Original Research Article

CARBON STORES AND CO2 ABSORPTION POTENTIAL IN PALM OIL RECLAMATION AREA AT PT. BORNEO INDOBARA (BIB), TANAH BUMBU DISTRICT, SOUTH KALIMANTAN

ABSTRACT

Stored carbon in plant coconut palm will experience change along with growth and development plant , where rate growth plants and carbon stored will affected by conditions fertility as well as topography soil in the planting area plant coconut palm . Study This aim For do analyze savings carbon and potential CO2 absorption in the reclamation area plant coconut palm oil at PT. Indobara Borneo (BIB). The research was conducted in the Batulaki Palm Oil Reclamation Area at PT. BIB, Administratively PT BIB with a work agreement area of 24,100 ha . Carbon storage in the reclamation area of PT. BIB in 2009 - 2013 amounted to 4,837.87 tons with a total reclamation area of 101.15 ha . CO2 absorption potential in the reclamation area of PT. BIB in 2009 – 2013, namely 17,754.99 tons of CO2 The model for estimating carbon storage in oil palm plantations in the reclamation area until the end of the mine (2036) uses a linear regression equation model with an R2 value of 0.96 4 with the resulting model " y=2.1341" ("x")" - 7.7287 " . Based on the resulting model, it is predicted that the carbon stock of oil palm plants in 2036 will be 52.6 tons C/Ha .

***Keywords: Carbon (* CO2), Reclamation , Coconut Oil palm , BIB, Tanah Bumbu**

1. INTRODUCTION

Enhancement concentration carbon (CO2) in the atmosphere is problem environment seriously you can influence system life on earth . Enhancement savings carbon can done with increase growth biomass forest , add savings wood with planting tree or reduce harvesting wood , and develop forest with type fast tree _ grow (Rahayu et al., 2007).

PT. Borneo Indobara (PT. BIB) is company mining coal in Tanah Bumbu Regency South Kalimantan Province with holder Agreement Work exploitation Generation Coal Mining (PKP2B). both happen _ until with the year 2036 with area concession 24,100 Ha .. Because That activity mining must do activity reclamation land post mining For return circumstances mining area ecosystem so that approach circumstances before .

kindly general reclamation land post mine aim For repair condition land that has damaged consequence activity mining so that can return level fertility and productivity land the . As for activities reclamation and revegetation has arranged in Regulation Republic of Indonesia Government No. 78 Years 2010 and Ministry of Energy and Mineral Resources Decree No. 1827 K/30/MEM/2018. PT. BIB has do activity reclamation in post area mine from 2009 to with moment This with use a number of type plant that is coconut palm , wood white , sengon , trembesi and jabon .

Besides that , PT. BIB as company continuously open _ committed in implementation of Environmental, Social and Governance (ESG) for help organization in set goal , measure performance and manage activity effort for more sustainable . Stored carbon in plant coconut palm will experience change along with growth and development plant , where rate growth plants and carbon stored will affected by conditions fertility as well as topography soil in the planting area plant coconut palm .

The results of research conducted by Pratamasari (2018) regarding potency backup carbon in coconut mineral fields PT . Use Dodos District Pelalawan Riau Province gets results amount backup carbon of 85.36 tons/ha on a flat surface , while on the surface wavy of 82.41 tonnes/ha. Besides That according to Brown's research (2005) in Anggraini (2021) states that plant coconut palm own potency For keep carbon Because results study show that in the process of photosynthesis coconut palm capable absorb around 161 ton CO2/ha/ year . When reduced CO2 is absorbed in the process of respiration , then in a manner net garden coconut palm capable absorbs as much CO2 64.5 tonnes CO2/Ha/ year . Interesting thing is absorption net CO2 of coconut palm the capable go beyond ability forest Rain tropical ones _ net absorbs as much CO2 42.4 tonnes CO2/Ha/ year .

Activity reclamation land post mine with use plant coconut palm has conducted by PT. BIB in Batulaki pit reclamation area start 2009 to _ with 2013. Conditions plants in the field grow with Enough Good even though planted in the reclamation area , various effort manipulation land For capable grow coconut palm agar conditions environment can recovered as in hue start that works one of them as storage backup carbon . because _ it , Research This aim For do analyze savings carbon and potential CO2 absorption in the reclamation area plant coconut palm oil at PT. Indobara Borneo (BIB).

