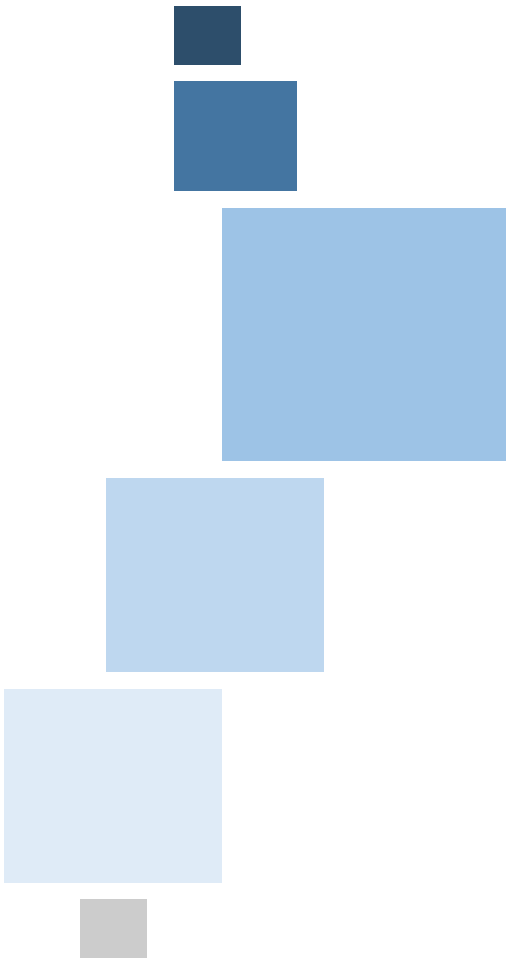


Cover image: screen capture of predicted flood inundation visualised using virtual reality technology (p. 46)

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GEOSPATIAL RESEARCH INSTITUTE Toi Hangarau



GRI Director's Statement

Tēnā koe e hoa, haere mai.

Welcome to our report for 2025. I hope you enjoy this issue as we reflect on some of the developments and achievements of the GRI Toi Hangarau. The GRI brings together expertise in geospatial science and technology to address a diverse range of environmental and societal challenges. Through transdisciplinary research, we seek not only to advance geospatial methods, but to apply them in ways that generate knowledge, tools and solutions of wider benefit.

In this issue, we focus on the various forms of visualisation we develop to help communicate research outputs (see Research Highlights, pp. 23–37). These range from dashboards and interactive story maps to immersive virtual reality. By improving the communication of research outputs, we aim to support community understanding of complex issues, while helping decision-makers and other stakeholders interact with and interpret data for their own needs.

Much of this work is underpinned by our continued development of the open-source Environmental Digital Data Intelligence Engine (EDDIE) (pp. 24–25), which provides a software foundation for developing environmental digital twins, including the interactive visualisations through which their data and models can be explored. For me, one of the most rewarding aspects of this work has been seeing EDDIE develop from a research concept into a functioning platform that can support new research across the University and through collaboration with external partners. One of the highlights of the year for me was presenting EDDIE alongside members of the GRI team at a number of conferences, including Adaptation Futures in Christchurch, where we had an interactive display and attendees could experience our virtual reality environment, and the international FOSS4G (Free and Open Source for Geospatial) conference, held in Auckland in December. I was also fortunate to visit the Indian Institute of Technology Delhi, supported by a Fellowship at the New Zealand Centre at IIT Delhi, where I engaged with researchers in the HydroSense Laboratory in the Department of Civil Engineering.

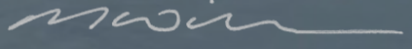
Our research continues to grow in support of our mission to deliver transdisciplinary solutions using geospatial technology. In new research, we participated in a pilot programme funded by SmartSat CRC to test the use of GNSS-IR (Global Navigation Satellite System–Interferometric Reflectometry) ground sensors for soil moisture estimation (pp. 40–41). This work has successfully led to a three-year research programme, commencing in 2026, to develop the SM-DAS (Soil Moisture Data Assimilation System), with sensors deployed in New Zealand and Australia and again underpinned by EDDIE. We have also commenced a three-year research programme to estimate agricultural methane emissions (pp. 44–45), in partnership with Earth Sciences New Zealand and the Ngāi Tahu Research Centre.

Alongside our main research programmes, we have continued to support several PhD projects, particularly through the GRI Scholarship programme. These students exemplify the transdisciplinary nature of the GRI: each uses or develops geospatial methods to tackle a different problem, and by bringing them together within the Institute, they benefit from and contribute to the sharing of ideas and expertise. You can read more about some of these PhD projects on pages 50–63. Clevon Ash (ongoing, MBIE funded, pp. 50–51) is assessing the implications of uncertainty in flood hazard assessments for planning; Sidney Wong (completed this year, GRI Scholar, pp. 52–53) took a geospatial view of language and dialects, and received a Fulbright Science and Innovation Graduate Award to conduct some of his research at the University of Illinois Urbana-Champaign; Andrea Pozo Estivariz (submitted, MBIE funded, pp. 54–55) developed methods for rapid flood risk assessment using combined hydraulic modelling and machine learning; Martin Nguyen (completed this year, MBIE funded, pp. 56–57) developed machine learning methods for uncertainty estimation in flood risk assessment; Regina Chau (ongoing, GRI Scholar, p. 58) is undertaking a geospatial analysis of patterns in Parkinson's disease; Katherine Booker (ongoing, MBIE funded, p. 59) is investigating the inclusion of urban growth models in assessments of future flood risk; David Pedley (completed this year, GRI Scholar, pp. 60–61) examined how housing intensification affects urban tree coverage, incorporating AI methods to assess canopy change; and Sunil Tamang (ongoing, GRI Scholar, pp. 62–63) is developing machine learning approaches to map rock glaciers, a critical yet poorly understood component of the cryosphere.

The team has also been very active in research dissemination (pp. 64–81), with no fewer than 29 conference presentations and a total of 25 journal publications by GRI team members in 2025. This included participation in IGARSS 2025 in Brisbane, where I joined the New Zealand delegation in supporting the successful bid for Auckland to host IGARSS 2028. Dissemination activities also included the sixth Spatial Data Science Symposium, for which the GRI hosted a local hub in conjunction with Dr Vanessa Bastos (pp. 68–69). Finally, Professor Malcolm Campbell, Director of the GeoHealth Laboratory, gave his inaugural professorial lecture in August, *Where is the geography in health?* Congratulations from all of us in the GRI team, Malcolm!

As we look ahead, it is encouraging to see the breadth of research emerging from the GRI, and the increasing connections between our research programmes, students, collaborators and external partners. Whether through advanced geospatial analytics, environmental digital twins, immersive visualisation or the application of machine learning to new environmental and societal challenges, our goal remains to develop research that is both scientifically rigorous and useful beyond the university. I look forward to seeing these collaborations and ideas develop further in 2026.

Ngā mihi nui,



Prof. Matt Wilson,
GRI Director

About us

We conduct interdisciplinary partnership-based geospatial research across the social and physical sciences.

Our objectives:

To conduct excellent, leading and novel geospatial research.

To enable innovative transdisciplinary geospatial solutions

To provide a hub for geospatial capability building

with positive impacts for Aotearoa's communities and the environment



GEOSPATIAL RESEARCH INSTITUTE *Toi Hangarau*



Vision

Leading transdisciplinary geospatial research towards a just and sustainable society for our whānau and communities.



Mission

Our mission is to be a national centre of gravity for geospatial research to deliver transdisciplinary solutions that enables the benefits of spatial information technology to be fully realised.



Core values

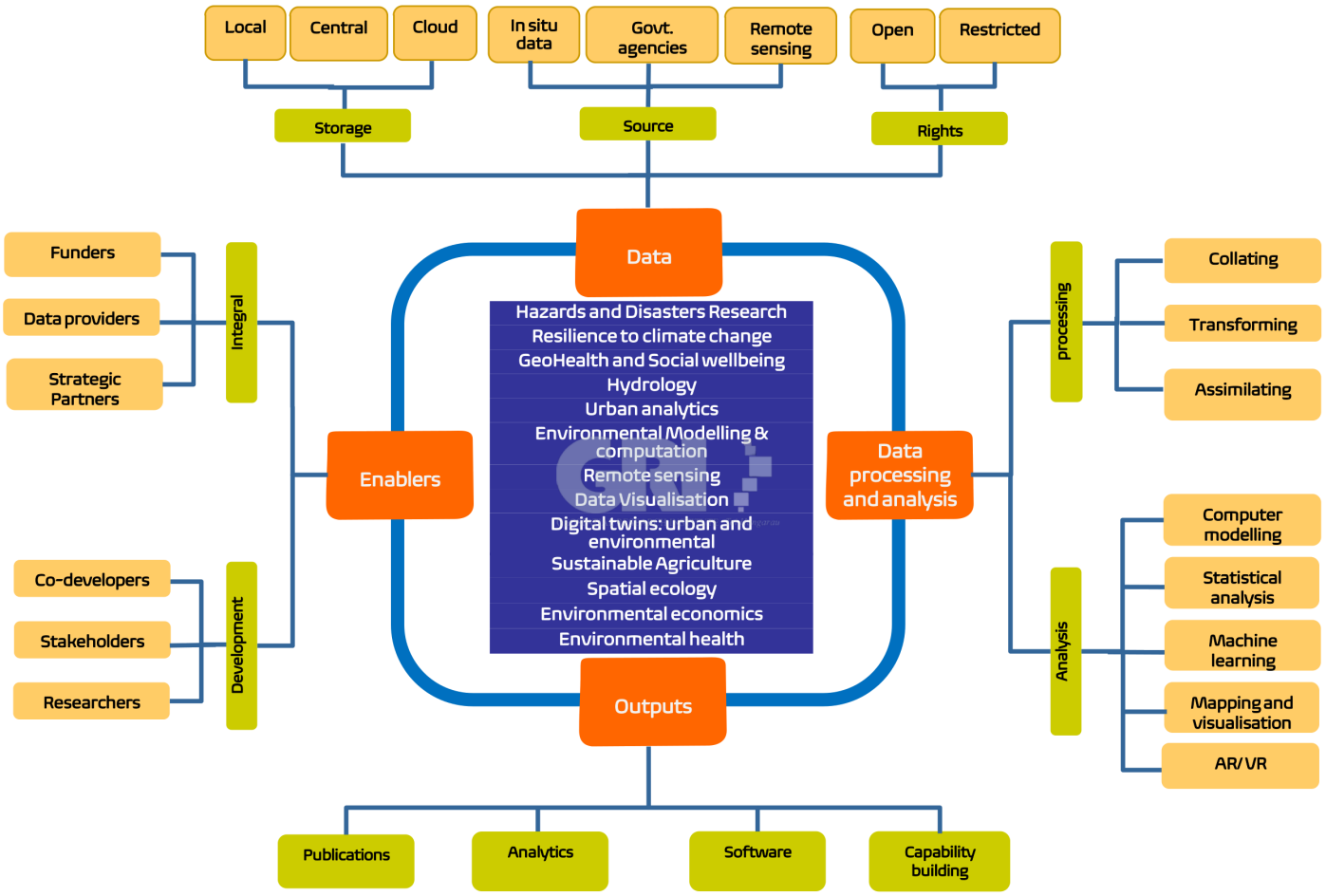
We are committed to develop research that is culturally appropriate, ethical, engaged and partnership-based. We promote diversity and inclusion and provide a supportive environment for everyone to thrive.

Research domains

Our research domains are aligned to the United Nations Sustainable Development Goals.



GRI research domains



GRI domain map: contextualizing the GRI research domain areas. *The GRI is a data driven institute. We are focused in the integration of data and automation of data processing and analytics. We have developed comprehensive and detailed databases of remote sensing, statistics, demographics and environmental data, which is available for all our research partners. The open source software developed in the GRI can be used for computing modelling, statistical analysis, machine learning, mapping and visualisation.*

Supporting Funders and Partners












































NIWA
Taihoro Nukurangi


Manaaki Whenua
Landcare Research


NGĀ RĀKAU TAKETAKE
Saving Our
Iconic Trees
from Kauri Dieback & Myrtle Rust


Land Information
New Zealand
Toitū te whenua


TE TATAU O
TE ARAWA


UC
Sustainability


AUGUSTANA COLLEGE
ILLINOIS


MINISTRY OF
HEALTH
MANATŪ HAUORA


NASA


THE OHIO STATE
UNIVERSITY


TE RŪNANGA O
TOA RANGATIRA


Natural Hazards
Commission
Toka Tū Ake


hrc
Health Research
Council of
New Zealand


UC NGĀI TAHU
RESEARCH CENTRE


University
of Otago
ŌTĀKOU WHAKAIHU WAKA
NEW ZEALAND'S FIRST UNIVERSITY

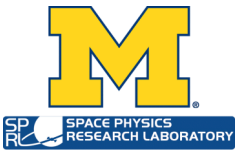

MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI


GATEWAY
ANTARCTICA


NEW ZEALAND
SPACE AGENCY


Te Whatu Ora
Health New Zealand


VICTORIA UNIVERSITY OF
WELLINGTON
TE HERENGA WAKA


SPRL
SPACE PHYSICS
RESEARCH LABORATORY


Ministry for
Pacific Peoples
Te Manatū mō ngā Iwi ō te Moana-nui-ā-Kiwa

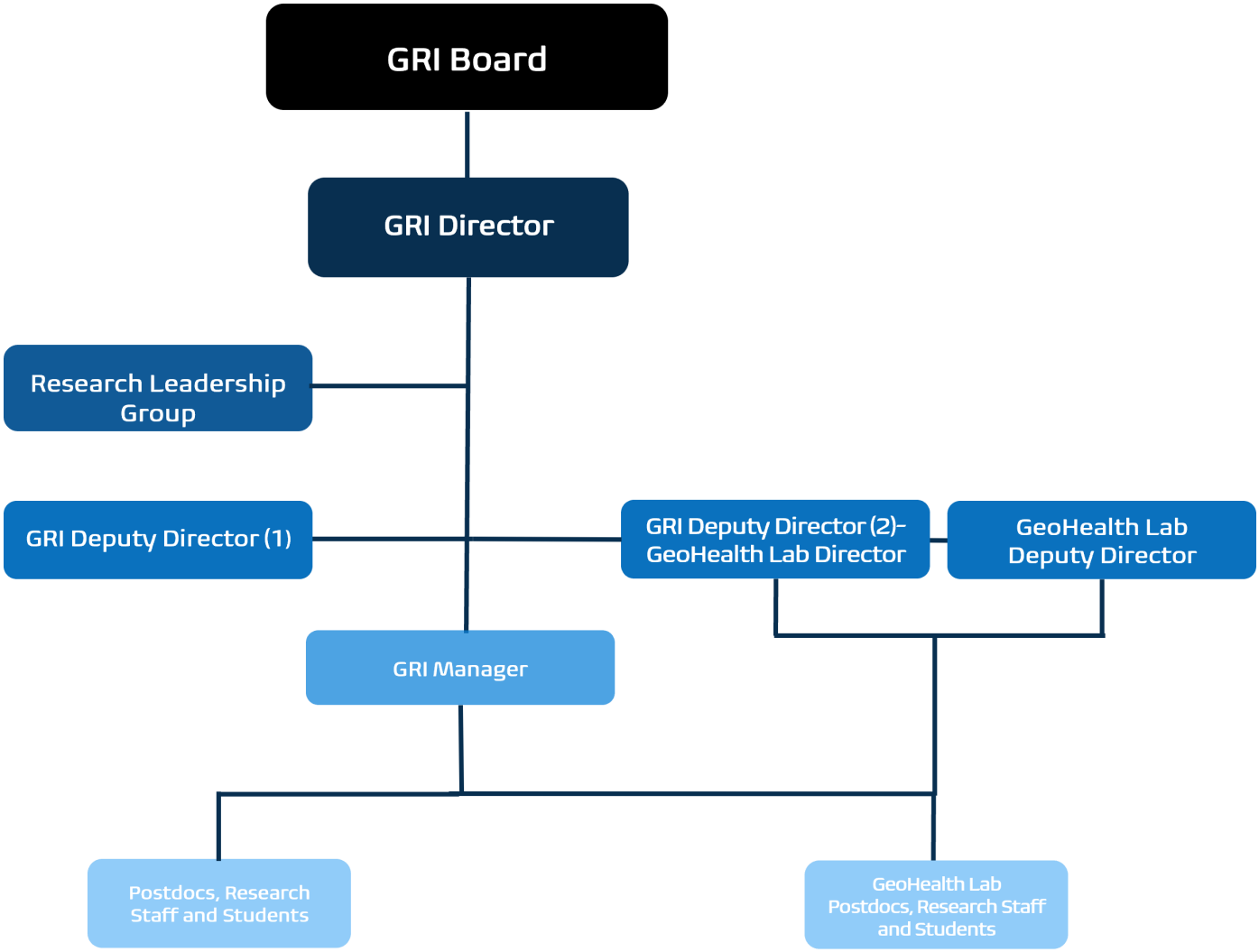

UC WIRELESS RESEARCH CENTRE



Governance


GEOSPATIAL RESEARCH INSTITUTE Toi Hangarau

The Institute's Structure





Board Members



Jan Pierce (Chairperson)
Deputy Chief Executive,
Land Information NZ.



Lucy Johnston
Deputy Vice-Chancellor — Research
University of Canterbury



Peter Shaw
Engineering Director,
Trimble



Kat Salm
Consultant
Urbankind



Mike Taitoko
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Research Leadership Group



Professor Jennifer Brown
Head of Teaching - Data Science

Professor Rob Lindeman
Director, HIT Lab NZ





Dr. Graeme Woodward
Wireless Research Centre, UC

Professor John Reid
Ngāi Tahu Research Centre.





Professor Malcolm Campbell
Director, GeoHealth Lab.

Professor Richard Green
Department of Computer Science
and Software Engineering, UC.



Management and staff



Matthew Wilson
Director



Jennifer Brown
Deputy Director



Malcolm Campbell
Director
GeoHealth Lab.



Simon Kingham
Deputy Director GHL



Luke Parkinson
Senior Geospatial Software Developer



Hannah Walker
Marketing Administrator



Maria Vega Corredor
Manager



Image: automated generation of virtual environments for visualisation (p.29)

Research Highlights

GRI Geovisualisation Development

Together with the challenges that the ever-increasing volumes of data have created in terms of processing and analysis, there is a growing need to find effective pathways to communicate outputs that are easy to understand and can visually replicate what the data analyses have produced in an effective way.

For the past years, this has become a cornerstone of the work developed in the GRI. Lately, we have focused in developing and combining software that helps to not only communicating better data analysis but also allows decision makers and end users to interact and interpret data in a user-friendly format.

Before explaining our innovative visualisation projects, is important to explain the research and technological developments achieved in the GRI that made them possible.

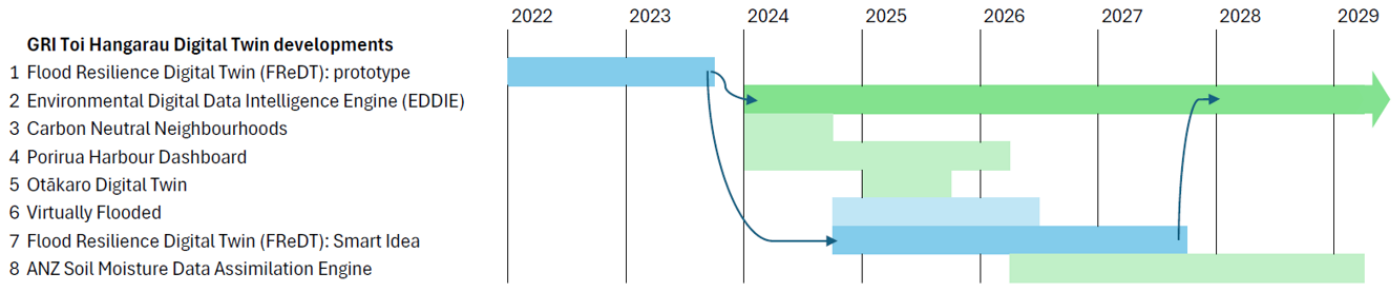
Environmental Digital Data Intelligence Engine (EDDIE)

Thanks to the Environmental Digital Data Intelligence Engine (EDDIE), created and developed in the GRI, a series of visualisation applications such as dashboards and digital twin front ends have been created. EDDIE provides a modular containerised architecture and core library for building environmental digital twins. This is a core open-source software framework for automated environmental/ geospatial data gathering, caching, updating, and processing.

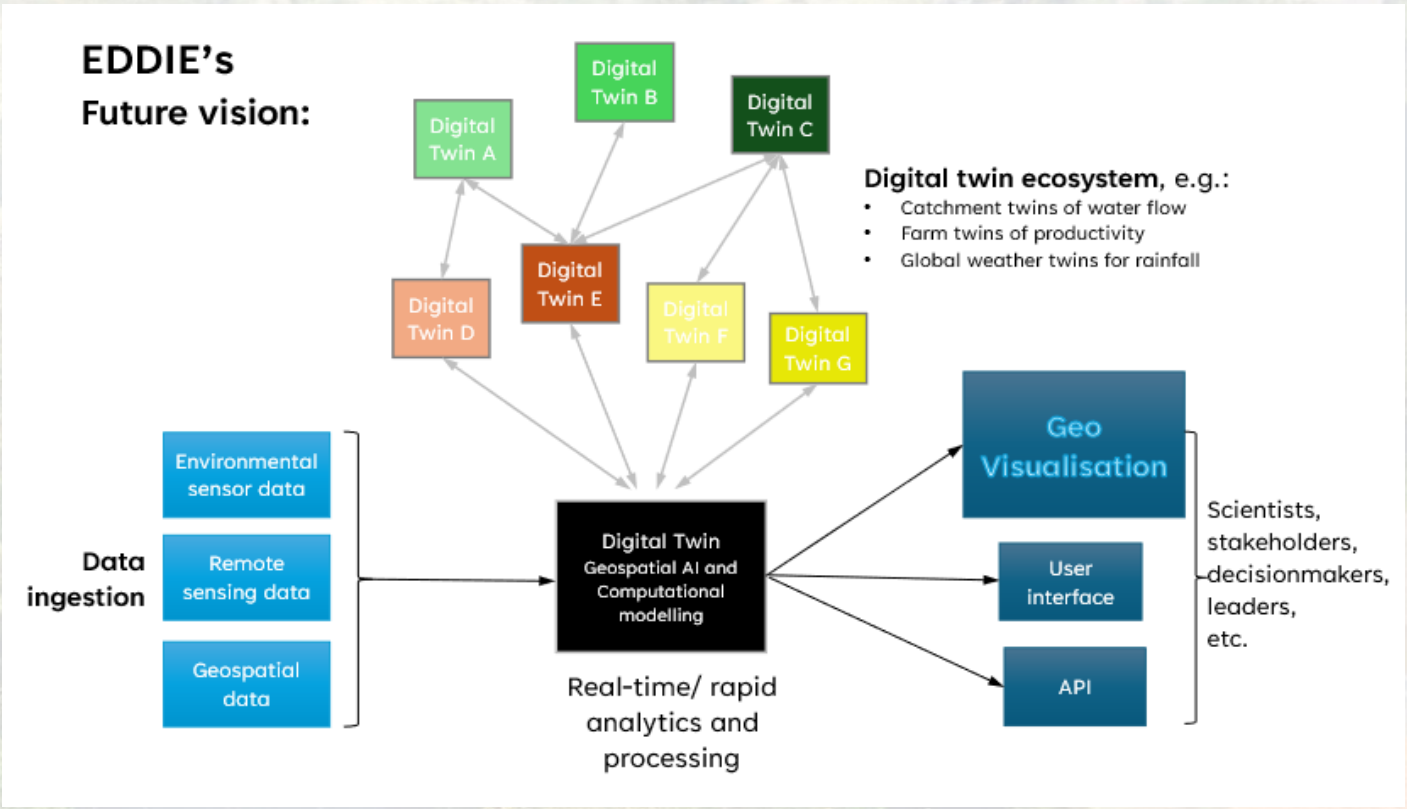
We use CesiumJS and TerriaJS for 3D geospatial web visualisations. PostGIS and GeoServer are used to store and serve geospatial data. Modelling and complex request tasks are handled by EDDIE plugin modules running in Python Celery workers to handle long running processing workflows. Modular plugins are developed to allow for complex models to be run on-demand, with all input data fetched automatically.

EDDIE's development through time has only been possible by the financial support of different organisations, such as: The Ministry of Innovation and Employment (MBIE), Christchurch Council, FrontierSI, Building Innovation Partnership, Building Research Association of New Zealand (BRANZ), Natural Hazards Commission Toka Tū Ake, Public Health and Forensic Science Public Health and Forensic Science PHF Science (formerly ESR).

The vision behind EDDIE's ongoing development is to create a digital twin ecosystem that enables interconnectivity, multisource real-time rapid processing and analytics, that will provide stakeholders with an interactive user-friendly interface for analytics and on demand data visualisation.



