CRC 990
Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems Sumatra, Indonesia

A05

Trace gas fluxes, soil N cycling, and nutrient leaching in heavily-weathered soils under rainforest transformation systems

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Background

Tropical soils are globally important sources/sinks of the climate-relevant trace gases: nitric oxide (NO), nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2). These trace gases all have in common that they are produced and consumed in soils through microbially-mediated processes, which strongly depend on soil chemical and physical characteristics. Transformations of rainforests in regions like Sumatra have profound effects on soil chemical, physical and biological characteristics which, in turn, strongly influence nutrient cycling and losses (i.e. trace gas fluxes and leaching).

Objectives:

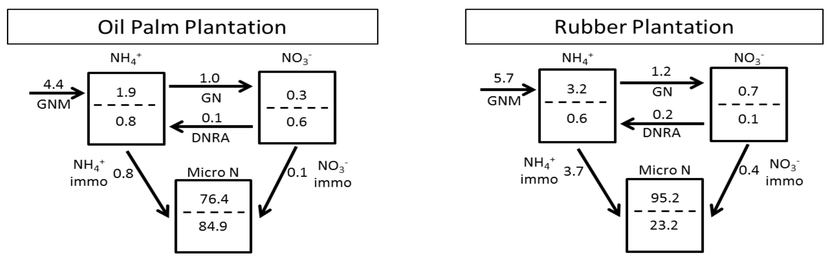
Assess the impacts of rainforest transformation to jungle rubber, rubber plantation, and oil palm plantation on:

1) soil chemical and physical properties
2) soil nitrogen (N)-cycling rates
3) soil-atmosphere exchange of trace gases
4) leaching losses

Soil chemical and physical characteristics (Kara Allen & Syahrul Kurniawan)

- Soil sampling down to 2-m depth (e.g. Fig. 1) at 32 core sites for quantification of chemical and physical characteristics, employing space-for-time substitution.

Status : Soil sampling is in progress and will be finished in December 2013.



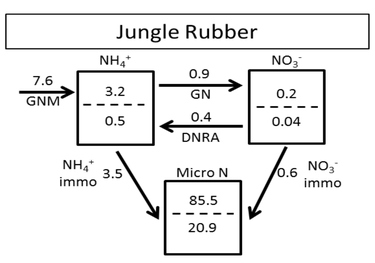


Fig. 2. *Gross rates of soil N cycling (mg N kg^{-1} d^{-1}; on arrows), N pools (mg N kg^{-1}; upper numbers in boxes) and mean residence time (day; lower numbers in boxes). GNM – gross N mineralization, GN – gross nitrification, DNRA – dissimilatory NO_3^- reduction to NH_4^+, immo – immobilization by microbial biomass, Micro N – microbial biomass N.*

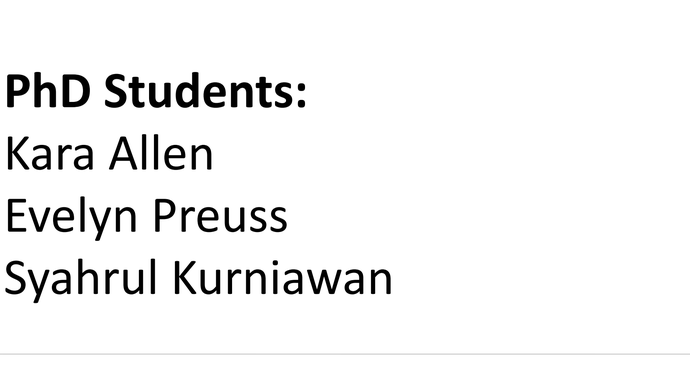


Fig. 1*. Soil profile down to 2-m depth in (1) jungle rubber and (2) forest.*

Soil N-cycling rates (Kara Allen)

- Quantify gross rates of microbially-mediated soil N cycling (Fig. 2) at 32 core sites, using ^{15}N pool dilution techniques.

Status: Sampling is finished on all plots. Laboratory analyses are on-going.

Soil-atmosphere exchange of trace gases (Evelyn Preuss)

- Whole-year measurements of NO, N_2O, CH_4 and CO_2 fluxes (Fig. 3) and soil factors known to control soil-atmosphere trace gas exchange at 32 core sites. In oil palm plantations, we are also conducting in-situ incubations of organic debris gathered on leaf axils in order to detect aboveground sources of N_2O, CH_4 and CO_2.

