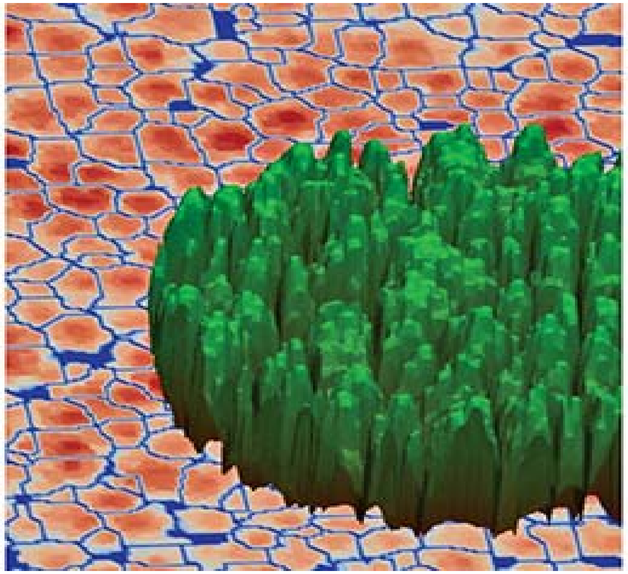
Growing confidence in forestry's future Research Programme

SCION
FORESTS | PRODUCTS | INNOVATION

National spatial analysis of radiata pine water use

Dean Meason, Barbara Höck, Priscilla Lad, Jody Bruce, Michael Battaglia



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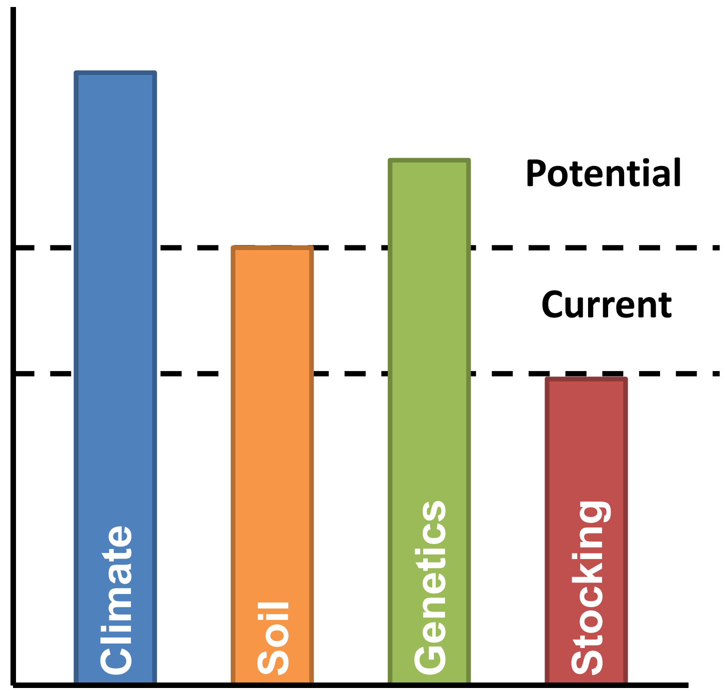
Radiata pine productivity and forest water use

- Radiata pine site productivity and resource use is limited by four major factors
- Site productivity directly or indirectly impacts radiata water use e.g.
  - Rainfall
  - Temperature & air “dryness”
  - Soil water storage capacity
  - Soil nutrients
- What is the estimated water use of radiata pine throughout NZ?
- Common radiata pine assumptions
  - Radiata forests use 42% of annual rainfall
  - No surplus water from radiata pine forest catchments in the summer



Powers, R.F., 1999. On the sustainable productivity of planted forests. New Forests 17, 263-306

