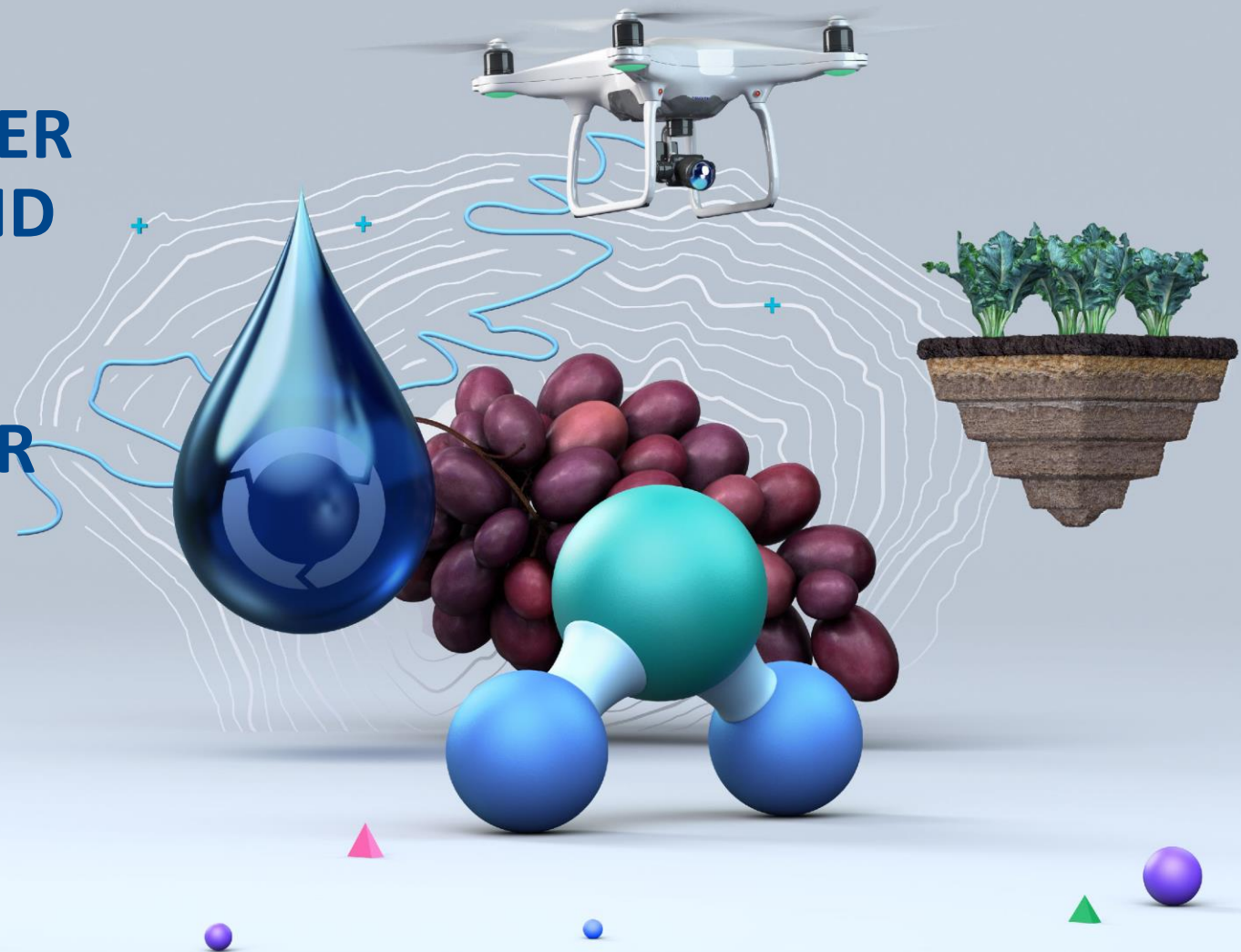


DECISION MAKING UNDER FUTURE VARIABILITY AND CHANGE

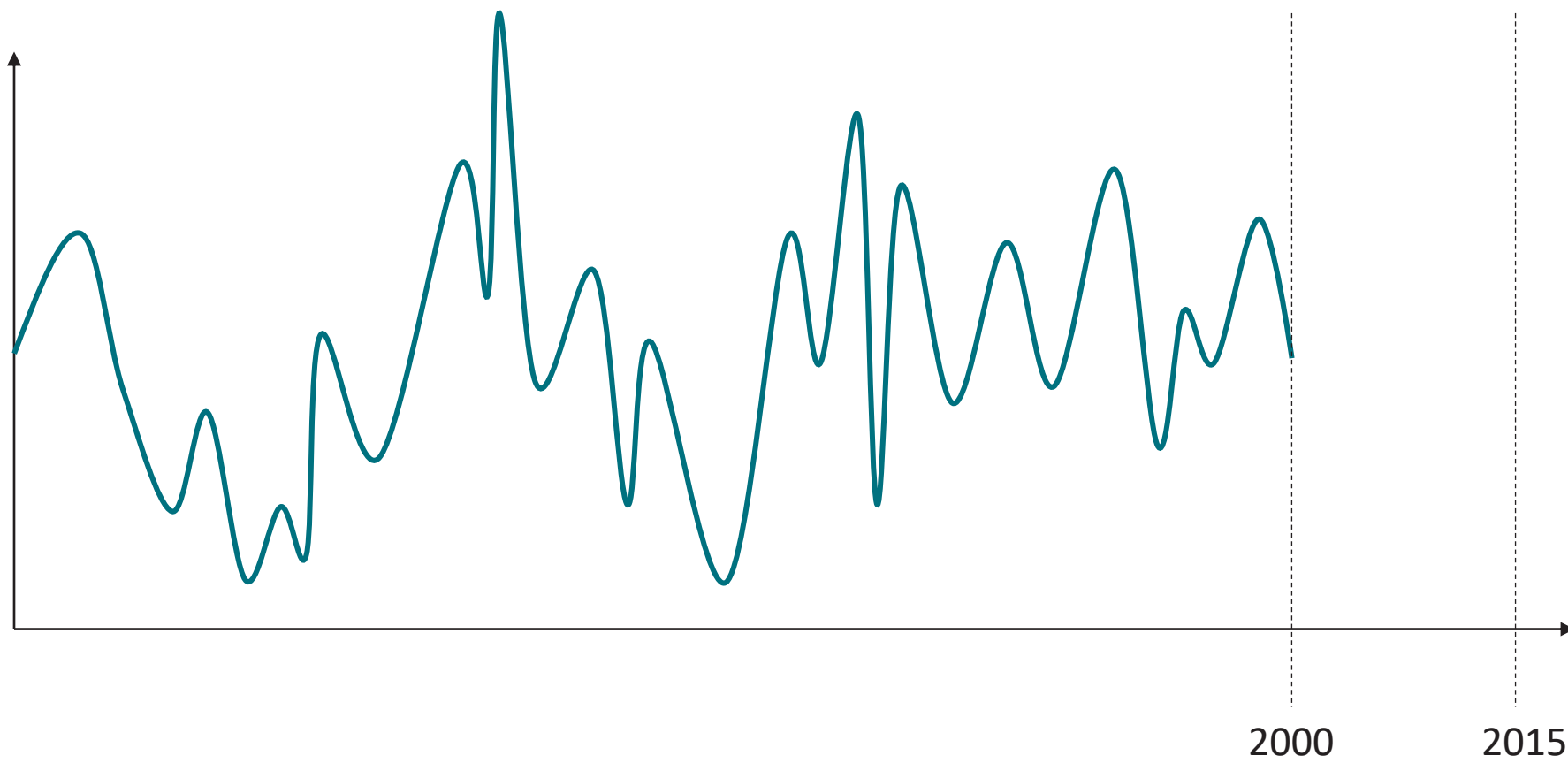
ENVIRONMENTAL WATER



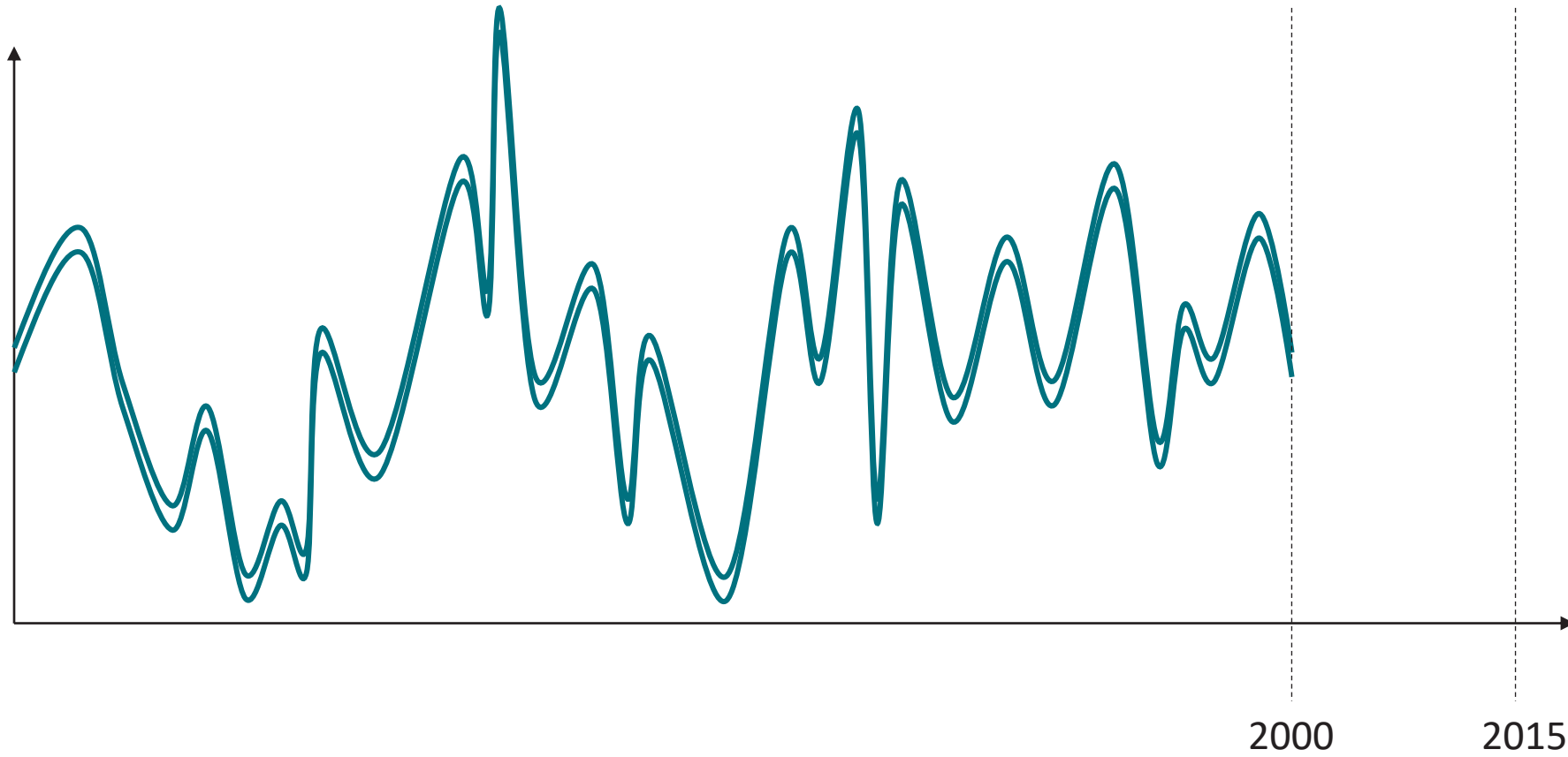
