Sumatra Journal of Disaster, Geography and Geography Education
ISSN: 2580-4030 (Print) 2580-1775 (Online)
Vol 1, No. 2, (pp. 118-123), December, 2017
http://sjdgge.ppj.unp.ac.id

Carbon Stocks Estimate of Padang City West Sumatra Province

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Abstract

The most fundamental problem in this research is land cover change into settlement area and open land that occurred are high in Padang City, so the forest has reduced. If cover land of forest reduced, while population, industry and transportation growth increase the environmental gap due to plants absorbing emissions released by human activity is reduced. As a result the surface temperature becomes warmer. If this is left continuously, the hydrometeorology disaster will threaten Padang City. In general, this research aims to determine how the phenomenon of climate change that occurred in Padang City based on the estimation of carbon stocks in accordance with land cover. Analysis of the occurrence of climate change can be known based on the tendency of temperature data and rainfall data contained in Padang City. In addition, climate change can be analyzed based on changes in land cover and carbon stocks. Based on the result, it is known that Padang City since 1989 experienced considerable changes, especially changes from forest to settlements and mixed land. That land cover changes, indirectly cause the carbon stocks of Padang City also decreased. This is because other land cover rather than forests have low carbon stocks, especially settlements and open land that do not have carbon stock. Carbon stocks reduced, it is assumed to cause increasing air temperature and reducing rainfall.

Keywords: Carbon Stocks, Land Cover

Introduction

The ability of forest in storing carbon makes forests have important role in reducing the amount of carbon that is the one of greenhouse gases that cause global warming. It is also embodied in the Kyoto Protocol document with the concept of CDM (Clean Development Mechanism) that the forest as a "Sink" which acts as a carbon sink and absorber, whereas in REDD (Reducing Emissions from Deforestation and Degradation) deforestation is viewed as “Source” (carbon emissions). The two roles of the forest are supported by the existence of forest ecosystems dominated by trees that process photosynthesis.The process of photosynthesis begins with the absorption of carbon dioxide (CO_2) from the atmosphere, stores carbon then releases oxygen gas (O_2) and returns to the atmosphere.

If land clearing activities enforce such as logging or forest burning, CO_2 absorbed by plants will be released back into the atmosphere (with different amounts), so that changes in land cover and land use of forest to other land cover are considered as the main cause of CO_2 release to the atmosphere. In addition to absorbing and emitting carbon, forests also play a role in water governance through hydrological functions. But the function of the forest can not stand alone, but it depends on the conditions of rainfall, soil characteristics, geology, slope, and management. Forest management practices are often recommended to follow watershed boundaries in order to provide sustainable benefits.

The Reducing Emissions from Deforestation and Degradation-plus (REDD-plus) scheme is a mechanism for reducing emissions from deforestation and forest degradation through the role of

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conservation, sustainable forest management and enhancement of forest carbon stocks. Increased greenhouse gas emissions are associated with rising earth surface temperatures. If the surface temperature of the earth increases, it can trigger climate change. Climate change is a global phenomenon, but the impact of climate change is not felt the same for all places. Places that are likely to be most affected by climate change are urban areas, with definite changes in climate elements being the increase in air temperature. In 1990-2100, the Intergovernmental Panel on Climate Change (IPCC) projected that the Earth's surface temperature would increase between 1.4-5.8 ° C.

The most fundamental problem in this study is the high change of land cover that occurred in Padang into settlement areas and open land, so that forest cover becomes reduced. If forest cover diminishes, while population, industry and transportation growth, there will be environmental gaps due to plants that absorb emissions released by human activity is reduced. As a result the surface temperature becomes warmer. If this is left continously, then the hydrometeorology disaster will threaten Padang City. Therefore, research needs to be done to find out how the phenomenon of climate change that occurred in Padang, considering Padang is one of the cities that encounter land cover change which quite large. In this study, climate change will be based on estimating carbon stocks according to land cover.

