inSCight

Inspiring stories from the Faculty of Science

ISSUE 17 | 2023

Climate science: forecasting our future and informing action

Our research

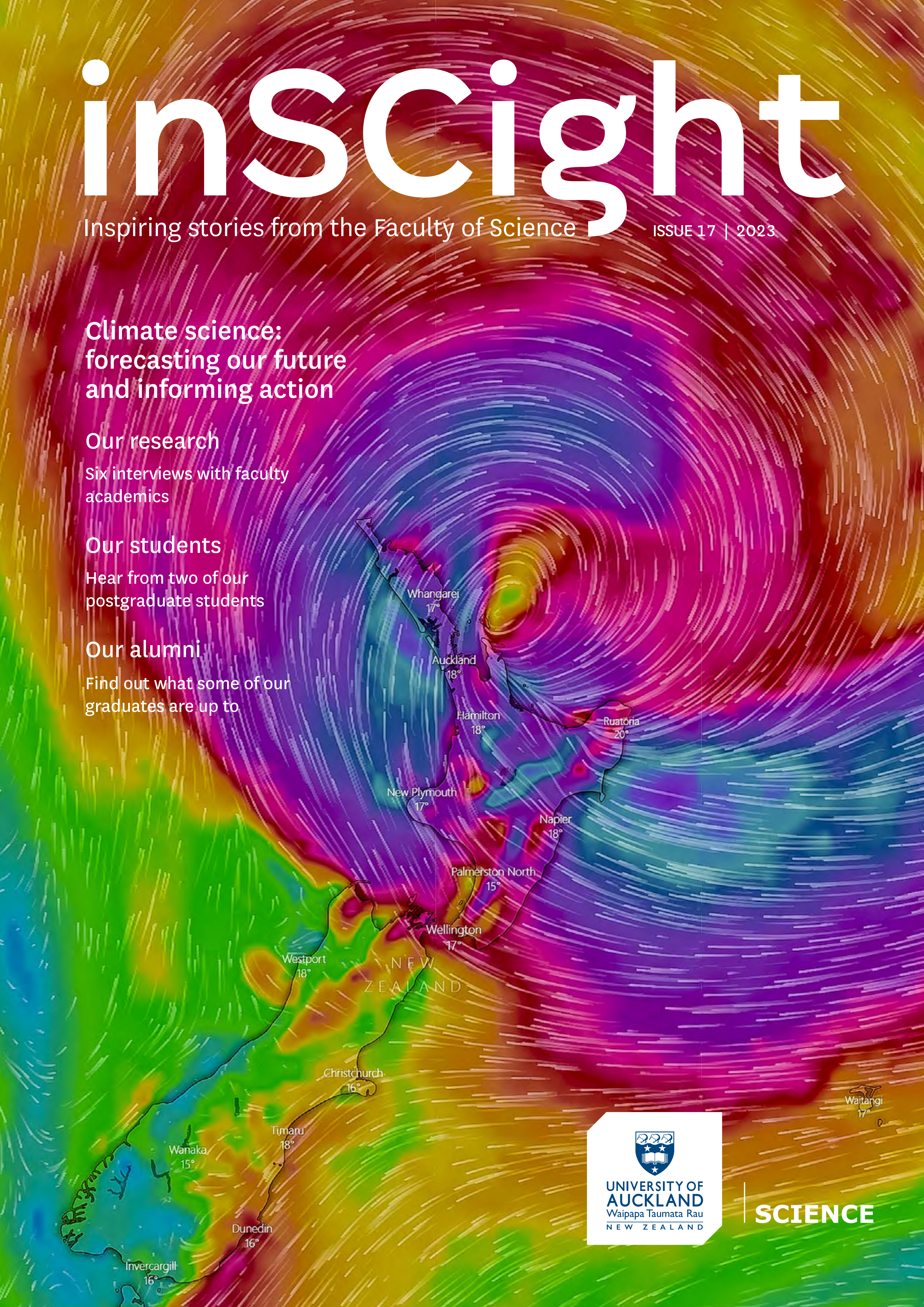
Six interviews with faculty academics

Our students

Hear from two of our postgraduate students

Our alumni

Find out what some of our graduates are up to



UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

SCIENCE

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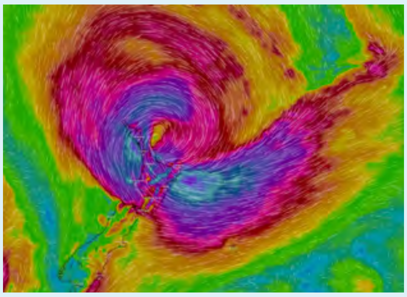
inSCIght 2023



Cover image: February 13, 2023: map of New Zealand, Cyclone Gabrielle.
Shutterstock/ Oleg Senkov

A word from the Dean

Kia ora tatau

WELCOME to the 2023 edition of *inSCight*. This edition is themed around climate change, an existential crisis the implications of which are becoming starkly apparent globally, and more locally with the February floods in New Zealand and the debate that has arisen around infrastructure resilience and the need for climate adaptation. We will be exploring many of the ways in which research in the faculty has responded to these issues in the past year.

Not surprisingly, given our location, we have articles with a strong focus on marine aspects of climate change with Craig Stevens on how ocean heat is mixed in eddies, Giovanni Coco on coastline impacts of climate change, Caitlin Blain on kelp forests and their role in carbon sequestration, and PhD student Trevyn Toone on mussel bed and ecosystem restoration work in Marlborough.

Given the frequency of storm impacts this year, the article on landslides, focusing on the impacts of Cyclone Gabrielle, is instructive. Martin Brook has been a regular in media commentary on climate resilience work post the February floods. PhD student Hamish Lewis discusses his research on the remote influence of meteorological variables on Tropical low-clouds.

The work of some of our highly impactful research centres also features strongly. Te Pūnaha Matatini, the Complex Systems Centre of Research Excellence, has a cluster of researchers across the country focussing on transdisciplinary work addressing threats and opportunities from climate change. Ngā Ara Whetū, our new University-level sustainability-focused research centre, and the associated philanthropically funded Climate Systems Laboratory have a strong theme on climate change and sustainability in their work.

Taking a different tack is Quentin Atkinson, who argues strongly against the view that humans are not evolved to deal with the climate crisis and highlights how linguistic and cultural diversity may be key to solving it. Alumnus João Albuquerque tells of his journey from Computer Science to being an environmental scientist and how his passion for surfing inspired a career in oceanography and climate change. Research Fellow Phillipa Pehi brings an indigenous perspective to the area of climate change.

Finally, as we go to press, it has been announced that Distinguished Professor Dame Margaret Brimble has been awarded the Davy Medal from the Royal Society (London).

The Davy medal is named after the famous chemist Sir Humphrey Davy and is awarded for outstanding contributions in the field of Chemistry. Margaret's award comes due to her "outstanding contributions to organic chemistry with wide-ranging applications across the life sciences." Previous winners of the medal include Pierre and Marie Curie and Linus Pauling, and, in all, 22 winners of the Davy Medal have gone on to win Nobel Prizes, so this is an outstanding achievement. Congratulations Margaret!

As always, a diverse set of contributions from our diverse and impactful faculty. I do hope you enjoy it and that you and yours are surviving well in these unusual times. This will be the last issue of *InSCight* that I will be writing the leader for as I am stepping down from my role as Dean in June next year and retiring. Being Dean of our Faculty is a life of vicarious pleasure: seeing good people within our faculty achieve outstanding things; seeing excellent students cross the stage at graduation full of ambition; and meeting alumni around the world who have turned their Auckland education into impactful careers. I recommend it.

Ngā mihi

PROFESSOR JOHN HOSKING
Dean of Science,
University of Auckland

Science pillars: navigating our future climate

Ngā Ara Whetū: Centre for Climate, Biodiversity and Society and the Climate Systems Laboratory.

Shutterstock

THE YEAR 2023 has delivered a confronting wake-up call to the world, with heatwaves, floods, and unprecedented weather systems destroying infrastructure, devastating communities, and displacing people across the globe. How we act in this moment will define our time and the future of generations to come.

Waipapa Taumata Rau, the University of Auckland is committed to being at the forefront of action on climate change in New Zealand, backing initiatives that support climate science, encourage cross-disciplinary research and establish relationships with various entities outside of academia that influence and drive action.

The Ngā Ara Whetū: Centre for Climate, Biodiversity and Society is the nerve centre of this vision, bringing together research from across the University.

Established in 2022, the centre is still in its infancy but already proving its value with impressive research output and engagement with the government through consultation on policy briefs and initiatives, specifically informing these projects on subjects fundamentally rooted in science.

Driving this output is another initiative, the Climate Systems Laboratory: a research centre emphasising disciplinary excellence that enables academics and their research from different fields to pursue a common goal, addressing the science of climate and environmental change. Leveraging the depth of knowledge emerging from core disciplinary research enables the holistic approach to addressing climate and biodiversity crises that Ngā Ara Whetū is well placed to foster.

"Academic institutions have always been placed in communities as a centre point for bringing people and ideas together. In meeting the challenges of societal transition needed to address climate change, again, the role of collective engagement with the processes of knowledge development is needed and where the University can help," says David Noone, Director of the Climate Systems Laboratory and Director of Strategic Engagement for Ngā Ara Whetū.

National governments worldwide are investing in application and engineered solutions to environmental change. This engagement is exciting, but we must recognise how basic science ultimately underpins action and decision-making. For this important work to continue, philanthropy has become essential to maintain investment in research.

The Faculty of Science is fortunate to have received philanthropic support from various partnerships. Notably, the support of Bill Buckley and Hilton Glavish has enabled the faculty to invest in research directly related to climate change, including the formation of the Professorial Chair of Climate Physics that Dr. Noone holds.

This kind of investment is invaluable to the faculty, supporting research into the science of climate change that will act as a pillar for the knowledge of the earth system on which a wider response to the climate crisis can be informed.

Despite being in the early stage of its existence, we can already see examples of valuable work coming out of the newly formed Climate Systems Laboratory.

Research is underway investigating the impact of the warming waters of the Pacific Tasman Sea on humidity and storms and how that informs the understanding of why intense flooding and rainfall events may continue to become extreme.

Optical and satellite remote sensing technology is in development, enabling measurements of national greenhouse gas emissions that can help guide national and international policy on transportation and agricultural practices.