Forest hydrological processes

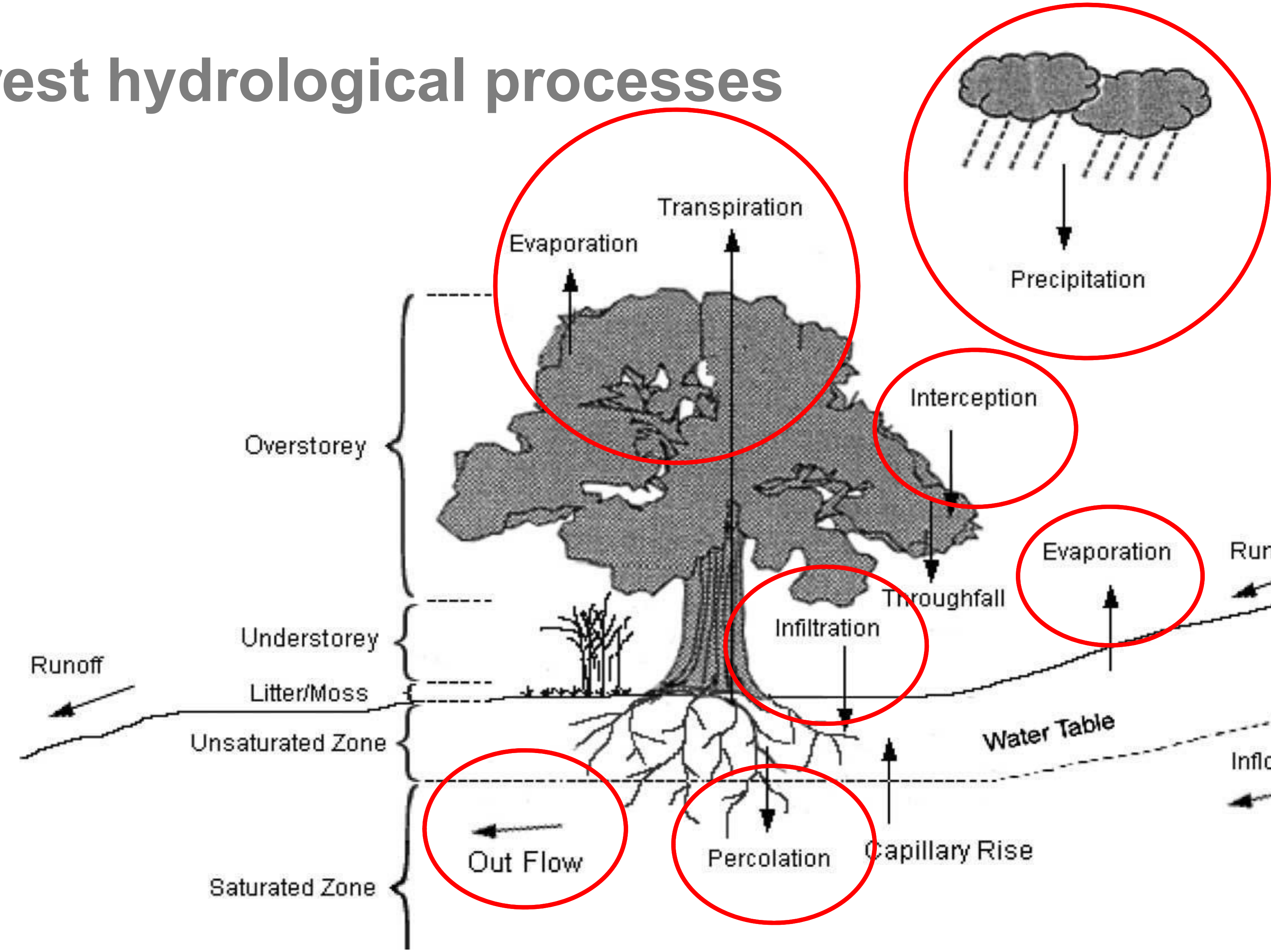
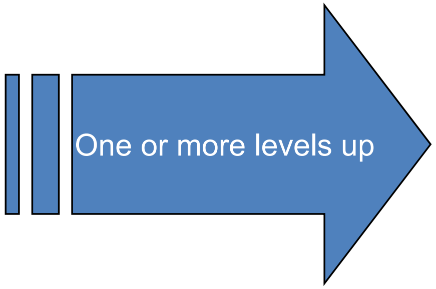


Figure 1 Hydrological processes at the forest scale (Chen et al., 2005)

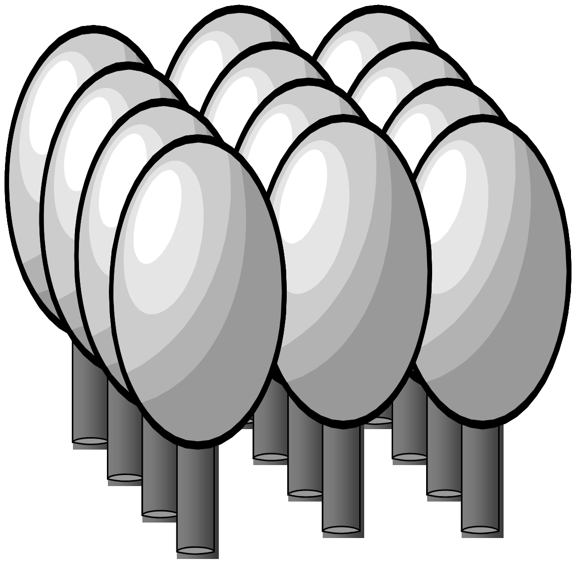
Process-based model - CABALA

Input level
- Soil
- Photosynthesis
- Leaves
- Roots
- Climate
- Silviculture
- etc.