Land is part of a landscape that includes the understanding of the physical environment including climate, topography / relief, hydrology including the state of natural vegetation that will potentially affect land use. Understanding land use, land cover, and land use systems have little difference. Ekadinata and Dewi (2012) explain that land use refers to human activities, land cover refers to the type of vegetation or physical embodiment of objects that cover the land without questioning the human activities of such objects. Land use system (SPL) includes both vegetation change cycles, management activities (planting, harvesting), and spatial diversity occurring within an SPL. Land use changes have various effects on human life, such as natural disasters, decreased land productivity and global climate change. Figure 1 explains that land use change is influenced by socio-economic aspects, ecological processes and policy factors. In addition, environmental awareness and economic development may alter the causal factors. Forest degradation and deforestation can be affected by planned and unplanned conversions. Unplanned forest conversion, entirely caused by economic factors, but planned forest conversion is generally caused by government policies. Biomass comes from the word bio which means life and mass means weight or is the weight of living material. Biomass is the total weight or volume of organisms in a definite area or volume. Biomass is also referred to as total living matter on the surface of a tree expressed by tons of dry weight per unit area. While forest biomass is the total amount of dry weight of all parts of living plants, whether for whole or part of the body of the organism, production or community and expressed in dry weight per unit area (ton / ha) (Hairiah *et al*.,, 2011).

Method

Analysis of the occurrence of climate change can be known based on the trend of temperature data and rainfall data contained in Padang City. In addition, climate change can be analyzed based on changes in land cover by comparing land cover in 1989, 2001, and 2017 by covering each of these maps so that any closure that will change during that time. Changes that occurred during the time period is then made in the form of tables to ease in viewing land cover changes that occur.

$$\Delta LC = \frac{K2-K1}{K1} X\ 100\%$$

Annotation:
ΔLC : Land Cover Changes
K1 : Land Cover Area Year 1 (ha)
K2 : Land Cover Area Year 2 (ha)

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Changes in land cover means changes in carbon stocks. Analysis of changes in carbon stocks in a definite land can be done by comparing the amount of carbon stocks due to land cover changes in 1989, 2007, and 2017. Suppose to carbon stocks for each type of land cover are done using calculations on the plot scale conducted in Indonesia from several literatures. The biomass value of the literature study is transformed from ton per hectare to ton per pixel of image with a size of 30 m^2 (0.09 hectares) as shown in Table 1. Alleged carbon stocks based on the type of land use may indicate CO_2 emissions estimates. Here's the CO_2 emissions formula: CO_2 emissions = Total carbon stocks x 3.67 (3.67 = Constant conversion C to CO_2)

Results and Discussion

This research aims to determine changes in land cover, carbon stocks and climatic conditions of Padang City. The results achieved in this research are:

1. Analyzing changes in land cover that occurred in the city of Padang in 1989, 2001, and 2017. Padang city is the capital of West Sumatra Province with an area of 659 km^2 or 69500 ha. Based on the picture above, it is known that the city of Padang experienced a considerable change in land cover. In 2001 there was considerable change from land cover to settlement, and primary forest became secondary forest. The same is true in 2017, where changes occur in primary forest cover into secondary forests, paddy fields into settlements, and secondary forests into mixed land.

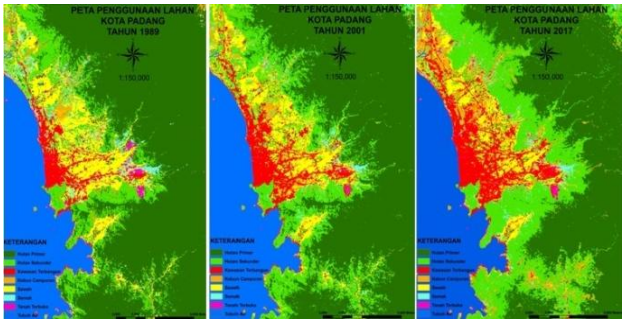

Figure 1. Land Cover Change of Padang

2. Determination of ground check point result of land cover analysis on Landsat satellite image 2017 with condition in the field.
3. Conducting ground checks at 101 points in Padang City consisting of primary forest cover, secondary forest, settlement, paddy field, field, bush, and open field. Field observation (ground check) aims to determine the level of accuracy of the digital image interpretation that has been done. Observations were made for classification accuracy tests on land cover at 101 scattered points as in Figure 2.

