Sea level rise and groundwater

Numerical modelling and risk-based decision making

Murihiku Regeneration

Energy and Innovation Expo

23rd May 2023

Photo: L. Homer, GNS

Lee Chambers
Groundwater modeller
Hydrogeology and Geophysics

GNS SCIENCE
TE PŪ AO

Talk outline

Groundwater – **A hidden asset**

Threats to our groundwater systems

New Zealand SeaRise platform – **Updated projections for NZ**

Groundwater, sea level rise and modelling **uncertainty**

Mapping New Zealand's groundwater resources

A hidden asset

The social, cultural, economic and environmental value of groundwater

Estimated **80%** of annual **river flow** volume comes from groundwater

Critical **for** sustaining **surface aquatic ecosystems** and **mahinga kai**

Approx. **40%** of New Zealanders depend on groundwater for **drinking**

Irrigation from groundwater contributes an *estimated* **$2B/year** to the **economy**

Groundwater *may* be more **resilient** than **surface water** (e.g., droughts)

Photo: M. Low, GNS

Groundwater vulnerability

What are the main stresses on our groundwater systems?

BBC

Scale of 'nitrate timebomb' revealed

10 November 2017

By Roger Harrabin

BBC environment analyst

Newshub.

18/06/2022

Caley Callahan

11 May 2023

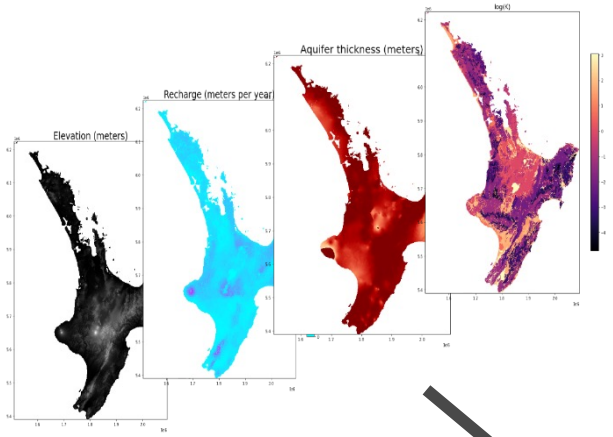
Tough decisions as councillors look to protect south Dunedin from flooding

National model of groundwater flow

Modelling across scales

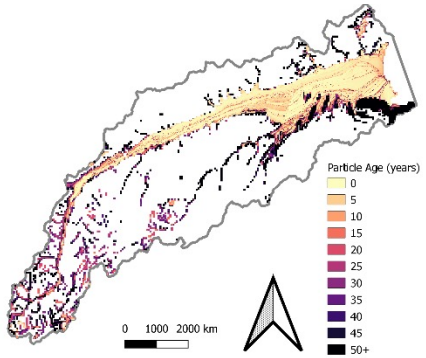
National scale data:

- Consistent datasets
- Consistent boundary conditions



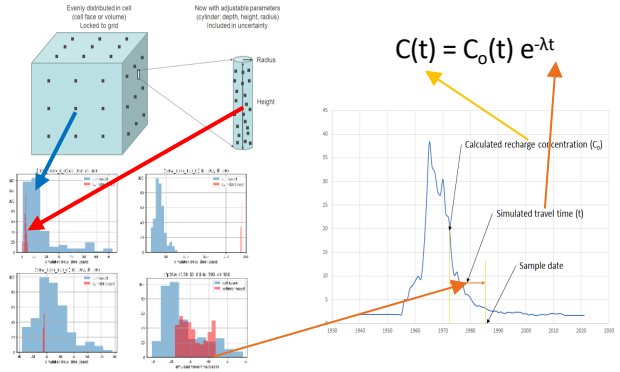
Simulate areas of interest
Informed by national model

