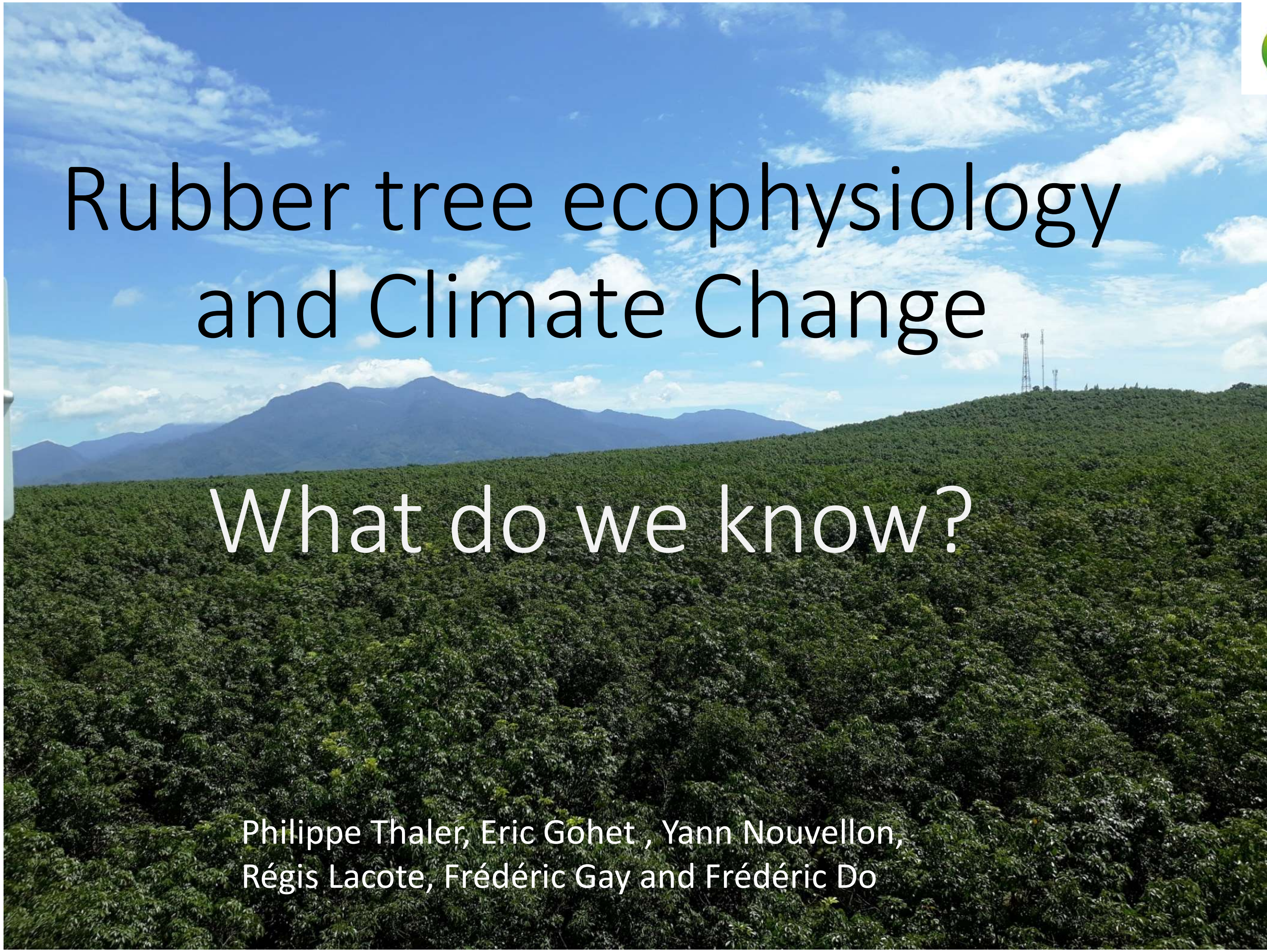


Rubber tree ecophysiology and Climate Change

What do we know?