Timeline of EDDIE development and funded projects associated



EDDIE's future developments: towards an interconnected Digital Twin Ecosystem

GRI–GHL Geovisualisation tools

As a result of EDDIE's development, the following dashboards and digital twins have been created:

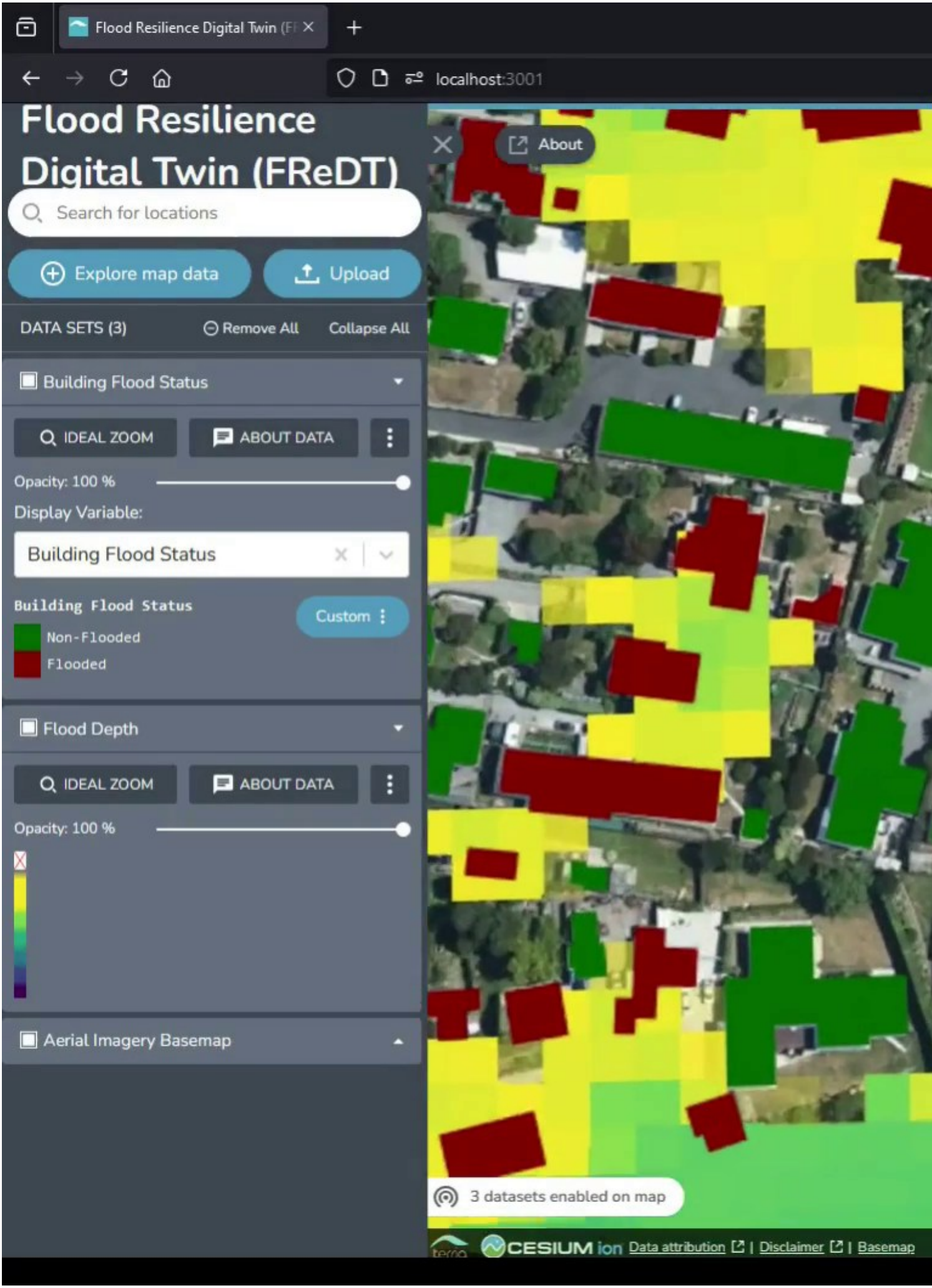
- Flood Resilience Digital Twin (2021—)
- Carbon Neutral Neighborhoods dashboard (2023-2024)
- Ōtākaro Digital Twin (2024)
- Virtually flooded (2025-2026)
- Te Awarua-o-Porirua Harbour flow model Phases 1-3 (2024-2025)
- Empowering community resilience to climate change through novel flood scenario analytics (2024-2027)
- Te Awarua Kai Ora dashboard (2025)
- Antarctic Digital Twin (2026—)

In addition, the GeoHealth Lab team have developed the following geospatial visualisations:

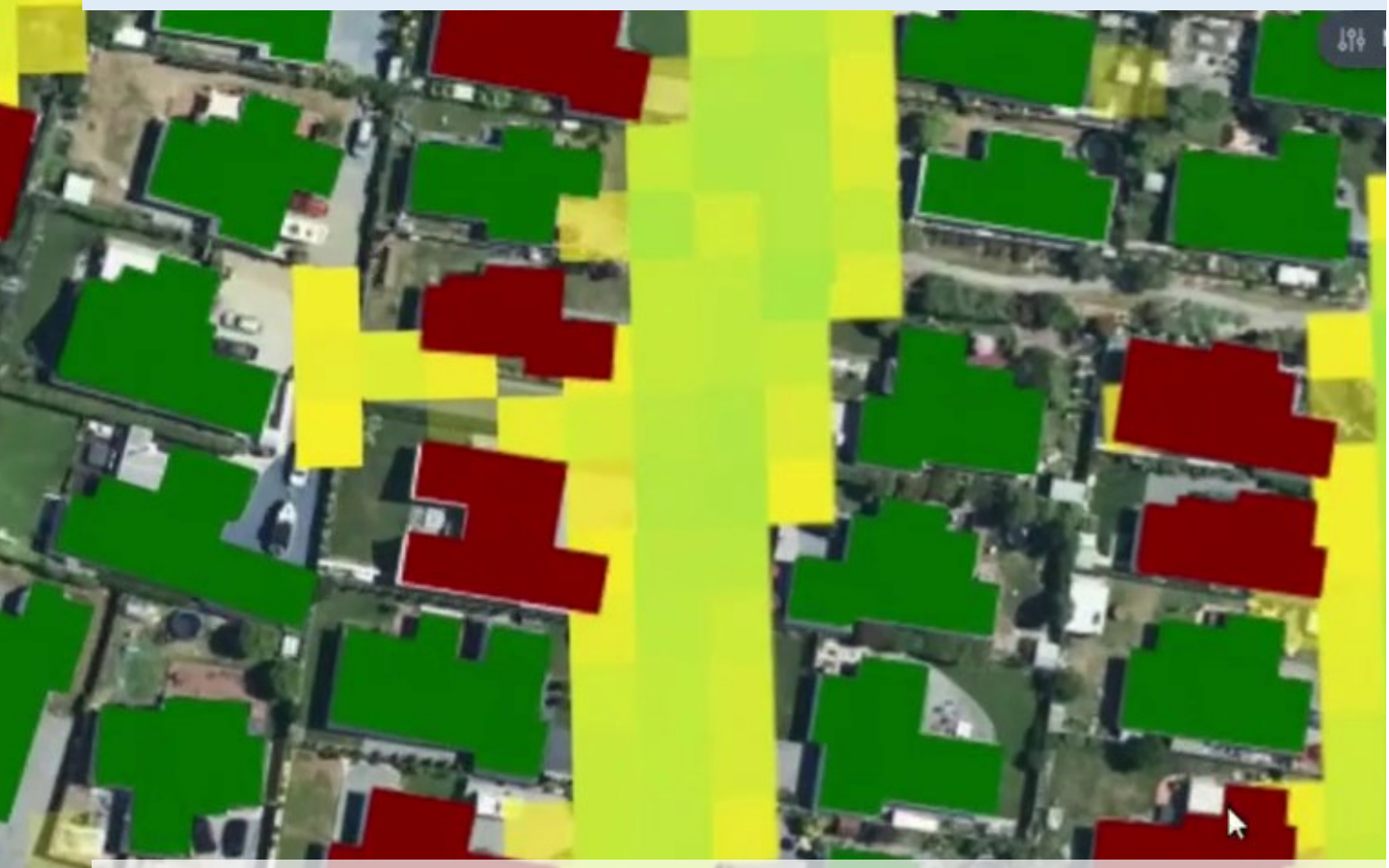
- The Healthy Location Index StoryMap — GeoHealth Lab (2024-)
- The Healthy Location Index Categories—GeoHealth Lab (2024-)

In the following pages we provide information about each visualisation tool. For more information, please visit our website https://geospatial.ac.nz/

or contact us at: gri-enquiries@canterbury.ac.nz


Flood Resilience Digital Twin (FReDT)
Search for locations
Explore map data
Upload
DATA SETS (3)
Remove All
Collapse All
Building Flood Status
IDEAL ZOOM
ABOUT DATA
Opacity: 100 %
Display Variable:
Building Flood Status
Building Flood Status
Custom
Non-Flooded
Flooded
Flood Depth
IDEAL ZOOM
ABOUT DATA
Opacity: 100 %
Aerial Imagery Basemap
About
3 datasets enabled on map
CESIUM ion
Data attribution
Disclaimer
Basemap

Visualisation of modelled flood scenarios to help communities to better understand flood risk



In the Geospatial Research Institute, we have developed the *Flood Resilience Digital Twin* which automates modelling process and its analysis. It enables users to automatically generate flood scenarios on demand, anywhere in New Zealand.

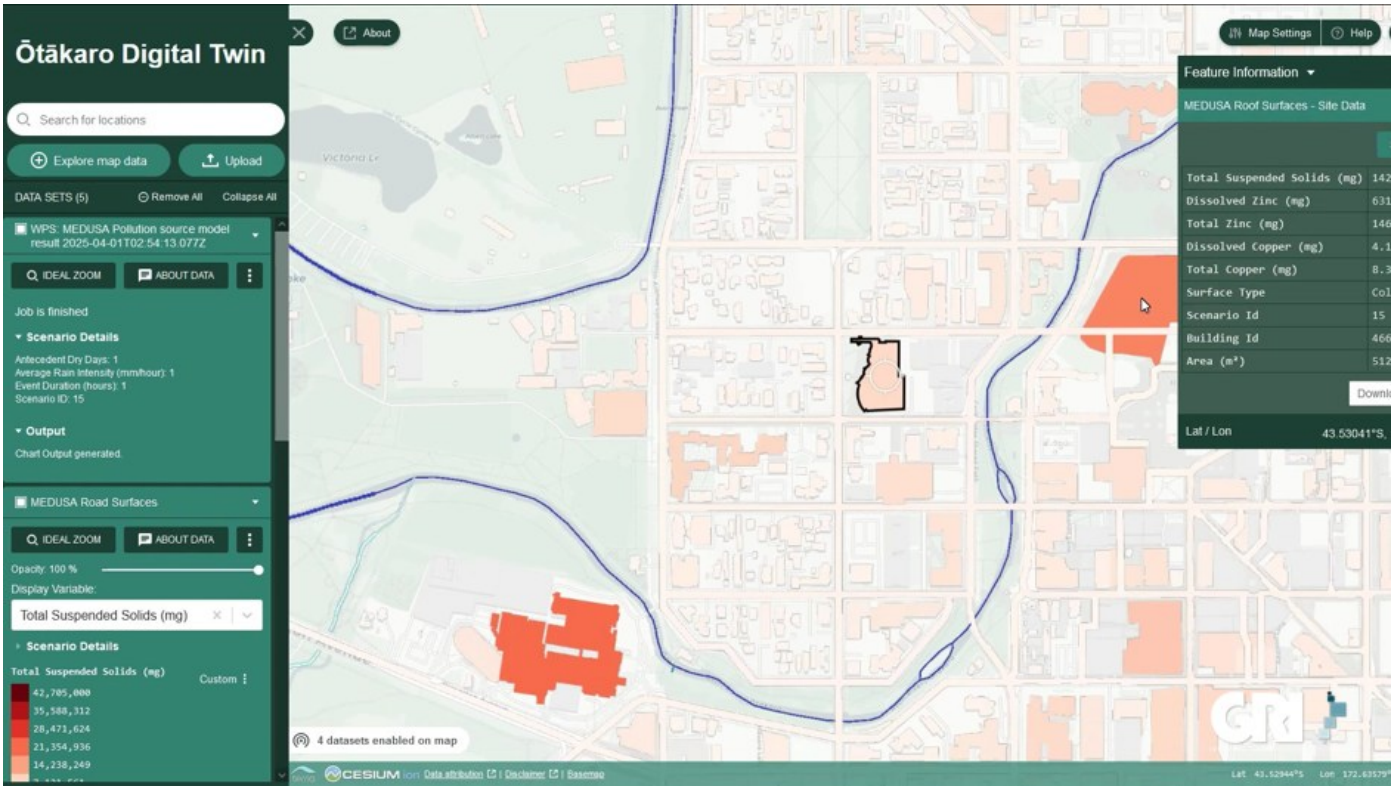
The model outputs from the flood resilience digital twin models or other flood models can be used to create flood visualisation in Unreal Engine.

The GRI team has developed methods for automated processing and designed a system of advanced visualizations of flood risk. We use geospatial data to create digital replicas of real locations and existing computer model outputs to develop these advanced visualisations (3D and VR) of flood scenarios for each location.

The main geospatial data used to create virtual recreations of real-life environments are:

1. Elevation: generated from LiDAR
2. Flow: derived from model outputs, injected at set locations, and routed using Fluid Flux 3.0.
3. Open Street Map data used to guide location of urban features:
    a. 3D buildings procedurally generated at location of footprint (City Builder)
    b. Road network and type
    c. Green spaces, vegetation type
    d. Aerial imagery used for tree locations and size

Team:
Luke Parkinson, Casey Li, Pooja Kholsa, Matt Wilson, Greg Preston, Rose Pearson, Cyprien Bosserelle, Emily Lane, Rob Deakin



Ōtākaro Digital Twin platform

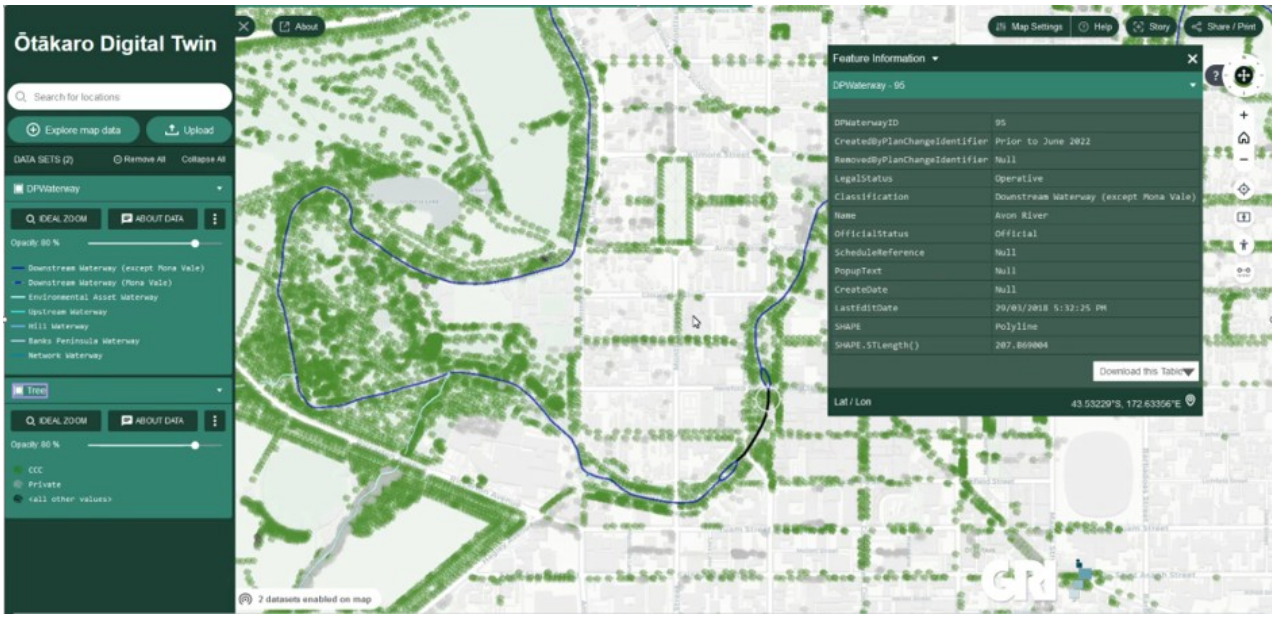
The platform was developed as part of the Ōtākaro Digital Twin project (ODT) to visualise environmental data as well as water quality (pollutants) model outputs.

The ODT purpose was guided by the Te Mana o te Wai framework, and it was expected to be adaptable to other locations and environments.

It was created to be an accessible and innovative platform to collect and communicate knowledge about the Ōtākaro River serving as a tool to give voice to the Ōtākaro (Avon River) and its importance to the associ-

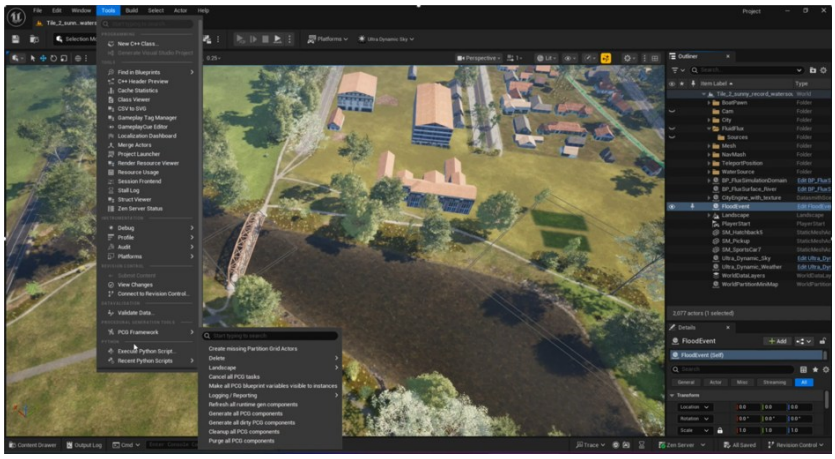
The platform aimed to foster collaboration to support and encourage:

- Holistic decision making & governance, to restore te mauri o te awa.
- Environmental health and resilience outcomes.
- Representation of the mauri of the Ōtākaro and;
- Amplify the significance of the Ōtākaro to the region and people by allowing users to model potential future narratives and tell stories of the Ōtākaro's past and present.



360-degree video development





From Digital Twin:

Automated generation of 3D visualisations

- Automated flood model representation
- Generation of baseline virtual environment.
- Automated environment details.

Final product

360-degree video presenting a futuristic vision of restored areas around the Ōtākaro river.





Team:

Matt Wilson, Luke Parkinson, Xander Cai, Greg Preston, Rory Clifford et al.

Christchurch City Council · Waipapa Taumata Rau University of Auckland · UC University of Canterbury Engineering Pūhanga · UC Ngāi Tahu Research Centre · GRI Geospatial Research Institute Toi Hangarau · Building Innovation Partnership

Virtually flooded project visualisations



Virtual recreation of a real location showing scenarios developed by the GRI team for before and during a flood event



Worldwide, more than 1.81 billion people are affected by flooding.

Flooding can cause damage to housing, infrastructure and disrupt activities among communities. With increasing frequency and intensity of storms under climate change, flood risk is likely to increase in the future.

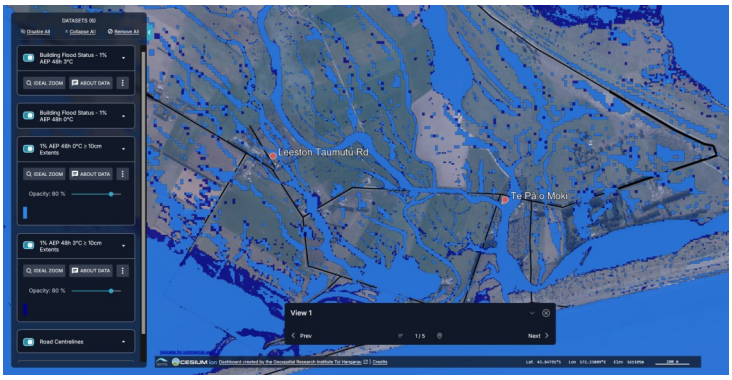
When using mapping for communicating flood risk, traditional two-dimensional risk maps can be limited by interpretability challenges. To improve flood risk management, changes in the way in which risk assessments for multiple scenarios are communicated are needed.

In this project, to help understand risk and to improve awareness of flood hazards, we designed a system of advanced visualizations of flood risk. We used technology to develop innovative methods to adequately communicate risk to different audiences.

The project aim was to develop and test high resolution, realistic, dynamic visualisations to improve the communication of the potential impacts of flooding under various scenarios, enabling communities and decision-makers to have reliable information about changing flood risks.

Using our existing prototype system for the automated generation of flood scenarios, we co-designed and developed advanced visualisations of future flood scenarios. We have actively engaged with Rūnanga, with the help and support of Te Rūnanga o Ngāi Tahu (TRoNT) geospatial and transformation teams as well as the Ngāi Tahu Centre, University of Canterbury. The scenarios developed will allow end users to be situated within a virtual visualisation of how the flood risk was like, is like, and might be like in future.

As part of this project, the effectiveness of this method to communicate risk and improve awareness will be compared to traditional two-dimensional maps of flood scenarios for each location.









Together with existing computer model outputs we used geospatial data to create digital replicas of real locations.

We developed methods to produce three types of advanced visualisations of flood risk scenarios:

- Interactive 3D visualisation tool.
- 360^0 video and
- Virtual Reality (VR)

Team:

Matt Wilson, Luke Parkinson, Xander Cai, Maria Vega, John Reid and Ian Grover (TRoNT).



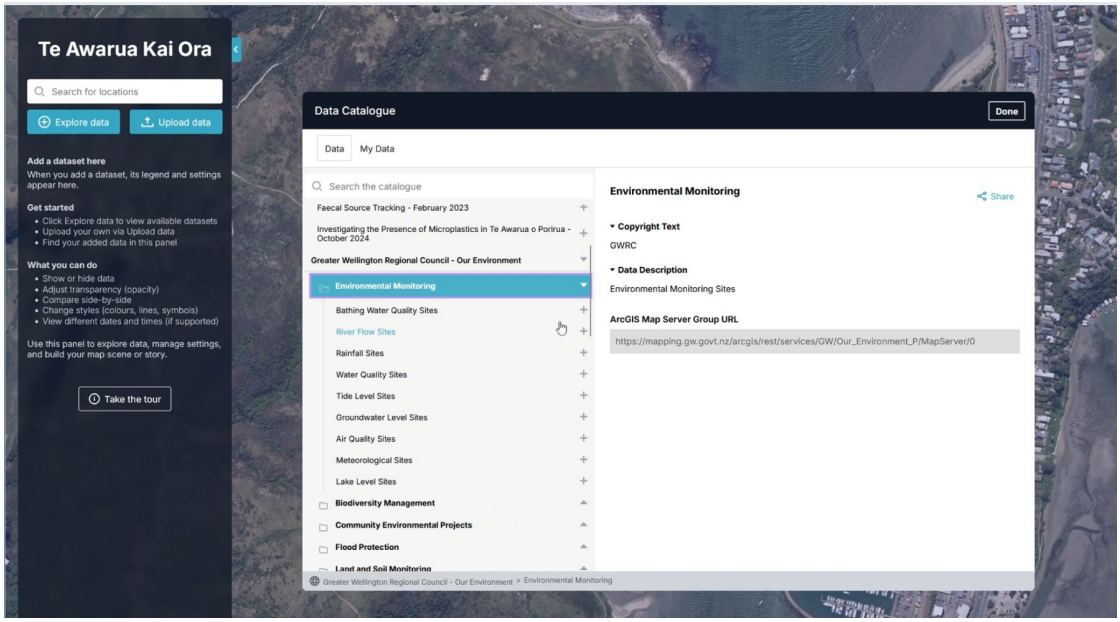
Te Awarua Kai Ora Visualisation tool

This project is the Phase Three of the Porirua Harbour Flow Model Project developed between 2024 and 2025. It was envisioned as a way to facilitate a better understanding and interpretation of the complex, and large amount of data from the flow model outputs.

The tool, called Te Awarua Kai Ora, was designed to combine the Harbour's flow model outputs into an interactive 3D map dashboard. It was based on the Environmental Digital Data Intelligence Engine framework, our open-source framework for developing digital twins.

From the beginning of this project, the Taiao team at Te Rūnanga O Toa Rangatira community was closely involved in the development of the analysis conducted and provided input to the tool developed.

The development of a open-source dashboard aided community engagement and facilitated decision making. This can be extended further with other community data or analysis.

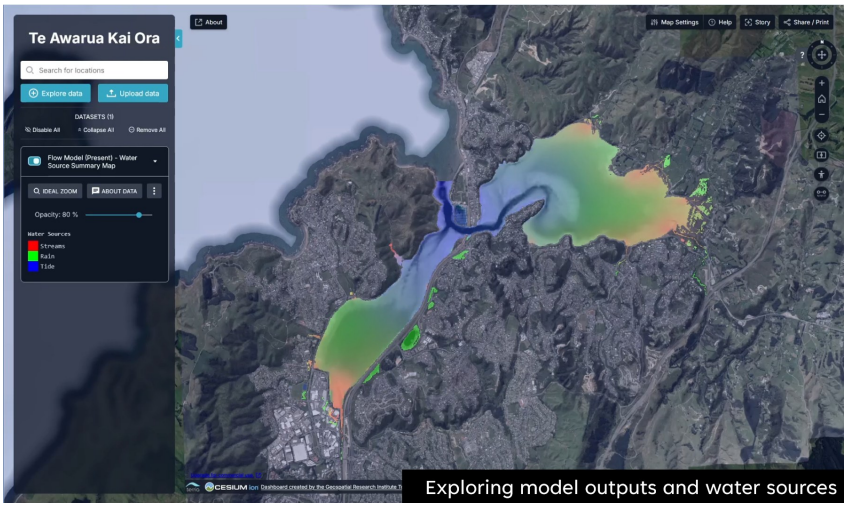




In the visualisation tool, users can interact with the water-tracing capability to view the contributing sources at each point in the harbour. Additional layers of other geospatial data have been included such as:

- PHF Science's microplastic survey and faecal source tracing surveys and
- The greater Wellington Regional Council environmental data.

The community members using the dashboard can understand how the flows in the harbour interact with issues that matter for them and their harbour.



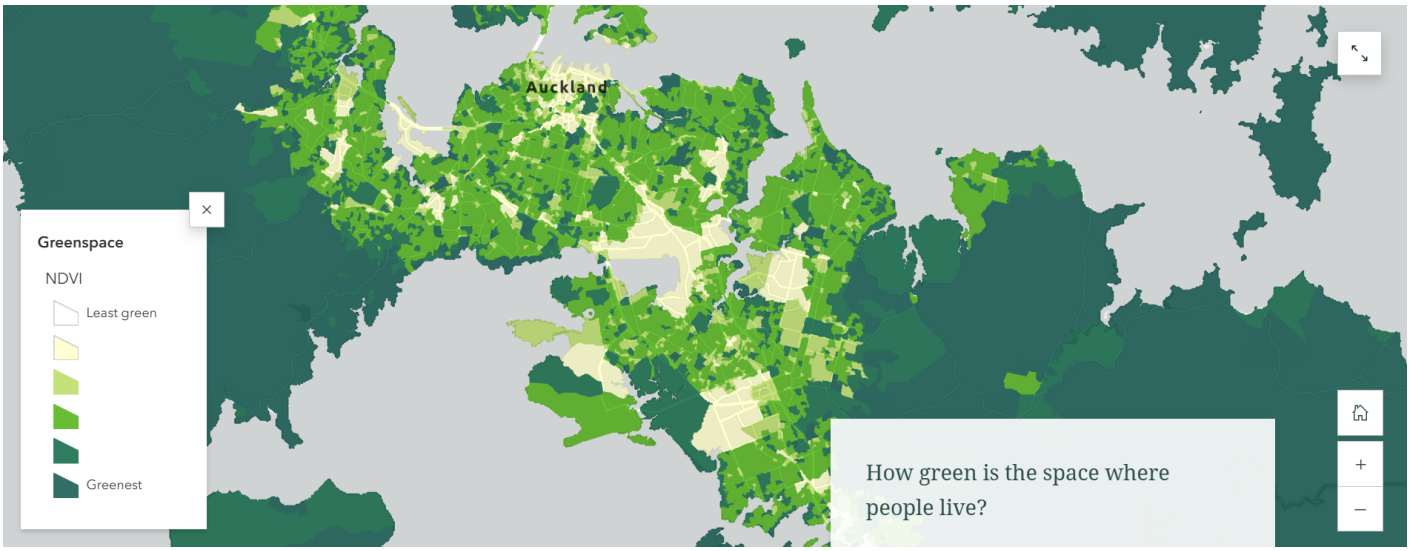
A 360 degree video of the flow model outputs of the Porirua Harbour was developed in the GRI. The video and the visualisation tool are available at Te Awarua Kai Ora Visualisation platform:

https://www.teawaruakaiora.co.nz/



Team: Matt Wilson, Georgina Dawson, Maria Vega, Russleigh Parai, Richard McClain, Donna Warren, Luke Parkinson, Xander Cai, Jaquan Nin.