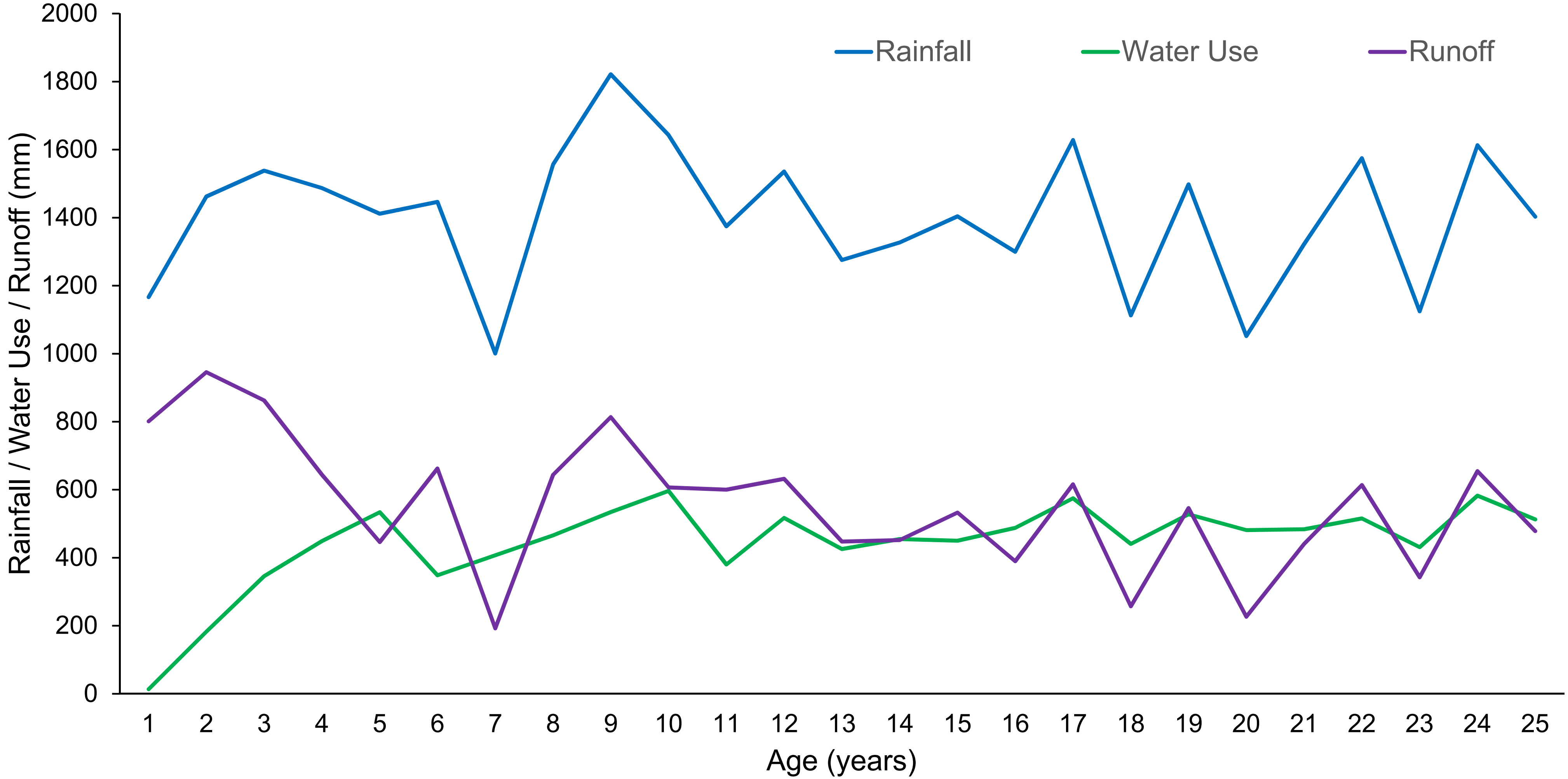
Modelling levels
- Sub-canopy
- Tree
- Soil processes
- Stand
- Forest



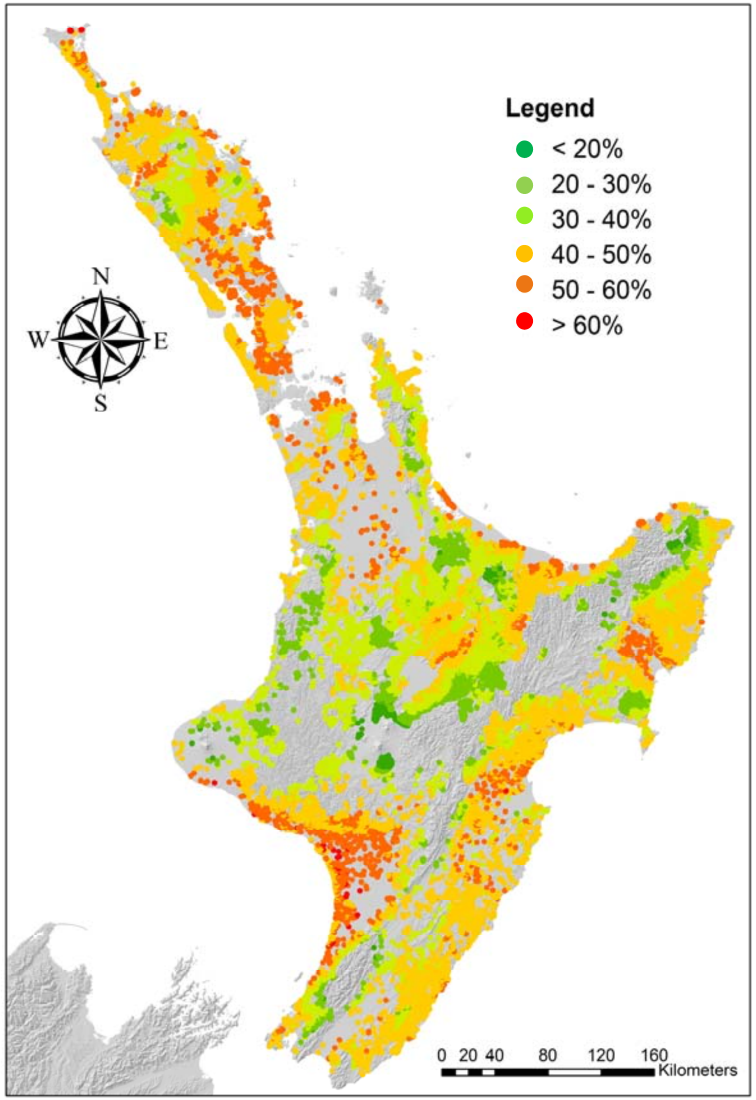
Output level
- Productivity
- Volume & wood quality (e-Cambium)
- Resource use & limitations
- Different time scales

