

An aerial photograph showing a vast, dense expanse of a tropical rainforest. The canopy is a mosaic of various shades of green, with some darker patches and occasional lighter, brownish areas that might be fallen leaves or different tree species. The perspective is from directly above, looking down on the forest floor.

The RAINFOR project



The Amazon Forest Inventory Network
Red Amazonica de Inventarios Forestales
Rede Amazonica de Inventarios Florestais

17 countries, 35 institutions,
>100 forest sites across
Amazonia



RAINFOR

<http://www.geog.leeds.ac.uk/projects/rainfor>

Contributors to the long term monitoring of tropical forests plots

Oliver Phillips (Leeds), Tim Baker (Leeds, Max Planck), Jon Lloyd (Leeds, Max-Planck), Simon Lewis (Leeds), Yadvinder Malhi (Oxford, Edinburgh), Sandra Patiño (Humboldt, Leeds, Max-Planck), Carlos Quesada (Leeds), Samuel Almeida⁴, Luzmila Arroyo⁵, Esteban Alvarez, Jerome Chave¹⁸, Kuo-Jung Chao, Claudia Czimcik, Anthony DiFiore⁶, Terry Erwin¹⁶, Rafael Herrera, Isau Huamantupa, Niro Higuchi¹⁷, Euridice Honorio, Eliana Jimenez, Tim Killeen⁷, Caroline Kuebler, Susan Laurance⁸, William Laurance⁸, Armando Lezama, Jim Martin, Patrick Meir, Lina Mercado, Abel Monteagudo⁹, Henrique Nascimento, David Neill¹⁰, Percy Nunez⁹, Nigel Pitman¹², Adriana Prieto,, Julie Richards, Agustin Rudas, Norma Salinas, Rafael Salomão, Natalino Silva^{13,14}, Marcos Silveira, John Terborgh, Rodolfo V. Martinez¹⁵, Ima Vieira⁴

4. Museu Paraense Emilio Goeldi, Belém, Brazil. 5. Museo Noel Kempff Mercado, Santa Cruz, Bolivia. 6. New York University, USA. 7. Conservation International, Washington DC, USA. 8. Smithsonian Tropical Research Institute, Balboa, Panama. 9. Universidad Nacional San Antonio Abad del Cusco, Peru. 10. Missouri Botanical Garden, Quito, Ecuador. 11. Alexander von Humboldt Biological Research Institute, Bogotá, Colombia. 12. Duke University, Durham, USA. 13. CIFOR, Tapajos, Brazil. 14. EMBRAPA Amazonia Oriental, Belém, Brazil. 15. Proyecto Flora del Perú, Oxapampa, Perú. 16. Smithsonian Institution, Washington DC, USA. 17. INPA, Manaus, Brazil. 18. CNRS, Toulouse, France.

How it all started

- Apparently undisturbed tropical forests, are undergoing unexpected changes:
- Long-term monitoring of tropical forest plots indicates that tree populations experienced increased rates of mortality and recruitment ("turnover") in the latter part of the last century (Phillips and Gentry 1994).
- These plots also seemed to show for the tropical Americas that the basal area and biomass of mature forests increased over the same period (Phillips et al. 1998), pointing to a sink for atmospheric CO₂ in South American forests of 0.5 - 1 Pg C per year - equivalent to the fossil fuel emissions of the entire European Union.

RAINFOR

One of the main challenges is

To understand the carbon cycle and the forest dynamics during this period of changes

The aims of RAINFOR are to:

1. Quantify long term changes in forest biomass and turnover to date.
2. Relate current forest structure, biomass and dynamics to local climate and soil properties.
3. Understand the extent to which climate and soils will constrain future changes in forest dynamics and structure.
4. Understand the relationships between productivity, mortality and biomass.
5. Use relationships (1) to (3) to understand how changes in climate may affect the biomass and productivity of the Amazon forest as a whole, and inform basin-scale carbon balance models.
6. Examine variability of tree biodiversity across Amazonia, and its relationship to soils and climate.

RAINFOR ACTIVITIES

1. FOREST INVENTORIES (BOTANICAL AND STRUCTURAL)



AIM

To establish if Amazonian forests are changing over time (in structure, biomass, composition, and dynamics)

Focus on previously established sample plots


IQUITOS, PERU, JAN 2001



DBH (Diameter at belly
height)



Je suis
Tim

A photograph of three men in a desert environment. The man on the left is smiling and holding a stick. The man in the center is looking down. The man on the right is wearing a cap and looking down. There are speech bubbles above each man. A small bottle is on the ground to the left.

Bonjour!
Je suis
Yadvinder

Je suis Michael

Je suis
Beto

Indirect measurements of forest structure (Allometry, LAI)