The latest space-based observations are being used to improve understanding of sea ice near the Antarctic and its role in the potentially catastrophic collapse of the ice sheets.

> ***"The science of climate change encapsulates the amalgamation of different fields of the national sciences and engages the cutting edge of technology development in observing and modelling the world around us..."***
>
> DAVID NOONE, DIRECTOR, CLIMATE SYSTEMS LABORATORY

"The science of climate change encapsulates the amalgamation of different fields of the national sciences and engages the cutting edge of technology development in observing and modelling the world around us – a combination of skills and curiosity-driven enquiry that allow us to train our students to lead the world's best practices in scientific and related technical industries." Says Dr. Noone. "And who knows, we might just change the world for the better on the way."

Find out more: *ngaarawhetu.org*

OUR RESEARCH

Rising sea temperatures

A deep dive into what is happening in the Southern Ocean.

IT MAY BE ONE of the world's most energetic stretches of water, and a pain when ferries are delayed, but Cook Strait has become a natural laboratory for Professor Craig Stevens – and a window into the world of climate change.

As a member of the University of Auckland's Joint Graduate School in Coastal and Marine Science based at NIWA in Wellington, Craig has spent the past two decades studying the Strait's turbulent waters to better understand how the planet is dealing with rising sea temperatures.

"Ocean heat content is probably one of the big challenges facing humanity," says Craig, who points out that while oceans currently capture around 90 percent of the heat from greenhouse gases, "we can only get away with that for so long."

Through Marsden-funded projects like CookieMonster (Cook Strait Internal Energetics MONitoring and SynThEsis Research) and TEddy-BaarE (Turbulence EDDY BAthymetRy Experiments), Craig and his team have been investigating how ocean heat is mixed in the circular currents known as eddies.

"The ocean is full of eddies! We're looking at the relationship between these eddies and turbulence to see how the energy cascades from a one-kilometre horizontal eddy into three-dimensional mixing at a molecular scale."

Using the deep-water research vessel Tangaroa, whose running costs are being funded by MBIE to the tune of almost one million dollars, researchers have deployed a range of technology including an ocean glider and – for the first time in 2023 – an array of drifting turbulence sensors.

> ***"Ocean heat content is probably one of the big challenges facing humanity... we can only get away with that for so long."***
>
> PROFESSOR CRAIG STEVENS

"What's remarkable about that technology is its acoustic sampling of turbulence," says Craig. "Hopefully, it will enable us to capture the life cycle of an eddy."

The ocean turbulence research is part of a suite of ocean-climate projects that Craig leads. One of these is part of MBIE's Antarctic Science Platform that's studying Antarctic waters where Craig says a warming ocean "comes into contact with the largest chunk of ice on the planet and is melting it at a greater rate than it's done in the past."

"Due to its remoteness, there is much to learn about the Southern Ocean and the Antarctic circumpolar current," he says, "and it's quite exciting being able to do oceanography in a part of the planet's oceans that have never been sampled before."

Some of this work samples how eddies behave around the coast of Antarctica where oxygen is absorbed into the ocean and then works its way around the planet, in what scientists describe as a big 'conveyor belt', before it emerges several hundred years later. "It's what's oxygenating the oceans, it's the planet's lifeblood if you like."

The concern is that warmer oceans will interfere with the conveyor belt circulation or mixing process in deep ocean currents. "The melting ice is reducing the amount of oxygen that gets into the global ocean and, in a hundred years' time, we're going to see some significant changes in marine ecosystems and coastal ecosystems. We will be in for some surprises," says Craig.

Among the many unknowns is how deeply the upper ocean heat penetrates and how it is mixed and stored, which makes it difficult to feed parameters into long-term climate models that are looking out beyond this century.

"What's not in question is the basic heat budget and heat balance. We're trapping this amount of heat and it's going to melt this amount of ice. What's less certain is, is it going to be 500 years for a particular outcome or 200 years – and how will the impacts play out in different parts of the planet?"

Of immediate concern are rising sea temperatures which topped a record 36 degrees off the coast of Florida in mid-July, well above the 27 degrees which can typically kick-start tropical cyclones.

"If that really warm layer extends down 50 metres or more, then that can keep driving these increases in tropical cyclones," says Craig, "and that's where we come full circle back to understanding ocean mixing and how to get those parameters and processes into long-term climate models."

While U.S. states like Florida have millions of dollars' worth of measurement infrastructure in the water to provide forecasts about extreme weather events, Craig says that New Zealand has almost none of that infrastructure because there are "very few taxpayers, a lot of ocean, and not enough awareness of what the ocean does for us all."

But if we're going to see more cyclones like Gabrielle, he says there's going to be a need for more storm prediction and more emergency response which the U.S. has done for decades. "It will be something that we will be needing to take much more seriously here."

Along those lines, Craig also has an interest in how to capture renewable energy from the ocean as "it is very clear that we have to do everything possible to reduce our greenhouse gas emissions – and soon!"

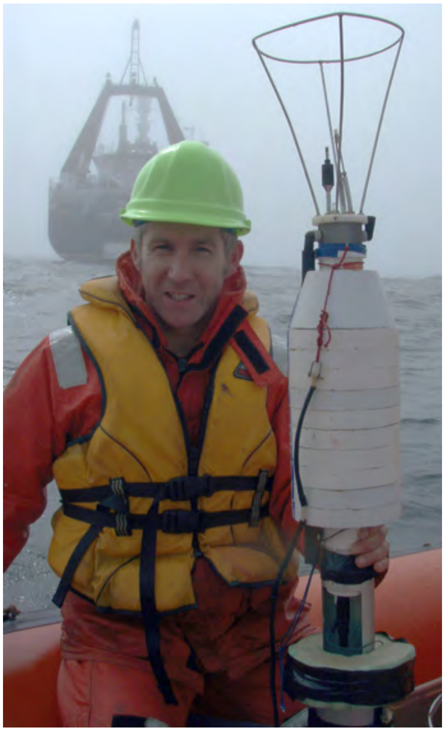
Another challenge for scientists is how to communicate the seriousness of the situation to people who are prone to switching off about an issue that's so far into the future. Craig says that being quite nuanced, especially with younger audiences, and striking a balance "about the vibe" is important.

"You need to be very clear to audiences that it's going to happen, we just don't quite know when."

Having a Te Ao Māori worldview about how oceans work also helps in this regard as it recognises the connectedness of systems, and he says that "we have to be very clear that everything we do to reduce emissions will improve outcomes."

On a personal level, Craig says that he's "in a privileged position" to be able to work at NIWA and be part of Auckland's Joint Graduate School because it allows him to directly connect with Crown Research Institutes through basic and applied science. "There's lots of benefits having those two sides of the table come together."

An oceanographic team aboard NIWA's *R/V Kaharoa* deploying an acoustic Doppler current profiler in Cook Strait. Facing page: Te Moana-o-Raukawa to measure flow variability in the highly turbulent waters of the strait.
Photos: Stevens/NIWA



Professor Craig Stevens.

Find out more:

Lawrence, J.D., Washam, P.M., Stevens, C. et al. (2023). Crevasse refreezing and signatures of retreat observed at Kamb Ice Stream grounding zone.

Stevens, C. L. (2018). Turbulent length scales in a fast-flowing, weakly stratified, strait: Cook Strait, New Zealand.

Stevens, C., Hulbe, C., Brewer, M., Stewart, C., Robinson, N., Ohneiser, C. and Jendersie, S., (2020). Ocean mixing and heat transport processes observed under the Ross Ice Shelf control its basal melting.

Valcarcel. A. F., Stevens C. L., O'Callaghan J., et al. (2022). Interacting wind-and tide-forced boundary-layers in a large strait.

Kelp forests

Are they nature's solution to carbon reduction and a greener future?

Photo: Caitlin Blain

AN AREA of research currently gaining momentum in the fight against climate change lies beneath the surface of our oceans.

Institute of Marine Science Research Fellow, Caitlin Blain, has dedicated seven years of her career to researching seaweed and kelp forests. After spending two and a half years in freezing Atlantic waters studying the impact of a seaweed called Desmarestia on biodiversity, she came to Aotearoa New Zealand, to complete her PhD.

Her work at the Leigh Marine Lab initially focused on the impact of anthropogenic stressors on kelp forest function and productivity, mainly coastal turbidity. A side component of this work led her to carbon sequestration. "As kelp photosynthesize, they draw down carbon into their tissues to grow, and they're kind of like these conveyor belts that keep growing and continually sloughing off tissue as they grow," she says.

It's a topic that is also gaining attention outside of academia, with interest from government, community groups, and private industry, all looking to kelp for answers. However, it is a complex process with many unanswered questions. For this reason, Caitlin explains, that despite being highly effective at processing CO2, kelp forests have typically been excluded from any estimates of blue carbon or climate mitigation schemes. While researchers are doing their best to keep up with industrial and government interest, a lot more work is needed to inform those initiatives.

Measuring the potential

Compared with terrestrial forests, where fallen leaves provide physical proof to account for carbon, it is much harder to identify what happens to carbon captured by kelp forests. This is because kelp grows on rock, so for the carbon to be sequestered, it has to be exported somewhere conducive.

Carbon comprises a whole suite of different chemical compounds, so Caitlin is looking at the different components of carbon as it is released from a kelp forest, where it might end up, and how long it might stay there. The hope is that scientists can provide measurable data to inform blue carbon budgets by unpacking this process.

She explains a lot of the existing literature is focused on tracing particulate organic carbon (POC). This is much more accessible because the particles are visible. In contrast, research on dissolved organic carbon (DOC) is not as well represented. The release of DOC is much harder to account for, but it's quite a significant makeup of what's released from the kelp and potentially longer lived. Closing this knowledge gap has become one of Caitlin's main focus areas at the moment.

Her research has returned some promising results, indicating that DOC could be important to consider in the future. Some experiments have shown that as much as 40 percent of the carbon released from the kelp forests in the dissolved form is long-lived. She compares this to other research on particulate matter, including her work, which measured around 10 percent of the tissue staying as an organic carbon that can be sequestered.

