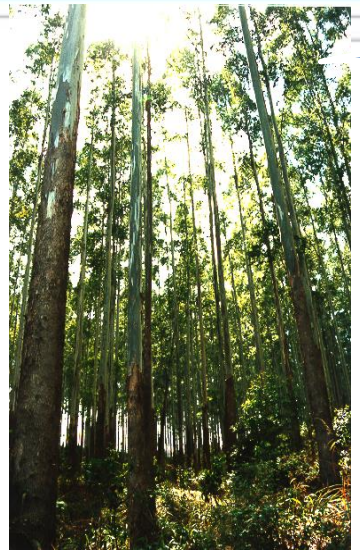
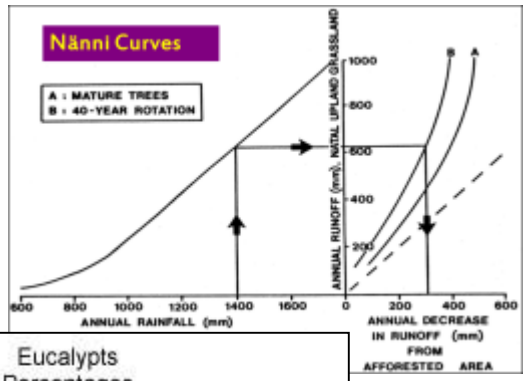
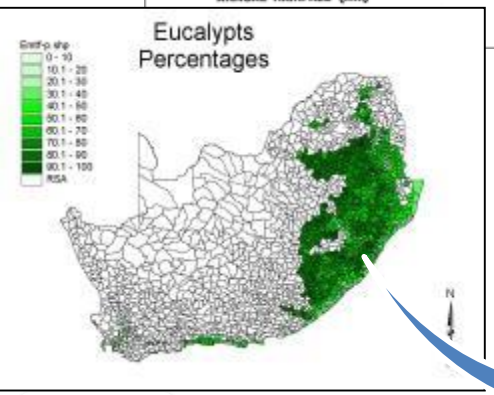
Water use, growth and socio-economic value of the biomass of indigenous trees

Mark Gush
Willem de Lange - CSIR
Peter Dye – WITS
Tatenda Mapeto - NMMU
Coert Geldenhuys - ForestWood

Background History







CSIR
our future through science

Indigenous tree products

Photos: Vanessa Masterson, John Soderlund

Background and Rationale

- Demand for timber & non-timber forest products in SA is rising
- Expansion of commercial forestry operations is restricted due to streamflow reduction impacts of introduced plantation tree species & available land
- Little is known about the water-use and growth of South Africa's 1000+ indigenous tree species
- Water use efficiencies, and the net benefit of water used are important for sustainable land-use planning from ecohydrological and socio-economic perspectives
- The numerous benefits of indigenous trees and forests, in terms of the goods and services that they offer, are widely recognised.
- Need to quantify the economic value of their products
- Develop recommendations for further establishment & sustainable use of indigenous tree resources

Project Details

Aim

- To measure and model the water use and growth of indigenous trees in different tree systems, and to quantify the economic benefits and costs of the biomass production under a range of bio-climatic conditions in South Africa.
- 6-year solicited WRC project (K5/1876)

