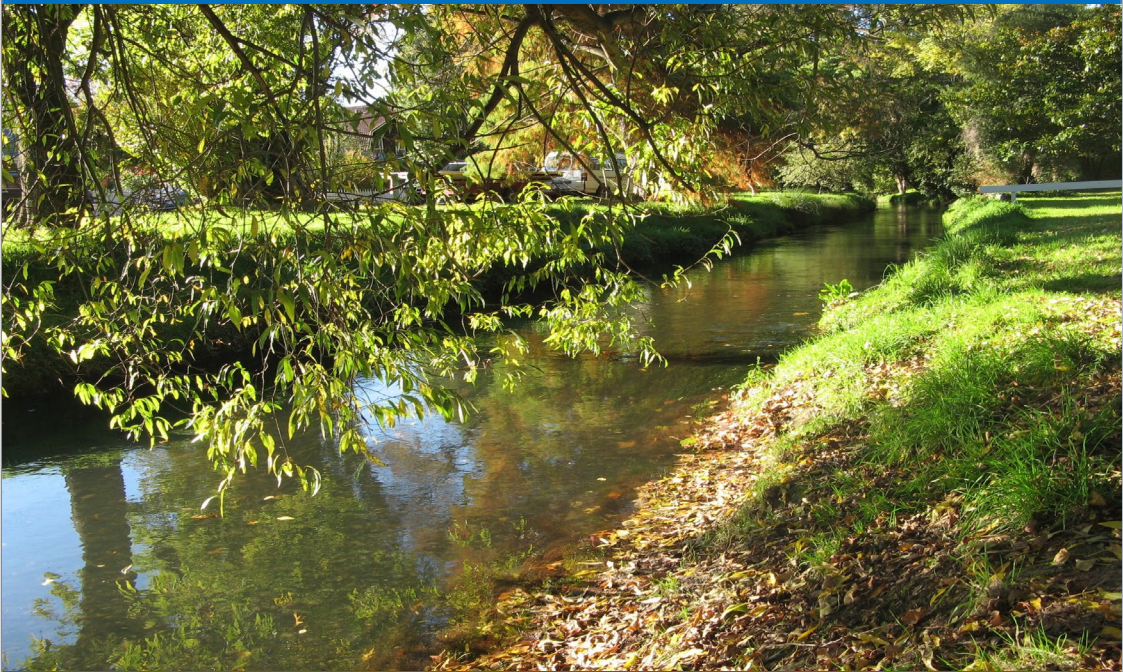


Waterways Postgraduate Student Conference 2019



Tuesday November 19, 2019
Lincoln University,
Christchurch, New Zealand



**LINCOLN
UNIVERSITY**
TE WHARE WĀNAKA O AORAKI



UC
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Te Whare Wānanga o Hōriua
Canterbury University New Zealand

Waterways
Centre for Freshwater Management

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National
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OUR LAND
AND WATER

Toitū te Whenua,
Toiora te Wai



Silver



Bronze



Te Wai Tuku Kiri

Rere, rere, ripo ana, e!
Te wai tuku kiri
Te wai tipua
Te kare maioha e rere nei
Ko koe te wai oraka mo to iwi
Rere, rere, ripo ana, e! (ano)

(Composed by Te Rita Papesch and adapted by Puamiria Parata-Goodall for Te Taumutu Rūnanga)

Translation:

Rippling, flowing, swirling around
Your waters lap upon shores of ancestral land
The waters, challenging waters! Beckoning voices, whistle, whisper, ripple over ripple
You are the life source for your people
[Waihora!] Rippling, flowing, swirling around

(Translated by Hariata Sally McKean. Approved for use by Te Taumutu Rūnanga)



The Waterways Centre for Freshwater Management is a teaching and research centre, jointly supported by the University of Canterbury and Lincoln University. Established in 2009, it aims to improve the knowledge-driven management of freshwater resources by offering a full complement of nationally accredited tertiary courses and actively supporting postgraduate research programmes.



Tēnā koutou, tēnā koutou katoa

The Waterways Centre for Freshwater Management began in 2009 as a partnership between the University of Canterbury and Lincoln University and celebrates its tenth anniversary this year. The Centre's vision was to improve the knowledge-driven management of freshwater resources by offering a full complement of accredited tertiary courses and actively supporting postgraduate research programmes in the freshwater space.

Under the expert guidance of Professor Jenny Webster-Brown and the support of both Universities, the Centre has seen 1394 undergraduates take a Water Resource Management paper, 53 students graduate with a Postgraduate Diploma in Water Resource Management, and another 50 graduate with a Masters of Water Resource Management. Six PhDs have completed, with another six underway. More than 50 academics across both Universities with interest or expertise in freshwater form the Waterways membership, with their postgraduate students having access to Waterways scholarships and support, and presenting at this conference. Many Waterways domestic graduates are working for local council, government, research institutes and consultancies. At the same time, Waterways members, staff and students work to communicate water resource information to the broader community.

With Professor Jenny Webster-Brown moving on after ten years and a new Director starting in 2020, the Waterways Centre enters the new decade with its vision more relevant than ever. Like the puna (springs), awa (streams) and roto (lakes) that we are working so hard to protect, our research findings flow into the world, as our students do in different professional roles, increasing and nourishing the body of knowledge of freshwater management. Thank you Jenny, for ensuring the Waterways purpose endures.

Ngā mihi

The 2019 Waterways Postgraduate Conference Planning Committee

Conference Programme

Time	Presentation	
8:30	Registration	
9:00	Introduction/Mihi Whakatau: Dr Dione Payne , Assistant Vice-Chancellor (Māori and Pasifika)	
9:05	Welcome – Professor Bruce McKenzie , Acting Vice-Chancellor/Tumu Whakarae, Lincoln University	
9:10	Welcome – Professor Cheryl de la Rey , Vice-Chancellor/Tumu Whakarae, University of Canterbury	
9:15	Mapping groundwater discharge into a large coastal lagoon in New Zealand	Katie Coluccio, University of Canterbury
9:30	The Ōtukaikino River: Factors contributing to apparent macroinvertebrate loss	Ariana Painter, University of Canterbury
9:45	Fluid Practices: Examining responses to disruption of everyday water use	Julie Clarke, Lincoln University
10:00	Prevalence of antibiotic-resistant bacteria in surface drinking waters	Deborah Paull, University of Canterbury
10:15	Restoration at a snail's pace? Differences in prey vulnerability to predation have implications for stream restoration.	Bridget White, University of Canterbury
10.30	Morning Tea	
11:00	Impact of riparian saltwater intrusion into a shallow aquifer under sea-level rise	Irene Setiawan, Lincoln University
11:15	N and P removal from wastewater: A novel approach using sequencing batch reactor technology	Parsa Mohajeri, Lincoln University
11:30	Surface water and mahinga kai as vectors of antibiotic resistance	Sophie van Hamelsveld, University of Canterbury
11:45	Assessing impacts of climate change on water resources and agriculture: A case study of Tonle Sap Basin, Cambodia	Sokna Ly, Lincoln University

12:00	Understanding the effects of Eiffelton Irrigation's targeted stream augmentation	Nicole Calder-Steele, University of Canterbury
12:15	Soil hydrology and water quality of a mole-tile drained, zero-order drainage basin in Southland, New Zealand.	Kirstin Duess, Lincoln University
12.30	Lunch; Poster Session	
1:30	Modelling the impacts of groundwater levels and abstraction on flows in the Waikirikiri/Selwyn River	Daniel Clark, University of Canterbury
1:45	What's up there and who eats whom? Macroinvertebrate community composition of South Island alpine tarns	Alexandra Barclay, University of Canterbury
2:00	The 25-27 March flooding event across western South Island: The role of an atmospheric river	Rasool Porhemmat, University of Canterbury
2:15	Negative resistance and resilience: A mesocosm experiment demonstrating consequences for biological recovery in restoration	Isabelle Barrett, University of Canterbury
2:30	Micro-plastic contamination within the Avon/Ōtākaro River, Christchurch, New Zealand	Mitchell Phillips, University of Canterbury
2:45	Coastal city flooding: Are eco-industrial parks a solution?	Suphicha Muangsri, Lincoln University
3:00	Afternoon Tea	
3:30	Access and impact: The spatial effects of off-road vehicles on Greenpark Sands	Johanna Blakely, Lincoln University
3:45	Resilience of tidal wetlands to vertical tectonic displacement and implications for sea level rise	Shane Orchard, University of Canterbury
4:00	Flood 'survivors' becoming 'dependents' under 'victimhood': Narratives of a flood affected community in Kelani riverside in urban Sri Lanka	Unnathi Samaraweera, University of Canterbury
4:15	Rainwater harvesting as a tool to protect urban waterways and to improve stormwater management	Mohamad Odeh, Lincoln University

4:30	The distribution of regionally endemic stream invertebrates, Banks Peninsula, Canterbury	Alice West, University of Canterbury
4:45	Population dynamics of West Coast inanga: Impacts of whitebaiting	Andrew Watson, University of Canterbury
5:00	Drinks and Nibbles; Prize Presentation	

Posters

Poster Title	Presenter
The Storminator™ - a retrofittable, sustainable stormwater treatment solution using waste shells	Sergio Hansen and Julian Maranan, University of Canterbury
Managing the effects of wildfires on freshwater systems, under a regime of climate change.	Cassandra Irvine, University of Canterbury
Shaped by stress: A trait-based meta-analysis of stream communities across stressor gradients in New Zealand	Isabelle Barrett, University of Canterbury
Can biofilms use methane to remove nitrate from nitrate-contaminated freshwater under aerobic conditions?	Emmanuel Egbadon, University of Canterbury
Sediment trace metals as indicators of rural land use change in lake cores in Canterbury and Southland	Lughano Mwenibabu, Lincoln University
A framework to assess the reliability of a multi-purpose reservoir under uncertainty in land use	Anh Nguyen, University of Canterbury
Trade-offs in ecosystem services in the residential red zone in Christchurch with particular focus on flood mitigation	Thuy Nguyen, University of Canterbury
Prevalence of antibiotic-resistant bacteria in surface drinking waters	Deborah Paull, University of Canterbury
Morphology and tidal asymmetry changes in the Avon-Heathcote Estuary	Justin Rogers, University of Canterbury