Philippe Thaler, Eric Gohet , Yann Nouvellon,
Régis Lacote, Frédéric Gay and Frédéric Do

Rubber ecophysiology and future climate

- What will the climate be in the main rubber producing areas? Y/N

- What will be the effects of higher T° on C assimilation? N
- What will be the effects of higher T° on tree growth? N
- What will be the effects of higher T° on latex production? N
- Adaptation of rubber trees to water stress? Y/N

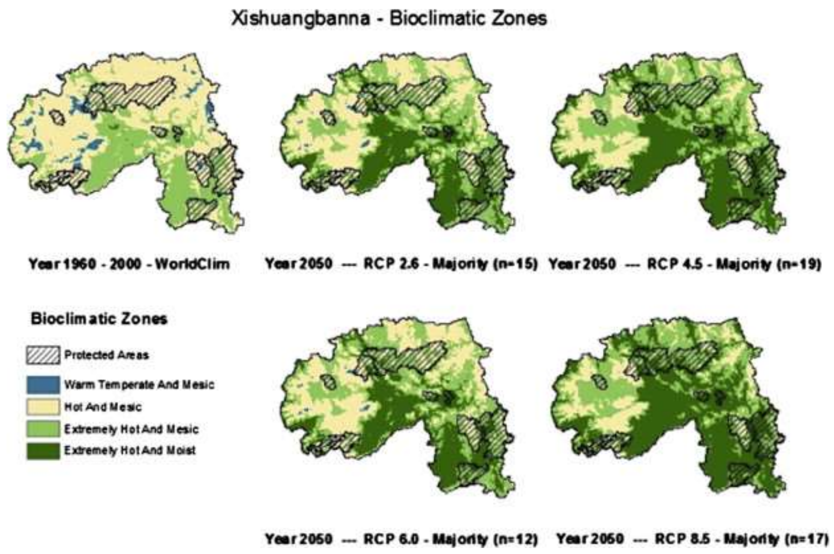
almost nothing

What will the climate be in the main rubber producing areas?

Probable Global Climate scenarios are rather well-known

- But need to be downscalled to every local NR area
- Methodologies are available
- Good forecasts in some areas
- Need to be generalized or updated

Y/N



Zomer et al. 2014 https://doi.org/10.1016/j.biocon.2013.11.028

What will be the effects of higher T° on C assimilation?

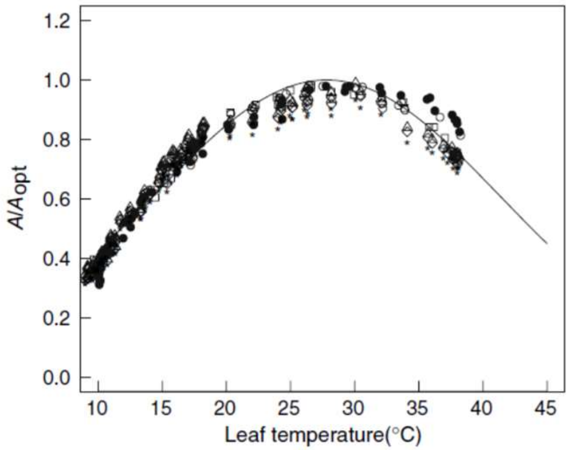
- Some knowledge at leaf scale (Kositsup et al 2010)

Trees (2009) 23:357–365
DOI 10.1007/s00468-008-0284-x

ORIGINAL PAPER

Photosynthetic capacity and temperature responses of photosynthesis of rubber trees (*Hevea brasiliensis* Müll. Arg.) acclimate to changes in ambient temperatures

Boonthida Kositsup · Pierre Montpied · Poonpipope Kasemsap · Philippe Thaler · Thierry Améglio · Erwin Dreyer



Parameter	Growth temperature (°C)	
	18	28
V_{cmax25} (μmol m^{-2} s^{-1})	26.1 ± 1.8^{a}	43.9 ± 2.9^{b}
E_{aV} (kJ mol^{-1})	60.8 ± 7.2^{a}	68.5 ± 6.2^{b}
J_{max25} (μmol m^{-2} s^{-1})	50.8 ± 9.9^{a}	77.4 ± 11.2^{b}
E_{aJ} (kJ mol^{-1})	39.2 ± 18.5^{a}	50.6 ± 13.5^{b}
J_{max25}/V_{cmax25}	1.93 ± 0.005^{a}	1.79 ± 0.004^{b}
LMA (g m^{-2})	64.1 ± 1.4^{a}	52.1 ± 1.3^{b}
SPAD	41.6 ± 0.9^{a}	55.6 ± 0.9^{b}
N_m (%)	2.72 ± 0.05^{a}	4.08 ± 0.05^{b}
C (%)	47.4 ± 0.2^{a}	48.2 ± 0.2^{b}
V_{cmax25}/N_a (μmol g^{-1} s^{-1})	14.8 ± 0.3^{a}	21.2 ± 0.3^{b}
J_{max25}/N_a (μmol g^{-1} s^{-1})	28.9 ± 0.9^{a}	37.0 ± 0.8^{b}

We can predict photosynthetic parameters at future temperatures

What will be the effects of higher T° on C assimilation?