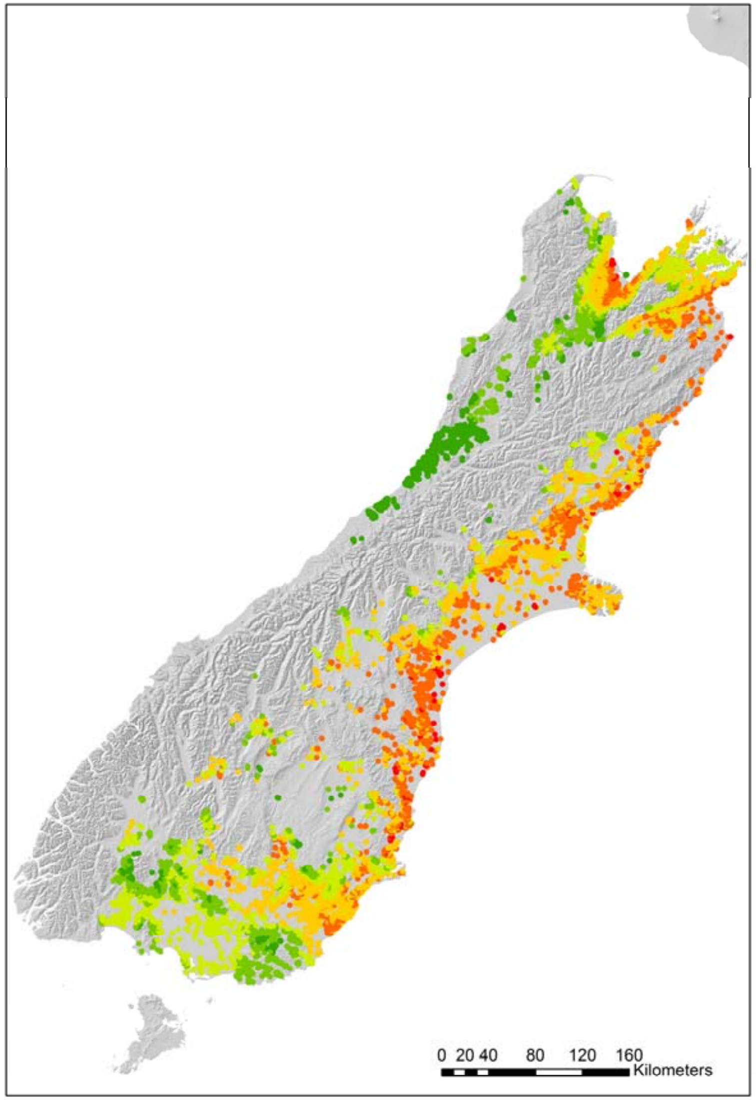


CABALA example – simulated stand water use over 25 years

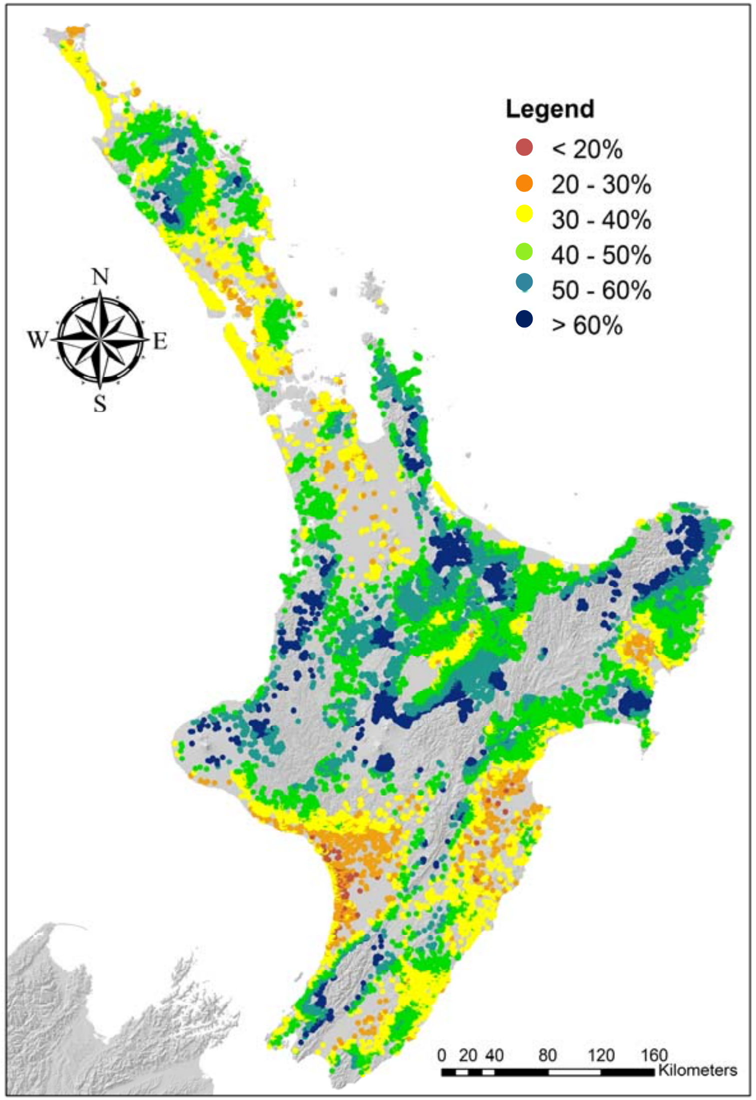


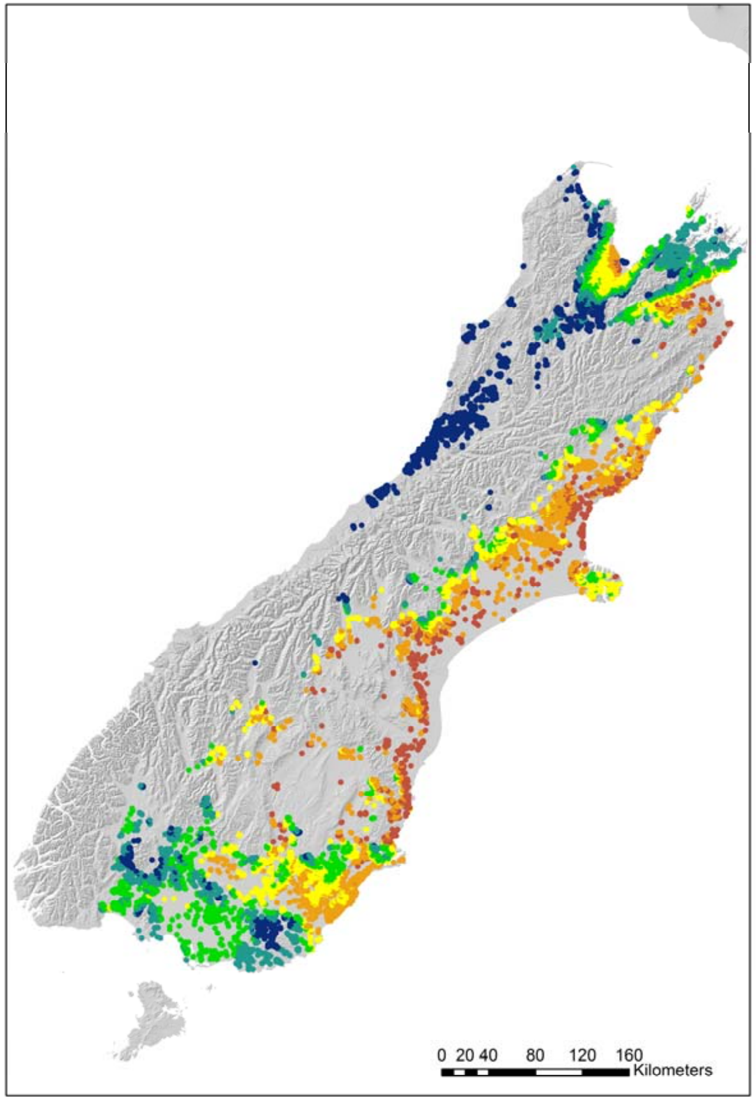
Radiata water use – percentage rainfall use over 30 years





Radiata water use – percentage surplus rainfall over 30 years





Water use verses water yield

- Two dimensional, “tipping bucket” model - difference between rainfall, forest water use, and changes in soil water storage
- Unable to represent the 3-dimensional catchment level processes
- Unable to represent the forest hydrology dynamics that change daily, weekly, monthly, & seasonally

