# Pūtaiao

MANAAKI WHENUA SCIENCE SUMMARY / ISSUE 19 / AUGUST 2024

## Tree thinking

Climate-smart science for Aotearoa New Zealand

# Pūtaiao

## Science for our land and our future

Tēnā koe and welcome to Issue 19 of *Pūtaiao* (*Science*), our quarterly publication showcasing the work of our scientists at Manaaki Whenua.

Each issue of *Pūtaiao* shares the benefits and outcomes of our science in helping to ensure a sustainable, productive future for Aotearoa New Zealand (AoNZ). In this issue many of the stories focus on science-informed land management and the challenges of climate change.

In this diverse issue, read about how our Manaaki Taiao team of Māori researchers is working with Māori landowners on te ao Māori approaches to land management, discover important new findings about carbon losses and gains for dairy pasture, and find out about how trees may help cows cope with heat stress induced by future climate change. We are also excited to announce the opening of a new "data supermarket" of land use datasets, and the publication of a brand-new geochemical atlas for Aotearoa.

If you wish to be included on the mailing list for *Pūtaiao*, or to find out more about any of the stories, contact Dan Park on parkdj@landcarereserach.co.nz

*Cover image: An aerial view of green mangroves in the North Island.*

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# Root and branch: the importance of Aotearoa's mangroves

Mangrove forests conjure images of lush, hot tropical swamps rich with life: wading birds such as herons or spoonbills, crabs skittering across the mud, lizards and snakes, and somewhere perhaps the flick of a crocodile's tail as it launches into the water. Although we don't have the snakes or the crocodiles, we do have the rest: the far north of Aotearoa lies at the southernmost limit of mangroves.

*Avicennia marina australasica* is our only mangrove tree. This tree, known as manawa in te reo Māori, is a small, native subspecies of the Australian grey mangrove. Mangroves are found in only a very small area of the country – they do not tolerate hard frosts, which severely restricts their range, and they only establish in shallow, low-energy, gently shelving, muddy coastal areas. But like mangrove forests around the world, ours punch far above their weight in the benefits that they provide to people. Aotearoa's mangroves are home to unique biodiversity both in the water and on land, act as a buffer against coastal erosion and storm surges, and stabilise soil. Perhaps most importantly, mangroves are better at carbon capture and storage than most other ecosystems.

Until recently there was no globally accurate picture of mangrove extent or the many benefits they provide to people. In the 80s and 90s, mangrove forests around the world were in steep decline because of pressures from urban expansion, pollution, land reclamation, aquaculture and agriculture. A new report by the UN Environment Programme provides an authoritative and up-to-date snapshot of mangrove status, and brings some positive news. Manaaki Whenua senior researcher in landscape ecology Dr Dan Richards was one of many co-authors from around the world, focusing on analysing changes in mangrove carbon stocks over two decades.

For the first time, the report quantified gains as well as losses in mangrove coverage. The combined results showed that net stocks of mangrove carbon have stabilised to some extent. From 1996 to 2020, only around 3.4% of the global mangrove carbon stocks were lost. This is much better news than was expected, although this still amounts to a substantial 139 megatonnes of carbon. Recent data on the Global Mangrove Watch website corroborate these findings, estimating that average global mangrove losses over the past decade are just 0.04% per year.

Dan is encouraged by the signs of mangrove recovery. "These ecosystems are crucial for biodiversity and need continued protection. As well as carbon storage, they contribute to the UN's biodiversity goals under COP and have significant benefits for coastal protection and fisheries too."

But mangrove success may come at the expense of other ecosystems. Mangroves in New Zealand are slowly extending their range as climate change takes effect. This may lead to some loss of salt marsh and seagrass ecosystems in the future as the limit of severe frosts moves south. To address trade-offs between protecting different types of ecosystem, the UN report recommends "integrated seascape thinking" – aiming to manage these interlinked and interdependent habitats in a more coordinated way to contribute effectively to our national carbon balance, support fisheries, and protect biodiversity. Understanding the current state and importance of mangroves is only the first step – we now need to plan for their future.

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*An aerial view of a mangrove forest in Te Puna, Tauranga Harbour.*

# Helping Māori to make informed decisions about their whenua

***Ki te kore te tāngata e manaaki i tōna taiao, Ka kore te tāngata e whai oranga***

**If people do not take care of the environment, we are not taking care of our own health and well-being.**

There is a Tiriti obligation on the part of agencies and institutions, local government and central government to include mana whenua as part of any climate change adaptation approach, plan or policy. At Manaaki Whenua, Kaihautu Māori Research Impact Leader Dr Shaun Awatere leads a team of researchers building tools to help Māori landowners to make informed land management decisions through a te ao Māori lens.

