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Estimation of Carbon Stock Using NDVI Vegetation Index in Primary Forest of Pinang-Pinang, West Sumatra

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Abstract— **The permanent research Pinang-Pinang Ulu Gadut primary forest, West Sumatra is a permanent plot that can be categorized as the longest in the world for approximately 40 years, thus this research has added value to carbon changes. Carbon reserve estimates for climate change mitigation require accurate calculations. Measuring by destructive methods takes a long time and costs a lot. Hence, the use of remote sensing data capabilities hase multiresolution (spatial, spectral, and temporal resolution). Current forest monitoring and transformation can be done more easily and quickly using remote sensing technology. The use of remote sensing brings many benefits such as relatively inexpensive costs, in relatively quick and safe times in various weather conditions. Satellite imagery is often used to view land covers. Remote sensing has long been an important and effective tool for the preservation of land cover and carbon stocks with its ability to provide information about the fast, broad, precise, and easy spatial diversity on earth. Research shows that the estimate of carbon reserves on the plot is permanently declining dramatically. From this study, we found the Estimates of carbon reserves on the permanent plot are 13.75 tons/ha. Statistical analysis is obtained (R) 0.644 and (R^2) 0.41 with $y = 1.64 + 23.75x$ equation. This recursive equation suggests that the regression coefficient value is positive.**

Keywords— **NDVI, Carbon Stock, Pinang-Pinang Forest.**

I. INTRODUCTION

The Pinang-Pinang forests measure their way into the tropical lowland rain forest located at 490-520 feet [490-520 M] above sea level. A forest, which covers an entire ecosystem of interactions with the factors of growth and of the environment and of the plant and animal communities, through a process called succession (Sumardi and Widyastuti,2007). Forests have very complex functions such as oxygen producers, which they can play a key role in maintaining global climate stability because of their ability to absorb CO_2 through the process of photosynthesis. When the forest is damaged it will affect climate change. That global climate change is due to the buildup of greenhouse gases.

The largest greenhouse gas emissions are CO_2. Thus, efforts are needed to address global climate change by lowering CO_2 emissions. CO_2 emissions can be taken down by managing forests sustainably, increasing forest density, conservation of carbon reserves and increasing forest carbon reserves. Loss of forest is adversely affected, loss of forest is caused by human actions such as fragmentation of habitat, illegal loging, degradation, deforestation, and clearing (Hairiah and Rahayu, 2007). Forest damage, climate change, and global warming, cause forests to suffer a decline because forests are the largest carbon absorption and play an important role in the global carbon cycle and can store at least 10 times as much carbon as other types of vegetation such as meadows, green crop, and tundra (Adiriono, 2009).

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Forests in Indonesia have a carbon reserve potential ranging from 61-300 tons of c/ha (rahayu). Indonesia's forest resources have a high potential for biodiversity and carbon absorption as well as for forests to serve as nature's protector and buffer (Suhendang, 2002). In general, primary dryland forests are capable of storing carbon in larger quantities than secondary land forests, as in secondary forests there has been a disruption of their call (Pregitzer et al., 2004). Fires, wood extraction, land use for cultivation, or other activities in forested areas cause a diminishing of the biomass potential that directly indicates its carbon storage capacity (Korner et al., 2005).

Carbon backup and land-cover analysis are always connected to the use of spatial data. One way to get effective and efficient spatial data is by remote sensing (satellite and air image). Remote sensing has multiresolution capabilities (spatial, spectral, and temporal resolution). Current forest monitoring and changes can be done more easily and quickly using remote imaging (alba et al., 2012). The data source used can be both photography and satellite images (cahyono et al., 2018). Long—term studies on the permanent plot of Pinang-pinang forest are expected to contribute to ecological disaster mitigation. Some information about Plots Permanen, Pinang-Pinang forests have been identified through the following research: Spread Pattern *Calophyllum soulattri* (mukhtar et al., 1992, 1998), the growth and death of the tree (yoneda et al., 2006). Dispersion of several main trees (mukhtar and koike, 2009). The level of the tree guild in the forest of pinang-pinang (yoneda et al., 2009). Counting carbon reserves for three decades (mukhtar et al., 2014).

II. Research Methodology

This study was conducted in a permanent plot forest of Pinang—Pinang. Data were collected from December 2020 to March 2021. Permanent Plot located in Ulu Gadut, Padang City, West Sumatra (Figure 1). To obtain the pixel values associated with biomass, the NDVI equation was used (Rouse et al, 1973).