2. RESEARCH METHOD

The research was conducted in the Batulaki Palm Oil Reclamation Area at PT. BIB, Administratively PT BIB with a work agreement area of 24,100 ha, includes the Satui District, Angsana District, Sungai Loban District and Kusan Hulu District, Tanah Bumbu Regency, South Kalimantan Province. Geographically, this location is located at coordinates 3°25'55" South Latitude, 115°39'29.9" East Longitude and 3°43'2" South Latitude, 115°25'56" East Longitude with Area Code (KW) 99 PB0 339.

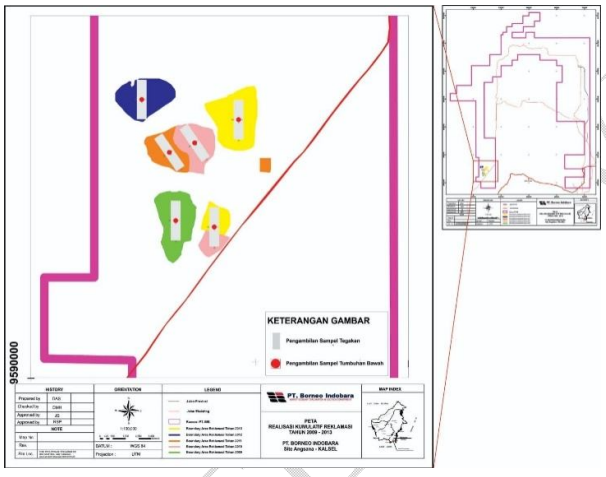

Figure 1 . Research Location Map

Data analysis techniques

Calculation of Total Carbon Stores

The calculation of total carbon storage is by multiplying the carbon stock per hectare from each pool by the area of the research object

Ctotal = Cn x Lar

Information :

C total	Total carbon content of the reclamation area which is the object of research (tonnes)
	Carbon content per hectare in each carbon pool in each plot (tonnes/ha)
	Reclamation area area

$_2$ Absorption Potential Calculation

The amount of CO_2 absorbed by plants can be estimated by multiplying the estimated total carbon value by the conversion factor of C atoms in the $CO_{2\ compound}$. The formula used according to Hardjana (2009) is as follows:

CO_2 = C x 3.67

Information:

C = Carbon content

3.67 = Conversion value of C atoms in $CO_{2\ compounds}$

Calculation of Predicted Carbon Storage of Oil Palm Plants Until the End of Mine Life in the Reclamation Area

To project carbon stocks until the end of the mining year, namely 2036, data from monitoring plant plots in the planting year 2009 – 2013 is required for carbon calculations per year and then regression analysis is carried out.

3. RESULTS AND DISCUSSION

The estimated total carbon storage in a land use system is the sum of above - soil and underground carbon stores. Aboveground carbon storage is measured by the sum of carbon stored in tree biomass, undergrowth and litter. Whereas in soil carbon storage is based on soil organic matter content which is calculated based on soil depth. Estimation of total carbon storage in the reclamation area of PT . Borneo Indobara seen _ _ _ _ p a da Table 1 .

T **able 1.** Estimation of total carbon storage in the reclamation area of oil palm plantations

Palm Oil Reclamation Area	Area (Ha)	Total C Storage in Plants (tonnes/ha)				Total C Store in Soil (tonnes C /ha)	Total C Savings Per Closing (tonnes C /ha)	Carbon Storage in Areas (tonnes C)
		Trees (tonnes C /ha)	Undergrowth (ton C / ha)	Necromass (tons C /ha)	Total C in Plants (tons C /ha)			
2009	20	0.205	0.60	0.77	1.58	46,31	47,89	957.85
2010	19,3	4,121	0.65	0.78	5.56	43.30	48,86	942.91
2011	13.5	2,729	0.99	0.80	4.52	46,60	51,12	690,11
2012	17,7	1,897	1.10	0.61	3,62	43,24	46,86	829.43
2013	30.65	1,694	1.14	0.73	3.56	42,69	46,25	1417.57
Total	101.15				18.83	222,14	240.98	4,837.87

