Exploring the role of water and nutrients in determining savanna structure and function

R. Verweij

E. February

W. Bond

University of Cape Town

Aim

- to contribute to our understanding of the functioning of savanna ecosystems,

  by assessing the water use and nutrient uptake of trees and (to a lesser extent) grasses, using a multi-faceted comparative approach.

This talk… (work in progress)

- Water Use:

  Experiences with the TDP (Granier type) sap flow system

  May 2004-present

Why measuring sap flow?

Tree-grass coexistence from a resource availability / resource use perspective

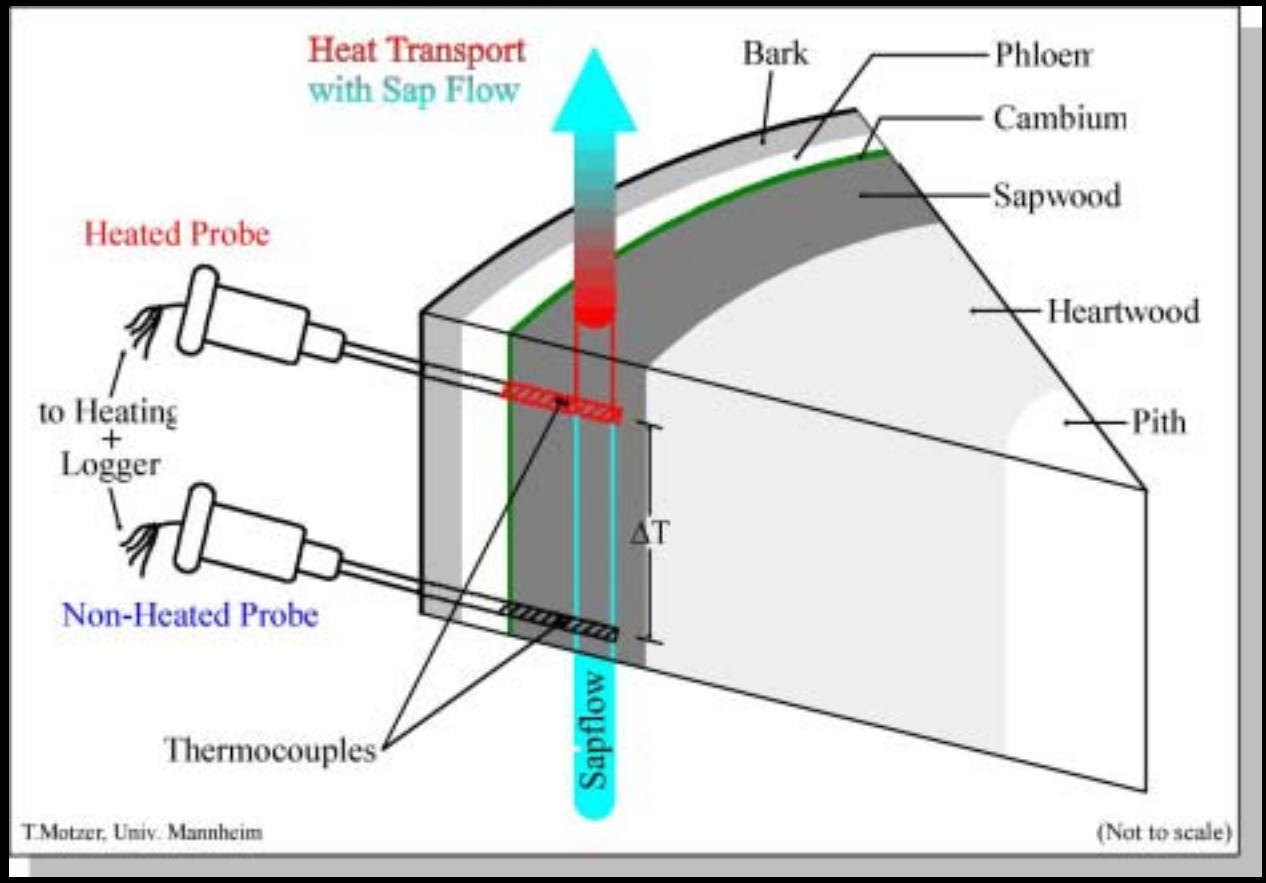
- What is the relationship between water availability, water use and leaf flushing/abscission?