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

Inofrmation :

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)

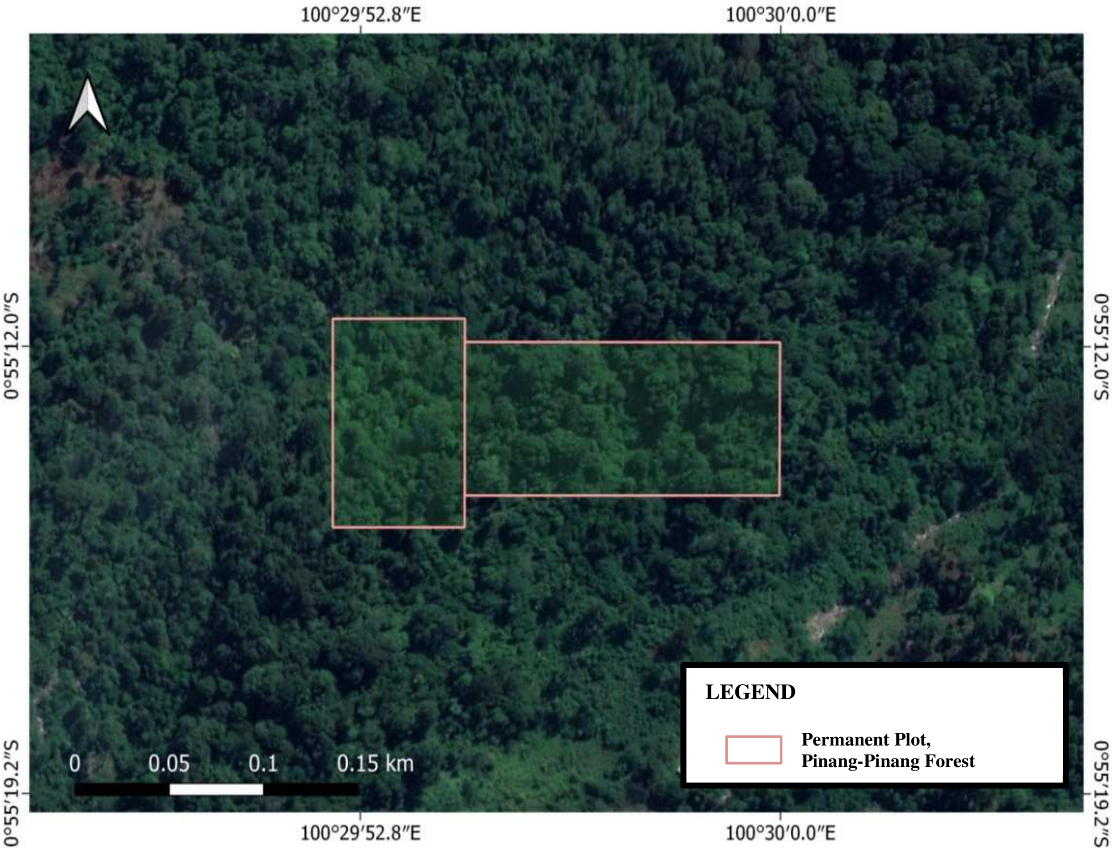

Figure 1. Map of Permanent Plot of Pinang-Pinang Forest, West Sumatera

NDVI has a range of values from -1.0 to 1.0. Clouds, water, and non-vegetation objects have a NDVI value less than zero. Values representing vegetation are based on a range of 0.1 to 0.7. If the value of the index is higher than this range it means the closing of the vegetation is healthier (Lillesand and Kiefer 1990). Above Ground Biomass (AGB) has been estimated to be more than seven hundred thousand observations from Geoscience Laser Altimeter System (GLAS) using allometric equations that estimate AGB based on the metrics of the canopy derived from the lidar (hanset et al. 2013).

III. RESULT AND DISCUSSION

The statistical analysis used is the correlation and regression analysis. Correlation analysis is used to measure the correlation relation between variables, where in this research the variables used are NDVI's vegetation index values and the value of carbon content. Whereas regression analysis is used to measure how large the variables are bound, where what becomes a free variable is the value of the vegetation index used and what becomes a bonded variable is carbon value. Based on the reforestation analysis of the target, the A value of 1.64 and the B value of 23.75 were the same as y= 1.64 + 23.75x. This recursive equation suggests the regression coefficient value is positive. This means that carbon and NDVI's grades are directly proportional or that the NVDI value increases accordingly.