Development and assessment of a sediment management routine for the Soil and Water Assessment Tool (SWAT)	Jayandra Shrestha, University of Canterbury
Monitoring a recently extended wetland in Christchurch	Fabio Silveira, University of Canterbury
Investigation of the hydraulic connectivity between the Avon River and the Christchurch Aquifer, Christchurch New Zealand	Natasha Simpson and Irene Setiawan University of Canterbury, Lincoln University
What's the attraction? The hold a mussel shell can have over a metal.	Rachel Skews, University of Canterbury
Fostering community engagement with the urban water environment: Why bother?	Rachel Skews and Rachel Teen, University of Canterbury
Towards Water Sensitive Cities: Ingredients for transition	Rachel Teen, University of Canterbury

The 2019 Conference Committee

This year's organizing Committee is:

Julie Clarke	PhD Candidate, Waterways (Chair)
Suellen Knopick	Administrator, Waterways
Sokna Ly	Masters Candidate, Waterways
Lughano Mwenibabu	Masters Candidate, Waterways
Katie Nimmo	Project Manager, Waterways
Mohamad Odeh	Masters Candidate, Waterways
Ariana Painter	Masters Candidate, Waterways
Irene Setiawan	PhD Candidate, Waterways
Rachel Skews	Masters Candidate, Waterways
Rachel Teen	PhD Candidate, Waterways

The MC for the day will be Julie Clarke. Please look for Julie if you have any questions on the programme or housekeeping at the conference.

How to find presenters

Presenters and committee members can be identified by coloured name tags. Presenters are keen to hear your questions and feedback, so please feel free to approach them throughout the day. Also, please let a committee member know if you need any assistance.

Posters

There is a scheduled poster session in the foyer from **12:30 to 1:30 pm** when all poster presenters will be available at their poster for questions and discussion. However, please feel free to approach poster presenters throughout the rest of the day.

The WaterNZ People's Choice Award

Please let us know who you think deserves to win for their outstanding oral presentation. At the end of the day, simply fill in the slip of paper at the back of the book and drop it in the box at the front desk. The winner will be announced during the prize presentation.

Welcome

Professor Bruce McKenzie

BS (Penn State), PhD (Cant), DipAgrSc (Cant)

Tumu Whakarae – Acting Vice-Chancellor, Lincoln University



By training Bruce is a crop and pasture agronomist specialising in crop science, environmental effects on crop growth, computer simulation modelling, water use of crops and pastures.

In 2008 he was appointed Dean of the Faculty of Agriculture and Life Sciences at Lincoln University.

In July 2016 he became the Chief Academic Officer. He was responsible for the three university faculties (Agriculture and Life Sciences, Agri-Commerce, and Environment, Society and Design), Library, Teaching and Learning, and the University Studies and English language Division.

In April 2018, Bruce was appointed Deputy Vice-Chancellor and in January 2019 was promoted to Acting Vice-Chancellor.

Welcome

Professor Cheryl de la Rey

Tumu Whakarae –Vice-Chancellor, University of Canterbury



Professor Cheryl de la Rey has been the Vice-Chancellor of the University of Canterbury since February 2019. Prior to moving to New Zealand, Professor de la Rey was Vice-Chancellor and Principal of South Africa's largest university, the University of Pretoria.

She has 18 years of experience as an executive in higher education. After an academic career in South Africa's university sector, she took up her first executive role as executive director at the National Research Foundation. Later she was appointed Deputy Vice-Chancellor at the University of Cape Town and was the CEO of the Council on Higher Education.

Over the years Professor de la Rey has also served on a number of national and international committees and boards. She was vice-chairperson of the Council of the Association of Commonwealth Universities and was the founding co-chairperson of the Australia-Africa Universities Network and the South Africa-Japan Universities Forum. She was a board member of the International Council for Science, the University Social Responsibility Network and vice-chairperson of the Talloires Network, an international association of institutions committed to strengthening the civic roles and social responsibilities of higher education.

Oral Presentation Abstracts

Mapping groundwater discharge into a large coastal lagoon in New Zealand



Katie Coluccio, PhD Candidate

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Supervisors: Leanne Morgan,
Marwan Katurji, UC;
Fouad Alkhaier, ECAN;
Isaac Santos, SCU

The overall aim of this study was to identify the spatial distribution of groundwater seepage into Te Waihora/Lake Ellesmere, a large (200 km²), shallow coastal lagoon in Canterbury, New Zealand. This lagoon holds important ecological, cultural and recreational value, yet has suffered from significant water quality decline in recent decades.

This study combined broad-scale methods to qualitatively map groundwater inflow into the lagoon. An airborne thermal infrared imaging survey was flown over the lagoon during summer to identify relative cool patches indicating groundwater inflow. This dataset was compared with high spatial resolution observations of radon-222 (a natural groundwater tracer), conductivity, temperature, and dissolved oxygen.

We found areas of groundwater seepage into Te Waihora at locations previously identified, as well as areas not known before this study. The data identified both point-source springs and diffuse seepage along the shoreline. This initial broad-scale survey of seepage into the lagoon revealed groundwater inflow in locations previously thought to be unlikely. This dataset will allow for follow-up work to improve the estimate of the groundwater proportion of the lagoon's water budget in light of identifying these new seepage locations.

Here we demonstrate the successful use of broad-scale methods for identifying the spatial distribution of groundwater discharge into a large coastal waterbody. The combination of methods builds confidence in interpretations and allows us to identify anomalies unrelated to groundwater seepage.

Research/Career Interests:

- Research, teaching, consulting
- Applied hydrology

The Ōtukaikino River: Factors contributing to apparent macroinvertebrate loss



Ariana Painter, Masters Candidate

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Supervisors: Jenny Webster-Brown, UC;
Michele Stevenson, ECAN

The Ōtukaikino River catchment, located just north of Christchurch, typically has the best water quality and stream health in the greater Christchurch area, and in fact won New Zealand's 2018 Most Improved River award. However, the absence of stoneflies from CCC surveys in 2017, indicates that aquatic invertebrates that are sensitive to pollution may be impacted in this catchment. This is of concern because the Ōtukaikino is the last remaining stronghold of some of the more sensitive aquatic taxa in this region.

This research aims to determine potential sources of pollution and habitat limitation, both current and historical, in the Ōtukaikino River catchment that may be related to the decline of a sensitive macroinvertebrate taxa. If identified, remediation options and targets will be recommended. Seven sites across the catchment are being monitored under different flow conditions for a range of physiochemical parameters - including nutrients, turbidity, trace metals, E. coli and major ions - supported by sediment analysis, invertebrate identification and ecological health assessment. GIS is being used to investigate short- and long-term land use change.

Results to date indicate that overall stream ecological health is good, and stoneflies have been observed (in low numbers) at several sites in the upper catchment. However, regular water quality sampling has identified some parameters of potential concern, including nitrates and E. coli.

Research/Career Interests:

- Freshwater management
- Aquatic ecology
- Stream rehabilitation

Fluid Practices: Examining responses to disruption of everyday water use



Julie Clarke, PhD Candidate

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Supervisors: Suzanne Vallance, LU
Ed Challies, UC

If water is a scarce and precious resource, how might we go about reducing our demand for it? One widely adopted yet largely unsuccessful approach is based on behavioural economics and targets rational consumers' attitudes, behaviour and choices. Individual responsibility is assumed to be key. In contrast, Social Practice Theory takes an holistic view and regards resource consumption as a consequence of performing social practices. Responsibility is dispersed and collective, rather than an individual burden.

For example, in the social practice of gardening, water is consumed. But, in addition to the individual who gardens, other elements must combine in a particular way for this practice to be performed. Such elements may relate to materials, competences or meanings. It is the practice itself, linking together elements within wider society, that results in resource consumption, rather than the individual who performs it.

In order to better understand our everyday water use practices, my study used the lens of disruption to illuminate some of our motivations. My findings indicate that our relationships, emotions and senses influence our water use in both subtle and profound ways. Furthermore, when one element of practice is changed, the others must accommodate or also change in order for the "new" practice to persist.

Policy approaches to reducing demand should therefore be based on a dispersed and collective responsibility for resource use, and holistically integrate water and non-water policies.

Research/Career Interests:

- Socio-hydrology
- Sustainable resource use
- Waste minimization
- Water footprints
- Community engagement

Prevalence of antibiotic resistant bacteria in surface drinking waters



Deborah Paull, Masters Candidate

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Supervisors: Jack Heinemann, UC

Antibiotic resistant bacteria are being found with alarming regularity in New Zealand's surface waters. These waters are used by livestock, irrigation and drinking water. There is increasing concern over the impact of antibiotic resistant bacteria on human health. The role of the environment as a source of antibiotic resistance has been widely acknowledged.

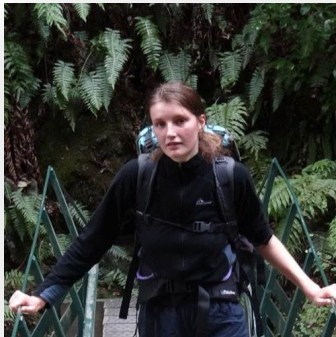
My research involves conducting a survey of drinking water that is sourced from streams and rivers, with a focus on isolations of the indicator bacterium *Escherichia coli*, and establishing a baseline survey of resistances to antibiotics. Resistant bacteria will then be tested for level of resistance, number of resistance genes and potential for horizontal gene transfer. Results from some preliminary testing around the Canterbury and Marlborough regions have shown *E. coli* counts above the safe drinking water limit, and antibiotic resistance levels that complicate or preclude antibiotic treatment. I will report on the kinds of drug resistances I have found even in water entering residential homes.