Unpacking the methodology

Caitlin uses a combination of laboratory and in-the-field (in situ) experiments to directly measure variation in POC and DOC production. These include sampling seawater from areas or tanks with and without kelp. "To collect the DOC associated with kelp in the field, I use photorespirometry chambers to monitor changes in photosynthesis and other biochemical processes in relation to different light levels and environments. Seawater samples are assessed for DOC using a total organic carbon (TOC) analyzer," she says. The assessment of DOC composition is still under development, but she will be using a range of techniques, including an untargeted assessment of metabolic profiles using gas/liquid chromatography.

To assess the longevity of POC and DOC, Caitlin uses laboratory and in situ degradation experiments across gradients of productivity and environmental factors. It is known from her previous work that there is a larger gradient in the morphology, productivity and chemical composition of kelp associated with the turbidity gradient in the Hauraki Gulf. "I've set up a degradation experiment across this gradient to examine how turbidity and kelp physiology impact carbon degradation. We will link these degradation experiments with microbial activity to see how this varies across environments," she explains.

Tackling a two-fold problem

While they show great potential in aiding carbon and pollution reduction, kelp forests also confront threats from factors like climate change and other influences.

Caitlin's earlier work focused on anthropogenic stressors threatening kelp forest function and productivity. This is still heavily integrated into her work today because in order to protect and benefit from kelp forests, it is vital to understand how the services they provide will change in the face of growing anthropogenic and climate-related stressors.

The challenge ahead is complex, and there is no one-size-fits-all solution. One of the most significant threats to kelp forest ecosystems in northeastern New Zealand is the destructive grazing by sea urchins. The Hauraki Gulf now has an abundance of sea urchins that have decimated kelp growth. The result is an imbalanced ecosystem. With fewer predators eating the sea urchins, they become more established. "Barrens can be extensive in northeastern New Zealand (Northland and the gulf), in some cases covering over 50 percent of the shallow reef. This means there's greatly reduced productivity and reduced potential for carbon sequestration," Caitlin explains.

Another concern is increasing turbidity caused by land runoff, particularly near cities and heavily developed coastlines, made worse by the recent storms and precipitation. The shallower water is more susceptible to sediment disruption, clouding the water and reducing the amount of light that can reach the bottom. Because kelp requires sunlight to photosynthesize, the reduction of light reaching the bottom limits the plants' productivity.

What steps can we take?

Actions should be targeted to address their region's individual stressors. Caitlin suggests fisheries management to help re-establish sea urchin predator populations responsible for kelp forest degradation.

> ***"A healthy ocean is truly our greatest ally in the fight against climate change, so we see Dr Caitlin Blain's research as vitally important."***
>
> SALLY PATERSON, LIVE OCEAN FOUNDATION CHIEF EXECUTIVE

By establishing a healthy ecosystem, the sea urchin population will return to a more manageable and natural level, allowing kelp forests to regenerate. She says tree planting and better coastal infrastructure management in problem areas will also help reduce sediment runoff.

Supporting the cause

Caitlin's postdoctoral research was funded by the George Mason Centre for the Natural Environment (GMCNE), a multi-disciplinary research center in the Faculty of Science.

Her current projects are funded by the Live Ocean Foundation (LOF), established by New Zealand sailing legends Peter Burling and Blair Tuke, to support marine scientists, innovators and communicators working to conserve and protect our oceans.

"A healthy ocean is truly our greatest ally in the fight against climate change, so we see Dr Caitlin Blain's research as vitally important. Her research will help fill critical knowledge gaps into the value of kelp in the blue carbon context and will help inform better marine management and conservation decisions, both here and globally.

"Live Ocean Foundation partners with exceptional marine scientists to inform action for a healthy ocean. We are incredibly proud to support Caitlin's work and pleased that we're able to help retain one of the world's best and brightest minds in this field here in New Zealand where we are guardians to one of the largest ocean spaces on the planet," said Sally Paterson, Live Ocean Foundation Chief Executive.

Caitlin also continues to collaborate with her PhD supervisor and current mentor, Associate Professor Nick Shears, on aspects of kelp forest restoration, with ongoing work in the Hauraki Gulf/ Te Moananui-ā-Toi and Queen Charlotte Sound/Tōtaranui with the support of local iwi.

Photo: Celia Balemi

Where to from here

Caitlin is optimistic, "Our marine ecosystems can be incredibly resilient when not subjected to the constant pressures we place on them. With more knowledge and outreach, I am hopeful that more people will understand the value and vulnerability of our hidden forests."

Find out more:

Blain, C.O., Hansen, S.C., Shears N.T. (2021) Coastal darkening substantially limits the contribution of kelp to coastal carbon cycles.

Blain, C.O., Shears, N.T., (2020) Differential response of forest-forming seaweeds to elevated turbidity may facilitate ecosystem shifts on temperate reefs.

Blain, CO., Shears, N.T., (2020) Nutrient enrichment offsets the effects of low light on growth of the kelp Ecklonia radiata.

Blain, C.O., Shears, N.T., (2019) Seasonal and spatial variation in photosynthetic response of the kelp Ecklonia radiata across a turbidity gradient.

Collaborations:

Eger, A.M., Marzinelli, E.M., Baes-Luna, R., Blain, C.O., Blamey, L.K., Byrnes, J.E.K., Carnell, P.E., Choi, C.G., Hessing-Lewis, M, Kim, K.Y., Kumagai, N.H., Lorda, J., Moore, P., Nakamura, Y., Perez-Matus, A., Pontier, O., Smale, D., Steinberg, P.D., Verges, A. (2023) The value of ecosystem services in global marine kelp forests.

Cornwall, C.E., Nelson, W.A., Aguirre, J.D., Blain, C.O., Coyle, L., D'Archino, R., Desmond, M.J., Hepburn, C.D., Liggins, L., Shears, N.T., Thomsen M.S. (2023) Predicting the impacts of climate change on New Zealand's seaweed-based ecosystems.

Qu, Z., Thrush, S., Blain, C.O., Lewis N. (2023) Assessing the carbon storage value of kelp forest restoration in the Hauraki Gulf Marine Park, New Zealand: Lessons from no-take Marine Protected Areas.

From computer science to environmental scientist

How a passion for surfing inspired a career in oceanography and climate change.

IN 2012 João Albuquerque stepped out of his comfort zone as a computer scientist and into the classroom as a lecturer at Federal University of Paraná and Pontifical Catholic University of Paraná. The experience inspired him to take on his PhD. A decision that brought him to Aotearoa New Zealand, and landed him a role as an oceanographer and climate scientist.

A surfer since the age of thirteen, João's passion for the ocean led him to a PhD in Environmental Sciences. His research is focused on the characteristics of the wave climate, ocean waves around New Zealand, and climate change effects in this area towards the end of the century.

João now works for MetOcean Solutions, an oceanographic consultancy which is a branch of MetService New Zealand. He creates wave simulations to design nearshore structures such as ports and harbours and estimate sediment transport and erosion on beaches.

"Until recently, we have only used past data from models and observations in our simulations, which might not represent the future wave climate. However, we are now also working on adding information about the future wave climate in our simulations," he said.

Can you describe a project or initiative you are particularly proud of and explain its significance?

"When we work with the future wave climates, which is part of my PhD research, the design of nearshore structures can be future-proof, and this can potentially increase our resilience for climate change. The same can be done to analyse whether our beaches will erode or accrete towards the end of the century, providing decision-makers with critical information for coastal management. This ongoing effort may benefit New Zealand and its coastal communities for years to come, which is amazing."

Has your experience in Computer Science contributed to your climate work?

"My programming and computer science background equipped me with valuable skills I could apply to my postgraduate research to understand the effects of climate change on New Zealand's wave climate. I built tools for pre-processing all

João Albuquerque. Photo: Ana Holub

the data needed for my models, running thousands of simulations, and post-processing all the data generated into tangible, condensed information to make a thorough analysis."

Did any scholarships support you during your study?

"GNS Science, Te Pū Ao funded the Climate Change Impacts on Weather-Related Hazards project. This was really valuable, as it made everything possible. If it weren't for this scholarship, it would not have been possible for me to work on this project with my supervisor."

What did you like most about the programme and why?

"It is a well-structured programme that allows freedom to attend the courses you want and need to. We frequently have lectures or seminars from renowned researchers and many other activities to learn and socialise. Also, the University's facilities are very good for study and leisure."

What advice would you give to someone considering studies related to climate change?

"This area includes many complex systems that feed back into each other. Hence, I'd advise them never to forget their critical thinking and always think outside the box. Even though we have been witnessing extreme events recently and we need a solution for the climate crisis, there is a lot to be understood on the subject before we can say what is causing it and what is evidence of it. There are, for example, cases of increased temperatures caused by internal climate variability that are not related to climate change. So, one must be careful when analysing the climate to avoid attributing such isolated events to global warming."

Anything else that you'd like to mention about your time at the University of Auckland?

"It was an amazing time despite the pressure. The University's staff were always friendly and helpful, and I had the opportunity to make great friends. I attended conferences and training in different parts of the world and met incredible people. On top of that, Professor Giovanni Coco is an outstanding person and supervisor who is now a good friend of mine. I got a lot more from this PhD journey than I would have ever imagined."

Finally, tell us something about yourself we can't learn from Googling you!

"I can brew beer, and I used to sing in a band back in Brazil."

Find out more:

Albuquerque, J., Antolínez, J. A. A., Gorman, R. M., Méndez. F. J., Coco, G. (2021). Seas and swells throughout New Zealand: A new partitioned hindcast.

Albuquerque. J., Antolínez, J. A. A., Méndez, F. J. & Coco, G. (2022) On the projected changes in New Zealand's wave climate and its main drivers.

Albuquerque, J., Antolínez, J. A. A., Rueda. A., Méndez, F. J., Coco. G. (2018). Directional correction of modeled sea and swell wave heights using satellite altimeter data.

Albuquerque, J., et al. (2021). Priorities for Wind-Waves Research.

Albuquerque, J., et al. (2020). 15 Priorities for Wind-Waves Research: An Australian Perspective.

Albuquerque, J., et al. (2018). Marine climate variability based on weather patterns for a complicated island setting: The New Zealand case.

Saidelles, .C. W., Ramos, M. S., Farina. L., Nicolodi. J. L., Albuquerque, J., Fernando, J., Méndez, F. J. (2022). Directional correction of ERA5 and CAWCR wave spectrum partitions in the Southeast Brazil.

Building a sustainable future

Chemistry graduate applying new technologies and research to advance positive change in the construction sector.