In other words: how much must the water balance change for trees to drop their leaves, and how flexible are species in their response? Can trees create a temporal niche that gives them an advantage over grasses early and late in the growing season? May this provide a (partial) answer to Sarmiento's "Savanna Problem"?

Sarmiento 1984, Scholes & Archer 1997

The Granier Sap Flow System

- Two probes are inserted horizontally into the sapwood of the stem, 15 cm apart. The upper probe is continuously heated at constant power (0.2W), the lower probe is left unheated.
- Temperature difference between the two probes is influenced by the heat dissipation effect of sap flow in the vicinity of the heated probe



Lu et al. 2004, Motzer 1998

The Granier Sap Flow System

- The Granier system directly measures the electrical potential difference (ΔV) between the two thermocouples
- Sap Flux Density (F_d) - the sap flow per unit sapwood area- can be directly calculated from the voltage measurements with the formula:

$$F_d = 118.99 \times 10^{-6} [(\Delta Vmax - \Delta V)/ \Delta V]^{1.231}$$

- Total sap flow (F) (kg h^{-1}) can be calculated by multiplying F_d with the sapwood cross sectional area

Granier 1985, Lu et al. 2004

What does the sap flow dataset look like?

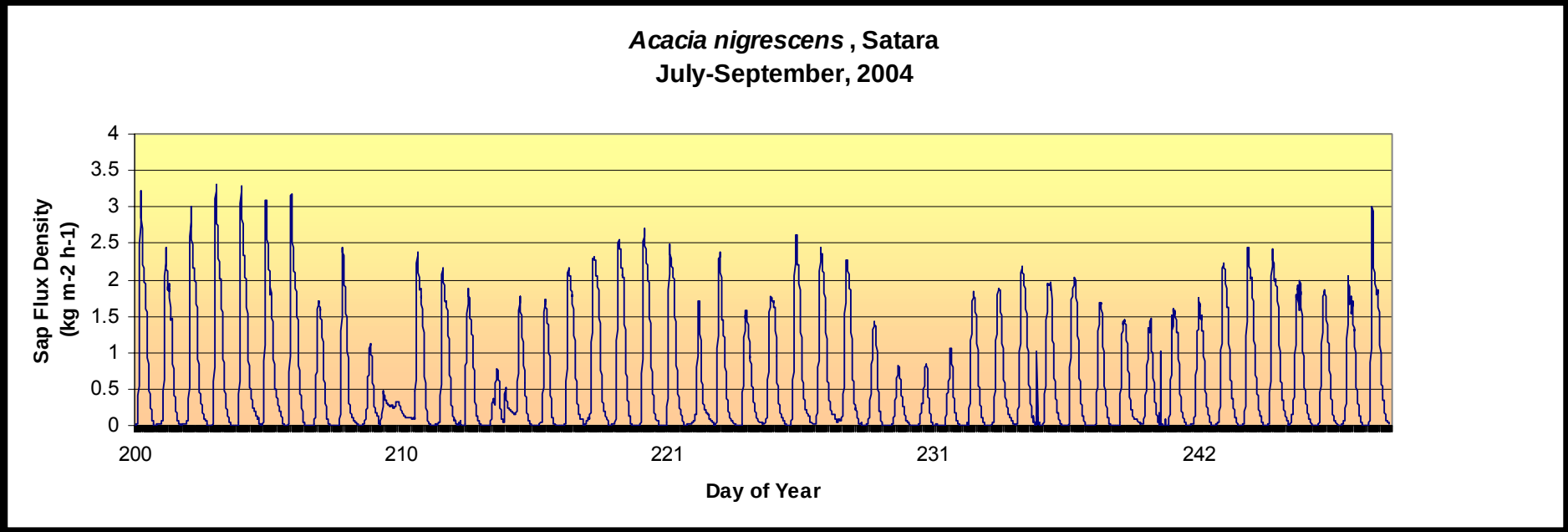
- -26 trees (in two sites)
  -2 sensor pairs each
  -reading every 10 minutes
  -since May 2004

