Dynamics Analysis Of Land-Based Carbon Stock In The Region Of Samarinda East Kalimantan Province

Zikri Azham, Daddy Ruhiyat, Abu Bakar M. Lahjie, Mustofa Agung Sardjono.

Abstract: This study aims to determine the potential dynamics of carbon stocks in various land cover classes in the city of Samarinda, in the calculation of carbon stocks, land cover only devided into three (3) Class Land Cover (CLC) is a secondary forest CLC, CLC thickets and CLC shrubs. Research results show that the above ground carbon (AGC) stocks on Secondary Forest Land Cover Class average of 71.93 tonnes/ha, the land cover classes thickets of 32.34 tonnes /hectares and shrubs land cover classes of 19.66 tonnes / hectare. The carbon stocks in 2009 amounted to 2,589,929 tonnes, in 2012 there were 2,347,477 tons and in 2015 there were 2,201,005 tonnes. Estimated decrease in land-based stock carbon in the city of Samarinda during the period 2009-2015 amounted to 388,943 tonnes, or an average of 70,170 tonnes per year, or approximately 2.73%/year or the emissions in the field of land amounting to 254,538 tonnes of CO_2 equivalent.

Keywords: Carbon stock, Clas Land Cover, Emissions, secondary forest, thickets, shrubs

A. INTRODUCTION

Forestry and land sector has contributed greatly to the greenhouse gas emissions in Indonesia. The greenhouse gas emissions from the forestry sector was related to the process of deforestation and forest degradation were accompanied by forest fires. Forests with high diversity to play a role in absorbing CO_2 through photosynthesis and store it in the form of organic matter or plant biomass in the form of trees, undergrowth, litter, nekromas, leaves, twigs, flowers and fruits, and in forest soil. According to Brown (1999) has a tropical rain forest biomass and carbon content of greater than those in other types of forests in the world. Ruhiyat D., (1995), states that there are two pool (repository) The main nutrients in forest ecosystems that stand biomass and soil components, especially topsoil. Furthermore, it is stated that the amount of biomass in the stands of virgin forest in the tropics generally range between 200-400 tons / hectare. By measuring the biomass in a land area then we can expect the amount of carbon dioxide (CO_2) in the atmosphere that can be absorbed in a vegetated land. To determine the role of land in reducing CO_2 gas in the atmosphere, can be done by measuring the amount of carbon stored in the biomass of trees and undergrowth, the carbon in the organic layer and carbon in the soil (Hairiah et al., 2001) Samarinda city as the capital of East Kalimantan Province should also be able to control greenhouse gas emissions, as well as the potential for carbon stocks should be calculated on an ongoing basis from year to year in order to monitor its development.

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As with other cities as a city that is growing, the city of Samarinda also carry out development in all areas, both the development of city infrastructure, roads, bridges, industrial, housing developers and exploitation of natural resources, especially coal mining. Ought development activities by government, community, business world still run by harmonizing both directly and indirectly to efforts to reduce greenhouse gas emissions (GHG). Through these research activities will be known carbon development from year to year. This research was conducted with the objectives is to knowing the dynamics of carbon stocks in Kota samarinda. As a follow up of the government's commitment that will reduce emissions by 26 percent from "business as usual", with economic growth at 7% in 2020, or 41 percent if have financial aid from developed countries. East Kalimantan Province also determined and has a strong commitment to reduce CO_2 emissions, the start of a process of implementation of the local development environment (green development) on the basis of governance environment (green governance) or called the Kaltim Green,

B. METHOLOGY

Location and Time Research

This research was conducted in Samarinda City area, with an area of 718 km2, the study period of 7 (seven) months from December 2014 until June 2015

Object Of Research

The plots of observation and measurement of vegetation distributed in the city of Samarinda and Samarinda land cover map is the result of land cover interpretation of Landsat imagery in 2009, 2012 and 2015

Material and Tools Research

Materials and equipment used in this study is

a. Map Landsat 7 ETM Year 2009 Year 2012 Year 2015 Samarinda and map interpretation;
b. Administration Area Map Samarinda
c. Tool positioning coordinates (GPS), the measuring rod diameter (phi band); measuring tree height and trunk length, measuring slope (clinometer) and Compass;

heavy gauge (scales), scissor cuttings, sacks, tally sheet.