The implications of this research are important because although surface and drinking water is frequently tested, there is a significant proportion of water sources that remain untested and unregulated. By 2050, the World Health Organisation predicts that antibiotic resistance will pose a greater risk to human health than cancer. This highlights the importance of minimising the role that the environment plays in contributing to antibiotic resistance.

Research/Career Interests:

- Molecular and microbiology
- Bio-engineering and protein science

Restoration at a snail's pace? Differences in prey vulnerability to predation have implications for stream restoration



Bridget White, BSc(Hons)

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Supervisors: Angus McIntosh,
Helen Warburton, UC

Food web properties in degraded stream communities may increase their resistance and resilience to the successful reinvasion of desired taxa after physical restoration, resulting in restoration failure. Degraded streams in New Zealand are often dominated by protected prey, such as freshwater snails, which are less vulnerable to predation than desired taxa such as mayflies. Therefore, recolonizing vulnerable taxa may be preferentially predated, limiting restoration success. Vulnerable prey may modify behaviours in the presence of protected prey e.g. changing feeding behaviour, leading to long term decreased prey fitness.

Using stream mesocosms, we investigated how differences in prey vulnerability to predation could impact restoration success. Different densities of protected *Potamopyrgus antipodarum* and vulnerable *Deleatidium* spp. were added to stream mesocosms alongside upland bullies, for 24 hours. We calculated consumption-based interaction strengths, and observed prey behaviour. Interaction strengths were stronger between *Deleatidium* and fish when fewer *Deleatidium* were present, and less total prey biomass was consumed when higher relative densities of protected prey to vulnerable prey were present. A minimum density of *Deleatidium* may therefore be required to re-establish in degraded communities containing fish. High snail densities modified *Deleatidium* behaviour so they appeared less on surfaces, which could lead to long term fitness reductions. Decreased fitness levels could reduce colonization success of vulnerable biota, preventing the biotic restoration of abiotically restored streams. Therefore, degraded community structure should be considered in stream restoration planning.

Research/Career Interests:

- Community ecology
- Stream restoration
- Negative resistance and resilience

Impact of riparian saltwater intrusion into a shallow aquifer under sea-level rise



Irene Setiawan, PhD Candidate

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Supervisors: Crile Doscher,
Leanne Morgan, LU

Incoming tides in coastal rivers are a source of saltwater, which can contaminate adjacent shallow aquifers through saltwater intrusion (SI). Under climate change driven sea-level rise (SLR), seawater would advance further upstream within the river, increasing the risk for riparian SI. This phenomenon can cause loss of freshwater supply, damage to municipal infrastructure, and vegetation death due to soil salinization, which is detrimental to agriculture and reserve management. This study is motivated by a need to better understand riparian SI and how it might change under SLR.

This study draws on the Christchurch shallow aquifer adjoining the Avon River as a case study and proposes to: (i) identify areas of greatest riparian SI vulnerability in the aquifer under current and SLR conditions using a GIS-based method, (ii) determine the real-world occurrence and spatial-temporal variation of riparian SI through field measurements, and (iii) simulate how riparian SI would occur under SLR.

Research/Career Interests:

- Sustainable groundwater management
- Climate change resilience
- Surface water – groundwater interaction

N and P removal from wastewater: A novel approach using sequencing batch reactor technology



Parsa Mohajeri, PhD Candidate

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Supervisors: Carol Smith, Henry Chau,
Niklas Lehto, LU

The agriculture sector has many challenges: how to produce food and fibre in a sustainable way to feed a growing global population, and also mitigate negative impacts on the environment. How can we protect the environment, while producing food and fibre in a sustainable way? Discharge of different contaminants from agricultural, industrial and residential sources threatens the surrounding environment and ecosystems. One of the biggest environmental issues facing New Zealand is phosphorus (P) and nitrate (N) contamination of freshwater.

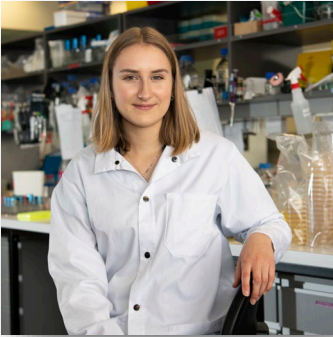
The batch reactor is one of the most popular methods of treatment used for treating wastewaters containing agricultural nutrients. This research investigated the treatment of agricultural wastewater by developing and adding a novel media (ALLODUST) to a single batch reactor. ALLODUST consists of two types of Allophanic soil, bio-wastes, silica powder, and a binder. The response surface methodology and central composite design were used as numerical and mathematical tools.

The results indicated that the ALLODUST achieved a high P and N removal capacity in a low contact time and energy use. The wastewater treatment system is optimized for the different ranges of the P and N contamination up to 300 mg/l for phosphorus and 110 mg/l for the nitrate. The optimum sorbent dosage of 3 g/l removed up to 100% of the P from 50 mg/l solutions in 30 min at the lowest aeration rate and 76% of the P from 300 mg/l solutions in the 450 min at the highest aeration rate. Also, 5.8 g/l of ALLODUST could remove almost 85-91% of the nitrate up to 110 mg/l with a significant drop in N₂O emission comparing to the activated sludge process.

Research/Career Interests:

- Environmental Engineering
- Geo-Environmental Engineering
- Water and Wastewater Treatment
- Environmental Sciences
- Contaminated Lands

Surface water and mahinga kai as vectors of antibiotic resistance



Sophie van Hamelsveld, PhD Candidate

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Supervisors: Jack A. Heinemann, UC;
William Godsoe, LU;
Gayle C. Ferguson

New Zealanders have a strong affinity for surface water and demand high environmental standards to allow its use for food production and recreation. Unfortunately, these standards are not always met. We aim to establish and monitor the levels of the fecal indicator *Escherichia coli* in Canterbury waterways. We chose *E. coli* because some strains are human pathogens, and its presence is correlated with other bacteria, like *Campylobacter*. Furthermore, *E. coli* is a sentinel for detecting increases in antibiotic resistance.

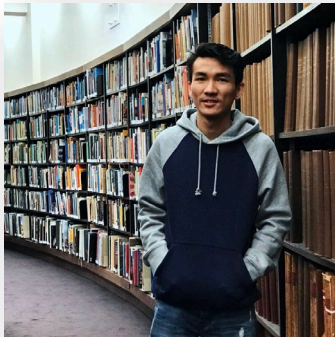
Initially, we quantified antibiotic resistance among *E. coli* in Ōtākaro/Avon River. The Ōtākaro is used for recreation and food harvesting. We have also been researching the potential for aquatic mahinga kai to serve as vectors of drug resistance. We isolate *E. coli* from water and food samples and perform antibiotic minimum inhibitory concentration testing. We use whole genome sequencing to find antibiotic resistance genes in our isolates. In most water samples, there were 10-1000 *E. coli* per 100ml.

A high prevalence of multiple drug resistance was observed. These phenotypes confirm the antibiotic resistance genes found in the whole genome sequences. The numbers of *E. coli* in our samples class these waterways as unsafe for skin contact. We have also detected *E. coli* in stream-grown watercress, making this mahinga kai a potential vector to transfer drug resistant *E. coli* to humans, but these data are preliminary.

Research/Career Interests:

- Environmental antibiotic resistance,
- Antibiotic longevity,
- Safe freshwater access

Assessing impacts of climate change on water resources and agriculture: A case study of Tonle Sap Basin, Cambodia



Sokna Ly, Masters Candidate

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Supervisors: Crile Doscher,
Geoffrey Kerr, LU

Cambodia's Tonle Sap Lake is the largest permanent freshwater body not just in Cambodia, but in Southeast Asia and also one of the world's richest lacustrine-wetland ecosystems. Agriculture and fisheries provide the primary livelihoods of approximately 4.9 million people (in 2019) living in the area. Despite a high abundance of natural resource, the area around Tonle Sap Lake is known to be one of the poorest spots in Cambodia with over a million people in the immediate surroundings of the lake living on US\$ 0.41 per person per day (in 1999), most of whom derive their livelihoods directly from the resources provided by the lake. This condition has placed them in a vulnerable position when the lake is under the threats of climate change.

This study aims to assess the impacts caused by climate change on water resources in the basin and quantify the total affected rice growing areas that are dependent on surface water and flood irrigation. The result is then translated into the likely economic implications. Preliminary findings show the amount of runoff in the basin will decline under the projected climate change scenarios. This shortage in runoff will then have further effects on both water availability and agricultural production in the area.

Research/Career Interests:

- Hydrologic / Hydraulic Modelling
- Imagery Analysis
- Agricultural Water under Climate Change

Understanding the effects of Eiffelton Irrigation's targeted stream augmentation



Nicole Calder-Steele, Masters Candidate

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Supervisors: Jenny Webster-Brown,
Ed Challies, UC
Adrian Meredith, ECAN

Eiffelton Community Group Irrigation Scheme (ECGIS) is a small owner-operated irrigation scheme located near the Canterbury coast near Ashburton. ECGIS operates using targeted stream augmentation, where deep groundwater is pumped from bores into surface drainage channels, which then transport the water to scheme members. Though the scheme has been operational for 30 years, its operational effects have never been quantified.

Aim: To understand operational effects of ECGIS on Windermere Drain, the largest and centremost drain used by ECGIS.

Methods: To understand the effects of targeted stream augmentation a field programme of groundwater and surface water quality and quantity monitoring was undertaken. Data was collected from March 2018 to April 2019. Monthly sample runs were conducted to collect water quality samples, undertake stream gaugings, and take groundwater level measurements.