The Healthy Location Index StoryMap



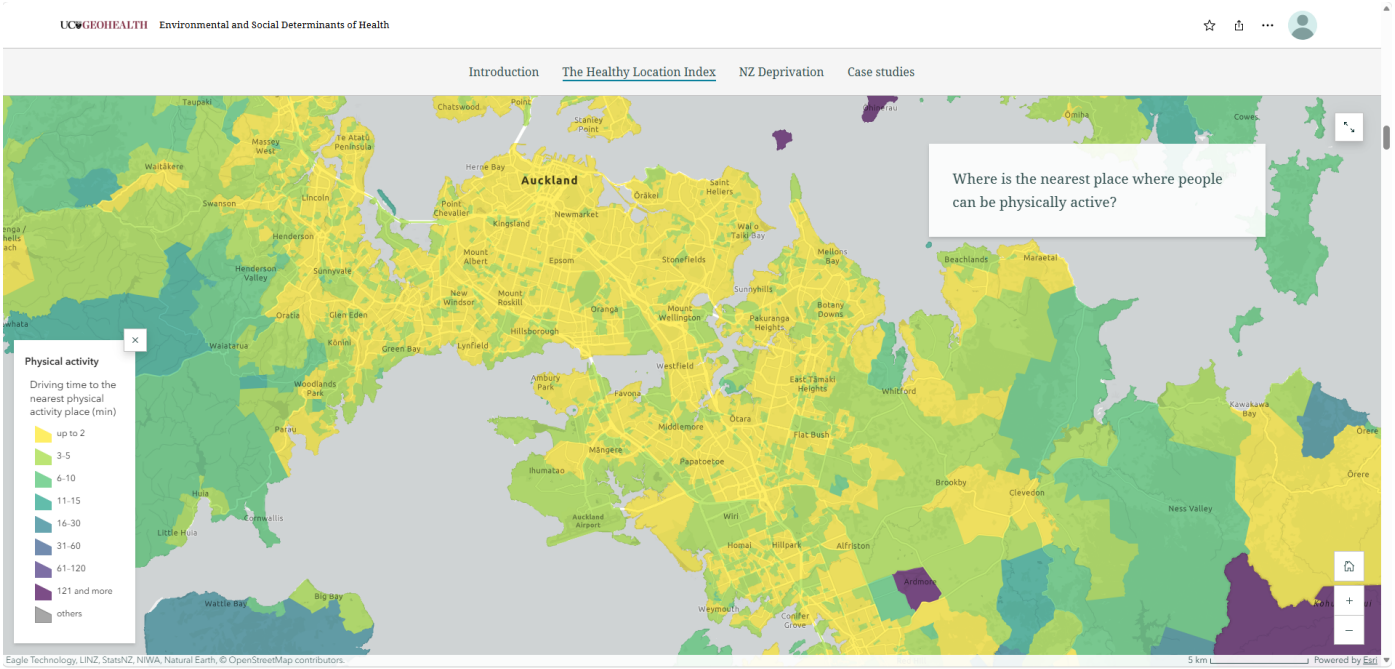
Our environment, both natural and built, is like a patchwork of things that influence our health and well-being. These things can have a positive or negative effect on health, or a combination of both. In the built environment, many of these features (such as food and alcohol outlets) do not exist independently, but are co-located in the same place or very close to each other. To assess how health-promoting or health-constraining an area is, we can use the Healthy Location Index (HLI).

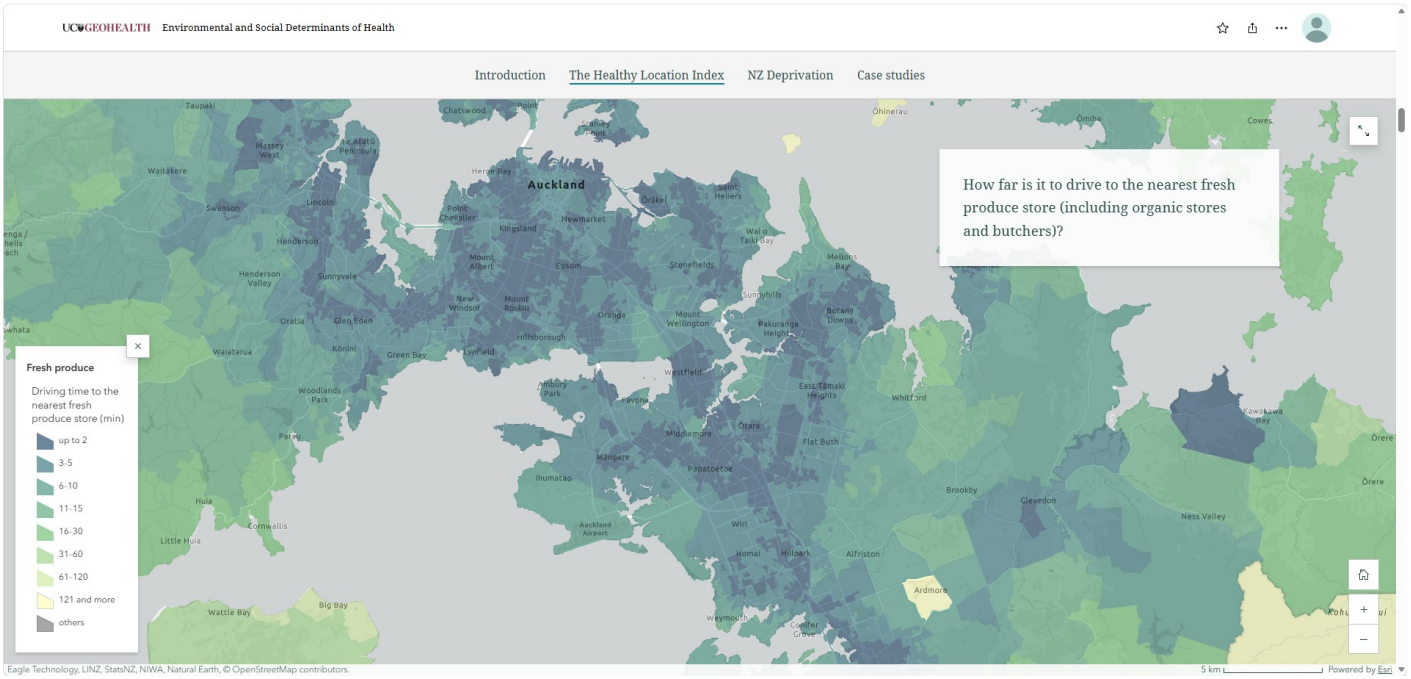
The HLI is a composite measure based on the distance from where you live to the nearest health-promoting 'goods' (green spaces, blue spaces (e.g. lakes, rivers, ocean), places for physical activity, fresh produce outlets, and supermarkets) and also to health-constraining 'bads' (fast food and takeaways, dairies and convenience stores, alcohol outlets, gaming venues, and vaping stores).

The Healthy Location Index and the StoryMap were developed by the GeoHealth Lab team.

The StoryMap and the information presented here are available at:

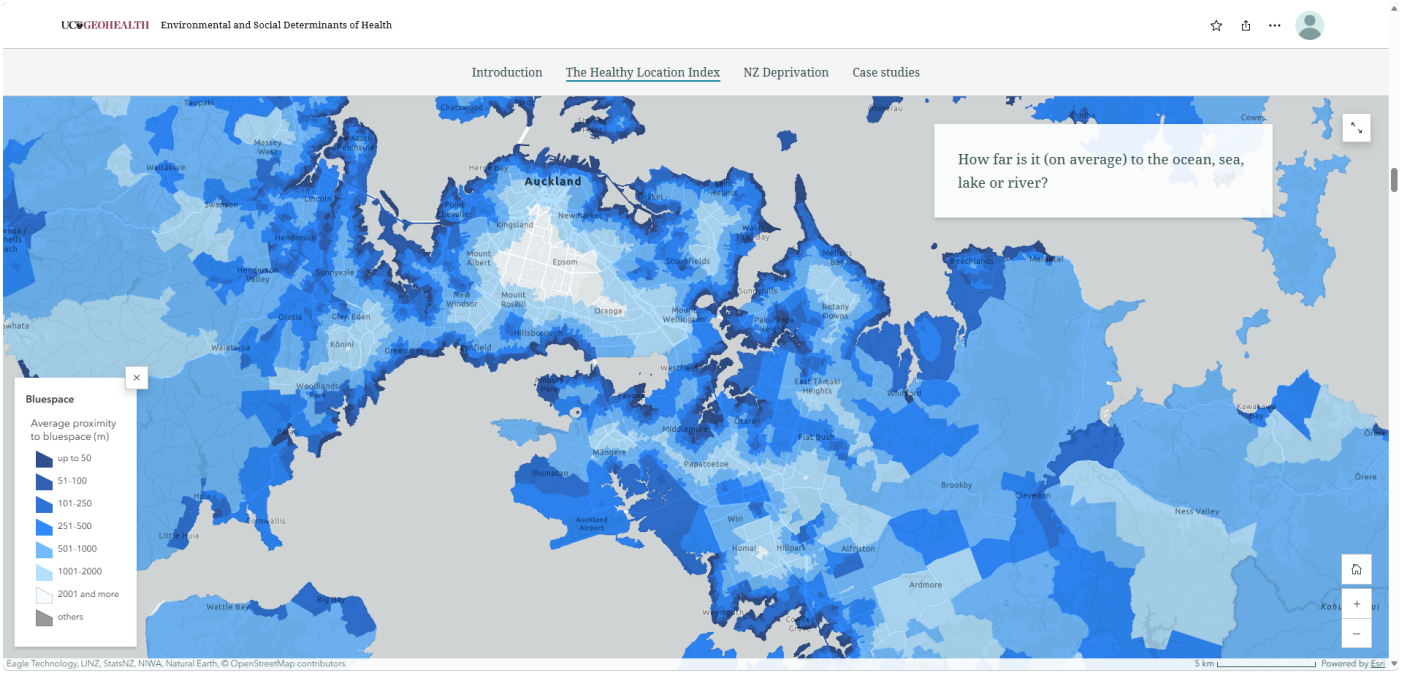
https://storymaps.arcgis.com/stories/f60828bf4e844b798378a238136f651a





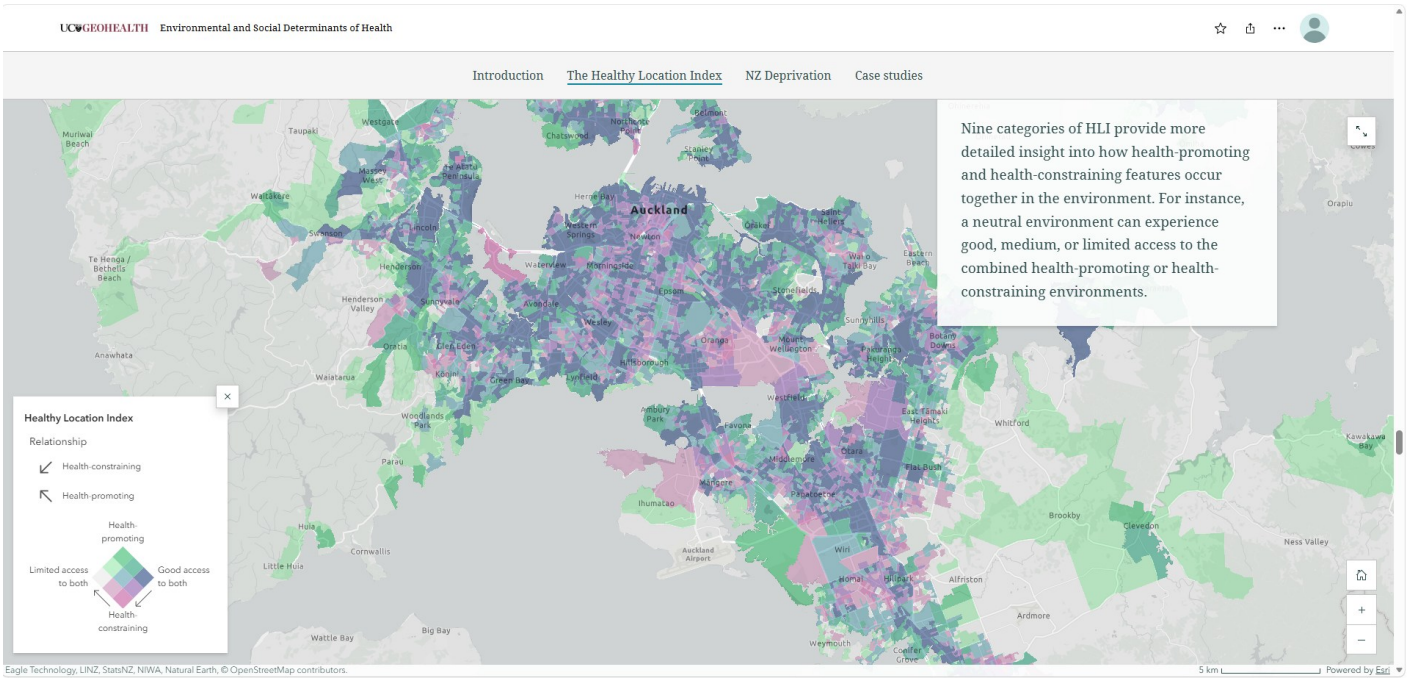
The HLI first ranks each geographic unit in New Zealand based on these domains (taking into account the population in that area). It then combines the rankings to calculate a final category. While the HLI has limitations (for example, lacking an assessment of the quality of the natural environment that is accessed, or accounting for whakapapa connections to whenua), it is still the most complete New Zealand-wide measure of the built environment that accounts for the co-location of places and integrates population size.

The maps illustrate the five health-promoting features. The distances to the nearest supermarket, fresh produce store, and physical activity facility are measured by drive time in minutes. Greenspace is measured by the Normalised Difference Vegetation Index (NDVI) score to show how 'green' an area is, and blue space is measured by average distance to it in metres. Scroll through the maps of Auckland to see the differences between the health-promoting categories.



Team: Lukáš Marek, Matthew Hobbs, Jesse Wiki, Phoebe Eggleton Malcolm Campbell, Simon Kingham.

The Healthy Location Index Categories



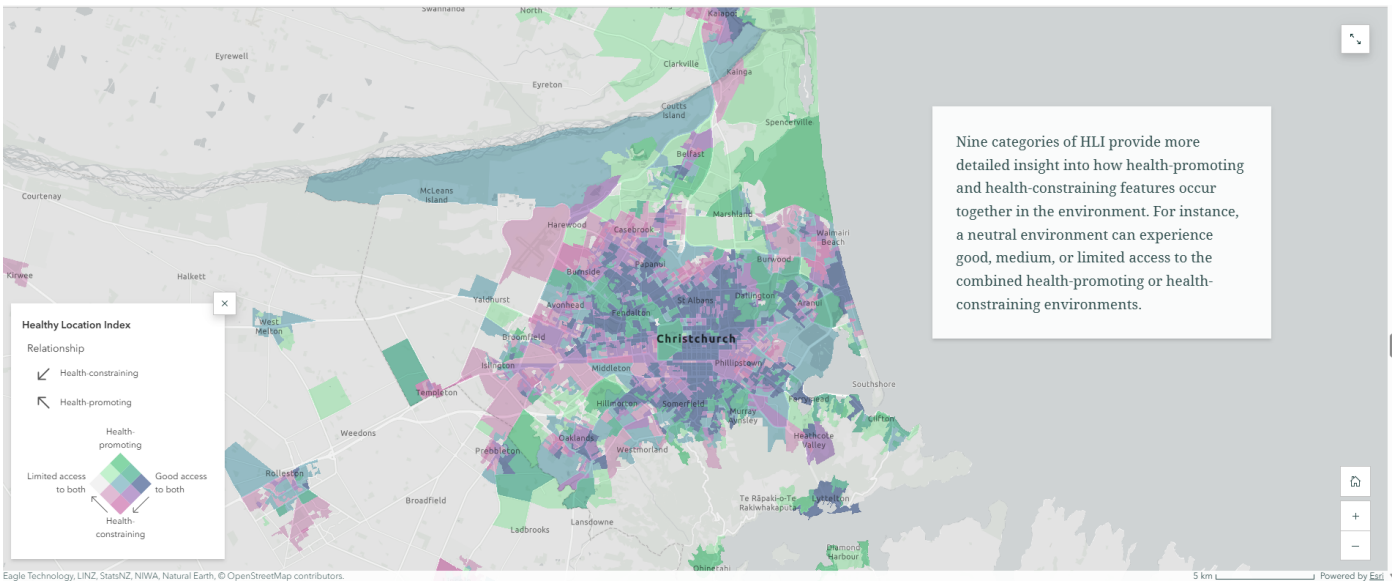
The StoryMap allows users to see and explore relationships between the HLI (represented by three categories: health-promoting, health-constraining, and neutral) and socioeconomic deprivation (NZDep2023) across different communities.

The case studies presented in the StoryMap take a closer look at the differences between two communities to illustrate some of the relationships between socioeconomic deprivation and the environment people live in.

The Healthy Location Index and the StoryMap were developed by the GeoHealth Lab team.

The StoryMap and the information presented here are available at:

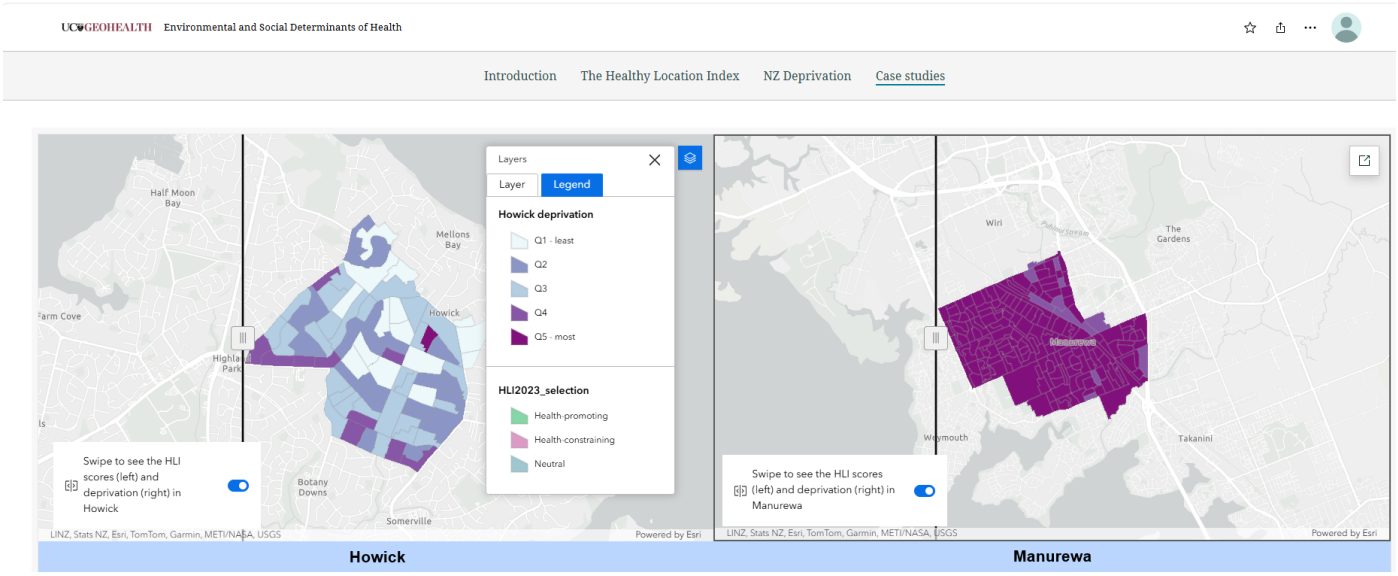
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Case 1: Howick and Manurewa

Howick and Manurewa are two suburbs in Auckland, about a 30-minute drive apart, but they have different demographic profiles. Howick has a smaller, older population with around one-third of people identifying as Asian, while Manurewa is larger, younger, and more diverse, with large Pacific, Māori, and Asian communities.

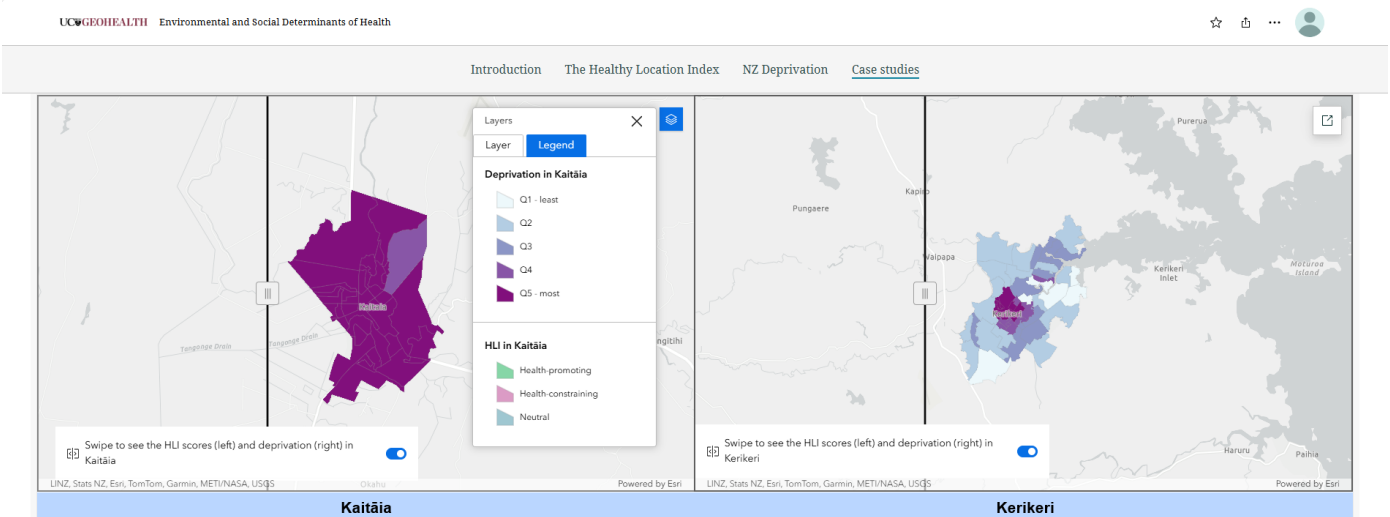
In Howick, the population is evenly spread across the first four NZDep2023 quintiles (Q1-Q4), with only 1.1% living in Q5 areas (the most deprived). However, in Manurewa, 94.6% of people live in Q5 areas (the most deprived areas), and the remaining 5.4% live in areas that are assigned Q4.



Case 2: Kaitāia and Kerikeri

Kaitāia and Kerikeri are two small towns in the Far North district, 90 kilometres apart. Kaitāia is smaller and more geographically isolated, with a much younger population. The majority of people living in Kaitāia identify as Māori. Kerikeri has an older, predominantly Pākehā (NZ European) population. In both locations, access to the natural environment is generally easier than in bigger cities.

In Kaitāia, 97.7% of the population live within the 20% of most deprived areas nationwide (Q5), with 2.3% living in Q4. In Kerikeri, the population is reasonably evenly distributed across the five quintiles, with most living in Q2, the second least deprived (35.4%)."



Team: Lukáš Marek, Matthew Hobbs, Jesse Wiki, Phoebe Eggleton Malcolm Campbell, Simon Kingham.

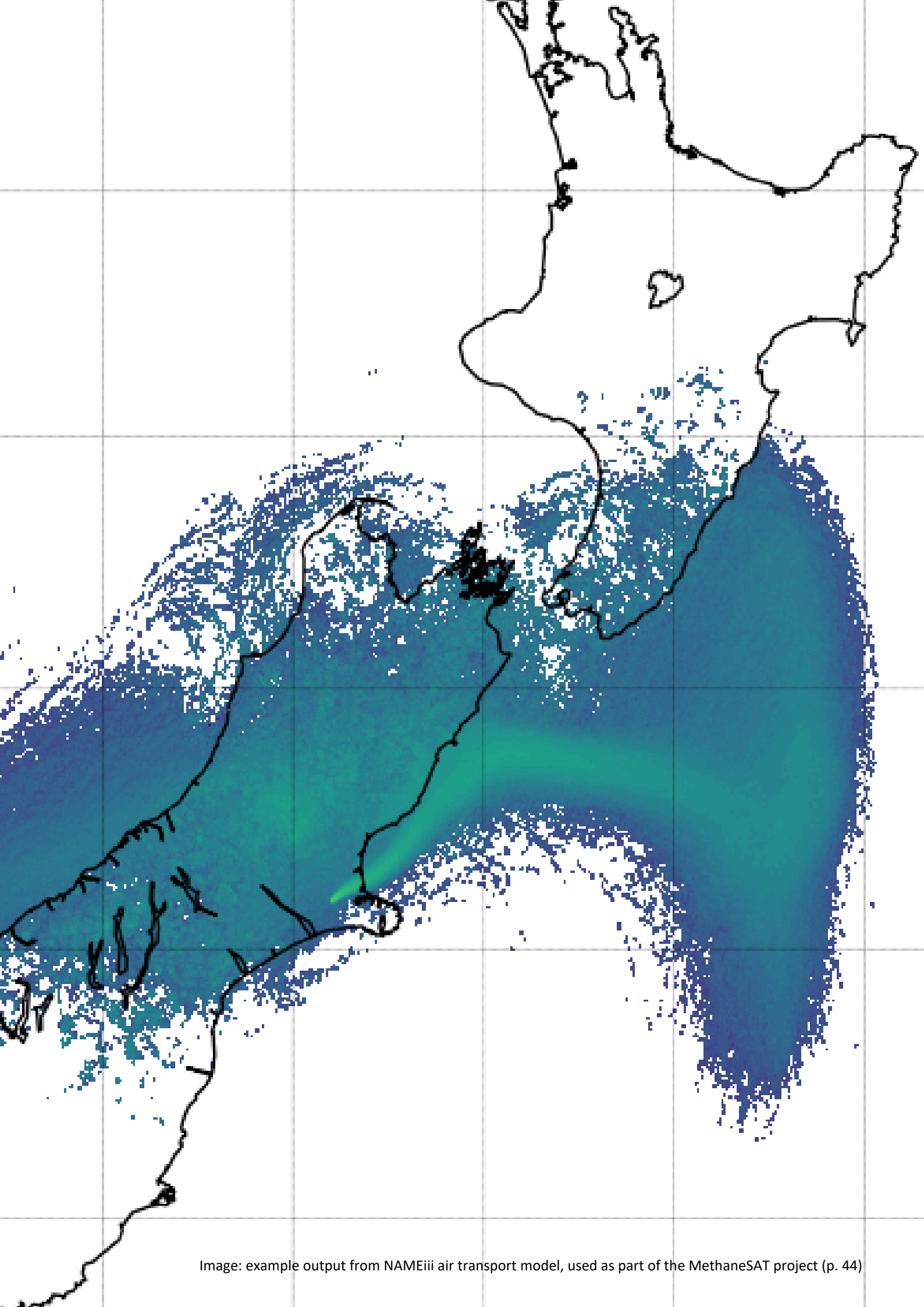


Image: example output from NAMEiii air transport model, used as part of the MethaneSAT project (p. 44)

New and Ongoing Research

Satellite sensing into agricultural practices: Cal/Val campaign of satellite, airborne and ground GNSS-Reflectometry of soil moisture

Research team

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Mehdi Khaki (UoNC, AU)
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George Townsend (UoNC, AU)
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Duration of project:
2024 – 2025

Funding:
Australia New Zealand Collaborative Space Program (Catalyst Fund and SmartSAT)

Summary:

Irrigation exploits most of agricultural use of water, consuming more than half of the total water in Australia and New Zealand. Given the size of water use in irrigation, using more efficient water management will lead to a great impact on freshwater resources. Soil moisture probes are widely used in irrigation, but sampling is only available "point-wise", not necessarily representing the overall water need over fields. To measure soil moisture comprehensively, our joint research exploits the L-band microwaves reflected off land surface and ubiquitously available from the GNSS constellation. This project integrated Global Navigational Satellite System (GNSS) remote sensing measurements of soil moisture from several platforms of satellites, aircraft and ground receivers. The study provided baseline information for exploiting remote sensing data to provide spatial and temporal variations of soil moisture at field scales through development of the soil moisture data assimilation system. In particular, the system's outputs aimed to be appropriate to local water resource management and decision making for agricultural practices and environmental applications.