Research Prosedure

Stratification on the Land Cover Map

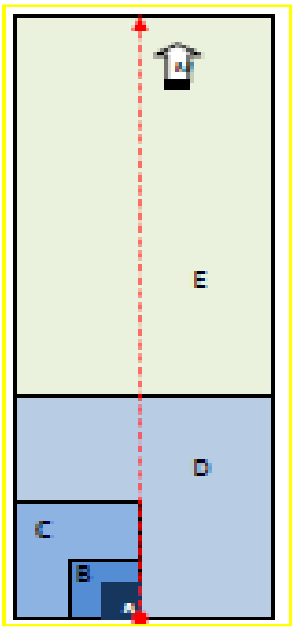
a. Land stratification aims to classify land based on land cover classes derived from Landsat imagery interpretation of the results map.
b. The grouping of the results calculated the area of each land cover classes
c. Conduct a field (ground check), as well as data collection for each class of land cover on plots observations

Plot Data Collection

Plot the data retrieval rectangular, measuring 20m x 125m (Solichin 2010), laying the plot as follows, Research plots for data collection are shown in Figure 1

20m

Figure 1. *Plot Research Data Collection to Measure Biomass (Manuri S, et al., 2011)*



1. On the Class Secondary Forest Land Cover as many as 11 of the plot, which is placed on a variation of Secondary Forest Land Cover Class form of 3 (three) plot, Medium 5 (five) plot and Rare 3 (three) plot.
2. Thicket land cover as many as 6 (six) plot.
3. In the form of shrub land cover as many as 5 (five) plot

Furthermore, the plot is divided into sub-subplot size:

1. 2m x 2m, for data undergrowth and destructively at the seedling stage of cutting all undergrowth diameter < 2cm
2. 5m x 5m for data retrieval sapling are high levels of more than 1.50 cm or dbh > 2cm to < 10cm, dead trees and dead wood
3. 10m x 10m for data pole rate of 10 cm < dbh < 20cm, dead trees and dead wood
4. 20m x 20m of data diameter trees is 20 cm < dbh < 35 cm, dead trees and dead wood
5. Plot 20m x 125m to diameter tree data dbh > 35 cm, dead trees and dead wood.

Tree biomass measurement procedures and regeneration

Measurement of trees and regeneration

a. Measuring the diameter at breast height (dbh), in accordance with the growth rate of trees, and the area of each subplot.
b. Calculation of tree biomass using allometric biomass equations according to the density of trees and the type of ecosystem

Measurement of undergrouth biomass

measurement of undergrouth biomass include grass plants, climbers, herbs, bottom, and woody vegetation dbh <2 cm more to grow on the forest floor, in the following manner:

a. Cut all understorey, the sub-plots of 2m x 2m;
b. Separating the components of the leaf and stem components;
c. Considering the wet weight of total components of total wet weight of leaves and stem of the plant components under the subplot area measurement
d. Taking a leaf sample components and sample components of wood /rod as much as 200 grams each;
e. Drying the leaves and stems components using an oven with a temperature range of 70 ° C to 85 ° C for 2 x 24 hours until reaching a constant weight (Hairiyah and Rahayu, 2007); and weighing the dry weight of the component leaves and stem components.

Measurement of biomass litter

Stages measurement of litter, as follows:

a. Collecting litter in the sub-plot of 2m x 2m;
b. Considering the total wet weight of litter;
c. Taking the example of 200 grams dry weight of litter to be known;
d. Doing drying litter example, using an oven at a temperature of 85 ° C for 2 x 24 hours, until it reaches a constant weight (Hairiyah and Rahayu, 2007); and weighing the dry weight of the litter.

Calculation of dead tree biomass

a. Measuring dbh dead trees;
b. Determining the level of integrity of dead trees;
c. Counting the dead tree biomass with a live tree biomass allometric equation, multiplied by a correction factor of the level of integrity of dead trees.