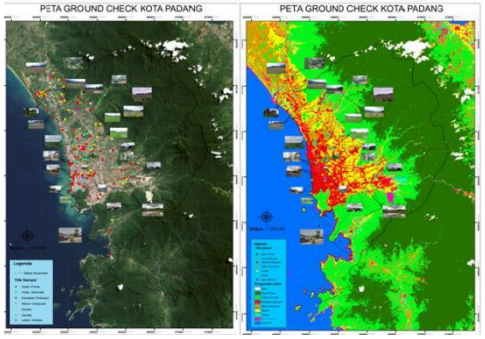

Figure 2. Ground Check Points

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4. Tabulation of land cover change data in Padang City. Based on Table 1 it is found that the largest increase in land cover from 1989 to 2001 was found in built up area and secondary forests that increased by 84.93% and 40.44%, while the conversion occurred on open land, shrubs, mixed land, primary forest, and rice fields. Furthermore, in 2001 to 2017 the largest increase occurred in mixed land cover, open land, secondary forest, and built up area, while the largest reduction of land cover on paddy and primary forest cover.

Table 1. Land Cover Change of Padang

No	Keterangan	Luas (ha)				
		1989	2001	1989-2001 (%)	2017	2001-2017 (%)
1	Hutan Primer	72472,77	65747,16	-9,28	51781,41	-21,24
2	Hutan Sekunder	15580,26	21880,98	40,44	31637,88	44,59
3	Kawasan Terbangun	4052,34	7494,03	84,93	9833,76	31,22
4	Kebun Campuran	2552,49	2019,87	-20,87	6535,44	223,56
5	Sawah	10525,32	9809,73	-6,80	6802,29	-30,66
6	Semak	3220,47	2390,31	-25,78	2408,13	0,75
7	Tanah Terbuka	1702,98	764,55	-55,11	1107,72	44,89
Jumlah		110106,63	110106,63		110106,63	

5. Analyzing carbon stocks in 1989, 2001, and 2017 in accordance with land cover changes using Landsat satellite imagery. Figure 4 below explains that the highest carbon stocks are in primary forests, followed by secondary forests, mixed land, fields, shrubs, and rice fields, while open land and settlements do not have carbon stocks. Thus, it can be seen that the reduction of carbon stocks in Padang City is caused by changes in land cover, especially land clearing in primary and secondary forests.

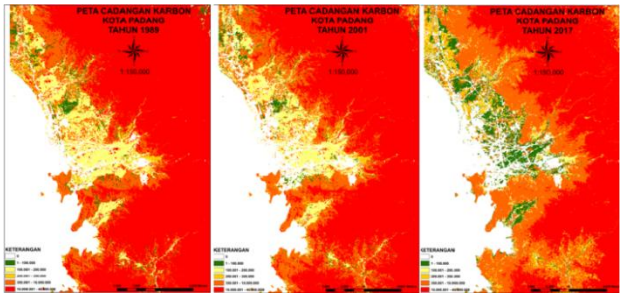

Figure 3. Carbon Stock Changes of Padang

6. Tabulation of carbon stock change data in Padang City. Tabular data in Table 3 shows that there was a reduction of carbon stocks from 1989 to 2017. The largest reduction of carbon stocks occurred in primary forests reached 10998492,41 t / ha. While the addition of the largest carbon stock in secondary forest reach 5419928,479 t / ha. This is due to the large number of primary forests that are transformed into secondary forests and other cover, so that as the largest carbon reservoir (above ground biomass), if the amount of primary forest is reduced, the carbon stock is also indirectly reduced.