Calculating value (R) of 0.644 and value (R^2) of 0.41 is obtained. Value (R^2) is a value that shows the correlation rate between interconnected variables, in this case of carbon and NDVI values. As higher grades (r grades), the better correlation between carbon values and NDVI values is. Young (1982) in Rakhmawati (2012) states that if a coefficient value (R^2) is greater than 0.4 then the NDVI relationship and the carbon reserve have a strong relationship. In this study, an R score of 40% marks means that the magnitude of carbon in the 40% field can be determined by the value of NDVI through the regression equation of y = 1.64 + 23.75x. The rest is determined by another factor.NDVI. Value relationship with carbon reserves can be seen in (figure 2)

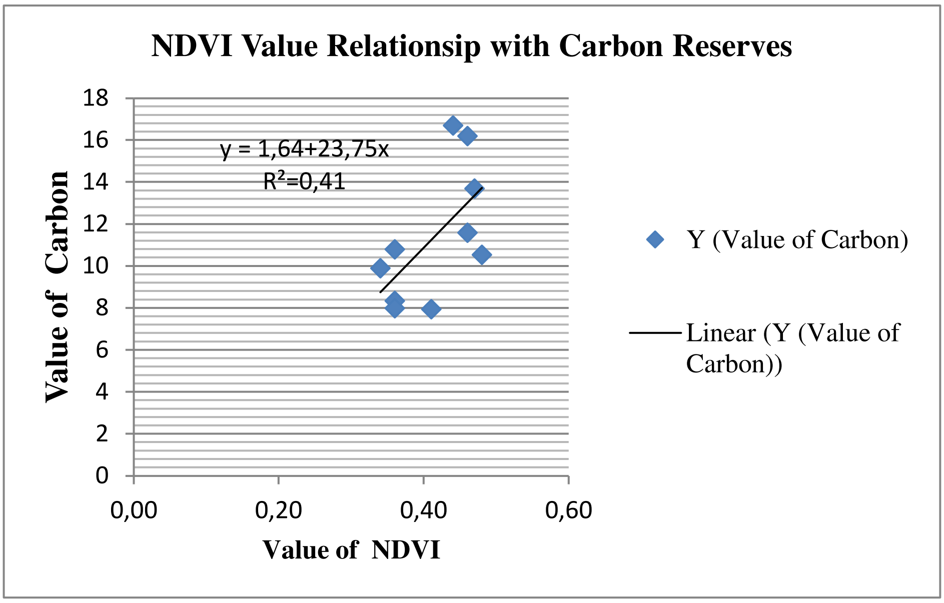

Figure 2. NDVI Value Relationship with Carbon Reserves

Estimates of carbon reserves on the permanent plot of the Pinang-Pinang forest are 13.75 tons/ha. The Pinang-Pinang forest has enormous potential for absorbing and storing carbon (Suwardi, 2013). According to data obtained from Forest Watch Indonesia (FWI) natural forests Indonesia has lost more than 23 million hectares or equivalent to 75 times the size of Yogyakarta Province of this data recorded by FWI since 2000-2017 (FWI, 2020).

Tropical forests contain as much as 40% of the carbon stored as terrestrial biomass and account for 30 percent of the treexterior productivity (Dixon et al., 1994). The role of forests became more important in Indonesia's climate change policies. Deforestation and land-use change, bringing about 60 percent of Indonesia's total emissions. So when the forest breaks, we lose twice. We not only remove carbon from the trees but also lose the forest's ability to absorb carbon dioxide (Boer et al., 2009).

Forests are closely associated with carbon dioxide gas emissions, current climate change is one of the key issues for forestry and environmental development both at the global and national levels. Climate change results from forest destruction, resulting in their ability to absorb and save co2, and the increasing greenhouse gases on the earth that create global warming that will change climate from normal circumstances.

IV. Conclusion

Pinang-Pinang forest is a primary forest located in West Sumatra, with the forest a permanent plot that has become the Andalas University study. Estimates of carbon reserves on the permanent plot are 13.75 tons/ha. Statistical analysis is obtained (R) 0.644 and (R^2) 0.41 with $y = 1.64 + 23.75x$ equation. This recursive equation suggests the regression coefficient value is positive. This means that carbon and NDVI values are directly proportional or that the more they increase, the more NDVI values.

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References

[1] Adiriono, T. 2009. Pengukuran kandungan karbon (Carbon Stock) dengan metode karbonasi pada Hutan Tanaman jenis Acacia crassicarpa (Studi Kasus di HTI PT. Sebangun Bumi Andalas Woodbased Industries). *Thesis*. Program Studi S2 Ilmu Kehutanan, Jurusan Manajemen Hutan, Fakultas Kehutanan, Universitas Gajahmada, Yogyakarta. Tidak diterbitkan.

[2] Alba, J. M. F., V. F. Schroder, dan M. R. R. Noberga. (2012). *Land Cover Change Detection in Southern Brazil Through Orbital Imagery Classification Methods.* Dalam *Remote Sensing – Applications.* Editor D.B Escalante: Rijeka-Croatia. InTech.