Dr Ashley Lindsay. Photo: James Angus

INSPIRED BY an encouraging high school teacher, Dr Ashley Lindsay's academic journey began as an undergraduate chemistry student at the University of Auckland. After completing a doctorate and working as a Research Fellow, she is now employed as an Innovation Catalyst for Fletcher Building.

The main focus of her role is reducing the impact of the building process on the environment by evaluating new technologies and research related to the building sector.

"The building industry significantly contributes to carbon emissions and has a massive and unsustainable environmental footprint. At Fletcher Building, there is a strong desire to change how we do things to reduce our environmental impact," she said.

What academic pathway led you to your current role?

"I studied a Bachelor of Science(BSc) with a specialisation in Medicinal Chemistry, followed by a PhD in Organic Chemistry. After completing my PhD, I worked as a Research Fellow at the University in the Green Chemistry Programme."

What did you like most about the programme?

"I enjoyed the freedom to experiment in the lab and learn new techniques. I also valued the support from my supervisor, who encouraged creative problem solving and allowed the research to take its course even when we didn't get the results we anticipated or hoped for – as is the nature of research."

How has your education experience at the University of Auckland influenced your work on climate change?

"Chemistry is traditionally a high-waste, high-emitting, high-environmental impact industry. When I transitioned to being a Research Fellow in the Green Chemistry programme, it required me to analyse the way I had approached doing chemistry in the past and rethink – find green solutions to classically environmentally detrimental processes. These are the same skills I apply to my current position."

What was your research/thesis topic?

"My PhD research was in the total synthesis of marine-derived natural products possessing a unique chemical structure – Iheyamines A and B, found in the ascidian Polycitorella Sp. As a Research Fellow, I worked in the green chemistry space. I sought sustainable ways to synthesise organic molecules that avoided traditionally toxic and environmentally damaging reagents. This involved looking at the valorisation of lignin, the electrochemical synthesis of indole derivatives, and investigating the use of mechanochemistry in organic synthesis."

Can you describe a work project or initiative you are proud of?

"I am particularly proud of the relationships with the universities we have developed. Relationships between researchers and industry are vital for the New Zealand economy going forward, particularly with the challenges we, as a country, face around climate change."

Where do you see your career taking you?

"Honestly, I don't know where my career will go, but I have an open mind! My current role was not something I envisioned when I did my Bachelors or PhD, so I am open to wherever this role might take me."

What advice would you give to someone considering studies related to climate change?

"Keep an open mind. There are industries and positions you can apply your skills to that you never dreamed of when you began your studies. So, keep your mind open to new avenues and the changing nature of this field. I never imagined that my studies in Medicinal chemistry as an undergraduate would lead me to where I am today."

Finally, tell us something we can't learn from Googling you!

"I have co-written a Young Adult Fiction novel called *When the Rain Falls* under the pen name Sasha A. Linderson."

Find out more:

Giraldo. J. J. A., Lindsay. A. C., Seo, R. C., Kilmartin, P. A., Sperry, J. (2023). Electrochemical oxidation of 3-substituted indoles.

Lindsay, A. C., Kilmartin, P. A., Sperry, J. (2021). Synthesis of 3-nitroindoles by sequential paired electrolysis.

Lindsay, A. C., Kudo. S., Sperry. J., (2019). Cleavage of lignin model compounds and lignin ox using aqueous oxalic acid.

Pham, T. T., Lindsay, A. C., Chen, X., Gözaydin, G., Yan. N., Sperry. J. (2019). Transferring the biorenewable nitrogen present in chitin to several N-functional groups.

Qiu, Y., Te, P. K., Duplan, C. C., Lindsay, A. C, Sperry, J. (2021). Tetrahydrocarbazoles by mechanochemical Fischer indolisation.

Above: The Parade, Bucklands Beach.
Photo: Shutterstock/Emagnetic

Predicting the future of Aotearoa New Zealand's coastline

Understanding the timeline of shoreline erosion with numerical models, satellite data and machine learning algorithms.

NEARLY TWO-THIRDS of Aotearoa, New Zealand's population lives by the coastline. Our communities and infrastructure are inextricably intertwined with the coast, and the future of our shorelines seems to be playing on everybody's mind, especially after the severe weather events of earlier in 2023.

Professor Giovanni Coco, from the School of Environment, is aware of the need to understand shoreline processes and to predict the future impacts of climatic change on our shorelines if we are to safeguard ourselves, and our coastal communities, more effectively in the future.

Urban beaches

Broadly speaking, one of Giovanni's research interests focuses on what happens at the very end of the huge body of work that is attempting to predict the impacts of climate change on the coast. This includes a variety of hazards, such as coastal flooding and erosion. One of the areas that Giovanni has become passionate about and intends to explore in detail is the future of urban beaches in Aotearoa New Zealand.

Professor Giovanni Coco.

Urban beaches, such as those found in Auckland's Waitemata and Manukau Harbour and in Wellington, are beaches that the public tends to use a lot. Beaches in these areas are not exposed to the open ocean waves and are often backed by sea walls. They serve as popular recreational areas, but also as protection for public infrastructure and private properties.

While necessary as a kind of defence mechanism, the presence of sea walls on these urban beaches also restricts the natural movement of their shoreline in response to waves and rising sea levels. Because of this, as sea levels rise, Giovanni points out that these urban beaches will slowly but inevitably get narrower and narrower. The sea walls backing these beaches will also become less effective against more frequent inundation events.

The need to improve current strategies or develop alternative strategies to protect infrastructure and manage erosion in urban coastal areas like this is, therefore, becoming increasingly important.

We know our shorelines will be impacted by climatic change and are already aware of these impacts occurring. Giovanni's job, as he says, is trying to predict when this is likely to happen.


Rothesay Bay beach, 19 May, 2016 and February 2023 (right). Photos: Matthew McNeil

Our changing coast

One of the ways in which Giovanni is working on these predictions is through a project funded by the Ministry of Business, Innovation, and Employment (MBIE) and led by Victoria University in Wellington called 'Our Changing Coast'. This multimillion-dollar project has multiple packages. Giovanni leads the one dealing with the impacts of climate change on the coastline.

Giovanni and his team have developed numerical models that help to predict shoreline evolution also under the effect of sea-level rise. He and the team take predictions from global climatic models and scale those results into the local storm surge and wave climate. Using a variety of models, they have also calculated the projected wave climate and storm surge until the year 2100. This type of data is critical to assess what is likely to happen to our beaches in Aotearoa New Zealand.

Satellites and data

For 'Our Changing Coast', Giovanni's team are collaborating with researchers at the University of New South Wales, who have developed techniques to extract shoreline data from satellite images.

To collect this satellite data, "first of all, you need the sky to be cloudless," Giovanni chuckles, "which in New Zealand is a little bit of an issue." After that, using several images and correcting for tidal levels, researchers can see where the shoreline is.

Using this data, they then develop and test numerical models, also based on machine learning, that allow the team to develop the future of Aotearoa, New Zealand's beaches, under climatic changes.

The future of our beaches

So, what does this mean for your favourite local beach? Thankfully, we will not lose all our popular beaches. Giovanni explains that there are still a lot of beaches in Aotearoa New Zealand, where we haven't built infrastructure too close to the dunes. Beaches like this are likely to move landward and, therefore, might get a bit smaller, but they will not disappear.

However, those urban beaches that are backed by sea walls have less room for movement. These beaches pose a unique challenge when it comes to shoreline erosion. "It's not a bright future for those beaches," Giovanni says.

Predictions and projections

While predictions regarding shoreline erosion and sea level rise are valuable, Giovanni makes it clear that it is crucial to acknowledge the uncertainties associated with such long-term predictions.

"Every time you have a prediction, you also have to account for the uncertainties," Giovanni explains.

Uncertainties become more and more significant the further into the future you try to predict. Giovanni points out that some scientists, therefore, wonder how significant the idea of 'predictions' actually is, and if we should even call them predictions at all.

Perhaps 'projections' is the alternative. "A projection," Giovanni explains, "focuses on scenarios, on plausible futures. Whereas, a prediction looks at the most probable future."

"We're entering a stage where we have a lot of data available and so that means we can better test models. The hope is that we can build better models, and yes, our ability to predict is improving."

PROFESSOR GIOVANNI COCO

Where to next?

Predicting shoreline erosion accurately has been challenging in the past due to the complexity of beach dynamics and sediment movement. "There are a lot of things that we know that we don't know," he says.

Perhaps the key to filling those gaps lies in harnessing artificial intelligence. "I thought it was a good idea to try to explore the possibility of using artificial intelligence and machine learning algorithms to predict shoreline erosion. Right now, a PhD student is looking at what is called 'deep learning' to predict shoreline change, and his results are better than any existing model we compared."

In the face of an uncertain climate future, Giovanni speaks positively about improving our ability to make predictions about the shoreline and coastal dynamics. "We're entering a stage where we have a lot of data available and so that means we can better test models. The hope is that we can build better models, and yes, our ability to predict is improving."

Find out more:

Cooper, J. A. G., Masselink, G., Coco, G., Short, A.D., Castelle, B., Rogers, K., Anthony, E., Green, A.N., Kelley, J.T., Pilkey, O. H. and Jackson, D. W. T., (2020). Sandy beaches can survive sea-level rise.

Montaño, J., Coco, G., Antolínez, J. A., Beuzen, T., Bryan, K. R., Cagigal, L., Castelle, B., Davidson, M.A., Goldstein, E.B., Ibaceta, R. and Idier, D., 2020. Blind testing of shoreline evolution models.

Vousdoukas, M. I., Ranasinghe, R., Mentaschi, L., Plomaritis, T. A., Athanasiou, P., Luijendijk, A. and Feyen, L., (2020). Sandy coastlines under threat of erosion.

Scanning the horizon for climate risks and opportunities

Te Pūnaha Matatini has brought together a cluster of researchers from across Aotearoa to make a real and measurable difference to understanding climate change impacts, and to find solutions.

Photo: Unsplash / Pascal-Habermann

CLIMATE CHANGE is the ultimate complex problem, and developing transdisciplinary approaches that can understand and respond to this complexity is crucial. Te Pūnaha Matatini is the Aotearoa New Zealand Centre of Research Excellence for complex systems, hosted by the University of Auckland in the Faculty of Science.