Results: Results suggested that ECGIS operation has maintained Windermere Drain discharge at a rate typically greater than that experienced before augmentation commenced. They also suggest that without this augmentation, Windermere Drain would flow intermittently. This is consistent with trends seen in non-augmented drains.

Research/Career Interests:

- Science and Management

Soil hydrology and water quality of a mole-tile drained, zero-order drainage basin in Southland, New Zealand



Kirstin Deuss, PhD Candidate

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Supervisors: Peter Almond, Henry Chau,
Crile Doscher, Carol Smith, LU;
Sam Carrick, Manaaki Whenua

Information about the processes and controls involved in soil hydrological response is fundamental to forecasting land-use impacts on soil health, water quality and catchment hydrology. Decision making around natural resource management in New Zealand relies on measured data and modelled representations of the soil-water system. Currently, the S-Map soil spatial information system provides the most finely resolved and widely distributed data on soil hydraulic properties.

A research gap exists around the hydrological and environmental response of soils to artificial subsurface drainage, a practice widespread in Southland. At present, S-map does not account for potential variation in soil properties due to land drainage practices. This research aims to evaluate the local and catchment-integrated effects of mole-tile drainage on hydrology and water quality in a zero-order drainage basin.

A 4-hectare drainage basin was instrumented on a sheep farm in Otahuti, Southland. Mole channels have been mapped, and profile-scale hydraulic properties have been derived from soil measurements and sampling. Catchment-scale soil properties such as field capacity and saturated hydraulic conductivity will be estimated through modelling of components of the water balance. Data will be used to test if a modified pedotransfer function approach can derive soil hydraulic parameters representative of the mole-tile drained system. Sampling of overland and tile flow will be used to monitor temporal responses of nutrient, sediment and pathogen loads to rainfall events and antecedent conditions. Outcomes will be considered in the context of regional soil hydrology and water quality.

Research/Career Interests:

- Soil & freshwater management
- Ecosystem services
- Pedology & soil mapping

Modelling the impacts of groundwater levels and abstraction on flows in the Waikirikiri/ Selwyn River



Daniel Clark, Masters Candidate

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Supervisors: Leanne Morgan, UC;
Tim Davie, ECAN;
Julian Weir, Aqualinc

The Waikirikiri/ Selwyn River is a hill-fed braided river which crosses the Canterbury Plains. As it flows across the plains it interacts with the groundwater, generally losing flow to groundwater in the upper plains and gaining from groundwater as it approaches Te Waihora/ Lake Ellesmere. The flows that emerge in the lower Waikirikiri are dependent on the surrounding groundwater levels.

In recent years, flows in the Waikirikiri have dropped to the lowest levels since flows have been recorded at Coes Ford. This dry period generated a lot of public interest and concern about the causes of the low flows. The question of whether this was caused by climate or abstraction was discussed at length.

I aim to simulate the impact of changing groundwater levels on surface flows in the Waikirikiri. To do this I am developing a numerical model which captures the hydrological and geological characteristics of the catchment. This involves representing the physical processes in the catchment in a 3D numerical simplification. The model builds on existing work within the catchment and includes surface water bodies, aquifers and geological formations. Measured climatic information and consented water abstractions are being used to ensure that these components are accurately captured, as they are key drivers of groundwater level and flow in the lower Waikirikiri.

Research/Career Interests:

- Surface water/ groundwater interaction
- Hydrological modelling

What's up there and who eats whom? Macroinvertebrate community composition of South Island alpine tarns



Alexandra Barclay, Masters Candidate

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Supervisors: Angus McIntosh, Dave Kelly,
Helen Warburton, UC

Alpine tarns are likely to be sentinel ecosystems for global climate change because they are subjected to harsh conditions induced by surrounding ice and snow and are dominated by cold tolerant communities, often of high conservation value. The ecology of alpine tarns in some regions of the world is reasonably well known, however, New Zealand is data deficient. This lack of knowledge compounds threats posed by global change drivers because there is so little information to underpin management actions.

We collected invertebrate samples from groups of tarns at eight locations between 980 m and 1740 m above sea level, in Canterbury-Westland. Tarns were intensively sampled for macroinvertebrates and physicochemical conditions measured, including: altitude, surface area, conductivity, pH, and temperature.

Macroinvertebrate community structure changed considerably with altitude, but contrary to expectations, overall species richness did not always. At high altitudes communities consisted of notably different community assemblages to those closer to sea level. In particular, high altitude assemblages were driven by the presence of *Coleoptera* and the absence of *Odonata*.

Alpine tarns are likely to experience substantial changes in physical conditions with climate warming, which will in turn alter community composition. Species may find themselves in 'summit traps' as temperatures increase, while others will be able to increase their altitudinal ranges. Our work demonstrates that there are unique macroinvertebrate assemblages at high altitude which will be especially vulnerable.

Research/Career Interests:

- Freshwater ecology
- macroinvertebrate community composition
- Biodiversity,
- Alpine tarns

The 25-27 March flooding event across western South Island: The role of an atmospheric river



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Atmospheric rivers (ARs) are narrow filamentary channels of moisture responsible for 90% of the poleward water vapour transport at mid-latitudes. Even though a recent global-scale study shows frequent numbers of ARs in the New Zealand region, knowledge about the hydrometeorological extremes related to ARs is still limited.

In this study, the relationship between ARs and the recent flooding event in the South Island during 25-27th March 2019 is examined. Our results show that the landfall and inland penetration of an AR over the South Island culminated in a destructive flooding event mainly across western regions of South Island. The atmospheric condition occurs over a period of 36 hours and is characterised by an Integrated Vapour Transport (IVT) exceeding values of $1125 \text{ kg m}^{-1} \text{ s}^{-1}$. The event was categorized as an extreme category 4 AR along the west coast of South Island. During this flooding event, the Waiho bridge near Franz Josef was partially washed out and the Cropp River rain gauge recorded 1086 mm of the rain over 48 hours (new 48-hour rainfall record for New Zealand).

Even though most parts of the country experienced below normal precipitation during March 2019, the western South Island rainfall was above normal due to the landfall of this one single AR, demonstrating the hydrometeorological impact of ARs on weather related hazards in the South Island of New Zealand.

Research/Career Interests:

- Hydrology
- Hydrogeology
- Snow Hydrology
- Climatology of Snow

Negative resistance and resilience: A mesocosm experiment demonstrating consequences for biological recovery in restoration



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Helen Warburton, UC

Traditionally, resistance and resilience are associated with good ecological health, often underpinning restoration goals. However, degraded ecosystems can also be resistant and resilient to disturbance (negative resistance and resilience) making them resistant to restoration. This may be a consequence of degraded communities becoming dominated by species whose traits enhance food-web stability, preventing recolonisation by other species and resulting in low biodiversity and poor ecosystem function.

We present a mesocosm experiment demonstrating how presence of a degraded community hinders biological recovery. We established 12 stream mesocosms, each mimicking a physically healthy stream. Degraded invertebrate communities were established in half, mimicking the post-restoration scenario of physical recovery without biological recovery. We then introduced a healthy colonist community to all tanks, to see if presence of the degraded community impacted establishment of a healthy community.

Colonists established less readily in the degraded community mesocosms. We observed decreases in abundance of sensitive taxa in the presence of the degraded community, potentially driven by changes in resources; algal biomass was reduced by degraded community presence, increasing resource competition. Reductions in abundances occurred by drift, but also by life history changes; more *Deleatidium* mayflies emerged in the presence of the degraded community, and their nymphs were more developed at smaller sizes suggesting accelerated development.

Since degraded community presence prevents colonist establishment and community recovery, we propose that degraded communities must first be destabilised to facilitate recovery.

Research/Career Interests:

- Stream restoration, resistance, resilience
- Mesocosms
- Community ecology

Microplastic contamination within the Avon/Ōtākaro River, Christchurch, New Zealand



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The reliance and use of plastics has grown exponentially since the 1950s. Microplastics are the result of larger plastic debris either fragmenting, chemically degrading or being purposefully manufactured to be under 5 mm. These polymers have adverse effects throughout the environment. Road wear particles (RWP) are less understood yet pose similar detrimental effects to aquatic organisms, the health of freshwater ecology and implications to recreational activities as microplastics.

Within urban environments like Christchurch, RWP can be derived from high traffic locations such as carparks, major intersections, schools and hospitals. The abrasion of tyres, flaking of external vehicle panelling, and general breakdown of traffic lights and road paint can produce microplastics that travel into gutters. During significant rainfall events, these particles will move through the stormwater network and directly into our freshwater rivers without any treatment occurring. Many of these RWP also carry trace elements harmful to the ecosystem.

For this research, 30 sample locations along the Avon/Ōtākaro River have been investigated where both river sediment and stormwater drain samples were tested to identify the shape, colour, polymer type and total volume of microplastics within the river boundary. A hot-spot analysis will be completed to show areas of potential microplastic infiltration and locations of microplastic collection. This study will aim to increase the awareness of microplastics within New Zealand's freshwater systems and create a framework for future RWP investigations.

Research/Career Interests:

- Natural & multi-hazard environments
- Coastal hydrology
- Freshwater pollution

Coastal city flooding: Are eco-industrial parks a solution?



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Backup systems for coastal city flood mitigation are needed to meet the challenge posed by climate change. Green infrastructure (GI) can provide supplementary flood mitigation to delay and reduce stormwater entering into waterways. To deliver significant flood reduction during intense storm events, interconnected networks of private lands are required, in addition to public lands.

