Dr Hamish Cresswell
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Day 2, 10.40am
Area of work: Land-use impacts on soil and water quality
Specialty: Soil physics; agricultural land-use options with multiple objectives.

Take-home messages:

- There are new high temporal resolution water-quality monitoring technologies (minutes to hourly frequency) that can give new insight into catchment function.
- Monitoring needs to be complemented with other 'layers of evidence' to understand catchment function and provide a basis for targeted NRM investment.
- The Landscape Logic CERF project seeks to help identify forms of monitoring with high information content for understanding catchment function and then prioritising investment in managing water quality.

Monitoring catchments to manage water quality

NRM (natural resource management) actions need to be targeted in the right places. To adequately target water quality investment we need to understand 'how catchments work' with respect to sediment and nutrient delivery into rivers. The impacts of NRM actions also need to be able to be assessed.

Government seeks to determine the extent to which interventions (e.g. metres of fence line installed or hectares of riparian zones or wetlands) contribute to outcomes (e.g. improved river health). To address these needs, the Landscape Logic Project 'Catchment Sediment and Nutrient Dynamics' is developing and evaluating new methods to identify likely critical source areas for nutrients and sediments, and building spatial conceptual models of nutrient movement through the landscape and into rivers.

The project advances the role of monitoring through evaluating new high temporal frequency (five minutes to hourly) water quality measurement. High temporal frequency data will yield detailed patterns of stream nutrient dynamics, information that might give revolutionary new insights into how catchments work. This new information might well change the way we view (and subsequently model) catchment processes.

The project asks: What can high frequency monitoring offer? How should monitoring be designed (spatially and temporally) to capture the key processes? What types of monitoring provide the highest information content? High frequency catchment nutrient monitoring has not previously been evaluated in Australia. This research will enable determination of the minimum level of temporal sampling intensity that would be required to adequately monitor catchment processes. This is significant in the design of monitoring programs.

The high frequency water-quality monitoring is complemented by a spatial assessment of critical source areas that disaggregates catchments into landscape units that relate to dominant hydro-chemical process dynamics. Other spatial information is obtained by longitudinal sampling (along the length of the river and its tributaries) and targeted spatial modelling. Information about the origin of nutrients is explored using isotope analyses.

Together these multiple 'layers of evidence' aim to capture how a catchment functions: e.g. Which nutrients contribute to water quality problems? What is their origin? Where are their critical source areas? Along what hydrological pathways were the materials transported to the waterways? The research is being conducted in Tasmania and includes delivery of guidelines for development of simple spatial models of catchment function to support the design of water-quality monitoring for use by regions and government agencies.

Relevant publications

Cresswell HP (editor) (2004). *Heartlands* – Planning for Sustainable Land Use and Catchment Health. *Heartlands* Technical report, Publication HL9-04, CSIRO.

Hill P, Cresswell HP and Hubbard L (2006) Spatial prioritisation of NRM investment in the West Hume area (Murray CMA region). Technical Report, CSIRO Water for a Healthy Country National Research Flagship, Canberra. <www.clw.csiro.au/publications/science/2006/wfhc-MurrayCMAWestHume.pdf>.

Wang E, Cresswell HP, Paydar Z, and Gallant J. (2008). Impact of land use and climate variability on plant water use, surface water flow and deep drainage on a topographic sequence. *Hydrological Processess* 22 (no. 6), 736-749.

Cresswell HP, Ringrose-Voase AJ and Western AW (2008). Hydrology. In NJ McKenzie (Ed) *Guidelines for Surveying Soil and Land Resources*. Australian Soil and Land Survey Handbook Series, Vol. 6, pp 93-114. CSIRO, Australia."

Monitoring catchments to manage water quality

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Ulrike Bende-Michl, Peter Hairsine

