameter and high density of the tree. Adinugroho et al. (Adinugroho et al., 2012) states that the larger the diameter of the tree of a stand and contains types that have a high density, the potential biomass and carbon content in the stand will be greater.

The production of net oxygen produced by plants is based on the amount of oxygen produced during photosynthesis minus the amount of oxygen collected during the process of respiration (Salisbury & Ross, 1978). If the uptake of carbon dioxide during photosynthesis exceeds the release of carbon dioxide during respiration, then plants will accumulate carbon (carbon stocks). Thus, the net oxygen produced can be calculated based on carbon accumulation (carbon

reserves) (Nowak et al., 2007). Total O_2 production amounted to 358,033 tons / hectare / year. The value of O_2 production in TBMK is higher when compared to O_2 production in Abdul Latief Forest Park of 241.05 toh / ha / year (Sribianti et al., 2022). This can be due to the larger amount of TBMK carbon stocks.

The economic value of environmental services CO_2 absorption produced by the Forest Adoption plot of PT Bio Farma (Persero) in Buru Masigit Kareumbi Park amounted to Rp28,318,422,- (twenty-eight million three hundred eighteen thousand four hundred twenty-two rupiah). This value is obtained from the amount of CO_2 absorption multiplied by the predetermined carbon price ($4.57). This value shows that forests have considerable environmental service value economically. Caring for and maintaining forests so that they are not degraded is very important so that forests can always produce environmental services for human survival.

CONCLUSION

PT Bio Farma (Persero) forest adoption plot in Taman Buru Masigit Kareumbi has carbon stocks of 134,095 tons, while CO_2 absorption value is 418,464 tons / hectare / year, and O_2 production value is 358,0,33 tons / hectare / year. The amount of carbon stocks, CO_2 sequestration and O_2 production fall into the large category. If evaluated, the Forest Adoption plot of PT Bio Farma (Persero) has a carbon sequestration value of Rp28,318,422 (twenty-eight million three hundred eighteen thousand four hundred twenty-two rupiah).

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