The *Huringa Āhuarangi, Huringa Oranga* research area recognises hapū and iwi in their role as kaitiaki by using both mātauranga Māori and science to build resilience programmes.

Shaun says the research helps Māori landowners to make informed decisions about climate change adaptation from a te ao Māori approach. "The way mana whenua see themselves within te taiao (the natural environment) is different from a te ao Pākehā perspective," he says.

"A te ao Māori perspective acknowledges the connections between people and te taiao and considers issues such as intergenerational equity. This includes mātauranga and the aspirations of Māori technologies that inform policies for climate adaptation that are often context-specific."

Shaun adds it's important to engage with whānau, hapū, and iwi on a local basis to understand what the community needs to be resilient to a changing climate.

The following three projects support the empowerment of mana whenua by using te ao Māori approaches for natural resource management and climate change adaptation. The projects are centred around what whānau, hapū and iwi need to build resilience through using adaptive strategies.

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PROJECT ONE

# He Awa Ora, He Tāngata Ora: Healthy Rivers, Healthy Communities

***Ka mau tonu ngā taonga tapu o ngā matua tūpuna, koinei ngā taonga i tuku iho, ngā te Atua***

**Hold fast to the treasures of the ancestors, for they are the treasures that have been handed down to us by God.**

Kairangahau Māori Jade Hyslop leads *He Awa Ora, He Tāngata Ora*, a project investigating how the study of river shapes and patterns can help Māori-led catchment restoration strategies. "It's about how that knowledge and insight can support community-led efforts to restore rivers in response to climate change in ways that are relevant and that align with iwi and hapū aspirations and vision," she says.

Jade's research has explored the links between sediments, water and vegetation across river catchments. "As tangata whenua we think of awa as living beings. They are our tīpuna who we have an obligation to care for and protect, and who will look after us in return, as well as future generations," she says.

Jade adds the project acknowledges both mātauranga Māori and science to find solutions.

"*He Awa Ora, He Tāngata Ora* considers how Māori have come to know and continue to know their awa, through mahinga kai practices, whakapapa connections, waiata, whakataukī, pūrākau, and many other rich sources of mātauranga. We are also interested in exploring how science can be better used alongside this mātauranga to empower and whakamana kaitiaki involved in river restoration."

The *He Awa Ora, He Tāngata Ora* report acknowledges that contemporary river restoration is complex. While fluvial geomorphic tools are useful, they can't capture the intricate relationships Māori have with the environment, which in turn drives restoration aspirations and practices. The report recommends meaningful river restoration that adheres to Treaty obligations enabling Māori to enact their rights of *rangatiratanga*, *mana motuhake*, and *kaitiakitanga*.

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Geoff Mackley

*A bridge in the Hawkes Bay region damaged by slash brought down in Cyclone Gabrielle.*

PROJECT TWO

# Whenua Koiora: Resilient restoration of wetlands informed by mātauranga-ā-hapū

***Kimikimi noa ana, rapurapu kau ana***
***Kei whea ngā matuku noho puku, ngā kawau horo ika, ngā ruru kai kiore***
***E... ka rehua i te ata***

**Searching... seeking... in vain**

**Where are the shy furtive bitterns,the fish-gulping shags, the rat-devouring owls? They are fading from sight in the early morning haze.**

*Kairangahau Māori Mahuru Wilcox and Taruke Thomson* (Ngāti Whakamarurangi, Mōtakotako Marae) *visit a site at Horokawau Falls, Toreparu Wetland.*

Kairangahau Māori Mahuru Wilcox leads *Whenua Koiora*, a project involving kaitiaki Māori to identify climate change impacts on wetland restoration projects. Mahuru has developed a resilient restoration wetland plan in partnership with Ngāti Whakamarurangi for the Toreparu Wetland, West Coast, Waikato Region. Resilient restoration is about restoring natural habitats as well as providing Māori communities who live near wetlands with strategies to deal with these climate change impacts.