- Identify critical areas
- Ask specific questions
- Update information



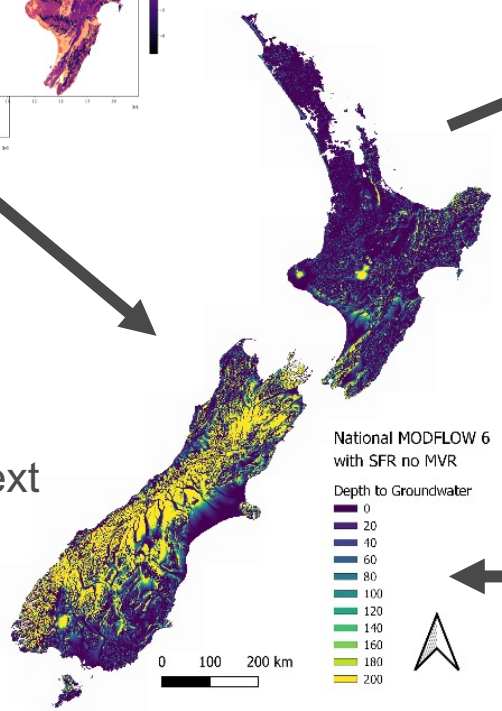
Refine process representation

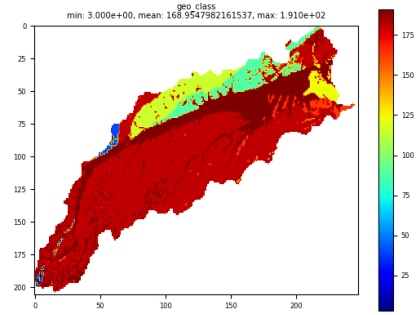
- Local processes
- History match (calibrate) to locally available data
- Extension to other areas



National scale models

- Consistent input
- National policy context
- Inform local models

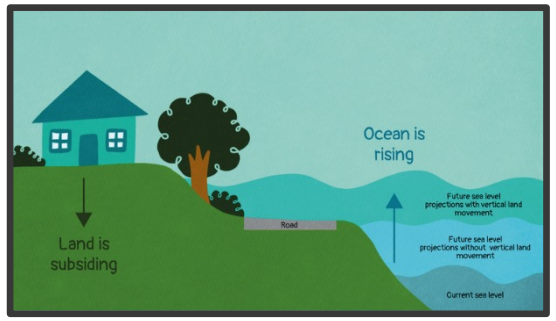




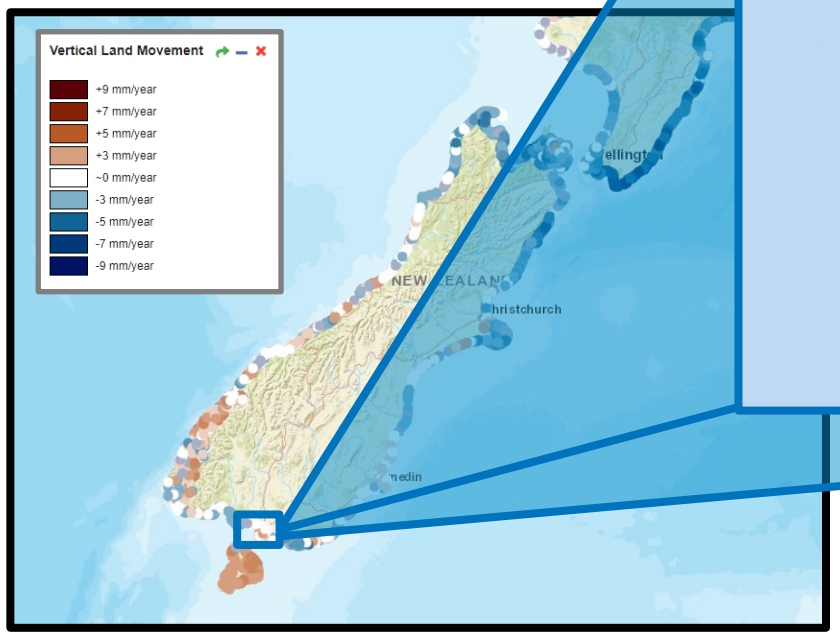
Decision support tools:

- Models designed to answer specific management questions at the appropriate scale
- Scripted for consistent, repeatable, rapid model development