Many industrial lands often have a high capacity for managing stormwater. Industrial complexes called eco-industrial parks (EIPs), where some industrial processes are networked to exchange water, energy and other by-products may magnify this potential significantly. Instead of going to waste, these “resources” can also be sold to other industries, or land users, while allowing industries to meet regulatory compliance. However, these exchanges currently take place mainly within building infrastructure, for example in pipes, and the concept has rarely been applied to the management of biophysical resources in the landscape. Little is known of its potential for providing supplemental stormwater storage. If water is stored by industrial land users, it may be profitable for them to trade it to others. The resulting GI for storing and carrying water could also provide additional private and public ecosystem services (i.e. wildlife habitat, recreation, aesthetics, and green branding for companies).

This research aims to evaluate barriers and enablers of EIPs or industrial complexes to providing supplementary flood protection. The results of this research will contribute to the improvement of strategic spatial planning and policies to enhance the role of industrial lands in coastal city flood mitigation.

Research/Career Interests:

- Coastal city flooding
- Climate change
- Stormwater exchange
- Eco-Industrial Park
- Green infrastructure
- Ecosystem services

Access and impact: The spatial effects of off-road vehicles on Greenpark Sands



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Don Royds, LU

Under the Ramsar Convention on Wetlands (1971), Te Waihora/Lake Ellesmere would meet every criterion for nomination as a Wetland of International Importance. The lake is already recognised for its international significance for migratory wader bird species, contains a range of nationally significant wetland vegetation species and is of outstanding value to tangata whenua. Despite this, there are multiple off-road vehicle (ORV) tracks that have ripped through the delicate saltmarsh vegetation at Greenpark Sands, with deep ruts and criss-crossing paths.

The aim of this study is to quantify the scale and intensity of ORV impacts at Greenpark Sands and to provide recommended mitigations to reduce recreation impacts. Using GIS analysis of high-resolution aerial images, the study focuses on quantifying the spatial extent of ORV impacts on the lake edge and calculating the percentage of area impacted by using a grid overlay. The results are to be analysed in relation to access points, the location of maimai, vegetation types and waterway/drainage networks. Recommended mitigations will be based on a literature review of best practice recreation ecology articles, within the context of the study's findings.

Initial findings from image analysis at the end of Embankment Road indicate that the vehicle damage is widespread and intensive. In areas of saltmarsh meadows dominated by glasswort (*Sarcocornia quinqueflora*), the ORV impacts are especially severe.

Research/Career Interests:

- Design for recreation and ecology
- Wetland restoration

Resilience of tidal wetlands to vertical tectonic displacement and implications for sea level rise



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Coastal wetlands are important protective buffers between the land and sea, delivering more ecosystem services per area than nearly all other ecosystem types. Their conservation is important for filtration, waste assimilation, coastal protection, fisheries and wildlife, and as highly efficient 'blue carbon' sinks that help mitigate the effects of climate change. Here, results are presented of recent research into the long term impacts of the Canterbury Earthquake Sequence on the coastal wetland ecosystems of the Avon Heathcote Estuary Ihutai in relation to altered ground levels and hydrology resulting from tectonic displacement.

Changes in the composition and extent of major coastal wetlands in the lower regions of the rivers and tidal lagoons were quantified over the period 2008 to 2019, using mapping of vegetation and geospatial analysis of digital elevation models. Responses were compared between three localities differing in the magnitude and direction of tectonic displacement. These showed a large scale loss of wetlands with contributions from sites experiencing both uplift and subsidence. There were mechanisms of loss that contributed to these impacts, and the risk factors are discussed that are amenable to human intervention and management.

Given the similarities between this event and eustatic sea level rise, these results provide a direct evidence base for progressing climate change strategies that incorporate aquatic margin ecosystems and their natural resources.

Research/Career Interests:

- Spatial ecology
- Conservation planning
- Aquatic systems
- Climate change

Flood ‘survivors’ becoming ‘dependents’ under ‘victimhood’: Narratives of a flood affected community in Kelani riverside in urban Sri Lanka



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Despite the significance given to disaster risk reduction in Sri Lanka, the narratives of flood survivors often remain inadequately examined. This study aims to identify the socio-economic impact faced by flood survivors in an urban riverside community in Colombo, Sri Lanka.

The research problem investigates multiple effects on the socio-economic relations of survivors of a flood hazard during a post-disaster context in Sri Lanka. Using the purposive sampling method, fifty flood affected households in Kolonnawa were selected to conduct the household survey. Further, twenty-five in-depth interviews with flood affected people and two structured interviews with officials were conducted. The narratives of the affected community emphasize how flood victimhood has actually transformed them from flood victims to flood survivors. However, constant identification and categorization as a vulnerable group has caused other non-affected groups, non- governmental organizations, local and national government authorities to keep assisting them with goods and services. Such material assistance has turned the flood survivors into dependents rather than expediting the recovery process both individually and collectively.

This research paper draws attention to the overwhelming dependency mentality of flood survivors in terms of material and sometimes social support which make them hold on to their identity as vulnerable flood victims as opposed to survivors. The paper also poses the question whether or not their dependency mentality is a part of their transformation process from victims to survivors.

Research/Career Interests:

- Disaster management
- Sexuality and gender
- Minority issues
- Social work

Rainwater harvesting as a tool to protect urban waterways and to improve stormwater management



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Jenny Webster-Brown, UC

Urbanisation process and its associated anthropogenic activities have impacted the ecological and hydrological conditions of urban waterways. The increase of impervious surfaces (i.e. rooftops, parking lots) in urban catchments results in larger volumes of surface runoff during rain events. Thus, runoff acts as a significant source of transferring contaminants from these surfaces to stormwater networks and eventually to receiving waterways. Contaminants such as dissolved metals (i.e. zinc, copper) have been classified amongst the contaminants of most concern for Christchurch's waterways, due to their toxicity on freshwater organisms.

Recent studies have shown rooftops to be significant sources of leaching dissolved metals into waterways. Thus, greater attention has been employed on developing onsite treatment systems to reduce contaminants loading from runoff before discharging to the receiving waterways. Recent treatment systems have promoted the use of readily abundant materials such as seashells, to treat the runoff, which would result in relatively lower costs and would add value to the lifecycle of the treatment system. However, these treatment systems have generally focused on improving the quality of runoff, without considering mitigating the volumes of runoff that discharge to the receiving waterways.

This research focuses on developing an integrated rainwater harvesting system equipped with a treatment unit to mitigate runoff volumes, and to remove zinc and copper from excess roof runoff.

The study also includes an evaluation of the impacts of this integration on the timing and volumes of runoff entering the stormwater network and the catchment hydrology.

Research/Career Interests:

- Hydrology
- Stormwater modelling and monitoring
- Water Quality

The distribution of regionally endemic stream invertebrates, Banks Peninsula, Canterbury



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Supervisor: Jon Harding, UC

Prior to human arrival Banks Peninsula was covered in indigenous forest. Today native forest and scrub covers only about 15% of the land area (much of this is regenerated). Banks Peninsula has 10 regionally endemic stream invertebrates, of which nine are considered to be critically threatened.

We surveyed 54 sites across the Peninsula to determine the distribution and habitat preferences of seven endemic stream invertebrate species. Only two species, the caddisfly *Hydrobiosis styx* and the stonefly *Zelandobius wardi* were found in all three of the Peninsula's Ecological Districts. Five species, including the caddisfly *Costachorema peninsulae*, the mayfly *Nesameletus vulcanus*, the net-winged midge *Neocurupira chiltoni*, the beetle *Orchymontia banksiana*, and an undescribed stonefly (*Zelandoperla* sp.1 BJJF00160: Banks Peninsula) were restricted to Akaroa and Herbert Ecological Regions. The occurrence of the endemic stream invertebrates was found to be mainly driven by shading, native riparian vegetation, altitude, and stream width.

Evidence from this study suggests that a number of the endemic species are restricted to eastern areas and central headwaters of the Peninsula. The future conservation of these endemic stream invertebrates needs focus on headwater, forested, hill sourced, and high gradient streams.

Research/Career Interests:

- Biodiversity,
- Freshwater ecology,
- Endemic species,
- Macroinvertebrates

Population dynamics of West Coast īnanga: Impacts of whitebaiting



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New Zealand's whitebait fishery is known to fluctuate widely with irregular and quite frequent rises and falls in catch. However, the cause of these fluctuations remains unknown. Although anecdotal evidence from historical catch data suggests that the fishery is in decline, frequent boom and bust years are not consistent with the typical decline in fish stocks characteristic of an overexploited fishery. Regardless, it is evident that the world's fisheries are deteriorating, and New Zealand's whitebait fishery is no exception.

To gain a better understanding of the impact that whitebait fishing has on īnanga (*Galaxias maculatus*) populations, we selected different stream types based on known fishing pressure (e.g., 'closed-areas' vs. fished) and paired them by stream order, catchment size, modelled land use, and distance from the coast, latitudinally along the West Coast of the South Island. Streams were sampled monthly for a year to estimate density, size-class structure, growth, and condition. We found differences between stream types in īnanga densities. In general, streams closed to fishing had greater īnanga densities than fished streams. However, streams with greater īnanga densities exhibited smaller size-class structures, slower growth rates, and poorer condition relative to streams with lower īnanga densities.

These results indicate that whitebait fishing can lower the density of īnanga in streams during the fishing season, but that density-dependent mechanisms are potentially a major driver affecting the dynamics and structure of īnanga populations.

Research/Career Interests:

- Conservation Biology
- Aquatic Ecology
- Community Ecology
- Stream and Watershed Assessment

Poster Abstracts

The Storminator™ - a retrofittable, sustainable stormwater treatment solution using waste shells



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Urban waterways are adversely impacted by heavy metals such as zinc, copper, and aluminium primarily sourced from untreated roof runoff. Water quality sampling from metal roof runoff throughout Christchurch has measured substantially elevated zinc and copper concentrations, magnitudes of order above recommended levels of protection set out in the ANZECC guidelines.

In order to address this problem, the UC Hydrological and Ecological Engineering Group invented a simple and cost-effective, point-source solution named the Storminator™. It is easy to install and maintain as it sits in line with the existing downpipe, has a minimal footprint, and uses a waste product to treat roof runoff. It won the 2019 National Stormwater Innovation award and is patented.

