National SCIENCE Challenges

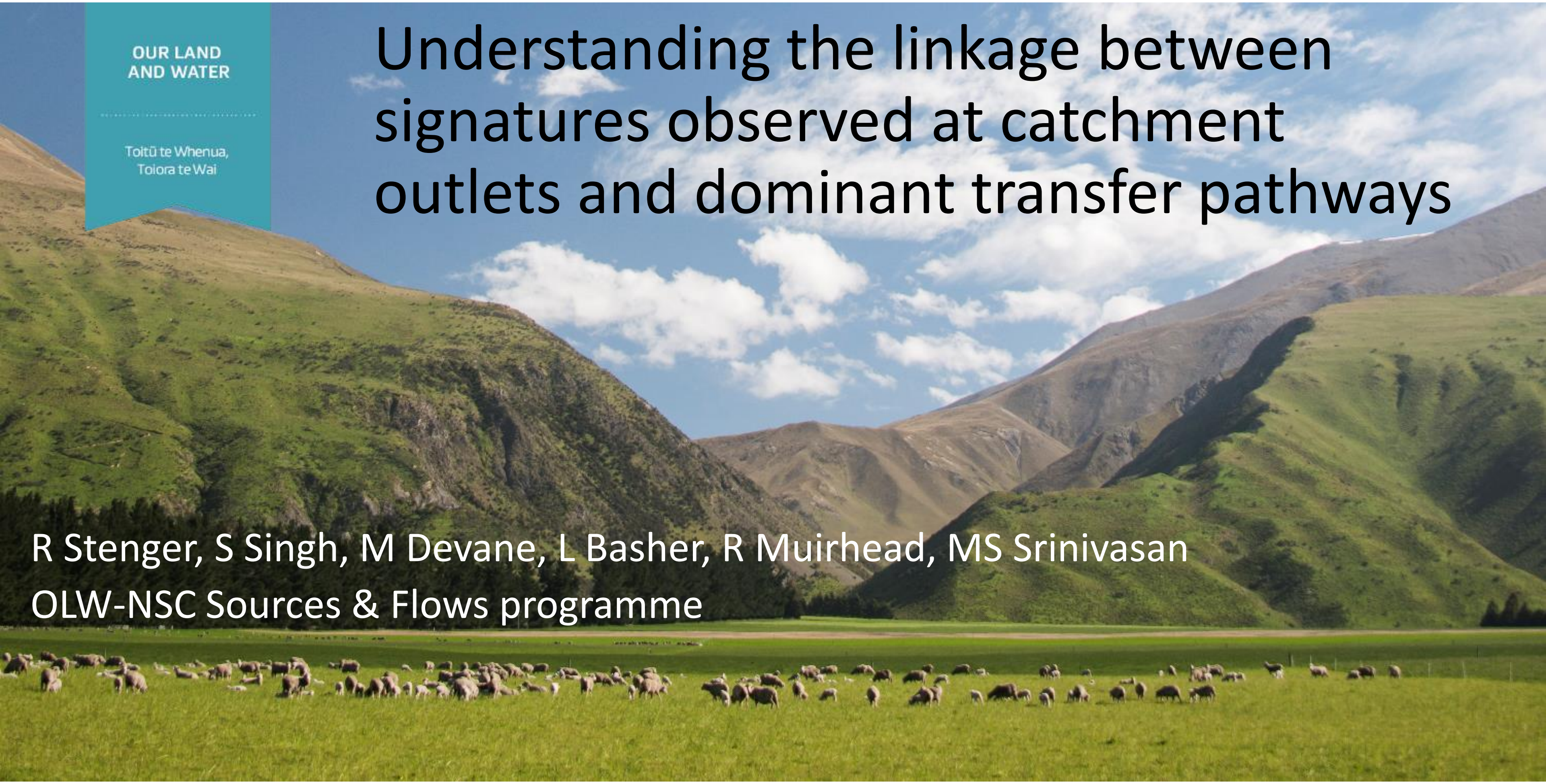
OUR LAND AND WATER

Toitū te Whenua, Toiora te Wai

Understanding the linkage between signatures observed at catchment outlets and dominant transfer pathways

R Stenger, S Singh, M Devane, L Basher, R Muirhead, MS Srinivasan

OLW-NSC Sources & Flows programme



ESR — THE SCIENCE BEHIND THE TRUTH

LANDCARE RESEARCH MANAAKI WHENUA

LINCOLN AGRITECH LTD

agresearch — āta mātai, mātai whetū

NIWA Taihoro Nukurangi

'Sources & Flows' programme within Our Land and Water

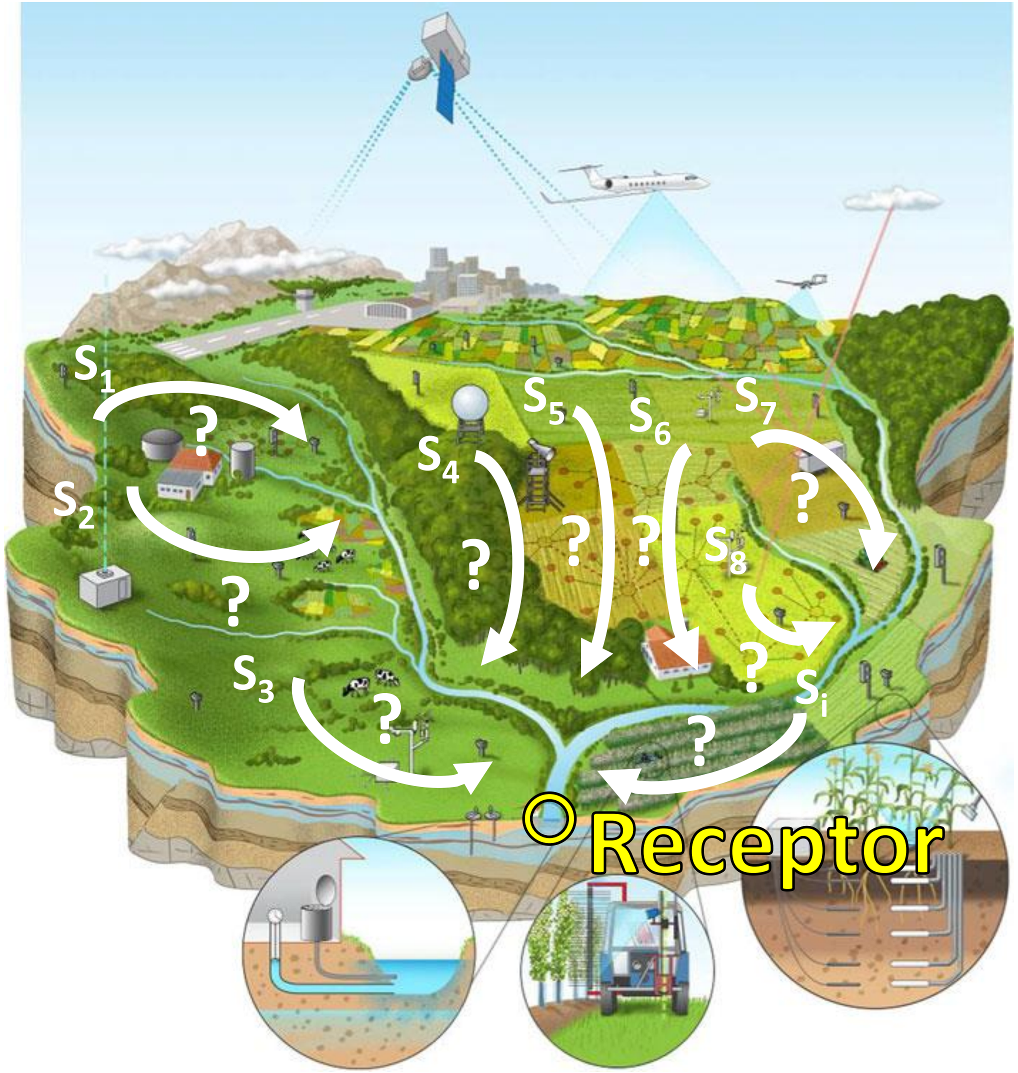
- Our Land and Water mission:
  "To enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations".