Chiqui

C'est moi

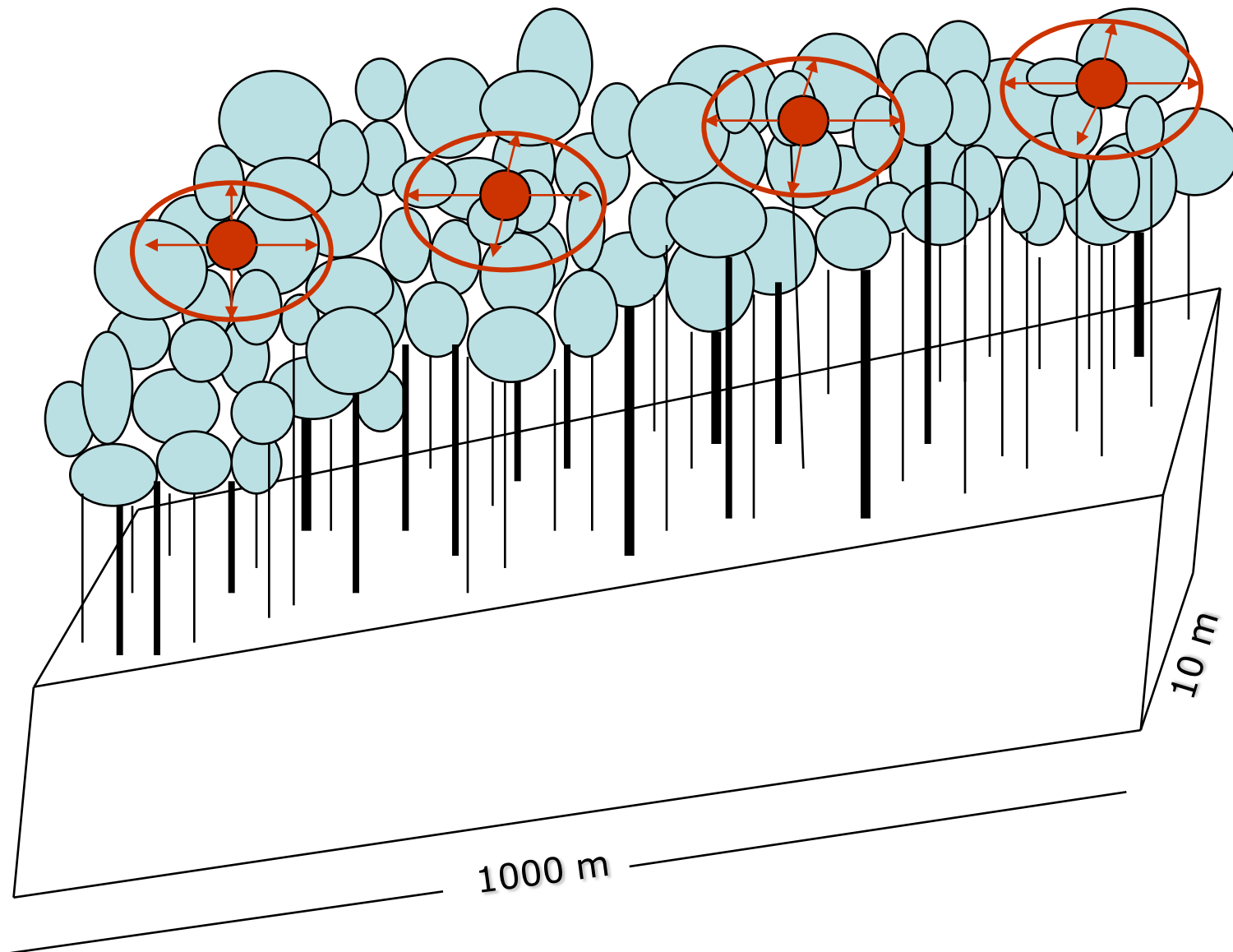
Antonio

**NOEL KEMPFF NATIONAL PARK,
BOLIVIA, JUNE 2001**

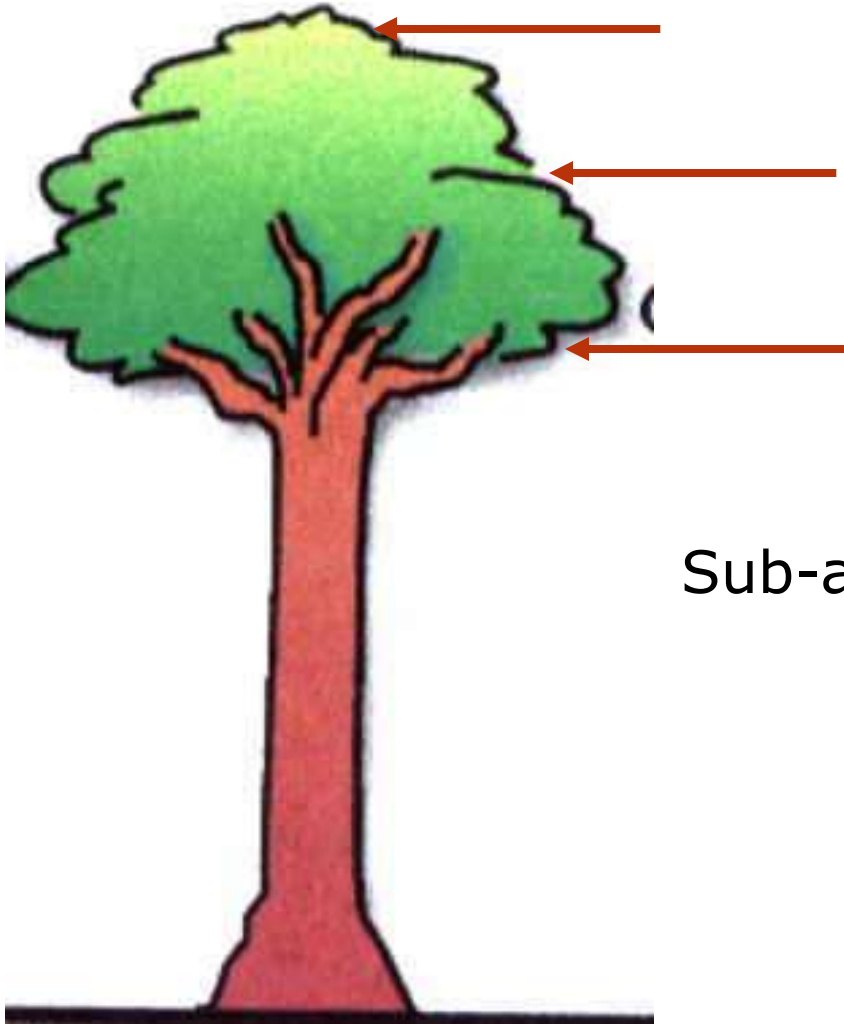




Coleta de material vegetal



**Coleta de folhas
para subgrupo**



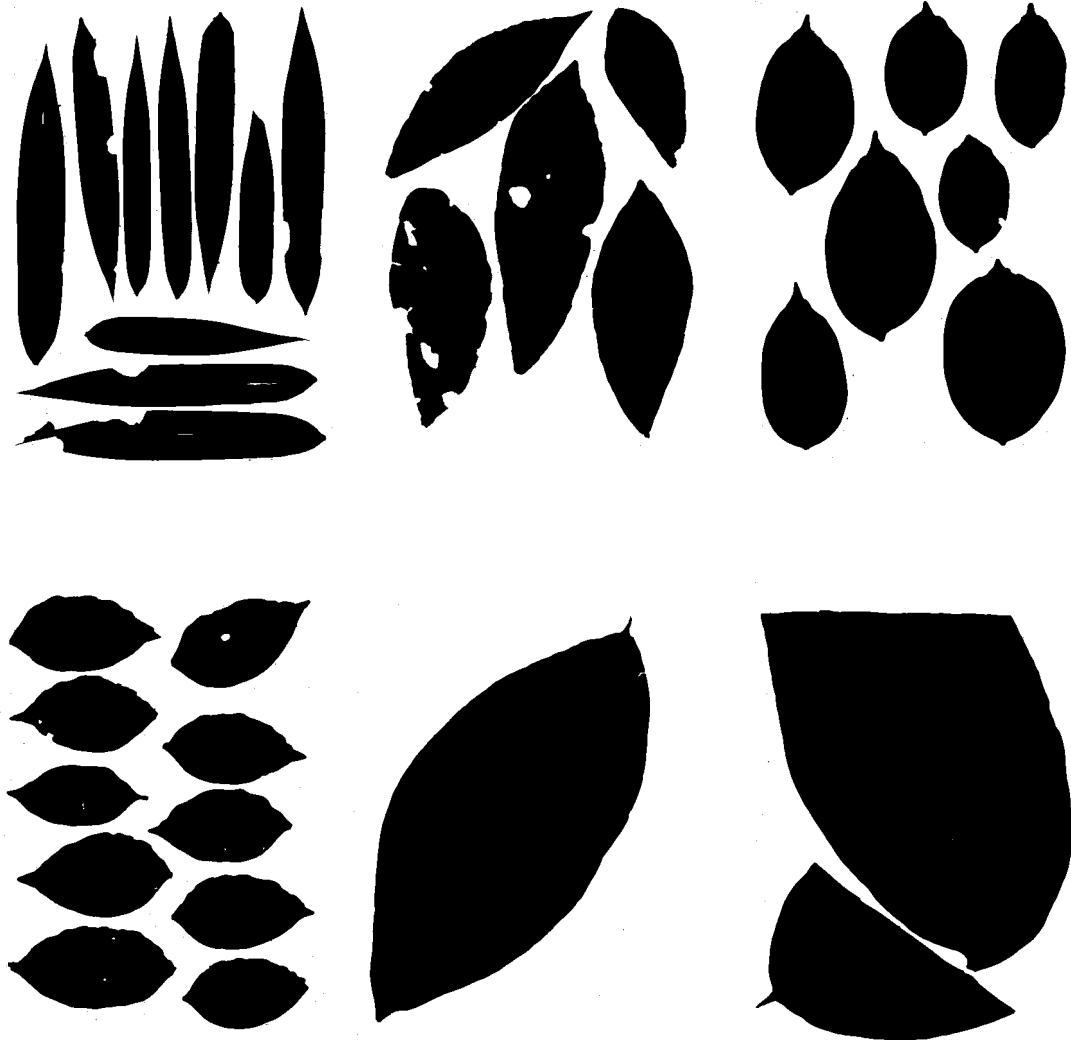
Sub-amostras para: SLA e
nutrientes

Leaves and wood sampling




Leaf traits i.e. size, SLA, etc

Alessandre



Wood characteristics:

- Wood density
- Sapwood area
- Ratio $WA:LA$ ($\text{cm}^2 \text{ m}^{-2}$)