This research is leveraging established sites where in-situ soil moisture measurements have already been gathered in Australia and New Zealand, to verify GNSS land reflection measurements from NASA's CYGNSS satellites, New Zealand's Rongowai aircraft, and University of Newcastle's ground GNSS remote sensing module. We performed extensive comparisons among satellite and aircraft GNSS reflectometry measurements, ground GNSS reflection records, and in-situ probes for verifying soil moisture changes at field scales.

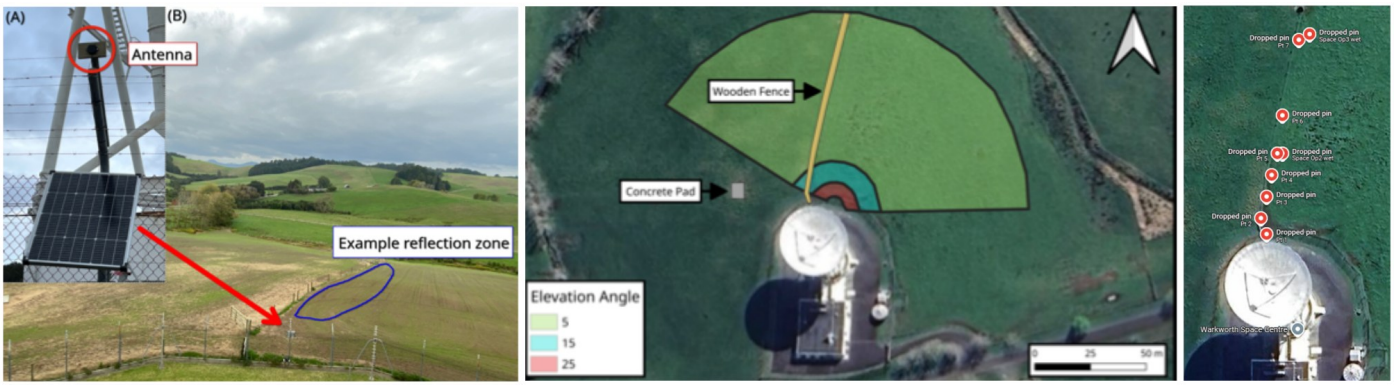
This feasibility study was the first of its kind to put all GNSS remote sensing systems together to make satellite-airborne-ground co-located GNSS experiments for soil moisture retrieval. The field campaigns enabled us to validate GNSS-based remote sensing sensors for monitoring soil moisture under real-world conditions; and to ensure that the sensing systems are tested across a range of climates, soil types, and terrains to optimize the sensor performance for various agricultural and environmental use cases.

The GNSS signal's reflectance changes with soil moisture content and is sensitive to wider areas in contrast to point-wise ground probes. These are early results from cross-validation of three GNSS remote sensing systems from satellite (CYGNSS), airborne (Rongowai), and ground-borne sensors, which work in the identical principle but at different resolutions and coverages. In this research, we conducted field campaigns of co-located experiments and extensive calibration and validation of three different types of GNSS-based soil moisture data.

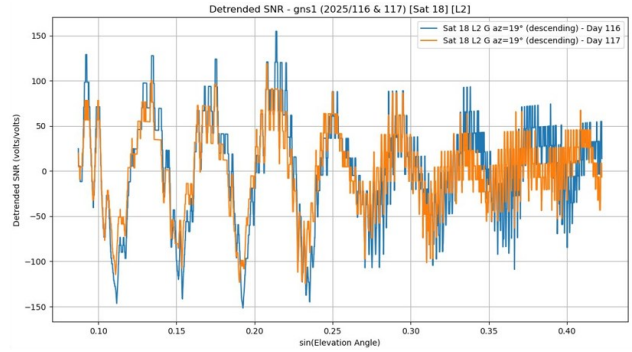
Our successful field calibration and validation (Cal/Val) of GNSS measurements is now leading to the development of the Soil Moisture Data Assimilation System (SMDAS), funded by an MBIE Catalyst grant starting in 2026. The SMDAS can be a game changer of integrating efficient GNSS-based remote sensing measurements with imaging radars and radiometers to retrieve soil moisture information adequate to farmers, practitioners, and governments, to save water for efficient and drought-resilient agricultural and farming practices.

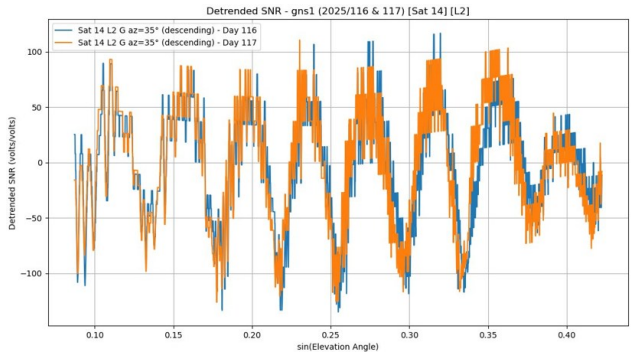
Field campaigns

A proof-of-concept GNSS-IR ground station installation system was constructed using Commercial Off-The -Shelf (COTS) components, including a Raspberry Pi single-board computer, u-blox ZED-F9P multi-band GNSS receiver, 4G LTE modem for data telemetry, housed within a custom weatherproof enclosure and powered by a solar panel and battery system. Open-source software solutions were configured for data acquisition, system management, and remote access. The system operating autonomously since installation in April 2025 until the end of the project. The onboard RTKBase software logs raw GNSS data hourly.

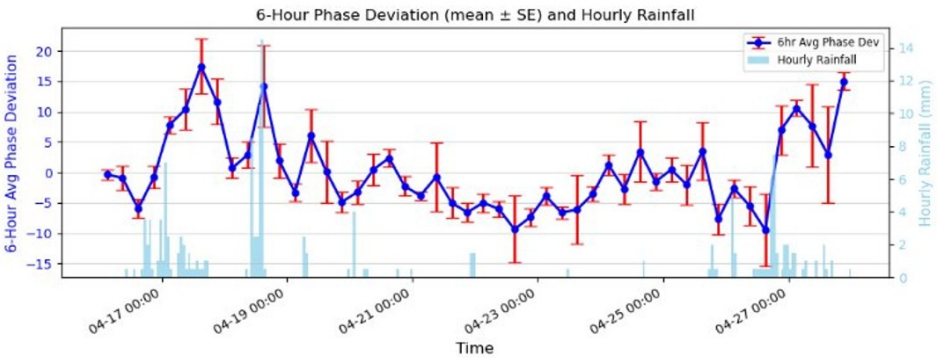


Images above: (left) the installed antenna and solar panel at Warkworth (A), and the clear view to the north which serves as the reflection zone (B); (middle) approximate reflection zones with physical obstructions marked; (right) soil samples for lab testing were collected in a transect in a northern direction.





Left: 'Raw' data of GPS-IR waveform from two example GPS satellites before (top image: day 116/ April 26, blue) and after (bottom image: day 117/ April 27, orange) rainfall. The rainfall causes a phase -shift (or equally wavelength shortened) in GPS-IR waveforms for signals received at the same location.



6-hour phase deviations align well with hourly rainfall and shows promise for use in soil moisture estimation.

Empowering community resilience to climate change through novel flood scenario analytics

Research team

Matthew Wilson (GRI - UoC)
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Martin Nguyen (GRI - UoC)
Maria Vega Corredor (GRI - UoC)
Jamie Ruwhiu (GRI - UoC)

Funding
Endeavour Fund - MBIE / Hikina Whakatutuki

Duration of project:
October 2024 – September 2027

Funding:
MBIE Endeavour (Smart Idea)

Project summary

We are delivering a novel digital twin (DT) for climate resilience, focussing on flood risk. The system facilitates rapid, low-cost risk assessments with on-demand scenario analytics, and effective ways to visualise and communicate this risk and its associated uncertainties. With guidance from our Māori partners, the scenarios developed will ensure appropriate options are considered.

Physics-based DTs such as ours will revolutionise access to and use of numerical model predictions, through a "digital twin web" which is powered by rapidly growing data and distributed cloud computing. Yet, individual components need to be built and tested to ensure they are fit-for-purpose, democratic and adaptive to society's needs. Our research will enable this, initially in Aotearoa, but with global applicability.

This strategic partnership consists of leaders in flood risk research, humanitarian engineering for hazards, infrastructure practitioners and Iwi leaders. Our team has successfully developed a prototype proof-of-concept DT which will form the foundation for this research. Our DT will remove barriers to flood risk assessment, greatly increasing the availability of information for resilience planning decisions. It will improve communication and understanding of flood risks, and enable communities to be better informed, prepared, and engaged in mitigation and adaptation.

2025 Digital Twin Update:

The work for 2025 on creating this digital twin built upon our work on the Flood Resilience Digital Twin prototype and other previous digital twin projects at the GRI. In early 2025, we split the core data ingestion, tasking, and visualisation components of our digital twins into a library and framework that can be more easily reused, the Environmental Digital Data Intelligence Engine (EDDIE).

We migrated the visualisation components of EDDIE from a custom-built Cesium-based library into using the more standardised TerriaJS library. TerriaJS also uses Cesium, but is much more full-featured for digital twin development than working directly with Cesium.

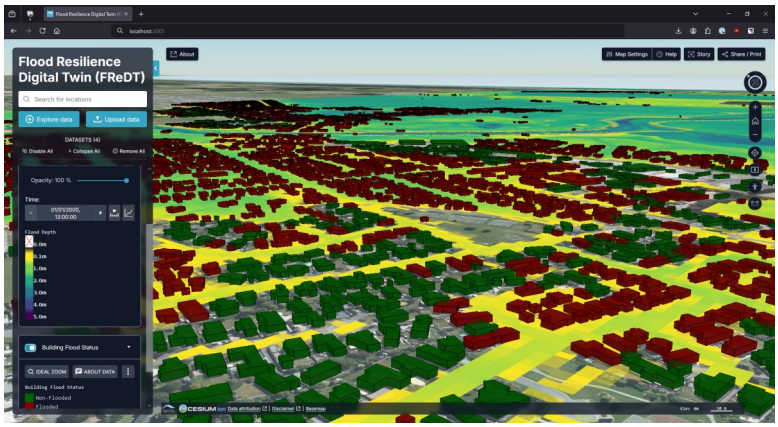
We began the work on expanding our hydrodynamic lower-catchment based Flood Resilience Digital Twin into a full catchment hydrological model, coupled to a hydrodynamic flood model for detailed areas of interest. We have developed preliminary designs for user interface to allow communities to model flood scenarios, and these will be further developed with community engagement in 2026.

2025 Modelling Update:

The dashboard for communities generating their own flood scenarios for decision making or impact assessment is nearly complete. After completion, it will be advanced and modified based on the feedback from the communities.

Necessary data and workflow/pipeline system are being developed and organised. This mainly includes data and models for hydrological and hydrodynamic modelling processes. For hydrological modelling, WRF-Hydro has been replaced by Wflow which is more efficient. For hydrodynamic modelling, two models have been considered – LISFLOOD-FP and BG-Flood.

There will be three meetings with Whirinaki and Mataura communities for introduction and collecting initial feedback. In the next meeting, we aim to let the communities experience the dashboard.



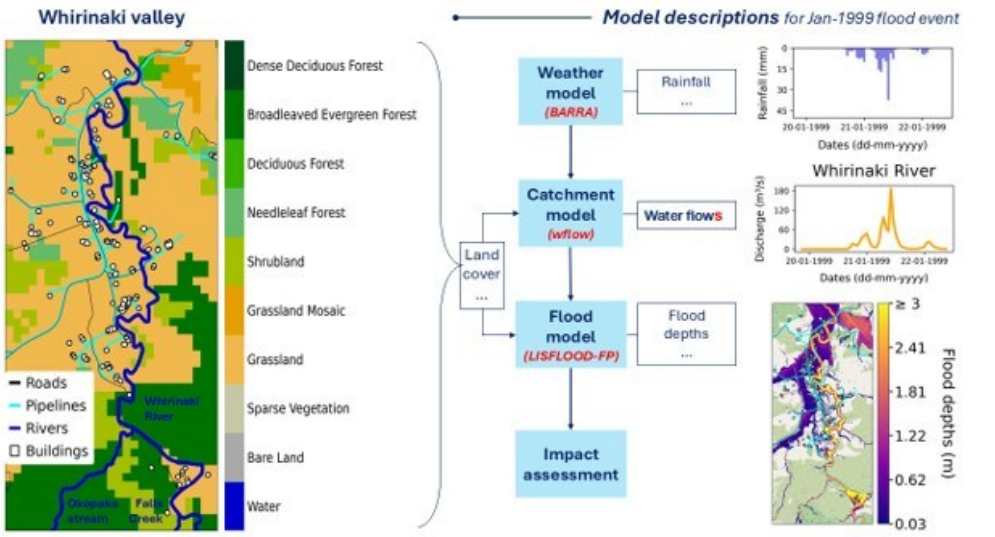


Figure 1. *Workflow behind DT dashboard – Whirinaki community*

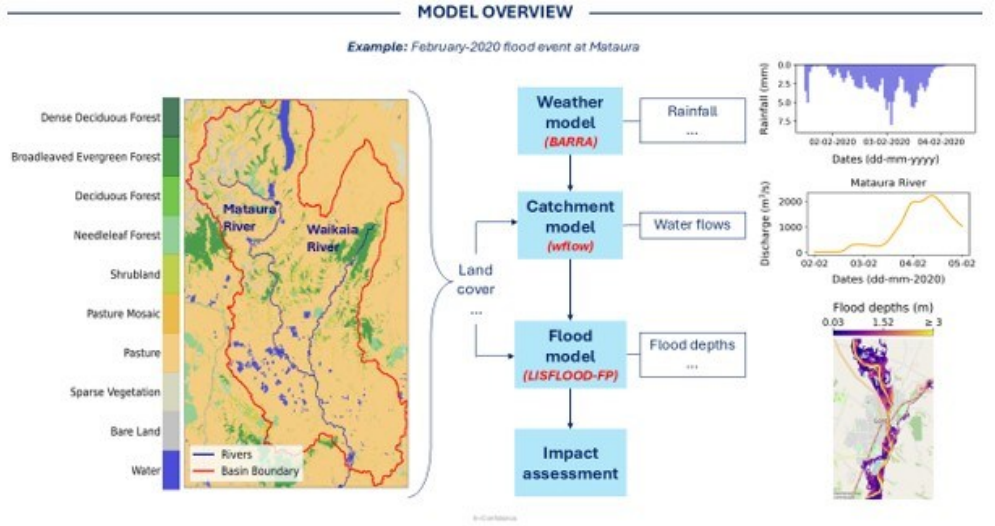


Figure 2. *Workflow behind DT dashboard – Mataura community*

Workflow behind the visualisation tool. Top figure presents Whirinaki catchment and the bottom one represents the Mataura catchment. These figures describe how the workflow can simulate the flood events. At first, it uses weather data from BARRA e.g. precipitation, temperature, and evaporation. Together with terrain and land cover data included into a Wflow catchment model to generate river/stream flows. Once the flow data is generated, it will be used in LISFLOOD-FP (or BG-Flood) along with terrain data to generate flood model outputs such as flood depths and flooded areas. These results will then be used for impact assessment. The tool will be mainly used to generate multiple nature-based solutions for flood mitigation planning.

Estimating agricultural methane emissions in Aotearoa New Zealand - an integrated multi-scale framework for satellite-based monitoring

Research Team
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Maria VEGA-CORREDOR (GRI)
John REID (NTRC)

In Collaboration with
Sara MIKALOFF-FLETCHER (ESNZ)
Beata BUKOSA (ESNZ)
Daemon KENNETT (ESNZ)

Funding
MBIE

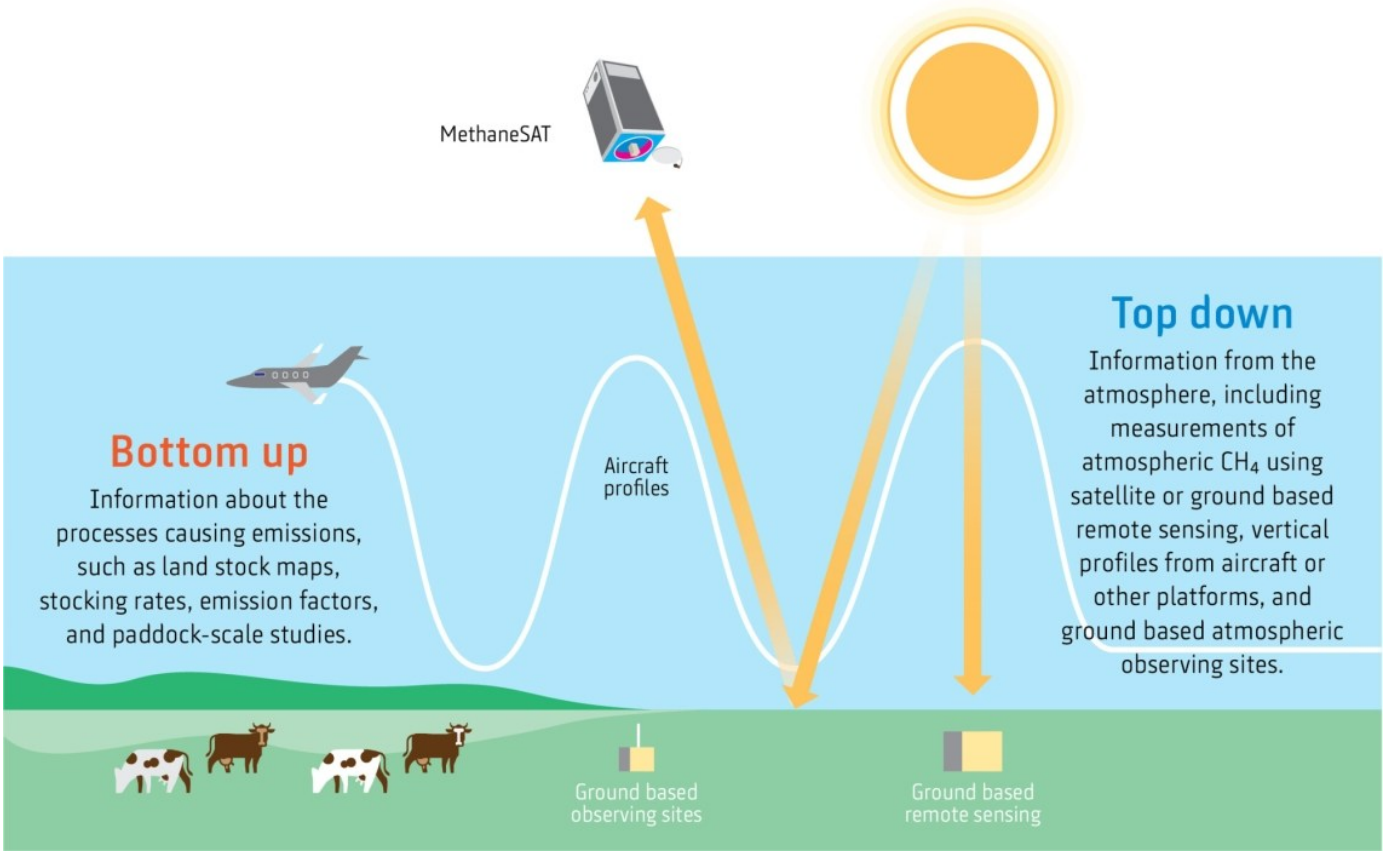
Duration
2025-2027

Project summary

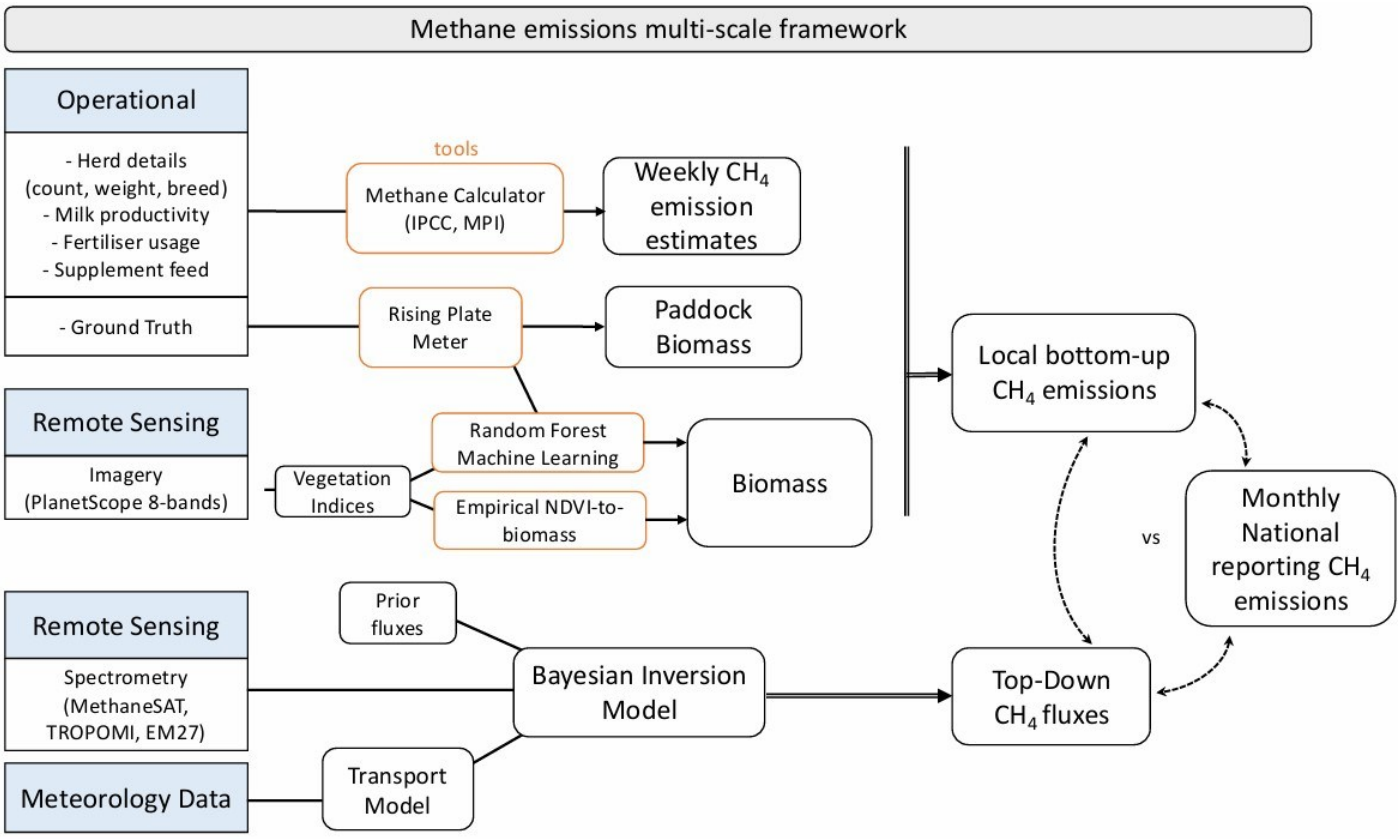
Pastoral agriculture accounts for over 40% of Aotearoa New Zealand's gross greenhouse gas emissions, with enteric methane from ruminant livestock representing the dominant portion. While national inventory methods provide aggregate estimates, they cannot resolve spatial heterogeneity at farm or paddock scales. Dedicated greenhouse gas satellites offer global atmospheric methane column measurements, yet whether their spatial resolution and retrieval sensitivity are sufficient to constrain emissions at farm and regional scales in dispersed pastoral systems remains an open research question. This project explores the feasibility of an integrated multi-scale framework that links bottom-up farm inventory approaches, top-down satellite observations and in-situ field measurements using the pastoral farming operations of Ngāi Tahu Farming in the Canterbury region.

The framework's bottom-up component implements four calculation methodologies (IPCC Tier 1, Tier 2 Simplified, Tier 2 Advanced and the New Zealand Ministry for Primary Industries Farm Emissions Method), in a purpose-built pipeline ingesting farm-specific operational data with transparent fallback to national defaults. Weekly to seasonal emissions estimates are produced for each farm, enabling temporal analysis of herd-level methane across a production cycle. Satellite-derived vegetation indices from PlanetScope imagery serve as spatial proxies for pasture biomass and livestock feed intake, calibrated against rising plate metre ground measurements using machine learning.

The top-down component, developed in collaboration with Earth Sciences New Zealand, uses atmospheric inversion modelling to estimate methane fluxes from MethaneSAT and Sentinel-5p TROPOMI column observations. Inversion priors are drawn from national inventory estimates and atmospheric transport is simulated using the UK Met Office NAME III Lagrangian particle dispersion model. The farm-scale bottom-up estimates may serve as a future test case for evaluating inversion outputs at finer spatial scales.



Complementary approaches to constraint methane emissions. Bottom-up modelling using on-farm processes and land-use factors, versus top-down atmospheric measurements from satellites (Sentinel 5P TROPOMI and MethaneSAT), aircraft and ground-based instruments. Image credits: Earth Sciences New Zealand (https://niwa.co.nz/atmosphere/methanesat)



Project's multi-scale methane emissions framework linking bottom-up and top-down data streams

Virtually flooded: Improved risk communication through immersive virtual reality

Research Team:
Xander Cai (GRI - UoC)
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Matthew Wilson (GRI - UoC)
Maria Vega Corredor (GRI - UoC)
Ian Grover (Te Rūnanga o Ngāi Tahu)

Funding:
Natural Hazards Commission

Duration of Project:
2024—2026



Project Summary:

Flood inundation is a frequent, widespread, and impactful hazard, which regularly causes damage to housing and infrastructure along with disruption to whanau, communities, and businesses.

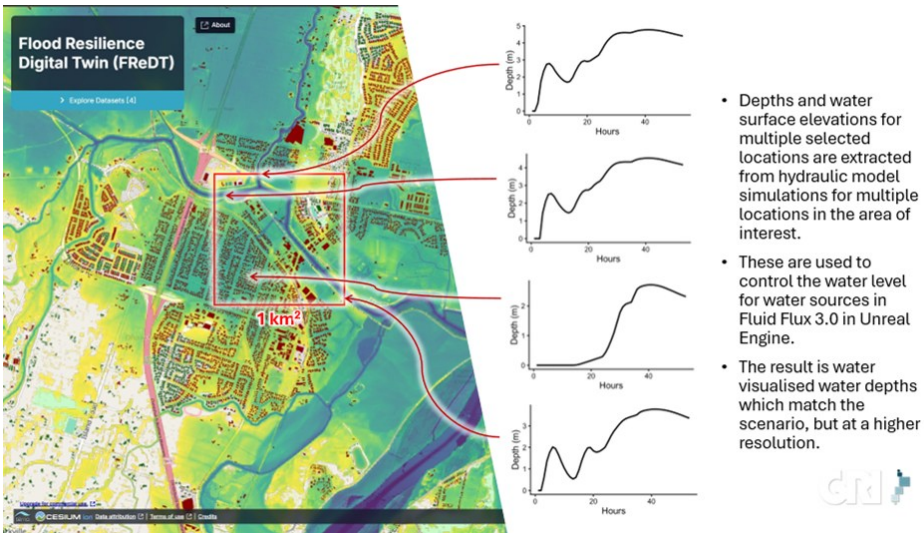
Flood risk is expected to increase in future because of climate change through increased storminess coupled with rapid growth of urban areas. To manage flood risk efficiently and effectively, now and in future, communication of risk assessments for multiple scenarios needs to be targeted with the right method for the right audience. However, there is limited information on what works best, why, and for whom. This has been particularly highlighted following Cyclone Gabrielle in February 2023, with its unprecedented impacts which were not well understood beforehand.