Dr Avril Horne

June 2020

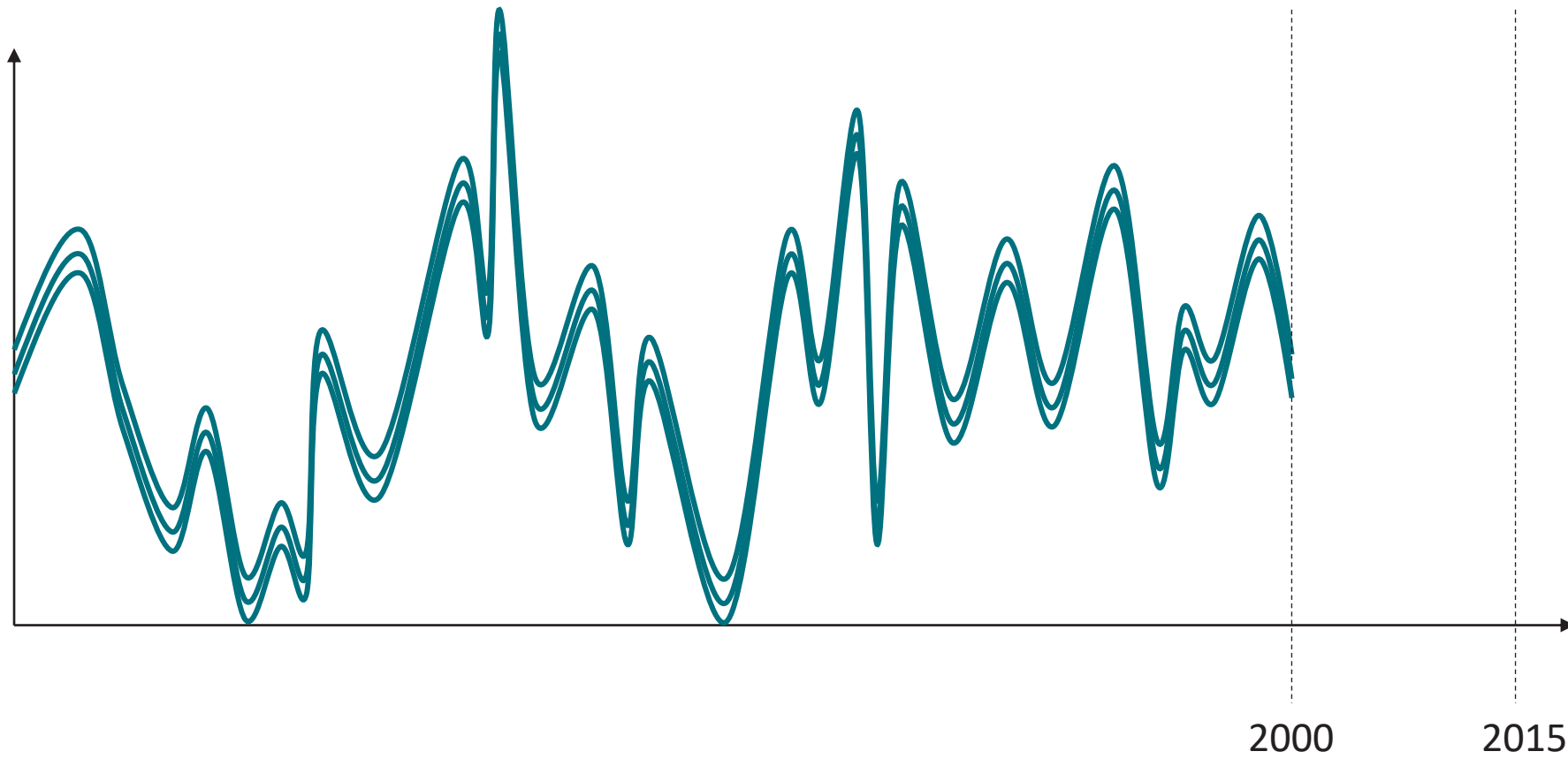
The benefit of perfect knowledge....



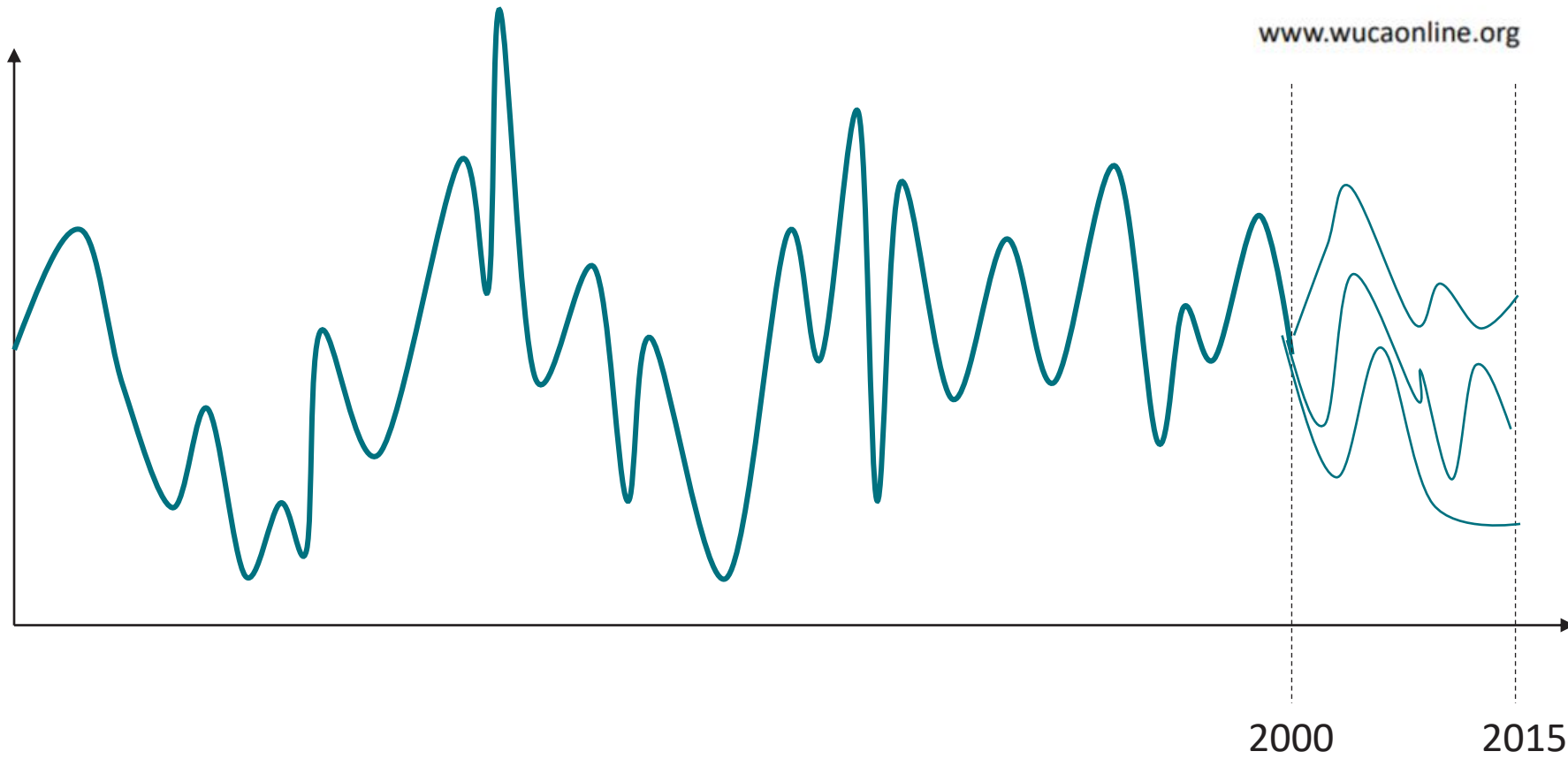
Traditional approach to assessing climate change....