Approach

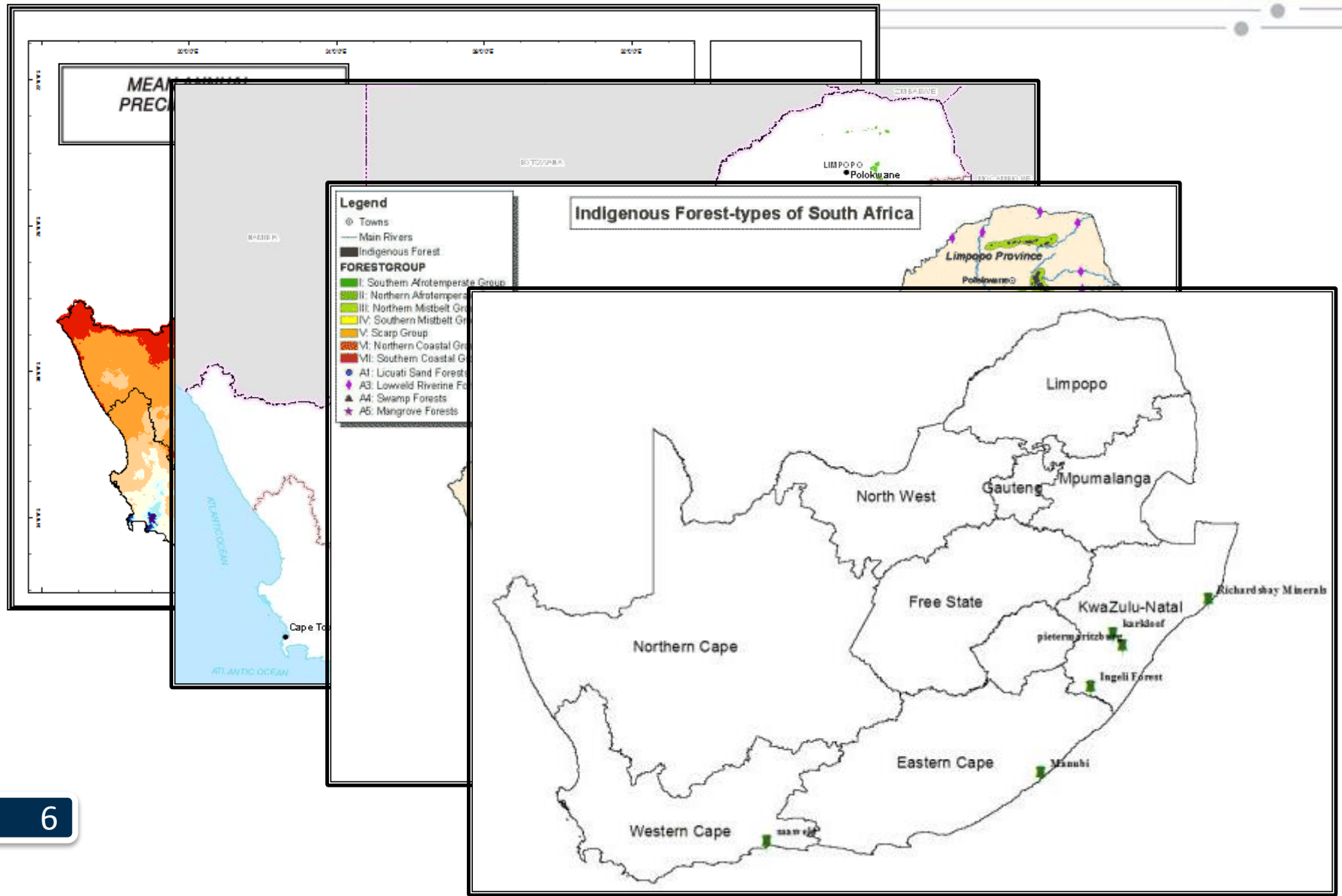
- Sites and species selection
- Data collection: Weather; Sap flow; ET; Soil Moisture; Growth
- Modelling
- Case study collection of economic data – field surveys
- Data analysis
- Comparison against introduced species / plantations

WATER RESEARCH COMMISSION

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

CSIR
our future through science

Site and Species Selection



Site and Species Selection

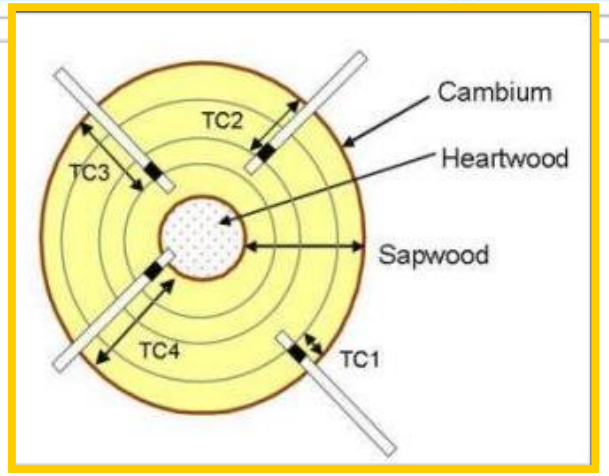
Indigenous Forests:

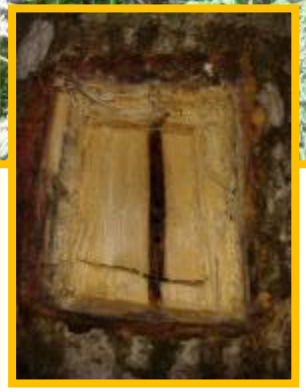
- Southern Cape Afro-temperate Forest (George)
- Southern Mistbelt Forest (Ingeli)
- Scarp Forest (Manubi)

Indigenous Trees:

- *Ptaeroxylon obliquum* (Sneezewood)
- *Millettia grandis* (Umzimbeet)
- *Ocotea bullata* (Black Stinkwood)
- *Prunus africana* (Red Stinkwood)
- *Celtis africana* (White Stinkwood)
- *Vachellia (Acacia) kosiensis* (Dune Sweet Thorn)
- *Afrocarpus falcatus* (Outeniqua Yellowwood)
- *Podocarpus henkelii* (Henkel's Yellowwood)
- *Ilex mitis* (Cape Holly)
- *Olea europaea* subs. *africana* (Wild Olive)
- *Rapanea melanophloeos* (Cape Beech)
- *Trema orientalis* (Pigeonwood)
- *Berchemia zeyheri* (Red Ivory)