Flood risks are generally poorly understood by the public, with flood events taking communities by surprise even if risk assessments have been completed. Further, traditional two-dimensional risk maps are limited by interpretability challenges. Three-dimension AI visualisations and immersive Virtual Reality (VR) technology have been found to be more intuitive due to their increased realism. This research will design and test advanced visualisations of flood risk using VR, with the aim to improve awareness of flood risk in Aotearoa.

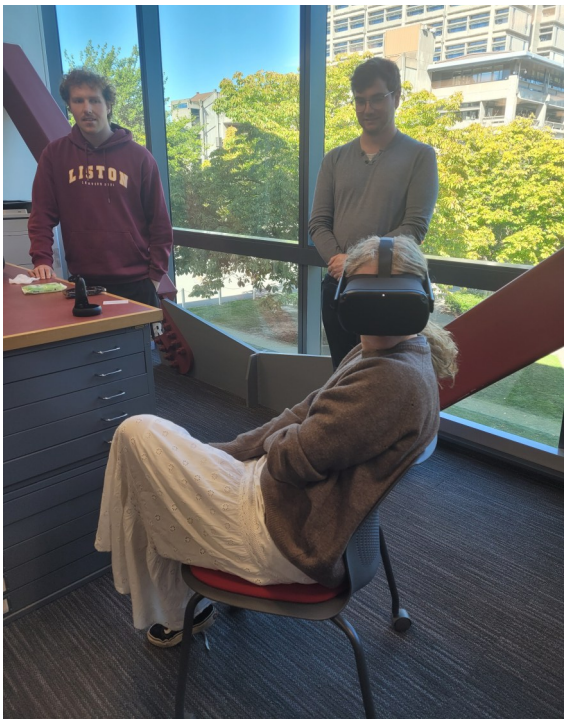
2025 Research Update

In 2025 we developed a workflow to bring high-detail flood models into Unreal Engine to use within the virtual reality world. This workflow starts with defining an area of interest and extracting depth over time curves from a flood model covering the area. From there we can transform the data into a form ready for Unreal Engine. Python scripting can automatically add these to the virtual world. Our plugin and scripting repository for this flood model ingestion is available open-source on GitHub at https://github.com/GeospatialResearch/UnrealFloodingScripts.

Advancements in procedural content generation and our skills in utilising the technology allowed us to create much higher detail representations of our chosen areas of interest than previously. We developed a public showcase of an unspecified New Zealand town and a private virtual representation of a small settlement for Rūnanga engagement. Through our development, we have been able to automate significant amounts of the process required to produce these geospatial visualisations of the real-world in VR, and this has increased our capability to produce these visualisations at much lower cost in the future.







Our research aims to help communities to better understand natural hazards in this case flooding, particularly when accounting for climate change.

We apply research into practical methods developed to aid the creation of mitigation strategies, and provision of the tools needed to communicate and address the complex nuances of changing risks.

Hydrological model of the Te Awarua o Porirua Harbour catchments

Research Team:
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Georgina Dawson (PHF Science)
Russleigh Parai (PHF Science)
Luke Parkinson (GRI - UoC)
Robert McClean (Te Rūnanga O Toa Rangatira)

Funding:
PHF Science (MBIE funds)

Project summary

This project corresponded to phase two of the Porirua Harbour flow model initiated in 2023, in which a flow model of the Porirua Harbour with water source tracing capability was developed to enable an assessment of where is likely to be most affected by fluvial pollutants and assess the tidal flushing of the harbour. The model was developed and is available under open-source licensing. By using the model to assess where in the harbour is affected by which contributing water source, and by how much, results from the model can be used to infer where fluvial pollutants are likely to be within the harbour. As part of the model developments and analysis, a seamless topography-bathymetry grid suitable for hydraulic modelling was developed, observations of river flow, tide level and rainfall were obtained and processed, and the flow tracing model was constructed using open-source CAESAR-Lisflood 2.0 software. The model was run for a one-year period (2023) and, in addition, two scenarios representing the potential impacts of sea level rise on water source mixing in the harbour were assessed. The main results from Phase 1 are summarised below:

- Three main data sources used: three river sources, rainfall and tide. As expected, the proportion of river water increases at low tide and after rainfall events in the river catchments.
- The model indicates where water from each source tends to accumulate in the harbour, showing that this occurs particularly in the upper arms and along the shorelines. Since the river water carries with it pollutants from the catchments, this provides an indication of where in the harbour is most likely to be affected by this.
- The sea level rise suggest an increase in river source depths in the upper reaches at both low and high tides.
- The model has been built using fully open-source software.

Phase Two of the project was focused on the development of a hydrological model of the harbour catchments. The model included 15 catchments and:

◊ Enables assessment of how catchment changes impact the health of the harbour and its community

◊ Hydrological model of full basin, including land cover, soils, groundwater

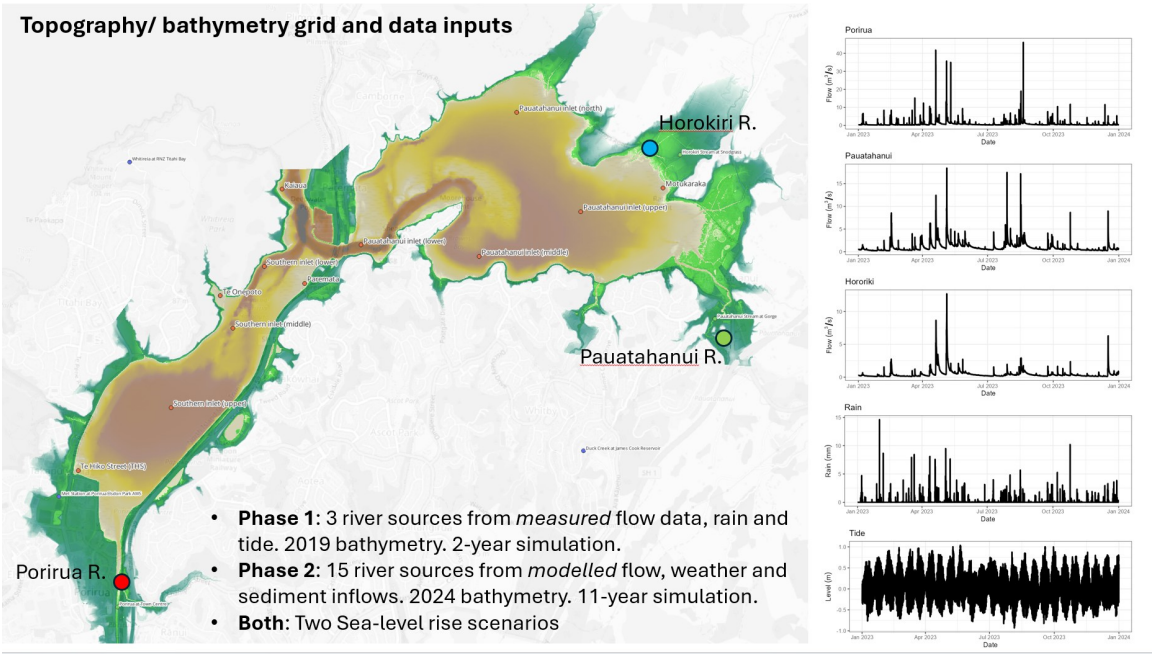
◊ Runs 11 years of simulation, using weather model inputs

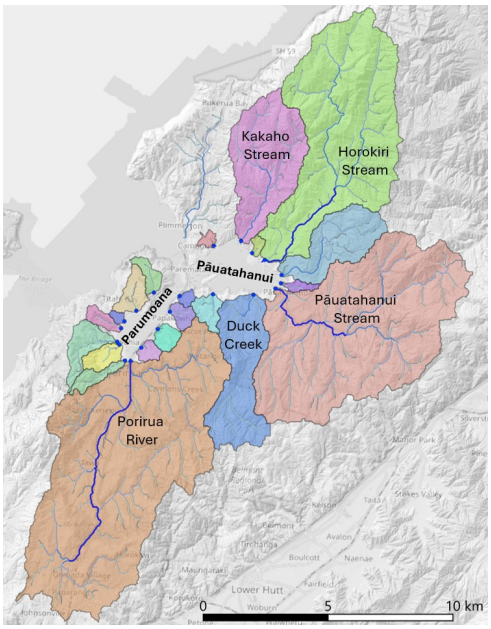
◊ River drainage from 15 catchments used in flow model, including sediment inputs

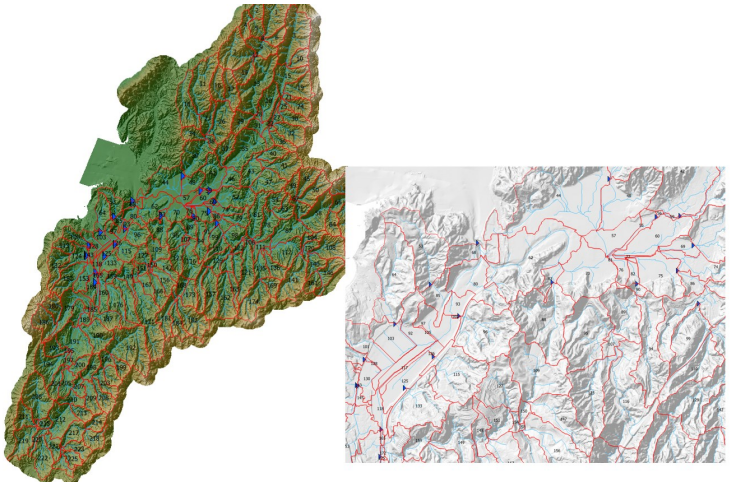
◊ Allows for sediment input

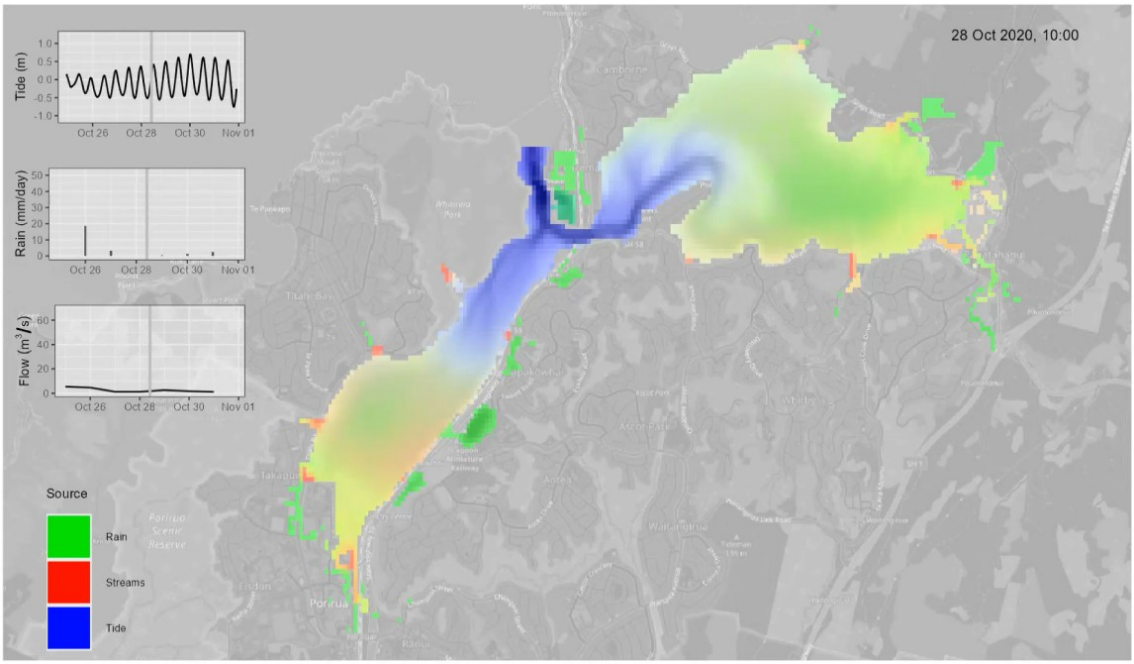
◊ Catchment model to produce inflows for all rivers, and sediment input.

◊ Catchment model developed for full river basin, inputs to this from a weather model.









Top figure shows topography, bathymetry and model inputs. Middle figures show the 15 catchments modelled. Bottom figure show the catchment model. This was use to assess the flows from all the contributing catchments flowing into the Porirua Harbour, and how they mix with rain and tide.

Implications of uncertainty in flood hazard assessments for planning under climate change

PhD Project
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Matthew Wilson (GRI - UoC)
Iain White (University of Waikato)
Carolynne Hultquist (UoC)

Funding
MBIE Endeavour Fund

Duration of Project
3 years



Word cloud of survey participant professions.

Project Summary:

Like many other countries around the world, New Zealand experienced numerous floods between 2022 and 2023. In 2022 Aotearoa experienced over 600 million dollars in losses, however, in 2023 this figure skyrocketed to over 3.5 billion dollars with the passage of Cyclone Gabrielle and the Auckland Anniversary weekend floods. According to the National Institute for Water and Atmospheric Research (NIWA) who uses complex flood models to predict how flooding is going to change over the next few decades, these figures are likely to increase based on climate projections. The aim of this research is to develop a better understanding of uncertainty representation in flood risk management and to determine the impact that it has on decision making. As the uncertainty associated with flood risk grows due to climate change and other factors it becomes imperative that decision makers can make the decisions needed within acceptable margins of error to protect the people of Aotearoa and its assets. To achieve this aim, the following research questions were defined:

I. How are different types of uncertainty represented in aspects of flood hazard risk assessments?

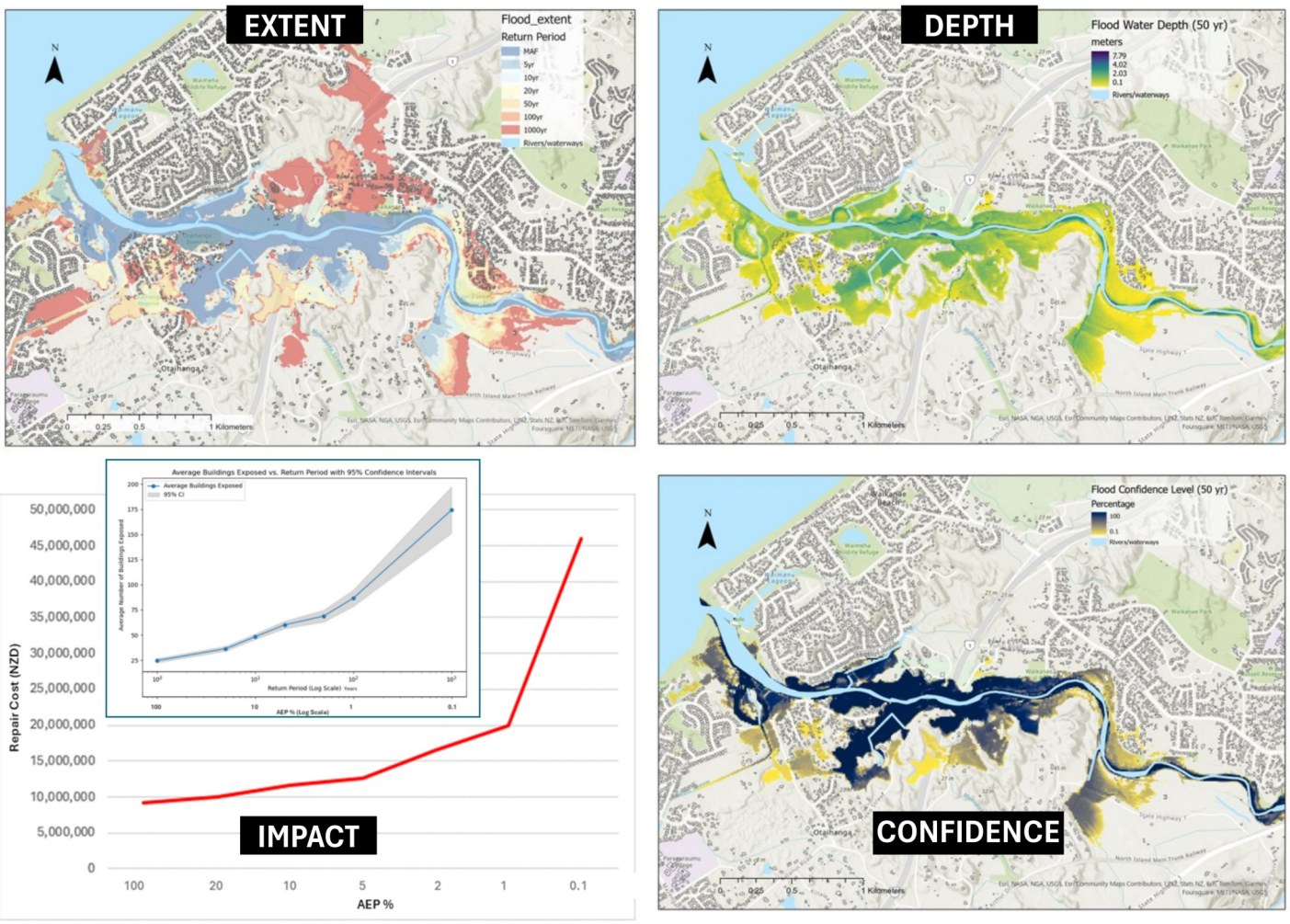
II. How do different uncertainty representations influence decision making for planning purposes?

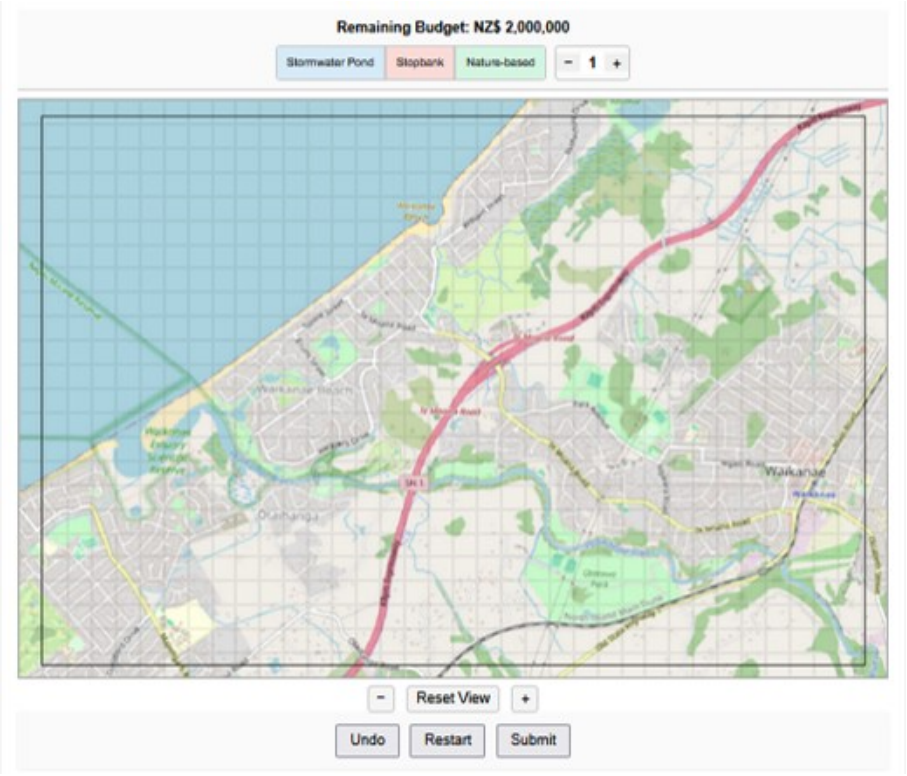
III. What are the options for improving the treatment of uncertainty in flood hazard risk assessments?

It is hoped that the outcomes from this research will help to improve our understanding of uncertainty representations for flood hazards and how it can be used to make better decisions to reduce the impact of climate change for future generations.

2025 Research Update:

Using the results of the Monte Carlo Method (MCM) modelling, an ensemble of flood model outputs was used to create uncertainty visuals using flood criteria such as extent, depth and confidence that were then tested with risk management practitioners from across regional/ district councils, central government and private sector agencies in New Zealand. This feedback was then incorporated feedback into a series of recommendations and used to design a novel map interface that was used to further test perceptions of flood uncertainty and its link to decision-making. At the final Endeavour Flood Project Roadshow this novel interface was used in a pilot test along with the GRI's Digital Twin Map interface.





Decision-making user interface for survey.

Language, Place, and Social Media: Geographic Dialect Alignment in New Zealand

PhD Project

Sindey Wong (GRI - UoC)
Benjamin Adams (UoC)
Jonathan Dunn (University of Illinois Urbana-Champaign)
Kong Meng Liew (UoC)
Jen Hay (UoC)

Funding
Geospatial Research Institute Toi Hangarau PhD Scholarship, UC Doctoral Scholarship

Duration
October 2021 - April 2026

Project summary

This project investigated geographic dialect alignment in place-informed social media communities, or to what extent place-based social media networks align with the linguistic context of underlying geographic dialect communities. With recent advancements in Natural Language Processing (NLP), there is an increased awareness of how well georeferenced social media language data represents an underlying population. Focussing on New Zealand-related Reddit communities, I showed how place-informed social media communities can be a source of good quality georeferenced language data.

Methods

I proposed a multi-stage mixed-methods analytical pipeline integrating qualitative analyses of user perceptions with computational methods. The purpose of this approach was to examine how language use reflects place identity and patterns of language variation and change based on user-informed lexical, morphosyntactic, and semantic variables. A key component of my research was the application of advanced language modelling, including static and diachronic Word2Vec language embeddings, to reveal semantic variation across place-based communities and meaningful semantic shifts within New Zealand English.

Results

The findings showed that users generally associate language with place, and place-related communities form a contiguous speech community, though alignment between geographic dialect communities and place-related communities remains complex. The project made several distinct contributions to the field by introducing place-informed social media dialectology and implementing advanced language modelling techniques. Through my research, I produced a comprehensive corpus of New Zealand-related Reddit communities- comprising 4.26 billion unprocessed words- providing a substantial and valuable resource for future sociolinguistic and computational inquiry.

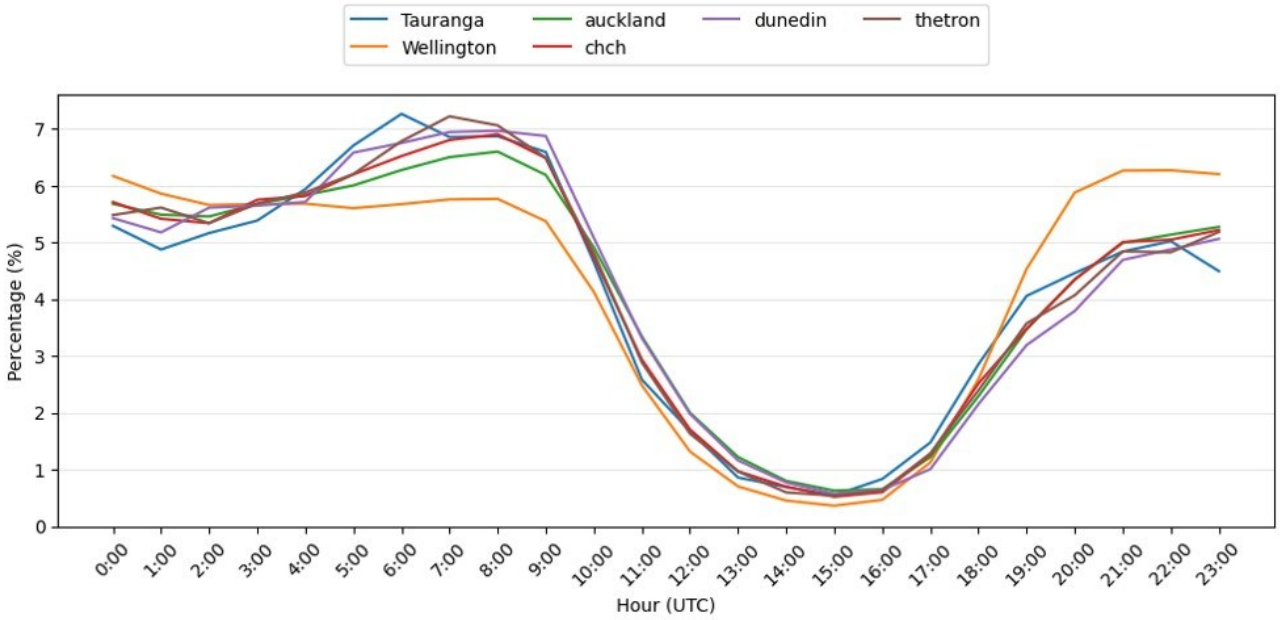


Figure 1: User Engagement by Hour in New Zealand-related Communities. *This line plot displays user engagement based on comment timestamps in UTC for place-based communities. Users in city-level communities adhere to NZST, whereas users in other communities do not, suggesting a level of local activity. Data is sourced from Reddit/Pushshift (Baumgartner et al., 2020).*

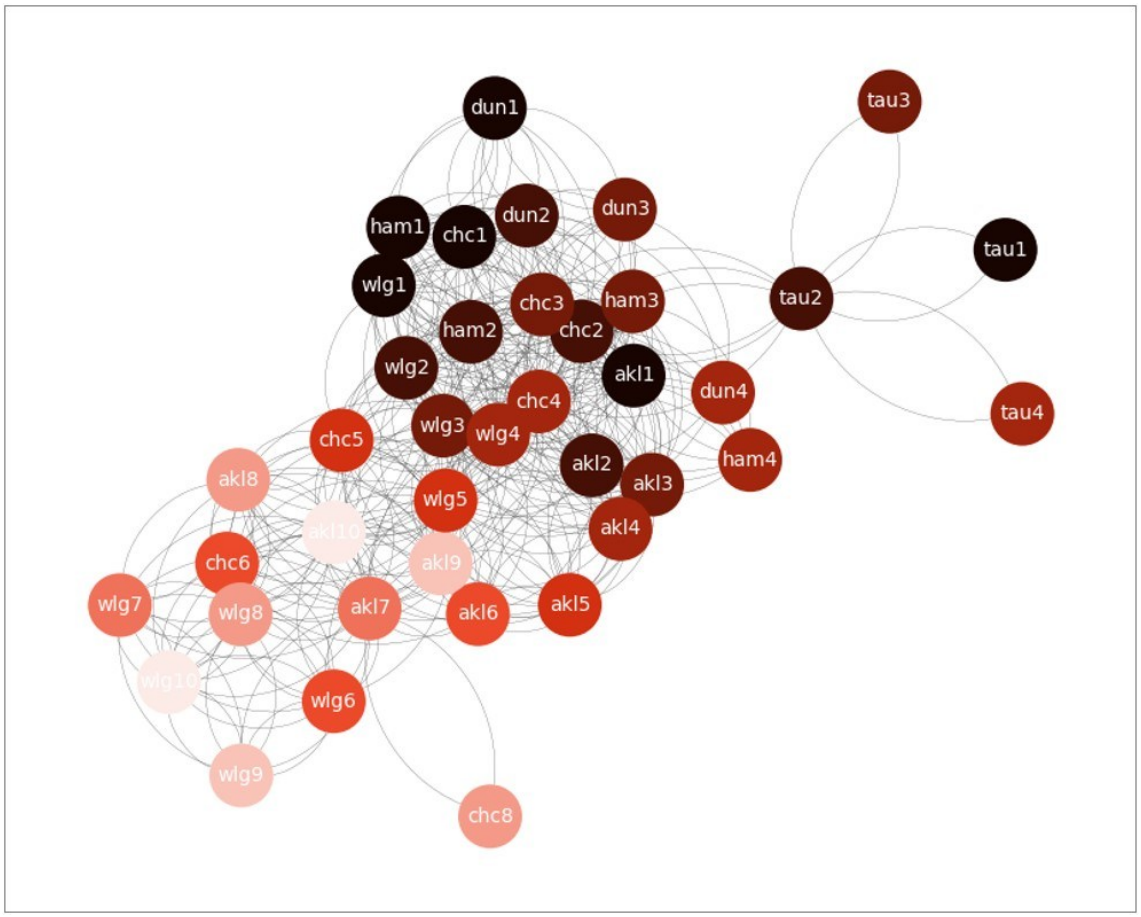


Figure 2: Cosine Similarity of Syntactic Features by Lifespan. *This network graph visualises the cosine similarity of C2xG syntactic features (syn) between city-level communities, segmented by lifespan cohorts, with a threshold of 99%. Each node represents users grouped by lifespan decile, ranging from the most senior in the darkest shade of red (1) to the most junior in the lightest shade (10). The visualisation identifies one primary cluster with a core of most senior users from five city-level communities, which connects to a branching cluster of most senior users from r/Tauranga (tau).*

Advancing methods of rapid flood risk assessment using climate informed hybrid approaches of hydraulic modelling and machine learning

PhD Project

Andrea Pozo Estivariz (GRI, UoC)
Matthew Wilson (GRI, UoC)
Emily Lane (Earth Sciences NZ)
Marwan Katurji (UoC)
Fernado Méndez (Universidad de Cantabria)
Cyprien Bosserelle (Earth Sciences NZ)

Funding:
MBIE Endeavour Research Programme – Increasing flood resilience across Aotearoa, New Zealand.

