

Application of a process-based model to support management for 'resilience

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Outline

- The case for process-based modelling
- CABALA – A linked carbon, nitrogen and water model for Silvicultural Decision Support
- Demonstration of use at Falls Block
- Some potential applications - DSS for resilient forests



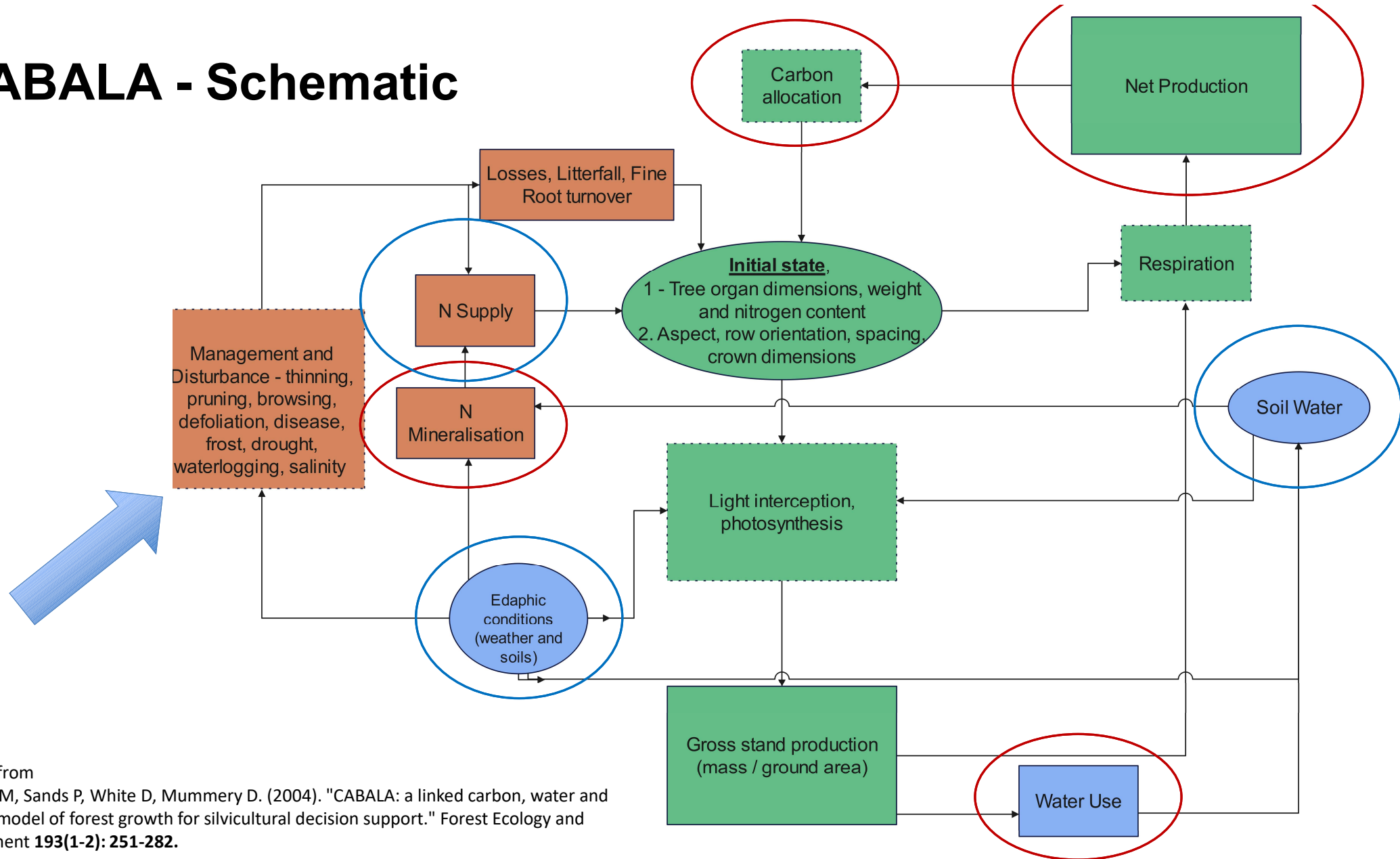
Why process-based models?