Tree Transpiration and Growth





CSIR
our future through science

Indigenous Forest Evapotranspiration

$$R_n - G - H - LE = 0$$

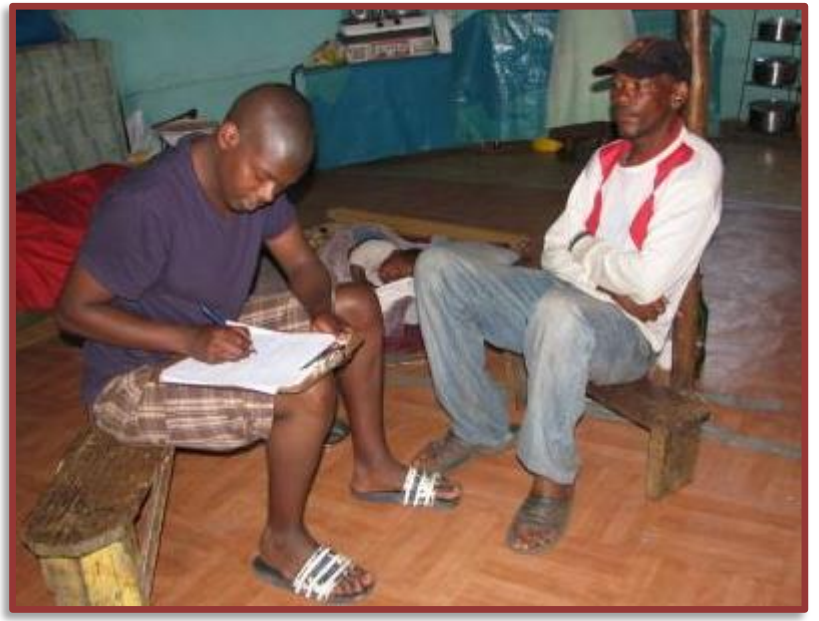
$$LE(ET) = R_n - G - H$$

CSIR
our future through science

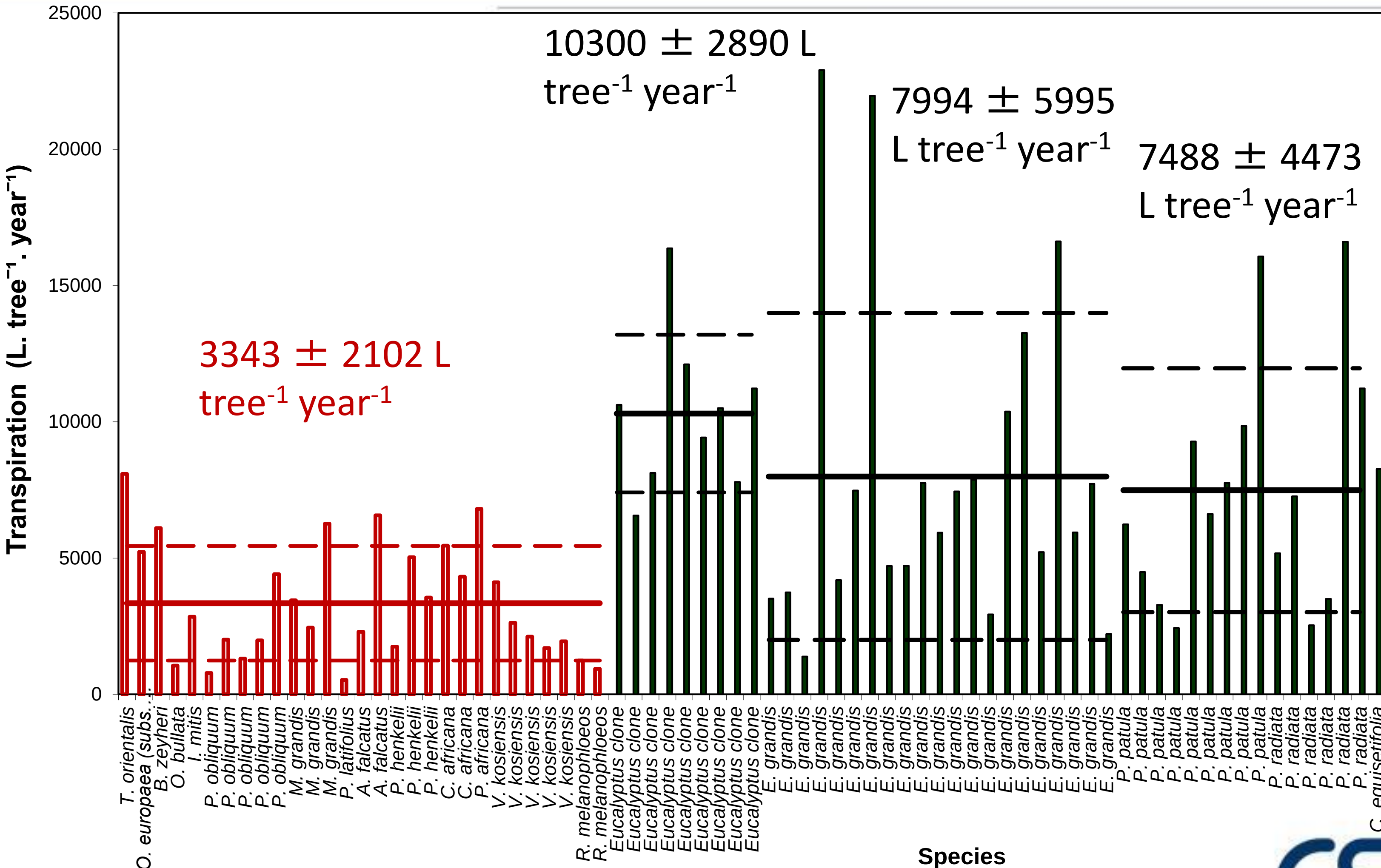
Resource Use Surveys