The focus of this research investigated the metal removal (treatment) capacity from roof runoff of seven operational Storminator™ units over different seasons. The effects of (1) metal roof type (Colorsteel, Zincalume and Copper), (2) Storminator™ size (100 mm, 150 mm and 225 mm diameter treatment cartridge), (3) rainfall characteristics (duration and intensity), (4) substrate mix (% shells) and (5) catchment location were investigated over 11 different sampling events. Results highlighted that more than 80% dissolved metals are consistently removed from the roof runoff after passing through the Storminator™ and that higher removal efficiencies are achieved when solely waste shells are used as the active media, under both first flush and steady state loading.

Research/Career Interests:

- Ecological engineering solutions
- Stormwater treatment
- Water quality and sustainability

Managing the effects of wildfires on freshwater systems, under a regime of climate change



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Wildfire is becoming increasingly more prevalent and severe as global warming continues. Wildfires tend to occur in forested catchments where the effects on freshwater systems are becoming an increasingly important focus.

In the aftermath of a fire, lack of vegetation results in increased erosion rates accompanied by changes to surface runoff as water repellency is enhanced in the soil. Freshwater systems become impacted as trace elements and nutrients are attracted to fine sediment which is eroded into surrounding streams. Water quality decline resulting from such processes has implications for domestic water supply, stream ecology and health.

New Zealand has recently experienced wildfires in the Port Hills in Canterbury (2017) and in the Waimea catchment in Nelson (2019). It is likely that under current climate change predictions, more frequent wildfires will occur in the drier regions of New Zealand. The aim of this study is therefore to review management options for avoiding, minimising and mitigating the effects of wildfires on freshwater systems and to identify those options which will be most useful in a New Zealand context.

This study is currently in the early stages and results will be presented at the postgraduate student conference which will include results on how water quality was impacted in the NZ case study sites and recommendation for management.

Research/Career Interests:

- Environmental Science
- Climate Change
- Freshwater Management

Shaped by stress: A trait-based meta-analysis of stream communities across stressor gradients in New Zealand



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Helen Warburton, UC

Environmental filtering shapes communities by filtering out species with certain traits (characteristics including morphology, behaviour and life history), resulting in communities associated with specific environmental conditions. Understanding how different environmental filters/conditions shape different communities may enable design of more effective restoration strategies which target biological recovery. To investigate if invertebrate community types were associated with different stressor gradients, a meta-analysis of New Zealand streams was conducted using data across drying, flooding, eutrophication, sedimentation and acid mine drainage (AMD) gradients. We hypothesised that whilst some stressors would apply different environmental filters resulting in different trait combinations, others might shape communities in similar ways, resulting in similar trait combinations. A trait-based ordination of communities using non-metric multidimensional scaling was conducted. Significant trait responses to stressor gradients were found for all stressors. Additionally, AMD and sedimentation worked to shape trait composition in the same direction, with higher stressor intensity leading to presence of hardier species. Flooding and eutrophication worked on the same axis but in opposite directions, with flooding selecting for more streamlined, mobile organisms and eutrophication for more sedentary organisms. Knowing that different stressors can work to filter organisms in opposite directions might be applicable as a restoration action to successfully displace less desired taxa. Whilst using artificial application of stressors to further disturb degraded ecosystems seems counter-intuitive, it could be used to trigger positive community change as a valuable restoration tool.

Research/Career Interests:

- Stream restoration, resistance, resilience
- Community ecology
- Species traits

Can biofilms use methane to remove nitrate from nitrate-contaminated freshwater under aerobic conditions?



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Aerobic methane-driven denitrification is a process with the potential to remove nitrate from nitrate-contaminated waters using methane. However, neither the process nor the microorganisms involved are fully understood. The objective of this study is to grow biofilms in a packed bed reactor using methane, investigate the nitrate removal rate, and determine the microbial community structure of the biofilm.

A biofilm was grown in a packed bed reactor with a continuous supply of 2% (v/v) methane in air as the sole carbon source. Nitrate, supplied in the form of nitrate mineral salt medium (NMS), was recirculated through the bioreactor and was periodically refreshed. The reactor was inoculated with samples from sandy gravel sediment from Lowcliffe, South Canterbury. Methane and nitrate removal, as well as nitrite and ammonium production were monitored. DNA was extracted from the biofilm to identify the microbial community.

The biofilm showed an average nitrate removal rate of 22.6 ± 6.3 mM $\text{NO}_3\text{-m-3hr}^{-1}$ and a methane removal rate of 150 ± 19 mM $\text{CH}_4\text{ m-3hr}^{-1}$. The methane-nitrate consumption ratio ranged between 4.6 and 9.4. The microbial community structure in the biofilm revealed a community dominated by a methane oxidizer *Methylocystis spp* and traditional heterotrophic denitrifiers.

The current hypothesis is these microorganisms coexist to drive the process of nitrate removal in the biofilm. These results demonstrate the potential application of biofilms in the removal of nitrate from nitrate-contaminated water using methane.

Research/Career Interests:

- Bioprocess engineering
- Environmental Microbiology
- Wastewater restoration and remediation

Sediment trace metals as indicators of rural land use change in lake cores in Canterbury and Southland



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Lake sediments provide a natural record of information on past catchment land use changes (LUC), water quality changes, aquatic biodiversity changes and current lake conditions. Large scale studies of lake sediment cores, such as the current “Lakes380” research programme, can lead to an understanding of how future management policies or strategies can be developed to reduce the effects of LUC on lakes. Such studies involve comprehensive collection of chemical, biological and physical parameters, which are collectively very expensive to determine. However a subset of key environmental land use indicators may be able to be identified.

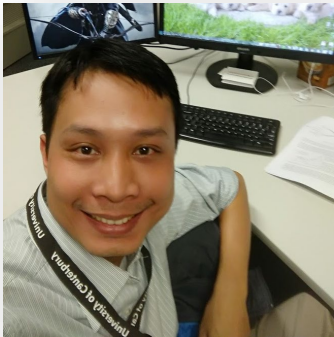
This research aims to assess the potential use of trace element concentrations, in lake sediment cores, as indicators of LUC. Sediment cores will be collected in collaboration with “Lakes380” project from six lakes in Canterbury and/or Southland, where catchments have a record of agricultural intensification. The cores will be analysed for trace elements used in agriculture, including arsenic, cadmium, copper and zinc, and binding elements, such as iron and manganese, as a function of depth. The trace element profile with depth will then be linked to the age of the sediment in the core and historic records for the catchment.

This study will potentially identify relatively simple and inexpensive indicators of past LUC, which can be used by local or regional authorities to understand and better manage the effects of this change on lake environments.

Research/Career Interests:

- Water quality and Quantity
- Water, Sanitation and Health (WASH)
- Paleo-limnology

A framework to assess the reliability of a multi-purpose reservoir under uncertainty in land use



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Reservoirs are one of the most efficient types of structures used to manage water resources for multiple purposes. Nevertheless, demands from individual sectors lead to a variety of constraints that need to be addressed. Furthermore, socio-economic development in reservoirs' catchments may result in land use changes and can significantly alter inflows into reservoirs. Thus, this study aims to develop a framework using a reliability-based optimisation approach in combination with the Soil and Water Assessments Tool Plus (SWAT+) model to assess the reliability of a reservoir's water supply under uncertainty in future land use.

The reliability of a reservoir's water supply is defined as the probability that a reservoir operates within suitable limits. A genetic optimization approach was applied with the objective of minimising the difference between water demands and water releases, thereby satisfying water use and policy constraints. A calibrated SWAT+ model was used to simulate reservoir inflows under various land use scenarios and results were used as input to the optimisation model to obtain the reliability of a reservoir's water supply.

To test the framework, the Nuicoc reservoir in Vietnam was used as a case study. Modelling results showed that land use changes have considerable impact on the reliability of a reservoir's water supply, with urban growth and changes to agricultural land cover having the greatest impacts.

Research/Career Interests:

- Water engineering
- Optimisation in water resources
- Hydrological modelling
- Irrigation and drainage

Trade-offs in ecosystem services in the residential red zone in Christchurch with particular focus on flood mitigation



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After the Canterbury earthquakes, flat land areas have been red-zoned where the land has been so badly damaged that it is unlikely it can be built on over the short to medium term. Most of the built structures on Crown-owned properties in the residential red zone have already been cleared. The Ōtākaro/Avon River Corridor Regeneration Plan, developed by Regenerate Christchurch, provides opportunities for short, medium and long-term future land uses in a red-zoned area of 602 hectares.

The Land Utilisation Capability Indicator (LUCI) – an Ecosystem services modelling framework – has been used to assess the effect of flood mitigation options (riparian planting and stopbank replacement) on the ecosystem services flood mitigation and carbon sequestration. Potential design options for the future flood protection scheme have been investigated to identify trade-offs. Thereby the current services provided by the landscape have been compared with estimates of their potential capability and their capability under the proposed flood mitigation options. This spatially-explicit and quantitative information can support land use decision making to arrive at synergistic solutions.

The next steps in this work are to add the aspects of erosion and sediment delivery, evaporative cooling and habitat provision in LUCI and to study the scenarios under climate change conditions.

Research/Career Interests:

- Urban hydrology
- Geographic Information Systems
- Low impact development controls
- Climate change

Prevalence of antibiotic-resistant bacteria in surface drinking waters



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Antibiotic-resistant bacteria are being found with alarming regularity in New Zealand's surface waters. These waters are used by livestock, and for irrigation and drinking water. There is increasing concern over the impact of antibiotic-resistant bacteria on human health. The role of the environment as a source of antibiotic resistance has been widely acknowledged.