- Sources & Flows objective*:*
  "To identify and map key flow pathways and contaminant fluxes in the landscape to inform suitability for land use and response at multiple spatial and temporal scales".

http://www.ourlandandwater.nz/

National SCIENCE Challenges OUR LAND AND WATER Toitū te Whenua, Toiora te Wai

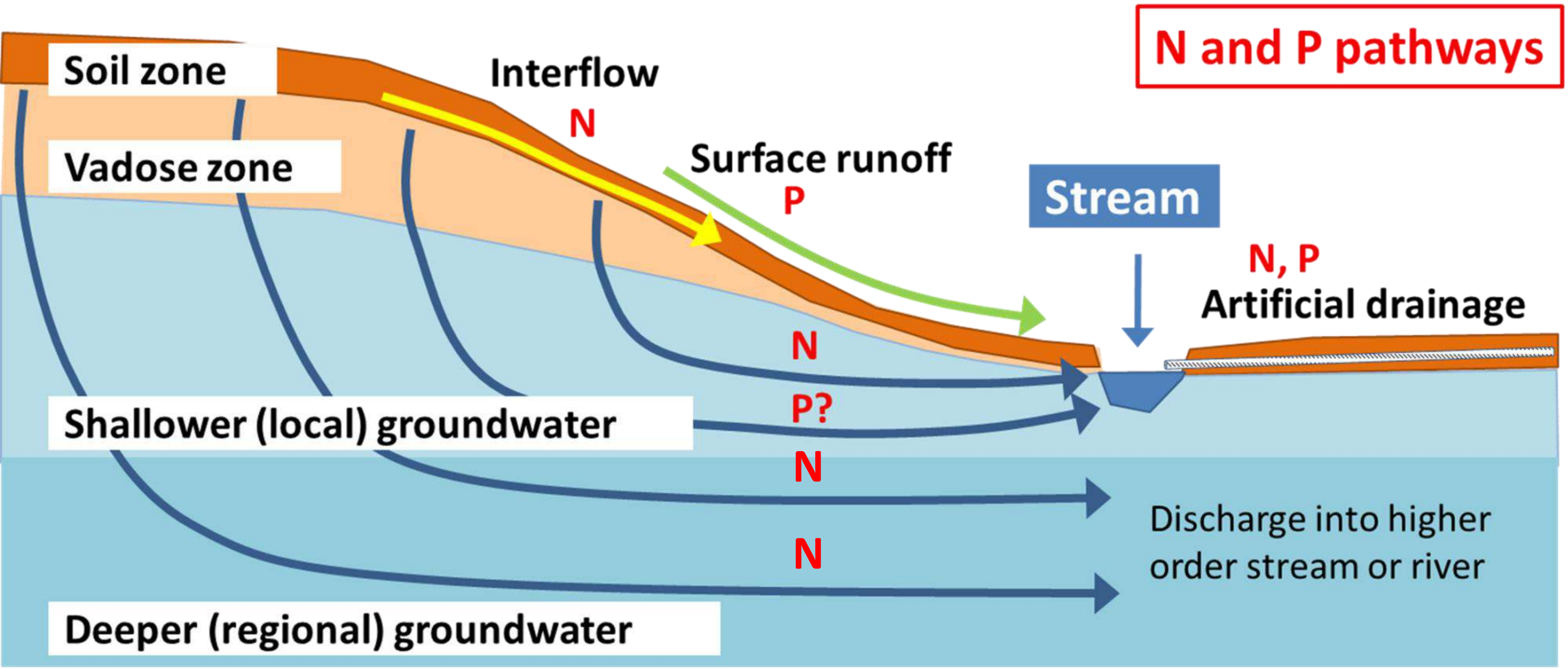
Key pathways and contaminant fluxes in the landscape?



- Spatial and temporal variability
- Progress in monitoring techniques
- In-depth country-wide investigations unaffordable
- Transport and transformation processes between sources (S_i) and receptor (R) still insufficiently understood