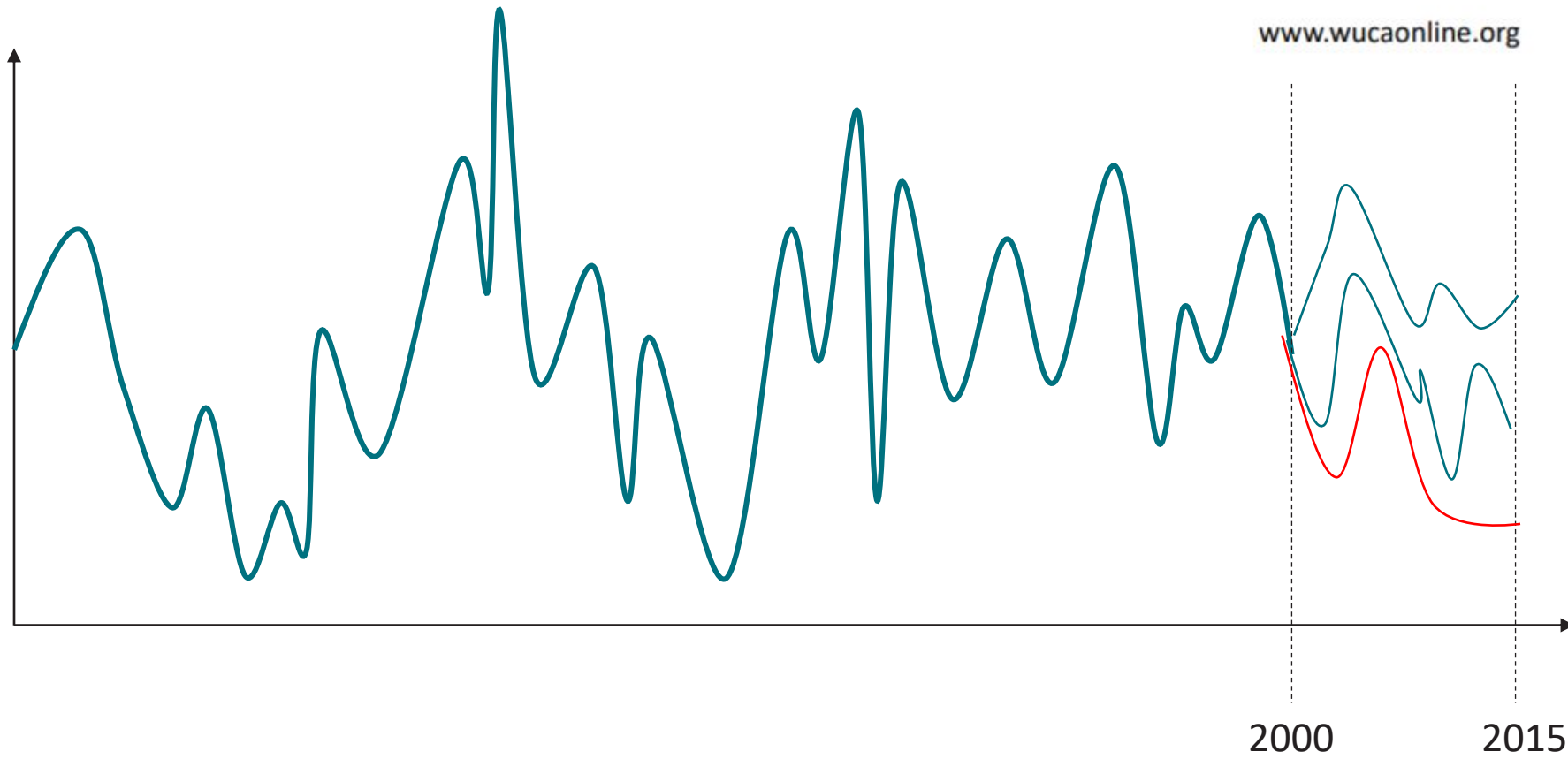
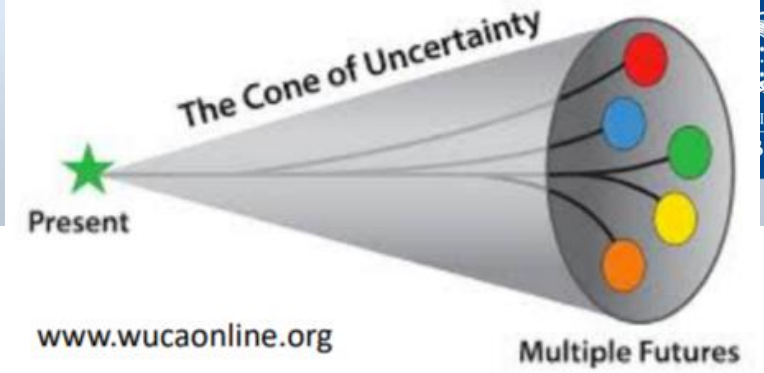
Traditional approach to assessing climate change



Traditional approach to assessing climate change



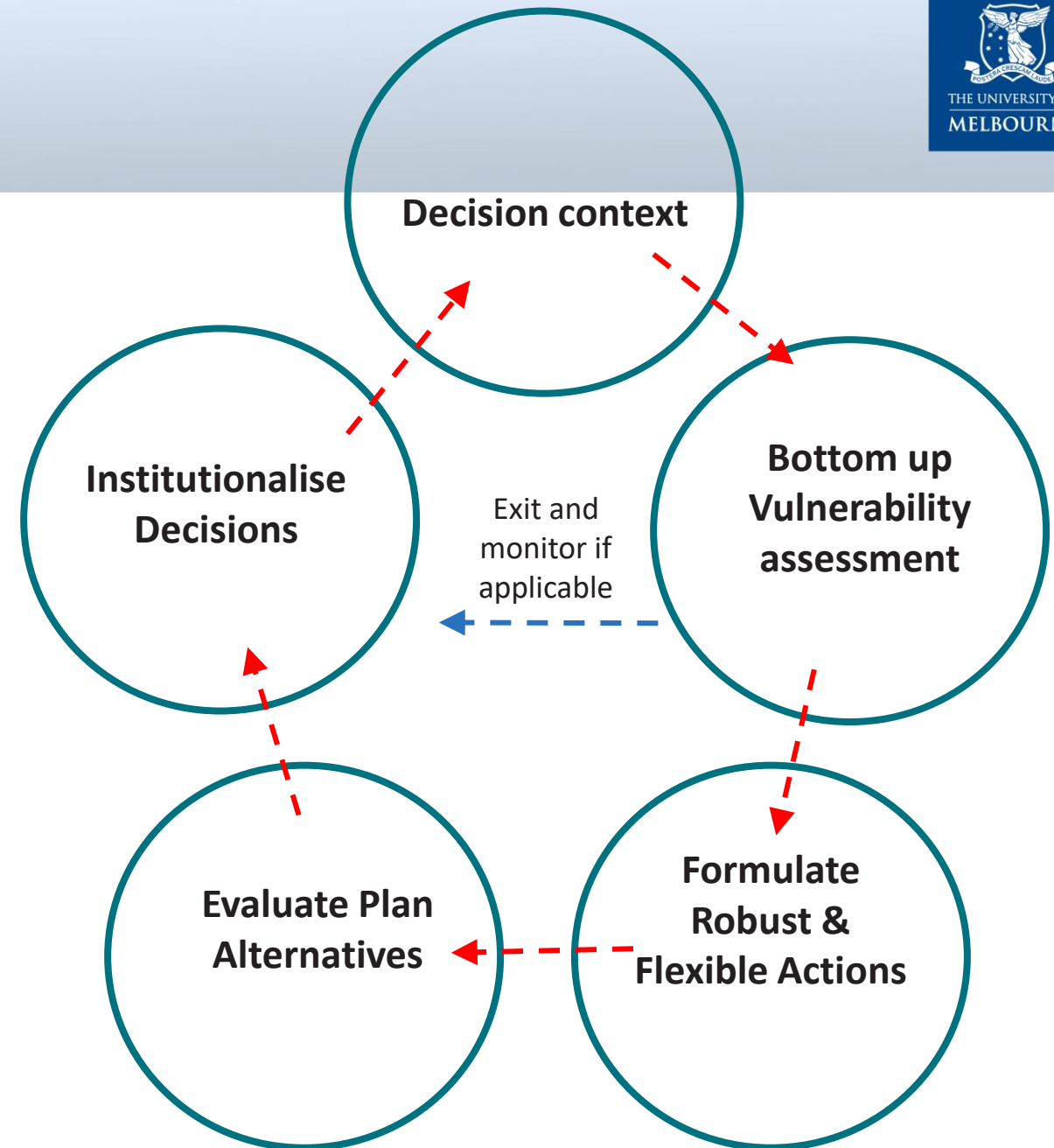
Traditional approach to assessing climate change



Making decisions under uncertainty – bottom up approach

“It is not the strongest of the species that survive, nor the most intelligent, but the ones most responsive to change.”

Charles Darwin



Making decisions under uncertainty – bottom up approach

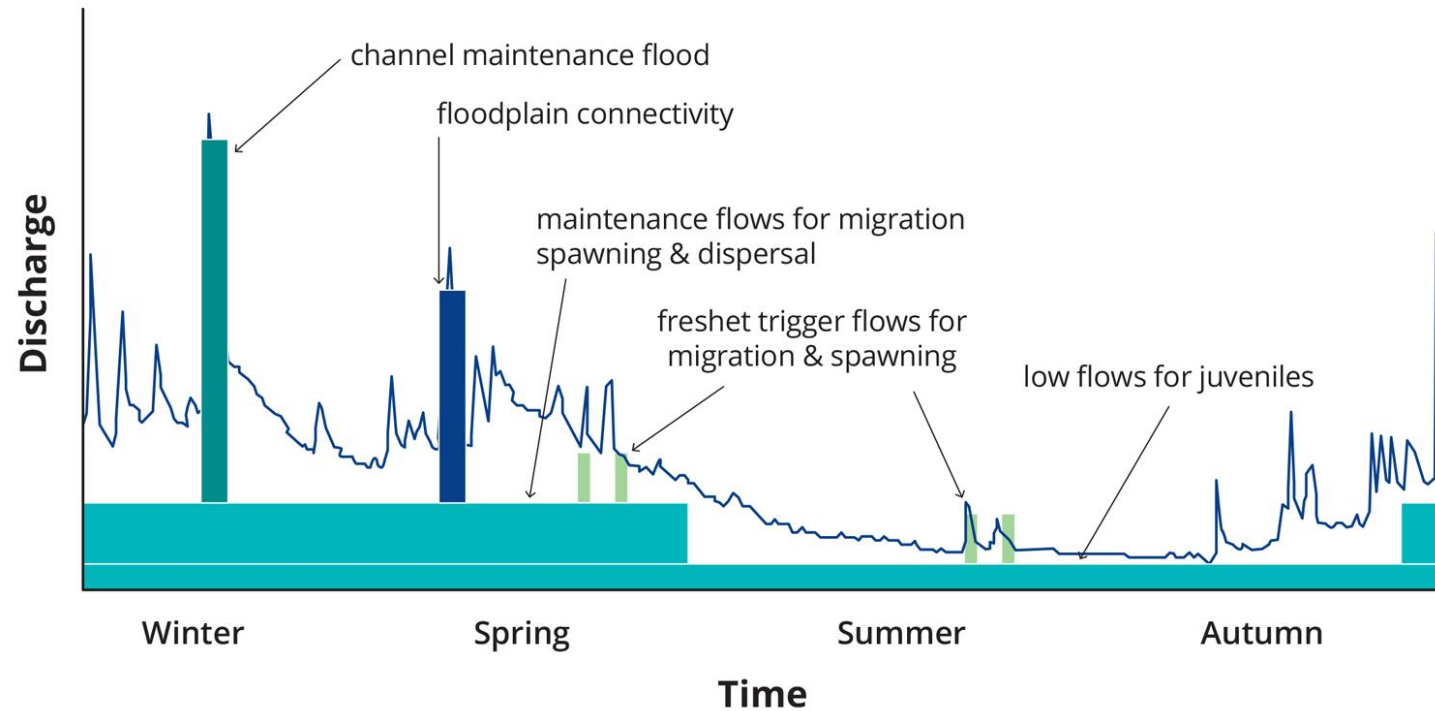
Decision context



- Who needs to be convinced?
- What are the key aspects of concern?
- How complex is the decision space?
- One off decision or ongoing adjustments?

Application of bottom-up methods for environmental water

“the quantity, timing, and quality of freshwater flows and levels necessary to sustain aquatic ecosystems which, in turn, support human cultures, economies, sustainable livelihoods, and well-being” (Arthington et al., 2018).