Over the last decade, Te Pūnaha Matatini has been building a transdisciplinary community of researchers with interests and expertise centred around complexity. They now have 101 principal investigators from universities and research institutes throughout Aotearoa New Zealand.

A cluster of researchers from this community has come together to make a real and measurable difference to understanding climate change impacts, and to find solutions. “There is an aspect of climate change in the research of many investigators at Te Pūnaha Matatini,” says Associate Professor Cate Macinnis-Ng from the School of Biological Sciences, who co-leads the climate change cluster with Professor Adrian McDonald from the University of Canterbury. “We want to connect all that expertise and focus on solutions and outcomes.”

“A horizon scan is a novel approach to apply to climate change, and a great way to leverage the transdisciplinary strengths of Te Pūnaha Matatini.”

Clusters are a new part of the structure of Te Pūnaha Matatini, introduced under its second director Associate Professor Cilla Wehi from the University of Otago. They bring researchers at Te Pūnaha Matatini together over shared interests and ideas. The climate change cluster sits alongside clusters focusing on healthcare, storytelling, and the future of food in Aotearoa New Zealand.

The climate change cluster includes expertise in ecology, business, mathematics, philosophy, human geography, history, science communication, statistics and physics, with members from all six of the universities in Aotearoa and many of the other research facilities across the country.

“Work in climate change is changing very quickly, and a group that has expertise in complexity can make a lot of useful contributions,” says Principal Investigator Troy Baisden, from the School of Environment.

One of the first actions of the cluster was to undertake a horizon scan to identify and prioritise threats and opportunities from climate change. This process uncovered key, under-discussed topics relevant to climate change in Aotearoa. This mahi was led by Cate and Dr Will Godsoe from Lincoln University.

Horizon scanning is an established method used by ecologists to identify potential emerging threats. It is a systematic approach to identifying medium- to long-term threats or opportunities that have not yet been identified in a particular field. Cate suggested applying the horizon scan process to climate change, after her experience with an earlier horizon scan looking at emerging threats in urban ecosystems. This earlier piece of work looked exclusively at threats, but Will pushed the team to include opportunities as well as threats in their work on climate change. Will explains that including

Associate Professor Cate Macinnis-Ng.
Photo: Chris Loufte

> ***"One of the best parts of the process was working together on a different way to collaborate."***
>
> ASSOCIATE PROFESSOR CATE MACINNIS-NG

opportunities as well as threats matches with current best practices for climate change education, which emphasise "hopeful alarm" rather than doom and gloom.

A horizon scan is a novel approach to apply to climate change, and a great way to leverage the transdisciplinary strengths of Te Pūnaha Matatini. Its researchers have learned over many years that working together to transcend disciplinary boundaries is a significant challenge, and they are constantly testing new ways of working together to achieve this outcome.

The Faculty of Science at the University of Auckland was strongly represented in this work by Cate, Troy, Dr Emma Sharp from the School of Environment and Associate Professor Ilze Ziedins from the Department of Statistics.

"One of the best parts of the process was working together on a different way to collaborate," says Cate. "Truly transdisciplinary research is rare but it is highly rewarding. Often when we collaborate, some individuals or disciplines may be more dominant but the horizon scan approach created a more level playing field."

Troy enjoyed the creativity of the horizon scan process. "Pitching things for inclusion was fascinating," he says. "Because often as academics our job is to criticise, but this was more of a creative process."

Using this process, the team identified the ten most important opportunities and threats (see box below).

These were selected from 171 threats and opportunities identified from the diverse fields of research of the participants. Each item was scored for novelty and potential impact and the list was reduced through a prioritisation process. At each scoring step, participants were asked to focus on novel and important climate change related issues that – based on their knowledge and experience – could impact Aotearoa in the medium to long-term.

For Ilze, "one of the strengths of this horizon scan is that it highlights some of the ways in which we might respond to climate change, and things we could do – some of which are happening already."

"Extreme events disproportionately affect people and places, and it is important that we respond in ways that support everyone in Aotearoa. We illustrated that we could do this during Covid-19, which was happening on a very fast time scale. Climate change is happening on a slower time scale (although faster than we might hope), but work like this shows how we can build a thoughtful and coordinated response."

The results of this horizon scan have been published in a special edition of the *Journal of the Royal Society of New Zealand*, focusing on climate change in Antarctica and Aotearoa. The paper is co-authored by thirteen Te Pūnaha Matatini principal investigators, with Cate and Will taking the lead.

The transdisciplinary strength of this group and its approach demonstrates the value of the transdisciplinary networks and approaches that Te Pūnaha Matatini has developed.

"For climate change and other environmental issues, things need to be done rather than studied," says Troy. "We know enough to take the action we need, we're just not getting it on to peoples' to-do list. One of the reasons that I'm involved with Te Pūnaha Matatini is that it can turn our understanding of a complex problem into clear actions."

"Our previous director Shaun Hendy is now working in the fast-moving climate change space at the start-up Toha," says Troy. "That says a lot about who we are as Te Pūnaha Matatini."

Find out more:

tepunahamatatini.ac.nz

Macinnis-Ng, C., Ziedins, I., Ajmal, H., Baisden, W. T., Hendy, S., McDonald. A., Priestley, R., Salmon, R. A., Sharp, E L., D. Tonkin, J., Velarde, S., Watene, Krushil (Ngāti Manu, Te Hikutu, Ngāti Whātua Ōrākei, Tonga) & Godsoe, W. (2023) Climate change impacts on Aotearoa New Zealand: a horizon scan approach.

The ten most important opportunities and threats

Opportunities

- Benefits from deploying technological solutions
- Financial disclosures improve
- Crop change to climate-friendly farming
- Food futures and agricultural identity
- Shifts to carbon capture and biodiversity farming
- Role of future generations now
- Changing epistemology incorporating Māori perspectives
- Awakening critical mass
- Recognising utility and value of soils
- Inclusive perspectives for better food production

Threats

- Siloed policy exacerbates other stressors
- Black swan events
- Poor preparation for heatwaves
- Interactions between extreme events
- Increasing disease outbreak
- Carbon uptake and storage poorly accounted for
- Increasing social inequity
- Eco-anxiety
- Global pandemic distracts from climate action
- Colonisation due to livable land

Cultivating a culture for climate action

CONFRONTING THE climate crisis is one of the most pressing issues of our time. The cause demands unprecedented levels of cooperation and collaboration from a world that seems more divided than ever. So, do we have the capacity to cooperate at the level required to change our trajectory?

Professor Quentin Atkinson believes the field of psychology has a lot to contribute to the conversation, but he is cautious about the potential for simplistic recommendations, recognising there is still so much we don't know.

He studies human cultural variation and the evolution of human culture. He is particularly interested in aspects of culture that help people cooperate and coordinate, like language, religion and political ideology.

His current research is specifically concerned with how these subjects apply to climate action, noting that despite being widely acknowledged in mainstream media and politics for decades and many initiatives and international agreements, progress toward tackling the climate crisis has been remarkably slow.

His research disputes claims that humans are not evolved or are inherently ill-equipped to deal with the climate crisis and highlights how cultural diversity may be key to solving the climate crisis.

Contesting claims

While on sabbatical in New York, Atkinson and NYU Associate Professor Jennifer Jacquet uncovered some interesting insights.

The pair produced a literature review challenging the validity of more than two dozen claimed psychological biases or barriers to tackling climate change. They pushed back on claims that evolution has left humans particularly ill-equipped to tackle climate change, which Atkinson says are "based on empirical evidence that is weak or doesn't necessarily translate to the real world."

Atkinson believes these claims aren't just inaccurate but may even be dangerous, perpetuating misinformation.

Counter to claims that humans are better suited to short-term problem solving or are inherently selfish; he argues evidence instead supports that humans are uniquely forward-thinking and cooperative. On cooperation, he says, "interestingly, humans tend to be conditional cooperators, so we're happy to cooperate if others are, which I think will be key to solving this problem".

"If we are going to solve the climate crisis, we need to be able to step outside our current cultural matrix and consider alternative ways of viewing and understanding the world."

PROFESSOR QUENTIN ATKINSON

The good news is people do care about climate change. Atkinson points to a recent Pew Research Center report on a survey carried out during the height of Covid-19 that revealed climate change to be a highly perceived threat across European countries, even during a global pandemic with immediate and tangible threats dominating news cycles.

Above: Fridays For Future: 30,000 protesters unite against climate policy in Munich, on 20 September 2019. Shutterstock/ FooTToo

So, what is holding us back?

Quentin believes the barriers to action are better viewed in our culture and social norms, not our genes. We operate within culturally constructed norms influenced by our values and ideologies. These are perpetuated by the institutions we have created. "If we are going to solve the climate crisis, we need to be able to step outside our current cultural matrix and consider alternative ways of viewing and understanding the world," he said. This leads to another area of research Quentin is focused on, linguistic and cultural diversity.

Linguistic and cultural diversity are intrinsically connected and heavily influence our perspectives. Quentin says this provides us with a massive resource of alternative ways of making sense of the world, a resource we should be tapping into.

This makes it all the more troubling to learn that the world is also in the midst of another crisis: the predicted extinction of as many as half of the world's roughly 7000 languages by the end of the century, taking with them valuable insights that could help shape new norms conducive to a more sustainable future and contribute to climate action.

Professor Quentin Atkinson. Photo: Billy Wong.

What do we stand to lose?

Much of Quentin's work has sought to understand the processes of cultural evolution that both generate and erode this rich diversity. "We're using models and database tools borrowed from evolutionary biology and applying it to languages to build a picture of the world's linguistic diversity – the linguistic equivalent of Charles Darwin's Tree of Life," he said. This new knowledge can be applied to unanswered questions that will help us identify where we will find the most diversity globally and how to protect it," he said.

"Modern linguistic diversity emerged over the last 100,000 years as anatomically modern humans expanded within Africa and then spread out to colonize the globe, ultimately producing the 7,000 languages we see in the world today," he said. "If we add up the thousands of branches in this global tree of language, each one an independent evolving lineage, we find there are over 10 million years of cultural evolution packed into the last 100,000 years of human history. I love that number because it gives some sense of the enormous wealth of accumulated knowledge carried by languages and the people who speak them around the globe".

"Unfortunately, some of my work is showing that linguistic diversity is even more fragile than biodiversity," he said. Atkinson points out that evolutionarily unique species with no close relatives (like the platypus) don't seem to be more at risk of extinction than species with many close relatives. But the same is not true of languages – those with few close relatives are also more at risk. This means these languages will take with them even more unique cultural diversity should we lose them.

