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The impact of land-use change from forest to oil palm on soil greenhouse gas and volatile organic compound fluxes in Malaysian Borneo

Julia Drewer (1), Melissa Leduning (2), Deirdre Kerdraon-Byrne (3), Emma Sayer (3), Justin Sentien (2), and Ute Skiba (1)

(1) NERC CEH, Biogeochemistry, Penicuik, United Kingdom (juew@ceh.ac.uk), (2) Faculty of Science and Natural Resources, Universiti Malaysia Sabah, Jalan UMS, 84400, Kota Kinabalu, Malaysia, (3) Lancaster Environment Centre, Lancaster University, Lancaster, LA1 4YQ, UK

Monocultures of oil palm have expanded in SE Asia, and more recently also in Africa and South America, frequently replacing tropical forests. The limited data available clearly show that this conversion is associated with a potentially large greenhouse gas (GHG) burden. The physical process of land-use change, such is felling, drainage and ploughing can significantly increase emissions of N_2O and soil CO_2 respiration and decrease CH_4 oxidation rates in the short term; and in the long-term regular nitrogen applications will impact in particular soil N_2O fluxes. Little is known about volatile organic compound (VOC) fluxes from soil and litter in tropical forests and their speciation or about the links between GHG and VOC fluxes. VOC emissions are important as they directly and indirectly influence the concentrations and lifetimes of air pollutants and GHGs. For example, oxidation of VOCs generate tropospheric ozone which is also a potent GHG. Within ecosystems, monoterpenes can mediate plant-microbe and plant- interactions and protect photosynthesis during abiotic stress. However, little is known about monoterpene composition in the tropics - a widely recognized major global source of terpenoids to the atmosphere. These knowledge gaps make it difficult for developing countries in the tropics, especially SE Asia, to develop effective mitigation strategies.

Current understanding of soil GHG fluxes associated with land-use change from forest to oil palm is not sufficient to provide reliable estimates of their carbon footprints and sustainability or advice on GHG mitigation strategies. To provide the necessary data we have installed a total of 56 flux chambers in logged forests, forest fragments and mature and young oil palm plantations as well as riparian zones within the SAFE landscape in SE Sabah (Stability of Altered Forest Ecosystems; http://www.safeproject.net). Soil respiration rates, N_2O, CH_4 and VOC fluxes together with soil moisture, pH, mineral and total C and N were measured over a two year period. Additionally the effects of changes in forest litter diversity on soil properties were investigated using mesocosms. For this experiment leaf litter was transplanted into different forest types and oil palm plantations of different stand ages to simulate the change in litter-fall caused by changes in above ground plant composition. Laboratory incubations using soil and litter from the field sites provide additional detailed data on soil properties, carbon storage capacity and microbial activity to identify potential mechanisms for the field observations.