Je suis
Willy

Installation of Automatic Weather Stations in Data-Poor Areas

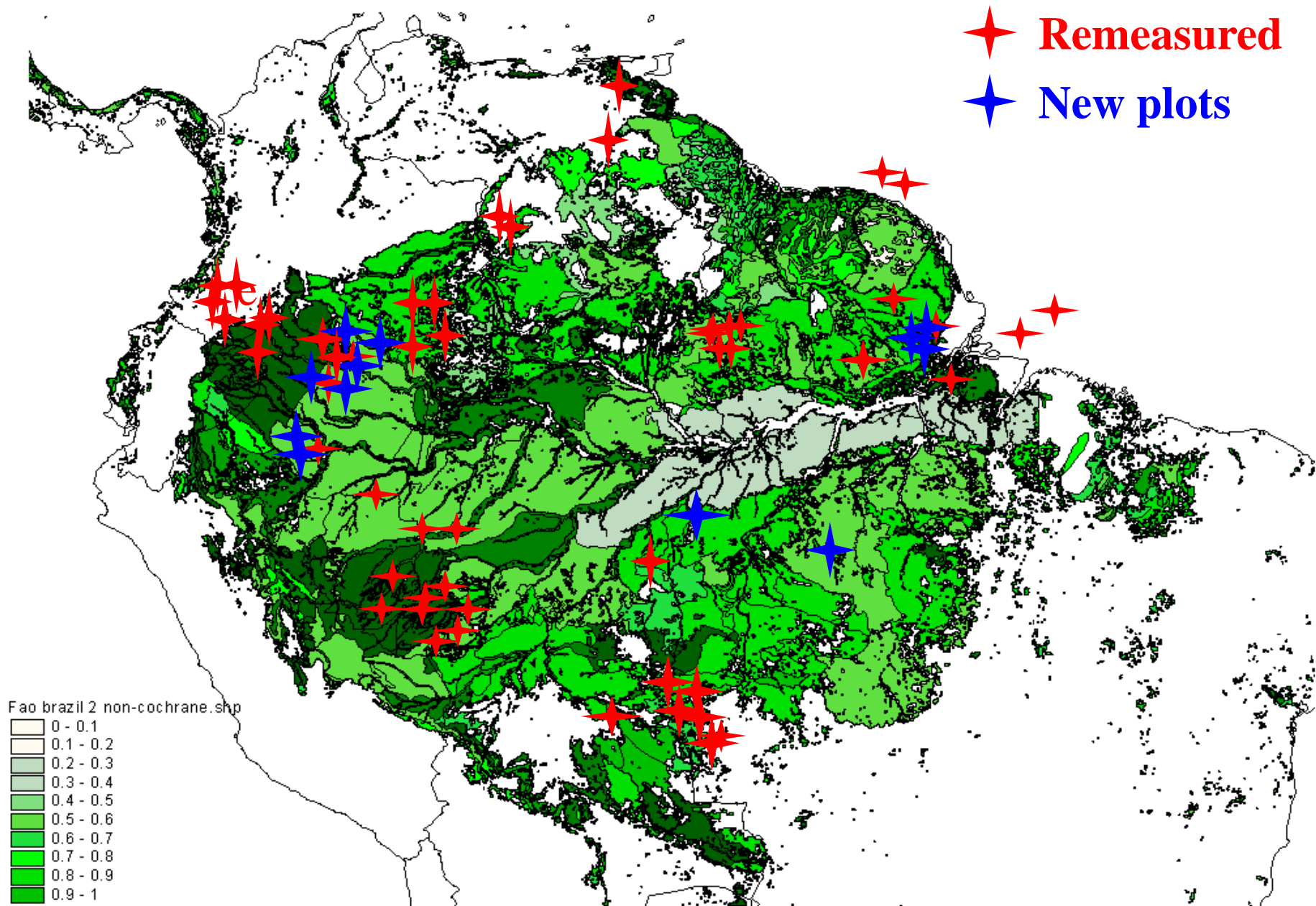
**NOEL KEMPFF NATIONAL PARK,
BOLIVIA, JUNE 2001**



RAINFOR activities 2001-2005



RAINFOR activities 2001-2005



82 plots visited

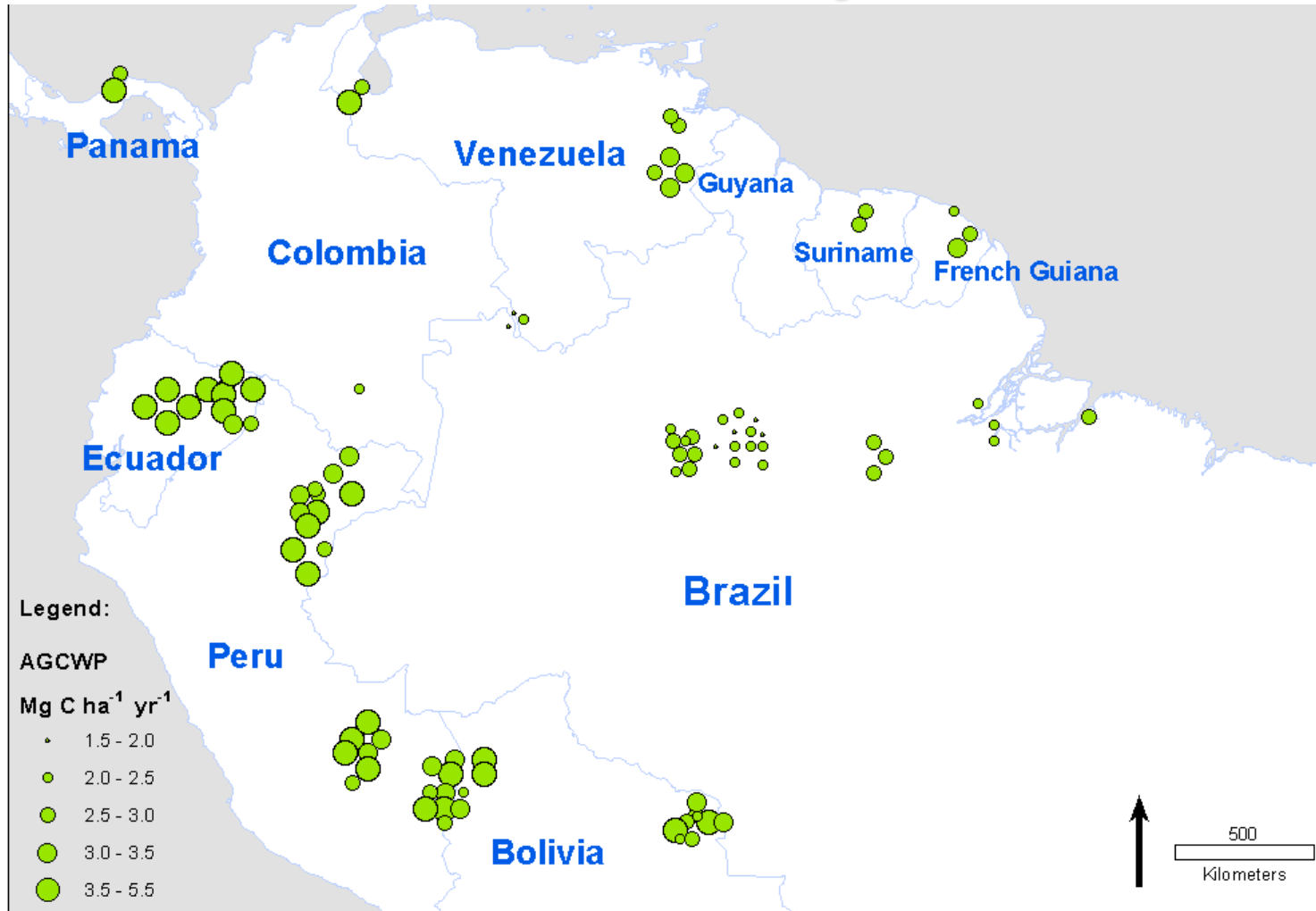
Country	Region	Number of plots	Forest formations
Bolivia		11	terra firme, seasonally flooded, liana, gallery
Peru	South	7	terra firme, swamp
	North	8	terra firme, seasonally flooded
Ecuador		9	terra firme, seasonally flooded
Colombia		8	Terra firme
Venezuela		7	Caatinga, Yevaro, terra firme
Brazil	Amazonas	6	terra firme
	Mato Grosso	2	terra firme
	Pará	13	mangrove, terra firme, seasonally flooded
	Acre	6	terra firme, bamboo

