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Correlation of Above Ground Biomass Carbon Storage and Productivity of Mangrove Species

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Abstract

Kuala Indragiri area is low-lying areas, namely regional stream sediment, peat swamp areas with soil (peat), brackish forest areas (mangrove) and consists of islands large and small with the average height of approximately 0-3 meters above sea level. The research design is the explorative research, by using nested quadrate method. Each station has three line transects consisting three plots of each transect. The total plots are 45 in each determined mangroves land. The methods followed the procedures developed by the Center for International Forestry Research (CIFOR) for mangrove forests. The finding showed the highest carbon storage at above ground biomass was mangrove species *Xylocarpus granatum* (46,58 ton/indv) and the highest productivity was mangrove species *Kandelia candel* (10,793 ton/indv). Correlation (r) between above ground biomass carbon storage and productivity of mangrove species was 0.07 with 37% coefficient of determination. It can be concluded that 37% of above ground biomass carbon storage affected by the productivity of mangrove species.

Keywords: above ground biomass carbon, productivity, Mangrove

Introduction

Kuala Indragiri sub-district were capitalized in the village Sapat is one of 20 districts that are part Indragiri Hilir district. The oldest sub-district consists of eight villages that include: Sapat, Teluk Dalam, Tanjung Melayu, Sungai Pyai, Tanjung Lajau, Perigi Raja, Sungai Bela, and Sungai Buluh. This area has an area of 24 334 hectares of mangrove forest. Indragiri along the river banks there are various types of mangroves. The type of soil is dominated by peat, stream sediment and marsh. This area has a wet tropical climate with somewhat humid air. The highest rainfall occurs in February and the lowest in September. Mangrove forest is a forest that grows in coastal areas, usually located in the area bays and estuaries with trait: not influenced by climate, there is the influence of the tide, sea water flooded soils, low soil beach, do not have a canopy structure, and has a tree species typical. Land in the mangrove forest is dominated by the mud of the order entisols. Land submerged in brackish water and without oxygen the unique root system, like the roots of breath.

Mangrove ecosystem role as a CO_2 absorber and the reservoir turns into a contributor to CO_2 emissions. The condition of participating in the world affecting climate change. The potential for carbon storage in mangrove forest vegetation is very large, therefore the estimated storage mangrove forest carbon stocks can be used as a basic reference in the assessment of the economic benefits of mangrove ecosystem services in the form of commodities C-sequestration. Sustainable management of mangrove forests suitable for carbon sequestration and storage. In addition to protecting coastal areas from erosion, mangrove plants are able to absorb emissions irrespective of sea and air. Absorption of exhaust gas emissions to a maximum because of mangrove root system has the unique structure of breath and coastal vegetation (Patil *et al.*, 2012; Kridiborworn *et al.*, 2012).

Steven *et al* (2013) suggested that the dynamics of carbon in nature can be explained simply dengaan carbon cycle. The carbon cycle is the biogeochemical cycle that includes the exchange or transfer of carbon in the biosphere, pedosphere, geosphere, hydrosphere and atmosphere of the earth. The carbon cycle is really a complex process and every process of mutual influence. The process of accumulation of carbon (C) in the body of living plant called sequestration process (C-sequestration). Furthermore Nwabanne & Igbokwe (2011) states that the measurement of the amount C stored in the body plant life (biomass) in an area can describe the CO_2 in the atmosphere is absorbed by plants. While the measurement of C is still stored in the parts of plants that have died (necromassa) indirectly describe CO_2 not released into the air through combustion. Plant will reduce carbon in the atmosphere through photosynthesis and store it in plant tissue. Until such time tersikluskan carbon back into the atmosphere, the carbon occupies one of a number of pockets or pools of carbon.

Study Area

Indonesia is the largest *archipelago* in the world. It consists of five major islands and about 30 smaller groups. The study area is located in the Mangrove forest of Kuala Indragiri coastal, Indragiri Hilir district area of Riau province (Sumatera island) Indonesia.