I have been conducting a survey of drinking water in the Okains Bay region. This water is sourced from the Opara stream, which runs from springs on some residential properties through farmland and the township to the estuary. I have been focusing on isolations of the indicator bacterium *Escherichia coli*, and have established a baseline survey of resistances to antibiotics. Resistant bacteria were tested for level of resistance, number of resistance genes and potential for horizontal gene transfer. Results from this survey have shown *E. coli* counts above the safe drinking water limit, and antibiotic resistance levels that complicate or preclude antibiotic treatment. Multi-drug resistance was also observed.

The implications of these findings are important because these residents are exposed to high levels of antibiotic resistant bacteria from a source that should be safe and clean. By 2050, the World Health Organisation predicts that antibiotic resistance will pose a greater risk to human health than cancer. This highlights the importance of minimising the role that the environment plays in contributing to antibiotic resistance.

Research/Career Interests:

- Molecular and microbiology
- Bio-engineering and protein science

Morphology and tidal asymmetry changes in the Avon-Heathcote Estuary



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GEOG404 project output, reviewed by
Deirdre Hart

The morphology of the Avon-Heathcote Estuary (AHE) was altered by the Canterbury Earthquake Sequence (CES), which uplifted much of the tidal lagoon by 0 - 0.4 m (Measures et al 2011). The abrupt CES changes follow a theorized 400-year period of gradual subsidence (Hughes et al. 2014) and tidal prism increase (Findlay & Kirk 1988). The tendency of the estuary to infill or erode is relevant to coastal and river management in Christchurch. This poster presents recent beach and bathymetric survey results at the AHE mouth and analyses of estuary form and tides to evaluate the morphological equilibrium of the estuary relative to hydraulic and sediment asymmetry relationships.

Friedrichs (2011) notes that “the morphological response of most tidal flats is rapid relative to the decade-plus timescales of engineering works, climatic fluctuations, and sea-level rise.” Tidal height data and DEM analysis within the AHE indicate an estuary that is flood-dominant except for the deep inlet channel, which is ebb-dominant. Survey results indicate that the inlet channel and some flood tidal delta regions have eroded back towards pre-CES dimensions. Tidal analyses indicate a return to morphological equilibrium. The potential ‘respite’ from sea level rise provided by uplift appears to be short-lived due to the energetic environment within the estuary.

Research/Career Interests:

- Coastal oceanography and limnology
- Modelling, field studies, consulting in Canterbury

Development and assessment of a sediment management routine for the Soil and Water Assessment Tool (SWAT)



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Dam operators face several challenges, with sediment deposition being one of the most crucial. Sedimentation may cause significant reduction of storage volume, lessen hydropower generation and result in negative downstream impacts. Different sediment management techniques are used in practice to manage reservoir sedimentation. A sediment management routine (ResSMan) has been developed, integrated in SWAT and tested. The ResSMan routine has capabilities to predict the accumulation of trapped sediment, its impacts on the storage-capacity of a reservoir and hydropower generation under user-specified operation policies. Furthermore, it allows users to compute the restoration of storage volume due to the removal of sediment by application of sediment management techniques flushing and sluicing.

The developed routine was applied in a case study to the Nam Kong 3 dam of the Sekong River basin (646 Km²) in Lao PDR. The performance of the routine was assessed by comparing results of the developed routine with the well-tested and established model SedSim, which was specifically designed to simulate hydropower reservoirs, given various multiple reservoir sediment management techniques. The ResSMan routine shows good performance with respect to the flushing sediment management technique with R^2 value of 0.99. At present, this routine can be applied to a single reservoir to assess and manage reservoir sedimentation, inflows and energy generation. Next, the model will be expanded so that the multiple-reservoir system can be investigated.

Research/Career Interests:

- Hydrological modelling
- Hydropower reservoir sedimentation
- Climate change impacts

Monitoring a recently extended wetland in Christchurch



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Supervisors: Tom Cochrane,
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Frances Charters, UC

Hayton's Stream, a tributary of the Heathcote River in Christchurch, has a long history of poor water quality; elevated heavy metals and nutrients have been recorded in both baseflow and stormflow conditions (O'Sullivan & Charters 2014; Silveira 2017). Recent sediment analysis of Hayton's Stream (ENGEO 2018) found toxic concentrations of heavy metals, in particular cadmium (Cd), lead (Pb) and zinc (Zn), thought to be the results of both industrial point source pollution and diffuse stormwater pollution.

Construction works are underway to increase the performance of the Wigram Retention Basin (WRB), an engineered detention pond located in the lower reach of the stream, by creating three additional wetland cells. The increased retention time would improve treatment performance as well as adding to flood resilience in this area. However, due to the elevated concentrations of heavy metals in the existing pond's sediment and continuing contributions from stormwater, the performance efficiency of the new treatment system is uncertain.

The main objective of this project is to assess the changes in water quality achieved by the upgrade, by monitoring the existing and new ponds water quality during pre and post-construction phases. Construction of the new wetland cells is due for completion in August 2019 and post-construction sampling will commence then to compare water quality parameters between pre and post-construct of the ponds. This monitoring programme would generate data on pollutant removal to help the future of wetland design.

Research/Career Interests:

- Stormwater
- Wetland
- Natural treatment
- Nutrients
- Heavy metals

Investigation of the hydraulic connectivity between the Avon River and the Christchurch Aquifer, Christchurch New Zealand



Natasha Simpson, PMEG Candidate & Irene Setiawan, PhD Candidate

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Supervisor: Leanne Morgan, UC

Coastal aquifers are at risk of seawater intrusion (SI) which is a global issue intensified by climate-driven sea level rise. As such, there is an increasing demand for understanding and managing coastal aquifer systems. There is evidence indicating that groundwater salinization may occur from saline surface water encroachment (and salinization of aquifers adjacent to surface water bodies). However, most SI studies have focused on salinization through the lower seawater-aquifer interface (i.e., at the coast). Limited research has been undertaken investigating the hypothesis that salinization can occur from saline surface water – groundwater interaction. Christchurch has been proposed as a case-study site to investigate this hypothesis.

This project aims to characterise the state of hydraulic connectivity between Christchurch's Avon River and the shallow unconfined aquifer and identify if there is evidence of ongoing intrusion of saline surface water entering the underlying shallow aquifer.

Research/Career Interests:

- Hydrogeology
- Contaminated Land
- Engineering Geology

What's the attraction? The hold a mussel shell can have over a metal



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Supervisors: Jenny Webster-Brown,
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Urban waterways are at risk from toxic heavy metals endangering aquatic biodiversity. Metals such as zinc (Zn) and copper (Cu) are ubiquitous in the urban environment, and roof runoff from storm events contains significant quantities of these metals which ultimately enter urban waterways. While most stormwater treatment has focused on the removal of suspended solids, very high proportions of Cu and Zn are present as dissolved ions and therefore a different treatment approach is needed for their effective removal.

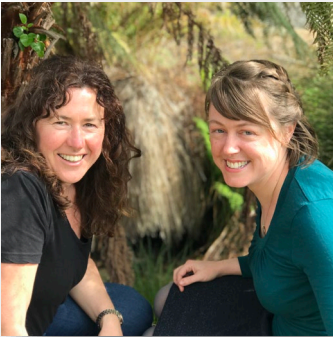
Mussel shells have been shown to be effective biosorbents for dissolved metals, with recent data showing very high dissolved Cu and Zn reductions (>75% and >90% respectively). The mechanisms by which the shells retain the metals have been proposed as: adsorption to the protein and/or carbonate layers of the shells; and/or precipitation of metal hydroxide or carbonate salts during dissolution of the calcium carbonate structure. However, evidence of the type and extent of each mechanism for each metal, at concentrations and retention times applicable to stormwater, has yet to be provided.

Therefore, this study aims to identify the key mechanisms of metal retention in a mussel shell-based stormwater treatment device, by using microscopy and geochemical modelling alongside chemical analysis of substrates and stormwater from experimental and operational treatment devices. This knowledge can then inform design and regeneration options for field treatment systems, aimed at limiting metal contamination of urban waterways.

Research/Career Interests:

- Water management
- Water treatment
- Water quality
- Behaviour change
- Systems improvement

Fostering community engagement with the urban water environment: Why bother?



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Local authorities in Aotearoa-New Zealand are mandated to look after communities *and* the environment, and increasingly it is recognised that these tasks must be approached in an integrated way. This is particularly so in the urban water space, where community wellbeing and environmental health are closely interconnected.

Through a review of the international literature, we explored the implications of community engagement and collaboration in initiatives to care for the health of urban waterways and address stormwater contamination. We found that governance approaches that invest in collaborative community groups engaged in their local water environment, are more likely to deliver sustainable behaviour change and foster community wellbeing. In particular, the kind of behaviour change required to address stormwater contamination at source (e.g. in private households and businesses) was found to relate to a complex range of social factors. Local authorities can better account for these factors in planning and management if they work in partnership with community groups, as they have significant social reach within households, neighbourhoods, and businesses. Apart from driving behaviour change, engagement with established and emergent community groups also builds social and human capital through partnership, thereby fostering social, cultural and economic wellbeing.

Therefore, by supporting and partnering with community groups, local authorities should be able to both facilitate behaviour change for improved environmental outcomes in the urban water space, and promote the wellbeing of people and communities.

Research/Career Interests:

- Water management
- Water quality
- Behaviour change
- Community Engagement
- Wellbeing

Towards Water Sensitive Cities: Ingredients for transition



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Supervisors: Ed Challies, UC;
Lin Roberts, LU

Urban water systems are dynamic and complex. They must continuously adapt and evolve as the urban environment and society changes. To foster resilience in the face of future uncertainties, we need to embrace new strategies and approaches to the management of urban water. Finding ways that can leverage the complexities inherent to urban systems is key to creating sustainable cities. Utilising the concept of a Water Sensitive City (WSC) can increase sustainability, and improve well-being and resilience within our urban communities.