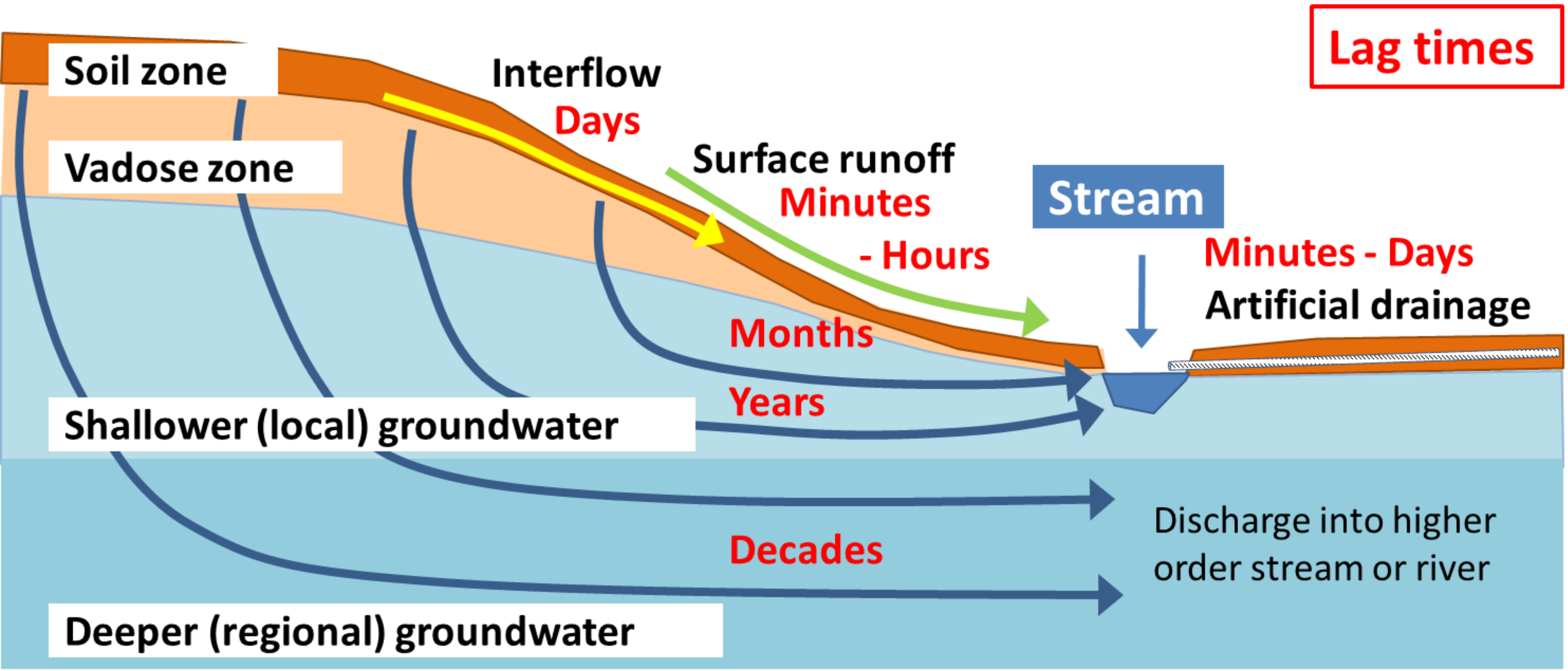
DFG, 2012; Gratwohl et al., 2013

1. How do contaminants reach the stream?



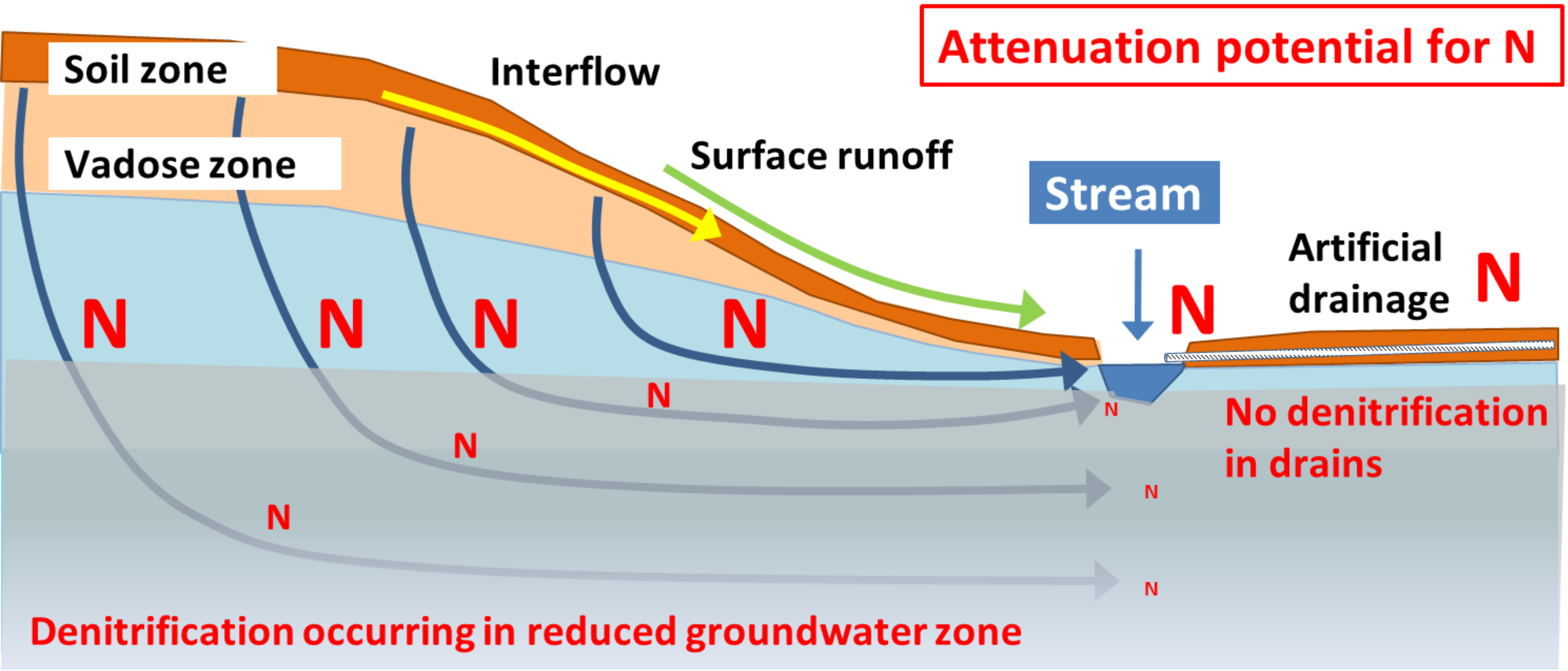
Stenger et al., 2016

2. How long does it take?



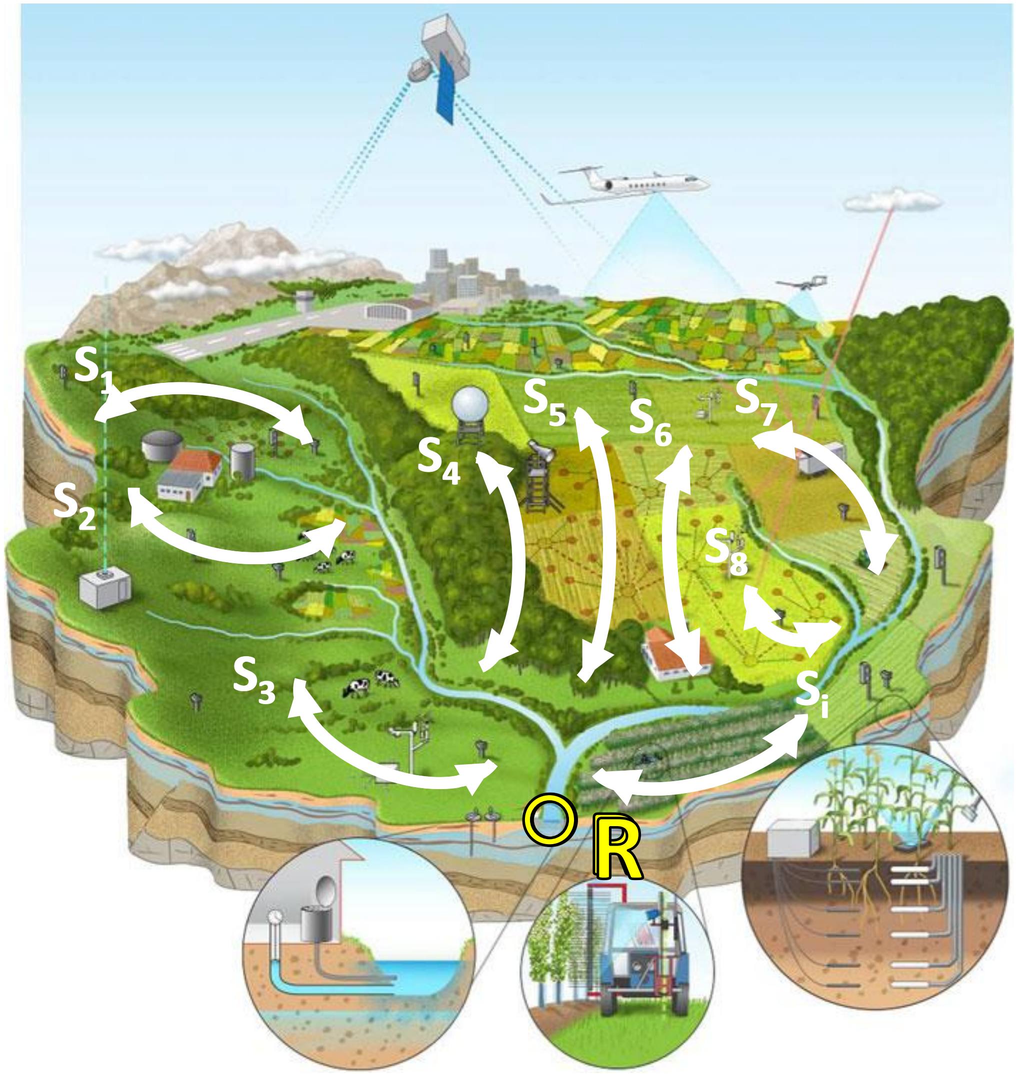
Stenger et al., 2016

3. What happens during transfer?



Stenger et al., 2016

Extracting pathways info from stream monitoring data?