Making decisions under uncertainty – bottom up approach



Decision context

Objective

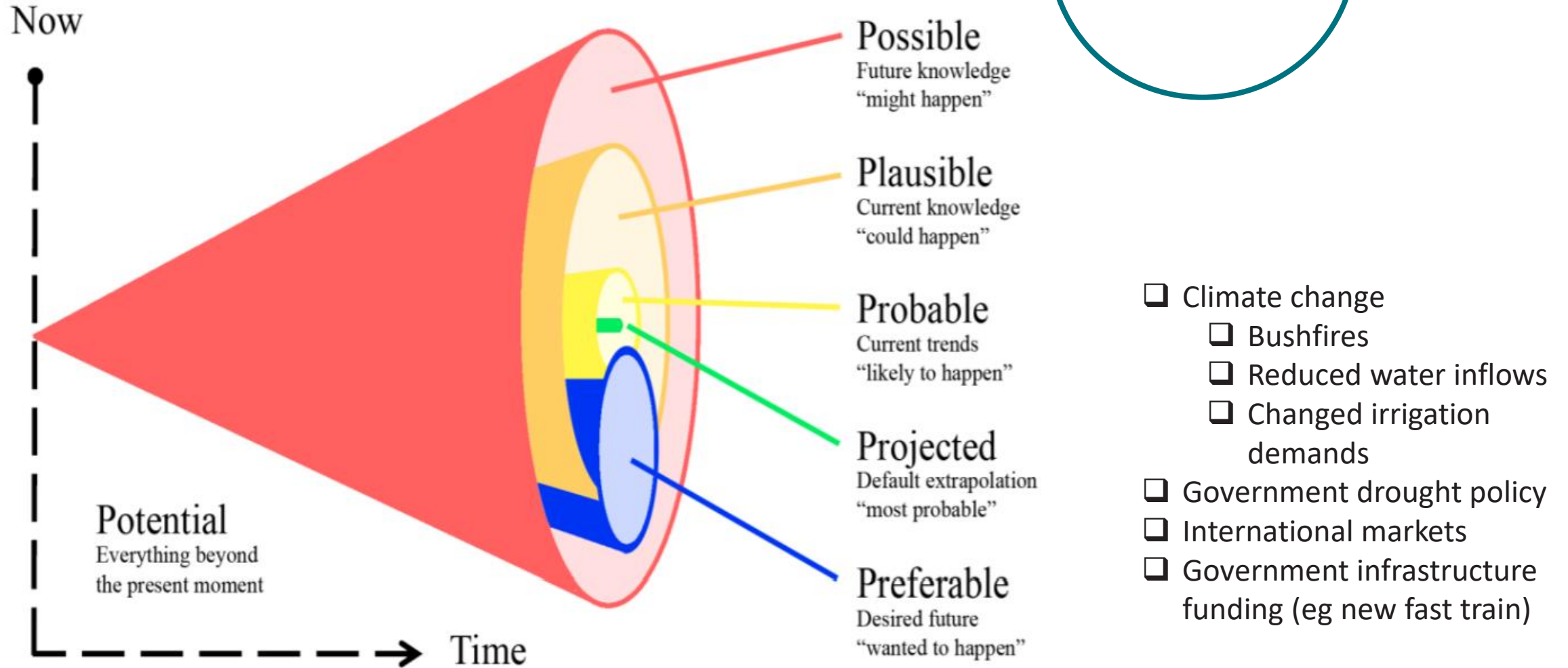
Environmental objectives

- What do we want?
- What do we want to avoid?
- On average? Everywhere?

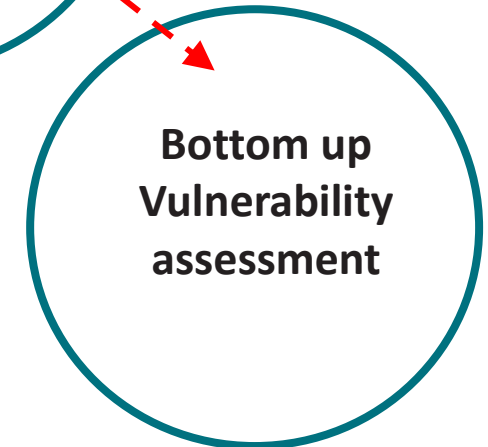
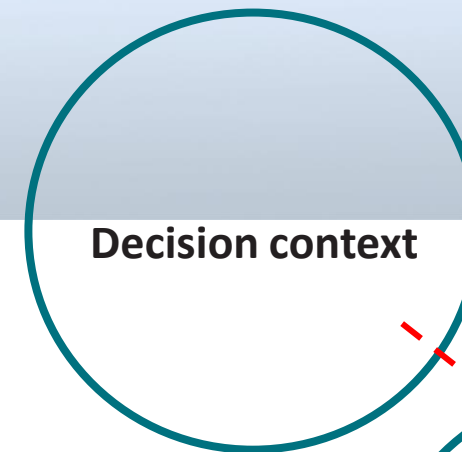
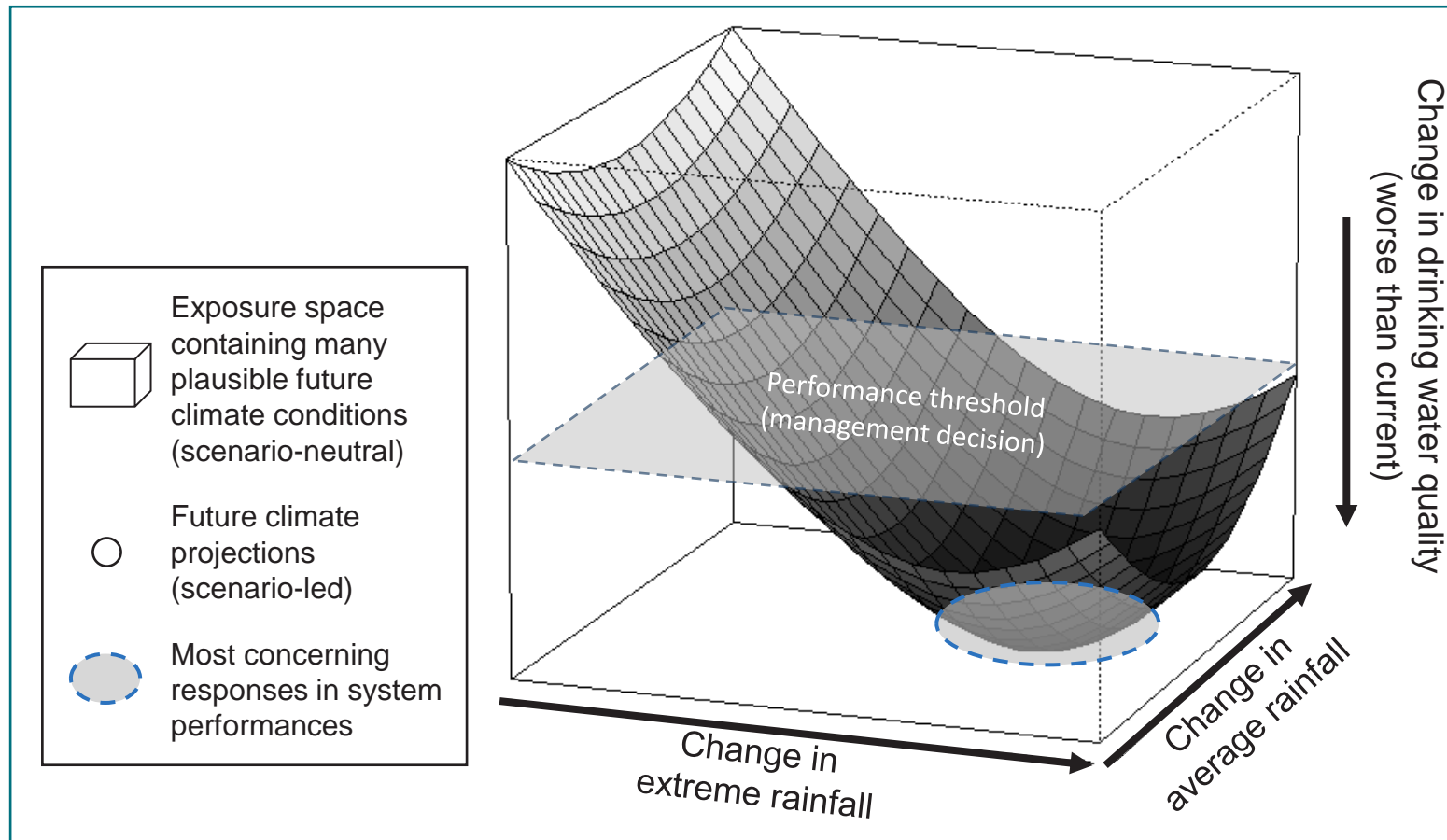
Concerns

- Reduced annual streamflow will reduce the water available to the environment
- Extended dry periods followed by acute flood events may increase blackwater
- Irrigation demands downstream may change the volumes and timing of irrigation delivery having adverse environmental impacts
- Sequencing of dry periods and fresh events may limit the ecological resilience in the system

