B04 - Carbon sequestration, litter C input to the soil, and resource use-efficiency in lowland rainforest transformation systems on Sumatra (Indonesia)

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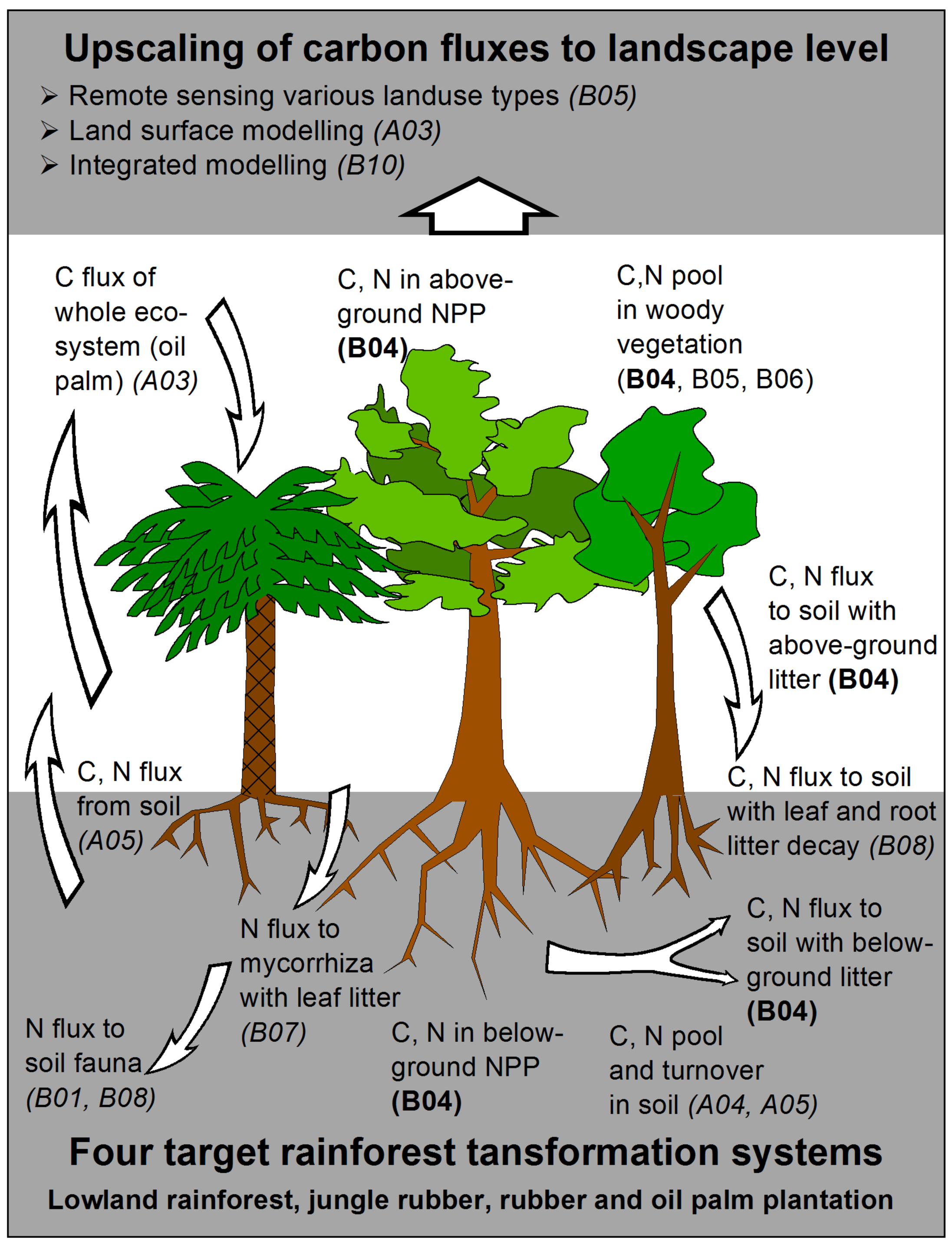
Research Aims

Assessing consequences of large-scale lowland rainforest conversion into jungle rubber, rubber monocultures, and oil palm plantations on:

- Carbon stocks in standing above- and belowground biomass
- Carbon sequestration via net primary production
- Resource use efficiency (nutrients, water)

Methodology

- Inventory of aboveground woody biomass and carbon stocks
- Annual above-ground primary production
  - Leaf litterfall and C and N transfer to the soil
  - Stem diameter growth
- Belowground productivity and C and N transfer to the soil
  - Sequential soil coring approach
  - Ingrowth core approach



