

COFFEE-FLUX (Costa Rica)

Observatory for **monitoring** and **modeling** carbon, nutrients, water and sediment ecosystem services in coffee agroforestry systems;

Mitigation and adaptation to climate changes through ecosystem manipulation

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Coffee-Flux⁽¹⁾: a SOERE F-ORE-T⁽²⁾ Observatory of biophysical research on coffee agroforestry systems

Sites:

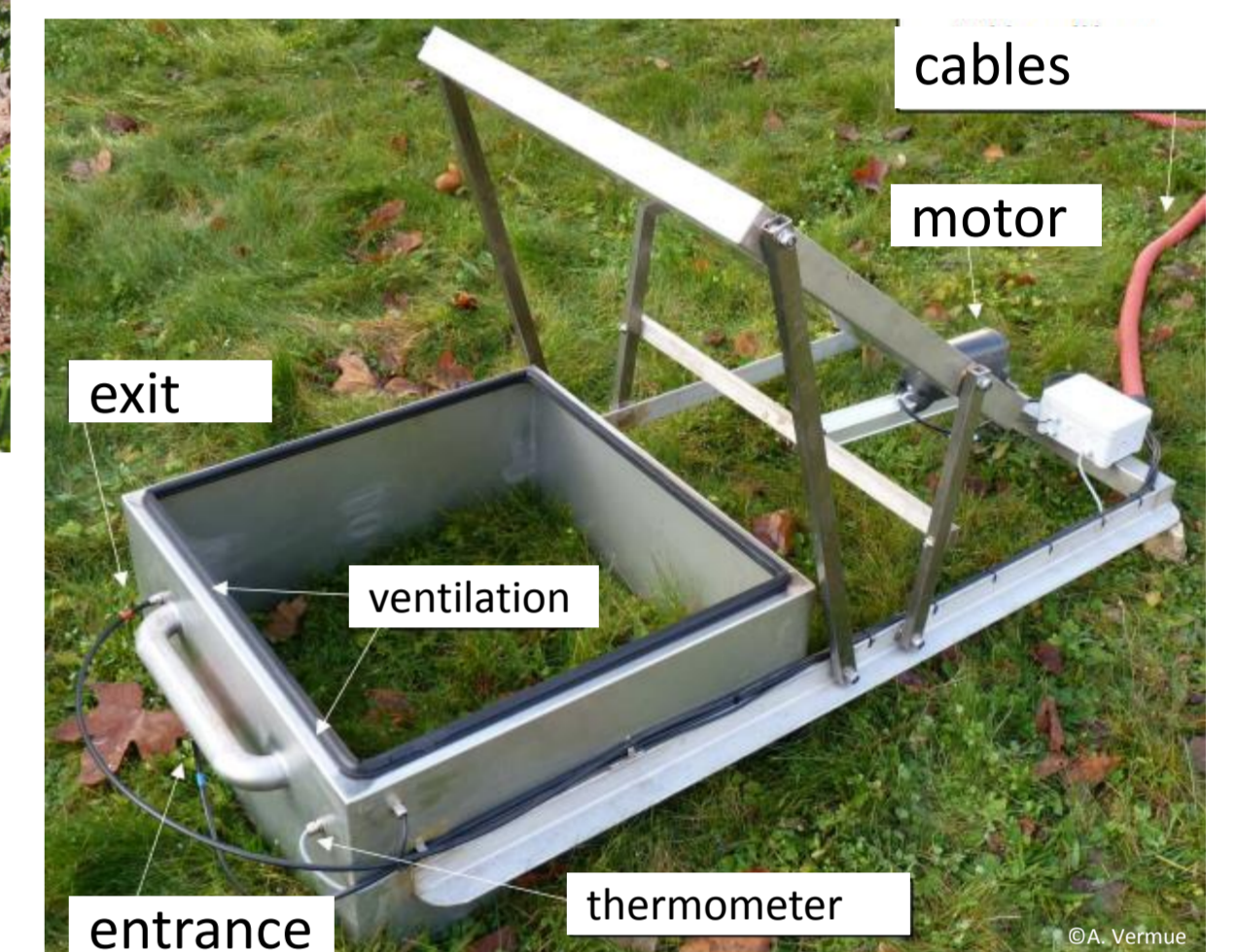
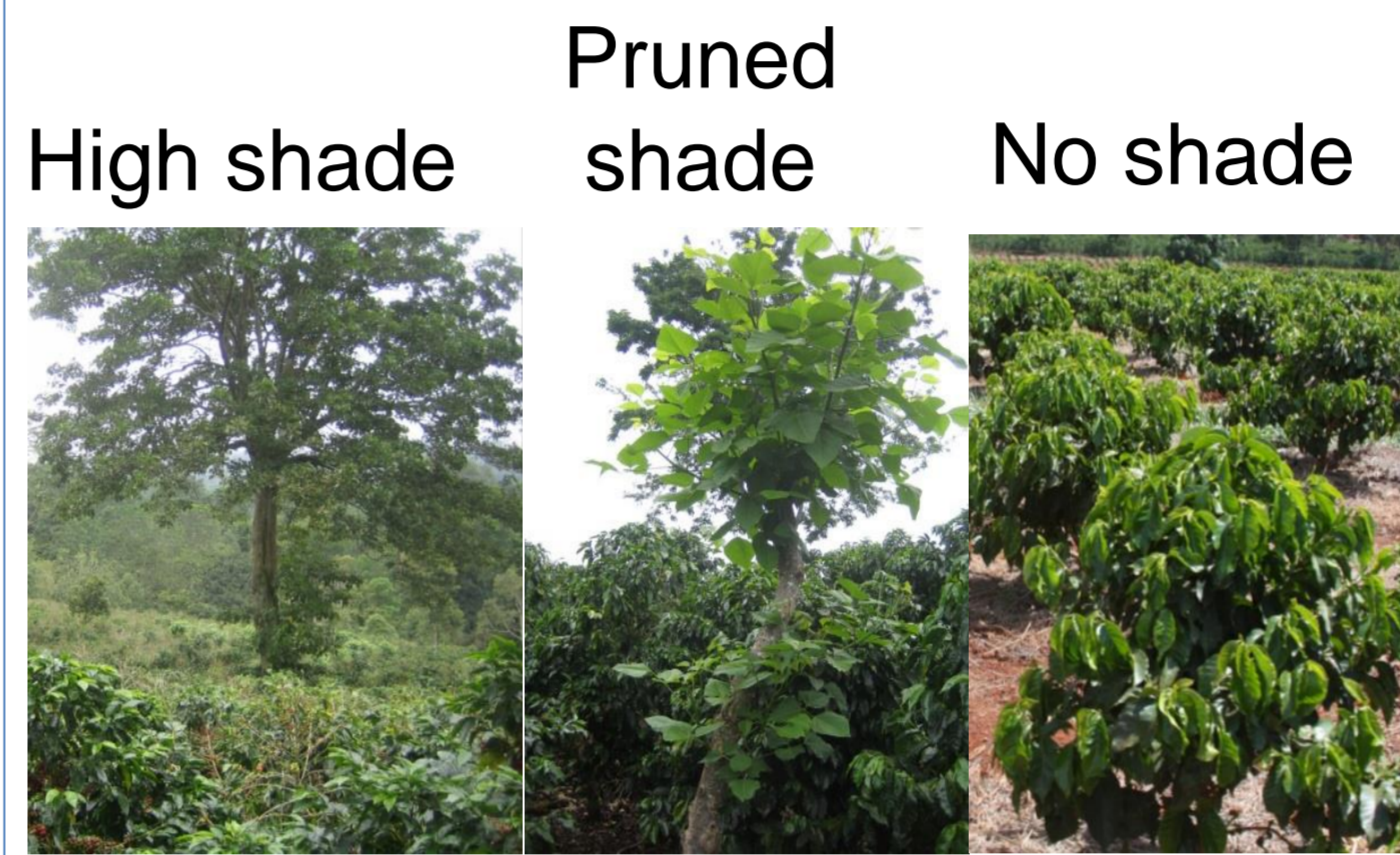
- Aquiares-Turrialba = wet site (Yield, NPP, C-fluxes, manipulation of Shade x Fertilization, N₂O fluxes, SOM deep stocks, hydrology, sediments)
- Llano Bonito-Tarrazu = dry site (yield, agronomy, hydrology, sediments)
- CATIE-Turrialba = wet site: long-term manipulation of Shade x Fertilization : yield, microclimate, profitability, labour.