CSIRO

Australian Government
Department of the Environment
and Water Resources

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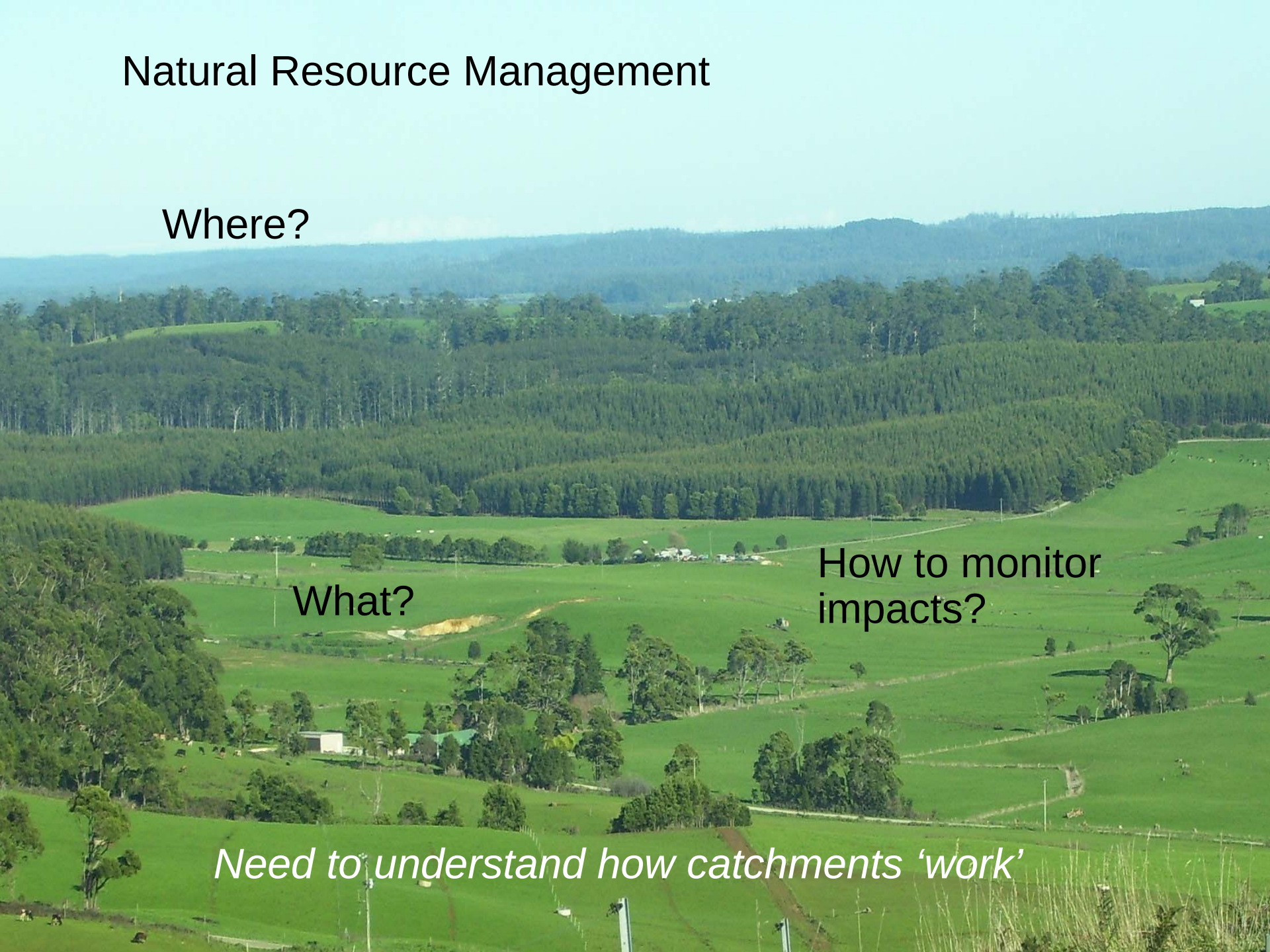
Why are nutrients in waterways of concern?

- Eutrophication and algal blooms
  - Human health (poisoning)
  - Impact on economically significant fisheries
  - Increased cost of treating water for drinking
  - Impact on tourism and recreational use of water
  - Damage to aquatic habitat - river, estuary & marine
- Nitrates in drinking water (poisoning)
- (Soil erosion)
- (Wasted agric production opportunity)