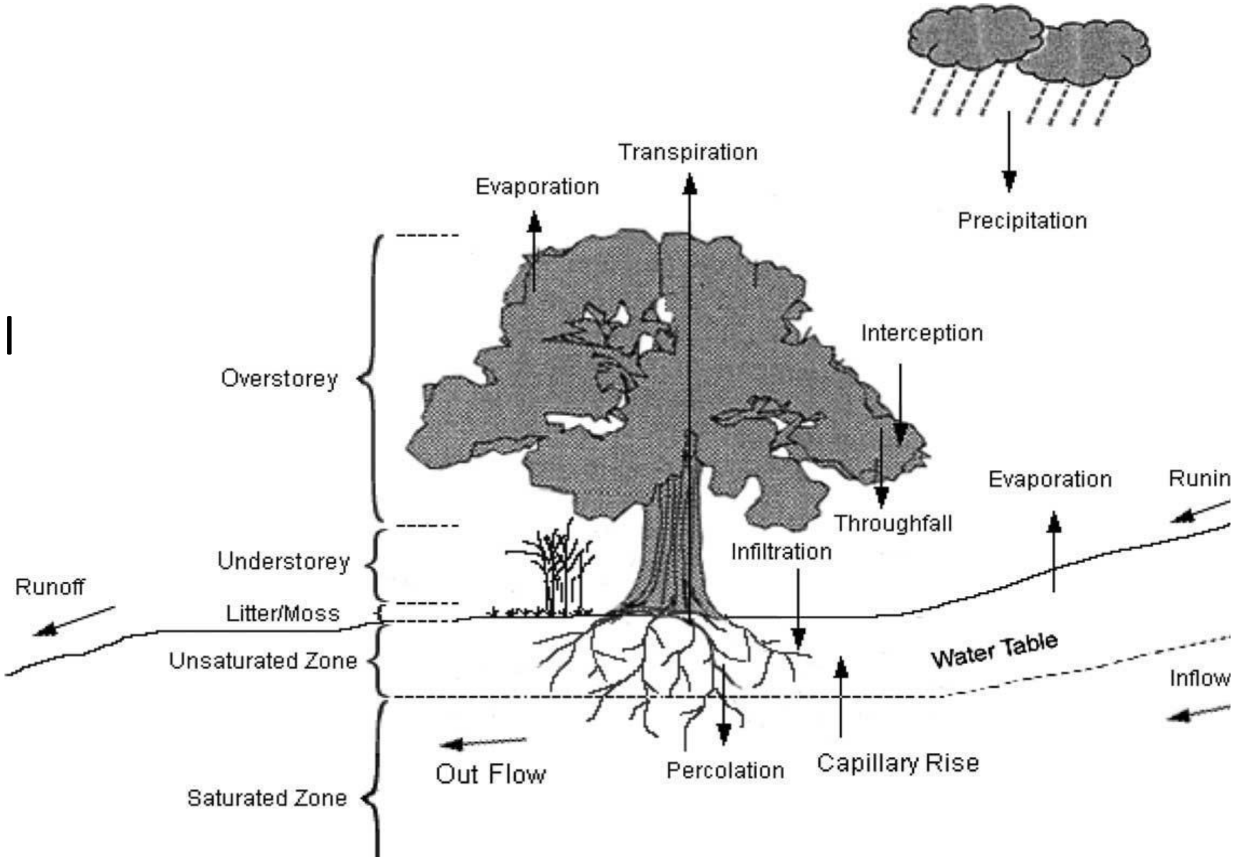
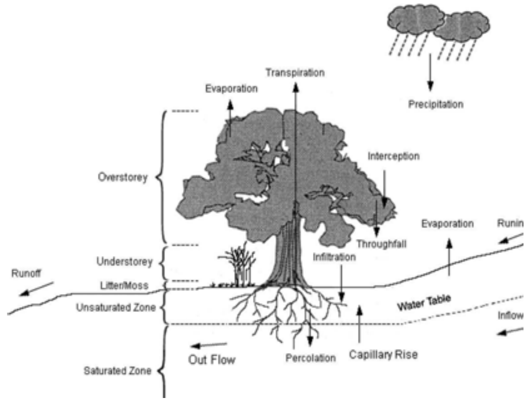


Figure 1 Hydrological processes at the forest scale (Chen et al., 2005)

Water use verses water yield

Forest catchment water yield is also controlled by:

- Rainfall event intensity, duration, amount
- Tree species, stand tree density (stocking), and age classes