The environment for forest managers is complex, and getting more so

- Increasingly complex forestry with multiple values
 - Wood
 - Carbon storage
 - Water supply / watershed management
- The pace of climate change is accelerating
- The social and policy context is evolving rapidly

Extrapolation to future climates and new forest management requires process understanding

CABALA - Schematic



Adapted from Battaglia M, Sands P, White D, Mummy D. (2004). "CABALA: a linked carbon, water and nitrogen model of forest growth for silvicultural decision support." *Forest Ecology and Management* **193(1-2): 251-282**.

Key Features

Ray tracing light interception model (agroforestry, thinning)

Biochemical photosynthesis (responds to CO₂)

Resource supply drives growth (stem, branches and roots) and

Goal seeking allocation of dry matter

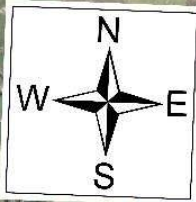
Finite element water balance (drainage, hydrology)

Nitrogen balance (including leaching)

Some management options

- Alternative “species”
- Layouts including agroforestry designs
- Thin – random, out-row, group selection, from above or below
- Pruning
- Defoliation – insect
- Disease (some limitations)
- Replant or coppice (redwoods?)
- Weeding
- Irrigation
- Woody debris retention or removal
- Interactions with Climate

