Technologies of Mechanical Engineering Industry

Edited by
Shishir Kumar Sahu

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Preface

2013 2nd International Conference on Advances in Mechanics Engineering (ICAME 2013) was held in Jakarta, Indonesia during July 13-14, 2013. The conference provides a platform to discuss Advances in Mechanics Engineering etc. with participants from all over the world, both from academia and from industry. Its success is reflected in the papers received, with participants coming from several countries, allowing a real multinational multicultural exchange of experiences and ideas.

The present volumes collect accepted papers and represent an interesting output of this conference. This book covers these topics: Acoustics and Noise Control, Aerodynamics, Applied Mechanics, Automation, Mechatronics and Robotics, Automobiles, Automotive Engineering, Ballistics, Biomechanics, Biomedical Engineering, CAD/CAM/CIM, CFD, Composite and Smart Materials, Compressible Flows, Computational Mechanics, Computational Techniques, Dynamics and Vibration, Energy Engineering and Management, Engineering Materials, Fatigue and Fracture, Fluid Dynamics, Fluid Mechanics and Machinery, Fracture, Fuels and Combustion, General mechanics, Geomechanics, Health and Safety, Heat and Mass Transfer, HVAC, Instrumentation and Control, Internal Combustion Engines, Machinery and Machine Design, Manufacturing and Production Processes, Marine System Design, Material Engineering, Material Science and Processing, Mechanical Design, Mechanical Power Engineering, Mechatronics, MEMS and Nano Technology
Multibody Dynamics, Nanomaterial Engineering, New and Renewable Energy, Noise and Vibration, Noise Control, Non-destructive Evaluation, Nonlinear Dynamics, Oil and Gas Exploration, Operations Management, PC guided design and manufacture
Plasticity Mechanics, Pollution and Environmental Engineering, Precision mechanics, Mechatronics, Production Technology, Quality assurance and environment protection, Resistance and Propulsion, Robotic Automation and Control, Solid Mechanics, Structural Dynamics, System Dynamics and Simulation, Textile and Leather Technology, Transport Phenomena, Tribology, Turbulence and Vibrations.

This conference can only succeed as a team effort, so the editors want to thank the international scientific committee and the reviewers for their excellent work in reviewing the papers as well as their invaluable input and advice.

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Table of Contents

Chapter 3: Mechanical Design Technology and Modern Design Technologies

Chapter 4: Heat Engineering and Emission Control in Automotive Industry

Chapter 5: Electrical Engineering and Electric Machines

Chapter 6: Power System and Energy Engineering

Chapter 7: Electronics and Integrated Circuits, Embedded Technology and Applications

Chapter 8: Manufacturing and Industrial Engineering, Management Applications

Chapter 9: Modern Control and Automation

Chapter 10: Monitoring, Detection, Measurement Technologies

Chapter 11: Communication Systems and Engineering

Chapter 12: Signal Processing and Data Mining

Chapter 13: Information Technologies and Networks

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Controlling CO_2 and CH_4 Emission in a Degraded Peat Swamp Forest Related to Water Table and Peat Characteristics

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Keywords: CO_2 and CH_4 emission, water table, peat characteristics

Abstract. This study focuses on factors controlling CO_2 and CH_4 emission in a peat swamp forest related to water table and peat characteristics such as peat depth, C-organic, pH, ash content and N-total. This study was conducted in the dry season at a Merang peat swamp forest that has degraded due to logging activities, forest fires and canal opening. Emission of CO_2 and CH_4 was measured by using a closed chamber made by PVC material (60 cm x 60 cm x 40 cm). This close chamber was completed with a fan inside the chamber to stir the gas, a thermometer inside the chamber to measure the gas temperature and a syringe to sample gas. This study has shown that the highest CO_2 emission is at an average of 438.93 mg/m^2/hr occurring in land cover type (1) ferns and grasses (open burned area) and the lowest is at average of 44.45 mg/m^2/hr in the *gelam* and *belidang*-dominated land. The emission of CH_4 is very low between 0.0018 to 0.0069 mg/m^2/hr. the main controlling factor on CO_2 and CH_4 emission is concluded to be the water table. The emission of CO_2 will be greater if water table, pH and C-organic increase.