But a long way to predict

whole tree C assimilation and plantation primary production (GPP)!

PS parameters x stomatal conductance x whole tree canopy x phenology….

↘ Because higher VPD?

Shorter leaf lifespan?

What will be the effects of higher T° on C assimilation?

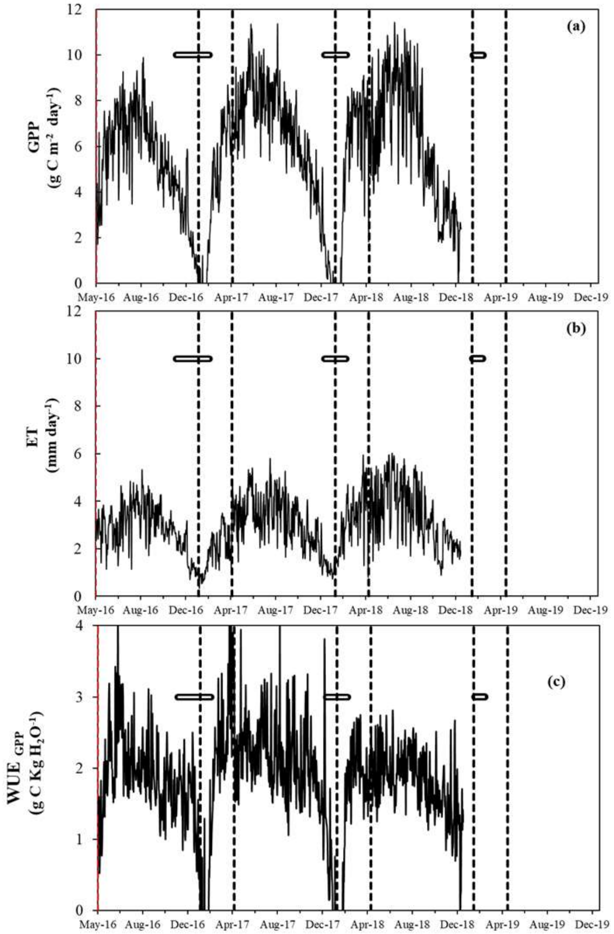
The way forward: upscalling flux measurements

