Extended abstract No. 82

A SMALL SCALE FIELD EXPERIMENT OF PEAT BURNING ON A TROPICAL PEATLAND LOCATED IN CENTRAL KALIMANTAN, INDOSESIA

Hamada, Y. (corresponding author)
Faculty of Environmental Earth Science, Hokkaido University, N10W5 Kita-ku, Sapporo, 060-0810 Japan; TEL: +81-11-706-3356; E-mail: yham@ees.hokudai.ac.jp

Darung U. (CIMTROP, University of Palangka Raya, Indonesia)
Limin S.H. (CIMTROP, University of Palangka Raya, Indonesia)
Hatano R. (Research Faculty of Agriculture, Hokkaido University, Japan)

SUMMARY

Gaseous emission from burning peatland in Indonesia was observed. A 3-m by 4-m plot was prepared and burned for a week. When the peat began to burn after aboveground firewood was burned out, soil temperature largely increased up to 350–450°C. Concentrations of gaseous components generally became maximum just after ignition, and then gradually decreased. The mean burn depth was 7.5±6.2cm inside the plot. Based on the bulk density of 0.22 g/cm^3 in the topsoil and the assumed carbon content of 55.5%, the amount of carbon emitted from the plot was 110.2 kg.

KEY WORDS: Tropical peatland, forest fire, greenhouse gas emission, carbon monoxide, particulate matter

INTRODUCTION

Not only in tropical peat swamp but also in all types of forest, fire (including slash-and-burn agriculture) is the most radical form of emission of carbon stored in the ecosystem. There have been several studies in which emission of gaseous components was observed during a field scale forest fire that was ignited and controlled for experimental purpose (*e.g.* Carvalho *et al.*, 2001; Christian *et al.*, 2007). However, few studies reported such kind of experiment conducted in tropical peatland. In this study a small scale field experiment of peat burning was conducted on a tropical peatland.

MATERIAL AND METHODS

The study site is located near Palangka Raya (2°S 114°E), Central Kalimantan, Indonesia (Fig. 1). Half of world tropical peatland is distributed in Indonesia (Wetlands International, 2010), where large areas have been drained to farmland farmland to support the population increase and economic growth in Indonesia. Severely dried peat is easily ignited but difficult to extinguish. Incomplete burning of peat generates much smoke causing dense haze which has recently become a serious health and social problem in this area, especially in El Niño and Southern Oscillation (ENSO) years (Hirano *et al.*, 2007).

Fig. 1. Location of the plot of peat burning experiment.

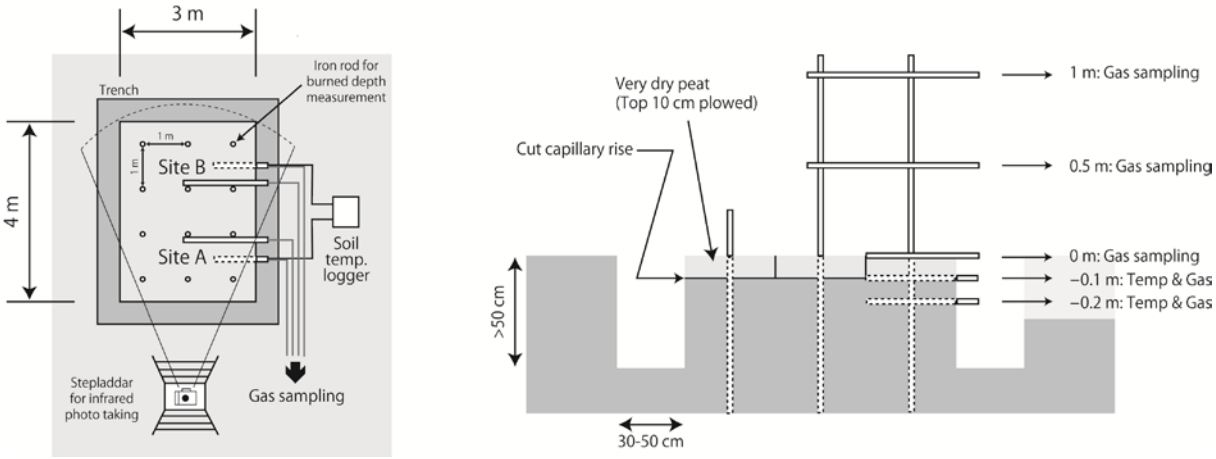

Fig. 2. Field settings of the peat burning experiment. Left: general ground plan; right: side view.