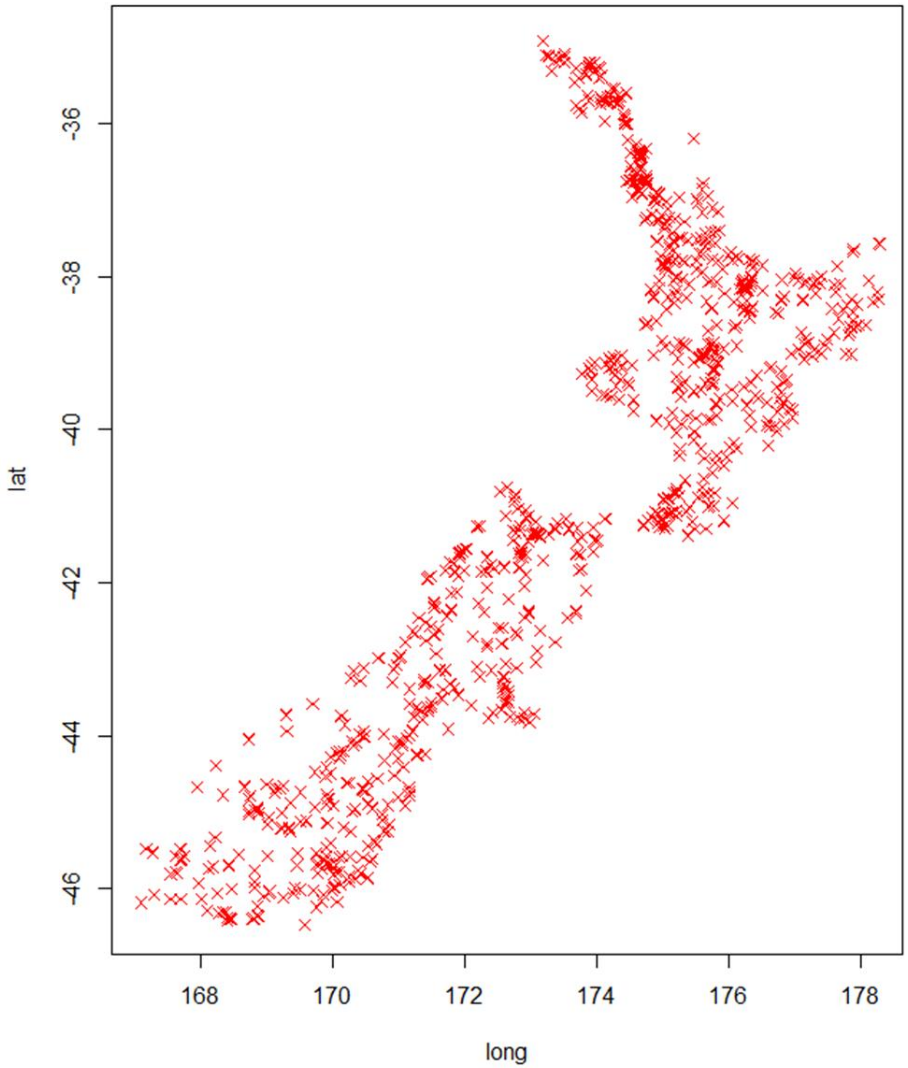
'Reverse hydrology'

- Analysis of data from receptor end of source-transfer-receptor chain
- Receptor 'sees' the contributions from all pathways from the entire catchment