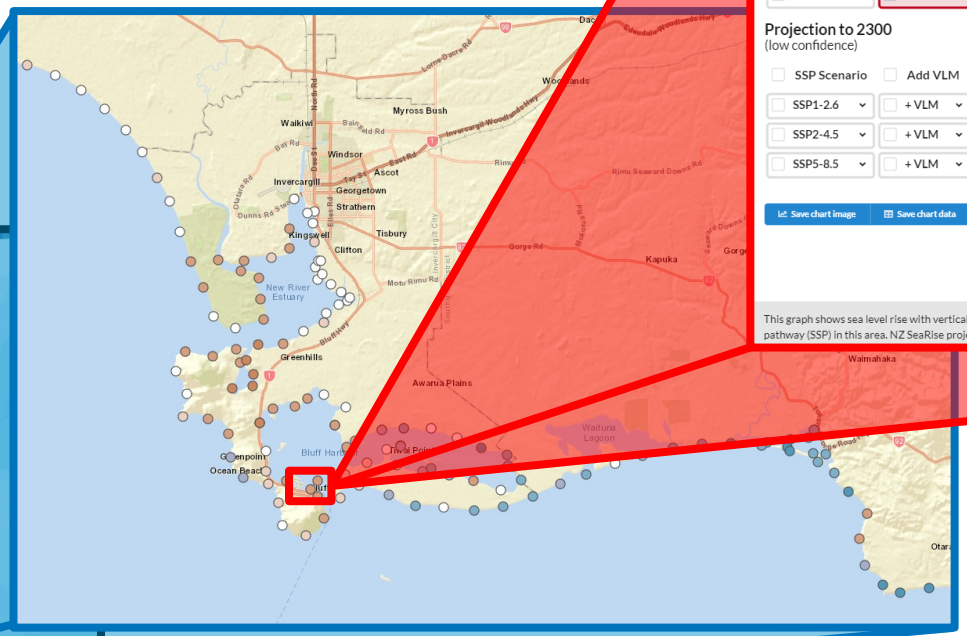
NZ Sea Rise
Explore location specific sea level rise projections



Updated Sea Level Rise projections + Vertical Land Movement (VLM) for every 2km of NZ coastline



Graphical User Interface (GUI) to interrogate local projections, example location (Bluff)



2050	p50	p17	p83
SSP1-1.9 + VLM (medium confidence)	0.13m	0.05m	0.22m
SSP2-4.5 + VLM (medium confidence)	0.16m	0.08m	0.25m
SSP5-8.5 + VLM (medium confidence)	0.19m	0.11m	0.29m

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https://www.searise.nz/

NZ SEA RISE
TE TAI PARI O AOTEAROA

Groundwater and sea level rise

How might sea level rise affect our communities?

Stranded assets?
Loss of crops?
Remobilisation of contaminants?

Health issues?
Insurability of housing?

+ Inundation by surface floodwater

Inundation by groundwater

Individual rainfall events (e.g., 1-in-10 year event)

Ground level

Groundwater rise

Water table w.r.t. floor level (m)