Status: Whole-year measurements of trace gas fluxes and in-situ incubations of organic debris on oil palm leaf axils will be finished in December 2013.

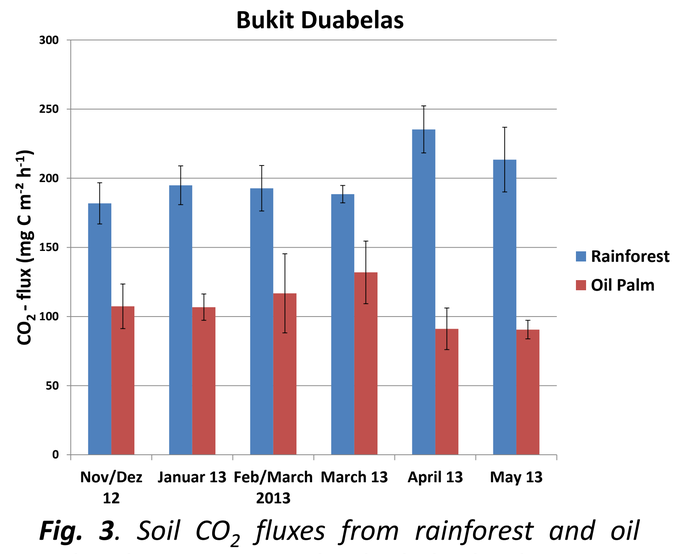


Fig. 3*. Soil CO_2 fluxes from rainforest and oil palm plantations in Bukit duabelas landscape.*

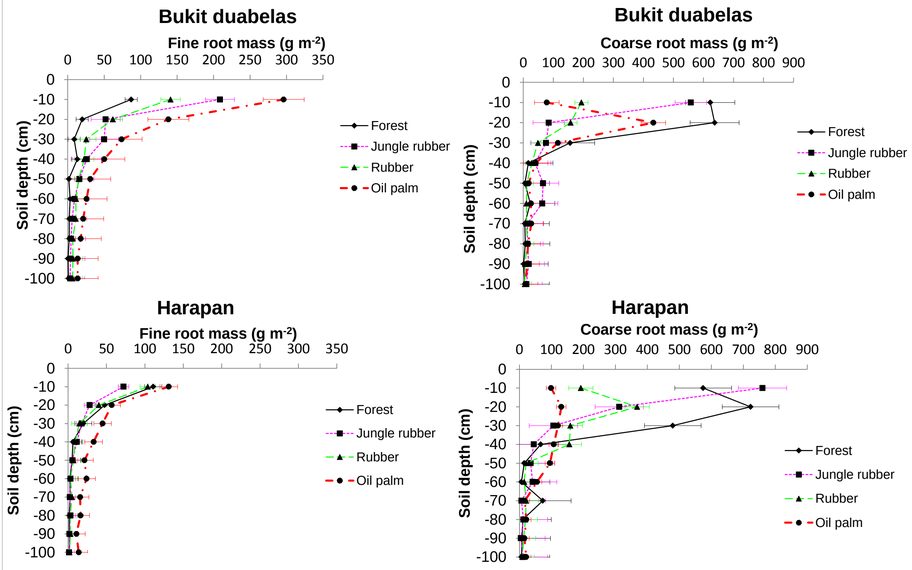


Fig. 5*. Root mass down to 1-m depth in Bukit duabelas and Harapan landscapes as supporting data for Expert-N water model.*

Leaching losses (Syahrul Kurniawan)

- Whole-year measurements of leaching losses (DOC, DON, NH_4^+, NO_3^-, K, Na, Ca, Mg, total Al, total Fe, total Mn, total S, total P, total Si, Cl^{-1}, HCO_3^- (Fig. 4)) at 32 core sites, using suction cup lysimeters installed at 1.5-m depth. Drainage flux will be calculated using a water model, parameterized with site conditions (Fig. 5).

Status: Whole-year sampling of leaching losses will be finished in December 2013.

Fig. 4. *Bicarbonate (HCO_3^-) concentration in leachate at 1.5-m depth.*