Introduction

Peatlands are a natural carbon reservoir and cover 3% of the surface area of the earth [1]. Globally, peatlands store approximately 329-525 Giga tonnes (Gt) of carbon, and approximately 86% (455Gt) of them are stored in temperate regions (Canada and Russia), while approximately 14% (70 Gt) is found in the tropics [2]. The peatlands in Indonesia are mainly spread in Papua (7.6 million acres), Sumatra (6.9 million acres), Kalimantan (5.8 million acres) and the rest of approximately 2.2 million acres [3]. The peatlands in the South-Sumatra region reach 1.4 million acres, however the area is gradually decreasing [4]. They cannot be separated from the movement of the world economy with their uses such as industrial timber plantations, agriculture, forestry, conservation, and plantations. However, their management is not easy because they contain complex physical, chemical and hydrological peat issues. The peatlands have long time been considered as carbon sink ecosystem. Related to climate change, they may become carbon source ecosystem with potential to lose carbon either as trace gas carbon dioxide (CO_2) and methane (CH_4) and fluvial dissolved organic carbon [5].

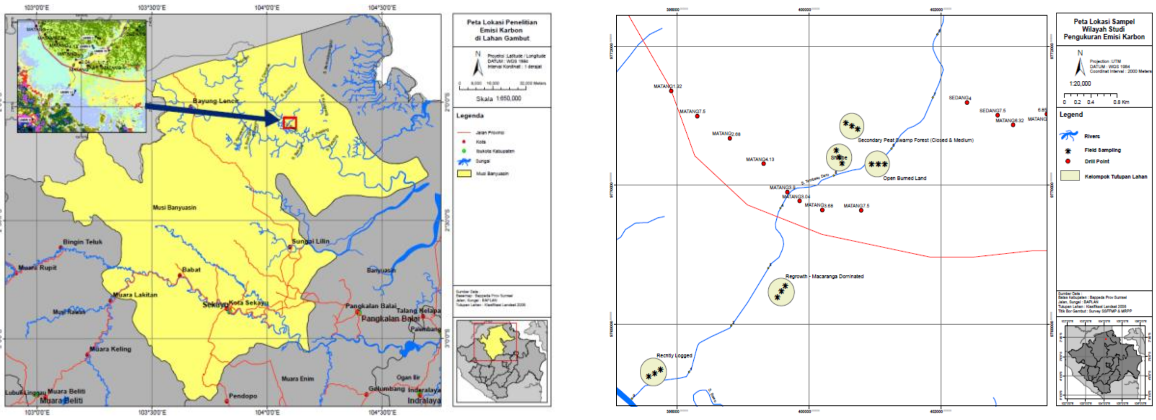
Carbon is one of the peatland elements that undergo recycling in an ecosystem. The carbon cycle is the movement of carbon from the air to the ground and back again into the air. The cycle begins when CO_2 in the atmosphere is absorbed by plants and then converted into carbohydrates through photosynthesis. The photosynthetic reaction will occur if there is sunlight and chlorophyll. Carbohydrates are a source of formation of other organic compounds in plants such as protein and lignin. If the leaves fall or crops die, there will be a process of decomposition and mineralization of soil carbon; they will return to the air in the form of CO_2 gas. Decomposition and mineralization is an overview of enzymatic oxidation and reduction reaction. [6]

Greenhouse gas emissions from the peatland consist of CO_2, CH_4, and N_2O. However, CO_2 emissions are much higher than others and CO_2 emissions are strong enough to represent emissions from the peatland, when measuring gas such as CH_4 and N_2O is difficult [7]. According to [8] - [9], CO_2 and CH_4 emission in peatlands are caused by decomposition of carbon compounds under aerobic and anaerobic condition. The condition of geography, subtract availability and vegetation significantly affect carbon emission [10]. In the exploitation of peatlands, it is usually accompanied by the opening of a canal or drainage, and the drainage in the peat causes changes in the nature of biotic and abiotic degradation and impact on peat degradation [11]. A study shows that the peat soil degradation increases with an increase in ph and ash content [12]. Water table is an important factor in the management of peatlands, a deeper water table will increase carbon emission[13]- [14]- [15]. This study was conducted on the peat swamp forest that has degraded due to logging activities, forest fires and canal opening; it focuses on factors controlling CO_2 and CH_4 emission in the Merang peat swamp forest related to water table and peat characteristics such as peat depth, C-organic, pH, ash content and N-total of peat soil.