Calculation of dead wood biomass (nekromas)

a. Measure the diameter of the base and tip; and the length of deadwood
b. Calculating the volume of dead wood with Smalian formula (Indonesian National Standard 7724, 2011) are:

$$Vkm = 0{,}25 \ \pi \left(\frac{dp + du}{2 \times 100} \right)^2 \times p$$

Information:

Vkm = adalah volume kayu mati (m^3)
Dp = diameter pangkal kayu mati (cm)
Du = diameter pangkal kayu mati (cm)

P = panjang kayu mati (cm)
P =π 22/7 or 4.14

c. Counting the dead wood biomass with formula (Indonesian National Standard 7724, 2011):

Bm = Vm x BJm

Information:
Bm = biomassa kayu mati (kg)
Vm =Volume kayu mati (m^3)
BJ + berat jenis kayu mati (kg/m^3)= 0,4

C. Data Analysys

Biomass calculation Trees
Using tree biomass allometric equation model in accordance with the wet tropical climate with rainfall 1500-4000 mm / year (Chave et al., 2005), namely:

$$B = \pi * \exp(1.499+2.148\ln(D)+0.207\ln(D)^2 - 0.0281\ln(D))^3$$

information:
B = biomass tree top soil (kg/phn)
π = density (g/cm3)
D = dbh = diameter breast height (cm)

The trees are not known to use specific gravity of 0.68 (Rahayu et al., 2006).

Calculation of root biomass
Calculation of root biomassa is done by using the formula (Indonesia National Standard 7725, 2011) are:

Information on the ratio of the root tip (NAP) are presented in Table 2.

Table 2. *Ratio Roots Shoots on the Different Types of Tropical Forests*

Tipe hutan	Nisbah akar pucuk	Contoh lokasi
Hutan hujan tropis	0,37	Hutan campuran Dipterocarpa di Kalimantan
Hutan yang menggugurkan daun	0,20 – 0,24	Hutan jati
Hutan daerah kering tropis	0,28 - 0,56	Hutan savana di NTT
Semak tropis	0,40	Hutan bekas kebakaran
Hutan pegunungan tropis	0,27 -0,28	Hutan wilayah dataran tinggi

Source: IPPC Guideline (2006)

Calculation of litter biomass, (Indonesian National Standard 7724, 2011) with the formula, as follows:

$$Bo = \left(\frac{Bks \quad x \quad Bbt}{Bbs} \right)$$

Information:
Biomass Bo = weight (kg)
Bks = dry sample weight (kg)
Bbt = total wet weight (kg)
Bbs = wet weight of sample (kg)

Calculation of Carbon Stock
carbon calculations
The calculation of carbon from biomass, using the formula (Indonesian National Standard 7724, 2011) as follows:
Cb=Bx%C organik
Information :
Cb = carbon content results from biomass (kg)
B = total biomass (kg)
% Organic C = 0.47 (IPCC, 2006)

Bbp = NAP x Bap

Information:
Bbp = under ground biomass (kg)
NAP= roots shoots ratio (kg)
Bap= Value above ground biomass (kg)

D. RESULTS AND DISCUSSION

1. Carbon Stock Estimation on Land Cover in Samarinda
Carbon stock from the calculation of each component on land cover classes Secondary Forests, thickets and shrubs, are presented in Table 1.

TABLE 1. *ESTIMATED CARBON STOCK (TONNES/HECTARE) EACH COMPONENT IN SECONDARY FOREST LAND COVER CLASSES,THICKETS AND SHRUBS IN SAMARINDA*

No	Roots	Litter	Necro-mass	Under storey	Trees Φ>2cm	AGC	Sum
Land Cover Classes of Secondary Forest							
Averages	25,87	3,13	2,03	2,16	64,61	71,93	97,80
Percent	26,45	3,19	2,08	2,20	66,07	73,55	100,00
Land Cover Class of Thicket							
Averages	11,52	2,18	1,44	2,97	25,10	32,58	44,10
Percent	26,13	4,93	3,26	6,73	58,95	73,87	100,00
a. Land Cover Class of Shrubs							
Averages	7,15	0,74	0,39	5,83	12,70	19,66	26,81
Percent	26,66	2,76	1,44	21,76	47,38	73,34	100,00