This poster outlines three pillars that can be seen as underpinning the transition towards Water Sensitive Cities – a) access to diverse water sources from centralised and decentralised infrastructure; b) ecosystem services provided within the built and natural environment; and c) integrated organisational strategies as proactive practice. WSCs can provide an innovative and robust platform from which organisations can make sustainable water resource management decisions.

Research/Career Interests:

- Sustainable cities
- Water sensitive urban design
- Hydrosocial contract
- Socio-technical models
- Transformations and resilience

About Our Platinum & Gold Sponsors



Environment Canterbury is the regional council for this magnificent region. In Canterbury we have one of the most astonishing environments in New Zealand – from the turquoise Lake Tekapo, the stunning Southern Alps, the widespread agricultural plains, and beautiful coastline – not to mention our ‘capital’ city of Christchurch – and everything in between. The regional council is responsible for this environment, with the community’s support and in collaboration with many other organisations.

The work of Environment Canterbury takes place under seven broad portfolios: the Canterbury Water Management Strategy; air quality; biodiversity and biosecurity; hazards, risks, and safety; planning, consents and compliance; transport, Greater Christchurch rebuild and urban development; and regional leadership. Within these portfolios, the regional council covers such things as the Harbourmaster’s Office, regional parks, coastal erosion, buses, freshwater quality, pest management, flood protection, and air pollution. Industry, and the economic impact of activity within the environment, are key to the council’s decision making.

We are proud to support the 2019 Waterways Postgraduate Student Conference. Water is the driving force behind much of our economy and protection of this precious resource requires science to mitigate negative impact to ensure that we have a positive impact.



Water New Zealand is the principal trade association representing the interests of the water industry. We have 1900 members representing Councils, engineering service providers and providers of goods and services. We are actively engaged in advocacy, development of technical guidance and industry engagement with the goal of driving consistency into the way in which water systems are operated.



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Hill Laboratories is New Zealand's largest 100% privately owned and operated analytical testing laboratory with three major testing areas: agriculture, environmental and food & bio analytical. Tried, tested and trusted for over 30 years, our focus has remained unchanged: providing New Zealanders with the best analytical testing service on offer.

Founded in 1984 by Dr Roger and Anne Hill, the company remains family owned today. With over 400 staff working across its laboratories in Hamilton, Christchurch, Auckland, Blenheim and Wellington, it is a significant employer of science graduates from New Zealand tertiary institutions.



OUR LAND
AND WATER

Toitū te Whenua,
Toiora te Wai

Our Land and Water is one of 11 National Science Challenges that focus on issues of national importance. The Challenges were designed to take a more strategic approach to the Government's science investment by targeting goals that, if achieved, will have major and enduring benefits for New Zealand.

For Our Land and Water, this means tackling the biggest science-based issues and opportunities facing our country in the area of primary production, and the complex relationship it has with our precious land and water resources.

Our mission is to preserve the most fundamental treasures of our country – our whenua, awa and associated ecosystems – while producing value from those same treasures. As a challenge, this is the ultimate. Every New Zealander, both alive today and yet to come, has a stake in the outcome.

The National Science Challenges are transdisciplinary, mission-led programmes that require collaboration between universities, Crown Research Institutes, businesses, iwi and non-government organisations to achieve their objectives.

Our Land and Water is one of the largest National Science Challenges, funded by MBIE for up to \$96.9 million over 8 years.

Our Land and Water is now beginning its second phase of work, which will roll out in 'waves'. The first wave of 6 research programmes started work in late 2019. The second wave will roll out in 2020 with the commissioning of up to 7 think pieces to build an evidence base for the development of new research.

To learn about future research opportunities, sign up for our e-newsletter: ourlandandwater.nz/news-events/



We're proud of the unique value we bring to our clients at WSP with unrivalled local knowledge harnessed from 148 years of pioneering the important infrastructure and environments of New Zealand. We connect our world-class technical experts in Transport, Water, Property & Buildings, Power and Environmental who are part of the 40 communities around New Zealand in which we live in, we know this place like no other. This combined with our network of 48,000 WSP experts around the world means that we have the power to generate solutions that question today, imagine tomorrow and create for the future.

We are technical experts and strategic advisors including engineers, technicians, scientists, planners, surveyors, environmental specialists, as well as other design, program and construction management professionals.

What sets us apart is our wealth of collective experience and the collaborative way we work across disciplines and with our clients: WSP projects are 'powered by connected expertise'.

We work closely with our clients to really understand their needs and aspirations, and deliver innovative and creative solutions for what are often complex design challenges.

Above all, we are proud to be trusted partners in the creation of sustainable communities through the development and management of world-class infrastructure - Creating what matters for future generations.



The NZ Rivers Group is a technical interest group of Engineering New Zealand and Water New Zealand that formed in 2009 to provide a forum for those involved with, and with an interest in rivers, flood risk management and the operational and environmental issues of catchments and river systems. Our members include engineers, geomorphologists, hydrologists, ecologists, scientists, planners, managers and others who are passionate about the successful management of river systems across New Zealand. The key objectives of the Rivers Group are:

1. To facilitate cross-disciplinary interaction between individuals, communities and professionals involved in catchment management, flood risk management and river management throughout New Zealand;
2. To promote best practice, leadership and the sharing of technical knowledge in all aspects of catchment management, including flood risk management, river restoration and river engineering throughout urban and rural environments in New Zealand;
3. To support and promote relevant science and research in river and catchment management and to disseminate that information among professionals, academics, decision makers and the general public;
4. To promote and facilitate input into local and central government policies, strategies, standards and programmes affecting catchment and river management;
5. To assist in the integration of the principles of the Treaty of Waitangi in best practice river management.



Christchurch City Council has a responsibility to ensure that surface water resources are managed in a manner that supports the environmental, social, cultural and economic well-being of current and future generations.

The Council's Surface Water Strategy 2009 goals are to:

1. Improve the water quality of our surface water resources;
2. Reduce the adverse effects of flooding;
3. Improve the ecosystem health of surface water resources;
4. Protect and restore Ngāi Tahu values associated with surface water resources;
5. Support a range of recreation activities on and around waterways;
6. Protect heritage values associated with surface water;
7. Protect and enhance the landscape values of surface water;
8. Support community involvement in surface water management;
9. Manage stormwater in an efficient manner that supports Goals 1 – 8.



Selwyn stretches across the Canterbury Plains, bounded by the Rakaia and Waimakariri Rivers, with Arthur's Pass National Park in the Southern Alps to the west and the Pacific Ocean to the east.

With a population of more than 62,000 Selwyn is the third largest territorial authority in the South Island, following years of sustained growth. While this growth was initially driven by relocation following the Canterbury earthquakes, it is now equally sustained by industrial and commercial movement towards the south west of Greater Christchurch. The district also supports a thriving primary production sector including dairying, assisted by ongoing irrigation investment.

Selwyn District Council is planning significant investment over the next 10 years in community services, facilities and infrastructure, including the management of our 5 Waters services – water supply, wastewater, stormwater, land drainage and water races.

The availability of clean, safe water and the safe disposal of wastewater are fundamental to the health of our community and natural environment. The Council takes an integrated approach to managing water resources, recognising that our 'mountains to sea' landscape means there is a strong connection between these services.

Much of the district lies within the catchment of Te Waihora/Lake Ellesmere, one of New Zealand's most important wetland systems, and central to the mana of Ngāi Tahu. The Council is working actively with Ngāi Tahu, Environment Canterbury and other partners on widespread cultural and ecological restoration projects.

Other priority projects include the expansion and upgrading of wastewater treatment facilities, increasing water supply capacity and the upgrade of water supply treatment plants.



Wallbridge Gilbert Aztec (WGA) is a multi-disciplinary, award-winning engineering and project management consultancy of over 270 staff, with an ethos based on developing long-term collaborative client relationships and delivering innovative, buildable and economical solutions. WGA offers experience across a wide range of consulting services, including structural, civil, water resources, maritime, mechanical, geotechnical, heavy lifting, electrical, pressure vessels and project management.

We offer over 30 years of practical experience in the investigation, consenting, design, delivery and operation of a wide range of Integrated Water Management Services, where the solutions to water management challenges are developed from a conjunctive surface-groundwater approach. These specialised services include applying the tools of Managed Aquifer Recharge (MAR) to varied hydrogeological settings. Our internationally-renowned MAR projects range from catchment scale to site-specific applications, utilising water sourced from high quality alpine rivers, stormwater, treated wastewater and co-produced water from mining activities.

Our approach to the delivery of water infrastructure projects recognises and builds on past successes and lessons learned, addresses challenges and enables our clients to realise future opportunities. In delivering projects, we work with the client to recognise and consider external drivers of change, including policy and regulatory developments, population growth, land use evolution and cross-jurisdictional issues.

WGA is a proud sponsor of this year's 2019 Waterways Postgraduate Conference to help provide a showcase for young professionals entering a career in water.



Aqualinc is a specialist provider of water resource engineering and management services. Our mission is to deliver long-term socio-economic benefits through world-class water and land management.

Wise management of water resources is fundamental to sustaining both economic growth and natural environments, and increasing the health, wealth and well-being of New Zealanders. Aqualinc is committed to helping New Zealanders allocate and use freshwater in a sustainable, efficient and equitable way. Increasingly, groundwater is also being recognised as a hazard, and its contribution to flooding and liquefaction is key to better management of these hazards.

We provide New Zealand with world-class water management and water use efficiency through scientific and policy research, technology development and deployment, water engineering water management advisory services, and irrigation management services. We enjoy making a positive difference to environmental quality and the economic well-being of communities through the projects we are involved with.

Our team of professional environmental, water resource, natural resource and irrigation engineers, hydrologists, hydrogeologists and resource management consultants, are available to help with your water and land management needs.

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Notes