Total carbon storage in plants includes carbon storage in trees, undergrowth and litter. The highest total carbon storage in plants was achieved in reclamation plants in the 2010 crop year of 5.56 tons C/ha. After the top soil management treatment (reclamation year 2010) the carbon storage in plants in the reclamation area is directly proportional to the age of the plants, meaning that the older the plants are the higher the carbon stores. This is in line with the research results obtained by Leh Dopler (2013) which showed that the older the oil palm plant, the higher its biomass. However, this statement is not in accordance with the results of calculating carbon storage in the reclamation area of oil palm plantations in 2009, judging from the age of the plants, the highest carbon storage should be in the reclamation area. This happened because the growth of oil palm plants in the oil palm reclamation area in 2009 was not healthy. Plant biomass is the result of plant growth processes over a certain period in a certain unit area. Thus the biomass of a type of plant is affected by the growth of that type of plant (Woesono, 2002). Carbon values are affected by soil fertility and disturbance (including theft and pests). That the higher the soil fertility, the higher the biomass produced (Dopler, 2013). While the total carbon storage in the soil relatively does not differ in various plant age classes. Carbon storage in land has a greater amount of carbon storage in the soil (height at a depth of 0-30 cm) greater than carbon storage in plants, even soil carbon contributes 92.18% of carbon to land. However, the presence of C in the soil cannot be separated from the contribution of vegetation on the surface, the difference in C content in the soil is thought to depend on the ease of decomposition of litter and organic matter on the soil surface.

Can be seen in table 1 total carbon storage in the reclamation area of PT. The highest BIB was in the 2011 reclamation area with a plant age of >10 years, namely 51.12 tons C/Ha, the total carbon store was lower when compared to Meanwhile, in oil palm land cover, the value of carbon storage in this study was also higher. low compared to research conducted T cover oil palm plantations in Jayapura District, the value of carbon stocks with a value of 100.89 tonnes/ha. Boer (2013) estimates that carbon stocks have varying values because they are determined by the age of the plant, density per unit area, climate and land cultivation as well as the environment for oil palm growth, especially the type of land and also the measurement techniques used. The amount of carbon stored in oil palm plantations when compared to natural forests is still less, this is because to boost fruit productivity, the spacing of oil palm plants is widened so that the number of plants becomes smaller (Maulana, 2011) .

The amount of CO_2 absorbed by plants was calculated using the approach of multiplying the estimated value of total carbon by the conversion factor of C atoms in CO_2 compounds . The formula used to calculate carbon absorption according to Hardjana (2009) is the amount of carbon content multiplied by the conversion value of the C atom in the CO2 compound of 3.67.

Plants need sunlight, water (H2O) and carbonic acid gas (CO2). Through the process of photosynthesis, CO2 in the air is absorbed by plants and converted into carbohydrates, then distributed throughout the plant body and finally stockpiled in the plant body in the form of leaves, stems, twigs. , flowers and fruit. The process of accumulating C in living plant bodies is called the sequestration process (C-sequestration). Thus measuring the amount of C stored in living plant bodies (biomass) in a field can describe the amount of CO2 in the atmosphere absorbed by plants (Hairiah and Rahayu, 2007).

The amount of CO_2 absorbed by plants is used for the physiological process of plants which is known as photosynthesis process, this process is carried out by absorbing carbon dioxide (CO_2) from the air and then carrying out physiological processes of plants so as to produce oxygen (O_2) which is released into the air and carbohydrates released into the atmosphere. stored in plant tissue. As the age of the plant increases, in this case it is indicated by the increase in the size of the plant parts such as the number of leaves, the dimensions of the stem/branches/twigs and the dimensions of the roots, the absorption of $CO2_{from}$ the air will also increase (Anggraini and Arifin, 2021), followed by an increase in release of $O2_{into}$ the air. The estimated amount of CO_2 absorption in the year of oil palm reclamation at PT BIB is presented in Table 2 .

Table 2. Potential $CO2_{in}$ crop areas reclamation palm oil PT BIB

Year of Oil Palm Plantation	Total C Savings Per Closing (tonnes C/ha)	Area (ha)	Average Annual Potential Absorption (ton $CO2_{/}$ ha/year)	Information
2009	47,89	20	13.52	13 years old
2010	48,86	19,3	14.94	12 years old
2011	51,12	13.5	17.06	11 years old
2012	46,86	17,7	17,20	10 years
2013	46,25	30.65	18.86	9 years
Total		101.15	81.57	

Based on the data above, the average potential for CO2 absorption $_{is}$ highest in oil palm reclamation areas in $_{2013}$. 18.86 ton $CO2_{/}$ ha/year.