- We have sampled leaves and wood of 1581 trees across the Amazon basin including Bolivia, Peru, Ecuador, Colombia, Venezuela, Brazil

Essential macronutrients	Essential micronutrients	Beneficial or of restricted essentiality	Isotopes
C	Mn	Cr	$\delta^{13}\text{C}$
N	Fe	Ni	$\delta^{15}\text{N}$
P	Co	Al	
Ca	Zn	Br	
K	B	Sr	
Mg		Ba	
S	Se		
	Mo		
	Na		
	Si		
	V		

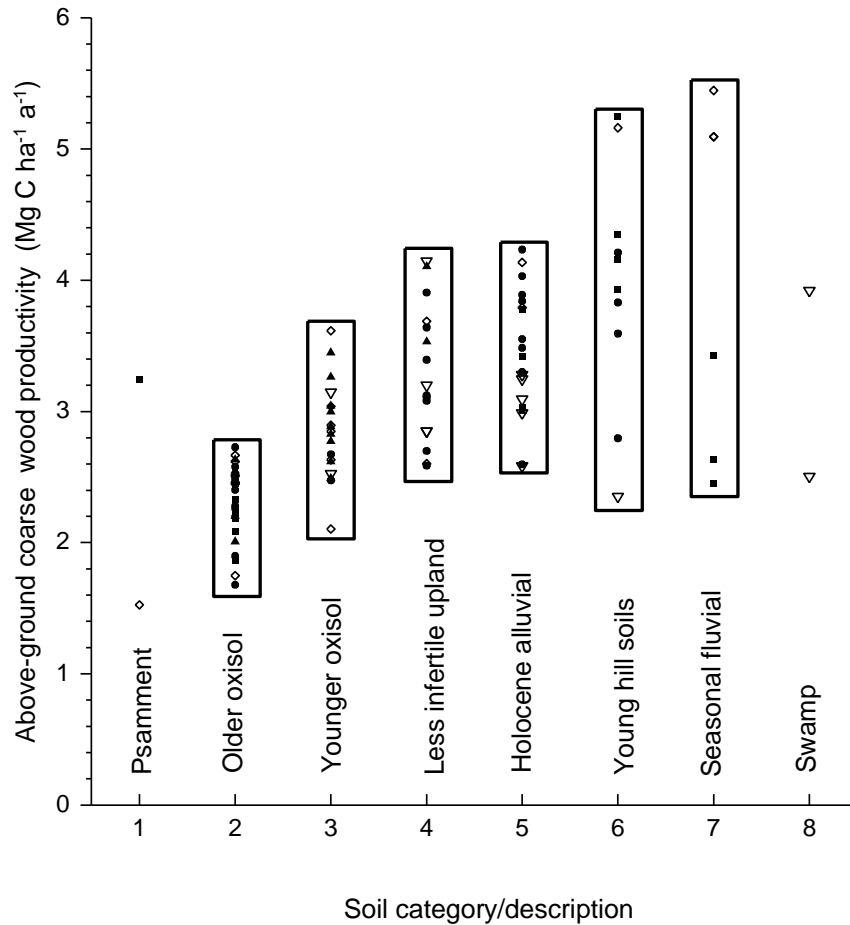
Subdivision according to Farago and Cole (1988)

Basin wide variations in stem growth rate



Malhi *et al*, The above-ground coarse wood productivity of
104 Neotropical forest plots, *Global Change Biology*, 2004

Soil fertility seems to be critical



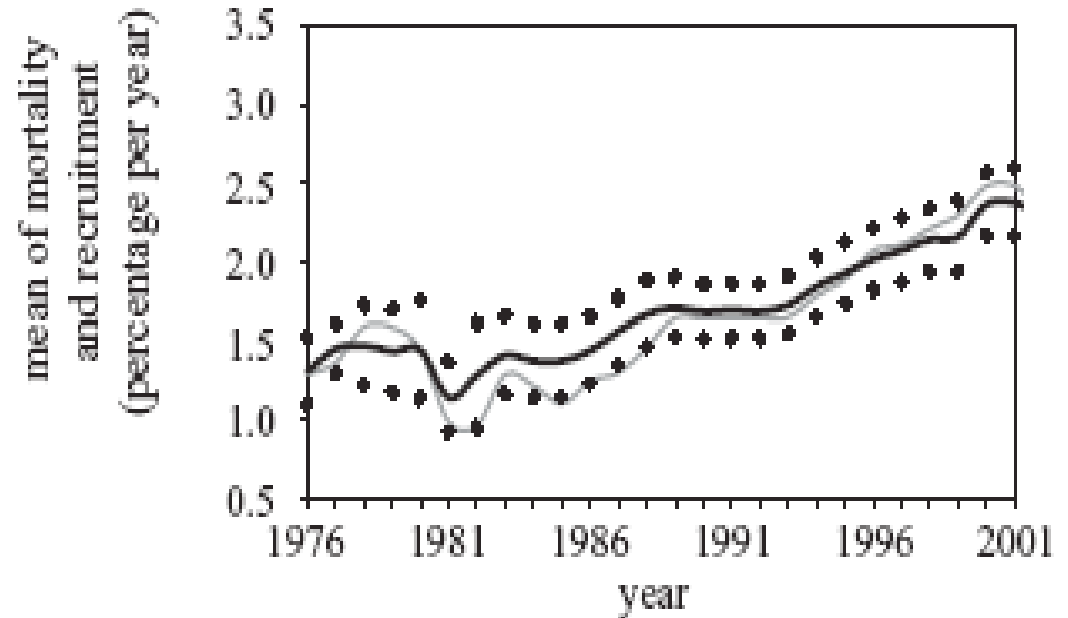
What is the basis of this underlying soil fertility effect ?

- Ph.D thesis work of Carlos (Beto Quesada) at Leeds
- “Amazon rainforest dynamics in relations to soil chemical and physical conditions”.