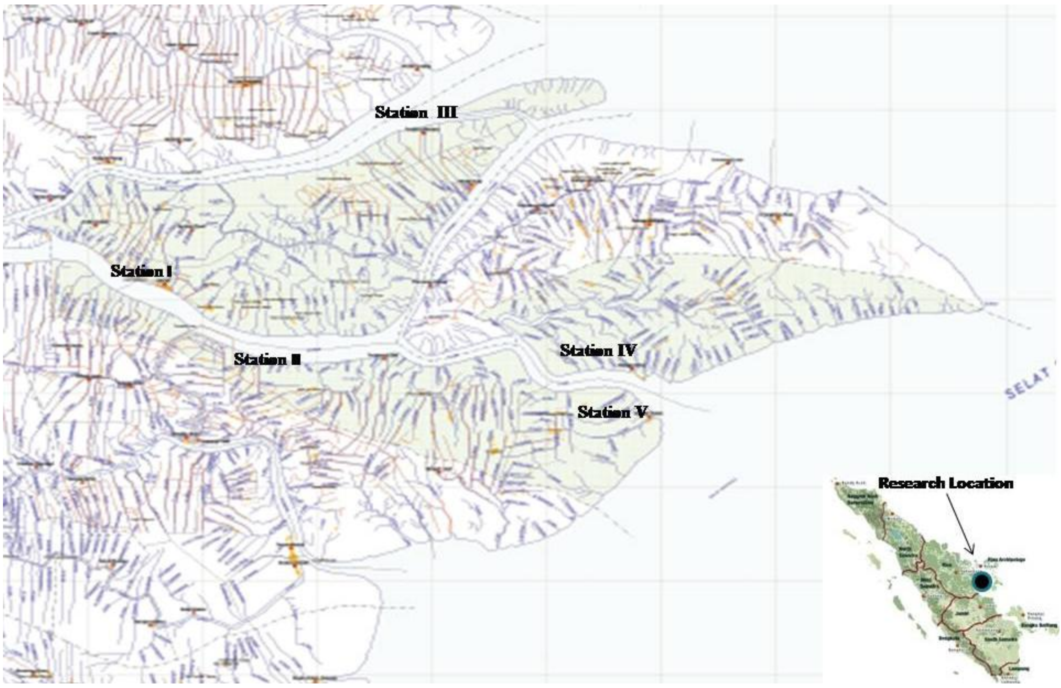

Figure 1: Location of the study site and sampling points in the mangrove forest of Kuala Indragiri coastal

Material and Methods

The design of the research is explorative by using nested quadrat method. There were 5 locations for carbon stocks sampling in Kuala Indragiri coastal, i.e.: Sapat as station 1, Tanjung Lajau as station 2, Tanjung Melayu as station 3, Sei Bela as station 4 and Sei Buluh as station 5. Each station has three line transects consisting three plots of each transect so that total plots are 45 in each determined mangroves land. Research sampling used for the plot was purposive random sampling by considering elevation equal to 100 m from sea level. Sample units were done by stratified sampling. Map of representative study sites were presented on Figure 1.

The field procedure was based on the protocols for measurements of carbon stocks in mangrove forest, to determine the biomass of tree from each plot, the measured parameters were diameter at breast hight (dbh). The values of measured parameters were used in the published allometric equations. The down wood volume was calculated from line intercept data using scaling equations. In each sample of mangrove ecosystem, a transect was laid on vertical from the river or coast shoreline with no prior knowledge of forest composition or structure. The Measurements and the collection of C-Stocks sampling were conducted as described below.

Carbon of Above Ground Biomass

All the trees were stem by diameter at breast height (DBH) greater than 10 cm (tress strata). The DBH (cm) and height (m) were measured, and the species identified within radius 5 m from the sampling of plots. Trees with stem diameters between 5 and 10 cm (belta strata) were measured in radius 5 m subplot, as located in the center of the main plot. To calculate the above-ground tree biomass, we developed a general allometric equation for all species found in the study area (Sitoe *et al.*, 2014: Jones *et al.*, 2014: Steven *et al.*, 2013) Soil carbon stock per sampled interval was calculated using equation:

$$\text{Carbon stock} = \text{Biomass x } \%C_{Organik}$$

Productivity of Mangrove

Productivity measurement is done by using the method of determining chlorophyll because productivity is closely related to the amount of chlorophyll present. Assimilation ratios for plants or ecosystem is the rate of productivity pergram chlorophyll. Chlorophyll measurements performed with a spectrophotometer. Spectrophotometer is a tool that is used to determine a compound both quantitatively and qualitatively by measuring the transmittance or absorbance of a footage as a function of concentration. Arnon method (Campbell *et al.*, 2009), using 85% acetone solvent and a solution of chlorophyll measuring the absorbance value at a wavelength (λ) = 663 and 645 nm. Calculation of chlorophyll content (mg / L) determined by the formula:

$$\mathbf{Ca\ (mg/l) = 12{,}7\ A\ 663 \pm 2{,}69\ A\ 645}$$
$$\mathbf{Cb\ (mg/l) = 22{,}9\ A\ 645 \pm 4{,}68\ A663}$$
$$\mathbf{Ct = Ca + Cb}$$

Correlation of above ground biomass carbon storage and productivity of mangrove species was calculated using Pearson product moment by the formula:

$$r_{XY} = \frac{n\sum XY - \sum X \sum Y}{\sqrt{n\sum X^2 - (\sum X)^2}\sqrt{n\sum Y^2 - (\sum Y)^2}}$$

Results

The source of the carbon (carbon pools) measured through field measurements. Carbon measurement methods in the field by placing the sample plots have been developed (IPCC, 2006: Kridiborworn, et al., 2012: Hairiah, et al: 2011: Lugina, 2011). The estimates data of biomass carbon storage in trees level mangrove vegetation in the area of Kuala Indragiri coastal conducted through nondestructive sampling at five observation stations are listed in Table 1.