Mahuru says both mātauranga-ā-hapū (local hapū knowledge) and science are needed for a holistic approach to resilient restoration. "When we want to build resilient restoration plans for our habitats like wetlands, we need to be looking at what data is available. For Toreparu Wetland, which is very close to the sea, the inundation of saltwater is going to significantly impact the breeding habitats of native kōkopu and īnanga and affect where people may harvest tuna. Combining data from external sources, such as existing monitoring information, with historical records, and traditional place names around the wetland can all give indicators on what some of those community priorities are," says Mahuru.

Mahuru says her role as a kairangahau is to support hapū aspirations based on mana whenua key priorities and aspirations.

"The mana whenua of Toreparu Wetland are Ngāti Whakamarurangi and the key priorities and sites of significance have been identified either through their [Motakotako Marae Hapū] Environment Plan, or through some of their mahinga kai priorities that they have for the marae. My role is to come in and support their aspirations and objectives and look at what climate data is available for those impacts, and how we move forward in terms of restoration and what that can look like."

**A Toreparu Wetland Restoration StoryMap** is a publicly available resource that combines local historical knowledge, hapū aspirations for restoration, and future climate change scenarios to highlight restoration approaches of key priority sites.

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PROJECT THREE

# He Ngahere, He Korowai: Resilient land-use strategies for whenua Māori

***Noho tahanga a Papatūānuku kia whakakorowai i ai ia***

**Papatūānuku (the Earth Mother) lays bare; we must recloak her**
**Keita Ngata (Ngāti Porou)**

Senior researcher Dr Suzanne Lambie leads *He Ngahere, He Korowai*, a project focused on identifying resilient land uses on highly erosion-prone whenua Māori (Māori land). Suzanne has identified transition pathways for converting highly impacted erosion-prone whenua Māori areas from exotic rotational pine forestry operations to natural regeneration of diverse native permanent forest.

"Land use change from pasture and rotational forest production to native permanent forest on highly erosion-prone land will decrease the impacts of future storm events," says Suzanne. "But for this to mitigate climate change, native forests need to be established in the very near future."

Suzanne says the project is focused on creating resilient landscapes for future generations,

"*He Ngahere, He Korowai* seeks to understand the barriers and solutions to changing to more resilient land uses on highly erosion-prone whenua Māori. As part of this we are investigating how much carbon is stored in naturally regenerating forests, after the pine has been harvested, to facilitate land resilience for future generations."

**The Natural Regeneration Transition Pathway** provides landowners with the tools to identify and manage the highly erodible land of exotic pine forestry that could be converted to natural regeneration, as well as identify support mechanisms for funding to undertake the transitions. The project has developed a natural regeneration plan that outlines the stages of a 3-year site plan.

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*Post-pine harvest natural regeneration in the foreground, mature* Pinus radiata *to be harvested in the background still to be harvested, near Shannon, New Zealand.*

# Carbon stocks – can ryegrass be beaten?

*Cows graze a paddock on a Canterbury farm.*

Around the world, soils under managed grasslands hold a lot of carbon: up to 22% of all land-based carbon stocks. How the land is managed affects whether these soils gain, lose, or keep their carbon – and historically, much carbon has been lost as natural ecosystems have been converted into grassland. Land management to maximise soil carbon stocks in grasslands could help New Zealand's overall greenhouse gas balance. With managed grasslands making up around 55% of New Zealand's land area, mostly for sheep, beef and dairy production, and with greenhouse gas emissions from the agricultural sector accounting for around 50% of the nation's total, it is important to optimise pasture management to preserve or increase soil carbon stocks and avoid losses.

Best-practice grazed grassland management, which broadly aims to limit environmental impacts, relies on practices such as rotating grazing areas, maintaining plant cover year-round, irrigation, pasture renewal, periodic cropping of pastures and increasing pasture plant diversity away from conventional ryegrass and white clover. These practices, and others such as planting deeper-rooted pasture species, are also thought beneficial to soil carbon stocks. The effects of these practices are not easy to quantify due to labour-intensive measures and lack of replication between farms.

Scientists from Manaaki Whenua and the University of Waikato recently combined the available data from three dairy farms in Waikato and two in Canterbury over 68 site-years, between 2008 and 2022, to calculate how different management practices have affected soil carbon stocks. On these farms, the net $CO_2$ exchange of the pasture was continuously measured, and carbon removals and additions associated with grazing, harvesting, effluent and fertiliser application were monitored.

Although the data were limited to five farms and only four main soil types, the results make for interesting, and perhaps unexpected, reading. Soil carbon stocks under grazed pastures were largely steady-state. None of the management practices assessed on these farms showed increases in soil carbon stocks over time, other than when carbon was added in the form of manure or effluent. Some practices, such as periodic feed cropping and pasture renewal, led to net soil carbon loss, although some or all of the carbon could be recovered over subsequent years. Irrigation did not seem to make a difference to soil carbon in Canterbury, while enabling large increases in grass production.