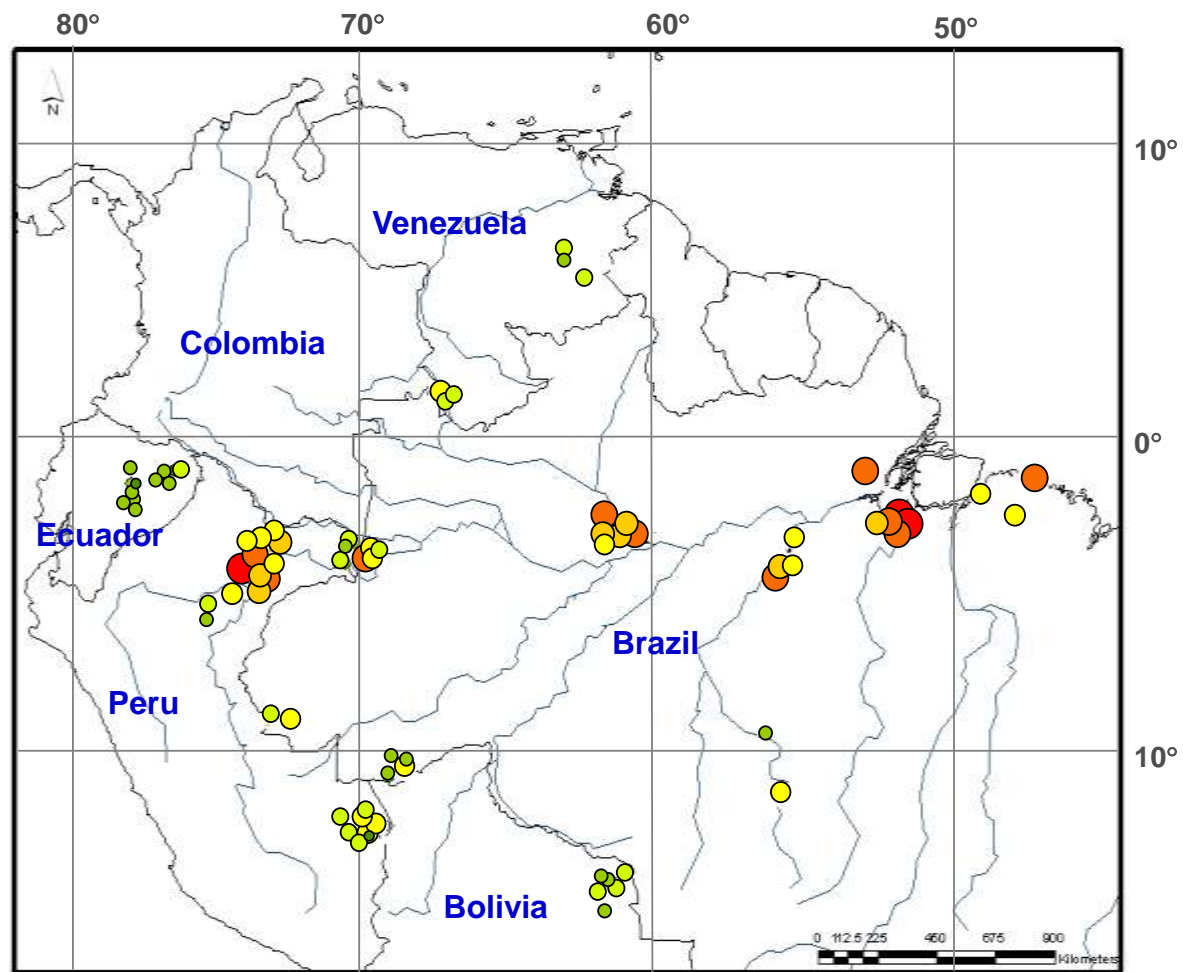


Results: There is an increase in turnover rates

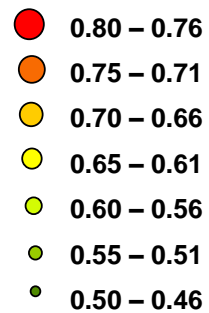
Changes in mortality and recruitment rates in Amazonian permanent plots, 1976-2001.



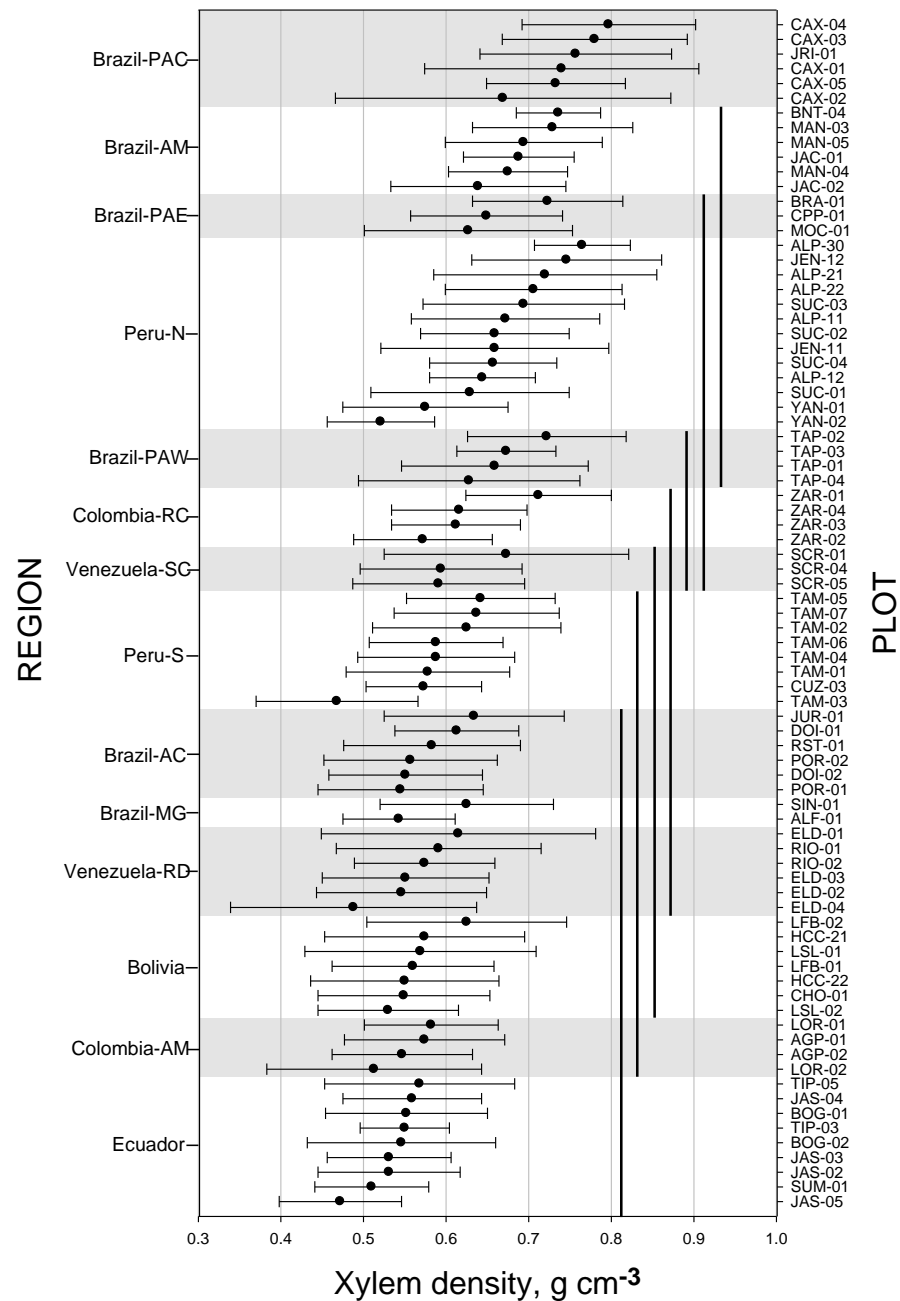
Phillips et al. (2004), Phil. Trans Roy. Soc, 359.