0.6 0.5 0.4 0.3 0.2 0.1 0 -0.1 -0.2 -0.3 -0.4

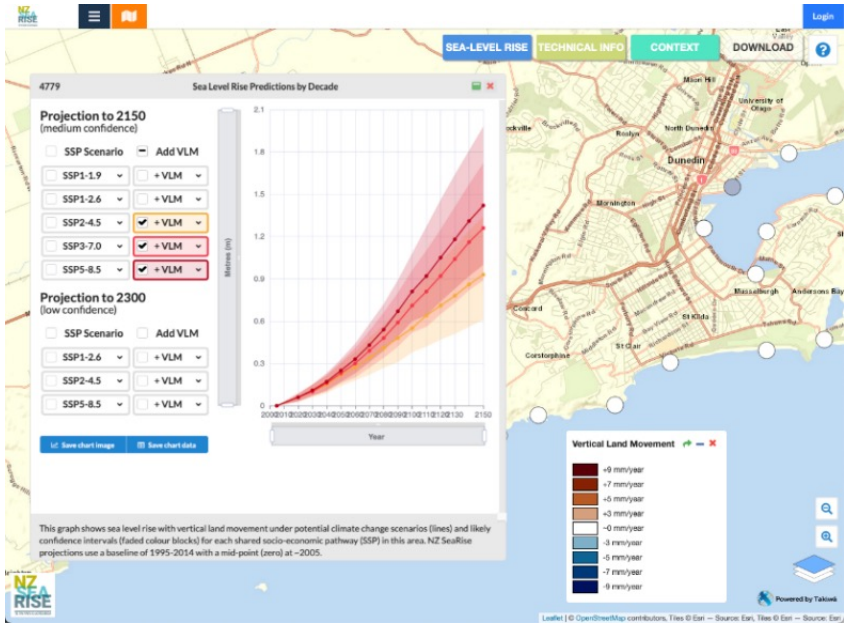
2010 2020 2030 2040 2050 2060 2070 2080

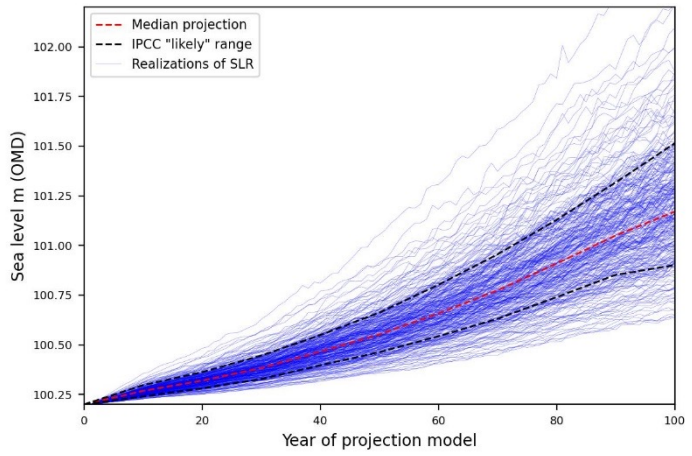
Time

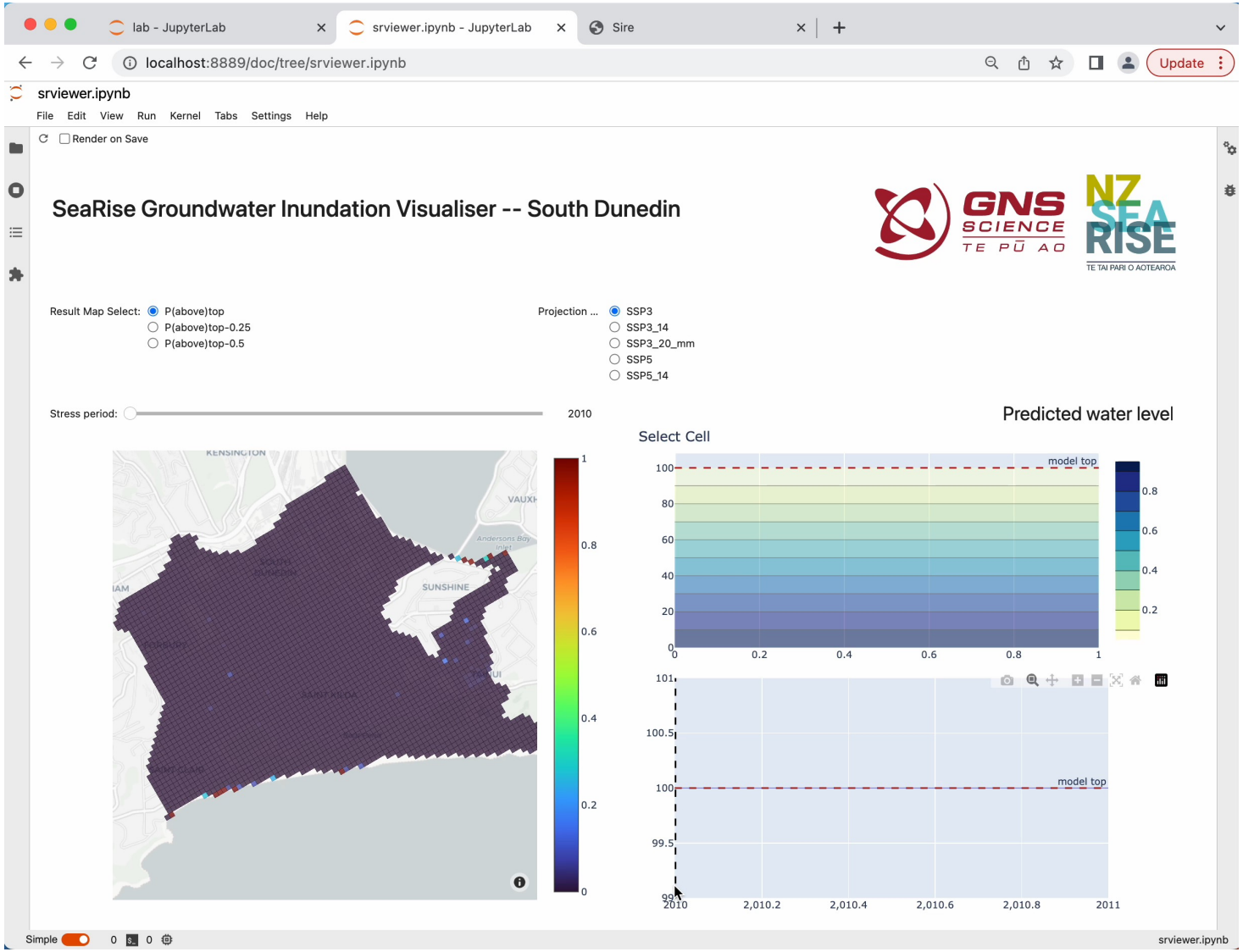
MARSDEN FUND TE PŪTEA RANGAHAU A MARSDEN | ROYAL SOCIETY TE APĀRANGI | STRAND Marsden Project | GNS SCIENCE TE PŪ AO | UNIVERSITY of OTAGO Te Whare Wānanga o Otāgo NEW ZEALAND | Bodeker Scientific

