Natural Properties of Carbon Stock in Customary Peat Forest at Danau Sentarum National Park, West Kalimantan, Indonesia

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Abstract

Natural properties of Carbon stock in tropical region are barely investigated. We aim at analyzing natural properties of variables that affect Carbon stock in tropical peats. We conducted this research in the Customary Nung Forest at Danau Sentarum National Park, which is an important Ramsar site with seasonal flood plain lakes, unique peat domes, and high biodiversity. A total of 431 peat samples from four transects were collected and analyzed to measure Bulk Density (BD), Total Organic Carbon (TC), and Total Nitrogen (TN). We also calculated Total Carbon Density (TND), Total Nitrogen Density (TND), and C:N ratio. We collected these samples with a Russian type peat auger. Means of these variables according to spatial and vertical distributions are compared by one-way ANOVA. When significantly different, we use Games-Howell multiple comparison approach to determine the difference.

We found the average values of variables affecting peat carbon stock are 0.166 t m^{-3}, 51.03%, 0.79%, 0.084 t m^{-3}, 0.0013 t m^{-3}, 71.06 for BD, TC, TN, TCD, TND, and C:N ratio respectively. Spatially, the mean values of all variables are significantly different among sample plots and transects. Vertically, the distribution of BD, TN, TCD, TND and C:N ratio indicate distinctive patterns. The patterns show significant high values in BD, TCD, TN and TND in top 100 cm depth, and significant low values in C:N ratio in top 100 cm depth. We conclude that an assessment of tropical peat carbon stock is sufficiently based on 200 cm depth, and 8 subsamples with 25 cm increment are statistically representative.

Keywords: *Peat Carbon Stock, Natural Properties, Danau Sentarum National Park*

Introduction

Tropical peats play a significant function as a major storage of carbon stores in the world (Anshari et al., 2010; Page et al 2010, Wetlands International, 2010). It is estimated that about 56% of tropical peats occur in Southeast Asia, and approximately contain 68.5 Giga ton (Gt) Carbon (Page et al., 2010). The largest Carbon stock in tropical peats occurs in Indonesia, and then Malaysia. According to Page et al (2010) and Jaenicke et al (2008) the range of Carbon stock in Indonesia is between 50 and 58 Gt, and Malaysia has approximately 9 Gt C stock. Distribution of Carbon stock in tropical peats in the world is presented in Table 1.

Under undisturbed environment, these Carbon stock are well preserved. When disturbed, Carbon embedded in tropical peat materials will decompose into CO_2 gas, and Dissolved Organic Carbon (DOC). Logging, fires, drainage and conversion of tropical peat forests are important underlying causes of Carbon loss in tropical peats (Couwenberg et al., 2010; Hergoual 'ch et al., 2010; Hooijer et al., 2010; Page et al., 2011; Jauhiainen et al., 2012).
We aim at analyzing natural properties of variables that affect Carbon stock in tropical peats in an un-drained tropical peat dome in Danau Sentarum National Park (DSNP), West Kalimantan Province, Indonesia (See Fig. 1).

No	Region	Area (km^2)	% Global	% Tropical	Average Carbon Stock (Gt)
1	**Southeast Asia**	247,778	**5.80%**	56.20%	**68.5**
2	South America	107,486	2.50%	24.40%	9.7
3	**Africa**	55,860	**1.30%**	12.70%	**6.9**
4	Central America and the Caribbean	23,374	0.50%	5.30%	3.0
5	**Asia (other)**	6,337	**0.10%**	1.40%	**0.4**
6	The Pacific Region	190	0.00%	0.04%	0.01
	Total	**441,025**	10.30%	**100.00%**	88.6

Table 1. Distribution of tropical peats and estimated Carbon Stock

(Source: Zink, 2011; Page et al., 2011)

Materials and Methods

We conducted this research in Nung peat Forest of DSNP, which has been designated as a Ramsar site since 1994. The park lies at approximately latitude 0°35'–1°07'N and longitude 111°50'–122°27' E in the upper Kapuas River basin, and its terrain varies in altitude from 35 to 50 m above sea level (Fig.1).