© Juliana. 2006



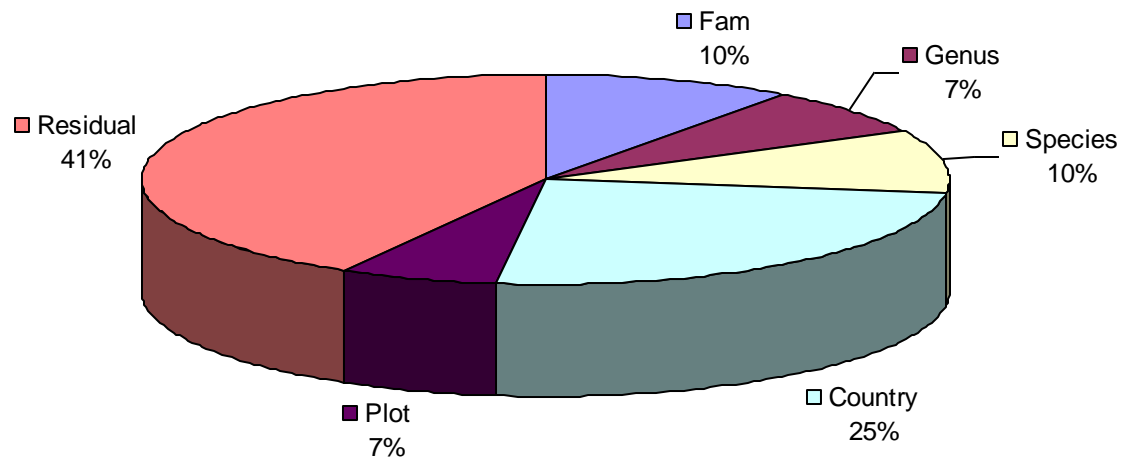
Xylem density

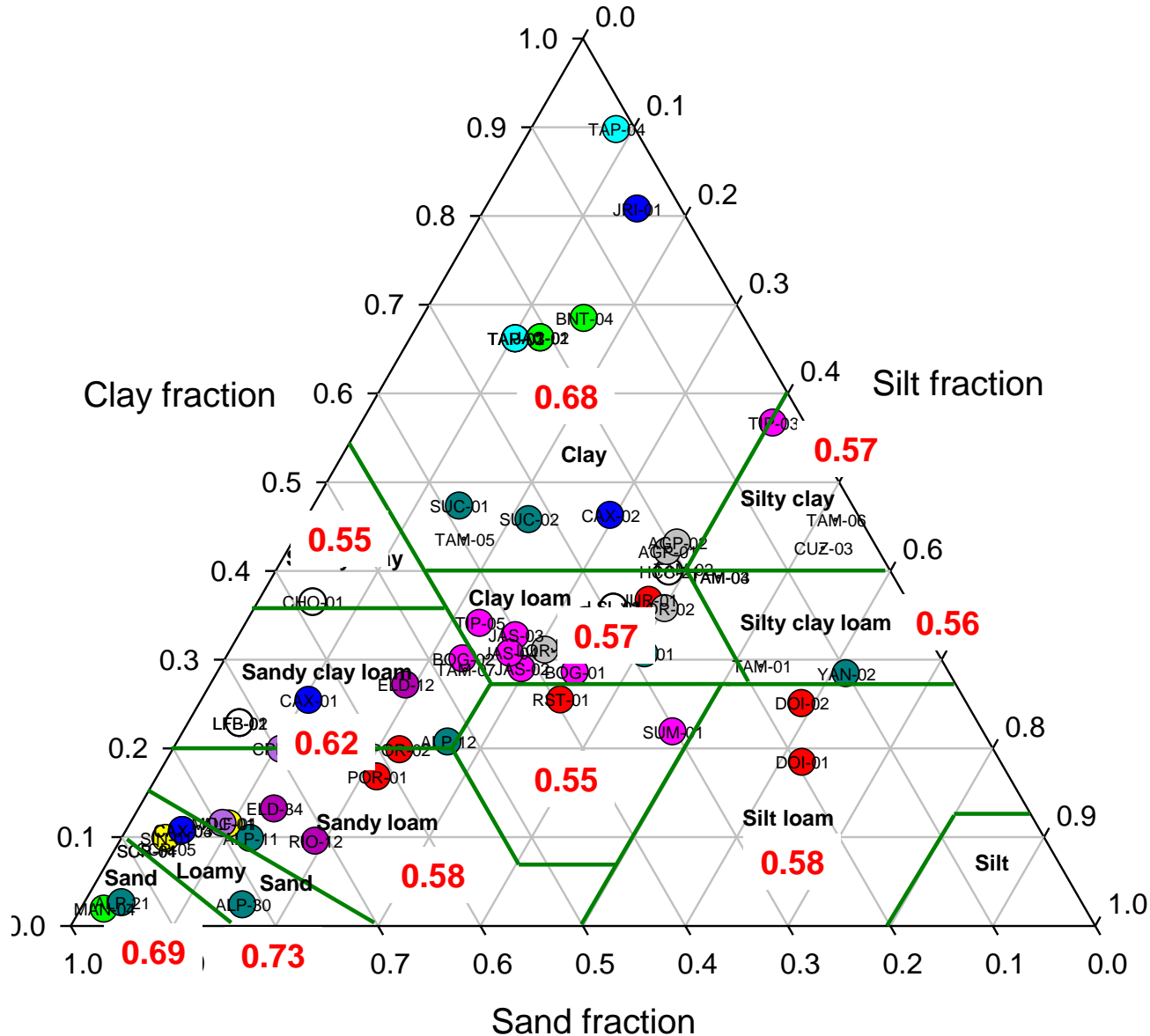


There exist significant differences between regions and within

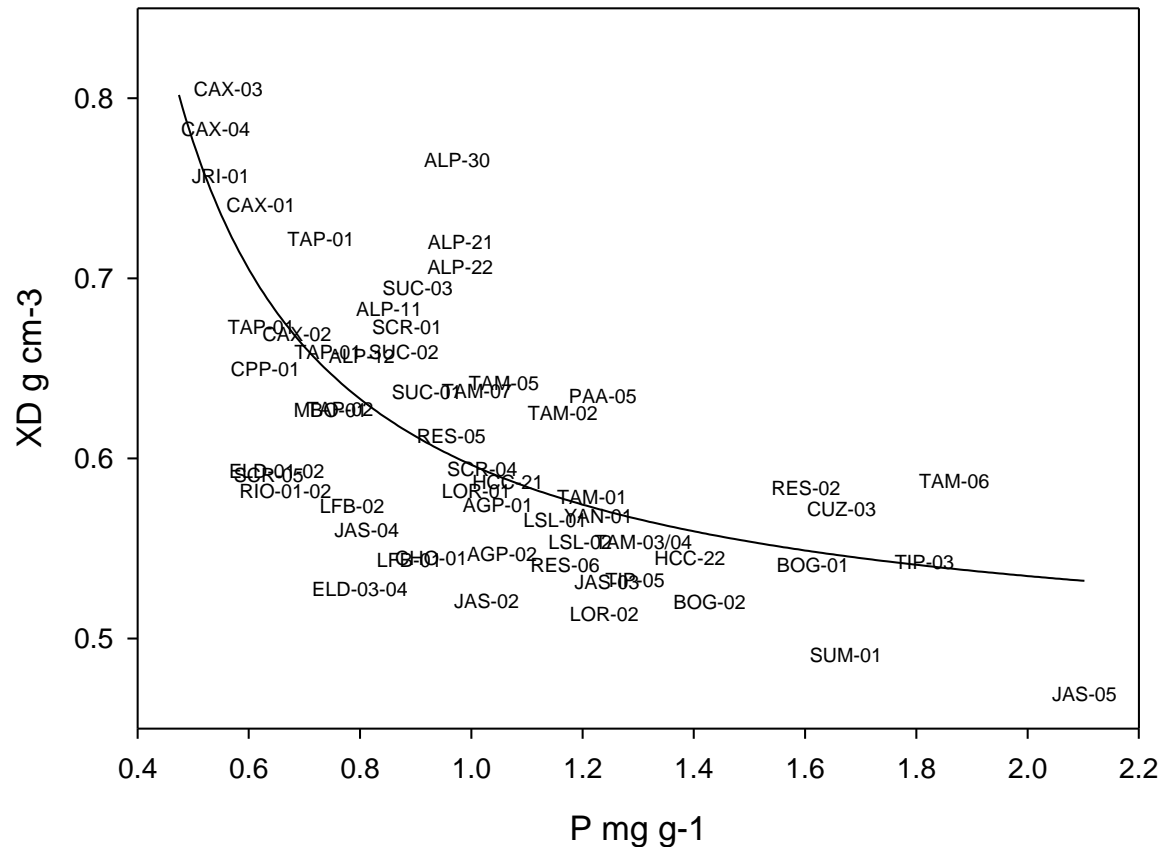


Relative importance of environment and taxonomic level in xylem

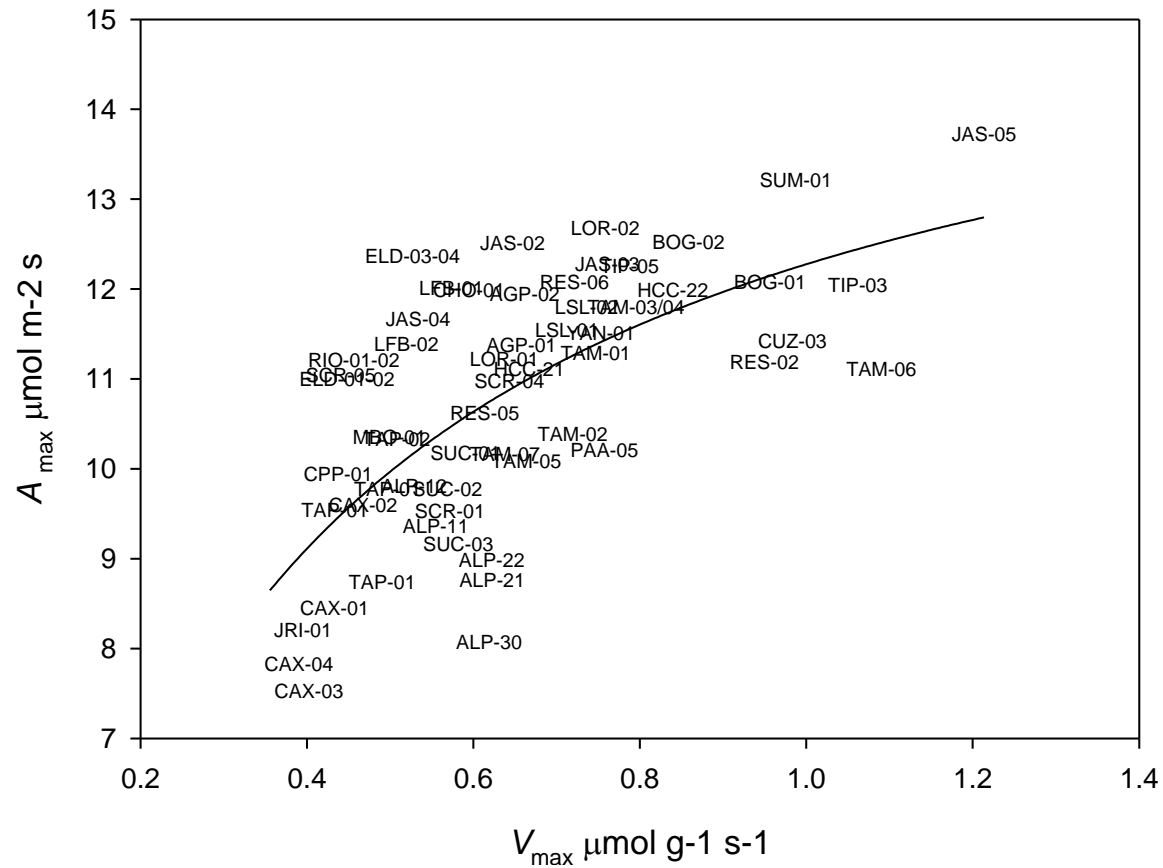




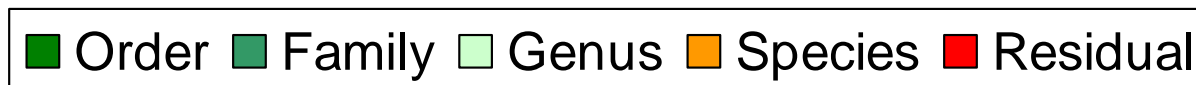
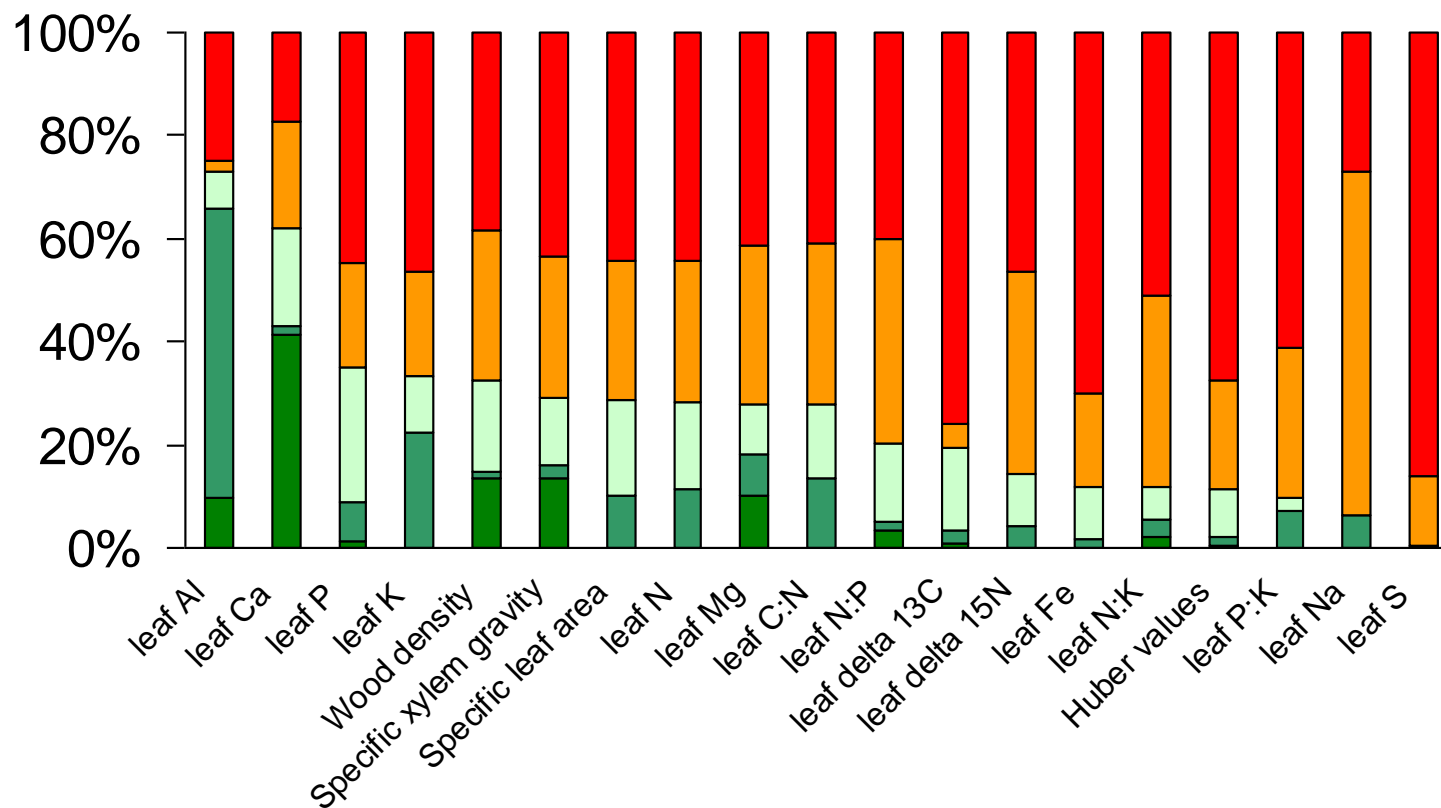
Relacion entre P en las hojas y densidad de la rama



Otras relaciones



Variance component [%]



Data bases: Tree by tree data, tree functional traits: Available at request



The screenshot shows a web interface for the RAINFOR database. At the top, there is a header with a dark blue bar on the left and a landscape image on the right. The word "RAINFOR" is displayed in large, bold, yellow letters. Below the header, the main content area has a light blue background. It contains a link to the RAINFOR web site, a mandatory agreement text, a checkbox for accepting the agreement, and two buttons: "Open Database" and "Exit Database".

