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How Significant is the Existence of Forest Community Contribution in GHG Emissions Reduction?

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Abstract: One of the Republic Indonesia Ministry of Environment and Forestry policies REDD+ is Government Regulation number P.20/Menhut-II/2012 on the Implementation of Forest Carbon. Calculation of carbon stocks is mostly done in peat forest areas or in industrial tree plantations managed by private companies. This research aims to calculate forest carbon stocks in forest community owned by people who have received a certificate of TLAS in order to prepare a Project Design Document (PDD) using a baseline method based on changes in carbon stocks measuring system. This model can show a trend of carbon uptake and carbon change by considering the maximum cycle Teak, Mahogany, Acacia and Albizia. The research in Indonesian's Forest Community shows that the total carbon pool in the form of sink C of 311.335 tons of C/ha with a baseline of 44.698 tons of C/ha with land cover conditions which is not cultivated intensively. With reserved estimation at 30% CO_2 then the potential of carbon that can be traded at 186.644 tons/ha is to be able to absorb as much as 684.9903 CO_2 tons/ha in a year.

Key words: Carbon stocks, community forest, TLAS, PDD, potential of carbon, Indonesian's

INTRODUCTION

The increasing emissions of Green House Gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) cause global warming. These causes climate changes including prolonged droughts, floods, storms and rising sea levels. The current greenhouse gas concentrations have reached levels that endanger the earth's climate and ecosystem balance (Jagger *et al*., 2011). GHG emissions are mostly caused by the processes of fossil fuel combustion by major industries which contribute 80% of emissions. While the forestry and agriculture sector only counts for 20% of emissions. Nevertheless, the forestry sector is one sector which has a significant role in the control of GHG through reducing emissions from deforestation and degradation. Presidential Regulation of Indonesia on the National Action Plan for GHG Emission Reduction states that the forestry sector plays a significant role in efforts to reduce greenhouse gases until 2020.

The forestry sector that has a significant role in GHG emission reduction faces problems to the timber trade commodity derivatives. Two things seem opposite regarding substance the mitigation of climate change is more oriented towards preserving while the issue of the legality of the timber trade demands. The Indonesian government has committed to combating all forms of illegal logging and to meet the needs of the market through the Minister of Forestry on Timber Legality Assurance System (TLAS). Community forest which is part of the action plan for the reduction of GHG emissions and climate change also contributes significantly to the production of wood in Java, although not widely understood by the various parties (Jagger *et al*., 2011). The contribution of community forests as a supplier of raw materials of industrial furniture and plywood in Java has a fairly strong chain (Setiahadi and Novianto, 2013). Moreover, the mandatory TLAS for industries that export products of the forestry sector to international markets (Setiahadi *et al*., 2012).

The given public forests in Java has a significant role both in climate change as well as timber production. The synergy of both will further strengthen the important part of community forests and to its central role in the ecosystem. The strategic position of the people as a buffer forest ecosystem in Java cannot also be ignored. Therefore, it is needed to be promoted, studies that put the area of community forests in a comprehensive manner to support the carrying potential of ecosystems to prevent global climate change. It must be made to obtain optimal results. The calculation of carbon stocks performs on natural forests, peatlands and the area of palm oil conversion but it is rarely done in the forests community area. Declining forest area due to deforestation and degradation occurs in natural forest areas but opposed the condition of community forest areas are increasing, particularly in Java Island. Bureau of Defining Forest Area Region Java-Madura, 2010 states that the community forest area on Java is at 3.1 million ha. While the state forest areas managed by the state is only 2.5 million ha of which 30% of the area is in a state of empty areas.

The use of allometric method can be used to connect between the diameter of the trunk with other variables. Such as the volume of wood, tree biomass and carbon content in harvested stands or on the standing. However, difficulties frequently encountered is the carbon calculations by measuring the diameter of the tree fall in the community forest. Measurements of carbon by cutting trees sampling cannot be done on forest land rights due to economic considerations (NSA, 2011a, b). The use of various types of trees allometric method for measuring biomass and carbon stocks in community forests conducted in 2009 showed that this technique must be modified match of the condition. This study focuses on the carbon stocks measuring in forests of the people who have received certificates of TLAS using a modified allometric method. The expected result can be used to determine the extent of public forests in taking part of greenhouse gas emissions reduction.