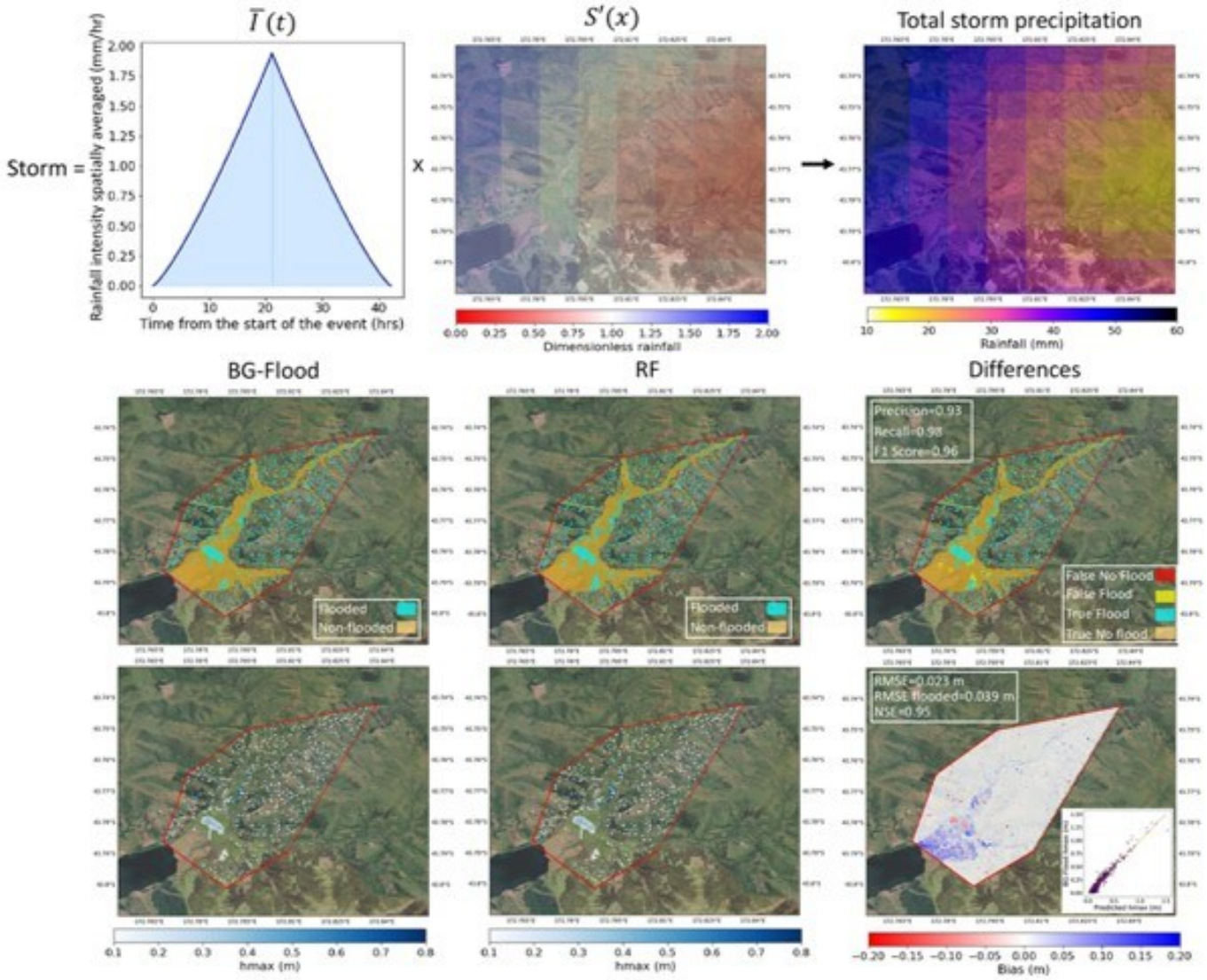
Duration of Project:
November 2021 - September 2024

Project Summary:

Flooding is among the most devastating natural hazards affecting communities, infrastructure, economies and ecosystems. As climate change impacts become realised, flood patterns are expected to change, leading to more extreme events. This context poses critical challenges to current flood risk assessment strategies. Therefore, it is increasingly crucial to develop robust tools that support practical flood risk assessment. This thesis focuses on a key part of flood risk assessment: pluvial flooding drivers and inundation. This research develops reliable, computationally efficient and flexible climate-informed tools that can be used to assess pluvial flood likelihood and inundation hazard and impact. These tools enhance the understanding of the main inundation driver (heavy rainfall) and enable climate-informed rapid flood inundation scenario assessment, large ensemble flood inundation scenario analyses, and long-term flood risk assessment.

These tools are developed using a combination of statistical, machine learning, and two-dimensional hydrodynamic modelling techniques. A method to statistically characterise local flood-inducing heavy rainfall using synoptic climatology and large-scale climatic patterns was first developed. Useful relationships were found between the synoptic and large-scale climatic patterns and heavy rainfall and flooding. This analysis provided both qualitative and quantitative value, displaying the range of weather and climatic configurations that lead to different types of storms and flooding, and helping in their identification and understanding. Drawing on the knowledge acquired in this study, two climate-informed hybrid hydrodynamic-machine models for rapid pluvial flood inundation hazard assessment were developed: a hybrid model for flood/non-flood prediction and a hybrid model for predicting maximum inundation depth. These hybrid models can be used for rapid and accurate assessment of flood inundation scenarios, enabling ensemble scenario analyses. Lastly, to progress beyond more event-targeted models and enable long-term probabilistic flood risk assessment, too, a framework for pluvial flood risk inundation assessment based on a climate based emulator of storms was developed.

The developed approach provides a comprehensive, reliable, and flexible framework for evaluating pluvial flood likelihood and inundation hazard impact. The proposed approaches are implemented and validated in a study site (Aotearoa New Zealand – the Wairewa rural catchment). However, they are conceived to be transferable and generalisable to other locations due to their flexible structure. Their adaptability also allows for the integration of climate change considerations. The developed methods are also designed to be interpretable and practically accessible, to be eventually integrated into a flood risk assessment operational framework.



Example of application of the hybrid framework for rapid flood hazard assessment. Result for validation case 168. The first row shows the synthetic storm: the hyetograph $\overline{I}(t)$, the rainfall spatial distribution pattern $S'(x)$, and the total storm rainfall. The second row shows the flood/non-flood prediction model: BG-Flood, RF and the difference between both (indicating the mean Precision, Recall and F1 Score values, and for each location if it was correctly predicted as flooded (blue), correctly predicted as non-flooded (brown), incorrectly predicted as flooded (yellow) or incorrectly predicted as non-flooded (red)). The third row shows the hmax (m) prediction model: BGFlood, RF and the difference between both (indicating the mean RMSE (m), RMSE of flooded locations (simulated as flooded by BG-Flood) (m) and NSE values, the bias (m) for each location (blue colour indicates hmax overestimation and red hmax underestimation by the RF model), and the scatter density plot of the RF hmax versus BG-Flood hmax including all the locations).

Advancing methods of uncertainty estimation in flood inundation modelling using Monte Carlo and machine learning approaches

PhD Project

Martin Nguyen (GRI - UoC)
Matthew Wilson (GRI - UoC)
Emily Lane (Earth Sciences NZ)
James Brasington (Waterways - UoC)
Rose Pearson (Earth Sciences NZ)

Funding
MBIE Endeavour Programme – Increasing Flood Resilience Across Aotearoa through GRI, University of Canterbury

Duration
4 Years

Project summary

Uncertainties inherent in the flood modelling process, especially in the input data, can affect flood predictions, reducing reliability of flood risk management plans. To increase the reliability and contribute to the field, In this project, we quantified two sources of uncertainties in the generation process of Digital Elevation Models (or DEMs), a critical input for flood modelling, using the traditional Monte Carlo framework. Since such uncertainty quantification processes are often excluded from the flood risk assessment owing to being computationally expensive, this project has developed an advanced method for quantifying such uncertainties using a machine learning approach. Bayesian Neural Network (BNN) was used as a potential alternative to using a Multi-Fidelity MC framework for estimating the uncertainty in flood model outputs arising from uncertainties in flood model inputs. Once successfully trained, this method could allow uncertainties to be included as part of flood risk assessments without having to run multiple model realisations.

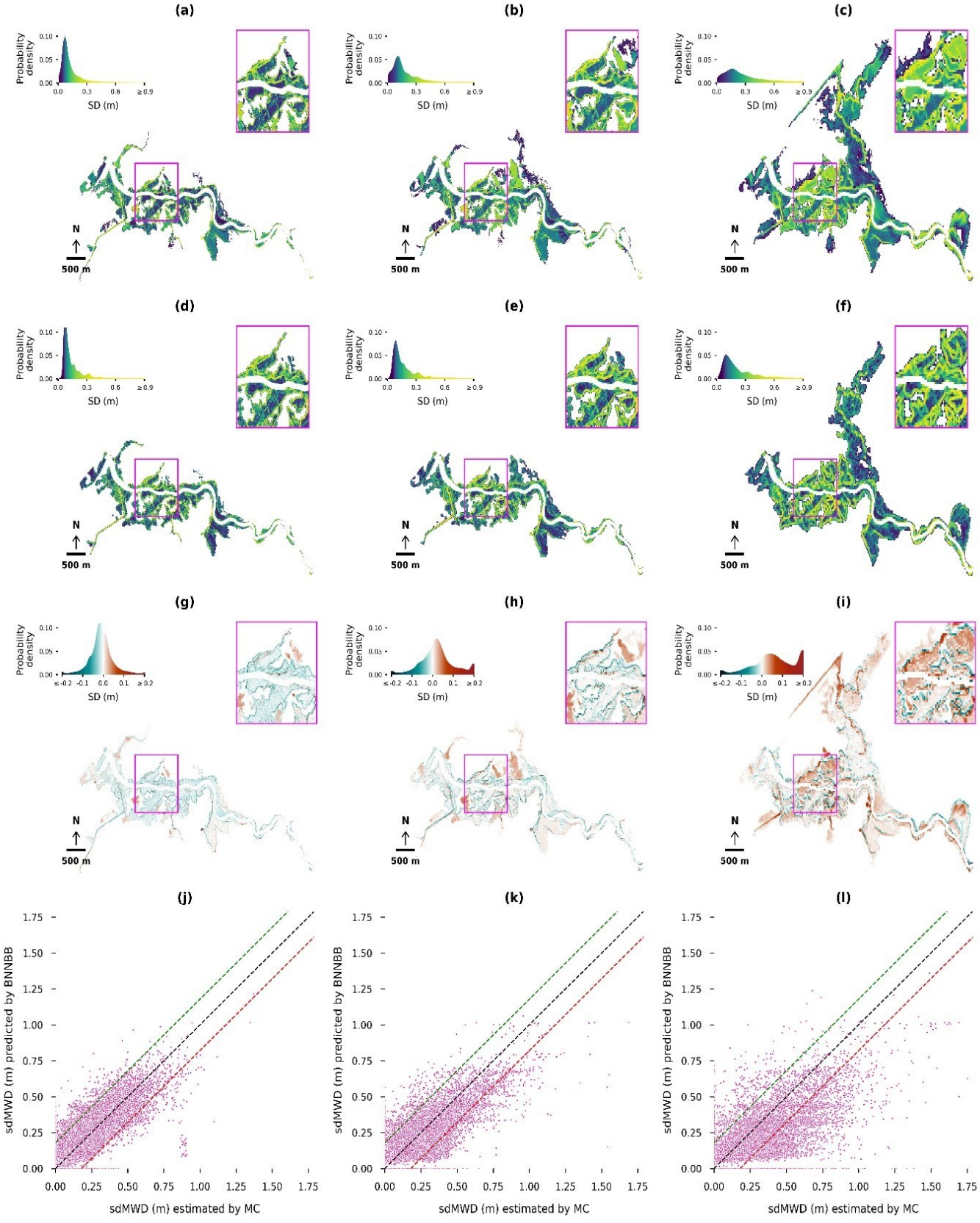
Methods

Monte Carlo framework and Deep learning models

Results

A Bayesian Neural Network has been developed to predict the uncertainty in flood modelling arising from uncertainties in the topographical bathymetric data generation process. we developed three Bayes by Backprop (BNNBB) models: model 1 and 2 used for predicting the pF (pixel was flooded) maps, and model 3 used for predicting the standard deviation of simulated maximum water depth sdMWD maps. The data for the model development were collected through the Monte Carlo (MC) framework from three flood events that occurred in locations around New Zealand. We used these data to train the models on the pixel-by-pixel basis at 10 -m resolution and tested on 5-, 10-, and 20-m resolutions and also used the Transfer Learning Technique (TLT).

More information about this project is available at: 'Estimating uncertainty in flood model outputs using machine learning informed by Monte Carlo analysis' (December 2025). Journal of Hydrology. https://doi.org/10.1016/j.jhydrol.2025.133928



Comparison of maps of the standard deviation of maximum water depths (sdMWD) for the January-2005 flood event occurred at the Waikanae River, Wellington. These maps were estimated by the Monte Carlo framework and predicted by the Bayes Neural Network (BNN) with transfer learning technique. The first, second, and third columns represent sdMWD maps at 5-, 10-, and 20-m resolutions, respectively: (a-c) maps estimated by the MC framework, (d-f) maps predicted by the model BNN, (g-i) difference maps between MC framework and the model BNN, and (j-l) scatterplots of results of these two methods – green and red dash lines are boundaries of over- and under-predictions (difference values are >= -0.1 m and <= 0.1 m), black dash line represents the equality of the MC estimates and predictions from the model BNN.

Geographic Patterns of Parkinson's Disease

PhD Project
Regina Chua (GRI - UoC)
Sinead Moylett (UoC)
Lukáš Marek (GRI GeoHealth Lab - UoC)
Malcolm Campbell (FoH - UoC)
Toni Pitcher (New Zealand Brain Research Institute)
Daniel Myall (New Zealand Brain Research Institute)

Funding
2025 Geospatial Research Institute Scholarship

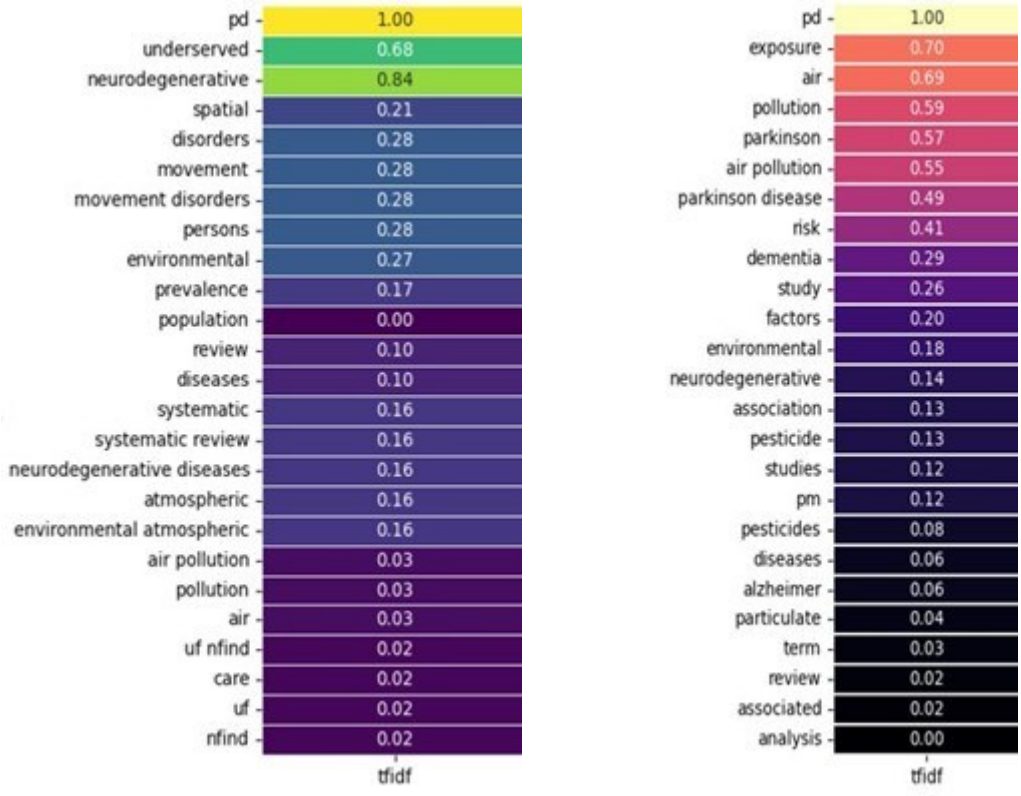
Duration
5 years

Project summary

The spatial epidemiology of neurodegenerative diseases, particularly Parkinson's disease (PD), is an emerging area of research. Geographic variables may influence PD onset and progression, while environmental exposures such as air pollutants (nitrogen dioxide, PM10) and carcinogenic chemicals like trichloroethylene have been implicated in elevated PD risk. However, gaps in spatial data limit our understanding of these associations as well as in long-term health outcomes.

2025 Research Update:

This systematic review synthesises current literature (2020-2025) on geographic and environmental risk factors associated with PD, with a focus on methodological innovation. Studies were identified through a targeted search of PubMed, augmented by a Natural Language Processing (NLP) pipeline using TF-IDF to improve the search and reduce noise.



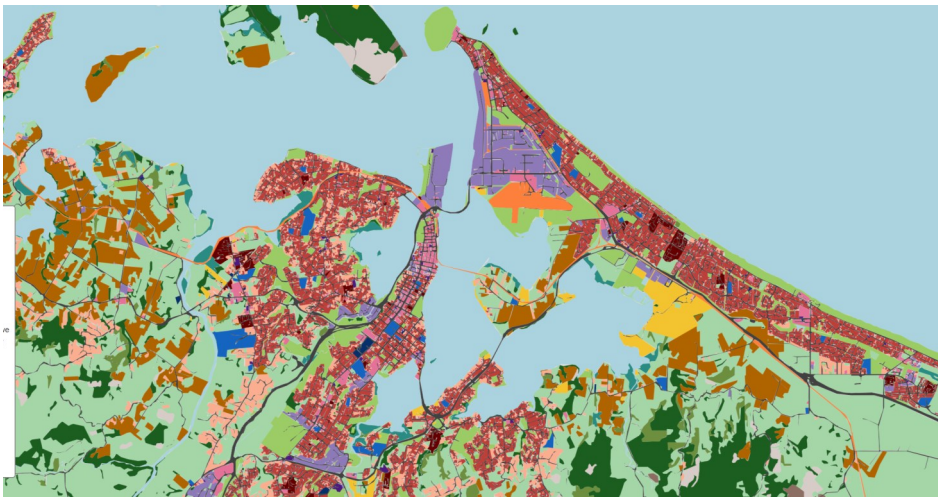
Ranks the importance of a search term using TF-IDF scores of n-gram

Building urban development scenarios into assessments of future flood risk

PhD Project
Katherine Booker (University of Waikato and GRI - UoC)
Iain White (University of Waikato)
Matthew Wilson (GRI - UoC)
Dr. Xinyu Fu (Texas A&M University)

Funding
MBIE-Endeavour fund (2020-2025) National Institute of Water and Atmospheric Research (NIWA).

Duration of the Project
May 2023 – July 2026



Detailed urban land use mapping to support urban growth modelling (Tauranga and surrounding area, 2023)

Summary

Flooding is one of the costliest natural hazards in Aotearoa-New Zealand, and with a warming climate is expected to become more frequent and more severe in the future. The dynamic and uncertain nature of flood hazards creates a fundamental challenge for urban planners, who are also facing intense pressure to fast-track urban development to fix problems of housing affordability. Projections of future flood hazards under alternative climate scenarios are available, but pairing those with current urban form fails to consider how future urban growth will change exposure, whether by new development, intensification, infrastructure investment, or greenspace strategies. In this research, we explore how long-term changes in urban morphologies might be envisioned under alternative future climate and flood scenarios, particularly if different paths for adaptation and mitigation are followed. The goal is to create a robust methodology for generating and then integrating urban futures with flood futures to provide a more comprehensive assessment of the uncertainties and inequalities of future flood risk.

2025 Research Update

A review of urban growth modelling (UGM) literature confirmed that UGM can generate future urban scenarios consistent with climate scenarios to support long-term spatial planning under climate uncertainty. However, the technical promise of UGM does not necessarily indicate its utility for spatial planning. A survey and interviews with Aotearoa-NZ practitioners revealed low awareness of UGM software capabilities, limited ability to use modelling tools, and a lack of advocacy at the institutional level in terms of financial support for modelling. We concluded that stronger direction from central government is required to create a robust methodology for integrating urban and climate futures. Decision-makers need UGM tools developed on a nationally consistent basis, and a mandate for longer-term, multi-scenario, risk-based spatial planning. Testing of UGM for long-term scenario generation is currently underway for a case study area in Aotearoa-NZ. We are investigating practical issues of data availability, spatial scale, temporal accuracy, transferability, and transparency of outputs for potential model users. Fitness-for-purpose for decision-making in planning is essential for UGM to support more flood-resilient planning that balances future development needs against sustainability and future flood risk.

Urban Trees and Housing Intensification: A Spatial Conflict?

PhD Project

David Pedley (GRI - UoC)
Justin Morgenroth (SoF - UoC)
Grant Pearse (Flinders University)
Mijam Schindler (Victoria University)

Funding
GRI Scholarship and UC Doctoral Scholarship

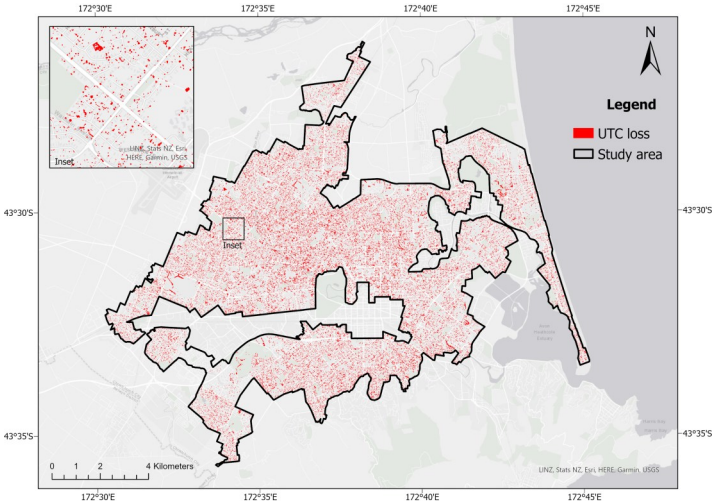
Duration
September 2022 to December 2025

Project Summary

Achieving a sustainable city requires balancing two essential elements: housing and urban trees. The provision of high-quality and affordable housing is necessary to enable occupation by a diversity of residents who contribute to urban vitality. However, without urban trees, would that be a city where people want to live? Urban trees are the epitome of a nature-based solution, providing a wealth of ecosystem services that enhance the liveability of urban areas. The critical sustainability challenge that this project addressed is how to retain the benefits of urban trees within the pressures of intensifying cities.

To investigate this critical tension, this study focused on housing intensification as a key form of redevelopment within compact cities. Due to its higher density nature, housing intensification presents a potential conflict with existing urban trees on private land that compete for valuable real estate. This research examined the nature and scale of this conflict by using a novel combination of high resolution aerial imagery, LiDAR, and deep learning to map tree canopy loss at the property scale across Christchurch, New Zealand over a five-year period (2016-2021). Comparing this loss to verified residential building consent data revealed important findings, including the significant relationship between intensification and tree canopy loss, the variable impact of different intensification forms, and the large proportion of loss that occurred on properties that were not redeveloped. To complement and deepen these empirical findings, online surveys and interviews were used to gather perspectives from key stakeholders that influence change, including property developers and local government. While these perspectives highlighted some commonalities, they also revealed mismatched priorities and preferences that reflect the site-specific financial objectives of property developers and the wider public responsibilities of local government. This tension affects the potential value and viability of regulation and incentives for the retention and replanting of trees during housing intensification projects.