Rubber Flux Tower at Chachoengsao
http://asiaflux.net

Primary Production

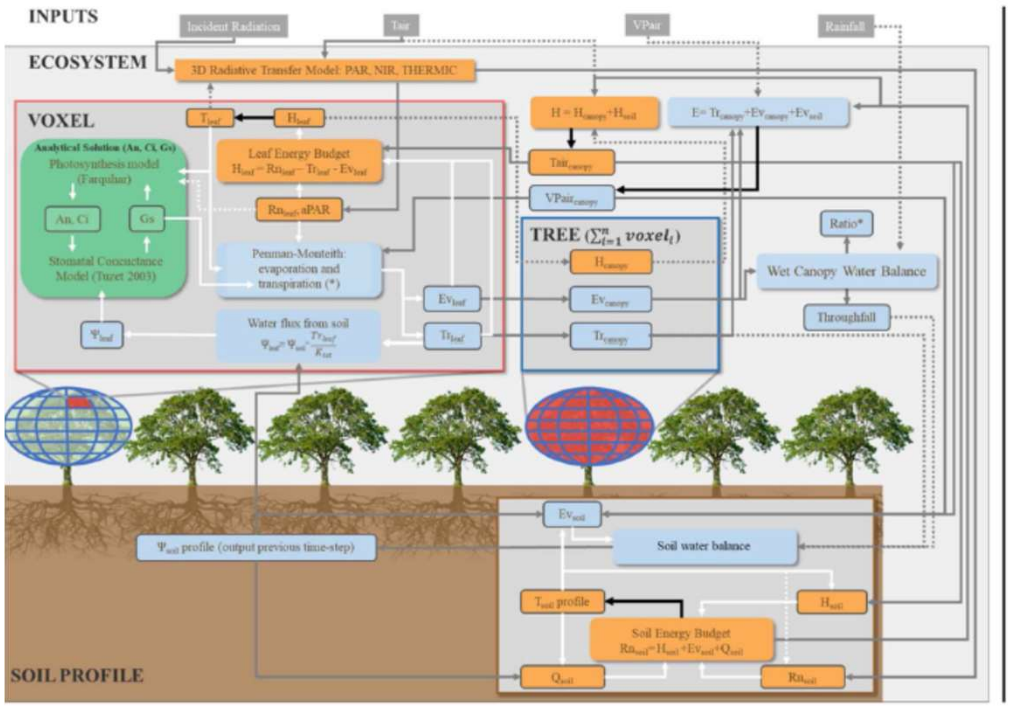
Evapo-transpiration

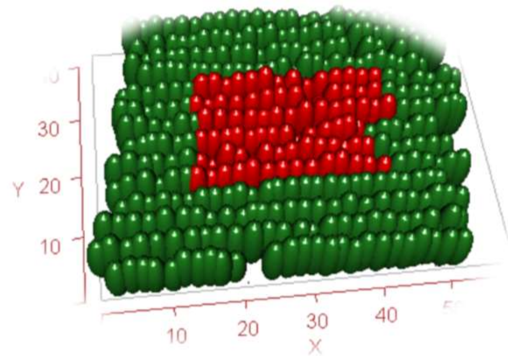
Water Use Efficiency



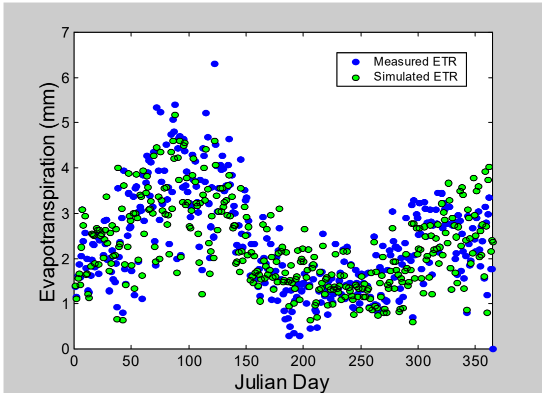
What will be the effects of higher T° on C assimilation?

The way forward: modelling





Example MAESPA Model



Simulation of water and CO_2 fluxes at tree and plot scale

What will be the effects of higher T° on C assimilation?

The way forward: modelling

Forest Ecology and Management 439 (2019) 55–69

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Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

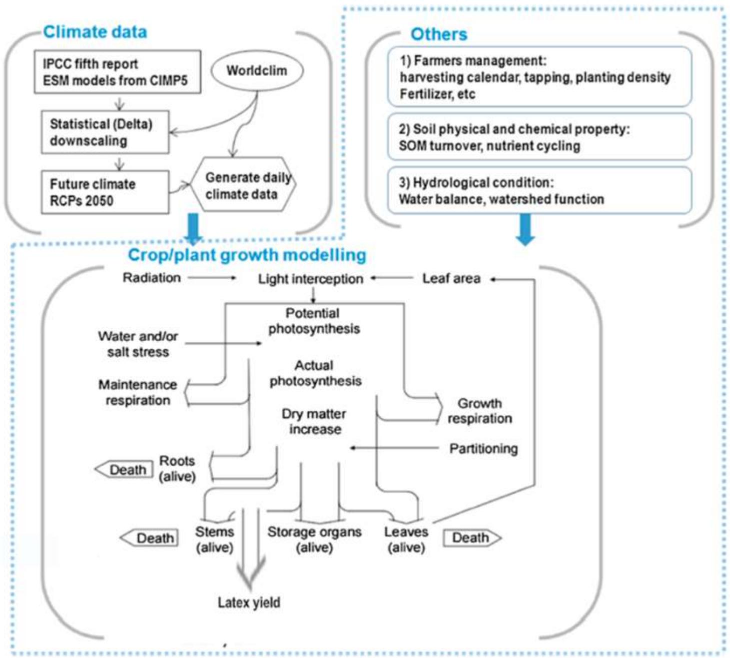
Climbing the mountain fast but smart: Modelling rubber tree growth and latex yield under climate change

Xueqing Yang[a,b,c], Sergey Blagodatsky[a,*], Carsten Marohn[a], Hongxi Liu[a], Reza Golbon[a], Jianchu Xu[c], Georg Cadisch[a]

[a] Institute of Agricultural Sciences in the Tropics (Hans-Ruthenberg-Institute), University of Hohenheim, Stuttgart, Germany
[b] Key Laboratory of Economic Plants and Biotechnology, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, China
[c] World Agroforestry Centre (ICRAF), China & East Asia Office c.o. Kunming Institute of Botany, Kunming, China