The field setting of the peat burning experiment is shown in Fig. 2. A 3-m by 4-m plot was prepared and isolated from the surrounding area by trenches to prevent the fire from spreading. Inside the plot, aboveground vegetation was removed and the top 0.1-m soil was ploughed. The plot was then exposed to the sun for a week to make sure the peat was dry. In case of rain and at night, the plot was covered by a plastic sheet.

Concentrations of gaseous components were observed at heights of 1.0, 0.5, 0.0 (aboveground), −0.1 and −0.2 m (belowground) at two sites in the plot (A and B). Gas samples were extracted at a rate of 1 L/min by an electric peristaltic pump (MP-2N, Shibata Scientific Technology, Soka, Japan) through stainless steel and/or aluminum pipes which were placed inside the plot and connected to vinyl tubes. Concentration of CO_2 and CO were measured in situ with a portable indoor air quality monitor (Model 2211, Kanomax Japan, Osaka, Japan), while that of CH_4 was measured by gas chromatography (GC-8A and GC-14B, Shimadzu, Kyoto, Japan) equipped with a frame ionization detector. Particulate matter (PM) content was determined with a portable digital dust monitor (Model 3442, Kanomax Japan, Osaka, Japan).

Soil temperature at −0.1 and −0.2 m was recorded every 10 minutes using K-type thermocouples which were heat- and water-proofed and installed laterally from the surrounding trench and were connected to a thermocouple data logger (OctTemp, Madge Tech, NH, USA). Distribution of ground surface temperature was also recorded as digital images with an infrared camera (Thermo Shot F30, NEC Avio, Tokyo, Japan), from the top of a step ladder placed at the outer edge of the plot. Twelve iron rods were installed at an interval of 1 m each other (3 x 4) and marked at the position of the original ground surface to measure the depth of peat loss after burning.

The experiment was started on 16 September 2011, almost the end of dry season in Central Kalimantan. The sampling and measurement during the experiment were repeated eight times in total.

RESULTS AND DISCUSSION

After ignition, firewood stacked on the plot was rapidly burnt away within one hour. After that the flaming stage of peat burning ceased within 2–3 hours. The smoldering stage of peat burning then continued for a week in spite of several periods of rainfall. The mean burnt depth during the experiment was 7.5 cm with standard deviation of 6.2 cm. Based on the bulk

density of 0.22 g/cm^3 in the surface peat in the plot and the assumed carbon content of 55.5%, the amount of carbon emitted from the plot was calculated to be110.2 kg.

Temporal change in soil temperature during the experiment is plotted in Fig. 3. The time for sampling and measurement is also shown as black bars. During the burning of the firewood placed on the ground , soil temperature at −0.1 m increased initially but decreased again. After the peat itself began to burn, the temperature largely increased and reached 350–450°C. The response of soil temperature at −0.2 m was less prominent relative to that at −0.1 m; it became maximal and exceeded 50–100°C. After 19 September the temperature at −0.1 m showed almost similar pattern to that in ambient air, because the tips of the thermocouple were completely exposed above the ground.