Natural Resource Management



Water quality monitoring

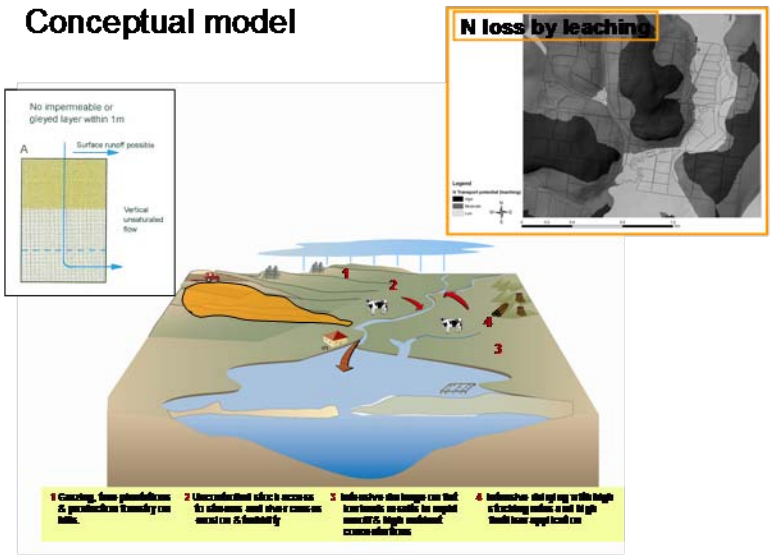
- Near the end (outlet) of the catchment
- Once per month

Much pollution is washed-off in first 15 minutes of the first storm after a dry period (or on saturated soil)

… a timing mismatch

Towards cost-effective WQ investment

1. Start with key questions
2. Catchment diagnosis: existing data with powerful new technologies
3. Use conceptual models to summarise knowledge
4. Design management interventions and monitoring of outcomes



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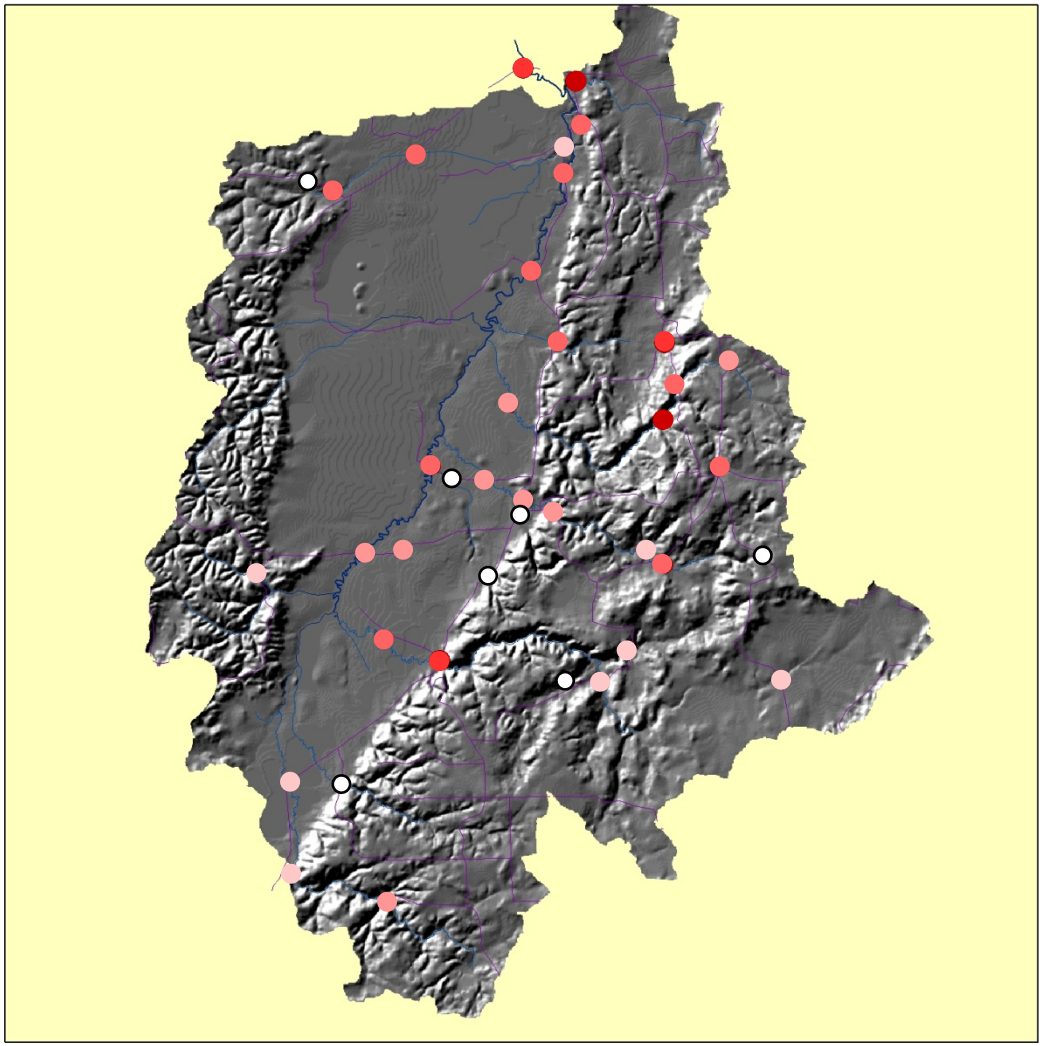
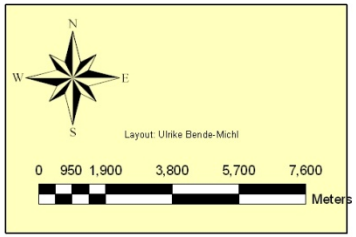
The key questions