Table 2. Tabulation of Carbon Stock Estimate

No	Keterangan	Cadangan Karbon (t/Ha)		
		1989	2001	2017
1	Hutan Primer	38522900,89	34947902,9	27524408,49
2	Hutan Sekunder	5258805,158	7385487,179	10678733,64
3	Kawasan Terbangun	0	0	0
4	Kebun Campuran	142939,44	113112,72	365984,64
5	Sawah	157879,8	147145,95	102034,35
6	Semak	228653,37	169712,01	170977,23
7	Tanah Terbuka	0	0	0
Jumlah		44311178,66	42763360,76	38842138,34

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7. Analyzing the relation of land cover change with the carbon stock of Padang City in 1989, 2001, and 2017. Based on Figure 4, it is known that from 1989 until 2017 there was a decrease of carbon stocks due to changes in primary forest cover to secondary forest land cover, built up area, mixed land, paddy fields, shrubs and open fields. Primary forests are the largest storage reservoir of carbon compared to other land cover, whereas built up and open land is a land cover that does not have the capacity for carbon stocks. Thus, carbon stocks in Padang City has decreased considerably.

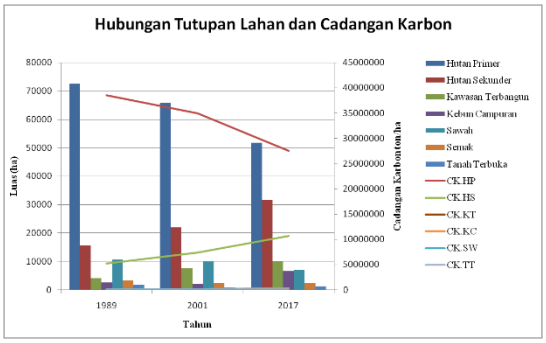

Figure 4. Land Cover and Carbon Stock Relation

Based on the results of the research, can be seen that the occurrence of forest cover decrease due to the increasing population growth, hence causing the increasingly deterioration of environmental conditions. Reduced land cover, also affect to decreasing the amount of vegetation, especially in urban areas, such as Padang City.

Padang City is the capital of West Sumatera Province which there is a continuous change of land cover, especially becoming built up area. Based on the results of the study, it is known that the largest land cover increase in 1989 to 2001 was found in the area of the built up and the secondary forest that increased 84.93% and 40.44%, while decreasing occurred in open land, bush, mixed land, primary forest , and paddy fields. Furthermore, in 2001 to 2017 the largest increase occurred in mixed land cover, open land, secondary forest, and built up area, while the largest reduction of land cover on paddy and primary forest cover. It is also supported in BPS (2015) that the area of green open space (RTH) in Padang City is 95.6% of the total area region in 1988 and narrowed to 88.1% of the total area of 1998, the year 2008 was reduced to 83.8% of the total area, and in 2014 decreased to 83.5% of the total area. Between 1988-2014 the RTH in Kota Padang converted to 12.1% of the total area (2015 BPS).

Changes in land cover, especially changes in forest cover to other land cover causes a decrease in carbon stocks. This is supported by Marispatin (2007) which explains that trees in the forest are able to absorb carbon dioxide (CO_2) for photosynthesis and store it in the form of carbohydrates in carbon sac in the roots, stems, and leaves before being released back into the atmosphere. The stored carbon is 47% of the measured tree biomass (BSN, 2011) so that carbon stocks are positively correlated with the amount of biomass, which means the larger the biomass savings the higher the carbon stock. Species diversity in a forest ecosystem also contributes to influencing carbon stocks in the forest ecosystem. According to Indriyanto (2010), a ecosystem have a high species diversity if the ecosystem composed by many species. Instead a ecosystem to have a low species diversity if the community composed by few species. Thus, if the number and species of trees in a region decreases due to clearing of land into other land cover, the carbon stocks stored in the area will also decrease.

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Conclusion

Based on the research results, it can be concluded that Padang City from 1989 until 2017 has undergone considerable changes, especially the reduction of primary forest and the increase of mixed land and open land. Changes in land cover, indirectly cause the carbon stocks of Padang City also decreased. In addition to reducing carbon stocks, vegetation land cover changes, especially trees to non-vegetation cover, also leads to reduced rainwater catchment area so that if high rainfall can cause flood.

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