Surveys (Nov 2012 & July 2013) – 120 responses

- Focus on *P. obliquum*, *M. grandis* and *A. karroo*



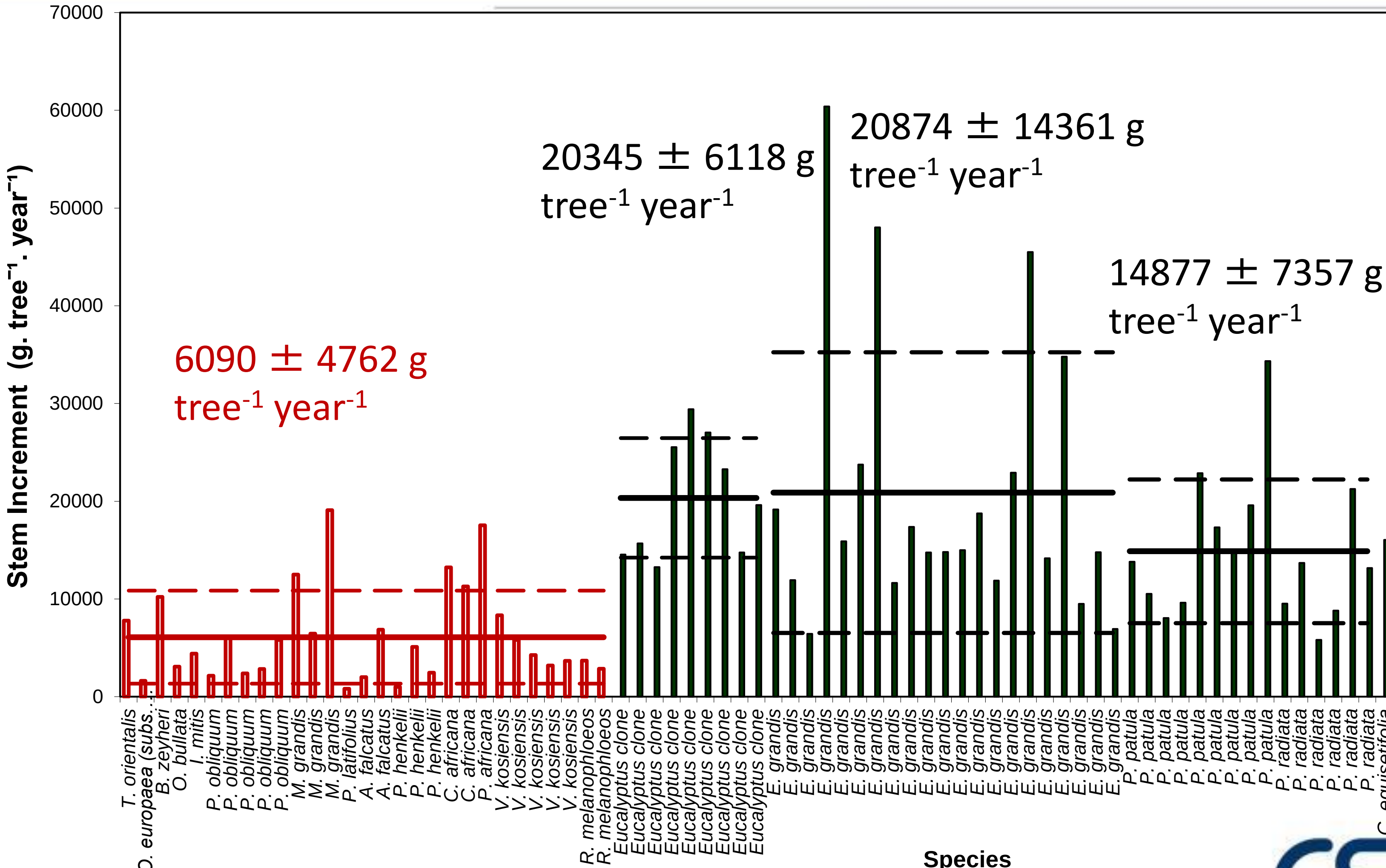
Results: Water Use (Transpiration)



(▌) Data for introduced plantation trees (Olbrich et al., 1996; Dye et al., 2001; Gush and Dye, 2009)