Receptor data

- Stream flow hydrographs
- Stream water chemistry

Stream monitoring data 1



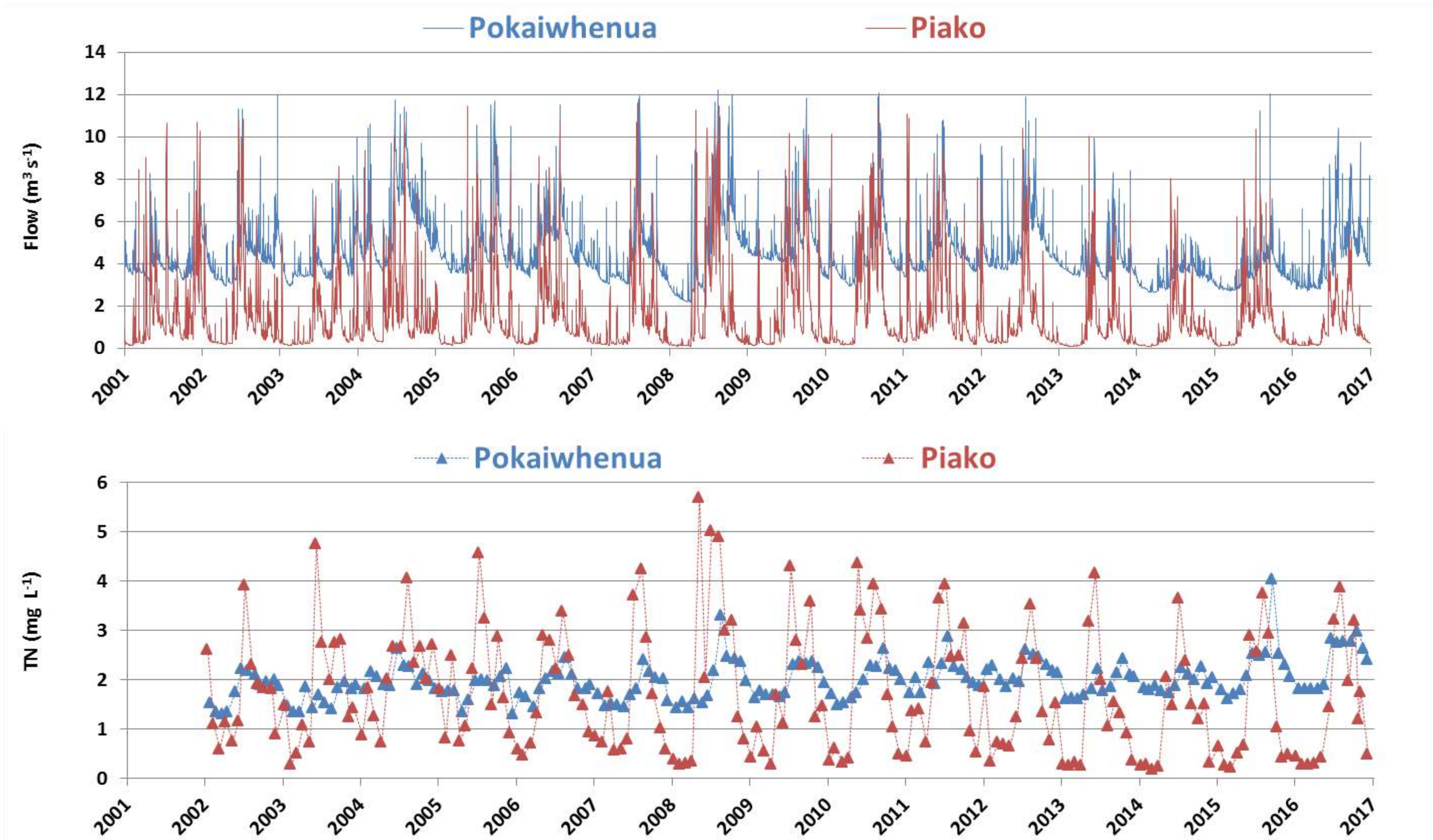
Stream flow

- North Island: n = 503
- South Island: n = 386

Stream water chemistry

- Available for subset of sites

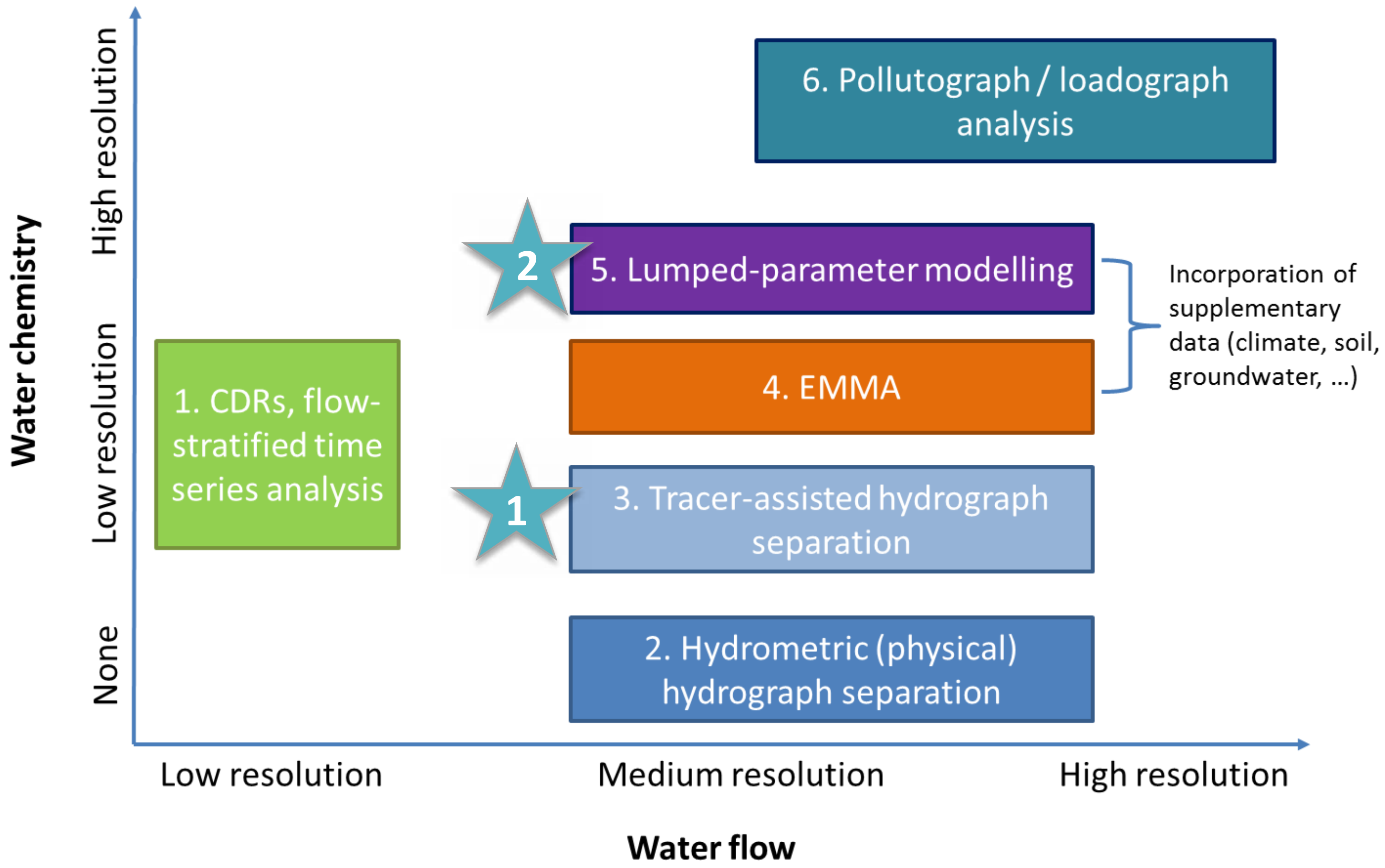
Stream monitoring data 2



Transfer Pathways Programme (TPP), 2015 – 2018, aligned to OLW-NSC

National SCIENCE Challenges OUR LAND AND WATER Toitū te Whenua, Toiora te Wai

Review of ‘Indirect Methods’ in Sources & Flows



Transfer Pathways Programme (TPP), 2015 – 2018, aligned to OLW-NSC

Examples: Tracer-assisted hydrograph separation 1

Bayesian chemistry-assisted hydrograph separation (BACH):

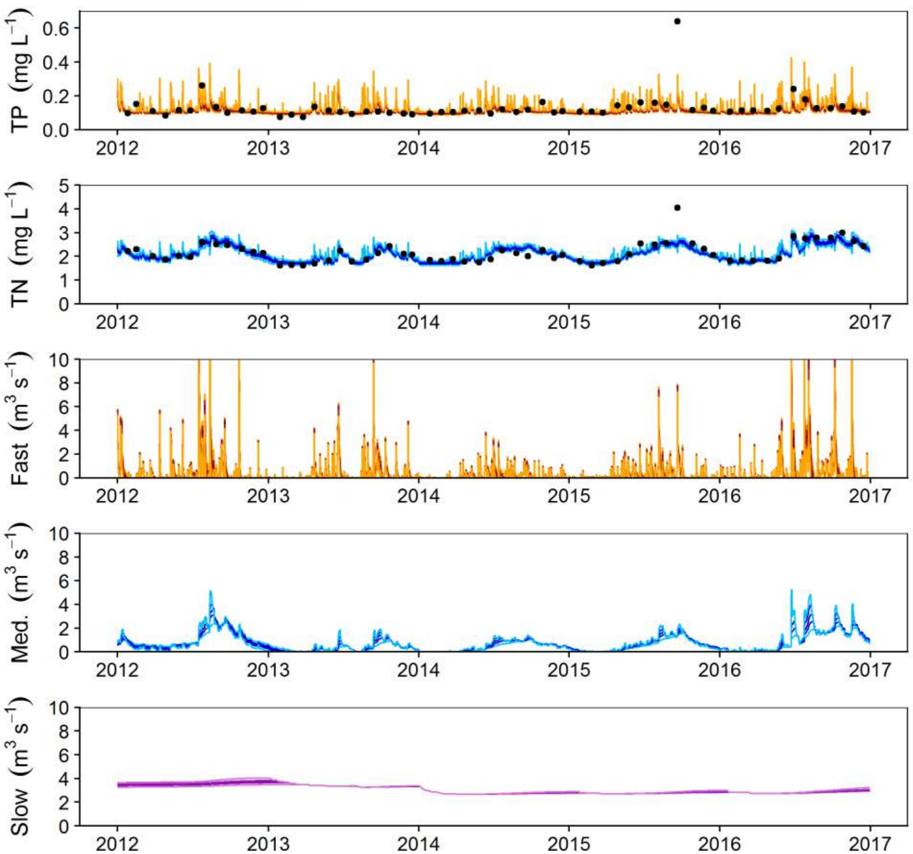
- Utilises nothing but flow hydrograph and two water chemistry parameters routinely analysed in State-of-Environment monitoring programmes
- Including chemical tracers results in hydrograph separation that is more representative of physical flow paths than purely hydrometric separation
- BACH estimates:
  a) the flow split into three contributing pathways:
  1) Fast, near-surface water
  2) Medium, shallow groundwater
  3) Slow, deep groundwater

  b) the concentration in each of these pathways of the two chemical parameters used for the calibration (e.g. TN, TP)