Catatan: ABC= Above Ground Carbon

a. Carbon Stock in Land Cover Classes Secondary Forest

Table 1 shows that the amount of carbon content in secondary forest land cover classes are an average of 97.80 tons/hectare, the largest carbon content contained in vegetation dbh trees in the top 2 cm of 64.61 tonnes/ha or 66.07%, componen of rooting, 25.87 tonnes/ha or 26.45%, a component of litter, and plant nekromas under each 3.13 tones/hectare (3.17%), 2,03 tonnes/hectare (2.08%) and 2.16 tonnes/hectare (2.20%). Dharmawan et. al., (2010), reported that secondary forests logged-over 30 years old get a larger carbon sinks of this study, namely 171.8 to 249.1 tons/hectare, whereas A. Yamani, 2013 to do research on secondary natural forest in Educational forest Fahutan Unlam, that the carbon content similar to this study, which amounted to 81.59 tons/hectare, subsequently reported on the secondary dry forest carbon stocks 178 tones/hectare (Krisnawati et. al., 2014). Vegetation trees at dbh above 2 cm is fastening largest carbon, the greater the diameter of the tree the more carbon content therefore if the tree is cut down or going clearings then function as carbon sinks (sequestrasion) will be reduced significantly, and the carbon stored in Sycamore trees will break and be emitted in the air. Similarly, just as the roots of trees, is to have the second largest carbon stocks after the trees, the larger the tree, the greater the rooting means more carbon they contain inside the roots. Seeing these circumstances it should forest stands must be keep well, so that in addition to a storage or mooring carbon stocks as well as an absorber (sequestration) of carbon

b. Carbon Stock in Class Land Cover Thicket

In the Thicket Land Cover Class average carbon stock of 44.10 tonnes/ha, the largest carbon components also found in trees in the amount of 32.58 t/ha or 73.87%, then the component Roots 11.52 tonnes/ha or 26.13%, below the growth component by 2.98 tonnes/ha or 6.73%, 2.17 tons of litter components/hectar or 4.93%, component nekromas 1,493 tons/hectare or by 3.62%. Land cover in the form of Thicket this part of trees was fastening the biggest carbon, besides lower plants, litter has an important role in the sustainability of nutrient cycling in forest ecosystems, and is closely linked to the forest structure (Denslow 1987, Hormones and Frangklin, 1989 in the Palace at al. 2008). Greater volumes of lower carbon content in plants on the forest floor than in secondary forests due to the closure of the canopy is more open, so the sunlight to the forest floor more and stimulate the seeds of pioneer species to grow more than in secondary forest canopy more tightly.

c. Carbon Stock in Class Land Cover Shrubs

In Class Land Cover Shrubs are average average carbon stocks 26.81 tonnes/ha, and the largest reserves are also located on the shaft of the trees with a diameter over 2 cm by 12.70 tonnes/ha or 47.78%, then Roots by 7,15 ton/ha or 26.88%, in the undergrowth of 5.83 tonnes / ha or 22.05%, to litter and nekromas respectively of 0.74 tonnes/hectare and 0.39 tonnes / ha or 2.76 % and 1.44%. The large amount of carbon stocks components contained in undergrowth on land cover such as shrubs, can be explained that indeed it was found that the vegetation on the bottom vegetation and is a kind of pioneer species that grow in abundance. such karamanting, krinyuh, nauclea, homalantus, Mallotus. For woody vegetation in the upper 2 cm diameter, the woody vegetation contained in the range of 2-10 cm diameter, namely the types laban, Mallotus, Makaranga, research has been carried Prasetyo (2000) in Muzahid (2008) on the carbon stocks at a thicket in Jambi was found at 15 tonnes/hectare and in Nunukan 19.4 tonnes/hectare

2. Class Size Carbon Based Land Cover Samarinda The results of image interpretation on carbon-based land

3. cover classes in the city of Samarinda in 2009, 2012 and 2015 can be seen in Table 2.

TABLE 2. *CLASS SIZE CARBON -BASED LAND COVER OF SAMARINDA*

No.	Year	Land Cover Class Size (ha)		
		ecundary Forest	Thicket	Shrubs
1	009	22.077	19.691	18.335
2	012	19.263	19.186	17.135
3	015	18.284	17.675	15.769

4. Estimation Of Carbon Stock in Samarinda

For the calculation of carbon stock in the city of Samarinda is to multiply the area of each land cover with an average stock of carbon on the surface (AGC) each Class Land Cover. Estimate of carbon stocks from three (3) Class Land Cover in the city of Samarinda are presented in Table 3.