MATERIALS AND METHODS

Carbon components are measured by the standards of the community forest IPCC (NSA, 2011a, b). At every plot measure the biomass and soil organic matter of trees. Data collected from four villages (zone), namely: Kuwiran, Randualas, Kare and Morang. On each zone, determined plot recording unit as much as 16 plots with a size of 25×25 m, so that each area of the plot measurements on each zone has an area of 1 ha. The measurement stages are as follows:

- Determine the latitude and azimuth angle plot using GPS
- Determine the firing angle direction with a compass plot recording unit as much as 16 plots. Each recording unit is demarcated
- Determine the latitude and azimuth of central point recording unit
- Measure or count the number of trees, tree height, tree species and vegetation distribution of trees in each recording unit and recorded on the tally sheet

Samples of selected tree that have a diameter of minimum circumference of 63 cm. Calculation of total forest carbon stock based on biomass and organic matter content of the 5 carbon pools are above-ground biomass, below-ground biomass, deadwood, litter and soil organic matter (NSA, 2011a, b). Nonetheless, it is needed to calculate the total forest carbon stocks in forest-dependent people in need and ease of data retrieval (NSA, 2011a, b). There are two carbon pools in community forest which should be measured, i.e., the top surface biomass and soil organic matter. Calculation of carbon from biomass types using the following equation:

$$C_{bj} = B\times\%\,C_{organic} \tag{1}$$

Where:

C_{bj} = The carbon content from biomass types (kg)
B = Total biomass types (kg)
$\%C_{organic}$ = The percentage of the value of the carbon content of 0.47% carbon or using values obtained from the measurements in the laboratory

Calculation of soil carbon using the Eq. 2:

$$Ct = Kd\times\rho\times\%C_{organic} \tag{2}$$

Where:

Ct = Soil carbon content (g/cm^2)
Kd = Depth examples of soil/peat soil depth (cm)
ρ = Bulk density (g/cm^3)
$\%\,C_{organic}$ = The percentage of carbon content value use value percent of the carbon obtained from measurements in the laboratory

Calculation of total carbon stocks. Calculation of soil organic carbon content per hectare using the Eq. 3:

$$C_{soil} = Ct\times 100 \tag{3}$$

Where:

C_{soil} = Soil organic carbon content per hectare (tons/ha)
Ct = Soil carbon content (g/cm^2)
100 = Conversion factor from g/cm^2 to tons/ha

Calculation of total carbon stocks in the plot measurement using the Eq. 4:

$$C_{plot} = (C_{bj} + C_{soil}) \tag{4}$$

Where:

C_{plot} = Total carbon content in the plot (tons/ha)
C_{bj} = Total content of biomass/ha on the type of plot (tons/ha)
C_{soil} = Total carbon content of soil per hectare on the plot (tons/ha)

Calculation of carbon stocks/ha in each plot for aboveground biomass using the Eq. 5:

$$C_n = 10\times Cx/l_{plot} \tag{5}$$

Table 1: Potential of timber based on plant in 4 zones

Plants	Average of species/ measurement plot	Average of volume/ measurement plot (m^3)	Land area (ha)	Total volume (m^3)
Kuwiran				
Teak	38.00	5.5970	27.6	154.400
Mahogany	1.19	0.1800		4.964
Acacia	4.00	1.2800		35.300
Sengon	0.00	0.0000		0.000
Randualas				
Teak	39.44	8.5400	397.0	3390.700
Mahogany	8.31	1.6430		652.300
Acasia	0.31	0.2593		102.900
Sengon	1.10	0.2505		99.500
Kare				
Teak	41.13	5.7430	54.8	314.800
Mahogany	1.44	0.1800		9.900
Acacia	3.00	1.1250		61.700
Sengon	2.00	0.6500		35.600
Morang				
Teak	40.31	8.7000	146.4	1273.700
Mahogany	9.00	1.6620		243.300
Acacia	1.19	0.3280		48.000
Sengon	2.19	0.2845		41.700
Total area and plants volume			625.80	6468.600

Plot extent: 0.0625 H

Where:

Cn = The carbon content/ha in each carbon pool in each plot (t/ha)

Cx = Carbon content of each carbon pool in each plot (kg)

l_{plot} = Spacious plot of each pool (m^2)

The total area of community forest is 718.59 ha spread in 4 zones (Table 1). The measurements are divided into three type such as:

- The kind of tree crops (woody) that is dominant is developed by farmers including Tectona, Grandis Lf, Acacia mangium Wild, Swietenia macrophilia King and Albizia falcataria
- Under the stands of the plant species such as maize, cassava, medicinal, porang, peanut and elephant grass
- Agriculture crops such as clove, chocolate, durian, jackfruit and hairy fruits

RESULTS AND DISCUSSION

The total biomass per species in each zone are presented in Table 2. The calculation of total carbon content of each type in 4 zones shows in Table 3.

Community forests have a multifunctional, i.e., social, economic and ecological (NSA, 2011a, b). Utilization of community forests in the form agroforestry, simultaneously capable of providing economic impact by increasing farmer's income through various business schemes. It is also in the kind of service provision of environmental services such as springs, ecotourism, biodiversity and carbon sequestration. Community forests also provide climate mitigation function (NSA, 2011a, b). Although, they were able to play the role in climate-change mitigation (mainly carbon trading), the role of community forests is affected by the value of willingness the community to accept (WTA) and pay (WTP) the environmental services (NSA, 2011a, b) (Table 4 and 5).