Modeling:

- MAESPA: a plot model for plant-to-plot scale energy, C and H₂O balance
- MACACC-GO+ and CAF2007: plot models for yield, ecosystem services
- Hydro-SVAT: watershed lumped hydrological and SVAT model

Manipulation of Shade x Fertilization (Aquiares)

- 4 nitrogen fertilization levels: 50, 110, 170, 230 kg N/ha/y
- Shade tree: *Erythrina poeppigiana* (N₂ fixer)
- 3 shade levels: Pruned shade, No shade
- Measurements:
 - Soil & plant N status
 - Soil nitrate
 - N mineralization rates
- N₂O emissions:
 - Automatic chambers
 - 3 treatments (low/high fertilization, no shade/shade)



- Experiments:
 - Horizontal nitrogen fluxes (¹⁵N enrichment)

NPP, C, H₂O, sediment balance (Aquiares)

CoffeeFlux Obs. Experimental display

Kinoshita R, Roupsard O, Chevallier T, Albrecht A, Taugourdeau S, Ahmed Z, van Es HM. 2016. Large topsoil organic carbon variability is controlled by Andisol properties and effectively assessed by VNIR spectroscopy in a coffee agroforestry system of Costa Rica. *Geoderma*, 262: 254-265.

Prieto I, Roumet C, Cardinael R, Dupraz C, Jourdan C, Kim JH, Maeght JL, Mao Z, Pierret A, Portillo N, Roupsard O, Thammahaeksa C, Stokes A. 2015. Root functional parameters along a land-use gradient: evidence of a community-level economics spectrum. *Journal of Ecology*, 103.

Sánchez-Murillo R, Birkel C, Welsh K, Esquivel-Hernández G, Corrales-Salazar J, Boll J, Brooks E, Roupsard O, Senz-Rosales O, Katchan I, Arce-Mesén R, Soulsby C, Araguás-Araguás LJ. 2016. Key drivers controlling stable isotope variations in daily precipitation of Costa Rica: Caribbean Sea versus Eastern Pacific Ocean moisture sources. *Quaternary Science Reviews*.

Long-term manipulation Shade x Fertilization (CATIE)

Split-plot design (9 ha):

- Main level: « Shade type » (tree species)
- Second level: « Management » (fertilization)

(source M. Soma)

Gagliardi S, Martin AR, Virgilio Filho EdM, Rapidel B, Isaac ME. 2015. Intraspecific leaf economic trait variation partially explains coffee performance across agroforestry management regimes. *Agriculture Ecosystems & Environment*, 200: 151-160.

Haggar J, Barrios M, Bolanos M, Merlo M, Moraga P, Munguia R, Ponce A, Romero S, Soto G, Staver C, Virgilio EdMF. 2011. Coffee agroecosystem performance under full sun, shade, conventional and organic management regimes in Central America. *Agroforestry Systems*, 82: 285-301.

Schnabel F, De Melo Virgilio Filho E, Xu S, Fisk I, Roupsard O, Haggar J. 2016. Agro-ecological interactions between types of shade and management in contrast to full sun and its implications in the development of coffee plants (*Coffea arabica* var. Caturra). In: Prep.

Yield, agronomy, hydrology, sediment (dry site)

Coffee under shade cast by *Inga Laurina*
Management: High conventional
Mean shade: 52%

Yield simulation by CAF2007 model

Cerdan CR, Rebolledo MC, Soto G, Rapidel B, Sinclair FL. 2012. Local knowledge of impacts of tree cover on ecosystem services in smallholder coffee production systems. *Agricultural Systems*, 110: 119-130.

Meylan L, Merot A, Gary C, Rapidel B. 2013. Combining a typology and a conceptual model of cropping system to explore the diversity of relationships between ecosystem services: The case of erosion control in coffee-based agroforestry systems in Costa Rica. *Agricultural Systems*, 118: 52-64.

Villatoro-Sanchez M, Le Bissonnais Y, Moussa R, Rapidel B. 2015. Temporal dynamics of runoff and soil loss on a plot scale under a coffee plantation on steep soil (Ultisol), Costa Rica. *Journal of Hydrology*, 523: 409-426.

Site intercomparison through Modeling

- Hydrological behaviour of 2 watersheds, wet and dry, under contrasting climate change projections: using Hydro-SVAT model
- Mitigation and adaptation of coffee: microclimate, yield and NPP behaviour according to Shade, Fertilization, under climate change projections : MAESPA, CAF2007 and MACACC-GO+ models (ANR-MACACC)
- Applications : **NAMAS** (Nationally Appropriate Mitigation Actions)

ENSAYO 3D STRUCTURE

Transmittance simulated by MAESPA in the coffee agroforestry trial (source PhD Rémi Vezy)

- *Chloroleucon eurycyclum*
- *Erythrina poeppigiana*
- *Terminalia amazonia*
- Trunk