**Forest Flows Sites
TiTokki Forest - Falls Block**

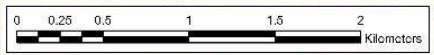


Titoki
Plot Locations
Catchment Boundary

**Planted 1996
Thinned 2003**

To Be Decided

- Primary catchment
- Secondary catchment
- Rejected/alternative catchment



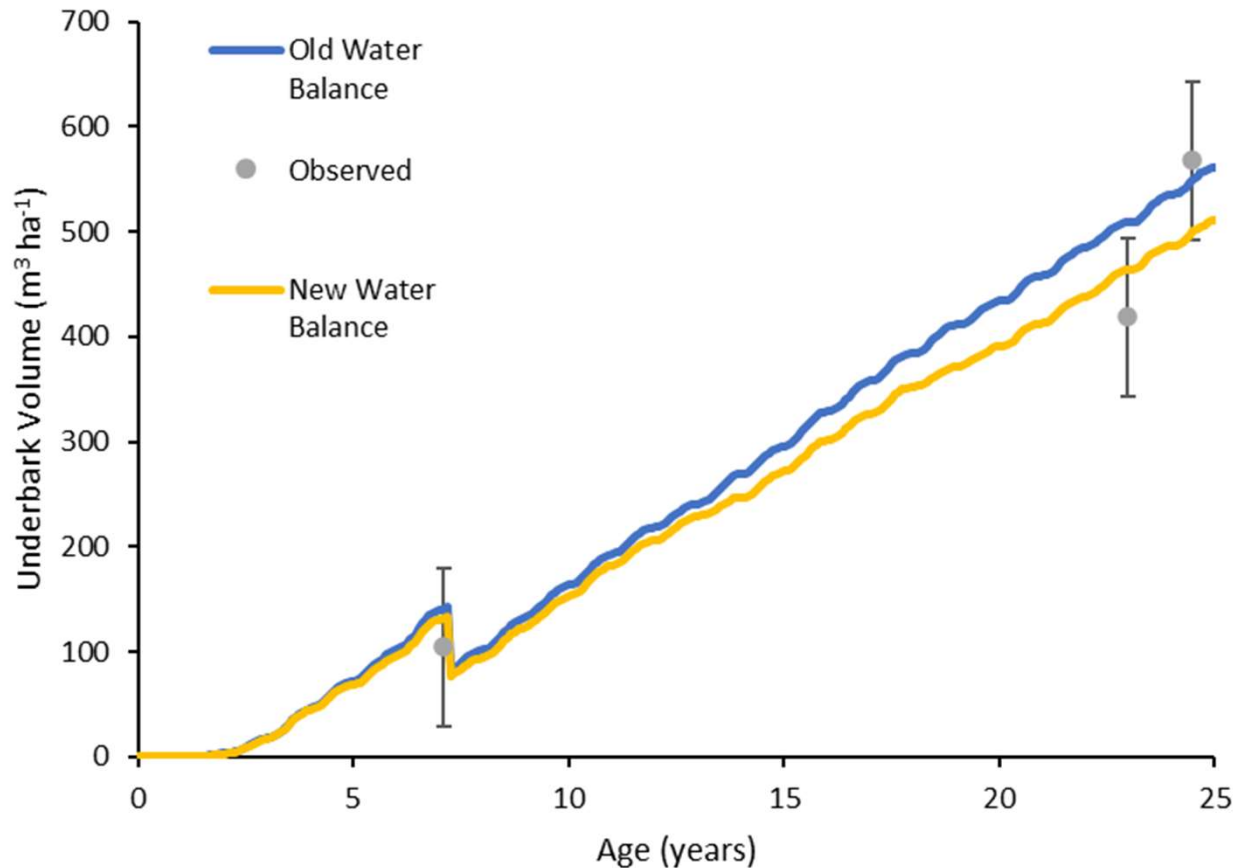
Google Earth

Image © 2020 Maxar Technologies

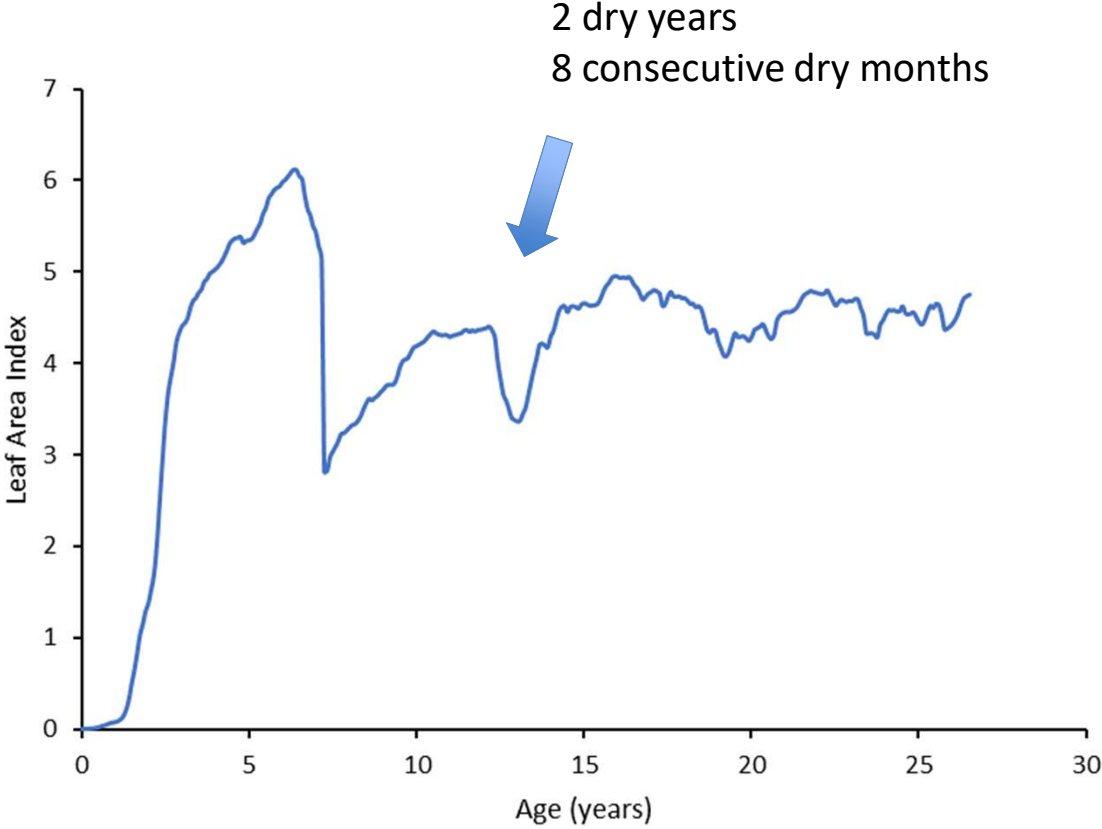
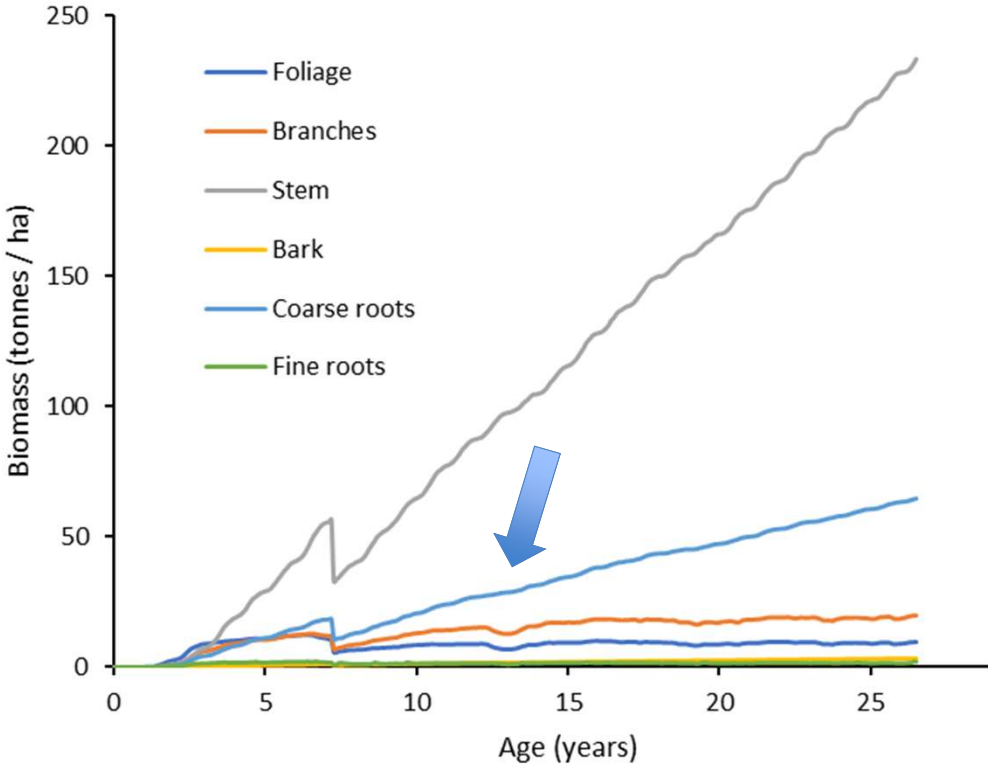
300 m