Decision-support modelling

Uncertainty in sea level driven groundwater hazard

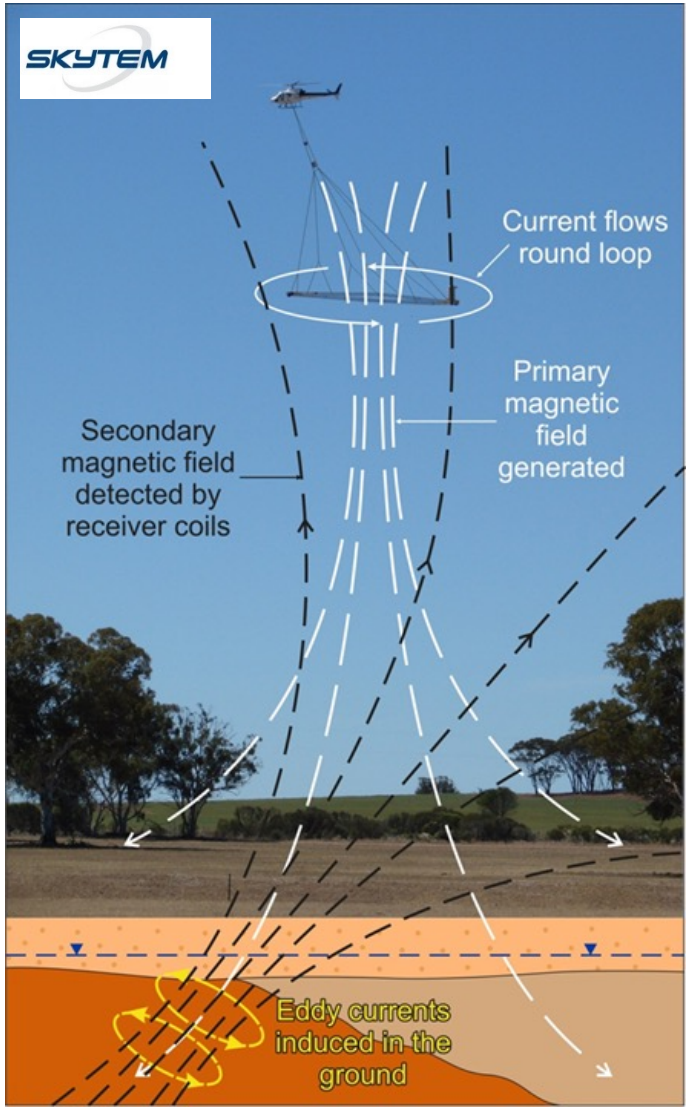




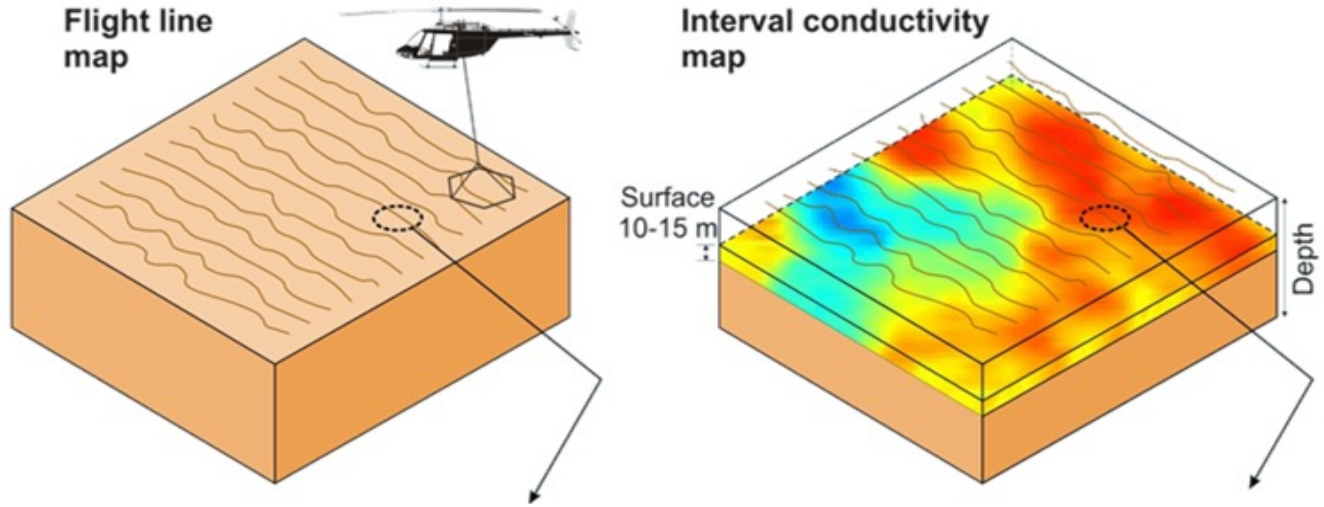


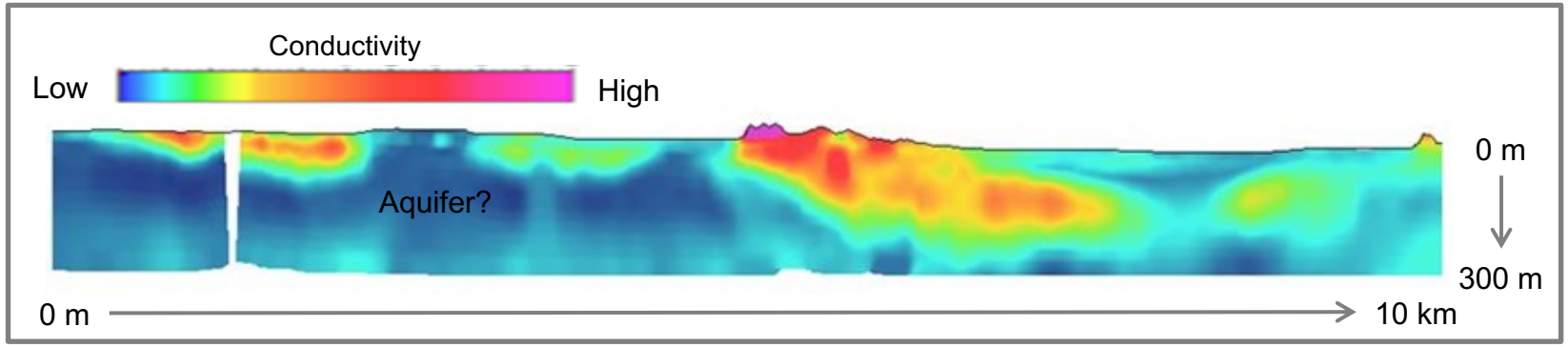
Scanning the subsurface