The farmer's participation is affected by their understanding on climate change mitigation. So, we cannot ignore farmer participation in encouraging the role of private forests in GHG emissions reduction program. Irawan (2011)'s research results showed that the involvement of the farmers who participated in supporting climate mitigation activities through community forests affected by age, formal education, family size and experience in carrying out the farming community forests (NSA, 2011a, b) while farmers who refuse are influenced by the value of compensation and monthly fee of cultivation land.

The calculation of carbon stock with Allometric equations to estimate the potential of carbon in the soil surface for one crop can be done by referring to Brown *et al.* (1989). However, to support the preparation of the PDD in REDD+ needs a comprehensive measurement of carbon stocks (Golden Agri-Resources,

Table 2: Biomass per species on 4 zones

Tree species	Amount of biomass per species (kg)					Total (ton)
	V(m^3)	Trunk	Root	Branch	Leaves	
Acasia (123)	47.9	22.7	1.8	1.8	1.40	27.8
Maho-gany (319)	58.6	26.8	17.0	5.9	5.20	55.0
Teak (2537)	457.1	329.5	116.7	67.9	53.95	568.0
Sengon (83)	18.9	6.9	2.5	1.1	1.10	11.6

Table 3: The carbon content of each type in 4 zones

Tree species	Amount of biomass per species in 4 zone (kg)				Total (ton)
	Trunk	Root	Branch	Leaves	
Acasia	10.7	827.2	863.6	657.8	13.0
Mahogany	12.6	8.0	2.8	2.4	25.9
Teak	154.9	54.8	31.9	25.4	267.0
Sengon	3.3	1.2	512.4	503.8	5.5

Carbon total amount = 311.3; Carbon average amount per hectare = 77.8; Carbon potential amount with forest right land area in 4 zones = 48,709.9

Table 4: Tree species of 4 zones

Tree species	Sink C (t/ha)	Baseline C (t/ha)	Net C (t/ha)	Buffer 30%
Teak (0-35th)	267.003	38.530	228.473	68.5419
Mahogany (0-20th)	25.850	4.613	21.237	6.3711
Acasia (0-10th)	13.020	1.322	11.698	3.5094
Sengon (0-10th)	5.462	0.233	5.229	1.5687
Total	311.335	44.698	266.637	79.9911

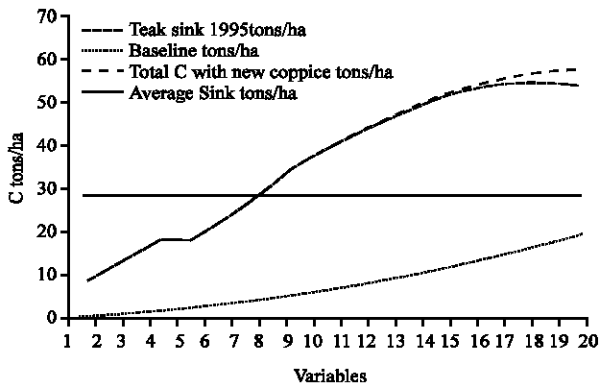

Fig. 1: Graphic of carbon sequestration in 1995 plantation at "Kuwiran" zone

2012) for some types of plants. Measurement of biomass is done on the surface of the ground and underground, lower plants (shrubs), dead wood (neuromas), refuse (garbage falls), soil organic matter and wood harvested. The method of calculating the total reserves of private forest carbon depend on the level of community needs and ease of data. There are two objects that need to be measured which are a type of plant biomass and soil organic matter (Kauffman and Donato, 2012).

In the context of the preparation of the PDD in the community forest for the free market requires the agreement of the parties. The fundamental method of readiness of the PDD is the important factor (Brown *et al*., 1989). Carbon stocks calculation need data backup of carbon stocks, the absorption rate of carbon sequestration recycling. Determination of recycling plants in the community forests depends on the type of plant. Sengon and Acacia have maximum 10 years cycle; Mahogany 20 years and Teak 30-35 years; this research uses 20 years as the assumption of an average cycle in all types of growing plants. As an illustration, the absorption of carbon in a sample area in Kuwiran Zone is shown in Fig. 1.

CONCLUSION

Model calculations of carbon stocks in forest folk used SVLK certifies maximum cycle on Teak, Mahogany, Acacia and Sengon. The total carbon stock is 311.335 tons/ha. There is potential for 186.644 tons/ha of carbon that can be traded with the potential to absorb as much CO_2 as 684.9903 tons/ha. It means.

Forest Community contributes to CO_2 emissions reducing by implementing certificate of TLAS. Sustainable forest community ensures sequestration CO_2 for reducing poverty and GHG.

SUGGESTIONS

In any community forest, development planning requires data on the spatial distribution characteristics of an area. Thus, the results of this study can be used to plan the development of community forests in a rural region, mainly used as a reference for the evaluation of forest carbon sequestration potential of the people and development with the principle of voluntary schemes.

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