  →LARGE DATASET

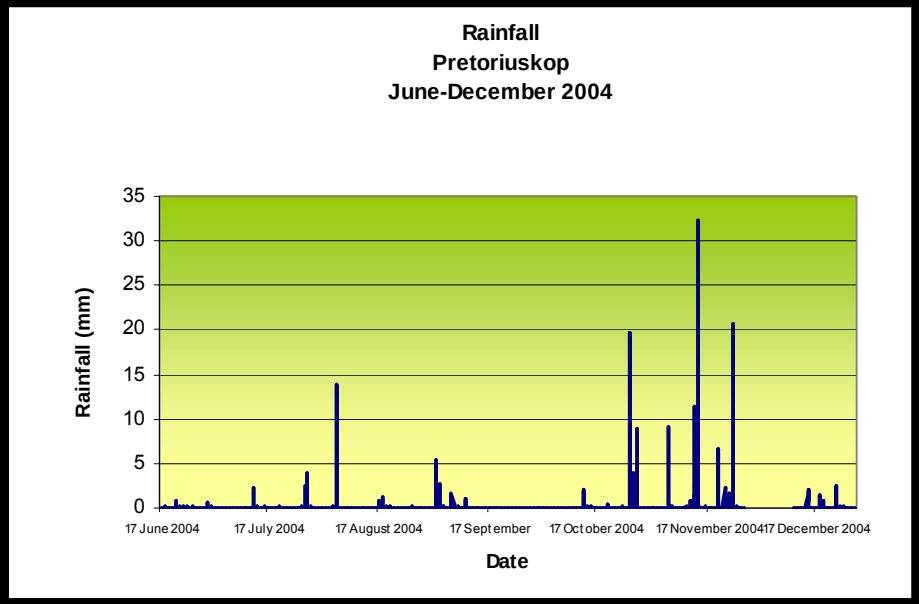
- -Short-lived sensors
  -“Wounding effect”