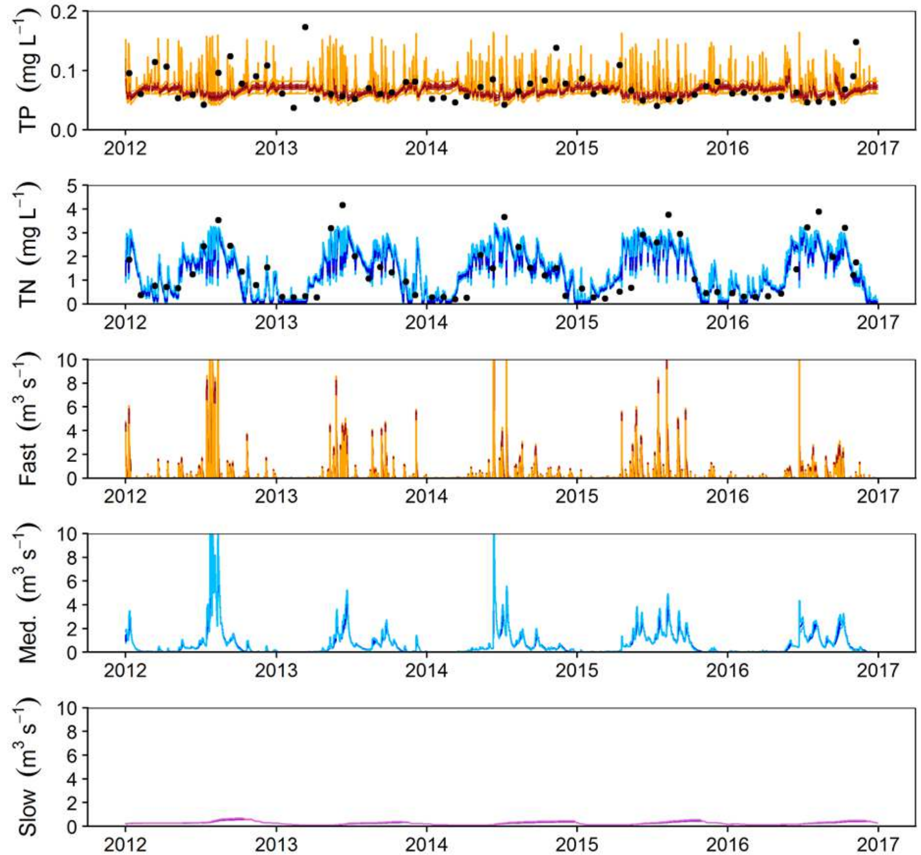
Woodward and Stenger, in preparation

Examples: Tracer-assisted hydrograph separation 2

Pokaiwhenua

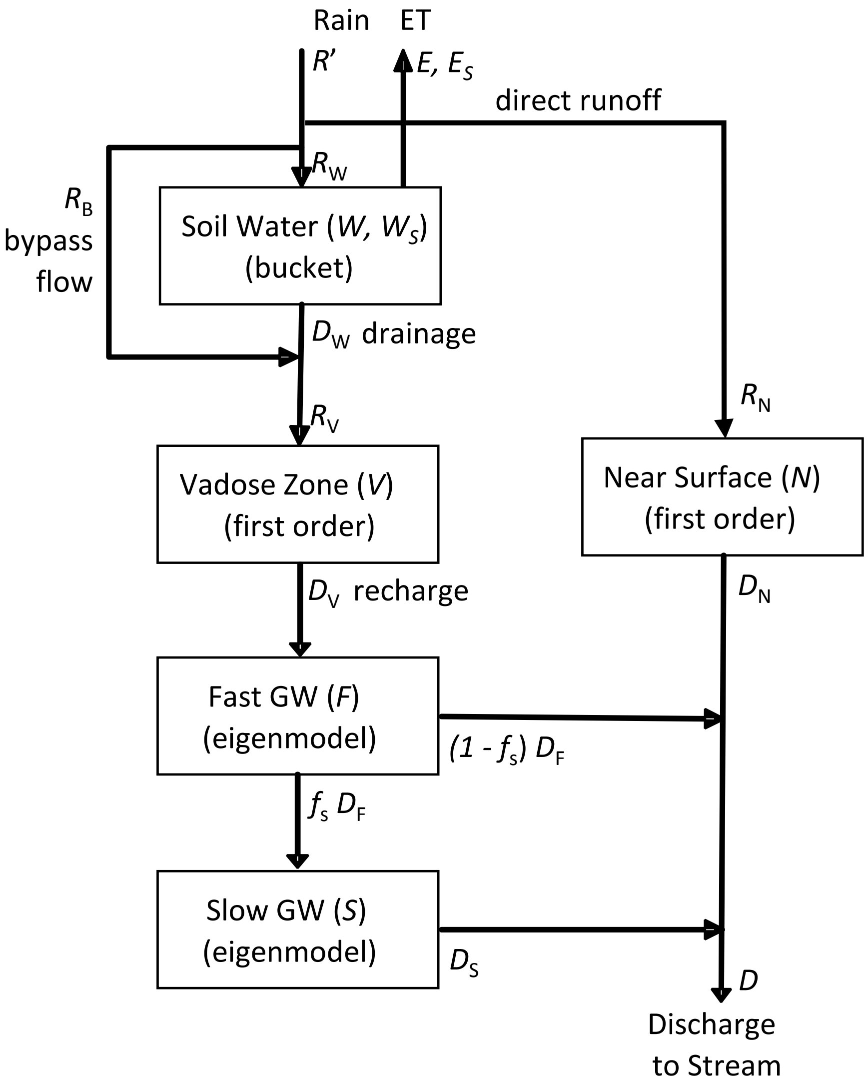


Piako



	Fast	Medium	Slow	Fast	Medium	Slow
Flow fraction (-)	**0.12**	**0.16**	**0.71**	**0.30**	**0.50**	**0.20**
TP (mg L^{-1})	**0.04**	**0.02**	**0.07**	**0.04**	**0.03**	**0.01**
TN (mg L^{-1})	**0.32**	**0.67**	**1.21**	**0.28**	**1.61**	**0.01**

Examples: Lumped-parameter modelling 1



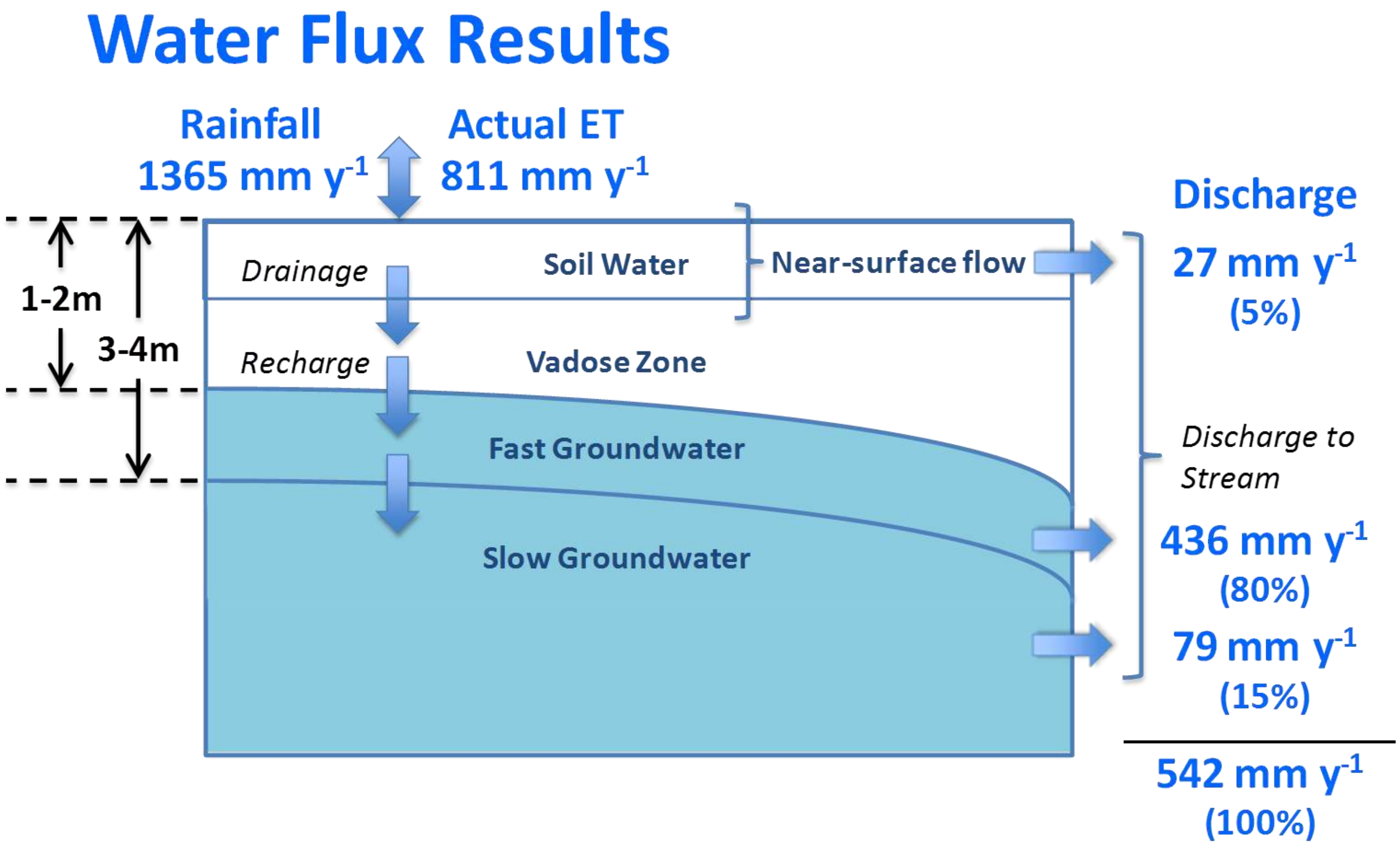
StreamGEM

(Streamflow Generation Eigen Model)

- Requires stream flow, water chemistry, **and** climate time series
- Remarkably effective provided appropriate calibration methods are used that correctly handle the inherent uncertainties
- Markov Chain Monte Carlo sampling code $DREAM_{ZS}$ used for calibration