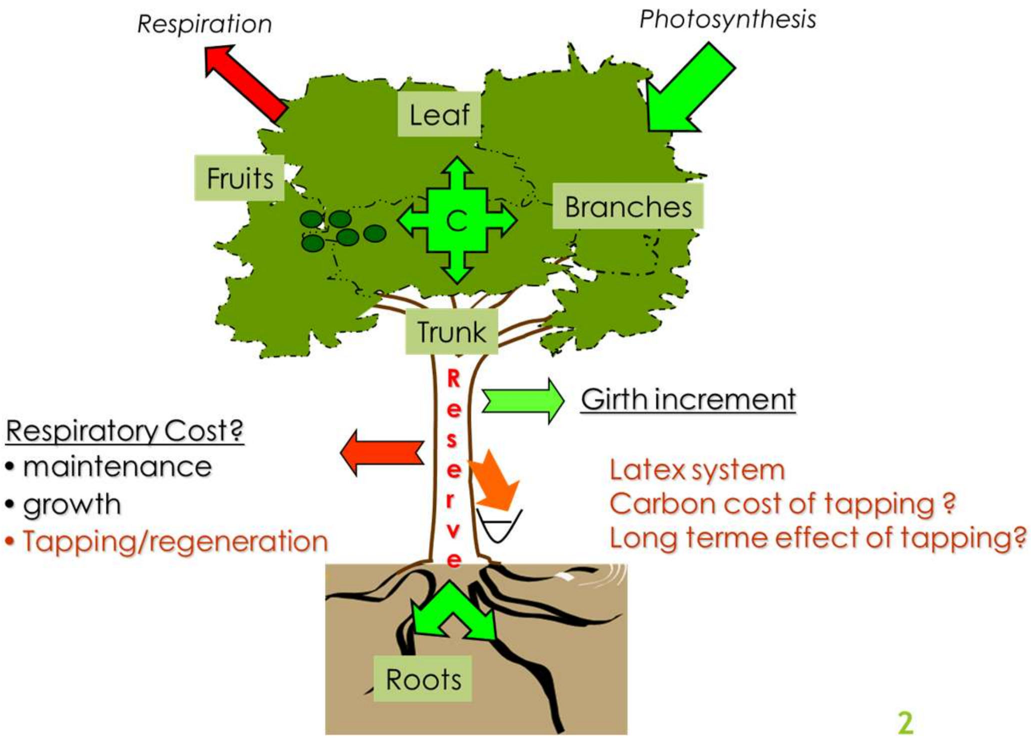
Presented by S Blagodatsky in Session 2

Example LUCIA Model



What about growth and latex production?

Biomass will be directly linked to C assimilation but growth /yield partitioning depends on C allocation

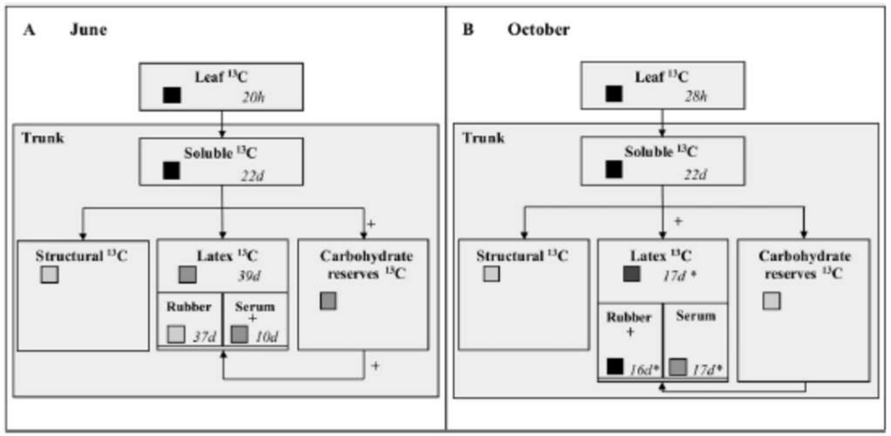


Journal of Experimental Botany, Vol. 71, No. 6 pp. 2028–2039, 2020
doi:10.1093/jxb/erz551

RESEARCH PAPER

In situ $^{13}CO_2$ labelling of rubber trees reveals a seasonal shift in the contribution of the carbon sources involved in latex regeneration

Ornuma Duangngam[1,2], Dorine Desalme[3,*], Philippe Thaler[4,5], Poonpipope Kasemsap[2,*], Jate Sathornkich[2], Duangrat Satakhun[1], Chompunut Chayawat[1], Nicolas Angeli[3], Pisamai Chantuma[6] and Daniel Epron[3,7]



What about growth and latex production?