1. Which nutrients (in what form)?
   - Dissolved nitrate, phosphorus attached to clay particles …
2. From what origin?
   - Soil erosion, fertiliser, effluent, point source …
3. From where in the catchment?
   - Intensive land uses
   - Shallow soils
   - Immediately upslope from streams
4. By which pathways to the stream?
5. When?

Longitudinal sampling - nitrate in April 2008





High Freq Water Quality (WQ) monitoring

- High freq WQ monitoring shows…
  - different patterns for nitrate, ammonium, phosphate
  - different flow paths to the stream
  - nutrient fluxes varying with rainfall, soil wetness, & nutrient availability
  - links between WQ impacts and land use/land management

- High freq WQ monitoring has potential to revolutionise our catchment understanding

High frequency instrumentation (15 min – 1 hr)

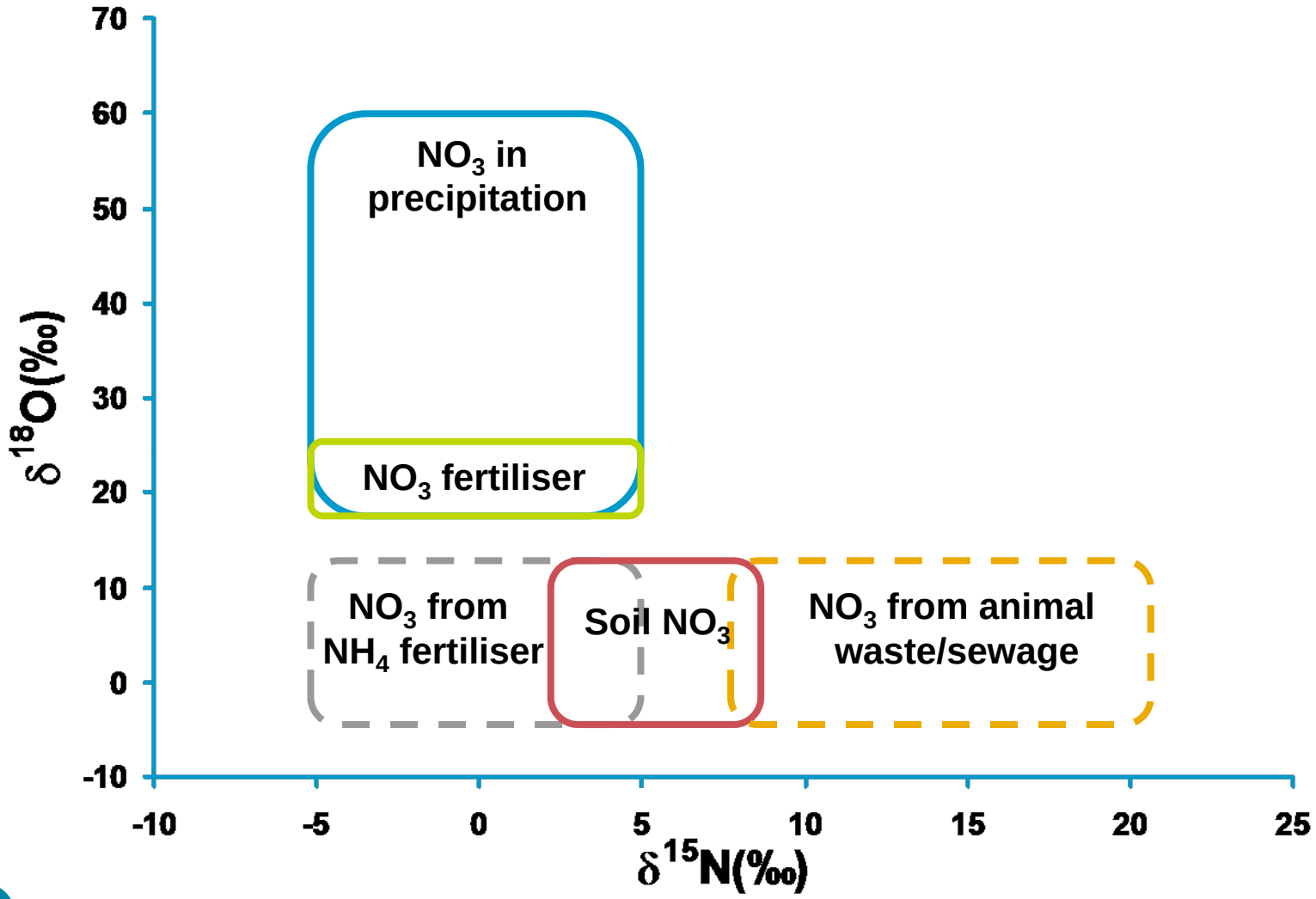
Fully automatic mini lab

UV/Vis submersible spectrometer

- Nitrate (NO_3), and turbidity

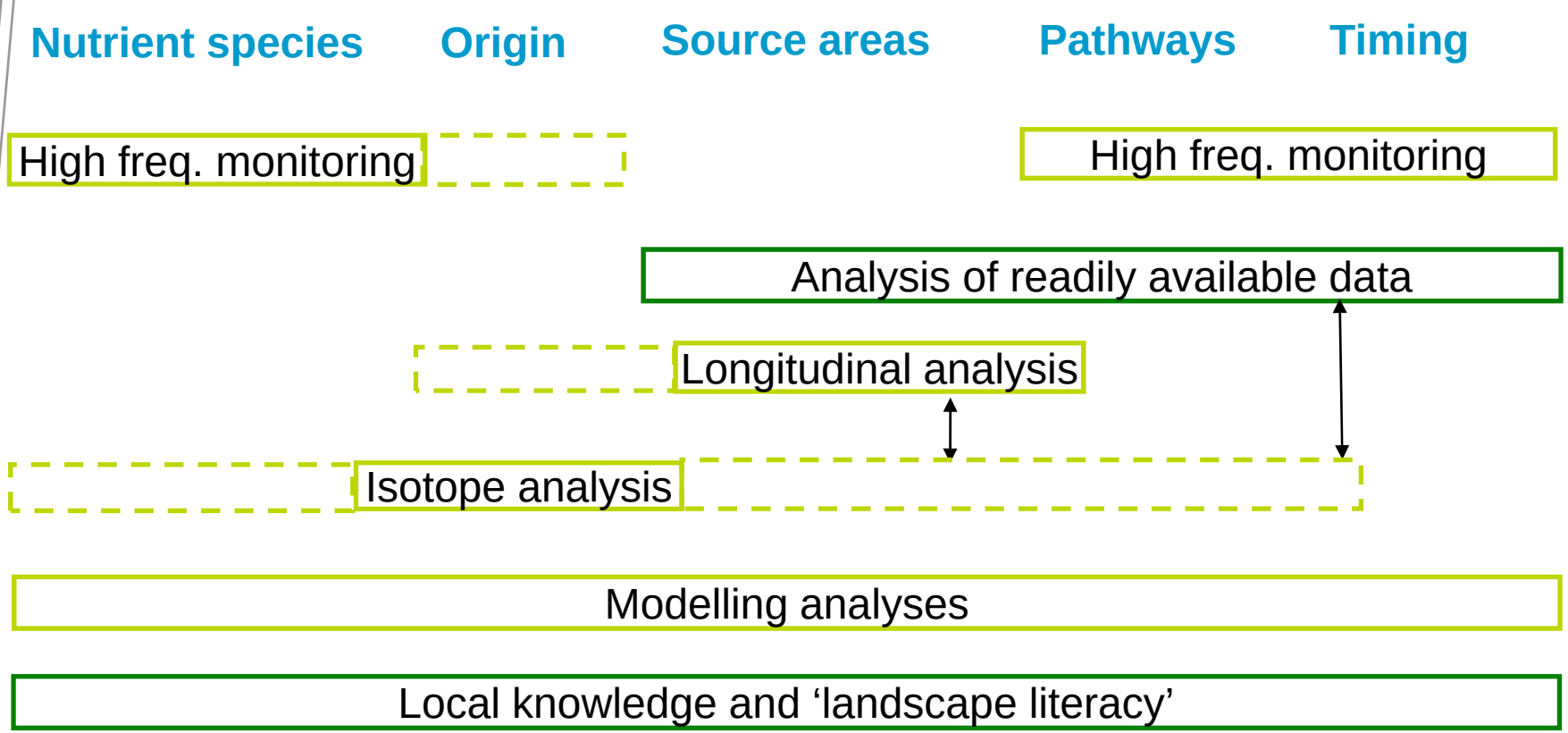
- Total phosphorus (TP), total nitrogen (TN), nitrate (NO_3), nitrite (NO_2), ammonium (NH_4) and phosphate (PO_4)