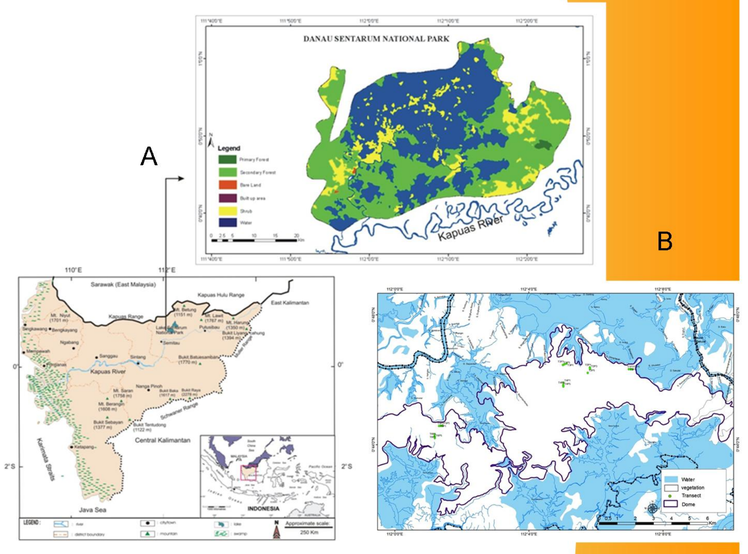

Fig. 1. Maps showing the location of Danau Sentarum National Park (A) and transect lines of sample collection (B)

We collected peat core samples with a Russian type peat auger. A total of 12 sample cores collected from four transect lines. Samples (10 cm long) for Total Carbon (TC) and Total Nitrogen (TN) were cut at 10 cm increment up to 300 cm depth, and at 50 cm increment below 300 cm depth. A total of 431 samples were dried at 40°C for Bulk Density (BD) measurements and combusted at high temperature to measure concentrations of TC and TN. We also calculated Total Carbon Density (TND), Total Nitrogen Density (TND), and C:N ratio. We multiplied TC and TN with BD to estimate TCD and TND. BD is dry mass of peat sample (ton) divided by sample volume (m^3), and both TC and TN are in fraction.

Means of these variables according to spatial and vertical distributions are compared by one-way ANOVA. When significantly different, we use Games-Howell multiple comparison approach to determine the difference. A SPSS version 17 is used to analyze these data.

Results

In this study we found the average values of variables affecting peat carbon stock are 0.166 t m^{-3}, 51.03%, 0.79%, 0.084 t m^{-3}, 0.0013 t m^{-3}, 71.06 for BD, TC, TN, TCD, TND, and C:N ratio respectively. The mean values of all variables are significantly different among sample plots and transects as well, as shown in Fig. 2.

The vertical distribution of peat properties in every 50 cm depth interval is presented in Fig. 3.The figure shows the decreasing pattern of the average values of BD, TN, TCD, and TND from top to 150 or 200 cm depth, then level off. The average values of TC shows an increasing trend from top 50 cm to 200 cm, and then decline until depth 300 cm. Whereas the average values of C:N ratio show an increasing trend from top layer to 200 cm depth