Direct effects of higher T° on latex yield?

- Negative for latex flow?
- Day/night differences?

Greater diurnal temperature difference, an overlooked but important climatic driver of rubber yield
Yu Haiying et al. 2014. INDUSTRIAL CROPS AND PRODUCTS 62: 14-21

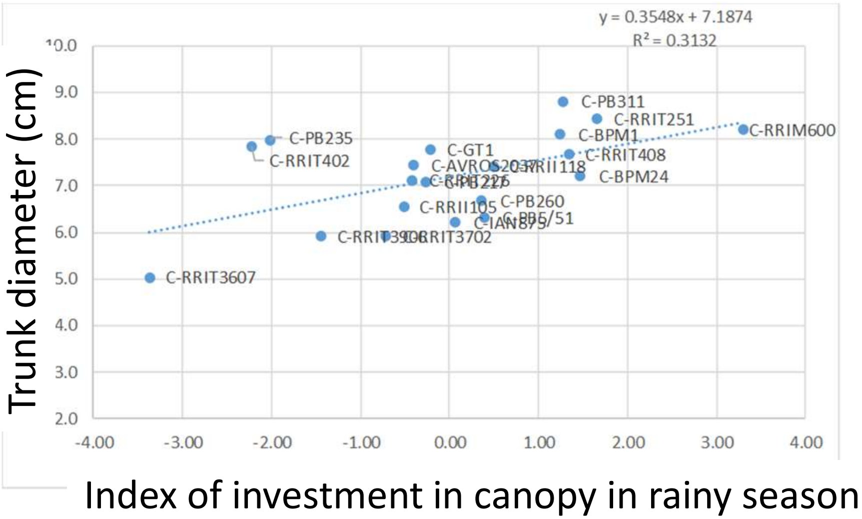
x

A key research topic will be the interactions between climate change and low tapping frequencies
Socio-economic x climate issue.

Adaptation of rubber trees to water stress?

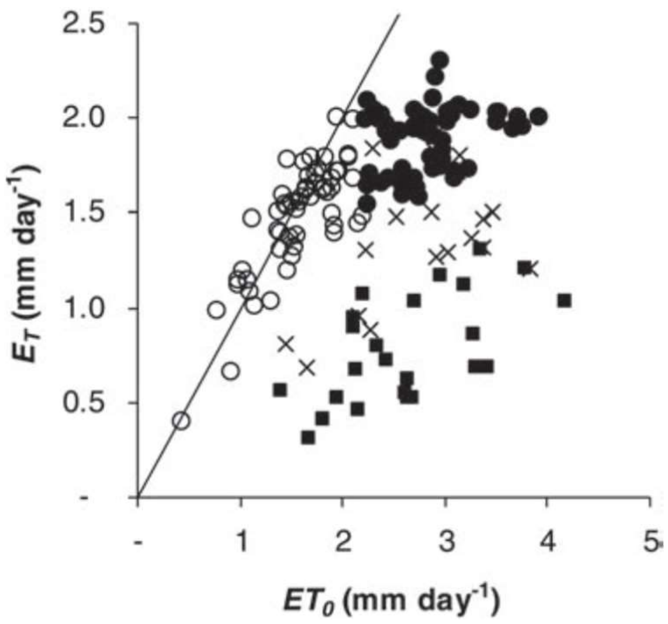
- More knowledge from the numerous studies of adaptation to drier conditions in marginal areas, particularly in India and NE Thailand
- Recent findings show a promising clonal variability in response to water stress

"Growth and Hydraulic" (GRHYD) project: Bases of rubber clones adaptation to water constraints in immature period



Adaptation of rubber trees to water stress?

- Important to untangle soil drought from atmospheric drought
- Strong regulation of transpiration with highVPD, even if water is available in soil.



⇨ Strong over-estimation of water use in many studies and models.

From Isarangkool et al 2011 (mature trees RRIM600)

Relationship between tree transpiration and reference evapotranspiration (ET0) in a well-watered period (REW > 0.5) with ET0 ≤ 2.2 mm day−1 (open circle), a well-watered period when ET0 was higher than >2.2 mm day−1 (closed circle), others drought periods (REW< 0.5).

Conclusion

- Little knowledge and huge gaps
- Potential risk of adverse effects of CC on growth, survival and yield
- Intensive research efforts to be promoted

Improving the ecophysiologIcal functions in integrative models could be a relevant cooperative project for the network.