From Table 2 it states that the oil palm in the reclamation area of PT. Borneo Indobara was able to absorb carbon dioxide where the highest CO2 uptake $_{was}$ in the 2013 reclamation area with a 10 year old plant, namely 18.86 tons $CO2_{/}$ ha/year, while the lowest absorption was in the 2009 reclamation area with a 14 year old plant, namely 13 .52 ton $CO2_{/}$ ha/year. Yulianti (2009) argues that North Sumatra has enormous potential, especially for oil palm plantations. The role of oil palm plantations as CO2 absorption, the result of this photosynthesis process is far greater than respiration. As a result of the oxygen produced per unit time, the wider the oil palm plantations that grow and produce, the greater the oxygen produced per unit time and space. In plantations (oil palm) the growth of biomass (including its production) continues until the oil palm is cut down (25 years old), so the rate of photosynthesis is greater than the rate of respiration. The value of $CO_{2\ absorption}$ in the reclamation area of PT. The BIB is still lower when compared to the results of research conducted by Anggraini et al (2022) on PT Mopoli Raya's oil palm plantations which are able to absorb carbon dioxide where in location I oil palm is 21.85206 tons CO 2 / ha / $_{year}$. This difference is of course caused by several factors such as plant type, plant age, temperature, sunlight and land quality (availability of water and nutrients) . et al. , 201 7).

In the process of photosynthesis, oil palm will absorb CO2 from the air and will release O2 into the air. This process will continue as long as growth and development are ongoing. The age of oil palm can reach more than 25 years with good management. Based on data from the Directorate General of Plantations (2006), oil palm plantations in Indonesia can absorb as much as 430 million tonnes of CO2 (Darmawan , 2009) .

Prediction of carbon storage in reclamation areas

Based on data on the annual growth of oil palm plants in the reclamation area measured in 2022, there will be an increase in the amount of carbon biomass in each year of oil palm reclamation planting. However, in 2009 the oil palm plants experienced growth stagnation, which was suspected because *the top soil* in the reclamation land was very thin so that oil palm was able to grow but did not develop *properly* . as a place to grow reclamation plant roots. After proper top soil management, there is an increase in carbon

stocks from year to year, the calculation of carbon stocks every year is based on permanent plot data which is carried out periodically. Calculation of the prediction of carbon storage in the reclamation area using permanent plot monitoring data which is carried out periodically on oil palm plantations by PT. BIB. Carbon deposits every year can be seen in Figure 2 .

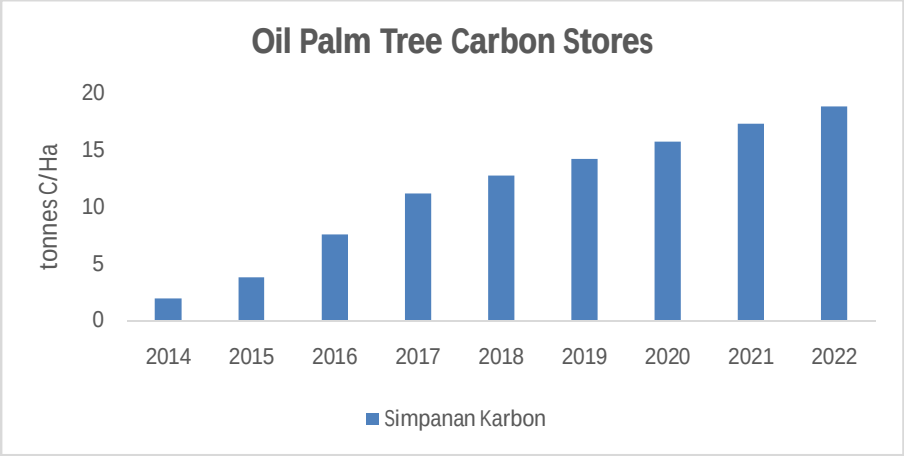

Figure 2. Carbon Savings Tree Coconut palm

After obtaining data for calculating the carbon stocks of oil palm plants from year to year, a regression analysis is then carried out to obtain the predicted value of carbon stocks for oil palm plants until the end of the mine's life, which is 2036.