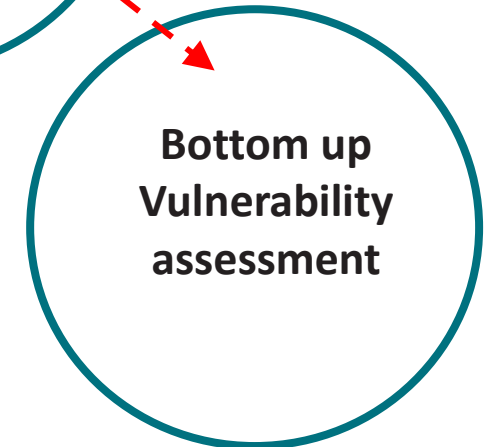
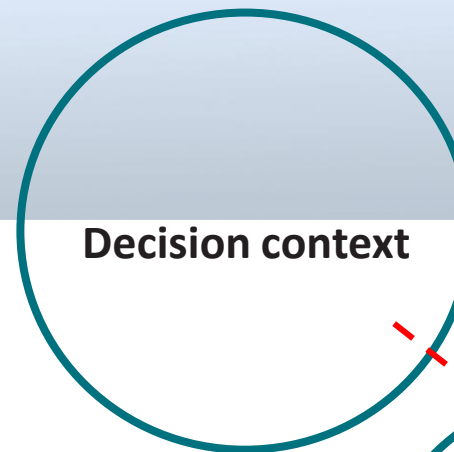
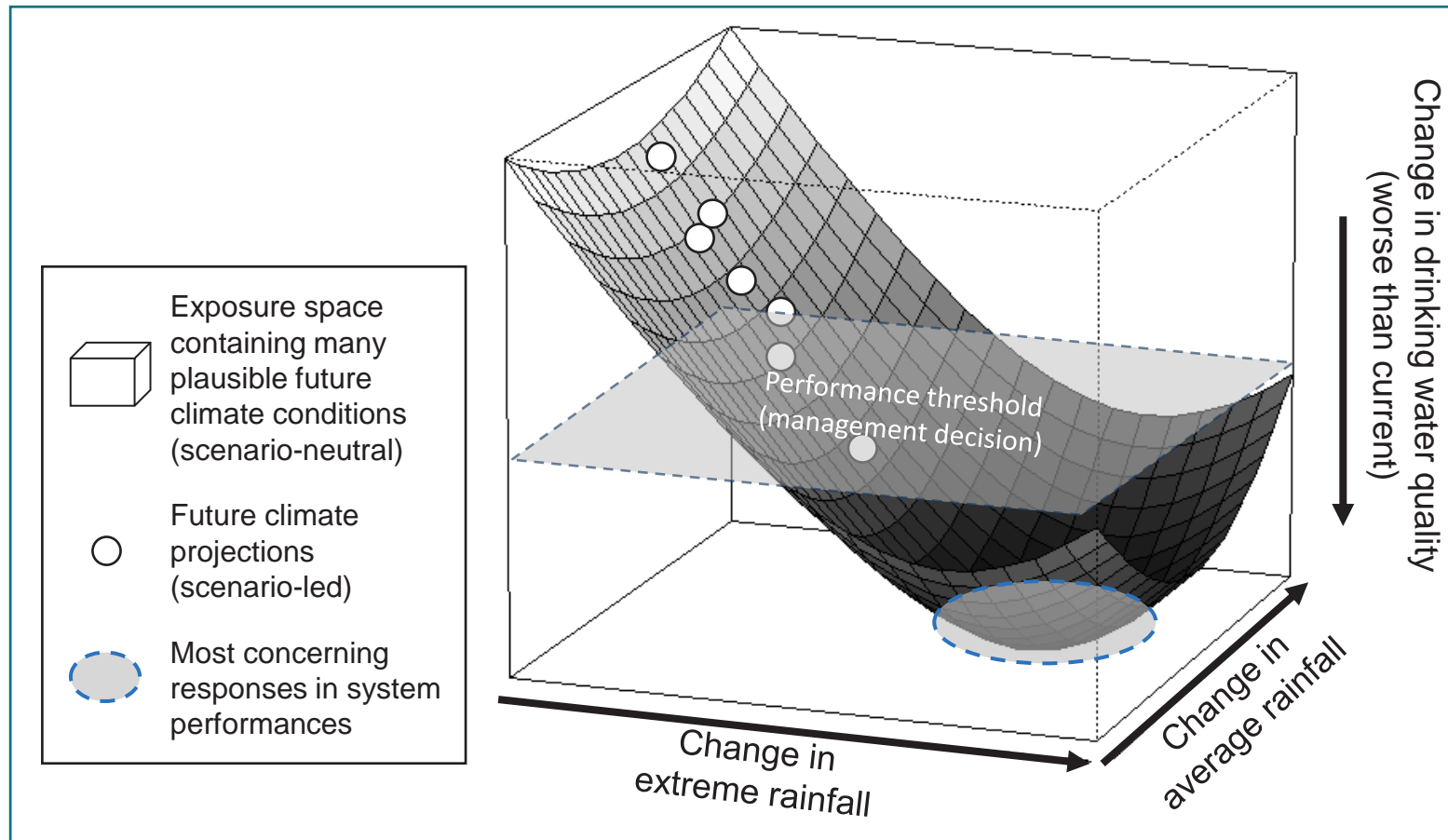
Making decisions under uncertainty – bottom up approach



Making decisions under uncertainty – bottom up approach



Making decisions under uncertainty – bottom up approach



Making decisions under uncertainty – bottom up approach

Environmental demands

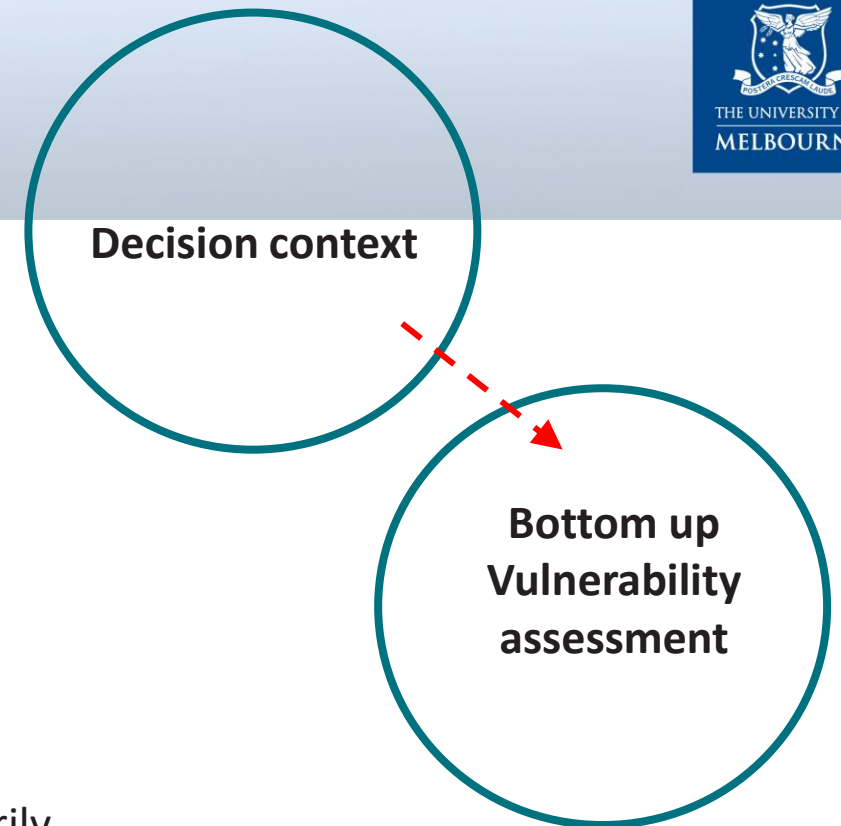
- Outside historical conditions
- Tradeoffs
- Importance of sequencing

Decision scaling

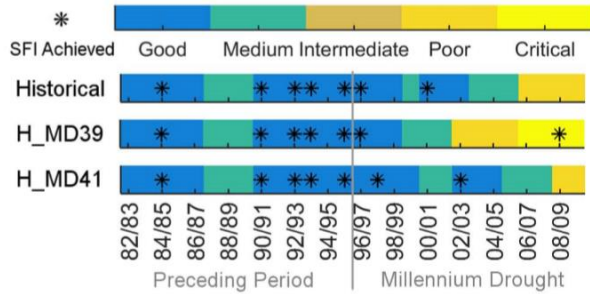
- Large spatial area
- Sub annual streamflow and inter-annual sequencing both important
- Can we generate plausible climate futures that are spatially and temporarily consistent?

System Modelling

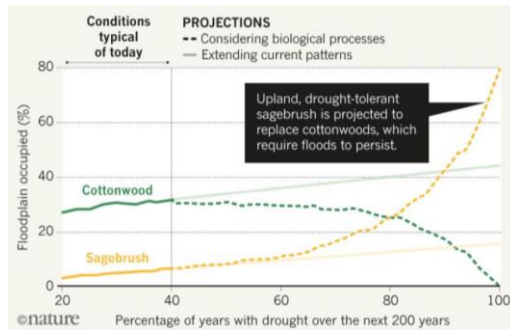
- Current Water Resource Models built for another purpose
- How to represent the adaptation approaches of all agents in the system?
- What is the requisite level of detail?



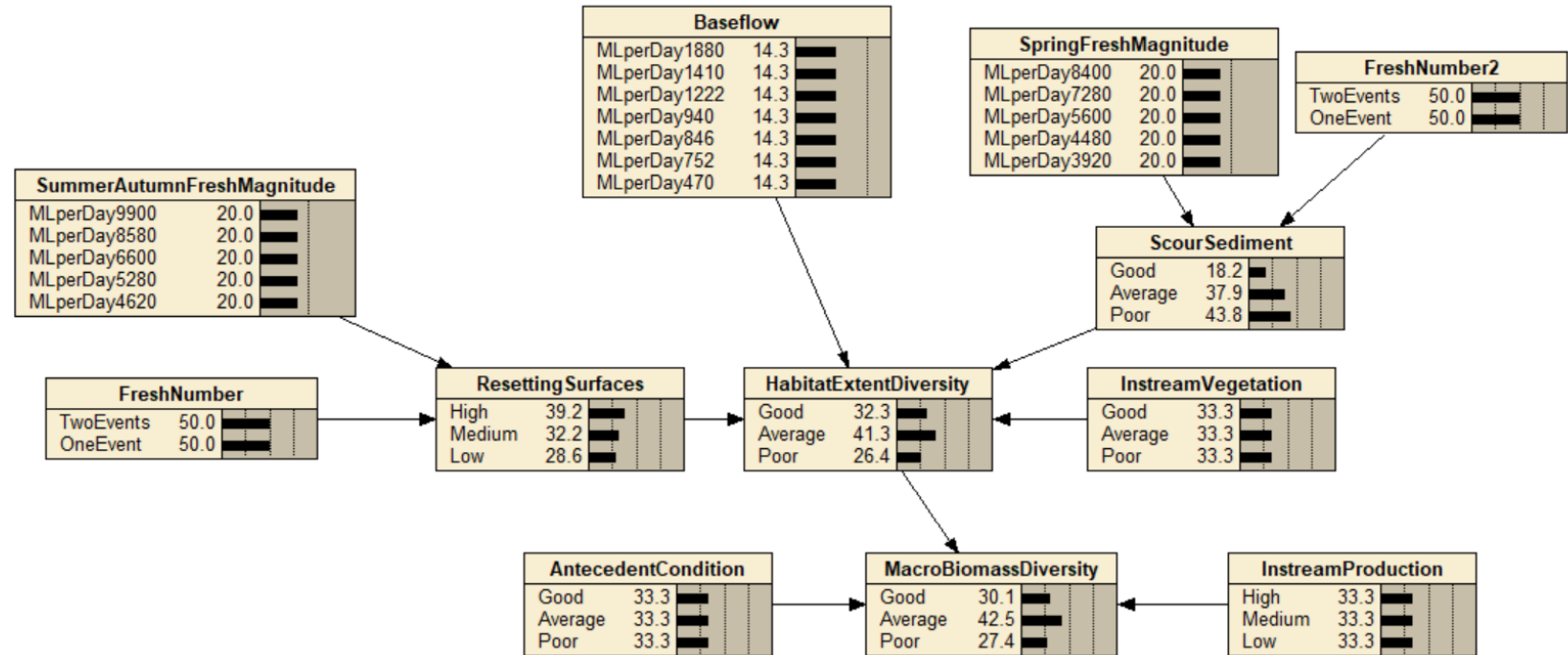
Ecological models that apply outside historical conditions