The researchers also found no evidence in their data that pastures with moderately increased diversity (5 species) increased carbon stocks compared with conventional ryegrass/white clover mixes. It appeared that use of a conventional ryegrass/white clover mix, the most common pasture mix in use in New Zealand over the past century, gave the best opportunity for maintaining soil carbon stocks in New Zealand's temperate climate, while also producing enough biomass to support dairy cows. However, the studied farms did not use highly diverse species mixes or altered grazing management aiming for higher standing biomass after grazing, which are practices explored by the growing regenerative agriculture movement.

"Research into the carbon effects of these practices is underway" says Dr Johannes Laubach, a senior researcher in greenhouse gases at Manaaki Whenua, "including measurements of the greenhouse gases methane and nitrous oxide, to identify trade-offs or synergy effects of management practices on net greenhouse gas emissions."

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HTTPS doi.org/10.1016/j.agee.2024.108962

# Using bird data for better urban planning

One of Manaaki Whenua's strengths as an organisation is that it is a great synthesiser – bringing diverse people, information and thinking together to create impact for Aotearoa New Zealand.

Recent work by Manaaki Whenua's Dr Dan Richards and colleagues provides a good example of this synthesising approach. The challenge was to define how the natural environment contributes to people's well-being in urban areas – a concept known as Nature's Contribution to People (NCP). In general, the more socially and economically vulnerable areas of a city have lower NCP – less access to green space being the most obvious aspect. Sound urban planning aims to reduce inequalities in NCP – but most studies of NCP have only used a narrow range of indicators to define it.

Dan's team used as wide a range of NCP indicators as possible to enable sound conclusions to be drawn. Post-quake Christchurch was chosen as a test case, as a diverse city that has experienced considerable planned redevelopment over the past decade. The questions to answer – where do current NCP inequalities lie, and where are the priority areas for future investment in green infrastructure?

Nine NCP indicators, which overlapped to some extent, were used to build a composite picture: tree biomass to show carbon stocks and offset urban carbon emissions; stormwater runoff retention to show how vulnerable an area is to flooding; soil erosion prevention; air pollution; tree shade; green cover within school boundaries; green space within residential areas; distance from a public outdoor space; and bird species richness. Most of these indicators were derived from remote sensing, but the last indicator used actual count data from Manaaki Whenua's national New Zealand Garden Bird Survey as a real indicator of biodiversity on the ground.

The Garden Bird Survey data were an invaluable addition to the research, providing a view from ground level. Almost 1000 Garden Bird Surveys were included in the analysis, representing a huge contribution from the public.

The indicators were compared against the Economic and Social Vulnerability Index (ESVI) – which combines 33 variables from the New Zealand census such as data on home and car ownership, smoking, and access to the internet, that can show whether people living in an area are socially or economically disadvantaged.

Few studies of NCP have had access to such detailed biodiversity records in addition to high-resolution spatial data. As expected, more socially and economically vulnerable people had less access to urban NCP, with less access to carbon stocks, more runoff/flooding, lower air quality, less shade, less educational, public and private green spaces, and lower bird biodiversity – although more vulnerable neighbourhoods did have (negligibly) better soil erosion mitigation.

The researchers suggest that inclusion of te ao Māori concepts of socio-cultural-ecological vitality will add another dimension to the next iteration of this work, and Dan is already encouraged by the overall proof of concept: "Our data and approach have proved sound, so these methods could be replicated to enable better and more affordable planning of urban green infrastructure projects by local and regional councils in the future," he says. "In fact, we are already working with Selwyn District Council on their network planning and park management for Rolleston, a suburb of Christchurch that has experienced huge recent growth."

