Nutrient acquisition strategies and fine root dynamics determine differences in soil carbon between intact and disturbed tropical peat swamp forests

Raczka, Nanette C, Nanyang Technological University, nanettechristine.r@ntu.edu.sg
Quezada Rivera, Juan Carlos, Nanyang Technological University, quezadarivera@gmail.com
Collins, Colton, Nanyang Technological University, COLTONLA001@e.ntu.edu.sg
Sukri, Rahayu Sukmaria Haji, Universiti Brunei Darussalam, rahayu.sukri@ubd.edu.bn
Cobb, Alex R, Singapore-MIT Alliance for Research and Technology, alex.cobb@smart.mit.edu
Slade, Eleanor M, Nanyang Technological University, eleanor.slade@ntu.edu.sg
Wardle, David A, Umeå University, david.wardle@umu.se
Andersen, Kelly M, Nanyang Technological University, kelly.andersen@ntu.edu.sg

Background/Question/Methods
Southeast Asian tropical peat swamp forests are highly distinct habitats, holding large numbers of endemic species and carbon stores. However, much of these intact peat swamp forests have been logged or drained, leading to the drying out of peat that has resulted in an increase in fire events. A critical first step to identifying restoration strategies is to quantify the degree to which disruptions in tree nutrient acquisition strategies due to degradation drive shifts in carbon dynamics. In Brunei Darussalam, the peat swamp forests hold a key tree species, *Shorea* albida, which dominates the waterlogged forests, growing up to 70 m high and forming extensive root mats above the peat. A gap in our understanding is how these unique trees acquire nutrients in intact peat swamp forests, and how these functions belowground may change with degradation. To unlock the hidden half of these forests, we examined how nutrients and carbon are cycled belowground along a degradation gradient experiment ranging from disturbed peat swamp forest to interior pristine forest. We also quantified fine root biomass, ectomycorrhizal colonization, and root necromass to a depth of 1.5 meters. We hypothesized that pristine forests would contain lower fine roots than the disturbed forest but would have a stronger rhizosphere investment, as well as, greater mycorrhizal colonization rates for nutrient acquisition. In contrast, disturbed peat swamp forest would contain greater fine roots along with a greater reliance on bulk soil microbes to acquire nutrients due to a lowered water table allowing for an increase in decomposition to occur in the peat.

Results/Conclusions
In line with our hypotheses, we found that while intact peat swamp forests store a lower amount of carbon in fine roots, at depth more carbon is stored in dead roots that resist decomposition in waterlogged conditions. Opposingly, at the disturbed forest sites, the trees store more carbon in fine roots at the surface but have lower amounts of carbon stored at depth in dead roots, potentially driven by a decrease in water in the peat. Additionally, we found differences in root investment in mycorrhizae and rhizosphere extracellular enzymes, in which the intact forest had greater ectomycorrhizal colonization than the disturbed forest, with the types of nutrient-acquiring enzymes varying by forest type. These differences are important in understanding how intact peat swamp forest trees grow and implications for how these forests will store carbon belowground with human degradation.