> ***"Interestingly, humans tend to be conditional cooperators, so we're happy to cooperate if others are, which I think will be key to solving this problem".***
>
> PROFESSOR QUENTIN ATKINSON

Where to from here?

There is still a lot of work ahead. Quentin is quick to point out he does not have all the answers. He says psychology has much to contribute to the cause, but staying humble and admitting what we don't know is important. "My own discipline of psychology is crucial to tackling the major challenges of the 21st century, but we need to be realistic about the current state of knowledge, and there is much we don't know," he says. Te Pūnaha Matatini, the Aotearoa New Zealand Centre of Research Excellence for complex systems, has recently provided seed funding to help Atkinson and colleagues work on indigenous and traditional knowledge. Still in the early stages of development, he hopes to learn how these perspectives might positively influence strategies for tackling the climate crisis. "One advantage of studying human cultural evolution is you have a very clear sense of how transient and contingent cultural systems are, and that includes the current dominant global cultural system, which is not more than a couple of centuries old. It's clear we'll need to find new cultural values, norms, and institutions if we're to solve the climate crisis, and I think we'd be crazy not to try to listen to speakers of as many of the world's 7,000 languages as we can, and the accumulated wisdom of 10 million years of cultural evolution that they represent."

Find out more:

Atkinson, Q.D. & Jacquet, J. (2021) Challenging the idea that humans are not designed to solve climate change.

Bouckaert, R., Redding, D., Sheehan, O, Kyritsis, T., Gray, R., Jones, K. E., Atkinson, Q. (Under review). Global language diversification is linked to socio-ecology and threat status.

Cyclone Gabrielle

Understanding Aotearoa's shifting terrain.

DAMAGE FROM landslides typically exceeds 300 million dollars a year, but that cost will be an order of magnitude higher in 2023, thanks to the impact of Cyclone Gabrielle.

While they may have come as a shock to those who lost homes and livelihoods, many of the earth movements in the Gisborne region came as no surprise to School of Environment Associate Professor Martin Brook. "They were in predictable areas, and they sped up as the slopes started moving more quickly during Cyclone Gabrielle."

What's more, Martin says the resulting damage to some properties was also preventable because landslides were exacerbated by human factors such as clearing trees and vegetation off slopes and cutting into slopes for roads and residential subdivisions.

"The soils are weak and very sensitive to changes in moisture content, very much the last place you'd build houses – but that's where people were building."

The unstable land around Gisborne was very much on Martin's radar before Gabrielle struck, thanks to a four-year research project funded by the Earthquake Commission with 'in-kind' support from the Gisborne District Council.

"From a scientific standpoint, it actually gives you a really good opportunity to understand what is generating these landslides," says Martin. "Then you can start unpacking; where have they occurred? What size are they? Are they all on north-facing slopes, for example?"

> ***"The soils are weak and very sensitive to changes in moisture content, very much the last place you'd build houses – but that's where people were building."***
>
> SCHOOL OF ENVIRONMENT ASSOCIATE PROFESSOR MARTIN BROOK

According to standard classifications, there are 32 different types of landslide which are categorised by factors such as their failure mechanism, the speed at which they move and whether they're constrained by topography, which could 'super elevate' material out of a channel.

"Understanding the type of landslide is really important," says Martin, which is why his research involves a range of techniques – from site visits to soil samples and remote sensing. Another key tool is LIDAR (Light Detection and Ranging) imaging, which produces high-resolution digital elevation models of land surfaces that are fed into predictive models.

Landslides are typically triggered by either earthquakes, which produced an estimated 40,000 landslide events when Kaikoura was struck in 2016, or heavy rainfall which can typically generate more than 10,000 landslides in a single major weather event.

Martin's research also draws on data from the European Space Agency's Copernicus Sentinel-1 satellite which has a 12 day revisit time and provides raw data that needs further analysis with algorithms to make sense of it.

Slope movement can be calculated in millimetres per year, and across Europe, the so-called InSAR monitoring has revealed how far and fast slopes have moved over the past five years – something Martin says would be great for New Zealand. "If we had something like that in New Zealand it would be fantastic. That's something that GNS, the other Crown Research Institutes or MBIE or EQC need to do."

In the case of Gisborne, 2023 has produced what's known as MORLEs – Multiple Occurrence Regional Landslide Events – which Martin believes were related more to land use change than climate change. "Land use change practices were causing a big problem in Gisborne, and it just makes the landscape less resilient when a big dump of rainfall comes along."

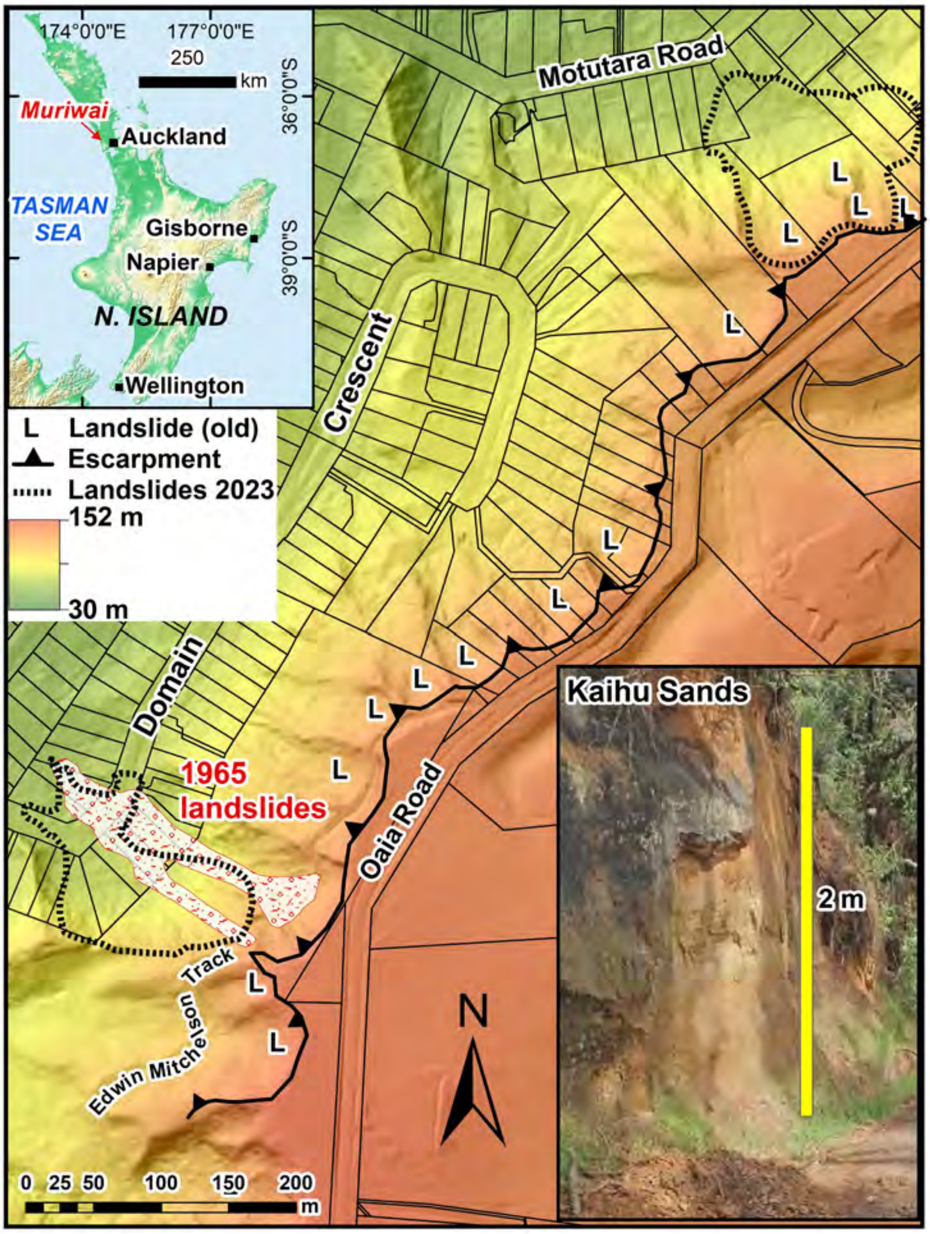
Nevertheless, climate change is expected to have an increased influence on the frequency of landslides because of extreme weather conditions which include rainfall intensity and rising temperatures.

In very dry summers, Martin says the clay-rich soils which are common around Gisborne and parts of Auckland are likely to shrink and crack with deep fissures which destabilise and weaken the soil – and allow rainfall to penetrate more deeply. "It's not just rainfall, but temperature extremes are probably an issue as well."

Which is why events like Cyclone Gabrielle are so important in terms of understanding the dynamics behind landslides. "It's a range of factors; you've got to understand the soil and the rock properties. You've got to understand the shape of the landscape known as the geomorphology."

"That 1981 Act has left a legacy in New Zealand. There's some really bad building and it's a problem."

SCHOOL OF ENVIRONMENT ASSOCIATE PROFESSOR MARTIN BROOK



LiDAR-derived digital elevation model, created by Martin Brook, revealing pre-existing ancient landslides (highlighted in gray) alongside newly identified 2023 landslides (marked with distinctive black hashed lines).

Facing page: Taurau Valley Road, Gisborne in February 2023, following Cyclone Gabrielle. (source: Murry Cave)

Looking ahead, Martin is concerned about 'legacy issues' created by the Local Government Amendment Act 1981 which absolved local authorities for any civil liability arising from building on unstable land. "That 1981 Act has left a legacy in New Zealand. There's some really bad building and it's a problem."

In particular, he sees a need for realistic setback distances in building codes – like the rigid distances applied in the Californian city of Santa Cruz – which would provide greater protection for buildings at the top and toe of slopes when material is brought down in a landslide.

To that end, he says that the recent slope stability hazard maps and planning controls included in the Hutt City Council's District Plan "sounds like a great idea", although something "more nuanced" might be required in Auckland because of its varied geology.

However, Martin is disappointed that Auckland City Council's 'Making Space for Water' initiative, announced in early 2023 as part of the city's flood recovery programme, doesn't reference landslides in its flood management plan. "Floods and landslides are two sides of the same coin in terms of a storm event," he says. "It needs to be a bit more holistic, I would have thought."