NO_3: Dual ^{15}N-^{18}O isotope technique

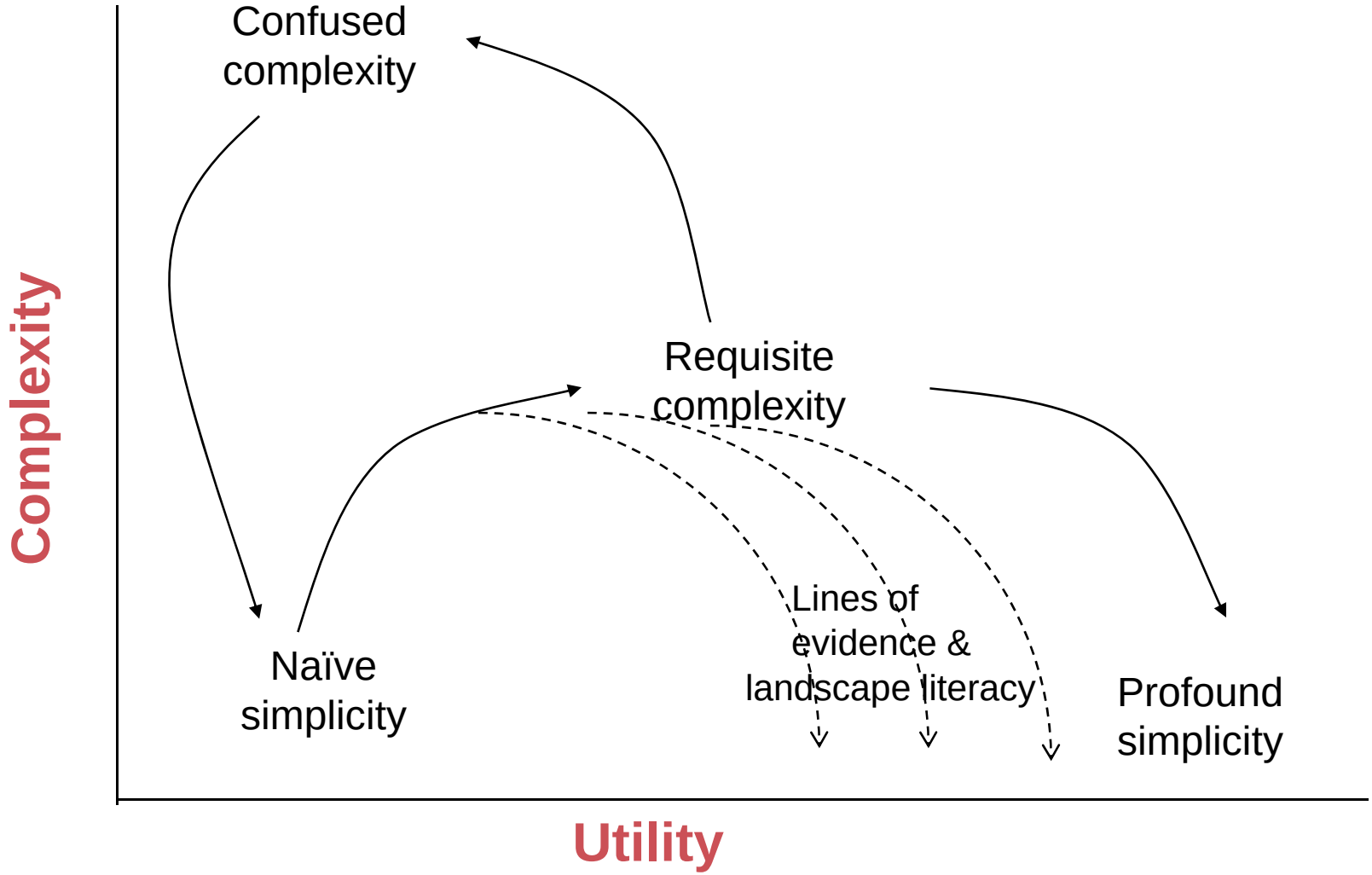


After Kendall et al

Catchment diagnosis - multiple lines of evidence



The Simplicity Cycle



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