- Topography & aspect
- Intermittent & permanent stream network
- Highly variable soil physical properties
- Unique soil processes that impact infiltration, subsurface flow, & soil water storage



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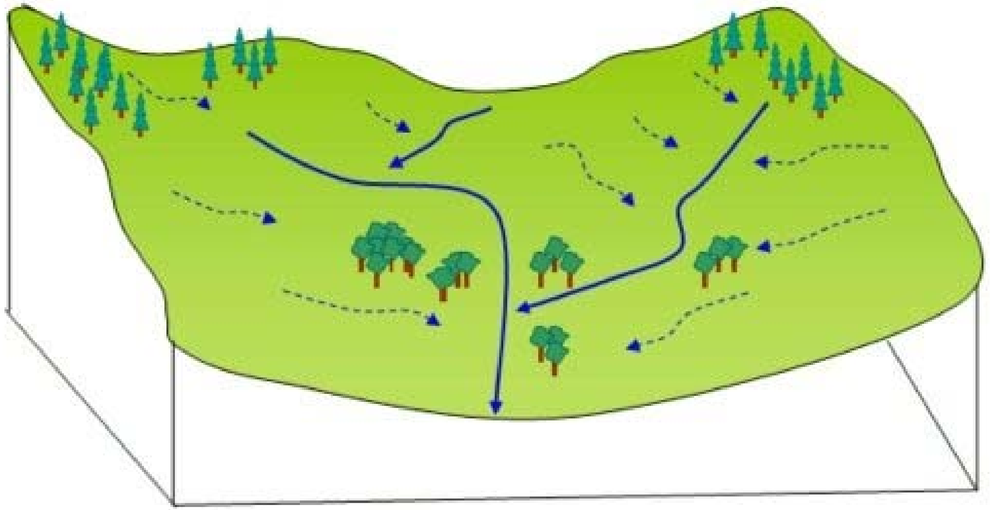
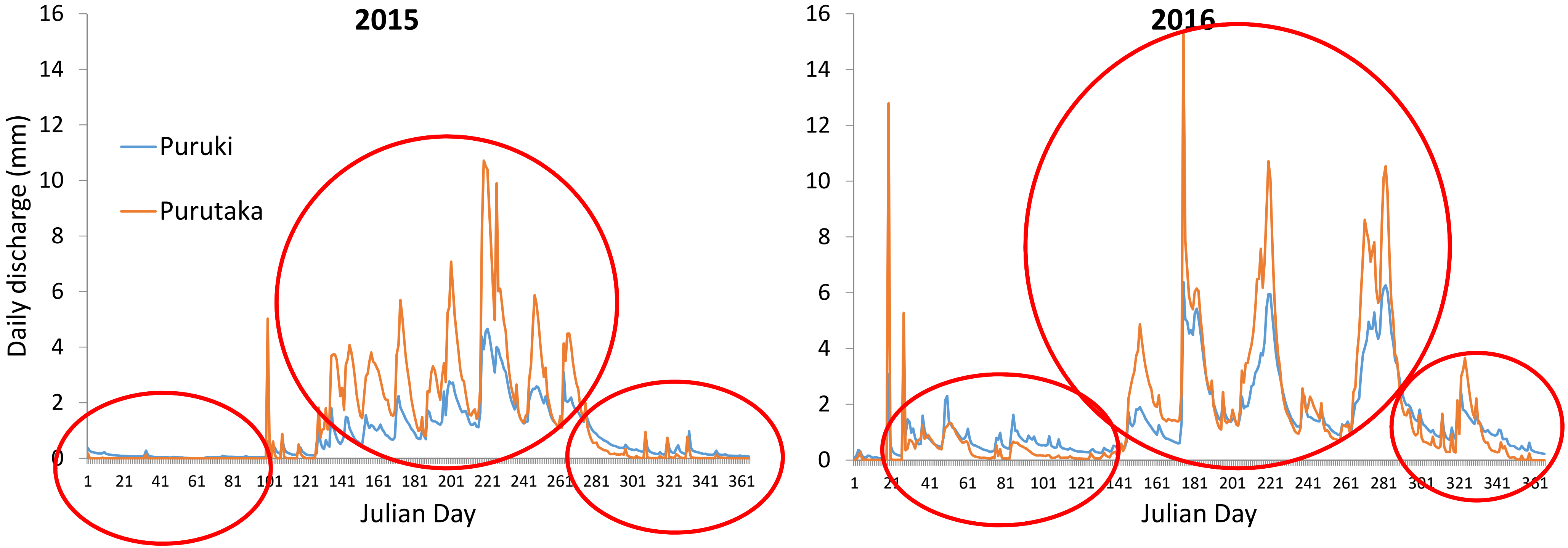


