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Carbon Release from Agricultural Cultivated Peats at Sungai Hitam Wetland, Bengkulu Province, Indonesia

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Abstract

This research aimed to determine CO_2 emission related to agricultural activities in peat soils. The research was conducted in peak of drought season, August, 2015 at Sungai Hitam, Bengkulu, Indonesia. In order to get representative sampling sites, field survey was conducted in May, 2015 in the research location. Primary data was collected from rice field, vegetables, bare land, and oil palm involved incubated CO_2 emissions, peat thickness, and level of water tables. The data were analyzed statistically from 10selected samples of the rice fields, 7 selected samples of lowland vegetables fields, 3 selected samples of bare lands, and 8 selected samples of oil palm fields. CO_2 emission values under the land on Sungai Hitam peat were as follow; 237.86, 238.57, 259.35, and 265.35 mg m^{-2} hr^{-1}, respectively. Moreover, carbon releases based on peat thickness; <100, 101 – 150, 151 – 200, 201 – 250, and > 250 cm, respectively were 119.71, 189.35, 229.47, 288.58, and 297.59 mg m^{-2} hr^{-1}. The trend of CO_2 emission (y_1) related to peat thickness (x_1) fit with a following equation; $y_1 = 3.996x_1^{0.778}$; $R^2 = 0.953$. Level of carbon emission affected by water tables; <100, 101 – 150, 151 – 200, and >200 cm, respectively was 192.80, 245.54, 292.21, and 309.97 mg m^{-2} hr^{-1}. CO_2 emission rate (y_2) related to lowering water tables (x_2) conformed to a following formula; $y_2 = 23.96x_2^{0.48}$; $R^2 = 0.949$. Peat ecosystems sequestering carbon have undegone for thousands of years. Therefore, cultivated peat for sustainable agriculture development should consider in managing peat thickness and water table.

Keywords: agricultural cultivated peatlands; peat thickness; water table; CO_2 emission

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1. Introduction

Indonesian peatlands lie on geographic areas which are characteristically prone to environmental impacts (Barchia, 2006; Sabiham, 2010). During a dry season, and the El-Nino effect, prolonged drought period initiates fire on peatlands, causing a hazard to animal environment and human. Indonesia peatlands plays an important role on ecosystem sustainability (Wösten et al., 2008). Today, the peatlands are an increasingly significant land resource for livelihood and economic development. While acting as a carbon sink under the natural forest, it turns into a carbon source of greenhouse gas once the peat forest is cleared and drained (Agus et al., 2010).

Indonesian peatlands, one of important natural resources, maintain hydrological systems and other ecological functions for human life and the whole biodiversity. In utilizing peatlands to support agricultural development, the peat should be cultivated under considerable management based on planning, suitable technologies, and perfect land management (Sowondo, et al. 2010). By following considerable management steps, agricultural cultivated peatlands provide high productive sustainable agriculture and food productions (Barchia, 2006; Kyuma, et al. 1992). Information about marginally peat characteristics and fragile ecosystems should be collected for accurate planning, perfect design in peat cultivation and conservation efforts (Agus and Subiksa, 2008).

Indonesia peatlands become the fourth following Russia, Canada, and US in term of area of peatlands. Based on the size of an area, the Indonesia peats cover 27,06 millions Ha, consisting of peat soil and peaty soil ***(***Indonesia Soil Research Center, 1981***)*****.** Ismunadji and Soepardi (1982) reported that in Sumatera Island, the peatlands may be 11 m in thickness. Driessen and Soepraptohardjo (1974) stated that peatlands with thickness of 15 m were commonly found along eastern Sumatera areas. In Sumatera and Kalimantan peatlands with thickness of 0 **–** 100, 100 **–** 200, and > 200 cm will be at the proportion of 36**.**2**%**, 14,0**%** and 49**.**8**%**, respectively **(**Radjagukguk, 1991**).**These peatlands are ideal source for potential agricultural cultivation**.** However, to develop peatlands for use in agriculture, careful consideration should be directed to productivity of the selected area, thicker of the peat, economical viability, and impact to environment, particularly the possibility of releasing CO_2 gas to the atmosphere **(**WWF, 2008**).**

Carbon transformation rates are quite related to peat thickness in which the thick peat would transform more carbon comparing to moderate and thin peat. Carbon releases from peatlands occur not only because of abiotic factors but also because of anthropogenic modified resultants (Melling et al. 2013). Various human activities working on peatlands affect natural peat ecosystems which disturb ecosystems with vary effect of carbon transformation (Hooijer et al., 2010). In western Sumatera, peatlands have been changed to agricultural cultivated area. However, there is little information with respect to peat destabilization and carbon transformation. In Indonesia, C-emission as a result of peat utilization have been given little attention compared with the application and utilization of peat for commercial purpose (Sabiham, 2010). Therefore, C-emission as a result of peat destabilization for use in agriculture in Western Sumatera was studied with respect to carbon emission rate from agriculture cultivation, peat thickness, and water table management.

2. Materials and Methods

The research was conducted in the Sungai Hitam agricultural cultivated peatlands, Bengkulu, Sumatera, Indonesia. The peatland covered about 2,500 ha. The research was conducted in peak of El-Nino effect in August 2015. In order to get representative sampling sites, field survey was conducted in May, 2015 in rice fields, lowland vegetables fields, bare land, and oil palm cultivated areas. Primary data collected from the land involved incubated emission gas, peat thickness, and level of water table in the agricultural cultivated areas. Carbon emission was analyzed at Soil Science Laboratory, Faculty of Agriculture, University of Bengkulu. The gas emitted through the peat surface was trapped by closed chambers made of transparent mica (Aini et al., 2007). Rate of carbon emission characteristic from incubated peat in the field trapped by KOH 0.2 N solution, then the carbon emission in the form of CO_2 measured through titration method. Chemical solution indicator used for analisys of the CO_2 emission was metyl orange of phenolphatalein, and then titrated by solution of HCl 0.1 N (Widyastuti and Anas, 2013). In oder to find equation formulas between CO_2 emissions and peat thickness, and between the CO2 emissions and water tables, samples of CO_2emissions, peat thickness, and level of water tables were analyzed statistically from 10 selected samples of the