Material and Method

Study Site

The study was conducted at the Merang peat swamp forest in South-Sumatra (refer with Fig.1a). The majority of these peatlands have been damaged by illegal logging activities, canal opening, and forest fires. This study site had previously been identified the level of damage. The peat swamp forest can generally be grouped into three classification: primarily degraded peat swamp forests, secondary peat swamp forests and the peat swamp forest degraded with land cover < 10 % [16]. However, in this study, the classification of the land cover developed more specifically by adapting to the current conditions in the field as follows 1. land dominated by ferns and grasses (open burned area); 2. land dominated by *mahang*; 3. land dominated by *gelam* and *belidang*; 4. land wih medium canopy. This classification is in the same line with the conditions of land cover classification by Project MRPP based on its reports [17]. At this location there was a canal located in the middle of the peatland with a depth of approximately 2 meters with an average width of 2.5 meters. This canal was built by illegal loggers for passing their timber from the Merang peat swamp forest . Observation points or sampling points in this study followed the direction of the canal towards the Merang peat swamp forests (refer with Fig. 1b).



(a) (b)

Figure 1.a. Location of Merang peat swamp forest, b. Location of sampling points

Measurement of CO_2 and CH_4 Emission

CO_2 and CH_4 emission have been measured by using a closed chamber method. This method was used for measuring the magnitude of emissions from peat soil [18]- [19]- [20]- [21]-[22-[23]. This study followed the path of the canal. The starting point of each study site was set at 100 meters from the side of the canal. Furthermore, observation points were set at intervals of 200 meters. At each study site, three observation points were established. The close chamber was a size of 60 x 60 x 40 cm. The close chamber was equipped by a fan and a thermometer. When gas emission was measured, the close chamber was placed in the ground and inserted about 3 cm in the soil to prevent a gas leakage. The gas concentration in the chamber was monitored at any given time. The time intervals for measuring the emissions of CO_2 and CH_4 were a three-minutes period for every 24 minutes [24]. Gaseous emissions were taken from the close chamber by using special tools such as the 10 ml syringe. Furthermore, the gas was analyzed using gas chromatography (GC). Increased concentration of the gas was used to calculate the rate of gas emissions from the soil surface.

Measurement of Water table and Peat Soil Characteristic

Water table measurements were performed using a piezometer to measure the depth of ground water in each of the study area. Peat depth was also measured at each site of study using a drill of peat and drilling was done until it reached the mineral soil layer. Along with the drilling, peat samples were taken at various depths to analyze the characteristics of the peat soil. Each of 500 gram soil samples from the peat drilling was taken and stored in the plastic bags. Furthermore these soil samples were taken to the laboratory for analysis. The analysis in the laboratory was aimed to find out the characteristics of peat soil such as C-organic, N-total, pH and ash content. For measuring C-organic, the Walkey and Black method was used, the pH by using pH H_2O, N-total using the Kjeldhal method and ash content by the loss igniation method.

Result and Discussion

Emission of CO_2 and CH_4.

The study results show that the magnitude of emissions of CO_2 and CH_4 at some land cover types and the result of peat analysis (refer with table 1). The highest emission of CO_2 occurred at land cover type 1 or land dominated by fern and grasses as much as 486.39 mg/m^2/hr with water table 1.65 m, peat depth 4.8 m, C-organic 45 %, pH 4.22, ash content 33.12 and N-total 0.49 %. The lowest emission occurred at the lower type 3 or land dominated by *gelam* and *belidang* as much as 44.45 mg/m^2/hr with water table 0.6 m, peath depth 0.08 m, C-organic 8.42 %, pH 3.2, ash content 60.56 and N-total 0.31 %. However the pattern of CH_4 emission could not be seen clearly. It was obtained that the smaller the water table the greater CH_4 emission was and the magnitude of CH_4 emission was very low, that is, between 0.0018 to 0.0069 mg/m^2/hr.