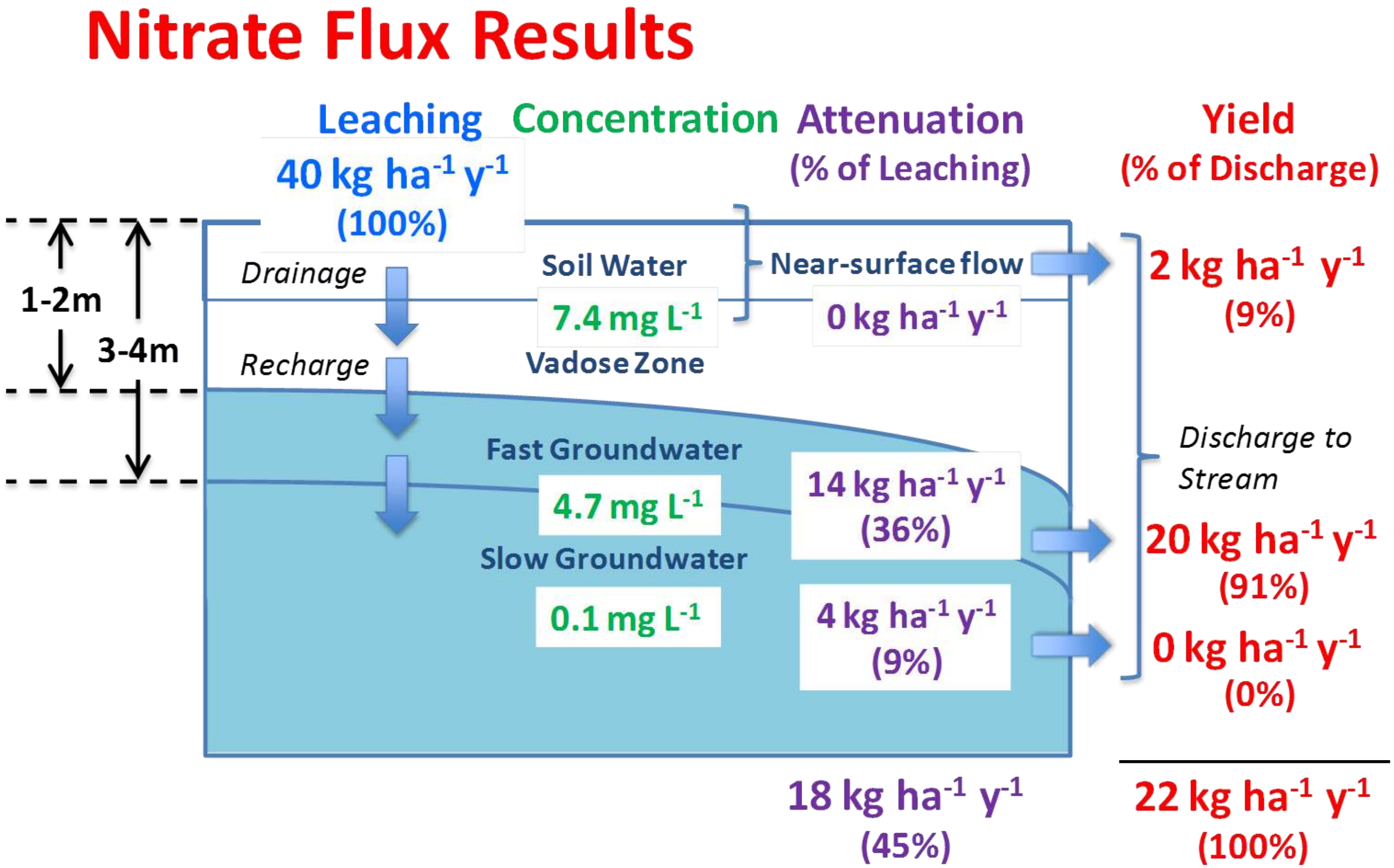
Woodward et al., 2013 + 2017

Examples: Lumped-parameter modelling 2



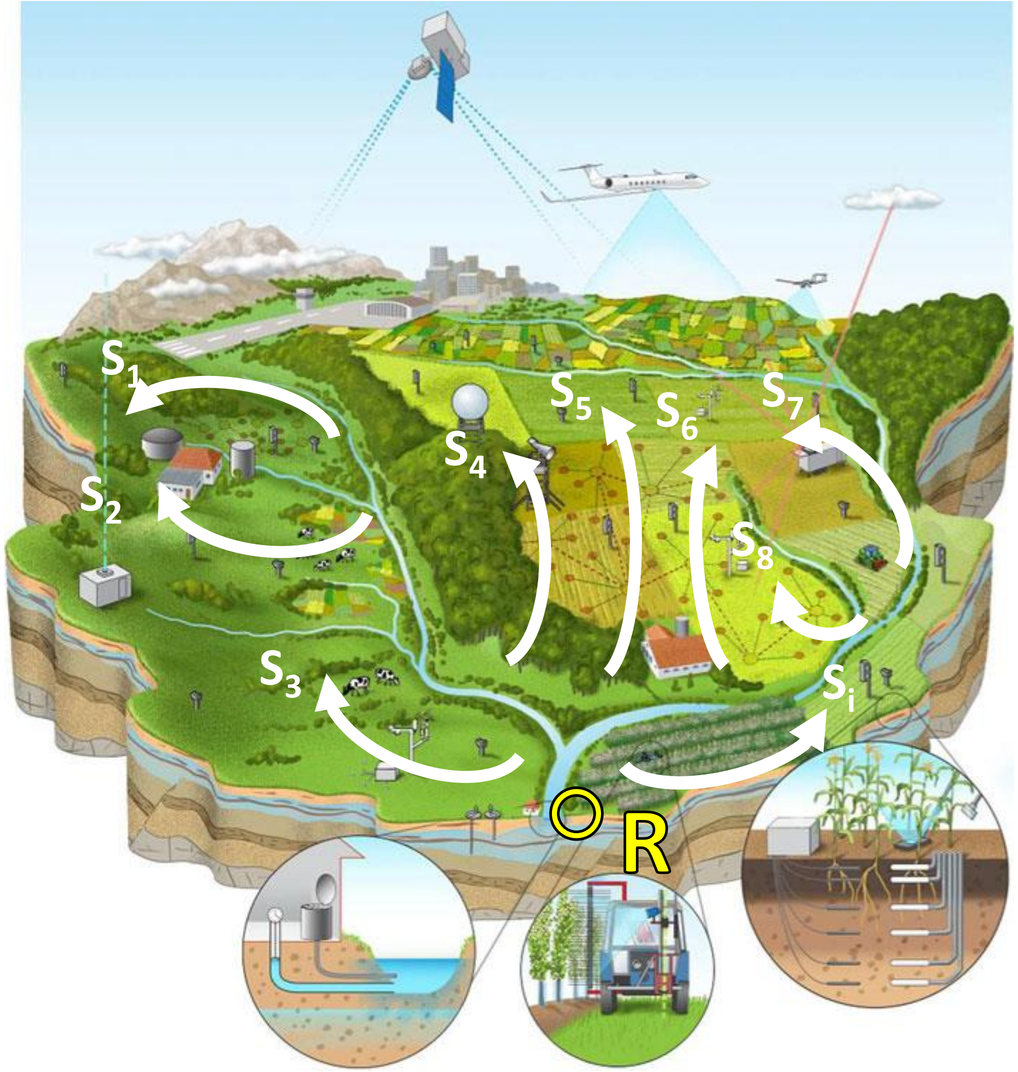
Woodward et al., 2013 + 2017

Examples: Lumped-parameter modelling 3



Woodward et al., 2013 + 2017

Extracting pathways info from stream monitoring data?



