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A method for measuring losses of soil carbon by heterotrophic respiration from peat soils under oil palms

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The effects of drainage and deforestation of South East Asian peat swamp forests for the development of oil palm plantations has received considerable attention in both mainstream media and academia, and is the source of significant discussion and debate. However, data on the long-term carbon losses from these peat soils as a result of this land use change is still limited and the methods with which to collect this data are still developing. Here we present the ongoing evolution and implementation of a method for separating autotrophic and heterotrophic respiration by sampling carbon dioxide emissions at increasing distance from palm trees. We present the limitations of the method, modelling approaches and results from our studies. In 2011 we trialled this method in Sumatra, Indonesia and collected rate measurements over a six day period in three ages of oil palm. In the four year oil palm site there were thirteen collars that had no roots present and from these the peat based carbon losses were recorded to be 0.44 g CO_2 m2 hr-1 [0.34; 0.57] (equivalent to 39 t CO_2 ha-1 yr-1 [30; 50]) with a mean water table depth of 0.40 m, or 63% of the measured total respiration across the plot. In the two older palm sites of six and seven years, only one collar out of 100 had no roots present, and thus a linear random effects model was developed to calculate heterotrophic emissions for different distances from the palm tree. This model suggested that heterotrophic respiration was between 37 - 59% of total respiration in the six year old plantation and 39 - 56% in the seven year old plantation. We applied this method in 2014 to a seven year old plantation, in Sarawak, Malaysia, modifying the method to include the heterotrophic contribution from beneath frond piles and weed covered areas. These results indicated peat based carbon losses to be 0.42 g CO_2 m2 hr-1 [0.27;0.59] (equivalent to 37 t CO_2 ha-1 yr-1 [24; 52]) at an average water table depth of 0.35 m, 47% of the measured total respiration of the plot. We conclude that, despite a few limitations, it is possible to use a linear modelling approach to partition heterotrophic respiration from the total respiration in oil palm plantations.