[3] Boer Rizaldi, Sulistyowati, Irsal Las, Farida Zed, Nur Masripatin, Dana Kartasasmita, Dadang Hilman, Haneda Sri Mulyanto. 2009. *Indonesia Second National Communication Under The United Nations Framework Convention on Climate Change (UNFCCC).*

[4] Brown, S., AZ. Shvidenko, W. Galinsk, R.A. Houghton, E.S. Kasische, P. Kauppi, W.A. Kerz, L.A. Nalder, and V.A. Rojkov, 1996: Forest and the global carbon cycle: past, present, and future role. In: *The Role of Forest Ecosystems and Forest Management in the Global Carbon Cycle* [Apps. M. And D. Price (eds.)]. NATO ARW Series, Springer-Verlag. New York. NY, USA (is press).

[5] Cahyono, B. E., A. T. Nugroho, dan J. Husen. (2018). Karakteristik Time Series Reflektansi Tanaman Padi Varietas Ciherang dengan Analisis RGB Citra Fotografi. *Jurnal Fisika FLUX* 15 (1): 59-65.

[6] Dixon, R. K., Brown, R. Houghton, R. A., Solomon, A. M., Trexier, M. C. and Wisniewski, J. 1994. Carbon pools and flux of global forest ecosystems. *Science* 263: 185–190.

[7] Forest Watch Indonesia. 2020. Diakses pada 10 Februari 2021, dari *https://fwi.or.id/publikasi/75-tahun-merdeka-hutan-indonesia-hilang-lebih-dari-75-kali-luas-provinsi-yogyakarta/*

[8] Hansen MC, Defries RS, Townshend JRG, Sohlberg R. 2000. Global land cover classification at 1km spatial resolution using a classification tree approach. International Journal of Remote Sensing. 21: 1331-1364.

[9] Hairiah K dan Rahayu S. 2007. Petunjuk praktis Pengukuran karbon tersimpan di berbagai macam penggunaan lahan. *World Agroforestry Centre*, ICRAF Southeast Asia. ISBN 979-3198-35-4. 77.

[10] Korner, C., Asshoff, R., Bignucolo, O., Hattenschwiler, S., Keel, S. G., Pelaez-Riedl, S., et al. (2005). Carbon flux and growth in mature deciduous forest trees exposed to elevated CO2. *Science, 309*(5739), 1360-1362.

[11] Lillesand TM, Kiefer RW. 1997. Penginderaan Jauh dan Interpretasi Citra. Yogyakarta: Gadjah Mada University Press.

[12] Mukhtar, E; E. Suzuki; T. Kohyama and M. Rahman. 1992. Regeneration Process of a Climax Species *Calophylllum* cf. *soulattri* in Tropical Rain Forest of West Sumatra. *Tropics* **2**(1); 1-12

[13] Mukhtar, E; T. Yoneda; Zalfiati and M. Rahman. 1998. *Regeneration process of a climax species Calophylllum soulattri in tropical rain forest of West Sumatra*. Tropics 2(1); 1-12

[14] Mukhtar, E and Fumito Koike. 2009. *Juvenile height growth rate of seven major tree species in a tropical rain forest of* West Sumatra. *Tropics*. 18(1).

[15] Mukhtar, E; Syamsuardi and Hermansah. 2014. *The change of tree diversity and carbon stock during three decades in Ulu Gadut, West Sumatra. 2014.* The Inaugural Asian Conference on the Life Sciences & Sustainability (ACLS), Hiroshima.

[16]Rakhmawati, M. 2012. Pemanfaatan Citra Landsat untuk Estimasi Biomassa Atas Permukaan dari Berbagai Penutupan Lahan dengan Pendekatan Indeks Vegetasi. IPB. Bogor.

[17] Rouse, J. W., Haas, R. H., Schell, J. A., Deering, D., Deering, W. 1973. Monitoring vegetation systems in the Great Plains with ERTS, ERTS Third Symposium, NASA SP-351 I, pp. 309-317.

[18] Sumardi dan Widyastuti. 2007. Dasar-dasar Perlindungan Hutan, UGM Press. Yogyakarta

[19] Suhendang. 2002. Pengantar Ilmu Kehutanan Bogor. Fakultas Kehutanan IPB.

[20] Suwardi A, B. Mukhtar, E. Syamsuardi. 2013: Komposisi Jenis dan Cadangan Karbon di Hutan Tropis Dataran Rendah, Ulu Gadut, Sumatera Barat. Berita Biologi 12(2)-Agustus 2013.

[21] Pregitzer, K., and Euskirchen, E. S. 2004. *Carbon cycling and storage in world forests:biome patterns related to forest age*. Global change biology, *10*(12), 2052-2077.

[22] Yoneda T, Mizunaga H, Nishimura S, Fujii S, Tamin R. 2006. *Stand structure and dynamics of a tropical secondar y forest: a rural forest in West Sumatra, Indonesia*. Tropics 15:189-199

[23] Yoneda T, Nishimura S, Fujii S, Mukhtar E. 2009. *Tree guild composition of a hill dipterocarp forest in West Sumatra, Indonesia*. Tropics 18:143-154.