Carbon, water and energy balance of Rubber ecosystem

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Rubber ecosystem
A major tree crop in Thailand > 2.7 M ha in 2007, world > 10 M ha. 80 % of the area in the Southern region

Land use change: the North-Eastern rush (drier area). Already 300,000 ha in the E and NE, but plans are for 1 M ha to be planted.

Mainly smallholders (< 3ha per holder)
Monoclonal plots with one major clone, RRIM 600

Planting density 500 to 600 t/ha
Main product is latex, but wood is important too
Life-cycle shortened from 30 to 20 years

Impact of rubber plantations on environment and particularly on water balance?

The project
Rubber Flux aims at providing a complete picture of CO₂, water and energy budget of a rubber plantation in Eastern Thailand. The experiment is situated at the Chachoengsao Rubber Research Station, about 140 km east of Bangkok. The observation site is in a 6 ha plot at the center of the 350 ha station.

The site
The plot is a monoclonal stand (clone RRIM 600). Trees were 14 years old in 2008. The average height was 20.5 m and average girth at 1.7 m was 62 cm.
Initial planting density was 500 trees/ha and actual stand density was 430 trees/ha in June 2008. Trees are tapped for latex production for 7 years.
### Tree water status, sapflow & soil water balance

**Partitionning of total water flux between soil and understorey evaporation (E) and stand transpiration (T)**

- Sapflow measured by heat dissipation method (Granier 1985). 20 mm long homemade probes (calibrated by gravimetry).
- Trees sampled according to distribution of trunk within the plot to calculate stand transpiration.
- On a tree scale, daily time-course of leaf water potential measured across the canopy together with climatic data and soil moisture content to understand regulation of water use by the tree.
- Petiole sensitivity to embolism studied, as the possible limiting factor for hydraulic conductance in rubber tree (Sangsing 2004).

### Leaf and canopy photosynthesis, measurement & modelling

**Estimation of parameters of Farquhar’s model of leaf photosynthetic capacity**

- Maximal carboxylation rate \( V_{c_{\text{max}}} \) and maximal electron transport rate \( J_{\text{max}} \) were estimated by fitting \( CO_2 \) response curve of net photosynthesis \( A/C_i \) curve.

Next: Integration at canopy scale comparing several models to describe canopy structure and light interception.

### CO2 and water fluxes

**Flux measurements by eddy covariance**

- \( CO_2 \) and water fluxes are measured by eddy covariance (ED).
- ED methodology adapted from experience in other tropical tree crop plantations, (coconut tree in Vanuatu, eucalypt in Congo).

- The flux tower is 25 m high.
- Sonic anemometer Young 81000V 20 Hz, open path gas analyser LI-7500. Data-logging and pre-processing by the "Tourbillon" software (INRA, France). Post-processing by EdiRe software (U. of Edinburgh, UK).

**Weather station**

- Rn, Rg, PAR, diffuse PAR, reflected PAR, Air T\(^\circ\), Rh, wind speed, wind direction, rainfall, vertical profile of air temperature (TCs).

**Energy balance** is assessed by measurements of net radiation (Rn) and estimation of the energy partitioning among heat fluxes and heat storage.

### Net primary productivity

**How much carbon in trees biomass and in soil?**

- Dynamics of above-ground biomass assessed by tape measurements of trunk diameter, tree height and allometric relationships.

- Litter traps used to assess both litter accumulation and, together with fish-eye pictures, LAI.

- Root biomass, fine root production, mortality and turn-over assessed by combination of root observation window, ingrowth cores and sequential coring.
Stand transpiration
Dry season Feb 2007
Leaf fall occurs in January, only some leaf remain. Re-foliation is initiated without delay and completed within two weeks


Temperature response of maximum CO₂ assimilation rate (Amax) in rubber leaf.
The full range of possible temperature in Asia areas suitable for rubber cultivation is covered.

CO₂ flux May-Sep 2007, corrected, no gap filling.

CO₂ daily flux May-Sept 2007, corrected, no gap filling

Conclusion:
Beyond the evaluation of the fluxes, our design provides information on the partition among the components and functions of rubber plantation ecosystem. Thereby, the validated CO₂ and H₂O fluxes will be used to model gas exchanges of one of the most important tree-crop ecosystem in tropical Asia, according to climate and other environmental parameters as well as crop management.

Developments:
- Continuous measurements of soil respiration with a multichamber system, modelling, upscaling.

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