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Deforestation for oil palm alters the fundamental balance of the soil N cycle

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Expansion of commercial agriculture in equatorial regions has significant implications for regional nitrogen (N) budgets, particularly nitrous oxide (N_2O) and nitric oxide (NO) emissions, produced largely by microbial nitrification and denitrification. However, current estimates of soil N turnover are poorly constrained in Southeast Asia for nitrogen gas (N_2) production and lesser known N transformations such as nitrate ammonification (DNRA) and anaerobic ammonium oxidation (anammox).

We investigated changes in N availability and turnover following replacement of tropical forest with oil palm plantations along a chronosequence of oil palm maturity (3-months to 15-year-old stands) and secondary to primary forest succession in Sabah, Malaysian Borneo. Samples were taken from ten sites during March and April 2012. Using ^{15}N tracing techniques, we measured rates of gross ammonium (NH_4^+) and nitrate (NO_3^-) production (mineralisation and nitrification) and consumption (n= 8), potential denitrification, DNRA and anammox (n= 12) in soil cores and slurries respectively.

Gross mineralisation rates (0.05 – 3.08 g N m^{-2} d^{-1}) remained unchanged in oil palm relative to forests. However, a significant reduction in gross nitrification (0.04 – 2.31 g N m^{-2} d^{-1}) and an increase in NH_4^+ immobilisation disrupt the pathway to N_2 production substantially reducing (by $>$ 90%) rates of denitrification and anammox in recently planted oil palm relative to primary forest. In forests, N_2 produced via anammox was $\sim$30% of that from denitrification highlighting the potential for anammox to contribute significantly to N_2 production. NH_4^+ production rates from DNRA were over two orders of magnitude less than N_2 production rates indicating that denitrification is the primary dissimilatory nitrate consumption process in these soils. Potential N_2O emissions were greater than potential N_2 production, remaining unchanged across the chronosequence and indicating an increased N_2O:N_2 emission ratio when soils were first disturbed. These results are an important precursor to studies providing improved estimates of regional N turnover and loss in Southeast Asia which will have global implications for N biogeochemical cycling.