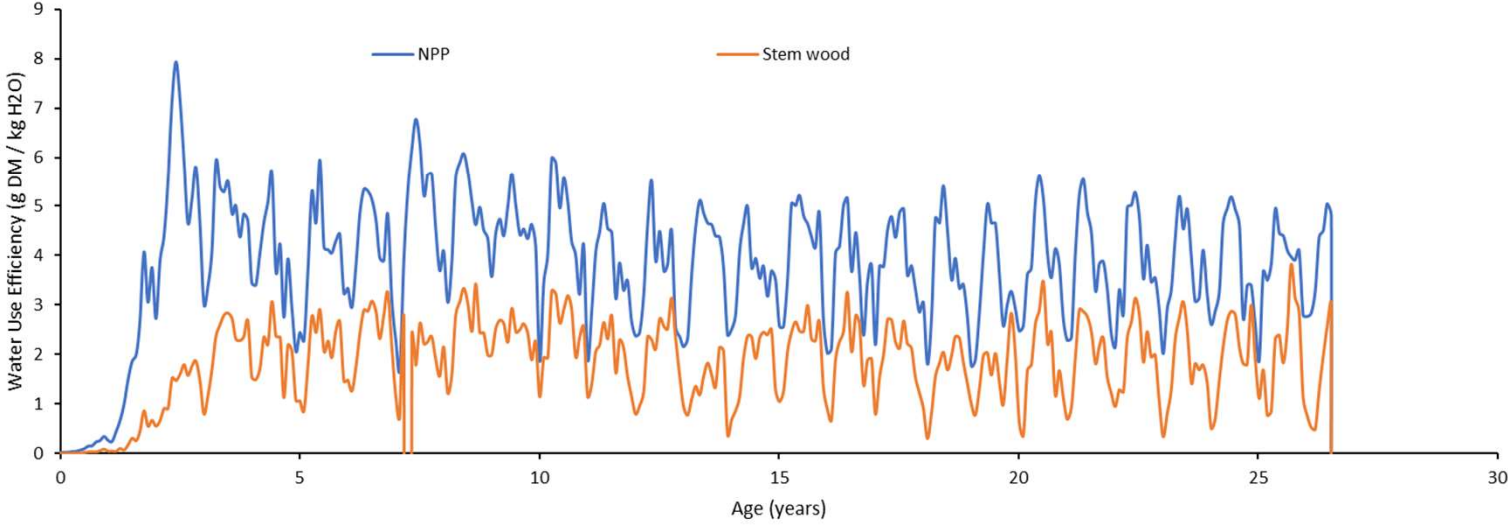
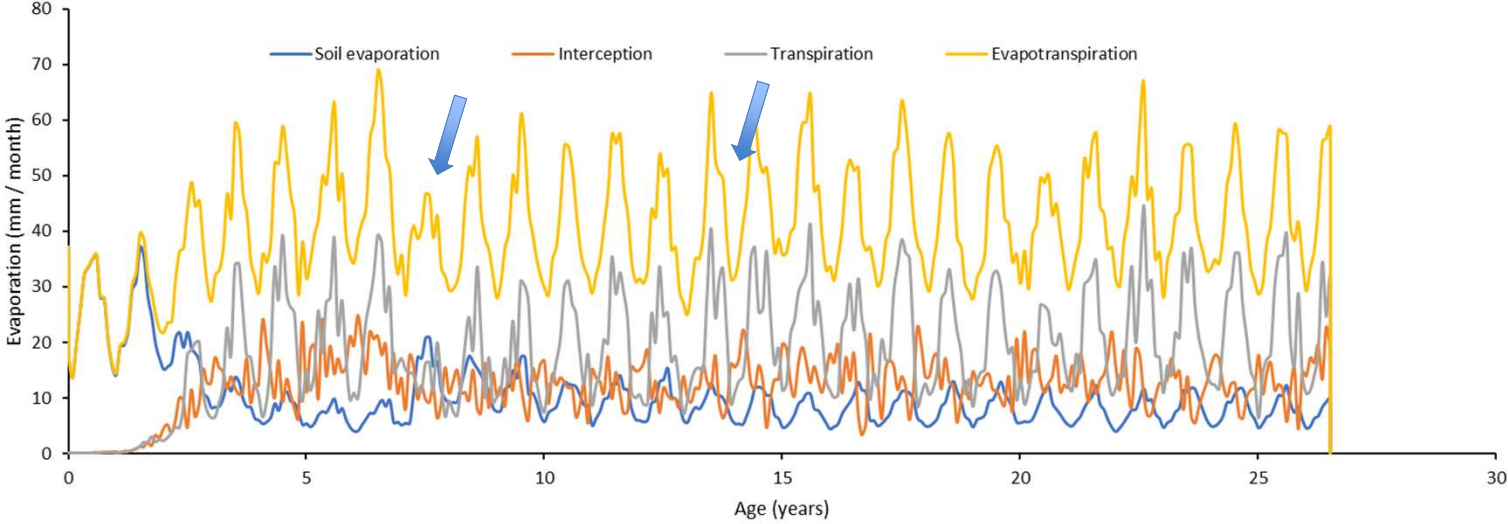
Predicted versus observed volume, falls block