A catchment area.

https://qph.ec.quoracdn.net/main-qimg-304b34b4131e6a4250f92d8c482e61a2

Water yield example – Catchment yield comparison: radiata forest (Puruki) and pasture (Purutaka)



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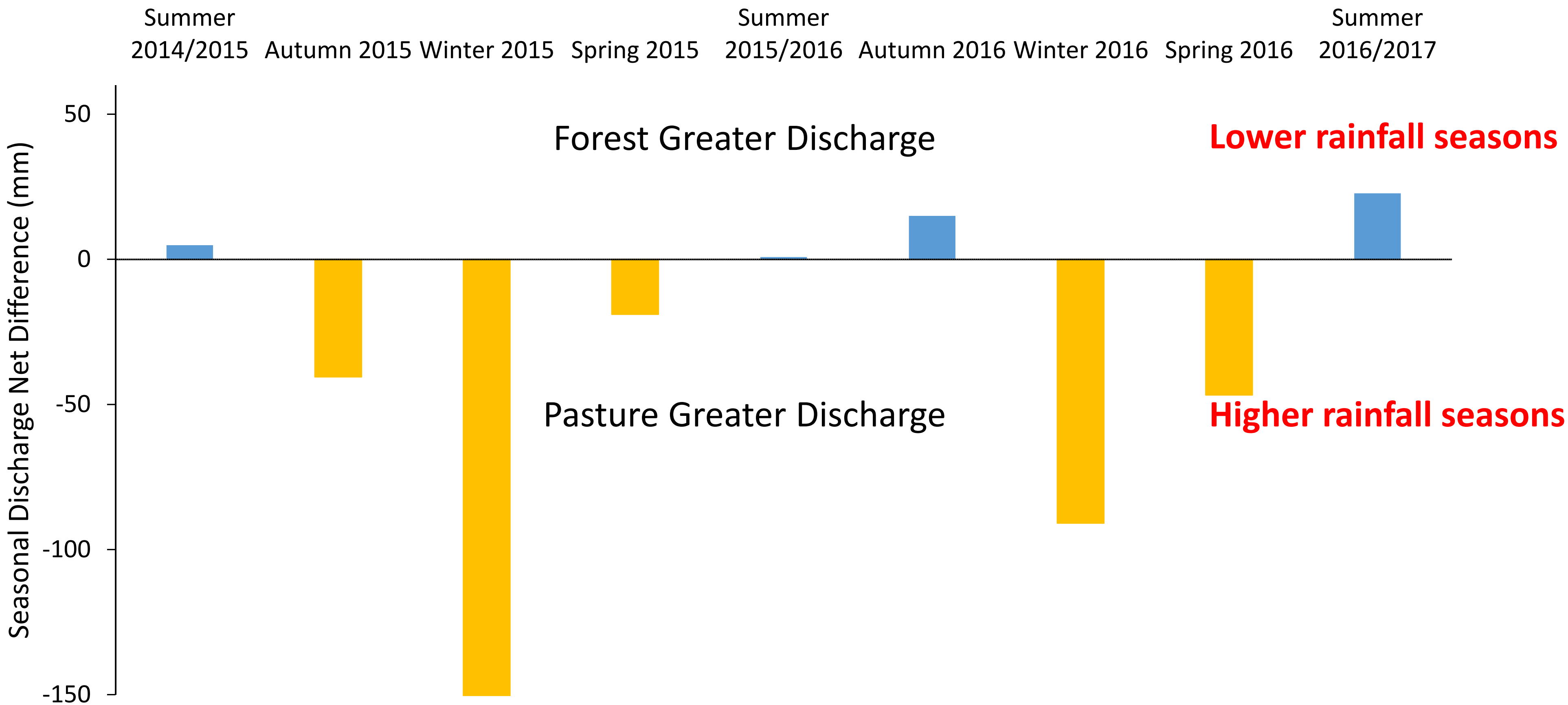