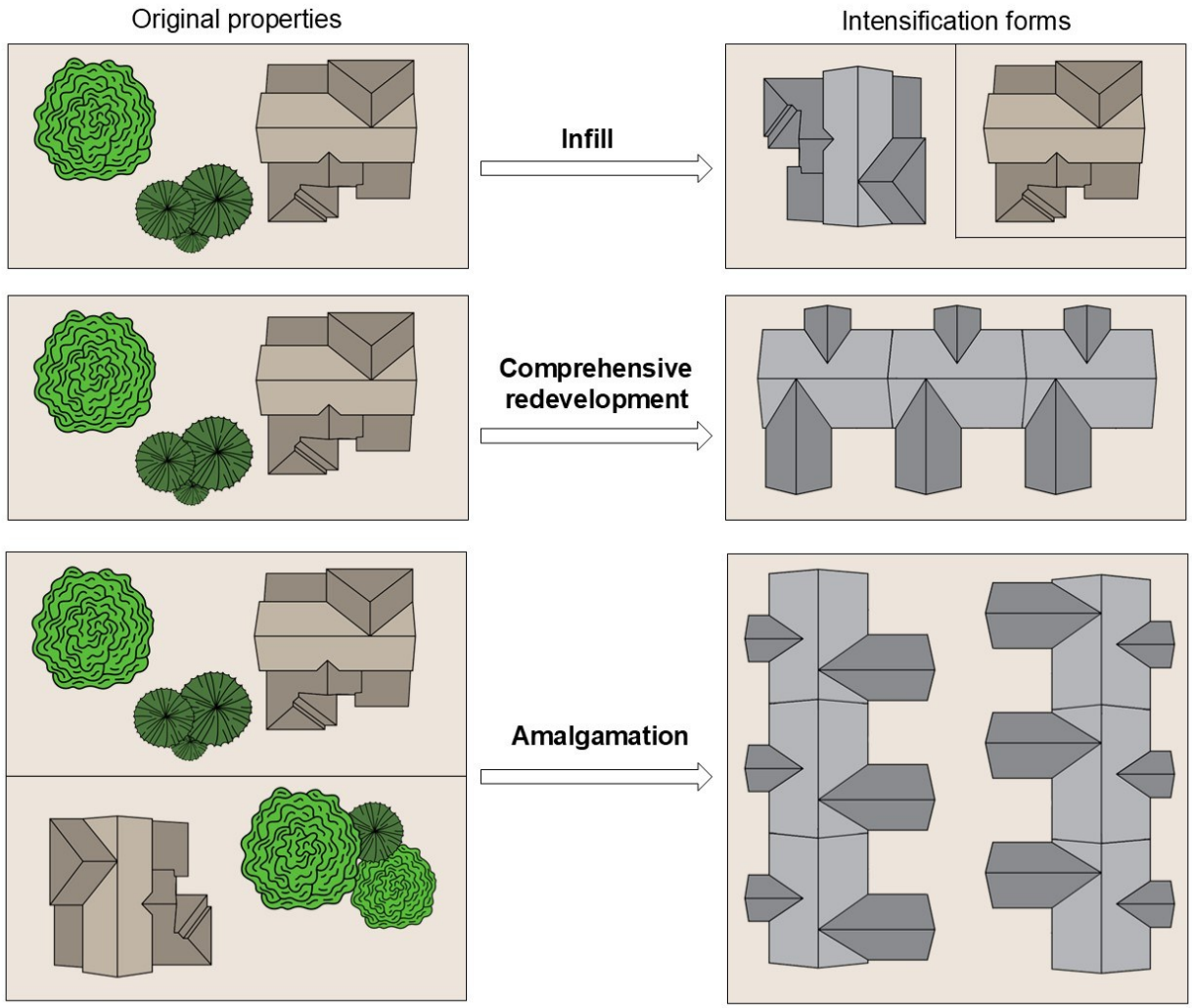
These findings have important implications for policy makers seeking to balance the two critical objectives of housing and urban trees. Although the conflict is real and should not be ignored, oversimplification of the issue risks masking potential solutions. By combining clear regulatory strategies with cost-neutral non-regulatory alternatives, opportunities exist to focus on forms of intensification that achieve housing priorities, whilst supporting improved outcomes for urban trees. While some trade-offs are inevitable, the insights provided by this study help to support more proactive and balanced integration of housing intensification and urban trees within growing cities. The final thesis was submitted in December 2025.



Distribution of tree canopy loss across Christchurch



Accuracy of detected tree canopy loss



Diagrammatic representation of housing intensification forms

Machine Learning Approach for Regional Scale Rock Glaciers Mapping

PhD Project
Sunil Tamang (GRI-UoC)
Shelley MacDonnell (UoC)
James Brasington (UoC)
James Shulmeister (UoC)
Benjamin Aubrey Robson (University of Bergen)

Funding
GRI PhD Scholarship
UC Doctoral Scholarship

Duration of the Project
1 February 2024 to 31 January 2027

Project Summary:

Rock glaciers constitute a critical component of the cryosphere and serve as prominent indicators of permafrost presence in mountainous regions. Accurate and consistent delineation of their spatial extent is essential for advancing research in geomorphology, hydrology, biodiversity, geohazard assessment, and permafrost dynamics.

However, mapping rock glaciers remains challenging for two primary reasons. First, they frequently co-occur with or transition into geomorphologically similar landforms that are difficult to distinguish based solely on spectral characteristics in aerial or satellite imagery. Second, their boundaries are inherently ambiguous and dynamic, influenced by evolving topographic and climatic conditions.

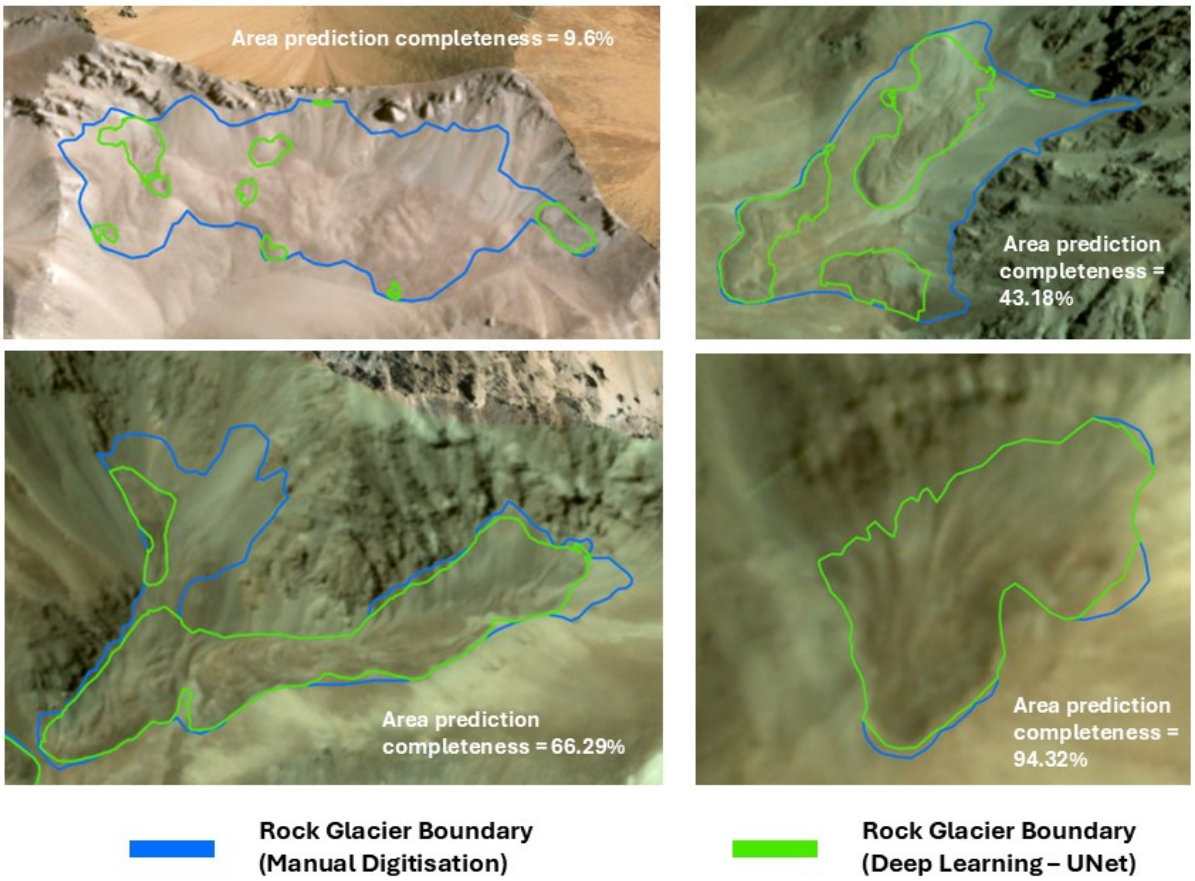
A conventional approach based on manual digitisation through visual interpretation of geomorphological features is both time-intensive and subjective, thereby limiting scalability and consistency across large spatial extents. Recent advances in geospatial technologies demonstrate the potential of deep learning techniques to automate rock glacier detection and delineation. Nevertheless, existing studies have largely overlooked the quantification and analysis of uncertainty associated with these methods. In this context, this PhD research is structured in the following objectives:

RO1: To conduct a comprehensive literature review of remote sensing and automated techniques in rock glacier mapping

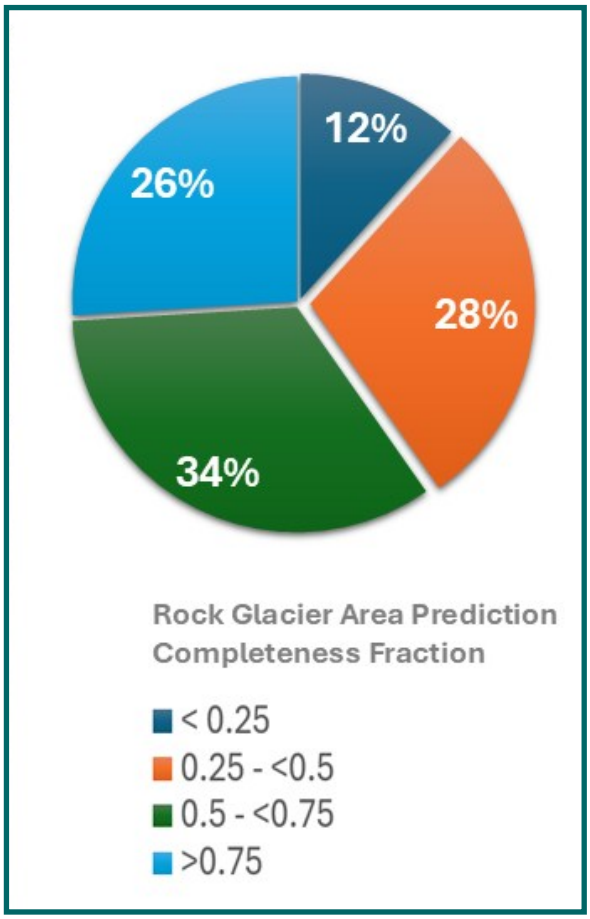
RO2: To evaluate how different methodological decisions in the application of deep learning models influence the accuracy of rock glacier detection and extent delineation.

RO3: To evaluate the application of deep learning models for rock glaciers detection and extent mapping across different mountain regions.

RO4: To develop a conceptual framework for evaluating uncertainty associated with deep learning-based rock glacier mapping.



Deep Learning-based rock glacier extent mapping and associated uncertainty



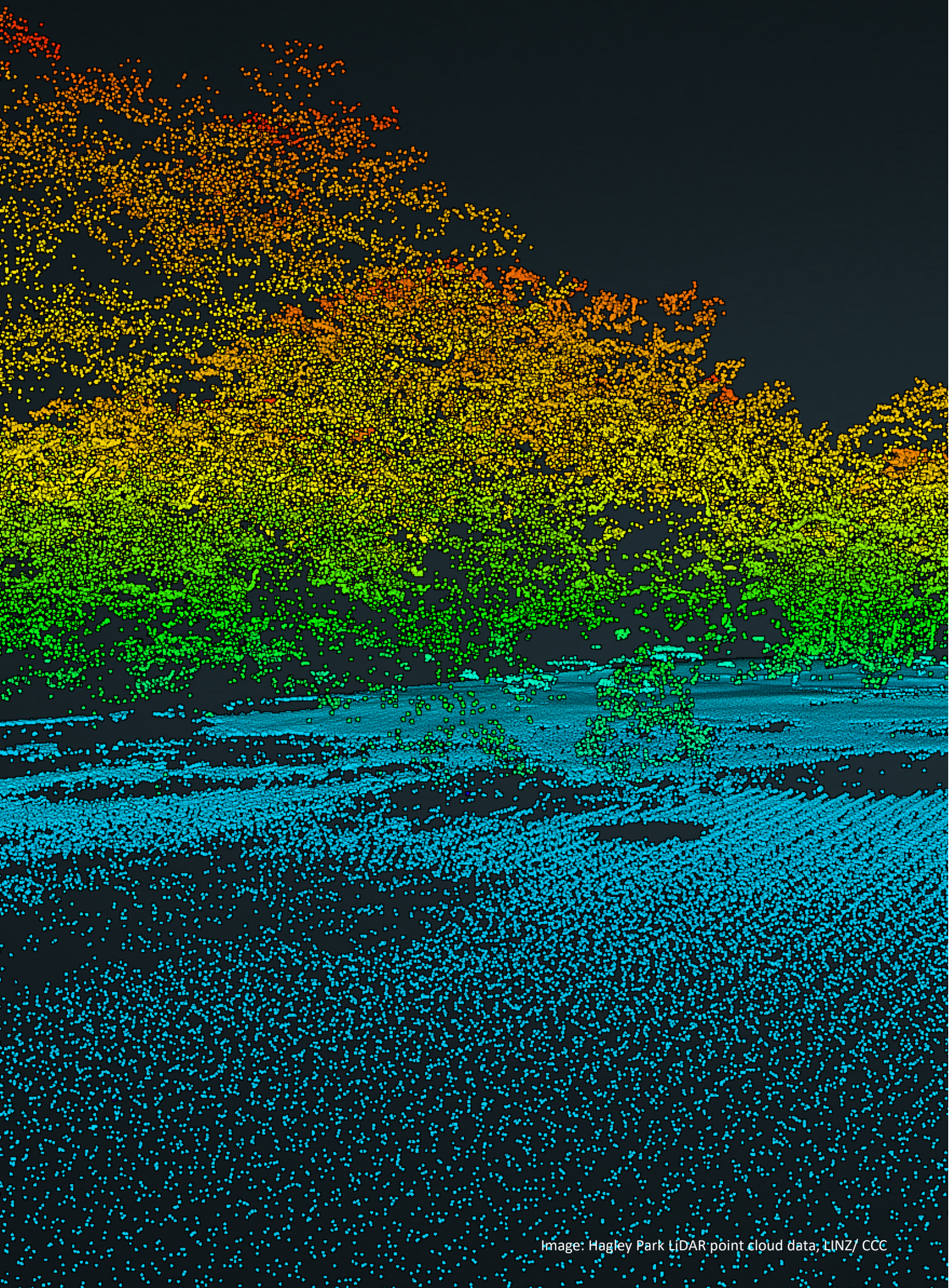


Image: Hagley Park LiDAR point cloud data, LINZ/ CCC

Engagement and Research Dissemination

Geospatial Research Institute Seminar Series

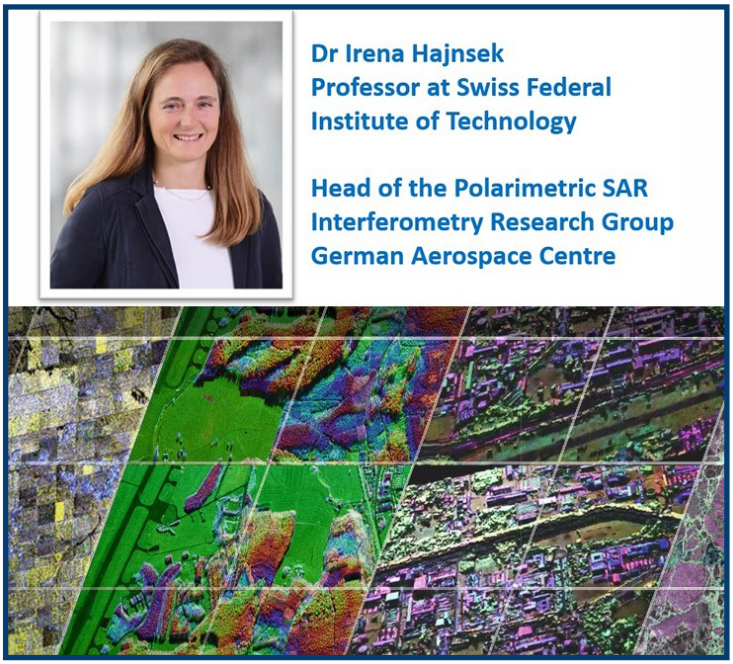


February 2025

Title: ***Geospatial science and health: An overview of the Te Taiwhenua o te Hauora | The GeoHealth Laboratory's impactful research over the past 20 years and what future health challenges will be tackled next.*** In this seminar, Dr Malcom Campbell explored the differences in health and health behaviours by neighbourhood, uncovering some of the underlying reasons for these variations in health.

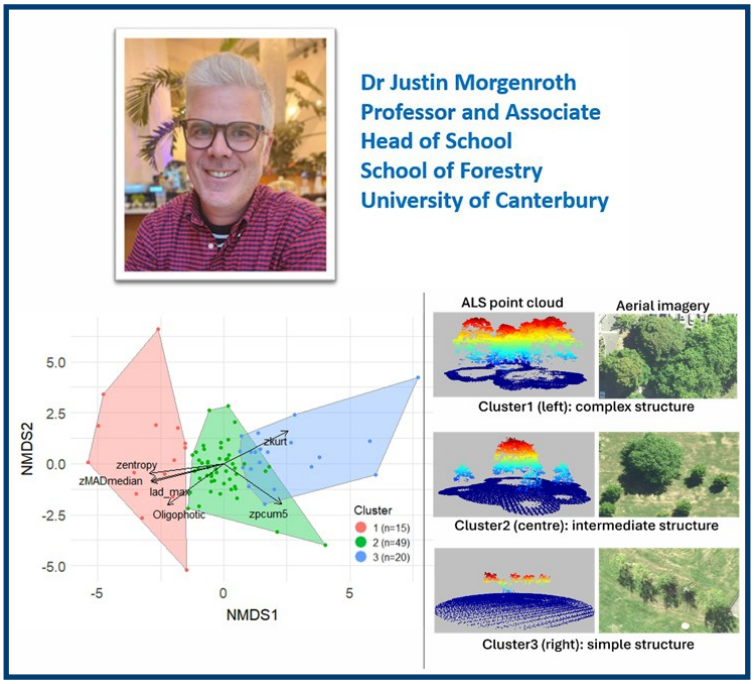
July 2025

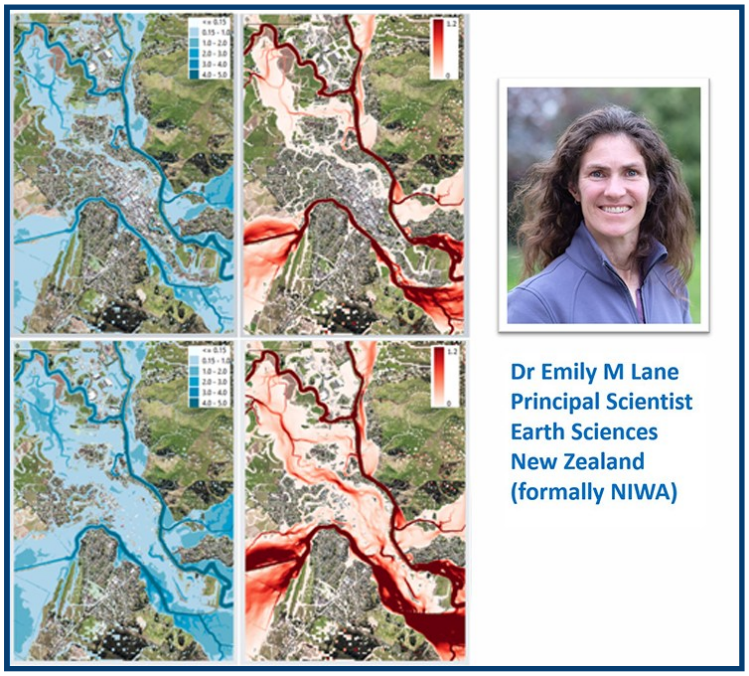
Title: ***Polarimetric and Interferometric SAR for 3D Applications.*** This presentation talked about the Earth surface having a strong dynamic component and how we need innovative remote sensing techniques to capture the changes occurring in our environment.



September 2025

Title: ***Spatial insights for greener cities.*** Dr Morgenroth is interested in understanding urban trees and the critical roles they play in cities around the world. He researches the growth, function, management, and ecosystem services of trees in urban environments.





November 2025

Title: ***Nationally Consistent Flood Hazard and Risk Information for Aotearoa.*** Dr Lane is leading an Endeavour Programme to increase Aotearoa's resilience to flooding by bringing together nationally consistent information on flood hazard and risk.



The Sixth Spatial Data Science Symposium (SDSS) is a biannual world-wide event. **The SDSS** is a distributed, online symposium that brings together participants through a network of hub locations around the world. Attendees are invited to join a local hub, where they can present their work and engage in discussions with fellow participants both in person and online.

The University of Canterbury hosted a local hub on 4–5 December. The event was coordinated by Dr Vanessa Bastos and organised in conjunction with the GRI.

The Symposium provides opportunities for collaboration, presentations, and networking.



Postdoctoral fellow, Phoebe Eggleston *presented Environmental and social determinants of health in New Zealand: A Story-Map".*



Prof Malcolm Campbell *presented "GEOHealth : Real-world application of spatial data science to improve population health and wellbeing"*



***Keynote Speaker**: **Prof Peyman Zawar-Reza** presented"Towards a NeuroSpatial Insight Engine"*

***Postdoctoral fellow, Camila Cesar** presented: "Methane emissions in pasture-based dairy systems in Aotearoa – from satellite and ground estimations."*





***Postdoctoral fellow, Martin Nguyen** presented "Empowering community resilience to climate change through novel flood scenario analytics"*

Adaptation Futures Conference 2025

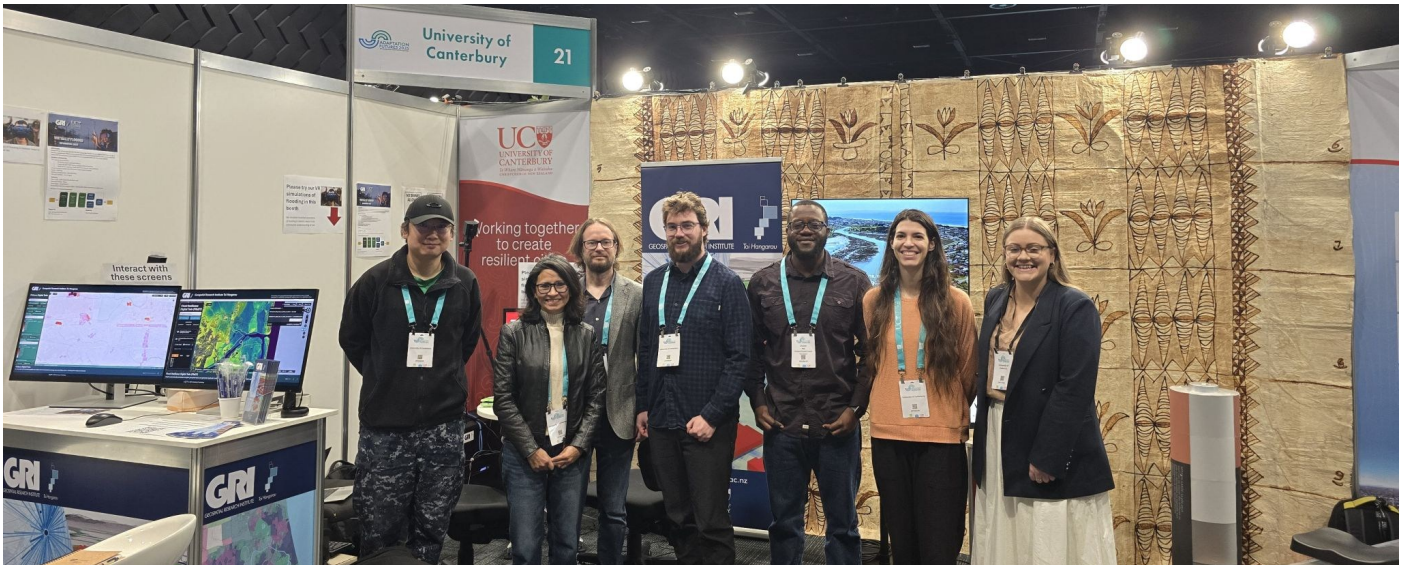


In October 2025, the **GRI** presented their latest research developments at **Adaptation Futures 2025** featuring GRI's work in the adaptation space: flood modelling, web apps for healthy communities assessment, transport carbon emissions scenario planner, the Ōtakaro Digital Twin including predicted pollutant runoff from urban surfaces, and the Flood Resilience Digital Twin which enables automated assessments of flood risk under multiple scenario.

In addition, the institute also presented methods developed for Virtual reality, 3D and 360 visualisations created to help improving perception and decision making towards natural hazards. The geospatial visualisations developed in the GRI, represent modelled flood scenarios in a more engaging, immersive way than maps typically do.



Adaptation Futures Conference 2025 opening ceremony set the scene powerfully - He waka eke noa: we are all in this together.



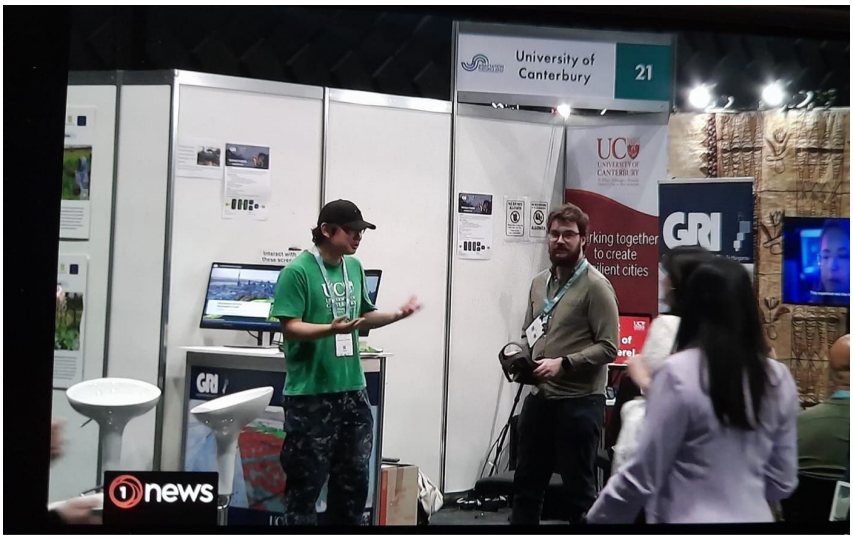
The GRI Team (from L to R) X ander Cai, Maria Vega, Matthew Wison, Luke Parkinson, Clevon Ash, Camila Cesar, and Phoebe Eggleton.



Takiwā—team members Mike Taitoko and Tasman Gillies try out the VR experience.



Prof Matthew Wilson as part of the discussion panel of "enhancing earth observation data for climate adaptation in indigenous communities.



The GRI presence at the UC stand in the conference was part of the 1News of TVNZ. On the first day of the event .

Other conferences and events in 2025

Geospatial Research Institute Director, ***Prof. Matthew Wilson*** *was awarded with the IIT Delhi India-New Zealand Centre Fellowship and visited the Indian Institute of Technology in Delhi, India in March 2025.*



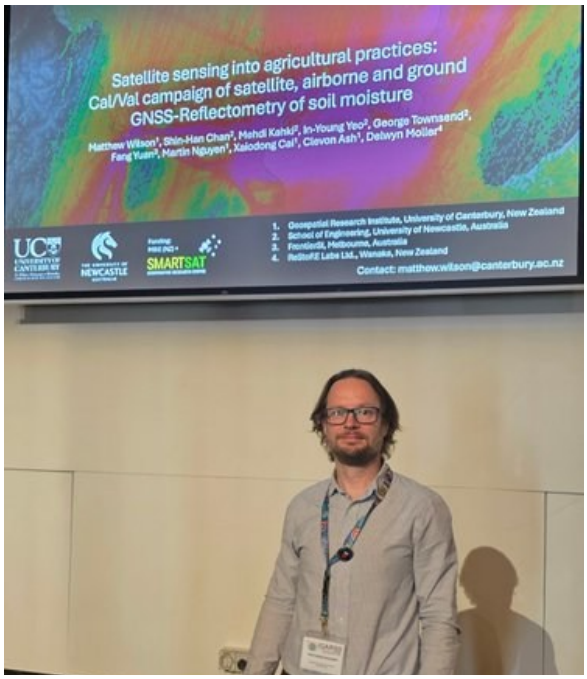






*GRI PhD candidate, **David Pedley** presenting at the **Esri Regional User Conference** held at Christchurch Town Hall. The talk related to the potential conflict between housing intensification and urban tree loss.*





GRI members attended and presented at IGARSS2025, held in Brisbane, Australia.