Table 1: Above Ground Biomass Carbon Storage

No	Species of Mangrove	Biomass	C-Storage
1	*Sonneratia caseolaris*	11.89	5.59
2	*Bruguiera gymnorhiza*	38.07	17.89
3	*Sonneratia ovata*	57.11	26.84
4	*Bruguiera parviflora*	16.72	7.86
5	*Rhizophora Sp*	22.63	10.64
6	*Kandelia candel*	27.03	12.70
7	*Avicennia alba*	25.67	12.06
8	*Avicennia marina*	7.86	3.69
9	*Sonneratia alba*	72.64	34.14
10	*Xylocarpus granatum*	99.1	46.58

Biomass values listed in Table 1 were the value of the biomass obtained from the conversion; by using diameter at breast height (dbh) were calculated by using allometric equations. From the calculation of biomass on each stem of the tree, the total value of the biomass obtained by summing all the results of the calculation of vegetation biomass all trees at each station. The value of total biomass can be identified from the value of biomass per area. The data obtained from the wide area 10 x 10 m plots were converted into units of acres, so that the value of biomass per area of carbon stock values obtained using the formula value of biomass 47%/area.

Table 2: Productivity of Mangrove in Kuala Indragiri Coastal

No	Mangrove	λ = 645 nm		λ = 663 nm		Klorofil		Σ Chlorophyll
		ABS	K* ABS	ABS	K* ABS	a	b	
1	*S.caseolaris*	0.072	0.721	0.169	1.696	1.955	0.857	2.812
2	*B.gymnorhiza*	0.086	0.861	0.256	2.564	3.022	0.770	3.793
3	*S.ovata*	0.310	3.099	0.408	4.085	4.351	5.179	9.531
4	*B.parviflora*	0.201	2.018	0.325	3.257	3.588	3.090	6.678
5	*Rhizophora Sp*	0.248	2.425	0.423	4.233	4.706	3.690	8.396
6	*K.candel*	0.340	3.398	0.490	4.904	5.309	5.484	10.793
7	*A.alba*	0.290	2.903	0.440	4.405	4.811	4.576	9.387
8	*A.marina*	0.323	3.233	0.440	4.401	4.714	5.339	10.053
9	*S.alba*	0.310	3.104	0.421	4.214	4.512	5.133	9.646
10	*X.granatum*	0.213	2.133	0.292	2.926	3.138	3.510	6.648

According to Kauffman & Donato (2012) the greater the potential of biomass stands caused by the older age of the stand. This is because the diameter of the tree to grow through cell division that takes place continuously and will be slow at a certain age.

The growth occurred in the cambium radial direction and will eventually form new cells that will increase the diameter of the rod. Correlation of above ground biomass carbon storage and productivity of mangrove species included Figure 1.

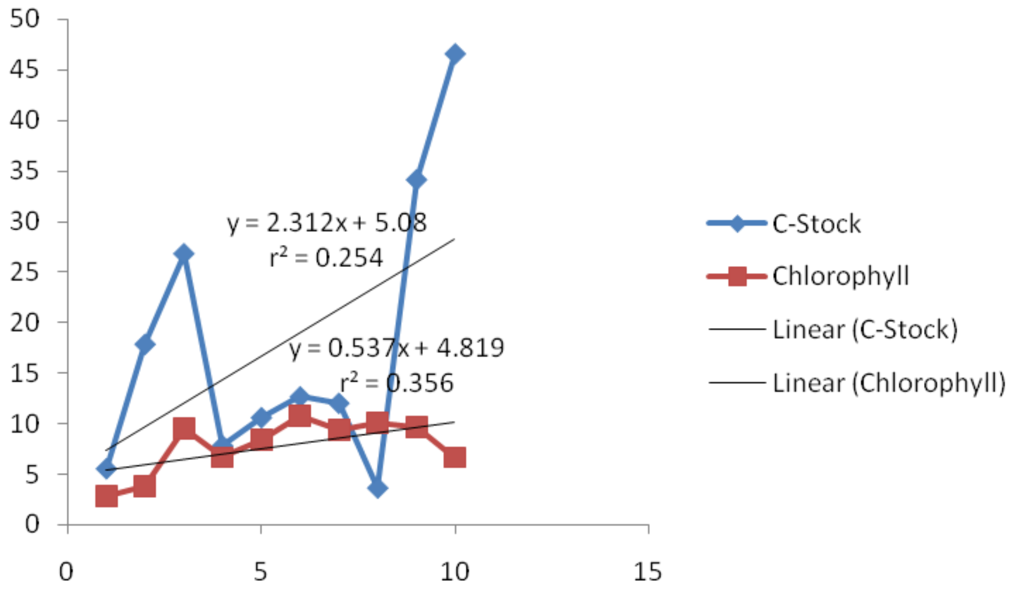

Figure 1: Correlation of Above Ground Biomass Carbon Storage and Productivity of Mangrove Species