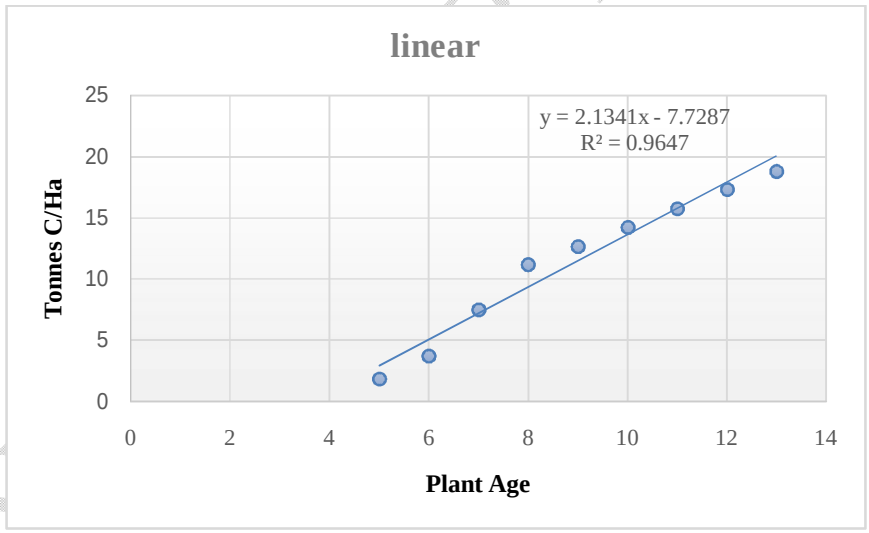

Figure 3. Analysis Results Regression

If seen from the results of the regression analysis in Figure 3, the graph tends to increase significantly along with plant growth at a young age. R square is a value that shows how much the independent (exogenous) variable affects the dependent (endogenous) variable. R squared is a number that ranges from 0 to 1 which indicates the magnitude of the combination of independent variables that jointly affect the value of the dependent variable. The R-squared value (R^2) is used to assess how much influence certain independent latent variables have on the dependent latent variable. There are three categories of grouping on the R square value, namely the strong category, the moderate category, and the weak category (Hair et al., 2011). Hair et al stated that the R square value of 0.75 was included in the strong category, the R square value of 0.50 was included in the moderate category and the R square value of 0.25 was included in the weak category (Hair iah et al. , 2011). Based on the results of the regression analysis above, the highest R2 value is obtained, namely in the linear regression analysis with an R2 value of 0.964 which is included in the strong category > 0.75 with the equation model

"y=2.1341" ("x")"- 7.7287" Based on the model equations obtained, carbon storage

predictions can be calculated. Calculation of carbon storage predictions up to the end of mine life, namely 2036, can be seen in table 3 .

Table 3. Predictions Carbon Storage Until the End of Mine Life

Year	Plant Age	Carbon Savings (tons C/Ha)
2014	5	1,9
2015	6	3,8
2016	7	7,5
2017	8	11,2
2018	9	12,7
2019	10	14,2
2020	11	15,8
2021	12	17,3
2022	13	18,8
2023	14	23,6
2024	15	25,8
2025	16	28.0
2026	17	30,3
2027	18	32.5
2028	19	34,7
2029	20	37.0
2030	21	39,2
2031	22	41,4
2032	23	43,7
2033	24	45,9
2034	25	48,1
2035	26	50,4
2036	27	52,6

Based on table 3 shows that the older the age of the oil palm plant, the value of carbon storage increases. Carbon storage experienced a significant increase at the age of the plant 5-14 years with an average increase of 23% and at the age of 16-27 years the plant did not experience a significant increase in carbon storage, which was only 6%. This is because the high or low amount of carbon stored by plants in the form of biomass is influenced by several factors, including the diversity of tree species, soil types, litter production and tree age (Hairiah and Rahayu, 2007). The amount of carbon stored per hectare in oil palm plants will increase as the plants age. This increase in carbon storage is caused by the growth and development of oil palm plants. Yulianto et al., (2018), stated that oil palm plants experienced an increase in biomass content which could become carbon storage, especially in oil palm plants in the 6-10 year age group, and decreased in the 16-20 year age group.

4. CONCLUSION

Carbon storage in the reclamation area of PT. BIB in 2009 - 2013 amounted to 4,837.87 tons with a total reclamation area of 101.15 ha . CO2 absorption potential in the reclamation area of PT. BIB in 2009 – 2013, namely 17,754.99 tons of CO2 The model for estimating carbon storage in oil palm plantations in the reclamation area until the end of the mine (2036) uses a logarithmic regression equation model with an R2 value of 0.962 with the resulting model as follows:
"y=8.228" "ln" ("x")"+0.0189"

Based on the resulting model, it is predicted that the carbon stock of oil palm plants in 2036 will be 52.6 tons C/Ha .

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