Table 1. Peat Emission and Characteristic

Land cover	CH_4 emission,mg/m^2/hr	CO_2 emission,mg/m^2/hr	Peat Depth,m	Water Tab.m	C-Org (%)	pH	Ash Cont.	N tot (%)
4	0.0069	117.89	4.3	1.10	30	3.1	15.58	0.7
4	0.0069	116.69	4.25	1.10	30	3.2	0.95	0.97
4	0.0069	119.94	4.6	1.10	32	3.25	13.33	0.67
4	0.0062	181.86	4.45	1.20	35	3.32	17.13	0.77
4	0.0055	228.76	4.35	1.30	36	3.3	12.69	0.76
4	0.0054	226.7	4.5	1.30	35	3.23	15.83	0.75
3	0.0018	44.94	0.1	0.60	8.16	3	57.78	0.35
3	0.0019	44.45	0.08	0.60	8.42	3.2	60.56	0.31
3	0.0031	45.43	0.1	0.60	8.11	3.15	55	0.32
2	0.0068	134.34	2	1.10	33	3.35	46.55	0.4
2	0.0068	128.93	1.99	1.10	32.4	3.3	34.18	0.38
2	0.0065	136.79	1.99	1.15	33	3.2	59.22	0.4
1	0.0034	474.91	4.8	1.60	42.14	4.1	23.84	0.53
1	0.0033	486.39	4.8	1.65	45	4.22	33.12	0.49
1	0.0032	355.49	4.5	1.45	37	4	26	0.49

An overview of the **average** CO_2 emissions for 4 types of land cover can be seen in Figure 2: the highest emissions occurred in land cover type (1) and the lowest in cover type (3).

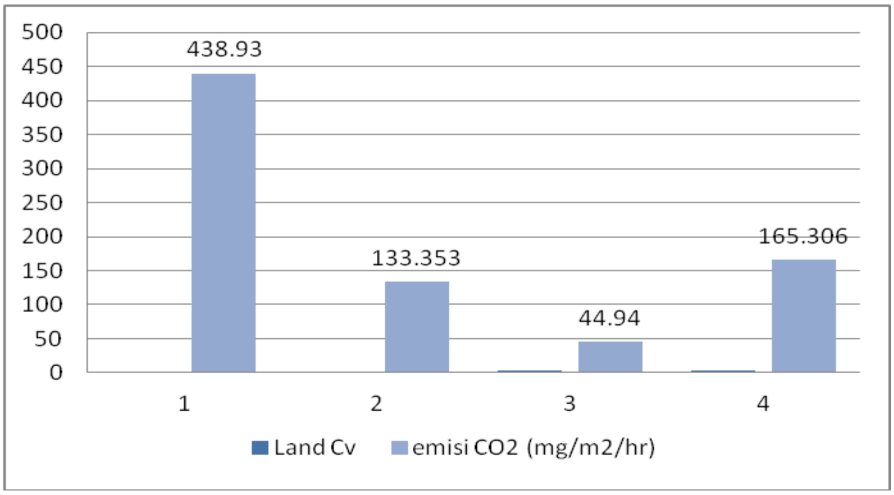


Figure 2. Emission of CO_2 under different land cover

Water Table and Peat Characteristics

The greater the water table, the greater CO_2 emissions increased (refer with table 1); this similarly applied to the C-Organic and pH. Based on statistical analysis, the relationship between CO_2 emissions with water table, C-organic and pH was significant but distance from the channel, ash content and total nitrogen content were. The overall results of the analysis show that at the Merang peat swamp forest the % C organic content was betwen 8-37%, pH 3.15 - 4.22, ash content 0.95 - 60.5, N total 0.31 - 0.97 %, peat depth between 0.08 - 4.8 m and the water table between 0.6 - 1.65 m. Finally, that most important factor in controlling CO_2 emissions was the water table, followed by C-organic and pH.

Summary

In brief, the water table was found to be a very important controlling factor; it was followed by pH and C-organic content. The water table could be controlled and the exploitation of peats was fruitful if the drainage or canal was not opened excessively. The opening of the canal accelerated the oxidation of the carbon stored in the peatlands.

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