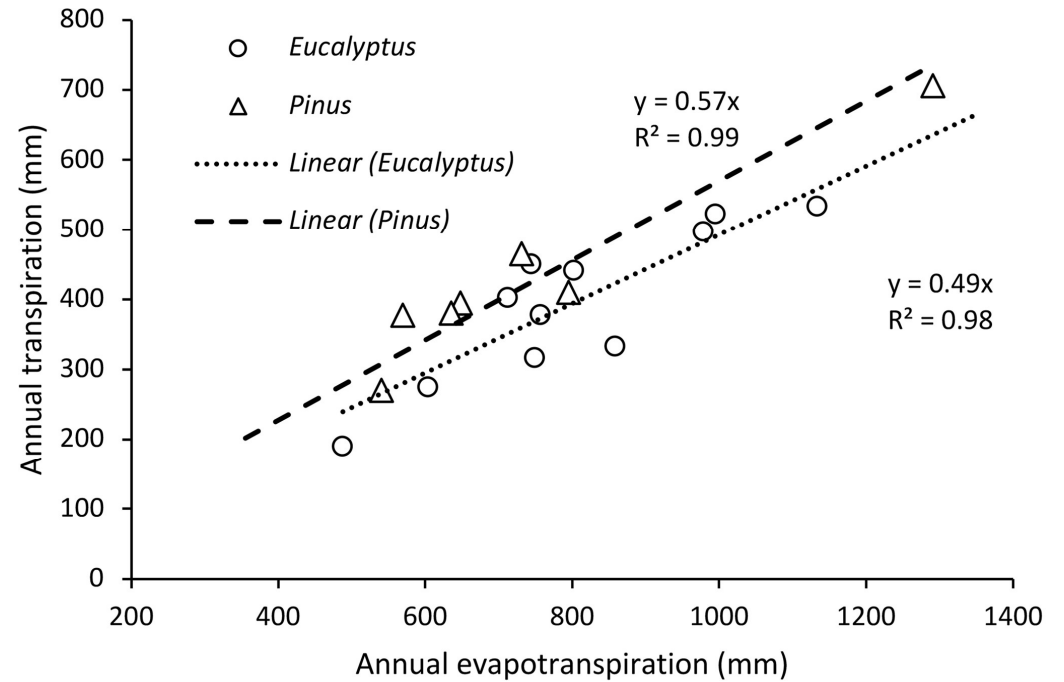
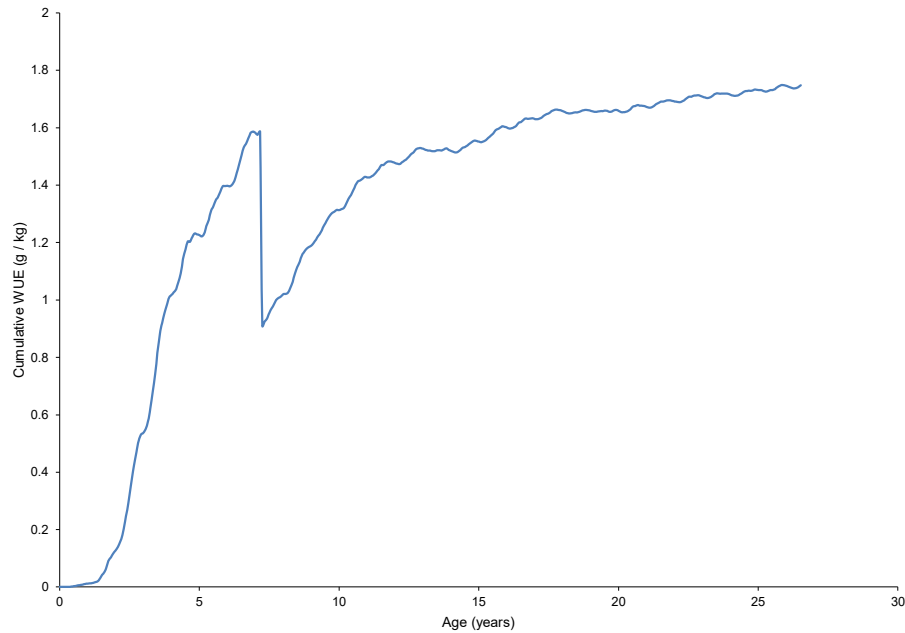
Where is the carbon?



How water use efficient is production?



Lots of seasonal fluctuation but



White, D. A., et al. (2022). "Is the reputation of Eucalyptus plantations for using more water than *Pinus* plantations justified?" [Hydrology and Earth System Sciences Discussions: 1-26.](#)

Other questions we could ask with CABALA

- How much carbon is in the soil?
- How much biomass is on the forest floor?
- What is the impact of woody debris removal on productivity over the long-term?
- How will climate change affect growth, water use and water use efficiency
- What effect will increased disease and defoliation have on productivity? Interactions with climate?
- How will soil depth interact with climate in the future?
- How much runoff and groundwater recharge is there?

Alternative species...

And how do all of these things interact with management!

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