More crop per drop:
Improving our knowledge on crop water requirements for irrigation scheduling

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Background:

- Food security = water security
- Increasing pressure on water resources in SA (population & economic growth, climate change, dilution capacity for water quality)
- Economic importance of agriculture and forestry to SA (GDP & value add / jobs)
- Significant water use by irrigated agriculture, forestry & invasive alien plants
- Varies by crop type, irrigation vs dryland, rainfall region, tree species, riparian / upland
- How to produce more “crop-per-drop?”
- Measure to manage
Water use by sector

- Agriculture / Irrigation: 60%
- Afforestation: 3%
- Municipal / Domestic: 27% total = 24% urban, 3% rural
- Livestock watering and nature conservation: 2.5%
- Mining: ± 2.5%
- Power generation: 2%
- Industrial: ± 3% (if not part of Urban Domestic)

Source: Dept. Water and Sanitation, NWRS-2.
Measuring water use
Transpiration (tree)
Measuring water use
Total evaporation (forest / orchard)

\[ R_n - G - H - LE = 0 \]

\[ LE(ET) = R_n - G - H \]
Modelling

Use of models to simulate ET from trees & canopy surfaces – calibrated & verified with seasonally observed data
Remote sensing & earth observation
Water use of fruit tree orchards
Results
Results

- A 14 yr old ‘Pink Lady’ apple tree transpires:
  - ± 20-30 L water/day in summer (max 42 L)
  - ± 4000 L water/yr (680 mm / 6800 m³.ha⁻¹)
  - ± 27 L water per apple (170 L/kg apples)
Forests & plantations

\[ \Delta \text{Et} \approx \Delta \text{Streamflow} \]

Zhang et al., 1999
• Cathedral Peak (1950 – 1987): Afforested (treatment) vs. grassland (control).

Results

Transpiration (L. tree⁻¹. year⁻¹)

<table>
<thead>
<tr>
<th>Species</th>
<th>Transpiration (L. tree⁻¹. year⁻¹)</th>
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<tbody>
<tr>
<td>3343 ± 2102 L tree⁻¹ year⁻¹</td>
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<td>7994 ± 5995 L tree⁻¹ year⁻¹</td>
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<td>7488 ± 4473 L tree⁻¹ year⁻¹</td>
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<td>T. orientalis</td>
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<td>O. europaea (subsp.</td>
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<td>B. zeyheri</td>
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<td>O. bullata</td>
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<td>I. mitis</td>
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<td>P. obliquum</td>
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<td>M. grandis</td>
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<td>M. africana</td>
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<td>V. kosiensis</td>
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<td>R. melanophloeos</td>
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<tr>
<td>Eucalyptus clone</td>
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<td>P. patula</td>
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<td>P. radiata</td>
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<td>C. equisetifolia</td>
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</table>
Invasive alien plants
Results

Landscape invasions
Percentage cover
- 9
- 0.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 90
- Primary catchments
- Excluded

MAR reduction (%)
- 0.0
- 0.1 - 1.0
- 1.1 - 5.0
- 5.1 - 10.0
- 10.1 - 25.0
- 25.1 - 34.4
- Primary catchment
- Quaternary catchment

Map showing the distribution of landscape invasions with percentage cover and MAR reduction across South Africa.
IAPs Summary

- Total condensed area 1.50 (1.3-1.7) million ha
- Total MAR reduction 1 444 (1 304-1 598) mill m³/yr
  (2.88% of MAR) - Equivalent to 97 mm/yr
- Most invasions in E Cape, KZN, Mpumalanga
- Most affected Biome:
  - Forest – issues of data resolution
  - Grasslands – greatest volume
  - Indian Ocean Coastal Belt – highest %
6-yr increase in streamflow = 114mm / 46.5%
1ha riparian zone cleared = 3.5 ha non-RZ cleared
Where to from here?

• On-going field measurements and modelling
• Use results in water allocation & irrigation scheduling
• Improved efficiencies & productivity (“crop per drop”)  
• Enhanced monitoring (water meters), reduced transmission losses / leaks, more use of waste-water (grey water, rainwater harvesting etc.)
• Increased use of groundwater for irrigation
• Ongoing removal of IAPs to augment water supplies
• Application of new technologies for precise monitoring of water use e.g. remote sensing (UAVs / satellites), online / real-time irrigation scheduling.
Conclusions

• Agriculture can & must become more efficient in its use of water
• Agricultural water allocation processes need to be enhanced
• Requires accurate crop and tree water use data (how much water is required, when, and where)
• Requires accurate data on crop areas (crop type mapping)
• Requires improved modelling, validated with accurate field data collected for a wide variety of trees and crops, growing in a range of conditions.
• Recognise full value-added benefit of agriculture to SA

“Crop-per-drop”; “Jobs-per-drop”, “Frogs*-per-drop”
*Environmental Indicators
Acknowledgements

• Funding:
  • Water Research Commission
  • Dept. Agric. Forestry & Fisheries
  • Dept. Environmental Affairs
• Project Teams (CSIR & external)
• Students
• Land Owners and Managers
Thank you