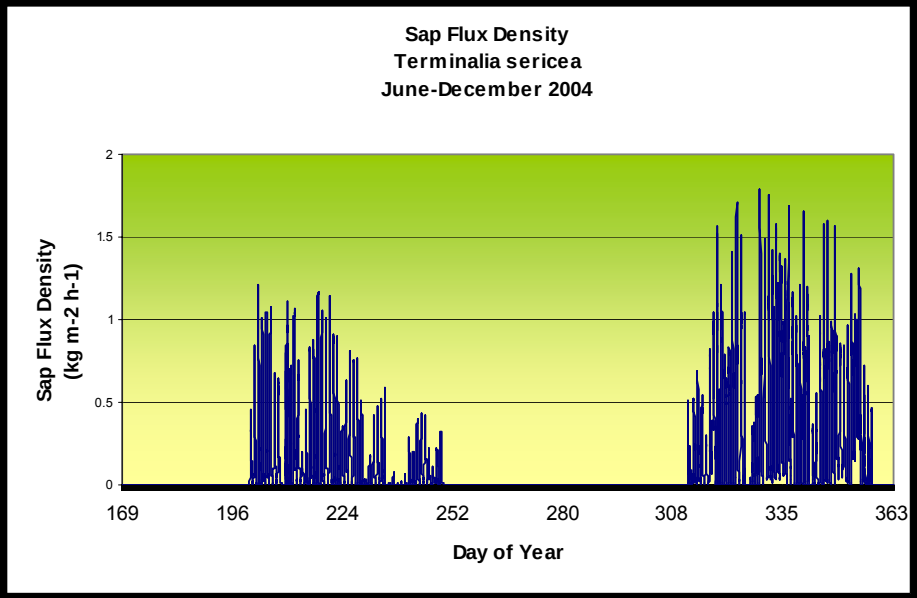
  →MANY GAPS

Some data look like this…

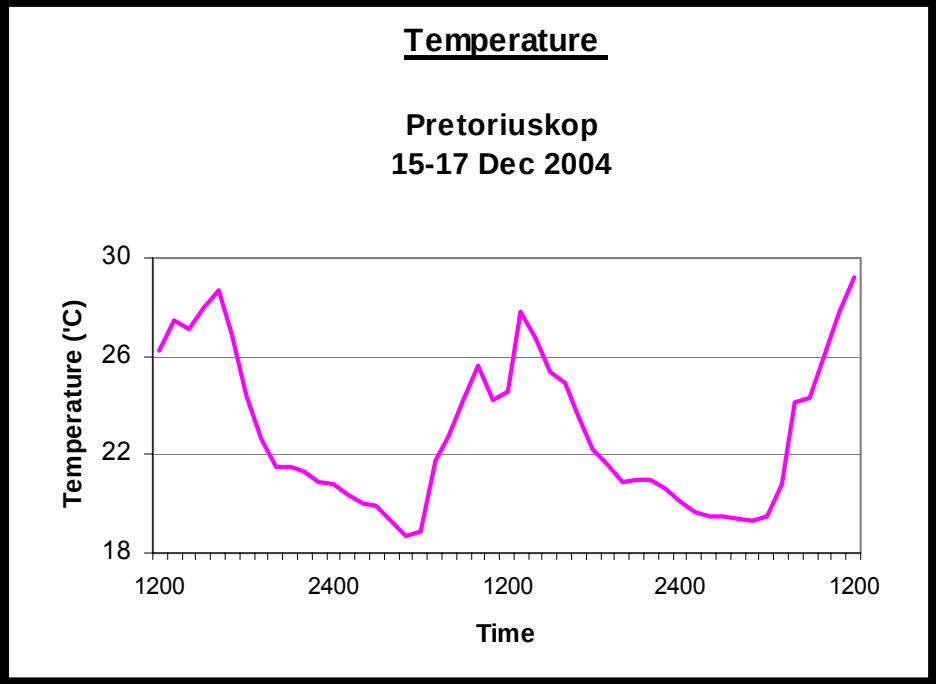