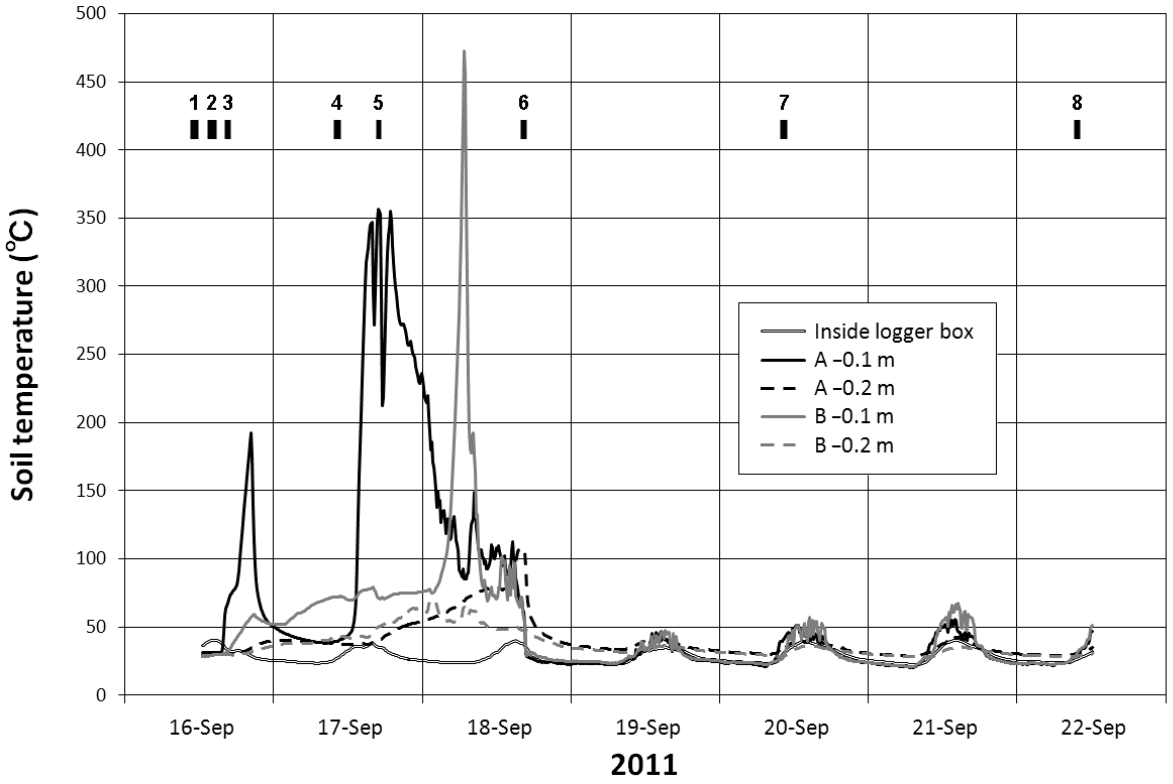

Fig. 3. Temporal change in soil temperature at heights of −0.1 and −0.2 m with temperature inside logger box during the peat burning experiment. The time for sampling and measurement is also shown as black bars (1 to 8).

Profiles of the concentration of CO_2, CO, CH_4 and PM were plotted in Fig. 4. Data plotted outside of the graph means out of measurable range. All horizontal axes are in log-scale. Just before the experiment began (1; see Fig. 3), CO_2 concentration decreased with height especially from the ground surface to −0.2 m. CO level was less than the detection limit, and CH_4 and PM contents were also very low. In most cases, concentrations of these gaseous

components became maximum just after ignition (2); in Side A, PM content exceeded the measurable limit at all heights. During the smoldering phase (3–7), the concentrations gradually decreased. CO concentrations at and under the original ground surface remained high which was over the range of detection of the instrument. The influence of burning on CO_2, CH_4 and PM concentrations was prominent at −0.1 m; those at −0.2 m were not affected so much. After the peat burning was almost extinguished (8), the levels of these components returned to similar values before the experiment. In the case of CO_2, however, the concentration at −0.1 m became the same level as that in the atmosphere because the peat soil was burnt away more than 0.1 m.

