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Estimation of Carbon Stock Using NDVI Vegetation Index in Secondary Forest of Gajabuih , West Sumatra

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***Abstract*— Gajabuih forest is a secondary forest. This forest is located in Ulu Gadut. Similar to other forests, the Gajabuih forest cannot be separated from various threats such as illegal logging, forest encroachment, land destruction for cultivation and agriculture. This will have an impact on land cover. So that analyzing land cover changes and carbon stocks is very necessary for mitigating ecological disasters. Analysis of land cover changes and carbon stocks can use remote sensing techniques. Remote sensing capabilities Landsat imagery has multi-resolution capabilities (spatial, spectral, and temporal resolution). The results showed that the estimated carbon stock in the Gajabuih permanent plot was estimated at 15.33 tons/ha. The results of the correlation analysis between the NDVI value and carbon stock obtained a regression equation = 48.358x -4.2339 with a coefficient of determination (R2) of 0.43. This regression equation shows that the value of the regression coefficient is positive.**

Keywords— Carbon stock, Secondary Forest, Landsat Imagery, West Sumatra.

I. INTRODUCTION

Gajabuih forest is a secondary forest. In 1981 a permanent plot was established, known as the Gajabuih plot. This forest is dominated by Dipterocarp and Fagaceae plants. Similar to other forest areas, the Gajabuih forest area cannot be separated from various threats such as illegal logging, forest encroachment, land destruction for cultivation and agriculture.

Several studies have been carried out in the Bukit Gajabuih forest, including tree growth and death (Yoneda et al, 2006), horizontal variance of stand structure, the impact of dry weather on stand dynamics (Yoneda, et al, 2006), distribution patterns of Calophyllum soulattri (Mukhtar et al. al 1992; Mukhtar et al, 1998) studied the distribution and survival of several tree species (Mukhtar and Koike, 2007; Mukhtar and Koike, 2009). Research on the composition of tree guilds in secondary forest, Ulu Gadut (Yoneda et al., 2006). Wahyudi (2011) on sprouting and Kardiman (2012) on tree stand structure after 14 years of felling. Rafdinal (2015) regarding the dynamics of tree structures and carbon stocks in the tropical rain forest area of Ulu Gadut, West Sumatra by using a field survey. The importance of this research is the analysis of land cover changes and carbon stocks based on initial data where most studies only focus on one period. The permanent research plot in the Ulu Gadut forest is a permanent plot that can be categorized as the longest plot in the world for approximately 40 years.

In detecting changes in land cover can use remote sensing techniques. This technique has the ability to cover a study area that varies greatly from small to large, can provide a comprehensive description of spatial elements with correct relative geometric shapes (and neighboring relationships), the measurement period (observation) is relatively short and can be repeated. quickly and consistently, the scale (spatial data accuracy) obtained varies from small to large, the tendency to get the most recent data, the overall cost, time and so on are relatively cheap (Prahasta, 2008). It is hoped that the use of remote sensing methods in analyzing land cover changes in Gajabuih secondary forest will get maximum results, determine regional developments, and provide an overview of physical and social conditions in the research area based on conditions and patterns of land cover development. It is important to conduct a dynamics study to see changes in vegetation. Prevention and reduction of the quantity of land use and carbon stock issues is a prerequisite in achieving the objectives of the REDD+ program. One of the efforts in reducing global emissions to address climate change is reducing emissions from degradation and deforestation, Sustainable Forest Management (SFM) and Sink Enhancement (REDD+). Calculation of carbon fluxes and carbon stocks in forest ecosystems (Pregitzer, and Euskirchen, 2004; Korner et al., 2005) is very important in evaluating the response of trees to climate change (Mann and Hughes, 2002) and in forest management.

The main issue regarding climate change is the increase in the CO2 content in the atmosphere (Cramer et al, 2001; Weis and Leip 2012). At the same time, the number of trees/forests capable of absorbing carbon decreases, so the amount of CO2 increases. With these issues, the existence of agreements such as the Kyoto Protocol (1997) has opened up opportunities for developing countries such as Indonesia to immediately take an inventory of carbon sequestration capabilities. Therefore, the calculation of carbon absorption per unit area needs to be developed and promoted so that the carbon absorption capacity can be known. Regarding the issue of carbon stocks and changes in vegetation, it is important to do this study.

