Geophysical Research Abstracts
Vol. 12, EGU2010-1777, 2010
EGU General Assembly 2010

Peat surface GHG fluxes related to peat hydrology in various tropical peat land uses

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It is generally accepted that the gradual increase in the mean temperature of the Earth's surface is primarily due to rising concentrations of greenhouse gases (GHG), especially carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) in the atmosphere. Tropical peatlands are an important component of the global peatland resource, contributing to terrestrial carbon storage in both their above-ground biomass (peat swamp forest) and underlying thick deposits of peat, which both participate soil-atmosphere carbon exchange processes. In their natural state, these forests have the ability to sequester carbon from the atmosphere during photosynthesis, retain this in plant biomass and store part of it in the peat. This process occurs mainly because of the frequent waterlogged condition of the peat, which reduces organic matter decomposition significantly and this causes the rate of organic matter production to exceed its breakdown. Peatland development, however, requires drainage, brings about changes in the vegetation type C-sequestration capacity and leads to changes in peat organic matter dynamics. Drainage promotes the depth of oxic conditions deeper in peat profile and thus speeds up peat stored organic matter mineralization. Aerobic conditions and high redox potentials created by drainage are known to favour microbial activity, which can enhance C and N losses by peat mineralization. Large areas of tropical peat have been drained, resulting in an abrupt and permanent shift in the ecosystem carbon balance from sink to source.
Discussion of the current role of tropical peatlands in regional and global climate change processes is based mostly on circumstantial and secondary evidence, largely because total ecosystem carbon balance studies are very few and unsatisfactory. Peat surface GHG flux data are spatially very fragmented and have not usually been collected over entire diurnal or seasonal cycles. Interpretation of the impact of biophysical factors of tropical peat on tropical peat carbon dynamics is very difficult because of variations in environmental conditions (especially peat hydrology), peat and vegetation that are not collected systematically or reported adequately in studies.

In this paper we (i.) compare the most important greenhouse gases, i.e. CO2, CH4, and N2O, related to peatland hydrology in typical land use types and peat drainage intensities, and (ii.) assess gaps existing in currently available GHG data collected from tropical peat in South-East Asia. Presented information is derived from our established GHG flux monitoring programs and reviewed values from literature. Land use types in GHG comparisons include selectively logged non-drained and drainage affected peat swamp forests, plantations, agricultural peat, and mismanaged abandoned peatlands. The results are discussed on basis of GHG dynamics controlling factors in various tropical peat land uses.