***Sunil Tamang** presented :"Automating the outline: How accurately can deep learning delineate rock glacier extent?" at the **Waterways Conference 2025,** held at Lincoln University, New Zealand.*

Other conferences and events in 2025



*GRI PhD Scholarship holder **David Pedley** took 2nd place in August in the **Exhibit your Thesis competition** at UC.*



*In September, GRI Postdoctoral Fellow, **Phoebe Eggleton** gave two oral presentations at the **24th European Colloquium on Theoretical and Quantitative Geography #ECTQG2025** in Tallinn, Estonia. She presented two projects - first on a project alongside **Malcolm Campbell Vanessa Brum-Bastos and Lukáš Marek** on mGeoHealth: using mobile phone location data to better understand population health. Second, she presented findings from her recent publication "Investigating the long-term impact of experiencing a major disaster in mid-adulthood on body mass index and waist circumference: A prospective birth cohort study"*

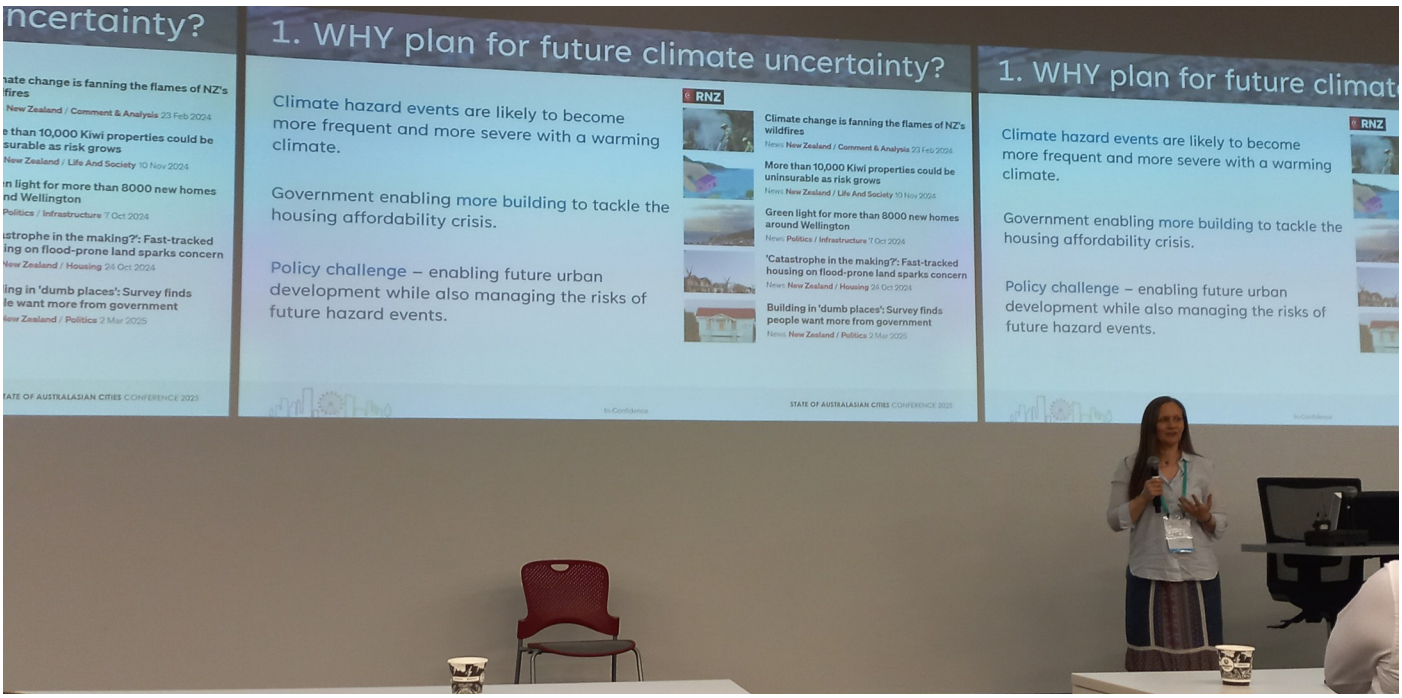




*GRI Director, **Matthew Wilson and** GRI Geospatial and GRI Senior Developer, **Luke Parkinson** gave a talk entitled "Development of open-source digital twins for automated analysis of flood risk" at the **FOSS4G** in November 2025 in Auckland. **Prof Wilson** also presented a second talk on bringing flood model outputs into virtual reality to aid community understanding of the risk of flooding.*



***Prof Malcolm Campbell** presented "From Resident to Reality: Examining static and dynamic environmental exposures in an urban setting using mobile phone location data" at **he 21st Annual International Conference on Urban Health (ICUH 2025)** in November of 2025 in Wellington, New Zealand.*



*PhD Student, **Katherine Booker** presented: "Integrating urban and climate futures: Improving urban growth modelling to plan for future climate uncertainty' at **the State of Australasian Cities Conference** in Brisbane on December 9, 2025.*

Other conferences and events in 2025



The GRI team presented of all ongoing research projects to UC the DVC-R, Lucy Johnston



*PhD students presented at the **EO Lab's Christchurch meet up event**, held at the University of Canterbury*



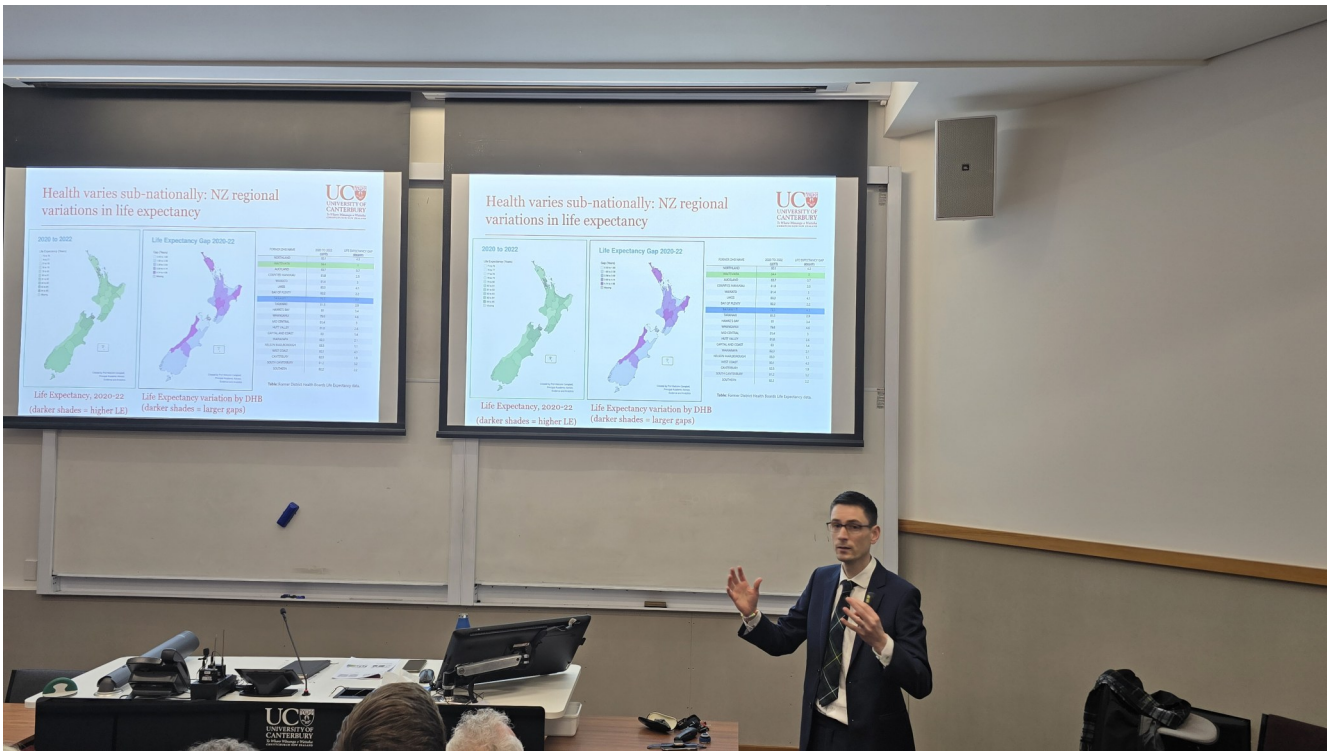
*Workshop at the headquarters of **Ngāti Toa,** in Porirua to discuss project development.*

Professorial Lecture of Prof Malcolm Campbell



On Wednesday 20, August 2025, the Director of the GeoHealth Laboratory and Prof in the School of Earth and Environment gave his professorial lecture:

Where is the geography in health?



The talk focused on explaining why geography matters for health, whether for individuals, communities or whole countries. Professor Campbell used a series of vignettes to illustrate how places, neighbourhoods, and environments are critically important in better understanding why health improves or declines. "*In essence, I will explain why geography matters for our health".*

GRI Publications and Outputs

Publications

Booker, K., White, I., Fu, X. and **Wilson, M.** (2025). Modelling urban growth for long-term planning under future climate uncertainty: A systematic review and decision pathway. Cities, 167, p.106310. https://doi.org/10.1016/j.cities.2025.106310.

Campbell, M., Hobbs, M., Mathias, K., **Eggleton, P.** (2025) An observational study of intergenerational sex differences in mortality in Aotearoa New Zealand. Social Science and Medicine. 373:117947. https://doi:10.1016/j.socscimed.2025.117947.

Campbell, M., Kingham, S. (2025) Best practice urban form for emissions reduction. Carbon neutral neighbourhoods. Building Research Association of New Zealand.

Deng, B., Boden, J., Ye, N., Morgenroth, J., **Campbell, M., Eggleton, P.,** McLeod, G., **Hobbs, M.** (2025) Life in green: Associations between greenspace availability and mental health over the lifecourse – A 40-year prospective birth cohort study. Environment International. 195:109223. https://doi.org/10.1016/j.envint.2024.109223.

Dunn, J., & **Wong, S.** (2025). Language Contact and Population Contact as Sources of Dialect Similarity. Languages, 10(8), 188. https://doi.org/10.3390/languages10080188.

Eggleton, P., Boden, J., Harvet, A., **Deng, B.,** McLeod, G., **Campbell, M., Hobbs, M.** (2025) Investigating the long-term impact of experiencing a major disaster in mid-adulthood on body mass index and waist circumference: A prospective birth cohort study. SSM - Population Health. 30:101781. https://doi.org/10.1016/j.ssmph.2025.101781.

Hobbs, M., Deng, B., Woodward, L.J., **Marek, L., Eggleton, P.,** Boden, J.M. (2025) Examining the association between air pollution exposure (PM10, PM2.5 and NO2) across the lifecourse on behavioural and mental health outcomes in adulthood in the Christchurch Health and Development Study: a prospective birth cohort study. Atmospheric Environment. 362:121553. https://doi.org/10.1016/j.atmosenv.2025.121553.

Hobbs, M., Deng, B., Woodward, L., **Marek, L.,** McLeod, G., Sturman, A., **Kingham, S.,** Ahuriri-Driscoll, A., **Eggleton, P., Campbell, M**. & Boden, J. (2025) Childhood air pollution exposure is related to cognitive, educational and mental health outcomes in childhood and adolescence: A longitudinal birth cohort study. Environ Res. 274:121148. https://doi:10.1016/j.envres.2025.121148.

Hobbs, M., Deng, B., Marek, L., Woodward, L., McLeod, G., Sturman, A., **Kingham, S.,** Ahuriri-Driscoll, A., **Eggleton, P.** and Boden, J., (2025) Childhood air pollution exposure is related to cognitive, educational and mental health outcomes in childhood and adolescence: a longitudinal birth cohort study. J Epidemiol Community Health.

Hobbs, M., Moltchanova, E., **Marek, L.,** Yogeeswaran, K., Milfont, T.L., **Deng, B.,** Sibley, C.G. (2025) Environmental influences on mental health: eight-year longitudinal data show a bi-directional association between residential mobility and mental health outcomes. Health Place. 94:103487. https://doi:10.1016/j.healthplace.2025.103487.

Khan, M. S. I., Vega-Corredor, M. C., & Wilson, M. D. (2025). Mapping Wetlands with High-Resolution Planet SuperDove Satellite Imagery: An Assessment of Machine Learning Models Across the Diverse Waterscapes of New Zealand. Remote Sensing, 17(15), 2626. https://doi.org/10.3390/rs17152626.

Marek, L., Bergler, H.U., Underwood, L., Bullmore, I., Jamieson, H., **Kingham, S.,** Milne, B. (2025) The Impact of Chronic Conditions Among Older Adults on Family and Whānau in Aotearoa New Zealand: A Cross-Sectional Nationwide Study Using Linked Microdata. New Zealand Population Review. 51:59-109.

Marek, L., Wiki, J., Mandic, S., Spence, J. C., Smith, M., García Bengoechea, E., et al. (2025). Access to healthy built and natural environments and physical activity and screen time in New Zealand adolescents: A geospatial cross-sectional study. GeoHealth, 9, e2024GH001101. https://doi.org/10.1029/2024GH001101.

McEwan, E., Stahl, T., Langridge, R., Davies, T., Howell, A., and **Wilson, M.** (2025) Seismic hazard and shifting channels: Exploring coseismic river response. Earth-Science Reviews, 261(105042) https://doi.org/10.1016/j.earscirev.2025.105042.

Nguyen, M., Wilson, M. D., Lane, E. M., Brasington, J., & Pearson, R. A. (2025). Quantifying uncertainty in flood model due to arbitrary conventions in grid alignment.

Water Resources Research, 61, e2024WR038919. https://doi.org/10.1029/2024WR038919.

Nguyen, M., Wilson, M. D., Lane, E. M., Brasington, J., & Pearson, R. A. (2025) Estimating uncertainty in flood model outputs using machine learning informed by Monte Carlo analysis. Journal of Hydrology, Vol 662, Part C. https://doi.org/10.1016/j.jhydrol.2025.133928.

Paynter, J., McIntyre, P., **Wiki, J.,** Nghiem, N, Liu, B., **Marek, L.. & Hobbs. M.** (2025) Using nationwide data to examine the relative effectiveness of Covid-19 vaccination against omicron amongst a population with low prior rates of SARS -CoV-2 infection: A cohort study. Vaccine: X, (24), 100624. https://doi.org/10.1016/j.jvacx.2025.100624.

Pedley, D. & Morgenroth, J. (2025). Detecting and measuring fine-scale urban tree canopy loss with deep learning and remote sensing. ISPRS Open Journal of Photogrammetry and Remote Sensing, 100082. https://doi.org/10.1016/j.ophoto.2025.100082.

Pedley, D. & Morgenroth, J. (2025). Green vs growth: The effect of residential intensification on urban tree canopy loss in Christchurch, New Zealand. Sustainable Cities and Society, 106678. https://doi.org/10.1016/j.scs.2025.106678.

Pozo, A., Wilson, M., Katurji, M., Cagigal, L., Méndez, F.J. and Lane, E. (2025). Characterising Local Flood-Inducing Heavy Rainfall Through Daily Weather Types and Large-Scale Climatic Patterns: Aotearoa New Zealand Study Case. Int J Climatol, 45: e8762. https://doi.org/10.1002/joc.8762.

Puente-Sierra, M., Marek, L., Hobbs, M., & Chambers, T. (2025). A national assessment of the drinking water infrastructure deficit in New Zealand by territorial authority and sociodemographic characteristics. Australasian Journal of Water Resources, 29(1), 35–48. https://doi.org/10.1080/13241583.2025.2481694.

Wallace, T., Crawford-Flett K., **Wilson, M.,** and Logan T. (2025). Computationally Assessing the Effect of Dam Operation on Flood Hazard. Journal of Flood Risk Management 18(3): e70061. https://doi.org/10.1111/jfr3.70061.

Wallace, T., Crawford-Flett, K., **Wilson, M.** and Logan, T. (2025). Investigating the Condition and Flood Effects of Undocumented Levees, A Case Study Within the Waimea Floodplain. J Flood Risk Management, 18(1): e70004. https://doi.org/10.1111/jfr3.70004.

Wong, S. (2025). Stronger together: Unleashing the social impact of hate speech research. Proceedings of the Linguistic Society of America, 10(1), 1-13. https://doi.org/10.3765/plsa.v10i1.5950.

Wong, S., & Li, A. (2025). cantnlp@DravidianLangTech-2025: A Bag-of-Sounds Approach to Multimodal Hate Speech Detection. In B. R. Chakravarthi, R. Priyadharshini, A. K. Madasamy, S. Thavareesan, E. Sherly, S. Rajiakodi, B. Palani, M. Subramanian, S. Cn, & D. Chinnappa (Eds.), Proceedings of the Fifth Workshop on Speech, Vision, and Language Technologies for Dravidian Languages (pp. 543–551). Association for Computational Linguistics. https://aclanthology.org/2025.dravidianlangtech-1.94/.

Conference papers and presentations:

Campbell, M. The 30-Day Map Challenge Atlas. December 16, 2025. doi:10.26021/canterburynz.31045564.

Booker, K., White, I., **Wilson, M.,** & Fu, X. Integrating urban and climate futures: Improving urban growth modelling to plan for future climate uncertainty. State of Australasian Cities Conference. Brisbane, December 9, 2025.

Booker, K., White, I., **Wilson, M.,** & Fu, X. Land use maps for urban growth modelling: informing future flood risk assessment. Sixth Spatial Data Science Symposium. University of Canterbury, December 4, 2025.

Cesar, C., Methane emissions in pasture-based dairy systems in Aotearoa from satellite and ground estimations. Spatial Data Science Symposium 2025. Christchurch, New Zealand, December 4, 2025.

Wong, S. Reddit as a Source for Perceptual Dialectology in New Zealand English. Paper presented at the Linguistic Society of New Zealand Conference, Te Kunenga ki Pūrehuroa | Massey University, Wellington Campus, New Zealand. Nov 27-28, 2025.

Wilson, M., Parkinson, L. Development of open-source digital twins for automated analysis of flood risk. FOSS4G2025, Auckland, NZ. November 17-23, 2025.

Ash C., Wilson M., White I., Hultquist C. Serious games and decision-making with flood risk uncertainty in Aotearoa-NZ. Waterways 2025 Postgraduate Student Conference. Christchurch. November 12, 2025.

Ash C., Wilson M., White I., Hultquist C. Implications of uncertainty in flood hazard assessments for planning under climate change. Endeavour Roadshow 8. Hamilton NZ. October 29-30, 2025.

Tamang, S., MacDonell, S., Brasington, J., Shulmeister, J., and Robson, B.A. Automating the Outline: How Accurately Can Deep Learning Delineate Rock Glacier Extent? Waterways Postgraduate Student Conference. Lincoln University, Christchurch, New Zealand. November 12,

2025.

Booker, K., White, I., **Wilson, M.,** & Fu, X. Building urban growth scenarios into assessments of future flood risk. Science-Practice Roadshow. University of Waikato, October 22, 2025.

Pedley, D. Oral presentation at the International Society of Arboriculture Conference, Christchurch, October 20-22, 2025.

Wilson, M., Parkinson, L., Vega-Corredor, M. Development Empowering community resilience to climate change through novel flood scenario analytics. Shown as an interactive display at the UC booth at Adaptations Futures Christchurch, NZ. October 13-16, 2025.

Wilson, M., Cai, X., Parkinson, L., Vega-Corredor, M. Virtually flooded: Improved risk communication through immersive virtual reality. Shown as an interactive display at the UC booth at Adaptations Futures Christchurch, NZ. October 13-16, 2025.

Tamang, S., MacDonell, S., and Robson, B.A. Earth Observation for Frozen Landscapes: Applications to Rock Glacier Mapping. Earth Observation Lab Aotearoa Meet Up. Christchurch, New Zealand. September 25, 2025.

Campbell, M., da Silva Brum Bastos, V., **Marek, L., Eggleton, P**. mGeoHealth: Using mobile phone location data to better understand population health. Presented at: 24th European Colloquium on Theoretical and Quantitative Geography (ECTQG 2025); September 14, 2025.

Wong, S. Constructing a Sense of Place in Social Media. Abstract presented at the Thirteenth International Conference on Geographic Information Science (GIScience 2025), Christchurch, New Zealand. Aug 26-29, 2025. https://doi.org/10.5281/zenodo.16777132

Wilson, M., Han, S., Khaki, M., Yeo, I., Townsend, G., Yuan, F., **Nguyen, M., Cai. X., Ash, C.,** and Moller, D. Satellite Sensing Into Agricultural Practices: Cal/Val Campaign of Satellite, Airborne and Ground GNSS-Reflectometry of Soil Moisture, IGARSS2025. Brisbane, Australia. August 3-8, 2025. https://doi.org/10.1109/IGARSS55030.2025.11244017.

Wong, S. Locating a Sense of Place on Social Media: A focus on Aotearoa New Zealand. Presentation for the Deputy Vice Chancellor R&I Visit to the Geospatial Research Institute, University of Canterbury. July 23, 2025. https://doi.org/10.6084/m9.figshare.29857097.v1

Cambell, M., Marek, L., Eggleton, P. & da Silva Brum Bastos, V. From Resident to Reality: Examining static and dynamic environmental exposures in an urban setting using mobile phone location data. The 21st Annual International Conference on Urban Health (ICUH 2025). July 1, 2025.

Campbell, M. A Smörgåsbord of applied research with a common health(y) theme. 20 years of GeoHealth Laboratory Research. Institute of Spatial Data Science Seminar Series. May 29, 2025.

Zou, H., Sila-Nowicka, K., **Campbell, M.,** da Silva Brum Bastos, V. Assessing Representativeness and Bias in Mobile Phone Locational Data. Presented at: Thirteenth International Conference on Geographic Information Science (GIScience 2025); May 15, 2025. https://doi:10.5281/zenodo.16886327.

Campbell, M. 20 years of GeoHealth Laboratory Research. A Smörgåsbord of applied research with a common health (y) theme. Platial Lab Seminar. May 2, 2025.

Di Fluri, P., Wilson M., Domeneghetti, A. A new physically-based numerical model to simulate flood triggered oil spills, EGU25. Vienna, Austria. April 27-May 2, 2025. https://doi.org/10.5194/egusphere-egu25-697

Wong, S. Social Media Sociolinguistics: Theory and Application. Invited speaker at League of Linguists Undergraduate Linguistics Student Organisation, University of Illinois Urbana-Champaign. April 3, 2025. https://doi.org/10.6084/m9.figshare.28727204.v1

Pedley, D. Oral presentation at the ESRI Regional Users Conference April 2025.

Wong, S. A Sense of Place in Digital Spaces: The Role of Geography in Social Media Dialectology. Invited speaker at the Virginia Tech Language Sciences (VTLx) Speaker Series, Virginia Polytechnic Institute and State University. Mar 19, 2025. https://doi.org/10.6084/m9.figshare.28639592.v1.

Ash C., Booker K. Ivory V., Reducing the uncertainty when we talk about uncertainty: Understanding and communicating uncertainty at the science-policy interface. Society for Risk Analysis Conference, Melbourne, Australia. February 6-7, 2025.

Ash C., Wilson M. White I., Hultquist C., **Nguyen M.** A Monte Carlo Approach to Representing Flood Risk Uncertainty for Decision-Making. Society for Risk Analysis Conference, Melbourne, Australia. February 6-7, 2025.

Wong, S. Beyond the Variable: Application of NLP in Sociolinguistics Research. Invited speaker at the Computational Psycholinguistics of Listening and Speaking (CPLS) Lab Research Meeting, University of California Santa Barbara. Feb 10, 2025. https://doi.org/10.6084/m9.figshare.28387244.v1.



Word cloud created from journal article and presentation titles.

Team building highlights 2025



End of the year GRI Family BBQ in Spencer Park





Annual GRI Ski Trip





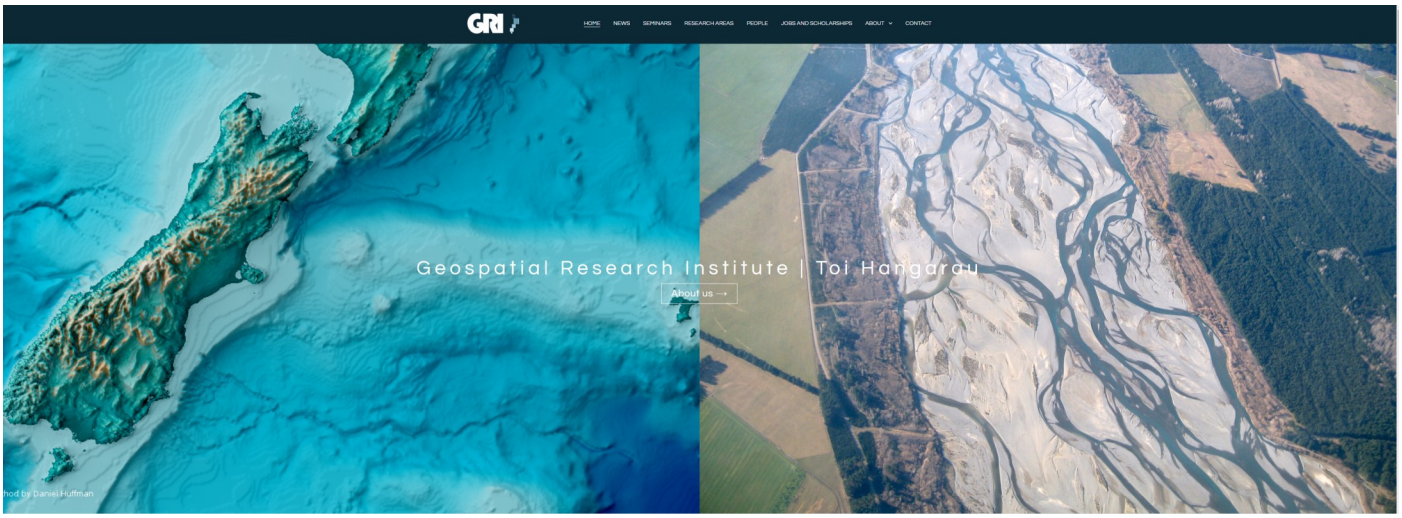
Image: @ David Garcia

Financial Report and Contact

Financial report

Accounts	FY2025
Operating Income	
Government Grants	238,646
Student Tuition Fees	34,674
Other Income	
Research excl PBRF	
Research External Income	689,772
Total	**689,772**
Consulting Income	168,333
Total	**858,105**
Total	**1,131,425**
Operating Expenditure	
Personnel Expenses	752,631
Site and Property Expenses	1,307
General Expenses	94,466
Depreciation	5,965
Overheads	167,914
Total	**1,022,282**
Net Income	109,143
Net Income %	9.6%
EBITDA	115,107

Contact us



Web pages outlining the GRI activities are available at:

https://geospatial.ac.nz

The GRI uses social media to disseminate news and features:

https://www.x.com/GeospatialNZ

https://www.linkedin.com/company/geospatial-research-institute

https://www.facebook.com/geospatialri

https://www.youtube.com/@GeospatialResearch

https://bsky.app/profile/geospatialresearch.bsky.social