Results

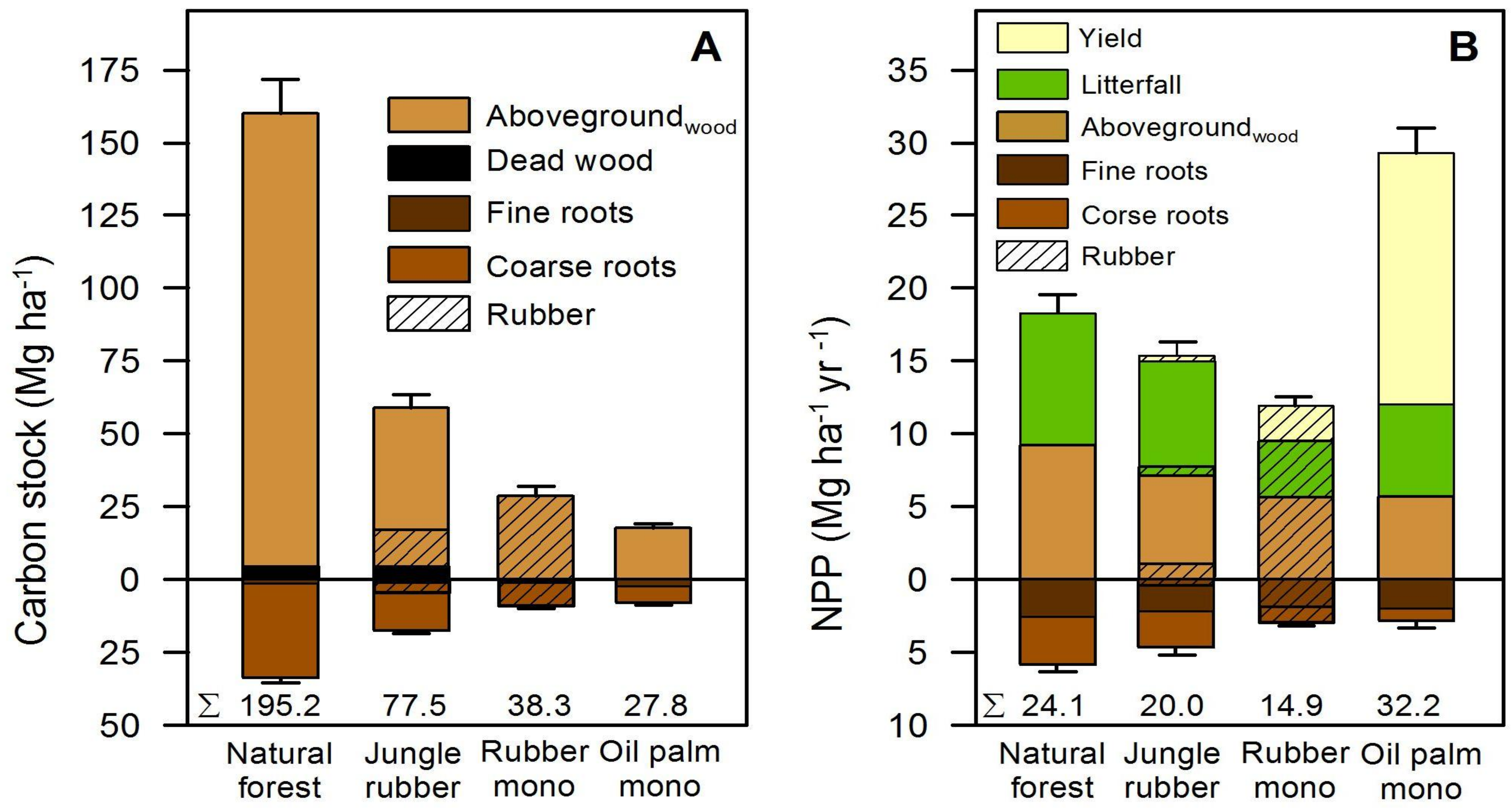


Fig. A: Above- and belowground carbon stock (Mg ha^{-1}) and **Fig. B:** Net primary production (Mg ha^{-1} yr^{-1}) of the four land-use systems in Jambi, Sumatra. Shown are means ± SE (n = 8).

Total live tree biomass in the natural forest stands was more than two times higher than in jungle rubber stands and more than four times higher than in monoculture rubber and oil palm plantations. Total NPP decreased from the natural forest with increasing land-use intensity towards the rubber plantation system, but was highest in the oil palm system due to the very high fruit production. We conclude that conversion of natural lowland forest into different agricultural systems leads to a strong reduction not only in the biomass carbon pool (up to 166 Mg C ha^{-1}) but also in the C sequestration via long-term biomass accumulation which was highest in the natural forest.

Table: 1 Stand-level water use efficiency (WUE, unit NPP per unit water used) and nutrient use efficiency (NUE, unit NPP in leaf litter fall per unit nutrient returned via litterfall). Water consumption data delivered by A02. Given are means ± SE (n = 8).

Resource use efficiency [a](g kg^{-1}), [b](kg kg^{-1})	**Natural forest**	**Jungle rubber**	**Rubber mono**	**Oil palm mono**
Canopy cover (%)	*92.1*	*87.6*	*85.8*	*76.8*
WUE[a]	2.48 ± 0.29 *ab*	2.28 ± 0.29 *b*	2.35 ± 0.22 *b*	3.13 ± 0.27 *a*
NUE-N[b]	80.2 ± 2.8 *b*	92.1 ± 5.6 *b*	80.4 ± 2.8 *b*	34.1 ± 6.9 *a*
NUE-P[b]	3563 ± 428 *b*	3899 ± 333 *b*	3105 ± 325 *b*	457 ± 103 *a*
NUE-K[b]	551.5 ± 51.4 *b*	549.4 ± 52.1 *b*	531.1 ± 58.3 *b*	10.0 ± 48.9 *a*
NUE-Ca[b]	199.5 ± 25.5 *c*	141.4 ± 19.4 *c*	103.7 ± 10.5 *b*	74.3 ± 15.3 *a*

Water-use efficiency was very similar across the natural forest and the two rubber land-use systems, while the oil palm plantations had a significantly higher WUE. Vice versa, oil palm plots had markedly lower nutrient-use efficiency (on a canopy level) regarding the usage of elements N, P, K, and Ca.

Under current land-use and climate change in tropical lowlands we expect further increases in seasonality of net primary production in the landscape as well as potentially increasing drought stress and decreasing nutrient cycling in these originally highly productive regions.

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