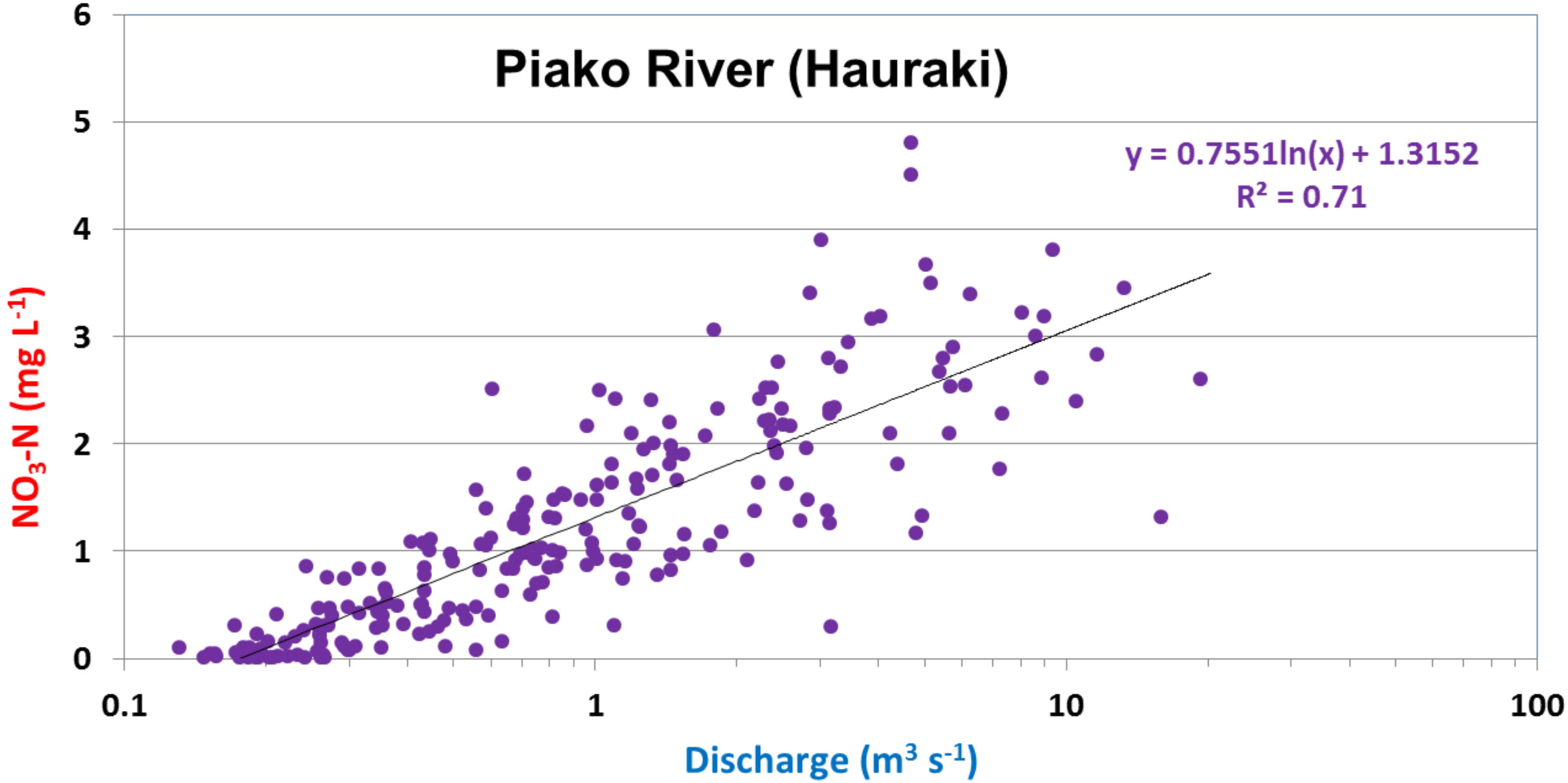
- Combined analysis of stream flow and water chemistry time series can provide valuable insights
- Proper uncertainty analysis crucial
- Temporal variability poses challenge at any spatial scale
- Superposition of various processes occurring at different locations or at different time scales will weaken signals in larger catchments

National SCIENCE Challenges

Thank you for your attention!

http://www.ourlandandwater.nz/

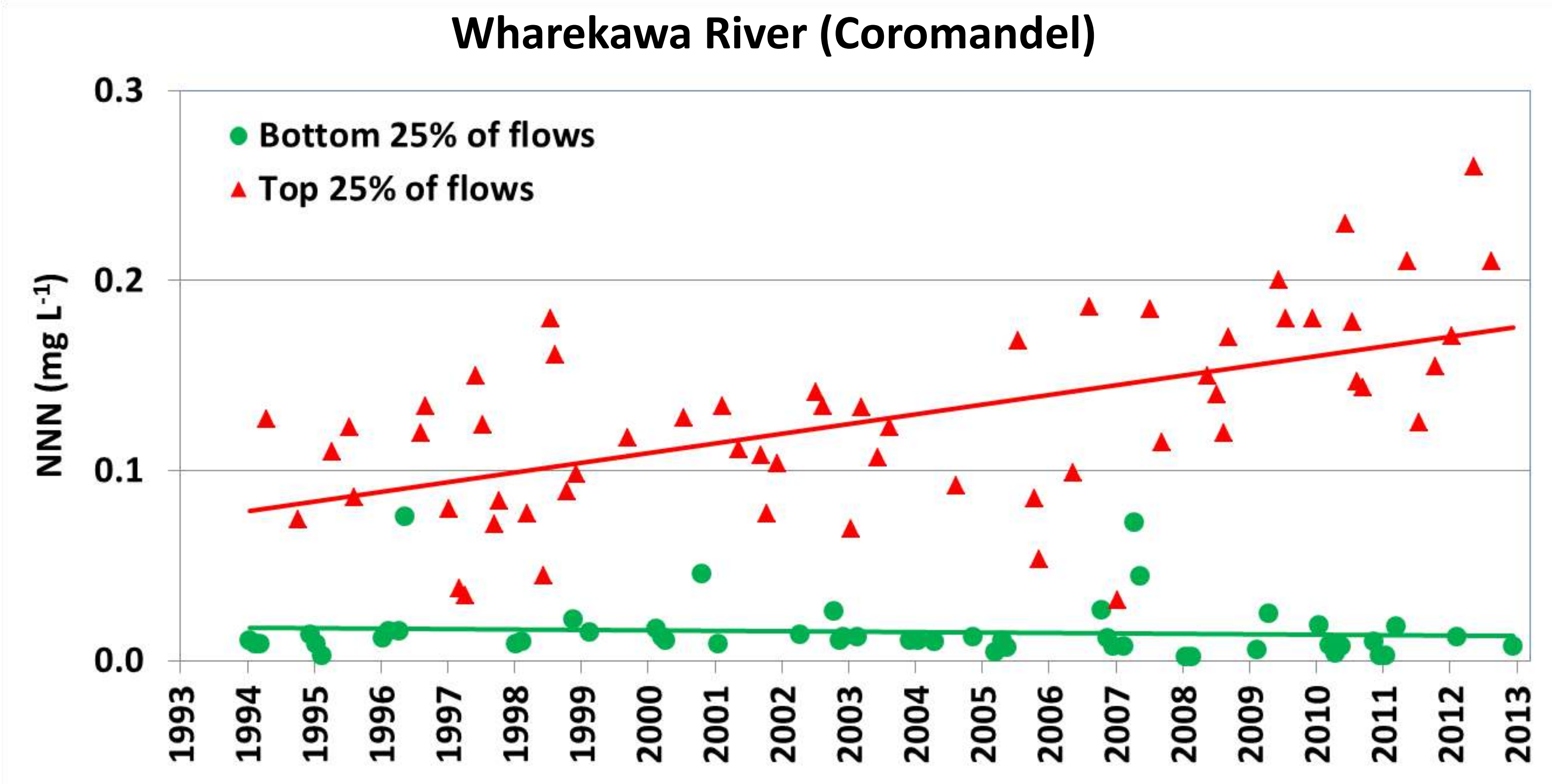
Examples: Concentration-Discharge Analysis



Stenger et al., 2014

National Science Challenges
OUR LAND AND WATER
Toitū te Whenua, Toiora te Wai

Examples: Flow-stratified time series analysis



- Near-surface flows responsible for rising nitrate concentrations
- Early response to relatively recent land use intensification

Stenger et al., 2014

National SCIENCE Challenges OUR LAND AND WATER Toitū te Whenua, Toiora te Wai