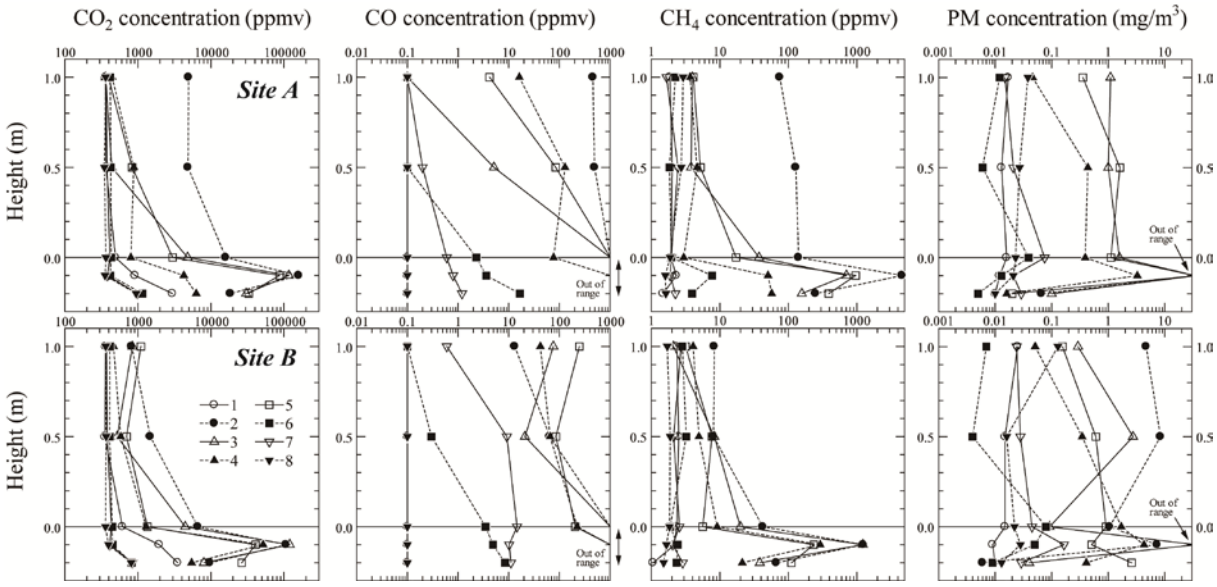

Fig. 4. Profiles of gaseous components observed during the peat burning experiment. From left to right: carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4) and particulate matter (PM), respectively. All horizontal axes are in log-scale.

ACKNOWLEDGEMENTS

The experimental plot was located in Kalampangan Zone, which was established and managed by the Centre for International Cooperation in Sustainable Management of Tropical Peatland (CIMTROP), University of Palangka Raya. All the field work was conducted in collaboration with staff members in CIMTROP. This study was financially supported by JST/JICA Science and Technology Research Partnership for Sustainable Development (SATREPS) Project “Wild fire and carbon management in peat-forest in Indonesia.”

REFERENCES

Carvalho Jr., J.A., Costa, F.S., Gurgel Veras, C.A., Sandberg, D.V., Alvarada, E.C., Gielow, R., Serra Jr., A.M. and Santos, J.C. (2001). Biomass fire consumption and carbon release rates of rainforest clearing experiments conducted in Northern Mato Grosso, Brazil. *Journal of Geophysical Research—Atmosphere*, **106** (D16), 17877–17887, 10.1029/2000JD900791.

Christian, T.J., Yokelson, R.J., Carvalho Jr., J.A., Griffith, D.W.T., Alvarado, E.C., Santos, J.C., Soares Neto, T.G., Gurgel Veras, C.A. and Hao, W.M. (2007). The tropical forest and fire emissions experiment: Trace gases emitted by smoldering logs and dung from deforestation and pasture fires in Brazil. *Journal of Geophysical Research—Atmosphere*, **112** (D18), D18308, 10.1029/2006JD008147.

Hirano, T., Segah, H., Harada, T., Limin, S., June, T., Hirata, R. and Osaki, M. (2007). Carbon dioxide balance of a tropical peat swamp forest in Kalimantan, Indonesia. *Global Change Biology*, **13**, 412–425, 10.1111/j.1365-2486.2006.01301.x.

Wetlands International (2010). *The Global Peatland CO_2 Picture: Peatland status and drainage related emissions in all countries of the world*. 33 pp.