He also questions whether there's a level playing field when it comes to red-stickering properties after major weather events – especially given that it's such an emotive issue and "potentially condemns somebody to a financial disaster."

Decisions are currently being made by structural engineers, but Martin says that a team of people – including geotechnical engineers or geologists – should look beyond the structural integrity of a building and include the land around it. "The accuracy and the efficacy of this whole stickering needs to get looked at, in my view."

One initiative that he'd like to see is the establishment of a Central Office of Geotechnical Control along the same lines as that established in Hong Kong after the 1972 landsides where at least 156 people died when several apartment complexes and houses were wiped out.

"The events this year have already cost the public and private sector 12 billion dollars, so I think that spending a few million setting up a satellite monitoring service would not be a big deal."

Find out more:

Cook, M. E., Brook, M. S., Tunnicliffe, J., Cave, M., & Gulick, N. P. (2022). Preliminary investigation of emerging suburban landsliding in Gisborne, New Zealand.

Hikoi for change

Embracing a Te Ao Māori worldview and the connection between tangata whenua and Te Taiao.

HAVING WALKED the length of Aotearoa on three separate hikoi since 2013, Dr Phillipa Pehi has borne witness to the impact that climate change is having on the landscape and the people she meets along the way.

"Over the time that I've walked, it seems like this is one of the issues that have increased, but people's awareness has also increased – often out of necessity," she says.

As a Research Fellow within the Faculty of Science's new Ngā Motu Whakahī-Raising our Islands pilot programme, Phillipa is retracing her academic and professional footsteps as a clinical and social psychologist to rigorously examine how Māori and indigenous understandings and practices of health, wellbeing, and healing can inform, improve and offer alternative approaches to current mental health systems and practices.

One of the central tenets of Māori culture is the belief that all within our world is interconnected and that people are descended from the environment, and Phillipa's past research has investigated the link between the wellbeing of tangata whenua and the wellbeing of Te Taiao/the environment.

While she describes climate change as a "background issue" to her specific research, Phillipa says "it was actually quite distressing, to say the least, to see what was happening to our environment and then seeing that in 60 to 70 years how we've totally destroyed so many ecosystems all around the world."

The Canterbury Plains are a prime example. Once covered in trees and treasured by Māori for the swamps, which provided food and acted as a natural filtration system, she says that some places are now like "walking through a dust bowl" because of modern farming practices. "With the drastic alteration of the environment that's come with climate change, that has affected Māori quite hugely, but it's also affected a lot of New Zealanders in general."

A key element of her overall research project will focus on hikoi as a potential pathway for healing, something that Phillipa has observed at a personal level by walking with both her daughter and sister. And she says that the four and a half months spent traversing the 3,000 kilometres of the country for the first time with her sister was literally the walk of a lifetime.

"I credit that hikoi with saving my life because I didn't realise how burnt out and unwell I was from my clinical work, and it made me realise we still live in a beautiful country. Yes, we've got issues, but it's still a beautiful country with many beautiful people."

In many respects, Phillipa says that her walks are a response to climate change and climate justice. "I wouldn't say my project is focused on climate justice, but it's driven by it," she says. "It's looking for community resilience, and it's looking for community adaptation to these challenges. It's also addressing some of the social aspects around it as well. Who is it affecting more?"

Hikoi, she says, are a perfect way to gather information about what is actually happening on the ground because you're meeting and talking to people. "Hikoi are also an amazing and direct way to disseminate information and to build networks of relationship throughout the country."

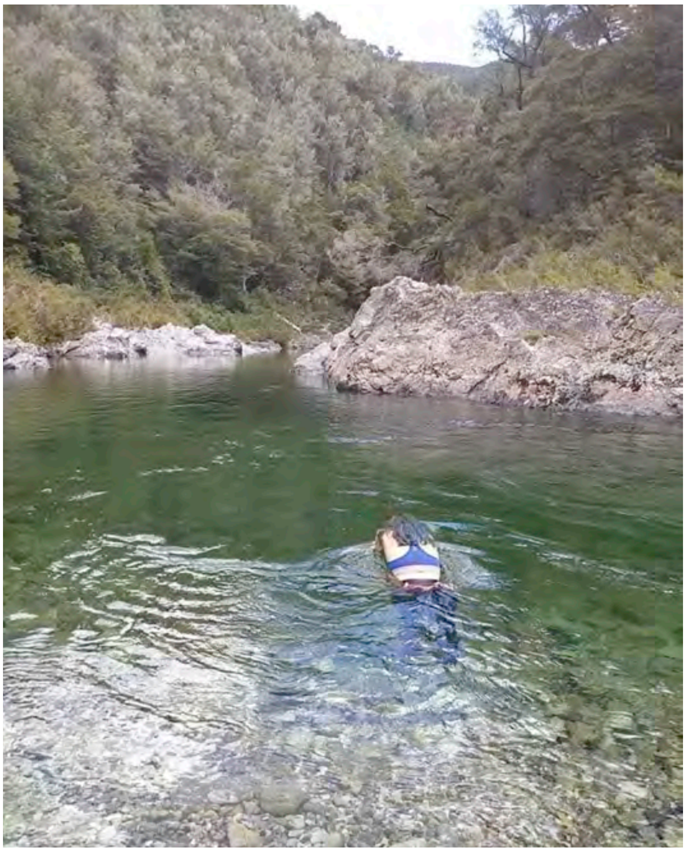
"I credit that hikoi with saving my life because I didn't realise how burnt out and unwell I was from my clinical work, and it made me realise we still live in a beautiful country."

DR PHILLIPA PEHI

To that end, Phillipa has travelled to Canada several times and will again join Canada's annual Tribal Canoe Journey this year as an invited guest of one of the Pacific Northwest Tribes that travel ancestral ocean pathways in an assertion

Phillipa and her daughter Maia at the end of a 6-month hikoi of Te Araroa (Bluff).

Maia on top of Tararua Ranges (overcoming her fear of heights), Te Araroa.



Maia diving into Pelorus River at the top of the South Island, Te Araroa.

of indigenous unity and cultural resurgence.

Like the hikoi, she says it's about connecting with the environment and sharing and gathering information between places and spaces. "It's like weaving that whāriki (woven mat) of connections, right? So the more of those connections that you have, or become aware of – the more amazing the world becomes again."

Ngā Motu Whakahī is a holistic and long-term initiative to nurture our future Māori and Pacific research leaders and students through targeted tuākana-teina cohort building, and one of Phillipa's roles is to support Māori and Pacific postgraduate science students and encourage undergraduates into research.

Once again, the focus is very much on interconnectedness and embracing a Te Ao Māori worldview, which looks at how the whole operates rather than reducing complex ideas or issues to their simplest component parts.

What's more, Phillipa says that a lot of psychological approaches and tools are European or American in origin, which come from homogeneous and usually settler populations, "so they don't necessarily reflect or resonate with people from indigenous cultures."

However, those cultures have a lot of helpful information to share, and she believes that science is increasingly turning to indigenous and, in New Zealand's case, Māori knowledge. "Mātauranga Māori and science can be viewed together to actually come up with some pretty unique solutions."

> ***"Mātauranga Māori and science can be viewed together to actually come up with some pretty unique solutions."***
>
> DR PHILLIPA PEHI

At a Government level, those solutions include the current development of a Māori Climate Platform in partnership with tangata whenua to enable Māori-led climate action, planning, and solutions that build climate resilience.

It's something that Phillipa views with "a healthy dose" of scepticism. "It's important to remain hopeful but also to be mindful of what's happened in the past," she says, referring to the historic disjunct between every sphere of governance and people at the grassroots.

"Like any initiative in terms of indigenous issues, unless it's actually looking at every level from the bottom to the top, then it's going to have limited efficacy in my mind."

Looking ahead, Phillipa has committed to walk the length of Aotearoa every three years "to be witness to what's happening in our country and as a vehicle for sharing positive and transformative stuff."

There may be no magic bullet when it comes to climate change, but she says "if every person on the planet just did one more thing that was good for the environment, one more thing to connect with their neighbourhood, one more thing to connect with their family, the world would change overnight because there's billions of us – it could be that simple."

Restoring mussel reefs and ecosystems in the Marlborough Sounds and beyond

In 2019, Trevyn Toone fell in love with Aotearoa, New Zealand, while visiting from the USA. When the opportunity to complete a PhD here arose, he jumped at the chance and has not looked back.

TREVYN co-led a research project on restoring mussel reefs in the Marlborough Sound with Emilee Benjamin. Their work has received support and recognition from the science community and engagement from the local community.

"I'm passionate about research and marine science, so pursuing a PhD was a natural fit." He eagerly awaits the examiner reports for his thesis submitted in March.

Photo: Emilee Benjamin

Can you tell us a bit about your research?

"I am interested in coastal restoration and creative ways to recover our incredible coastal ecosystems that have been devastated by humans. More specifically, my research focuses on restoring mussel reefs in the Marlborough Sounds."

How does your research relate specifically to climate change?

"In the environmental sciences, especially restoration research, the subject of climate change is unavoidable. Climate change is the most pressing issue impacting coastal ecosystems worldwide. Increased water temperatures lead to mass die-offs of coral reefs, while heatwaves decimate intertidal shellfish reefs. Increased storm events can rip up seagrass and seaweed beds while rising water levels threaten to eliminate the intertidal areas many ecosystems rely on."

"Mussel reefs in the Marlborough Sounds were historically very common in the intertidal area, but overharvesting has decimated these sites over the years. One of our goals is to restore mussel reefs into the intertidal, but the environment isn't the same as it was in the 1960s and 1970s when they were first harvested. Notably, temperatures have continued to rise, and extreme heat events are more common. This heat has killed off some of our restored mussel reefs, even at the previously-populated tidal heights. Ultimately, this means that due to climate change, the areas mussels can now thrive in may be smaller in the intertidal zone than they were historically. When restoring ecosystems, we're hoping they survive for decades. Climate change is an undeniable reality in the coming decades, so we must prepare for it now."

What are the accomplishments or milestones you are most proud of?