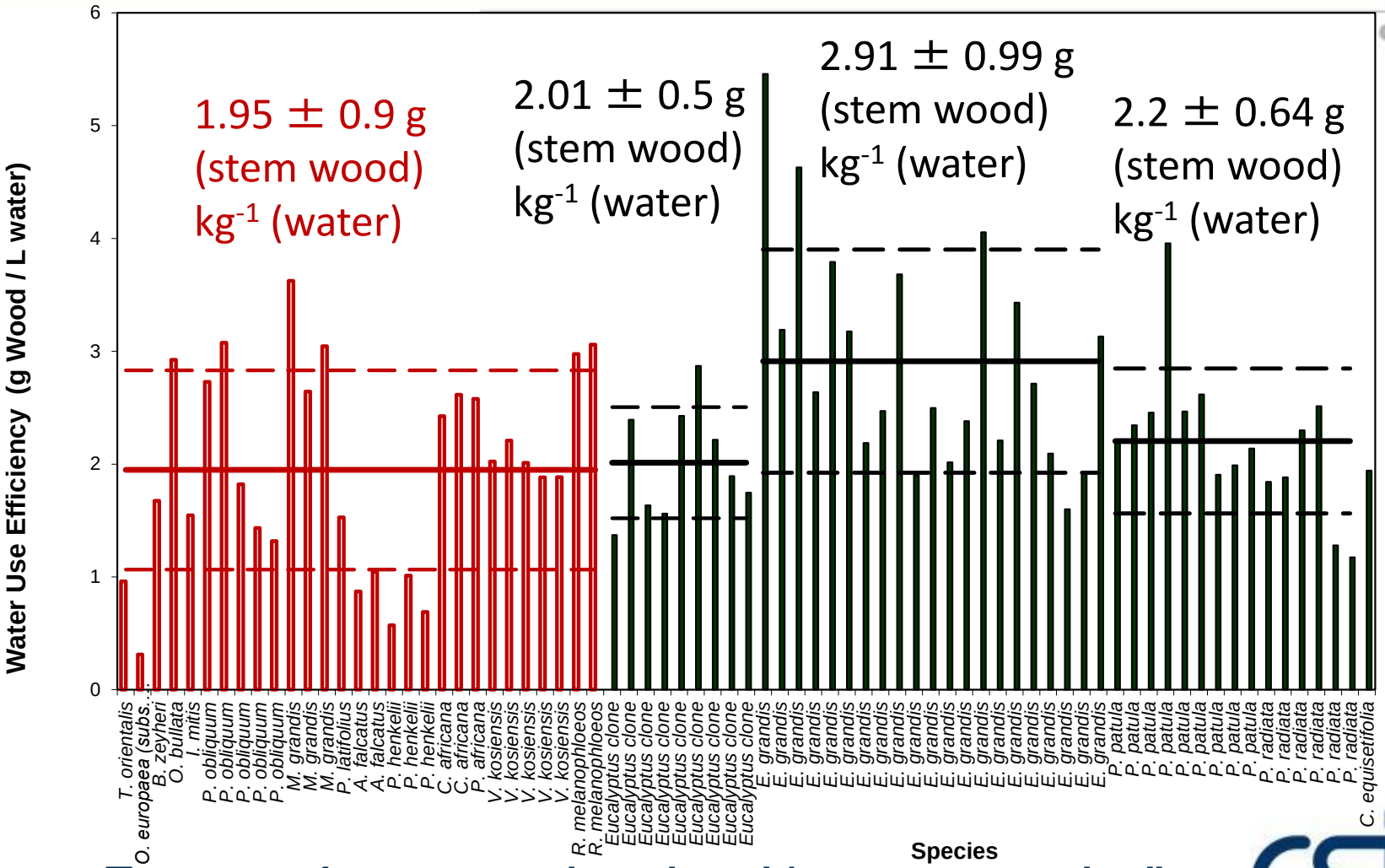
CSIR our future through science

Results: Stem Growth Increment



(▌) Data for introduced plantation trees (Olbrich et al., 1996; Dye et al., 2001; Gush and Dye, 2009)