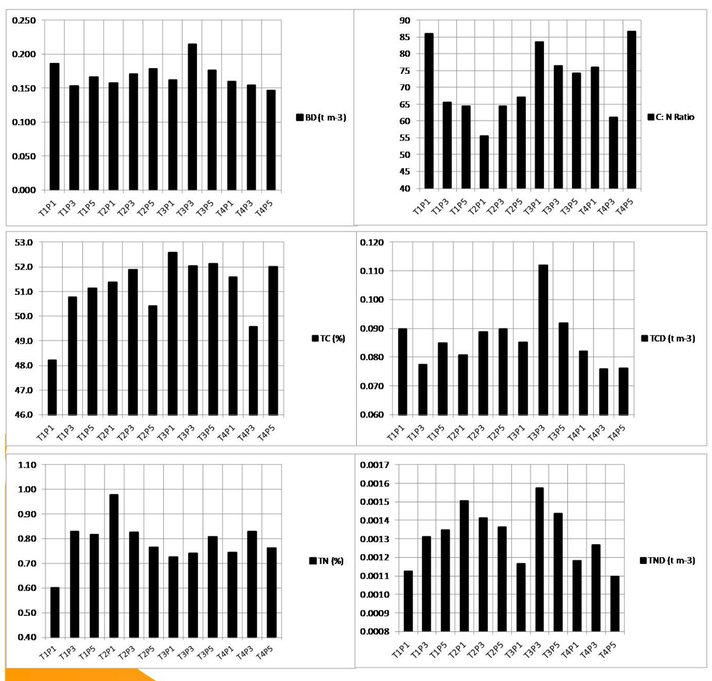

Fig. 2. Spatial distributions of BD, TC, TN , C:N ratio, TCD, and TND in sample plots

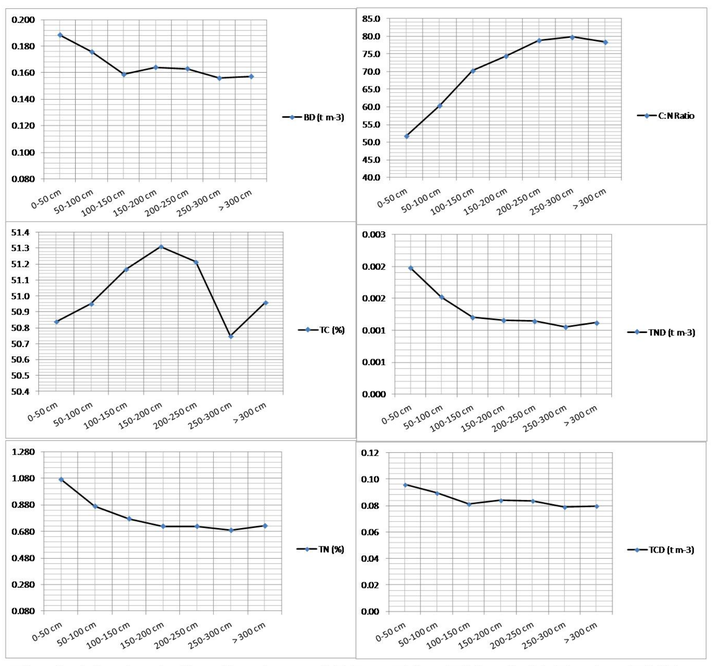

Fig.3. Vertical distribution of BD , TC , TN , C:N Ratio, TND and TCD in Transects in every 50 cm depth layer interval

Discussion and Conclusion

Both spatial and vertical distribution of selected variables affecting peat Carbon pool in Nung Forest shows some variability. In general, spatial variability seems to relate with peat depths, which are determined by the age of peat formation and accumulation. Samples from deep peats seem to be more variable than those samples of shallow peat (i.e. samples from Transect T3).

Vertical distribution of BD, TN, TCD, TND and C:N ratio indicate distinctive patterns. All vertical patterns of these variables show a threshold value at 100 cm depth. In summary, the patterns show significant high values in BD, TCD, TN and TND in top 100 cm depth, and significant low values in C:N ratio in top 100 cm depth. These findings suggest that an assessment of tropical peat carbon should sufficiently look at natural properties of peats up to 200 cm depth. Samples are adequately analyzed at a 25 cm interval, or only have a total of 8 samples from every 200 cm peat core. The top layer, probably up to 100 cm seems to represent properties of the above water table depth (acrotelm), and the bottom layer (between 100 cm and 200 cm depth) represents properties of an-aerobic layer (catotelm).

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