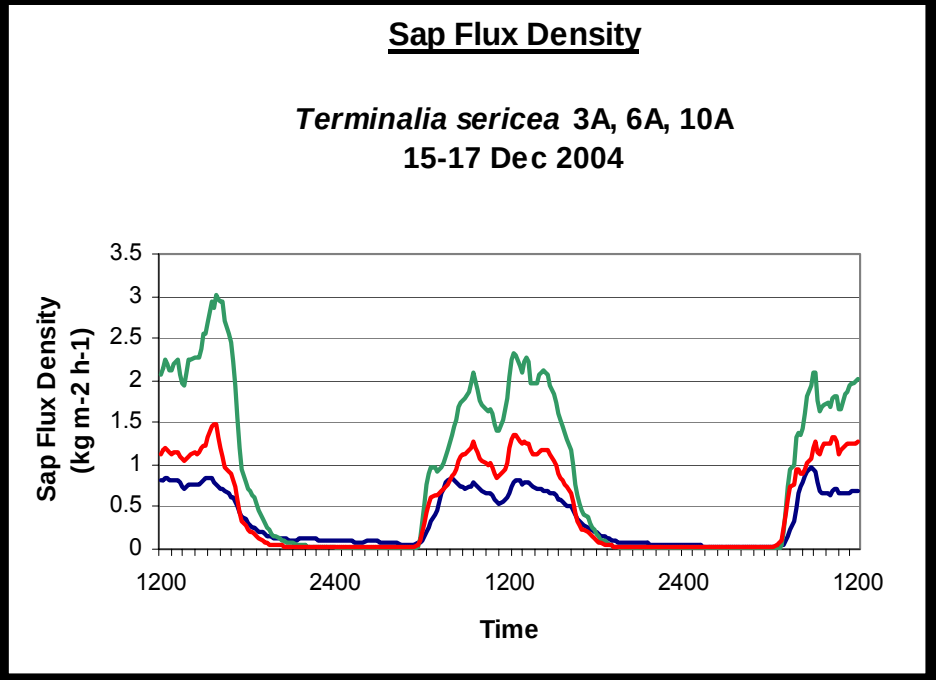
Response to Rainfall





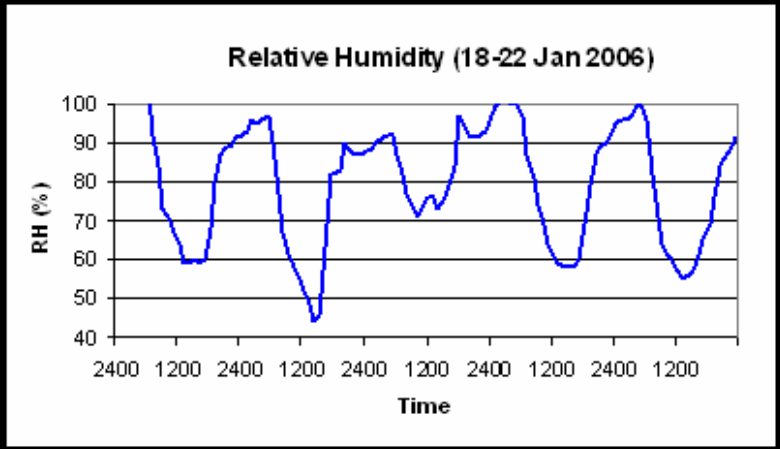
Response to microclimate (1)