How do we ‘see’ our groundwater systems?



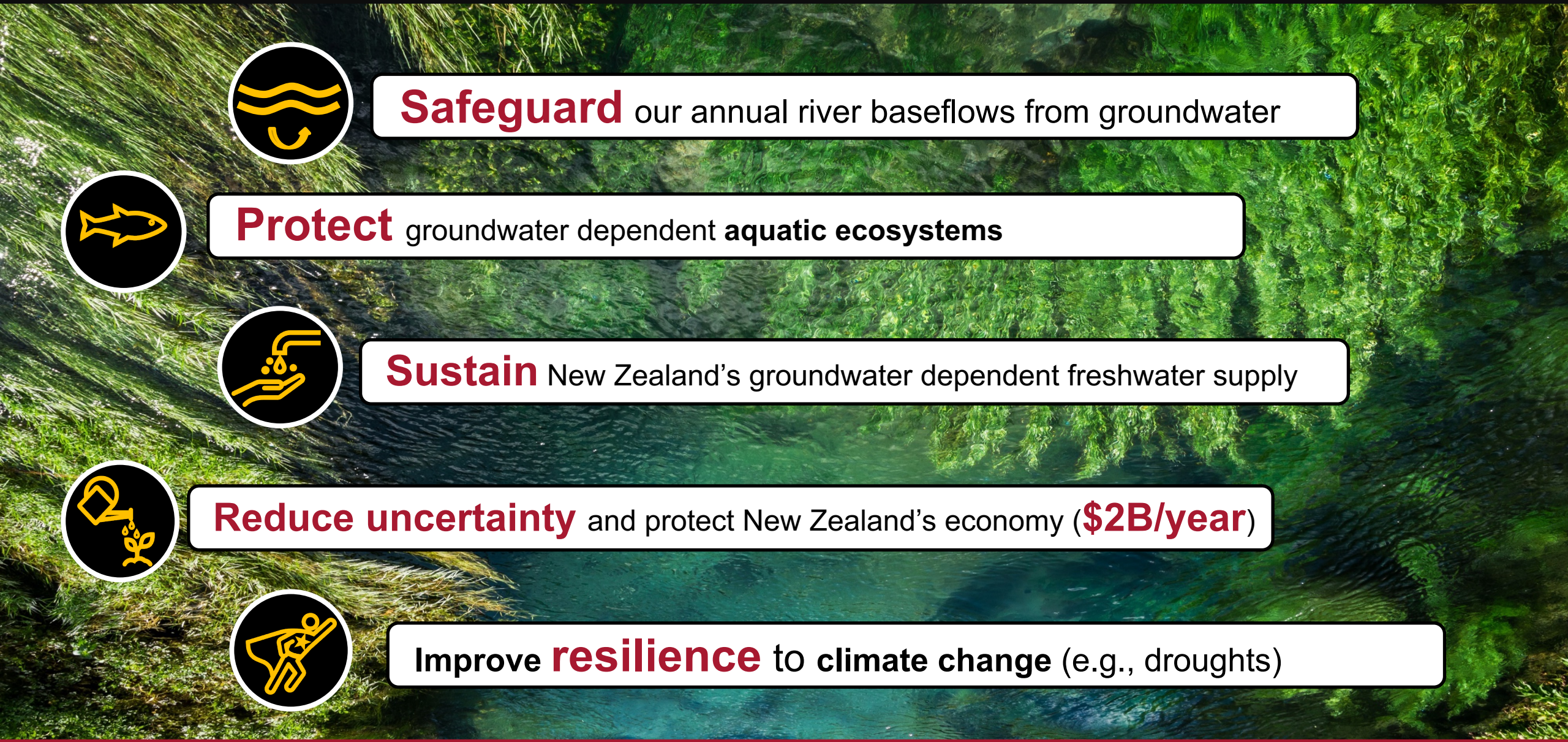
Geophysics takes our subsurface knowledge from drillholes (a join the dots picture) into a 3D continuous image like an x-ray