Results: Water Use Efficiency



- WUE = (g stem wood produced / L water transpired)
- Also referred to as Water Productivity

our future through science

Results: Resource Use (informal)

- Uses: walking sticks, construction poles, medicinal / cultural, firewood
- Reasons for use: Poles & shelters – strong & durable; sticks – beautiful dark wood desired by customers; firewood – coals last
- Sticks & poles traded; ceremonial uses not traded
- Acquisition of poles incurred labour costs
- Customers are local community members , tourists, craftsmen
- Prices (Acacia): head loads R10-R20/bundle; bakkie loads R450/tonne
- Prices (Sneezewood & Umzimbeet): Sticks = R100, poles = R33
- **Total annual economic value of three priority species (Sneezewood, Umzimbeet, Acacia) for 120 informal traders - R939 432/yr**

CSIR
our future through science

Results: Resource Use (formal)

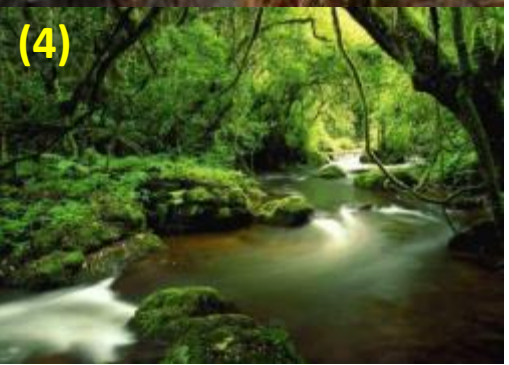
- Uses: Furniture, carving, beams, instruments, flooring, veneers
- Reasons for use: Unique, attractive grain, strong & durable; sentimental
- Trade: Auctions (under review); furniture & craft shops; turning blanks
- Costs: Plantation establishment and maintenance (Yellowwood); transportation; specialist sawmill equipment & expertise
- Customers are local buyers, tourists, overseas traders in rare wood
- Challenges: Sourcing & availability, reliability of supply, quality variation
- **Formal market value (R11000 /m^3- R45000/m^3), but supply limited**
- **Financial analysis of Yellowwood plantation (45-yr rotation) is profitable (with assumptions), but very long-term**

CSIR
our future through science

Conclusions

- Indigenous trees generally use less water than similarly sized “exotic” introduced tree species
- Correspondingly slow growth = similar WUE (bio-physical perspective)
- Significant site and species-specific variation
- Genetic improvement of indigenous trees (Provenance trials?) but trade-off between growth rates & water-use
- Informal indigenous tree product industry is heterogeneous & amorphous; yet economically significant at a local scale.

CSIR
our future through science



Implications

- Low water use and growth rates require use of marginal land or high product value to be viable
- Potential for high economic WUE, but commercial viability requires new / expanded markets & long-term perspective
- Tree form and wood quality require further research
- Hydrological benefits of indig. trees in riparian zones, reforestation, urban greening and rural woodlots (1 & 2)
- Consider the role of fire in the landscape (3)
- Ecological infrastructure, biodiversity and aesthetics (4)

CSIR
our future through science

Applications

- Continue applying water-saving management practices in commercial forestry
- Reduce non-beneficial water use
- Consider expansion with low water using indigenous tree species
- Objective is sustainable commercial forestry from eco-hydrological and socio-economic perspectives

"Crop-per-drop"; "Jobs-per-drop", "Frogs-per-drop"

Thank you!

- Funding - Water Research Commission & Dept. Env. Affairs (NRM)
- SANParks (Garden Route National park), Ms. Theresia Ott (Richards Bay Minerals / Rio Tinto), Mondi Forests (Doug Burden), Manubi State Forest, iNgeli State Forest, and the UKZN Arboretum.
- Vivek Naiken, Siyasanga Daka, Barry James, Brian Mahumani, Tembelani Nokwali for assistance in the field.

Mark Gush (mgush@csir.co.za)