TABLE 3. *RECAPITULATION ESTIMATED TOTAL CARBON STOCK DURING THE PERIOD 2009- 2015 IN SAMARINDA*

Tahun	Total stock of carbon in land cover classes (tons)			Jumlah
	Hutan Sekunder	Semak	Belukar	
2009	1.587.954,46	641.454,02	360.521,11	2.589.929,58
2012	1.385.549,06	625.003,14	336.925,51	2.347.477,71
2015	1.315.131,55	575.780,80	310.073,71	2.200.986,06

From the table contained 2,589,929.58 tons of carbon stocks in 2009 and in 2012 there were 2,347,477.71 tons, thus the span of the decline of 242,451.87 tons/hectare, whereas from 2012 to 2015 decline amounting to 146,491.64

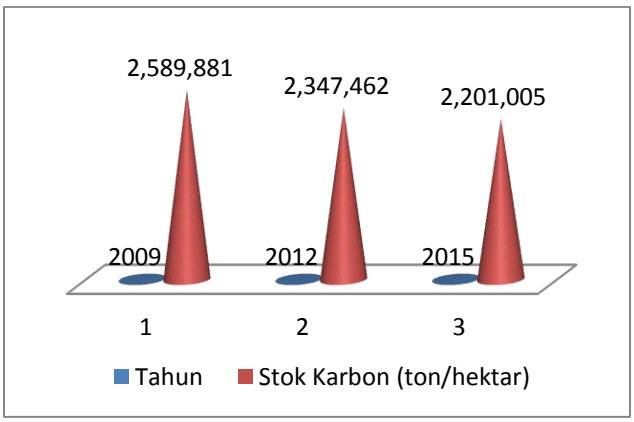


Figure 1 *Carbon stock in Samarinda in 2009, 2012 and 2015*

tons/year. In other words, that the estimates of carbon stocks in Samarinda city during the period from 2009 to 2015 occurred at 388 943 tons, or an average decline of 70.170 tons per year, or approximately 2.73 %/year. From these images it appears that there is a decrease in carbon stocks are land-based or included in the field of activity of RAD GRK Kaltim form of sector Land Use (AFOLU = Agriculture, Forestry and Land Use) (Anonymous, 2012), in the city of Samarinda happens in carbon emissions field of Land Use (Land Use) annually to an average of 70,170 tons/year or 2,73% or CO2 emission field of land use (land use) amounted to 254,538 tons of CO2 equivalent . The decrease in carbon stocks samarinda city can not be denied because like many other cities, the city of Samarinda also in the process of development. The population of the city of Samarinda ever-increasing annually by 3.1% in 2014. Moreover, East Kalimantan, including the five (5) major population growth highest in Indonesia, Kaltim population growth was 2.64% in 2010-2014 and accretion Indonesia's total population (1.4%) 2010-2014 (BPS, 2015). The existence of a growing population is certainly accompanied by the need for shelter, and the new home will certainly to changes land into new settlements or in other words forested land will be turned into land for residential and other urban infrastructure. likewise, the increase in the company coal mine in the city of Samarinda, in 2009 found 42 Permit Cool Mining with an area of 19.636 hectares and in 2012 in the find 70 Permit Cool Mining with area of 23,626 hectares (Profile of Samarinda City, 2012), although now many mining companies were closed.

5. Conclusion

From this research, several conclusions can be drawn as follows :

a. Samarinda city is divided into three (3) Land Cover classes, namely Class Land Cover with a secondary

forest carbon stocks above the ground Carbon (AGC) on Secondary Forest Land Cover Class average of 71.93 tonsha, the land cover classes Thicket an average of 32.34 tons/hectare and bush land cover classes an average of 19.66 tons/hectare

b. Samarinda carbon stocks in 2009 of three (3) classes of land cover are included 2,589,929.58 tons, in 2012 there were 2,347,477.71 tons and in 2015 there were at 2,201,005 tons. Estimated decrease in carbon stocks in Samarinda city during the period 2009-2015, amounting to 388,943 tons, or an average of 70,170 tons/year or about 2.73 %/year or the CO_2 emissions the field of land use (land use) per year, amounting to 254,538 tons of CO_2 equivalent

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