Abstract

Expansion of commercial agriculture in equatorial regions has significant implications for regional nitrogen (N) budgets. Here we investigate changes in N availability and turnover in Southeast Asia following the 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. Ten sites were sampled during March and April 2012 and rates of gross ammonium ($\text{NH}_4^+$) and nitrate ($\text{NO}_3^-$) production (mineralisation and nitrification) and consumption ($n = 8$), potential denitrification and “anaerobic ammonium oxidation” (“anammox”) ($n = 12$) were determined using $^{15}$N isotope additions to soil cores and slurries respectively. Gross mineralisation rates ($0.05–3.08 \text{ g N m}^{-2} \text{ d}^{-1}$) remained unchanged in oil palm relative to forests. However, a significant reduction in gross nitrification ($0.04–2.31 \text{ g N m}^{-2} \text{ d}^{-1}$) and an increase in $\text{NH}_4^+$ immobilisation disrupt the pathway to nitrogen gas ($\text{N}_2$) production substantially reducing (by > 90%) rates of denitrification and “anammox” in recently planted oil palm relative to primary forest. Potential nitrous oxide ($\text{N}_2\text{O}$) emissions were greater than potential $\text{N}_2$ production and remained unchanged across the chronosequence indicating a potentially increased ratio of $\text{N}_2\text{O}:\text{N}_2$ emission when soils were first disturbed. These results are an important precursor to studies that could yield improved estimates of regional N turnover and loss in Southeast Asia which will have global implications for N biogeochemical cycling.