Wang et al (2018)

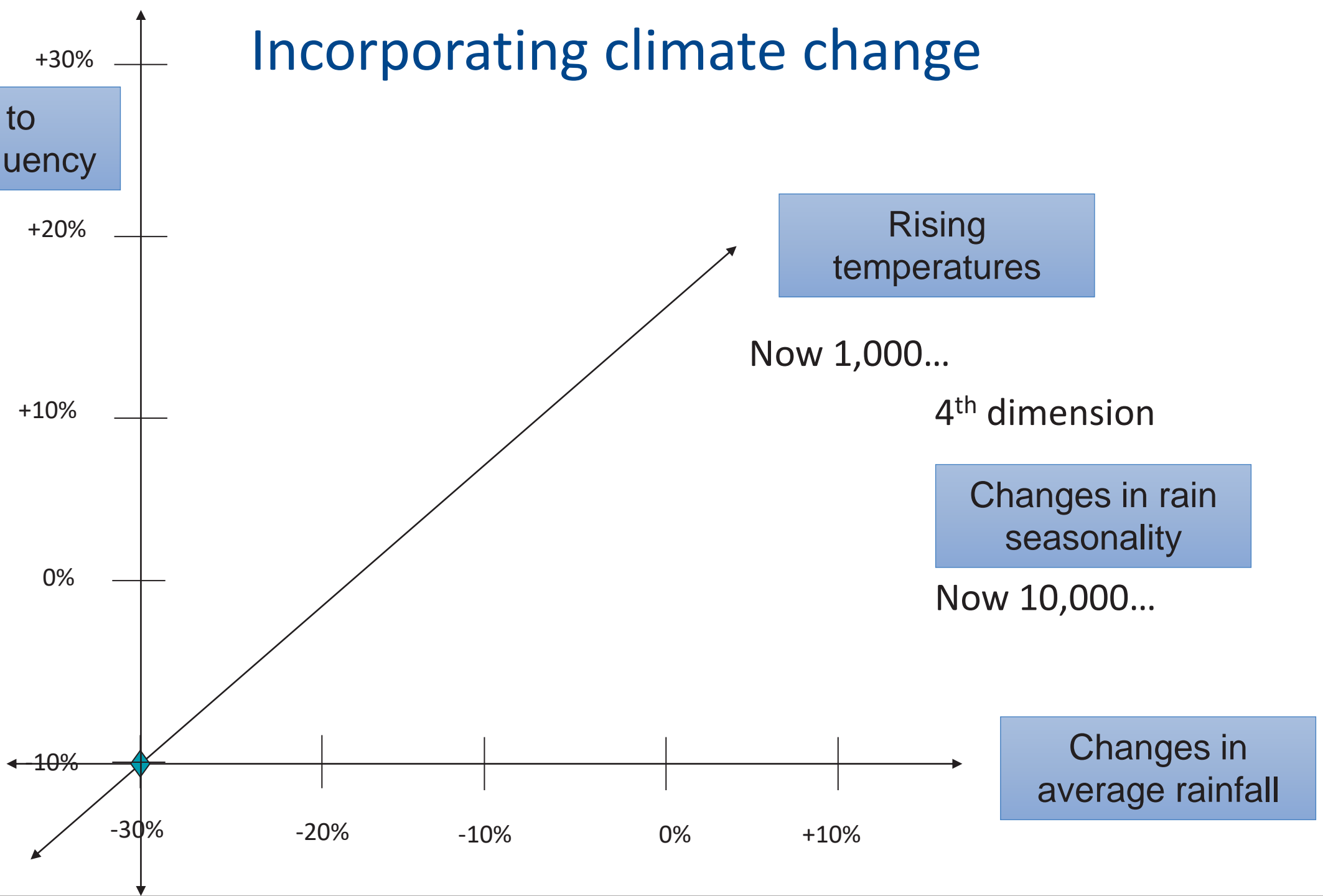


Tonkin et al (2019)



Mussehl et al (in prep)

Incorporating climate change



Changes to
Low flow frequency

Rising
temperatures

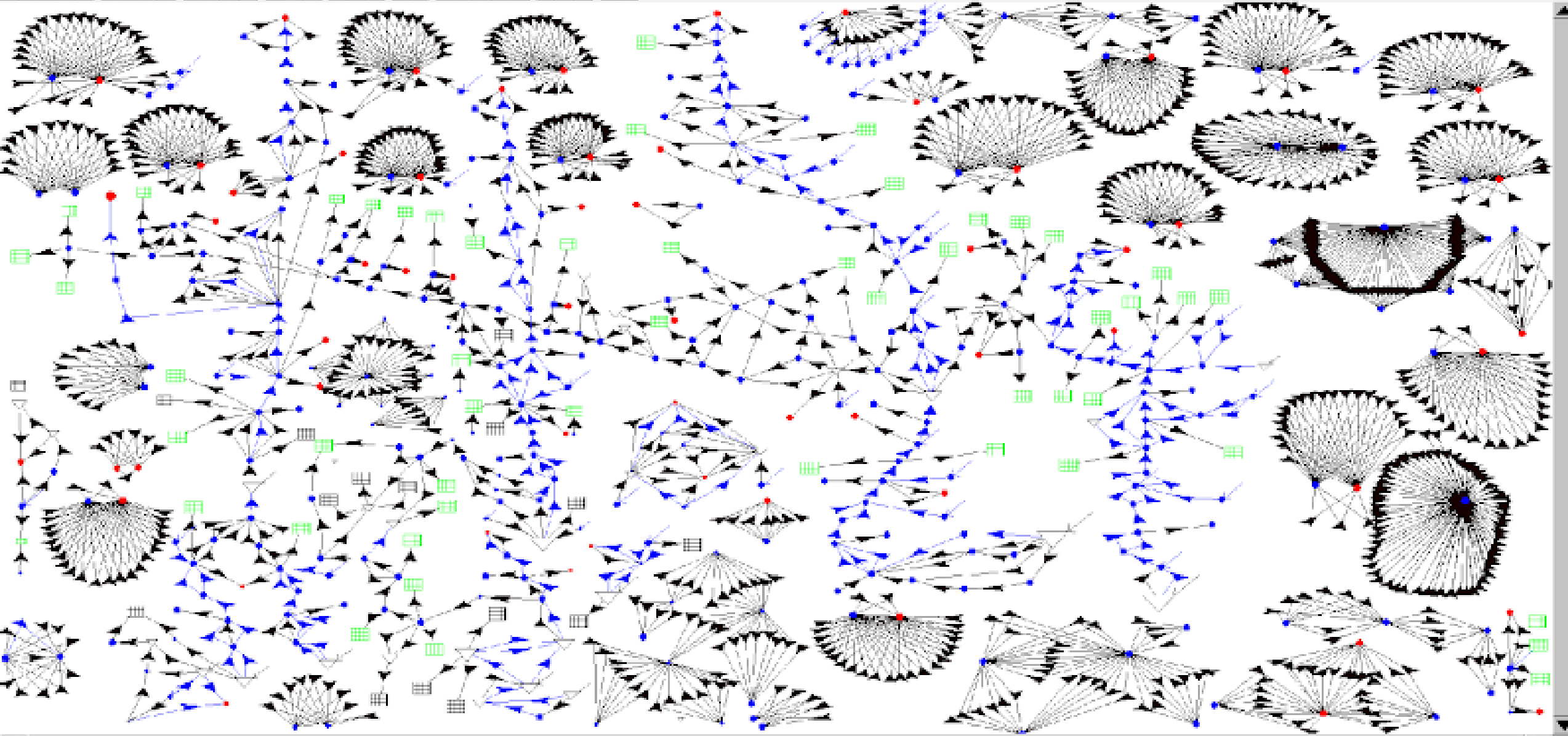
Now 1,000...

4th dimension

Changes in rain
seasonality

Now 10,000...

Changes in
average rainfall



Reduce spatial detail

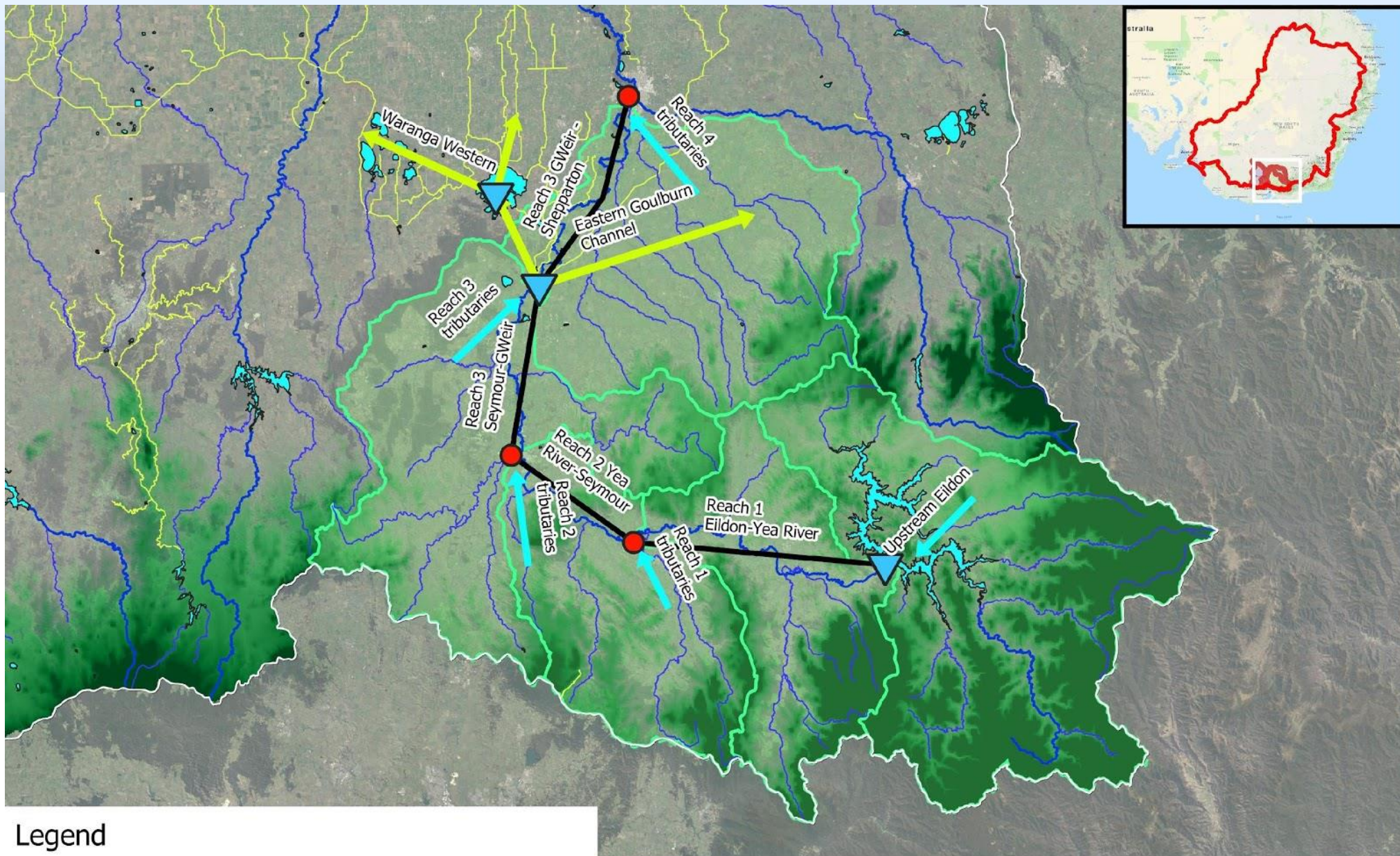
- Aggregate sub-catchments and tributaries
- Reduces complexity where it is not needed