Discussion

Plants absorb carbon from the air and convert it into organic compounds through photosynthesis. Results photosynthesis is used for vertical and horizontal growth. The greater the diameter of the tree caused by the storage of biomass results increasing carbon conversion increases with increasing number of carbon that is absorbed by the tree. According to Howard *et al* (2014) is generally mangrove forest with net growth (trees that are in the growth phase) is able to absorb more carbon, whereas mature forests with little growth hold and store carbon stocks but are unable to absorb extra carbon.

Jones *et al* (2014) stated that in the process of photosynthesis, $CO2$ from the atmosphere bound by vegetation and stored in the form of biomass. Carbon stocks are closely related to biomass stand. The amount of biomass is obtained from an area of biomass production and density estimated from measurements of the diameter, height, and density of trees. Biomass and carbon stocks in a mangrove forest outside the forest services other biophysical potential, where the great potential of forest biomass is to absorb and store carbon for the reduction of $CO2$ in the air. The immediate benefits of forest management in the form of timber is only 4.1%, while the optimal functioning of forests in carbon sequestration reached 77.9%.

Conclusion

The highest carbon storage at above ground biomass was mangrove species *Xylocarpus granatum* (46,58 ton/indv) and the highest productivity was mangrove species *Kandelia candel* (10,793 ton/indv). Correlation (r) between above ground biomass carbon storage and productivity of mangrove species was 0.07 with 37% coefficient of determination. It can be concluded that 37% of above ground biomass carbon storage affected by the productivity of mangrove species.

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References

[1] **Patil.V, Singh A, Naik.N, Seema.U, & Sawant**. 2012. "Carbon Sequestration In Mangroves Ecosystems". *Journal of Environmental Research And Development*. 7 (1), pp. 576-583

[2] **Kridiborworn, P., Chdthaisong, A., Yutittham, M & Tripetchkul, S**., 2012, "Carbon Sequestration by Mangrove Forest Planted Specifically for Charcoal Production in Yeesarn, Samut Songkra,". Journal of Sustainable Energy and Enviroment. (3), pp: 87-92

[3] **Steven.B, Alberto V.B, & Edward C. M**. 2013. "Mangrove Production and Carbon Sinks: A Revision of Global Budget Estimates". *Global Biogeochemical Cycles*. (22). GB2013. pp: 01-12

[4] **Nwabanne, J.T. & Igbokwe P.K**. 2011. "Preparation of Activated Carbon from Nipa Palm Nut: Influence of Preparation Conditions". *Research Journal of Chemical Sciences* 1 (6), pp. 53-58

[5] **Sitoe, A.A., Mandlate, L.J.C., & Guedes, B.S**. 2014. "Biomass and Carbon Stock of Sofala Bay Mangrove Forest". Forest (5). pp: 1967-1981

[6] **Jones, T.G., Ratsimba, H.R., Ravaoarinorotsihoarana, L., Cripps, G., & Bey, A.** (2014). "Ecological Variability and Carbon Stock Estimates of Mangrove Ecosystem in Northwestern Madagascar". *Forests*. (5), pp. 177-205

[7] **Steven.B, Alberto V.B, Edward C. M**. 2013. "Mangrove Production and Carbon Sinks: A Revision of Global Budget Estimates". *Global Biogeochemical Cycles*. (22), pp. 01-12

[8] **Hairiah.K, Andree.E, Rika.R, & Surbekti.R**., 2011, "Estimation of Forest Carbon Stock," World Agroforestry Centre: Bogor. Indonesia

[9] **Howard, J., Sarah.H., Isensee.K., Emily.P., & Telszewsk.M**. 2014. *Coastal Blue Carbon. methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrass meadows.* Conservation

International, Intergovernmental Oceanographic Commission of UNESCO, International Union for Conservation of Nature. Arlington, Virginia; USA

[10] **Kauffman, J.B & Donato, D.C**. 2012, "Protocols for the Measurement, Monitoring and Reporting of Structure, Biomass and Carbon Stocks in Mangrove Forests," Working Paper 86; Center for International Forest Research (CIFOR): Bogor, Indonesia.

[11] **Campbell, A., Reece, J.B & Mitchell, L.G**. 2009. *Biology Concepts & Connections*. Pearson: San Fransisco.