Why we do what we do...

Use, value and protect our groundwater systems for future generations



Safeguard our annual river baseflows from groundwater

Protect groundwater dependent **aquatic ecosystems**

Sustain New Zealand's groundwater dependent freshwater supply

Reduce uncertainty and protect New Zealand's economy (**$2B/year**)

Improve resilience to **climate change** (e.g., droughts)

Photo: M. Low, GNS

Questions?
Some publications below

EGU European Geosciences Union

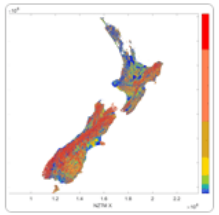
Hydrology and Earth System Sciences

ARTICLES & PREPRINTS · SUBMISSION · POLICIES · PEER REVIEW · EDITORIAL BOARD · ABOUT · EGU PUBLICATIONS

Research article | 13 Dec 2018

Application of an improved global-scale groundwater model for water table estimation across New Zealand

Rogier Westerhoff, Paul White, and Gonzalo Miguez-Macho



ELSEVIER

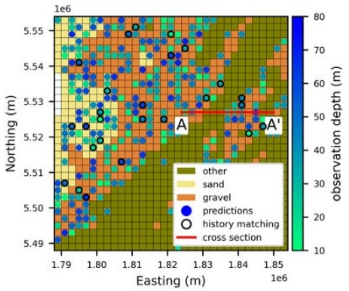
Journal of Hydrology: Regional Studies

Volume 40, April 2022, 101053

Climate change and New Zealand's groundwater resources: A methodology to support adaptation

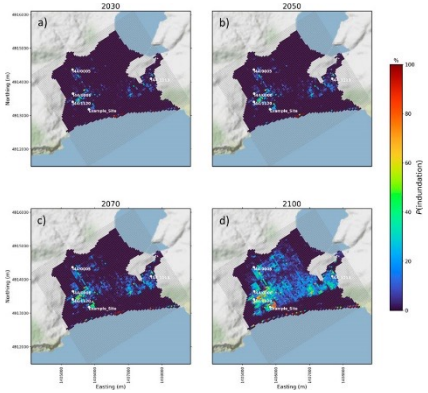
Frédérique M. Mourot, Rogier S. Westerhoff, Paul A. White, Stewart G. Cameron

frontiers



Frontiers in Earth Science > Hydrosphere > Research Topics > Rapid, Reproducible, and Robus...

Rapid, Reproducible, and Robust Environmental Modeling for Decision Support: Worked Examples and Open-Source Software Tools



Chambers LA, Hemmings B, Cox SC, Moore C, Knowling MJ, Hayley K, Rekker J, Mourot FM, Glassey P and Levy R (2023), Quantifying uncertainty in the temporal disposition of groundwater inundation under sea level rise projections. Front. Earth Sci. 11:1111065. doi: 10.3389/feart.2023.1111065

Kitlasten W, Moore CR and Hemmings B (2022), Model structure and ensemble size: Implications for predictions of groundwater age. Front. Earth Sci. 10:972305. doi: 10.3389/feart.2022.972305