RAINFOR

Click [here](#) for the RAINFOR web site

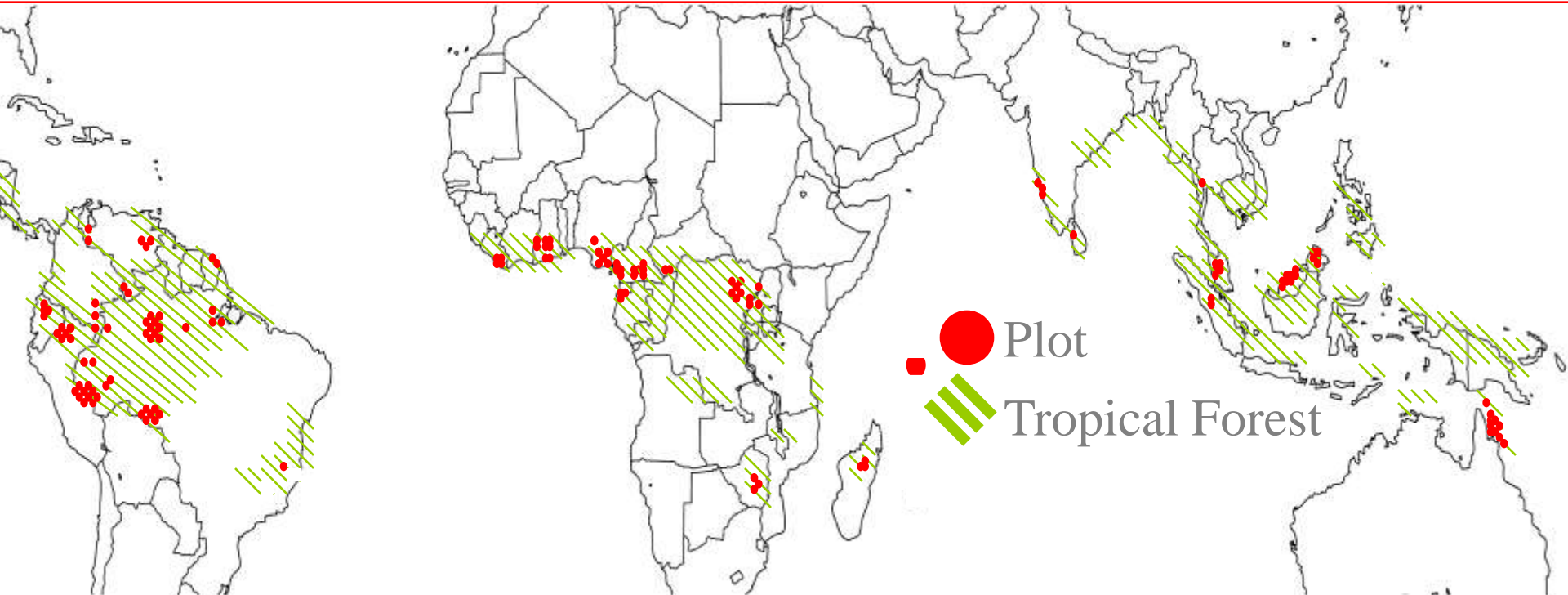
You must read and accept the RAINFOR Database Agreement before using the database.

I have read and understood the RAINFOR database agreement. I understand that this agreement may change and I will be bound to the new conditions. ☒

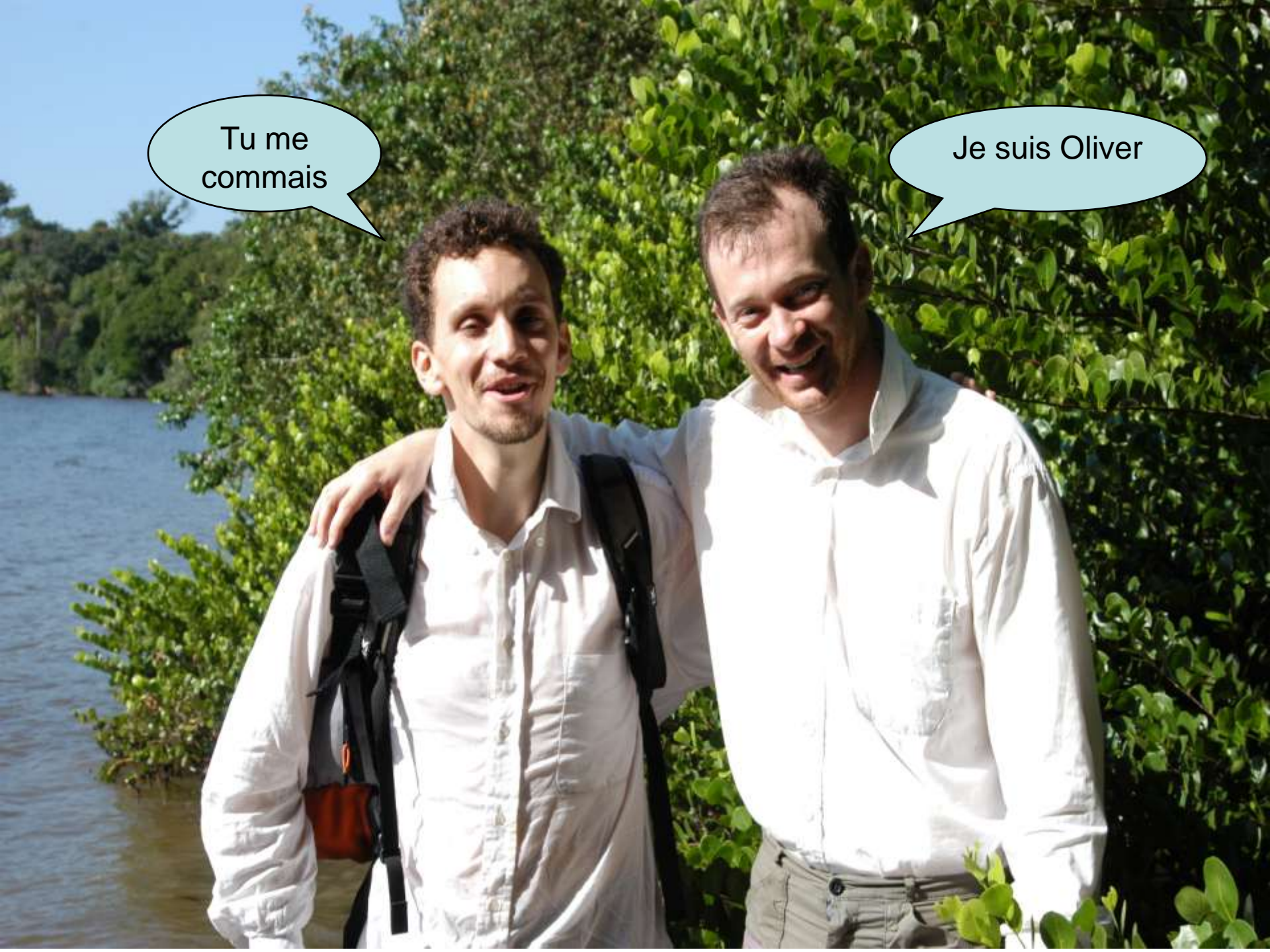
Some Current & Future Directions

1. Testing for impacts of Amazon drought
2. Are the changes in the Amazon also occurring elsewhere?

Developing a global tropical forest monitoring network



- 300 permanent plots
 - 24 countries
 - >250,000 trees periodically measured
- A few plots monitored for 50 yrs, median ~15 yrs

A photograph of two men standing outdoors by a body of water, surrounded by green foliage. The man on the left is wearing a white shirt and a black backpack. The man on the right is wearing a white shirt and has his arm around the first man's shoulder. Both are smiling. Speech bubbles are overlaid on the image.

Tu me
commais

Je suis Oliver