Summary & Future Directions

- Radiata pine water use varied throughout NZ
- Generally more water surplus in higher rainfall areas
- Radiata water use dynamic and depends on a number of factors – not one static factor
- Forested catchments have the potential to supply water to downstream users during the spring and summer
  - Potential important ecosystem service for the primary sector

Summary & Future Directions

- More research required to develop accurate radiata forest water yield model that can be readily applied to large & small catchments across NZ
  - Not reliant on a large number of expensive catchment studies
  - Process-based, dynamic modelling approach
  - Able to model water yield on a time scale smaller than a year – especially during periods with low water flow
  - Able to model radiata genotypes with different water use efficiencies

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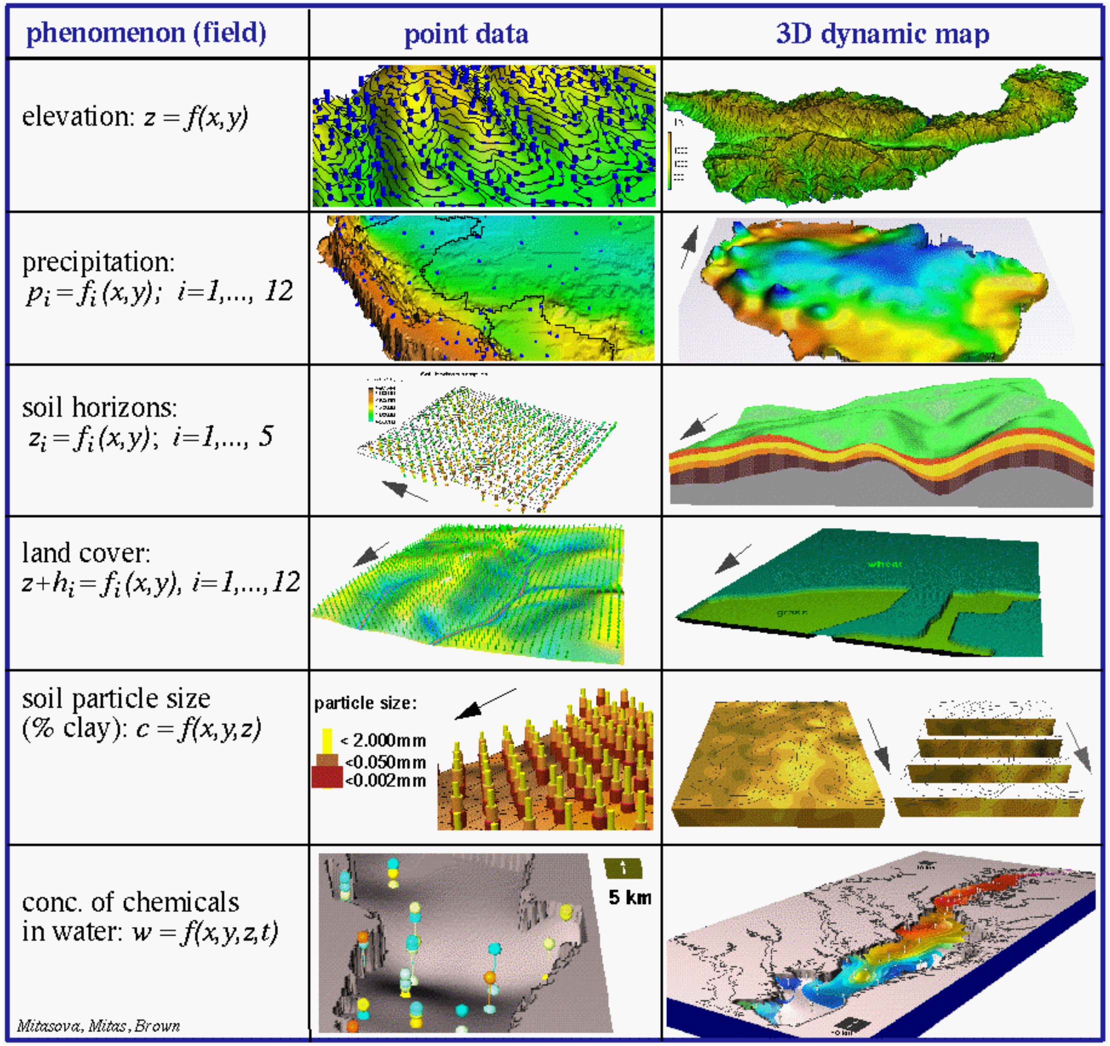
Future Directions – development of new generation hydrological models

- Model heterogenetic water use & movement across catchment
- Dynamic modelling of evapotranspiration and rainfall events
- Model unique forest soil properties including infiltration, subsurface flow, & storage
- Water use differences between radiata genotypes & species
- Able to simulate range hydrological dynamics: daily, weekly, monthly, etc.



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