Reduce temporal detail











- Adopt a monthly timestep
- Allows simpler representation of routing, storage and losses

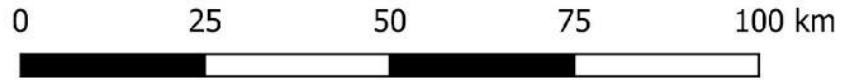
Simplify relationships

- Concentrate on aspects relevant to ecology and environmental water
- Model decision making processes of most importance
- Add functionality for management responses

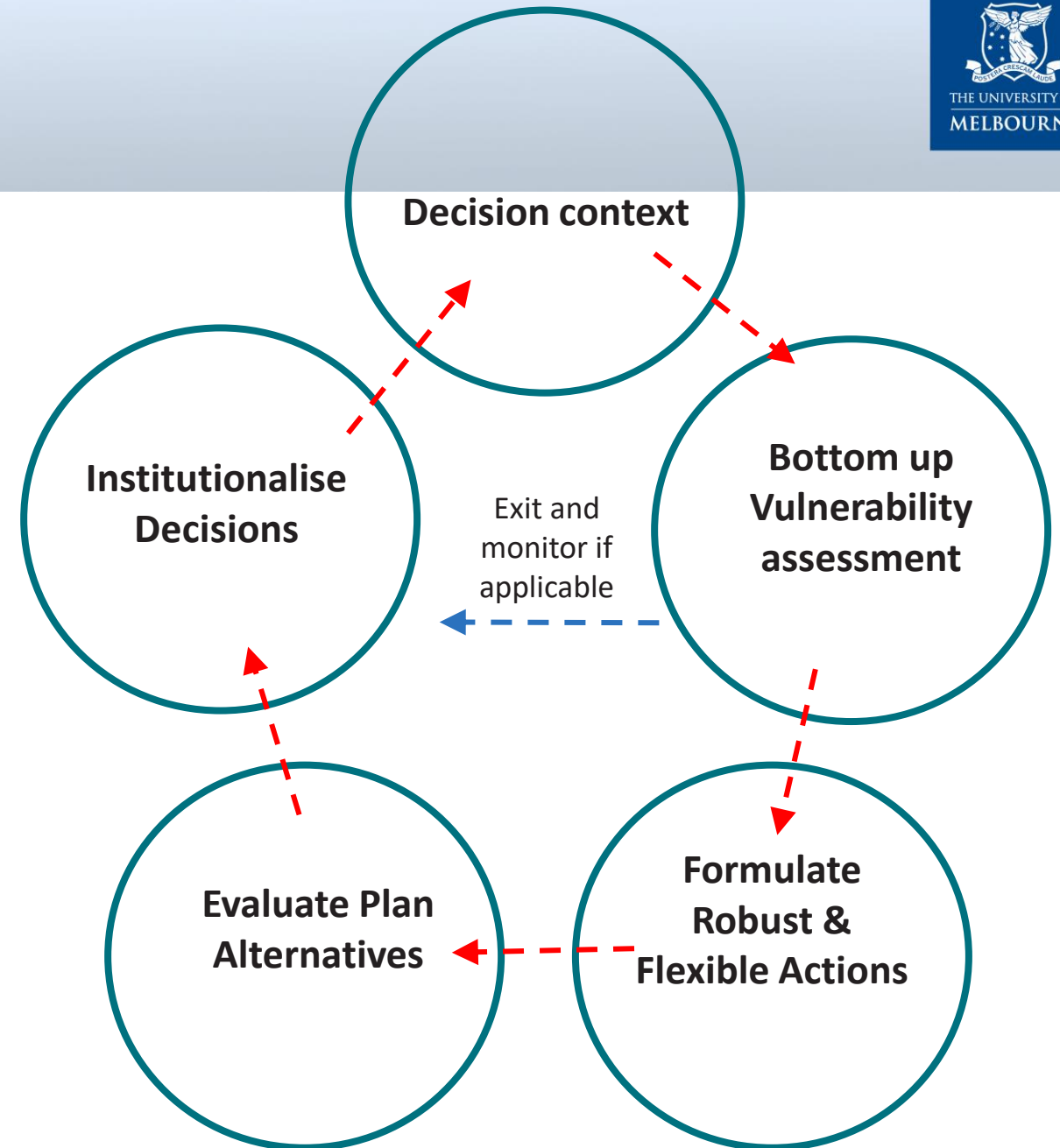


Legend

- | | | |
|---|---|--|
|  Channel |  Simplified model Junction |  Diversion |
|  River |  Storage |  Inflow |
|  Tributary |  Reach |  Aggregated inflows |
|  Lake/storage | | |

