Drought in tropical forests

The role of tree height and wood density for hydraulic efficiency, productivity and vulnerability to cavitation of trees along a lowland precipitation gradient

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January 25, 2018

Structure of my PhD project

- **Chapter 1:** Predicting radial sap flow profiles from Costa Rican tropical dry forest species
- **Chapter 2:** Predicting plant vulnerability to embolism in Costa Rican humid tropical forest species
- **Chapter 3:** Relationship between productivity, structural and functional, wood anatomical and hydraulic traits of tropical forest species from Costa Rica

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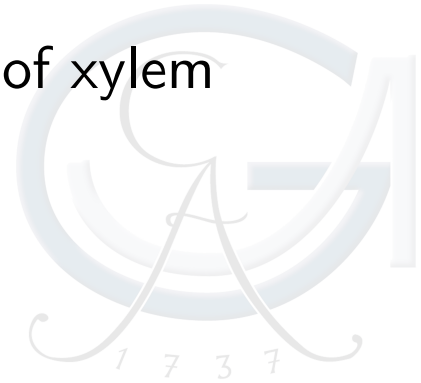
- **Bonus Chapter:** Maximum-likelihood estimation of xylem vessel lengths



Structure of this presentation

1. Introduction
2. Predicting radial sap flow profiles from Costa Rican tropical dry forest species
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5. Maximum-likelihood estimation of xylem vessel lengths: **Not in the focus of this presentation!**

Introduction

- Basics about plant water relations
- Why is it important to know about drought effects in the tropics?

Design of the study

- 5 research sites along a rainfall gradient on the Pacific shoreline of Costa Rica
- Gradient from tropical dry forest to humid tropical lowland forest
- Based on existing research sites of the **Instituto Tecnológico de Costa Rica**

Design of the study

- At each of the 5 research sites:
  - 8 species representing a gradient in tree height and wood density
  - 5 replicates per species

  $\Rightarrow$ 40 trees per site, 200 trees in total
- Field measurements of temperature, relative humidity and precipitation
- Problems with the design
  - Opportunistic use of pre-existing plots
  - Different plot sizes and numbers at each site
  - Differences in historic land use (pristine primary forest vs. disturbed primary forest vs. secondary forest)

  $\rightarrow$ Plot-based comparisons are difficult

  $\Rightarrow$ Not that important for our (eco-physiological) research questions, but limits usability of plot network for other studies

Radial sap flow

- What are radial sap flow profiles?
- What are they needed for?

Heat field deformation sensors

- Explain how they work

Heat field deformation sensors

- Problems: Figures from Sebastian's paper
- Relative values are probably reliable, absolute values have to be handled with care

Research questions & hypotheses

- Why we focus on radial gradients
- Hypothesis: The shape of radial sap flow profiles can be predicted by wood density and tree height

Data analysis

- Non-linear Bayesian hierarchical model
- Simultaneously estimating shape of profiles on one stage on the model, and regressing relationship between parameters and predictors on second model stage
- ONE SLIDE!

Preliminary results I - predicted profiles

- Figure and some explication

Preliminary results II - predicted relationships

- Figure and some explication

Vulnerability curves

- What are vulnerability curves?
- What kind of information do they offer?

The Cavi1000

- Some photos, basic information about how it works

Research questions & hypotheses

- Plant vulnerability to embolism can be predicted by structural, functional and wood anatomical traits

Data analysis

- Non-linear Bayesian hierarchical model
- Compare to HFD model, mention Ogle et al. 2009
- ONE SLIDE!

Observed vulnerability curves

- Do not overinterprete!

Big picture

- Analyzed variables (methods section)
- Design

Growth data

- short description
- picture

Wood anatomy

- short description
- picture

Non-structural carbohydrates

- short description
- picture
- data not available so far

Research questions & hypotheses

- Lots and lots of hypotheses

Data analysis

- Short explanation of structural equation models

Meta-model & causal diagram

- figures on one or two slides

Example for SEM: Martyna's paper

- Meta-model, causal diagram & final path model

Summary

- Sap flow
- Vulnerability curves
- SEM

Thanks & goodbye

- Names of assistants (pictures?)

References

- **Fuchs S, Leuschner C, Link R, Coners H, Schuldt B, 2017.** Calibration and comparison of thermal dissipation, heat ratio and heat field deformation sap flow probes for diffuse-porous trees, *Agricultural and Forest Meteorology* **244–245**,151-161. https://doi.org/10.1016/j.agrformet.2017.04.003..