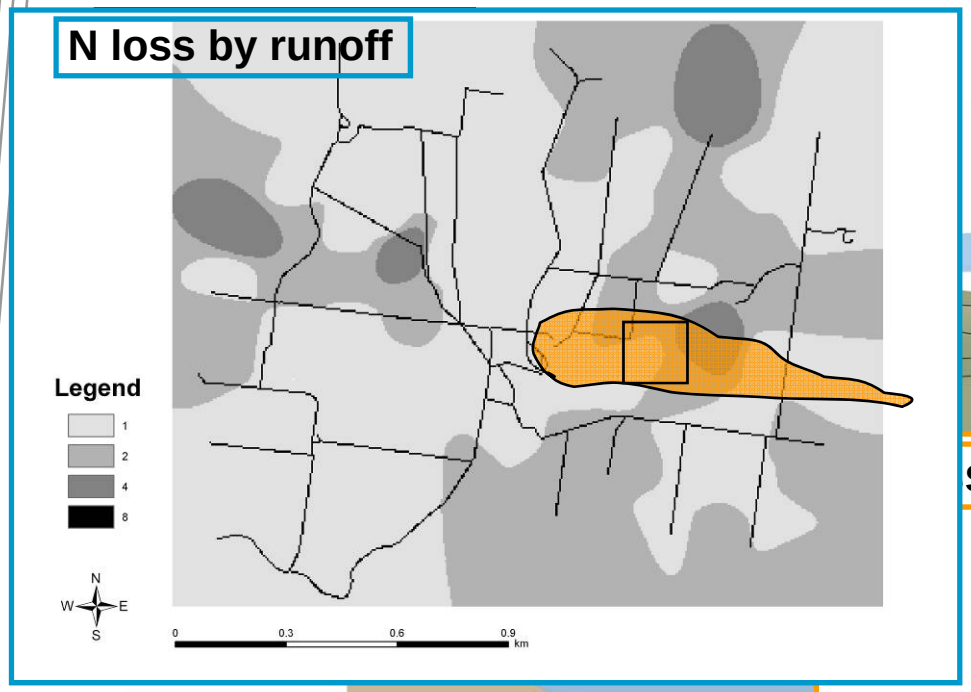
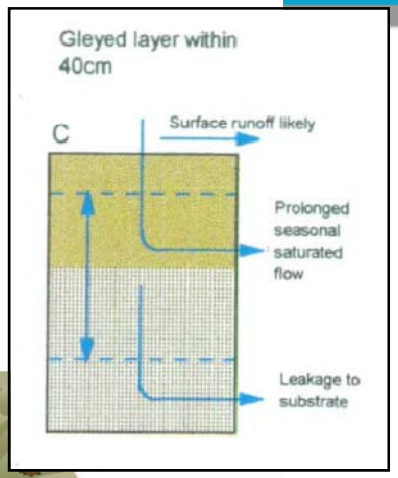
Translating lines of evidence to a conceptual model





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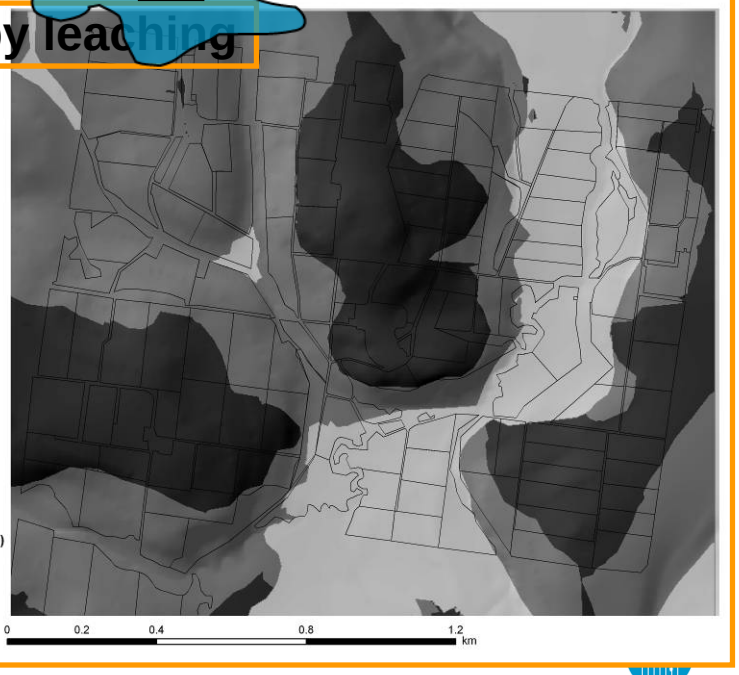