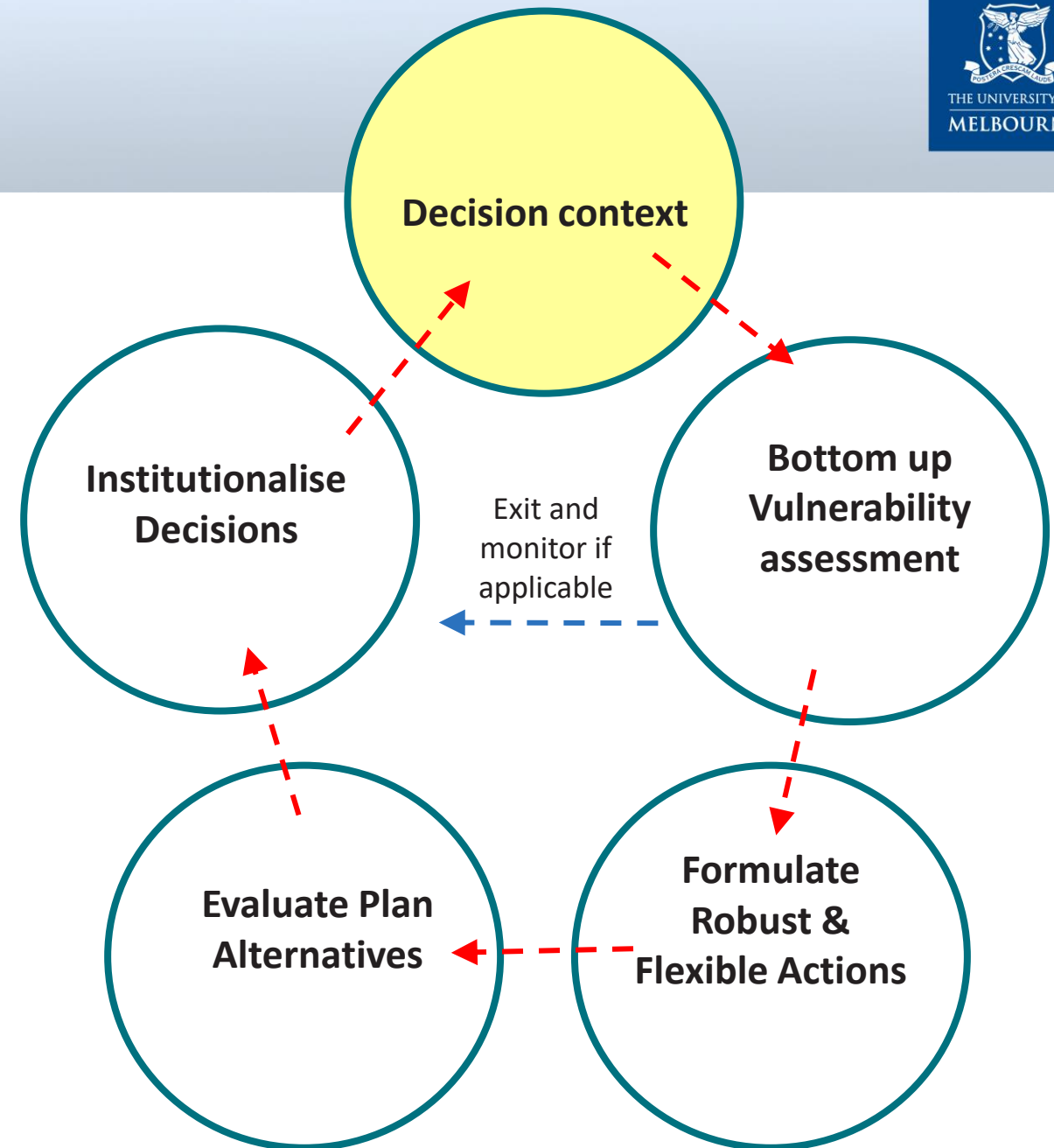


Bringing it together



Bringing it together

Participatory
workshops to set
objectives



Bringing it together

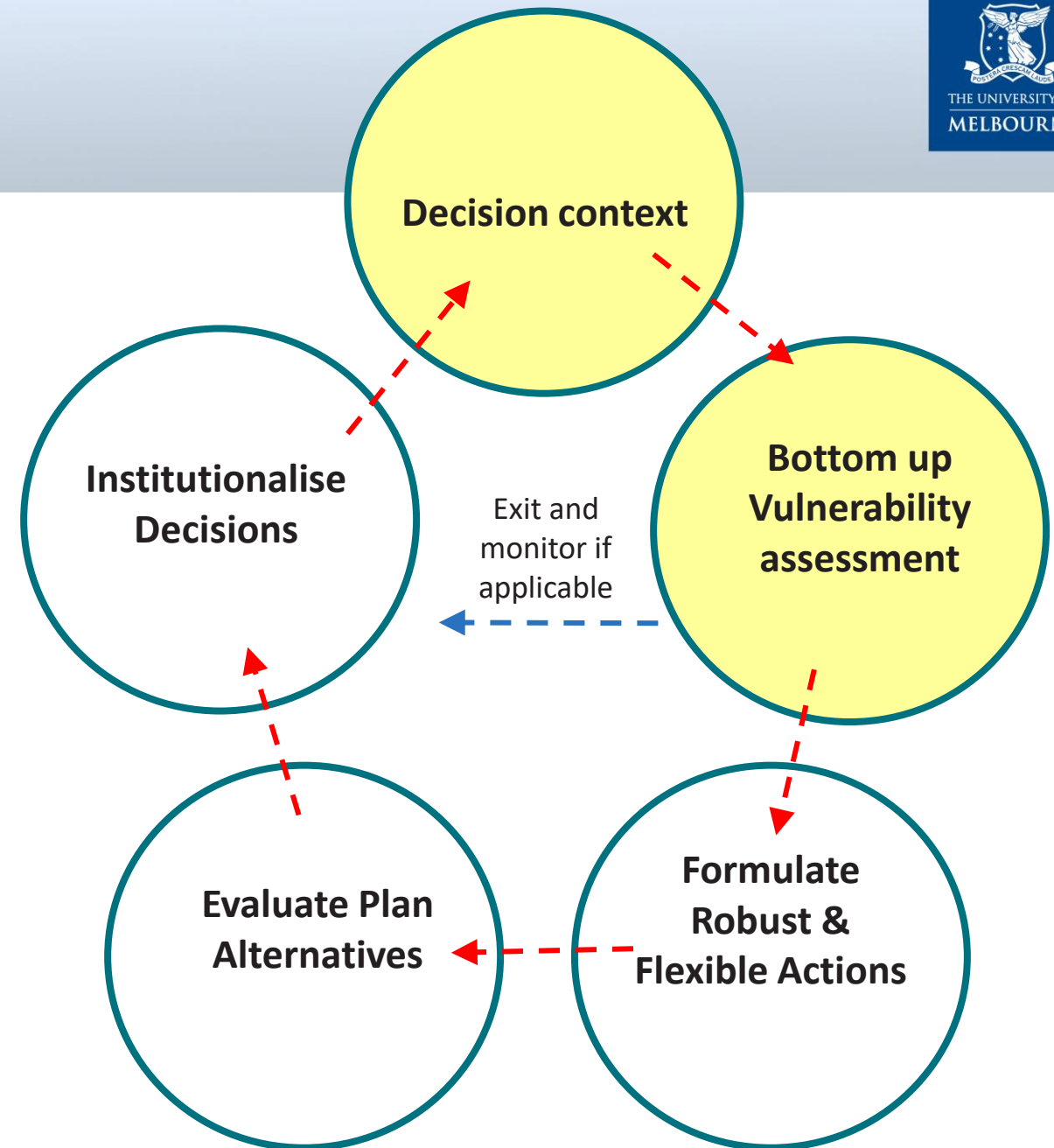
Participatory
workshops to set
objectives



Simple
Water
resource
model

Temporal and
spatially
consistent
stochastic
streamflow

Mechanistic
ecological
models



Bringing it together

Participatory
workshops to set
objectives



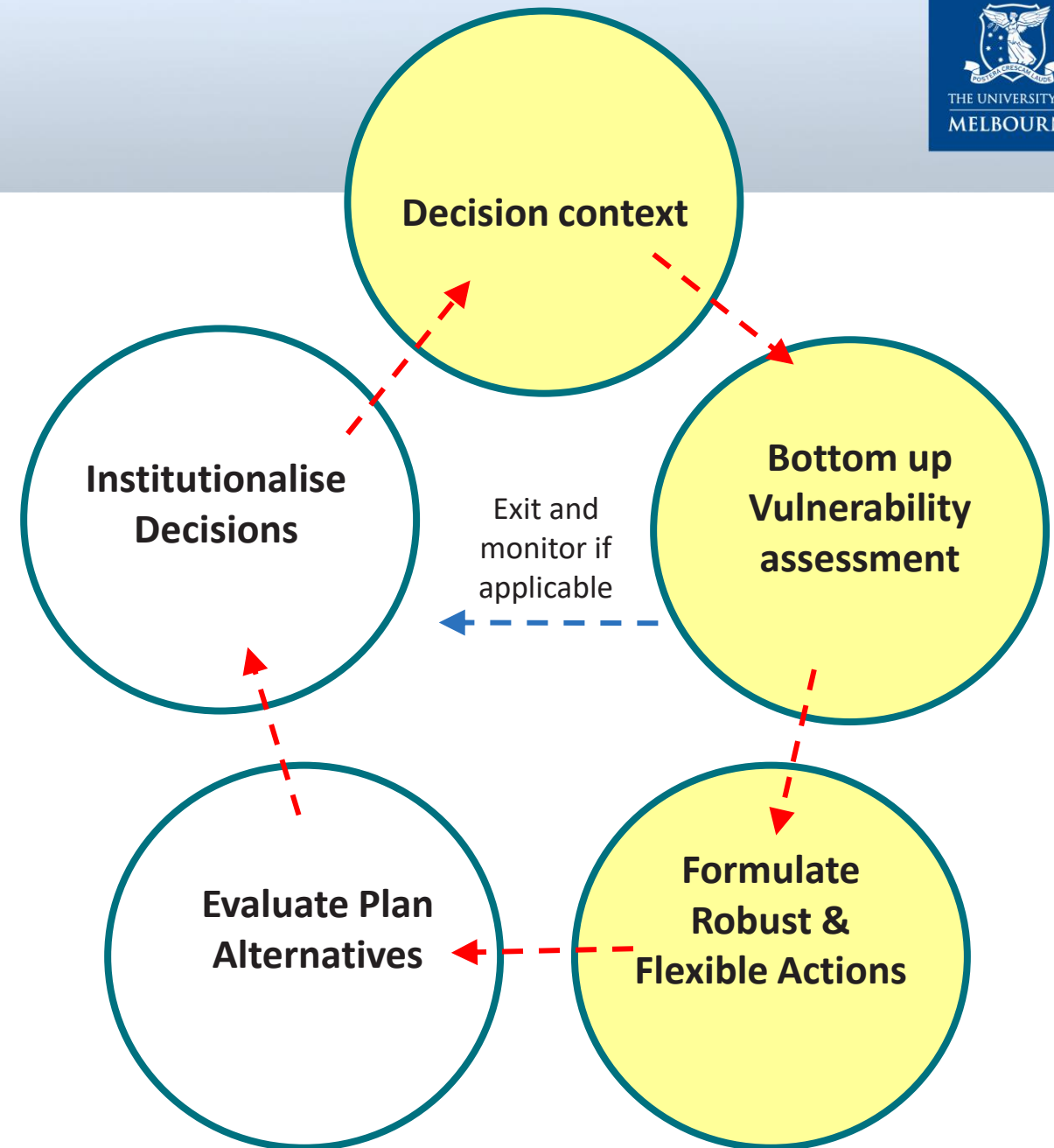
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Bringing it together

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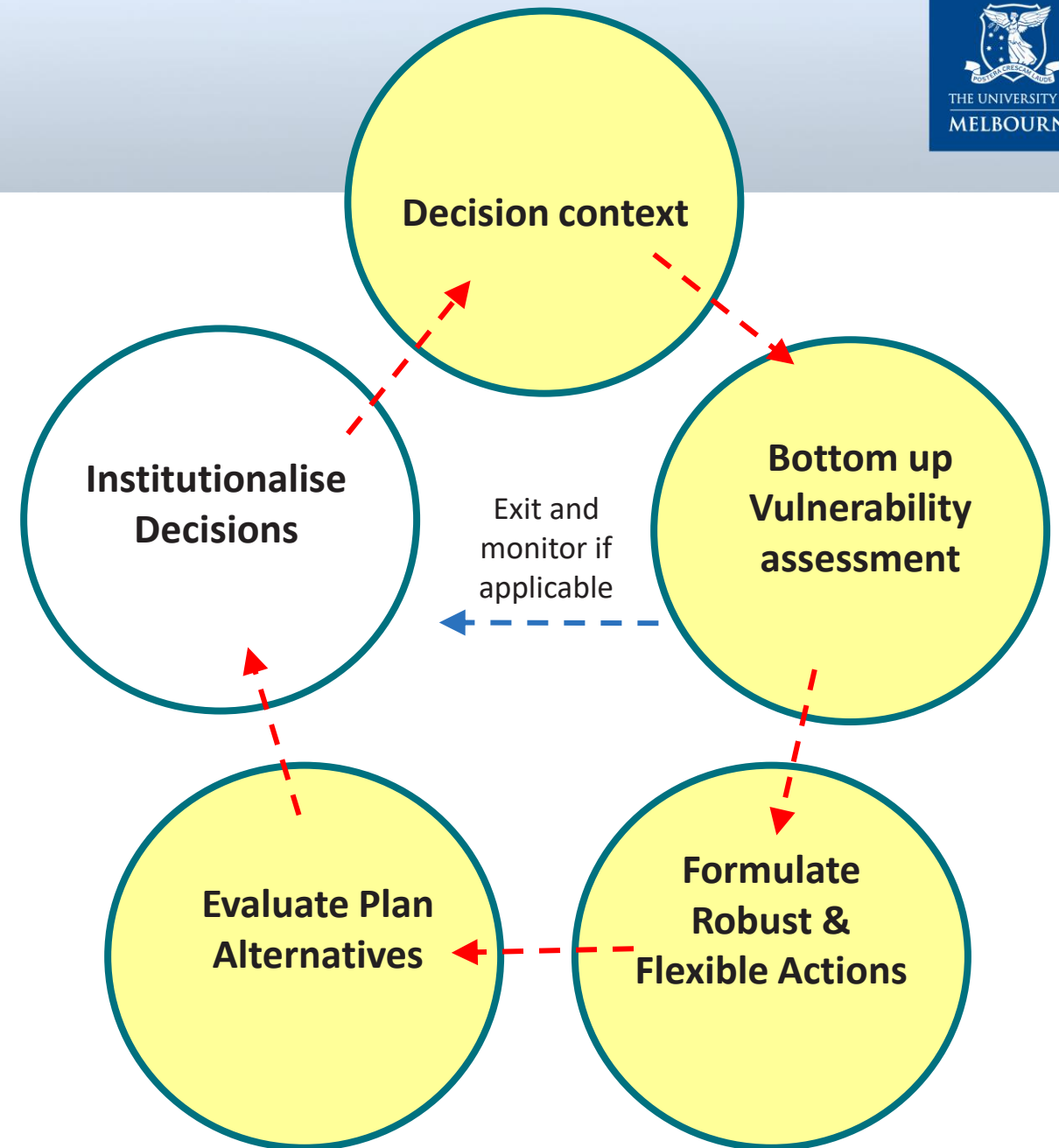
Simple
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streamflow

Mechanistic
ecological
models



Participatory
workshops



- Stakeholder / decision driven
- Process of developing model as important as modelling itself
 - forces important discussions
 - Develop understanding of priorities and tradeoffs
- Different modelling tools for different problems