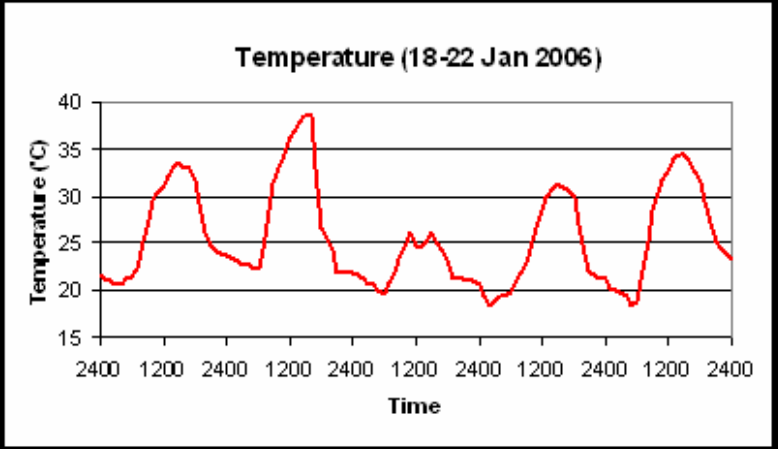


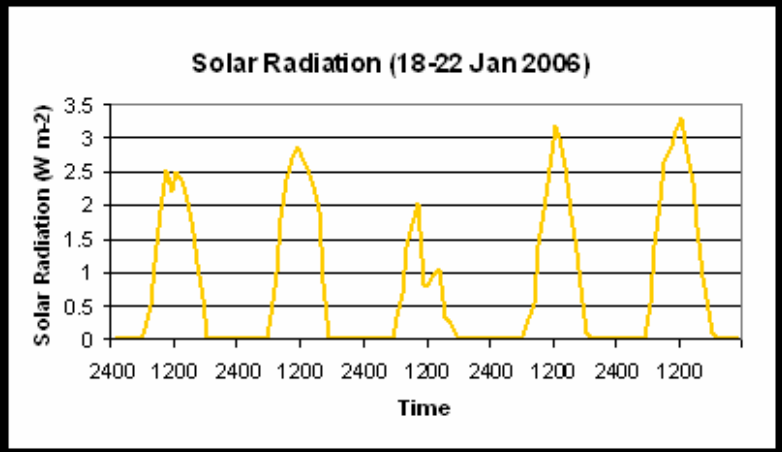


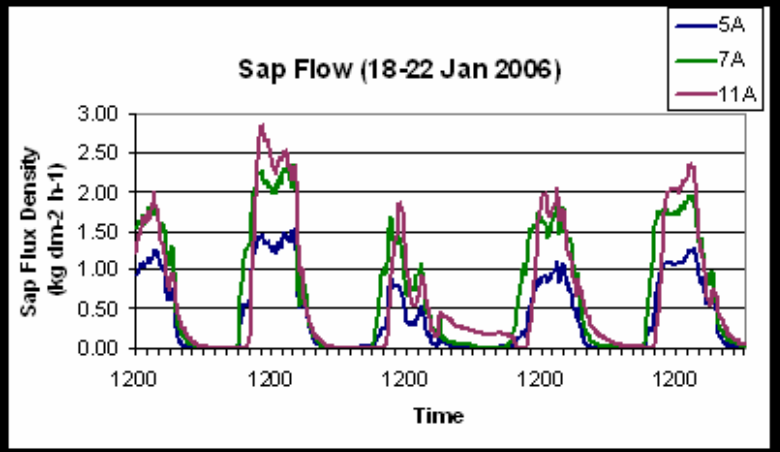
Pretoriuskop – *Terminalia sericea*

Response to microclimate (2)



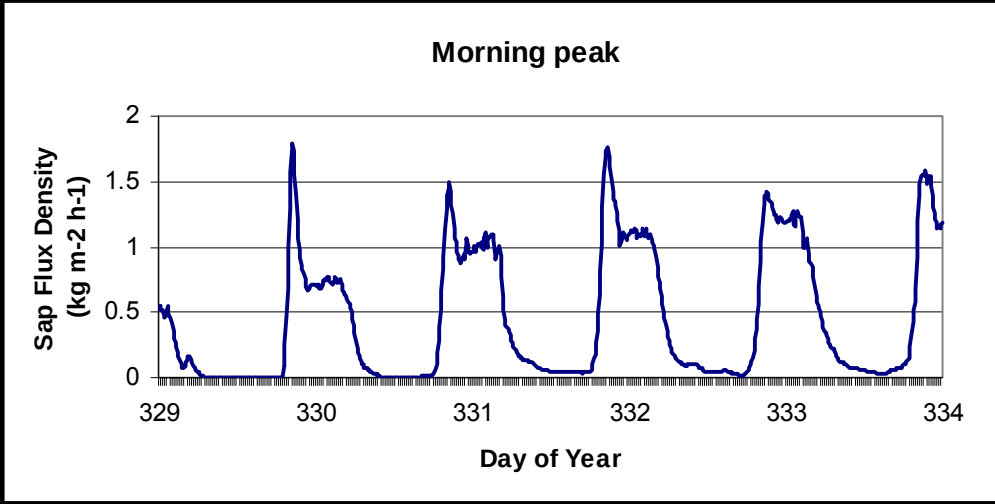






Satara – *Acacia nigrescens*

Sub-optimal: Ambient thermal gradients



- Morning peak: rapid increase to unrealistically high sap flow rates observed soon after sunrise
- Morning peaks can be avoided by improving insulation
- The unrealistic values can be corrected for with the natural thermal gradients. These can be measured by an extra pair of (unheated) thermocouples in the same trunk

Final Remarks

- The past year has been a learning curve, which has resulted in overall useful data, however with many gaps
- Future challenges: to minimize gaps in the data by intensive monitoring
- If well maintained, the Granier system can provide valuable insights in the long(er) term water use of trees as a function of available water.

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