II. Research Methodology

This research was conducted in the Gajabuih secondary forest area, Ulu Gadut, West Sumatra. This study was conducted from December 2020 to March 2021. The permanent plot of Gajabuih is in Ulu Gadut, Limau Manis Selatan District, Padang City, West Sumatra, Indonesia (Figure.1) To obtain the pixel values associated with biomass, the NDVI equation was used (Jaya, 2010).

$$NDVI = \frac{(NIR - R)}{(NIR + R)}$$

Information :

NDVI : Normalized Difference Vegetation Index

NIR : Near Infrared Band

R : Red Band

Calculation of tree biomass using allometric equation is as follows (Brown et al., 1996) :

Y= W * 0,5

Information :

Y: Above Ground Biomass (Ton/Ha)

W: The Total Biomass (Ton/Ha)

Figure 1. Map of Permanent Plot of Gajabuih Forest, West Sumatera

NDVI has a value range from -1.0 to 1.0. Clouds, water, and non-vegetable objects have NDVI values less than zero. Values that represent vegetation are in the range of 0.1 to 0.7. If the index value is higher than this range, it means that the vegetation cover is healthier (Lillesand and Kiefer 1990). Above ground biomass is estimated at over seven hundred thousand quality-observation Lidar Geoscience Laser Altimeter System (GLAS) filtered using allometric equations that estimate AGB based on lidar-derived canopy metrics. The global set of GLAS AGB estimates was used to train a random forest model that predicts AGB based on continuous spatial data. The predictor dataset includes Landsat 7 Enhanced Thematic Mapper Plus (ETM+) reflectance over the atmosphere and tree canopy cover from the Global Forest Change dataset version 1.2 (Hansen et al., 2013). AGB density value data (megagrams of biomass/hectare); the aboveground carbon density value can be estimated as 50 percent of the biomass density value.

III. RESULT AND DISCUSSION

This study using correlation analysis and regression analysis. Correlation analysis is used to see the relationship between NDVI values and carbon stocks. Regression analysis is used to measure how much the independent variable is able to explain the dependent variable, where the independent variable is the value of the vegetation index used and the dependent variable is the value of the carbon content in each sample. The relationship between NDVI values and carbon stocks can be seen in Figure 2.

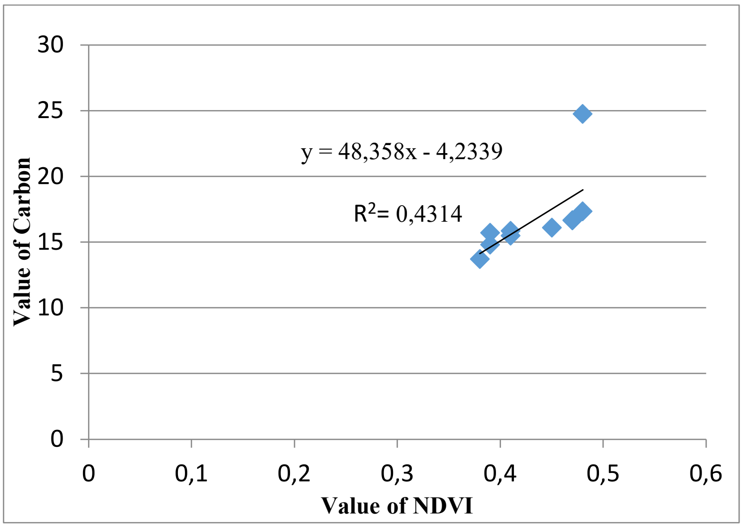

Figure 2. NDVI value relationship with carbon value

The R^2 value is a value that shows the level of correlation between the variables connected, in this case the carbon value and the NDVI value. Thus, the greater the R^2 value, the better the correlation between the carbon value and the NDVI value. The results of the correlation analysis between the NDVI value and carbon stock (Figure 9) where the regression equation = 48.358x - 4.2339 with the coefficient of determination (R2) is 0.4314 which shows a strong relationship. Young, 1982 in Rakhmawati (2012) states that a positive relationship if the value of the correlation coefficient R2 0.4. This regression equation shows that the value of the regression coefficient is positive. This means that the carbon value and NDVI value are directly proportional or the higher the carbon value, the higher the NDVI value and vice versa.

The carbon stock in the permanent plot with an area of 0.9 is estimated at 15.33 tons. The condition of carbon stocks in 2020 will increase. Whereas in year 2000 there was a decline, this was due to deforestation in the Gajabuih hill plot area in 1998, causing a lot of land that has the potential to be a contributor to carbon stocks to be converted into open land. Saswita (2013) said that deforestation that occurred in 1998 caused a reduction in carbon stocks in the Gajabuih hills. Carbon stocks in a land use are influenced by the type of vegetation, a land use system consisting of trees whose species have high wood density values, the biomass will be higher when compared to land that has species with low wood density values Hairiah and Rahayu, 2007).

IV. Conclusion

The carbon stock in the Gajabuih permanent plot is estimated at 15.33 tons. The results of the correlation analysis between the NDVI value and carbon stock obtained a regression equation = 48.358x - 4.2339 with a coefficient of determination (R^2) of 0.4314. This regression equation shows that the value of the regression coefficient is positive. Where the carbon value and NDVI value are directly proportional or the higher the carbon value, the higher the NDVI value.

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