1 Grazing, tree plantations & production forestry on hills.

2 Uncontrolled stock a to streams and river erosion & turbidity

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Emphasize the most important elements

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Implications for monitoring post-intervention

Catchment diagnosis	Implication for monitoring
‘Flush’ of nutrients commonly coincides with large rainfall events (autumn then late winter)	Ensure regular (event) monitoring occurs at those times
Ammonium from fertiliser application to dairy pastures moves via surface runoff (fast)	Measure ammonium (not just total N) to identify result of specific fertiliser management interventions

Multi-purpose monitoring

Catchment condition and problem identification

Catchment diagnosis (planning interventions)

Monitoring outcomes

Monitoring designed for multiple purposes, aligned to management action and outcomes

Delivering …

- Landscape Logic CERF is providing ‘how to’ guides for spatial diagnosis of a catchment to
  - Design and locate appropriate WQ management interventions
  - Design multi-purpose monitoring
- Resolving …
  - Sources, sinks and pathways for nutrients
  - Which data has the highest information content?
  - What is the minimum necessary data?
  - Where and when to monitor?

More effective NRM investment

- Adjusting WQ monitoring strategy to better align with management action and outcomes is likely to have significant National benefits

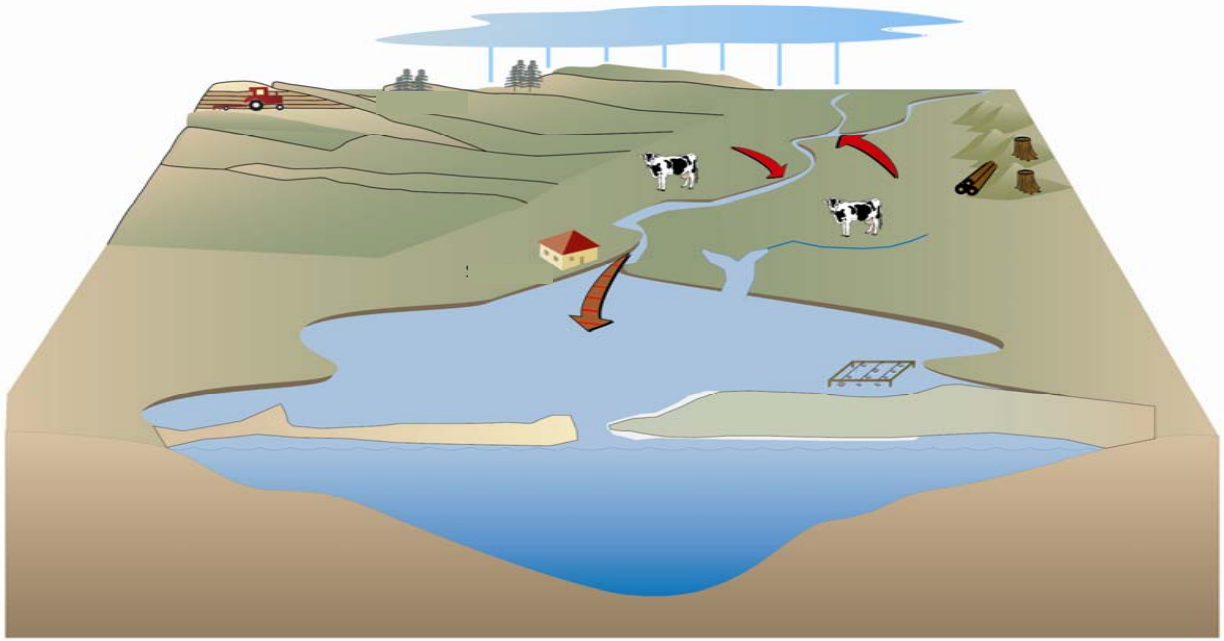
- Improved monitoring, strategic use of new technologies and fully utilising existing data can enable targeted WQ investment

- Catchment diagnoses need to be available to CMAs

This Session – Catchment to the Coast

Linking:

- **Land use (Dr Shane Broad)**
- **River health (Prof Peter Davies)**
- **Sediment management (Dr Lachlan Newham)**
- **Estuarine health (Dr John Gibson)**



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