"We have restored upwards of 60 tonnes of mussels across over a dozen sites and demonstrated that these reefs are increasing local fish populations and serving as biodiversity hotspots. We have also identified significant potential bottlenecks in the current ecosystem, which we can target in the future to re-initiate natural recovery. In the community, we have partnered closely with the local mussel farming industry and local farmers to co-lead restoration efforts. We also work closely with local residents, councils, iwi, and researchers across multiple institutions to collaborate on the restoration initiative."

"In 2021, we were presented with the Cawthron Marlborough Environmental Award. I won the Three Minute Thesis Asia-Pacific championship last year and received multiple research poster awards from the University of Auckland. Emilee has also secured funding from The Ministry of Primary Industries to continue our work."

Where do you hope this qualification will lead you?

"I have accepted a postdoctoral position at North Carolina State University, where I will be looking at the restoration of other coastal ecosystems, including seagrass beds, oyster reefs, and salt marshes. Emilee will continue our work as postdoctoral research with the University of Auckland. She will develop the project to include other areas in the top of the South Island."

Can you share something about your experience completing your PhD with a Joint Graduate School?

"I completed my PhD with the Joint Graduate School at NIWA, based in Nelson. This provided some unique opportunities and a chance to experience a different research environment. Nelson has a good community of joint graduate students, mainly through Cawthron, which helps maintain some of that university feel."

Is there anything else that you'd like to mention about your time at the University of Auckland?

"Emilee and I have had the support of our incredible advisers, Professor Andrew Jeffs and Dr Jenny Hillman, which has really underpinned the success of our research and restoration efforts throughout the last four years."

Finally, tell us something about yourself we can't learn by Googling you!

"I'm colourblind, which often surprises people!"

Find out more:

Benjamin, E. D, Jeffs, A., Handley, S.J., Toone, T.A., Hillman, J. R., (2023). Determining restoration potential by transplanting mussels of different size classes over a range of aerial exposures.

PhD research on low-clouds to enhance climate model precision

Hamish Lewis came to Auckland at the beginning of 2019 after completing his undergraduate and honours degrees in Otago.

HAMISH IS studying for a PhD in Physics, specialising in atmospheric physics, focused on low-clouds, and is set to complete his degree in January 2024.

His research looks at the upstream control of large-scale meteorological variables on low-clouds. That is to say, his research is focused on how low-clouds depend on upstream atmospheric conditions.

Why did you decide to pursue this qualification?

"As part of my honours degree, I took a single atmospheric science paper. It was my favourite paper I had ever taken at university, and I was very interested in learning more, so I chose to pursue a masters, which led to a PhD in this field."

How does your research relate to climate change?

"Low-clouds are one of the worst-represented physical systems in climate models and are one of the most significant contributors to the uncertainty in climate projections. Incorporating upstream controls into climate models is one possible way to improve low-cloud fields, which could significantly reduce this uncertainty. Whether the global average surface temperature increases by just 2 degrees or 5.5 makes a big difference!"

What inspired you to focus your research on addressing climate change?

"When I first began studying atmospheric physics, I immediately felt that the problems being addressed in the subject were highly important (I guess everyone probably thinks that about their own research), as a better understanding of the climate is invaluable for all aspects of society. The more I continue to research, the more agency I feel I have in addressing problems relating to climate change, which is very fulfilling."

Can you share any specific accomplishments or milestones you've achieved in your research?

"Getting the first paper from my PhD published was a great milestone for me, as it gave me a sense that the things I was researching were worthwhile to the scientific community. I also visited one of my supervisors in Toulouse for a couple of months. The travel was an amazing experience, especially considering I began my PhD in 2020 and had worked through multiple lockdowns in Auckland."

Hamish Lewis. Photo: Billy Wong

What are the biggest challenges you face in your work, and how do you address them?

"Initially, just being seen in the research space was a challenge, as there isn't a group dedicated to low-clouds here in Auckland like in some universities around the world, so I had to put myself out into the international community. My supervisors connected me with some of their collaborators in the field, which provided valuable discussions. I also presented at international conferences, which got my research out there and has connected me with multiple people in the research community."

What do you like most about the programme and why?

"The self-directed aspect of PhD research is great and difficult simultaneously. I have taught myself so much, learning a lot of the analytical skills I use in my research on my own, and I am becoming a better scientist in the process. However, when things aren't quite working, it can be a while before you figure them out!"

Where do you hope this qualification will lead you?

"I would like to continue researching as a career, as it's very interesting and fulfilling, whether that begins in a Postdoctoral position or a research position for a company or government agency."

Have you received any scholarships?

"I was supported with a Marsden Fund Scholarship, managed by Royal Society Te Apārangi, and a University of Auckland Doctoral Scholarship Extension. This financial support has allowed me to enjoy my studies and my time in Auckland a lot more, and it likely wouldn't have been possible to pursue my PhD without this support."

Is there anything else you would like to add?

"I have become friends with many PhD students in the department; I think it's a good cohort. Although most of us are in different fields, there is definitely great camaraderie and a lot of great people. I also have the utmost respect for my supervisors; they are truly world-class scientists, and I have had an incredible time working with them!"

Finally, tell us something about yourself that we can't learn by Googling you!

"I love to cook! Life's too short not to eat the food you love all the time!"

Find out more:

Lewis. H., Bellon. G., and Tra, D. (2023). Upstream large-scale control of subtropical low-cloud climatology.

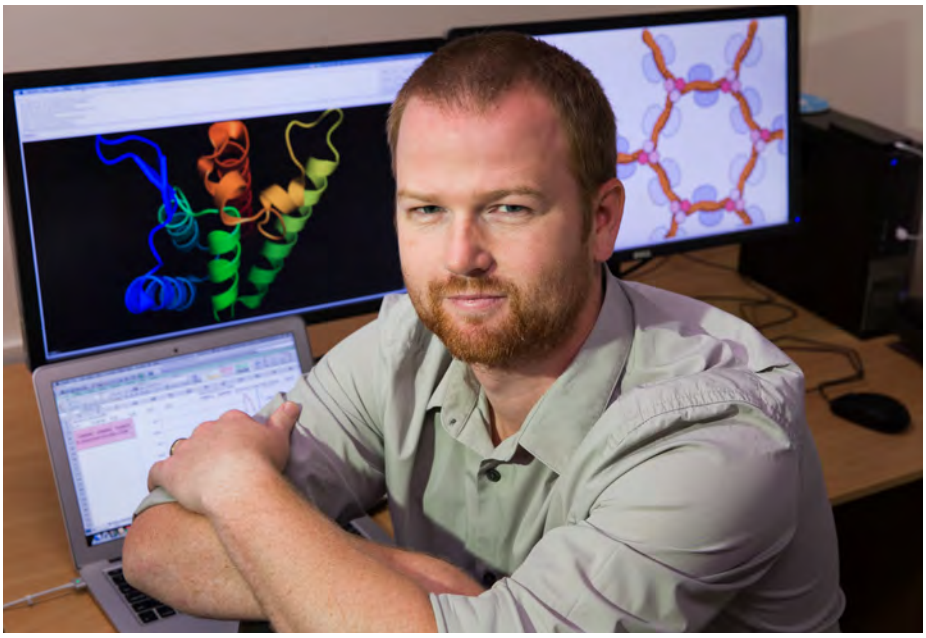
Climate change research impact

Research and innovation is central to understanding and adapting for the future.

THE SUBJECT of climate change is usually accompanied by Words like uncertainty, destruction, erosion, impact, global, complex, managed retreat, and loss, all of which bring with them a sense of foreboding and negative consequences. But words like innovation, adaptability, resilience, and cooperation bring hope and positivity for our ability to rise out of these problems.

Climate change is an area where it is often difficult for individuals to comprehend the impacts, scale and complexity of what might be ahead. At the beginning of 2023, Auckland was hit with rainfall unlike that seen before, and shortly followed by Cyclone Gabrielle. This gave us a sharp reminder about our climate's power and the devastation it can bring. The University of Auckland was not insulated from this event with flooding and an unplanned swimming hole in front of the Kate Edgar Student Services building. These local impacts on the University Campus pale in comparison to the consequences for communities elsewhere in Auckland, including for staff and students of the University, and elsewhere in New Zealand. In this single event, some of the future possibilities were starkly highlighted.

In considering the impacts of climate change, it is often easy to focus on the tangible and obvious impacts: the washed-out roads, the destroyed houses and the retreating coastline. These Impacts obviously merit our consideration and efforts to address. Reflecting on the damage that occurred at the beginning of the year, it is evident that every dollar we can put into understanding, predicting and innovating will provide dividends in our future. This can be measured in purely monetary terms from improved infrastructure, new technologies, increased resilience to future events and not having to rebuild what the next event breaks. But we also mustn't lose sight of the less obvious impacts: what is happening within our oceans and ecosystems, the loss of biodiversity and the impact on people's wellbeing and culture. As highlighted by Quentin Atkinson, humans are uniquely forward-thinking and cooperative, able to work together towards a common aim. In this spirit, the Faculty of Science is well-placed to contribute.



David Goldstone, Associate Dean Research (acting).

The complexity of climate change impacts means new collaborative approaches are required to mitigate and prepare for the future. Research is vital to understanding the changes occurring and likely to occur in our environment. Traditionally, this effort is often distributed, with many individual groups contributing in their areas of expertise. More recently, this research has started to become more concentrated, with a new transdisciplinary approach bringing individuals together into broader teams to identify and address some of the difficult questions that need to be tackled. As championed by the Centre of Research Excellence, Te Pūnaha Matatini and more recently the University Research Centre for climate, sustainability and society, Ngā Ara Whetū, this approach is vital to identifying productive pathways.

It is important not to forget our shared aim of training excellent future scientists. The next generation is living in our legacy. We must prepare them for the future but also hope they will be in a position to adapt and innovate to lead a better world.

DAVID GOLDSTONE,
Associate Dean Research (acting),
University of Auckland

"Climate change is an area where it is often difficult for individuals to comprehend the impacts, scale and complexity of what might be ahead."

DAVID GOLDSTONE

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EDITOR
Stephanie Look

WRITERS
Stephanie Look
Owen Poland (OP Media Ltd)
Natalie Modrich
Jonathan Burgess

DESIGN
Jacinda Torrance
(Verso Visual Communications)

EDITORIAL CONTACT DETAILS
inSCight
Faculty of Science Communications
and Marketing
University of Auckland
Private Bag 92019
Auckland 1142, New Zealand
auckland.ac.nz/science/inscight

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