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*Citizen scientists doing the Garden Bird Survey.*

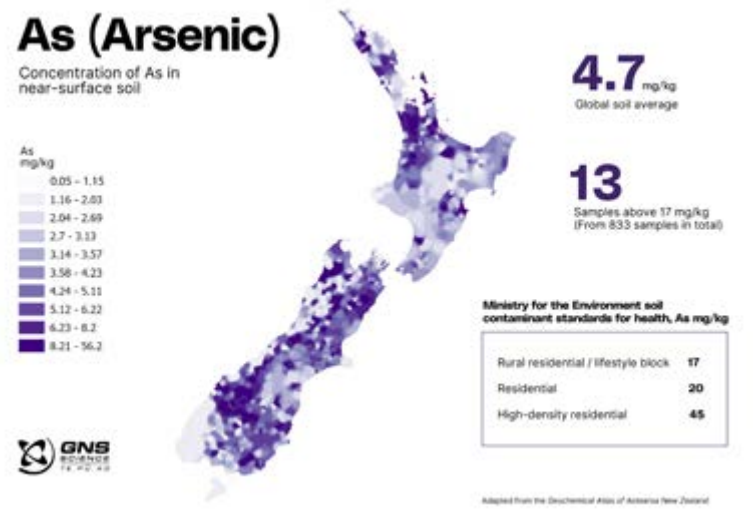
# Metal detectors: a new geochemical atlas for Aotearoa

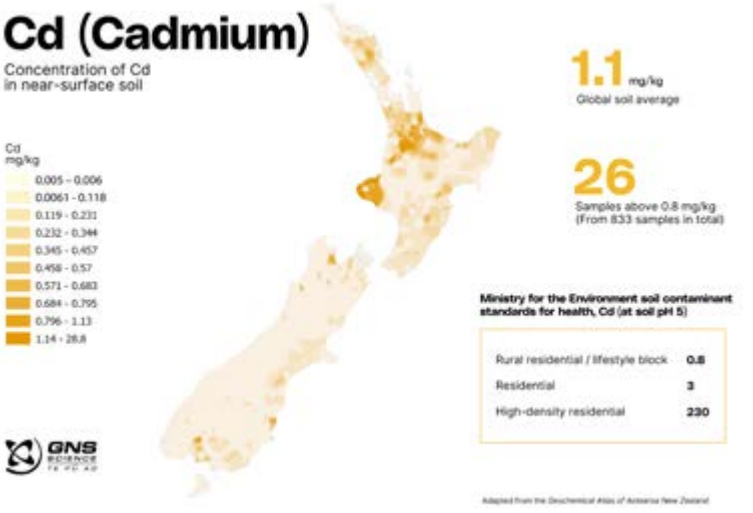
Thanks in part to experts in soil contamination from Manaaki Whenua, Aotearoa New Zealand now has its first ever *Geochemical Atlas*, providing a baseline of concentrations of elements in our near-surface soil.

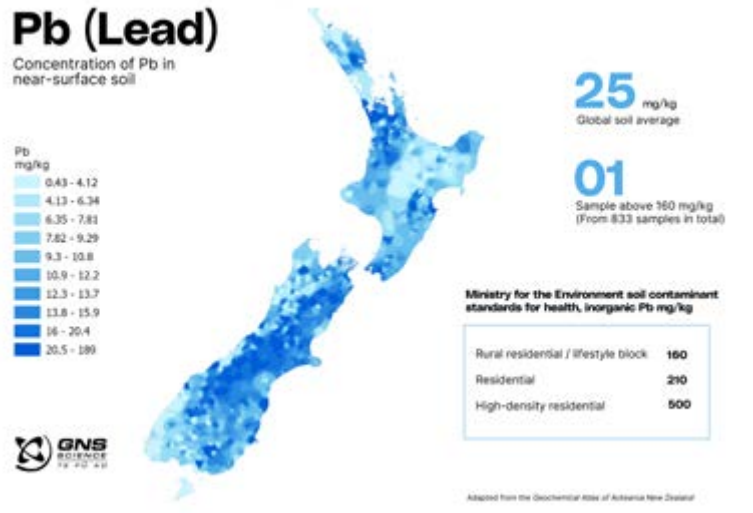
Manaaki Whenua senior researchers Dr Jo Cavanagh and Dr Pierre Roudier worked with a team from GNS Science and the University of Auckland to measure the concentrations of 65 different elements in our soils, with analysis drawn from more than 800 samples taken from within the top 20 cm of soil. The atlas presents the results using maps, showing the changes in concentration in each element across the country from Cape Reinga to Rakiura Stewart Island.

"This information helps identify where trace elements may need to be added to enhance productivity or improve the nutritional quality of food crops for livestock and people," says Jo.

"For example, selenium is an essential trace element, and the atlas shows many New Zealand soils are low in selenium, particularly in the central North Island, Otago, Canterbury and Marlborough."



Several of the elements included in the atlas are metals that can be hazardous to human health, including arsenic, boron, cadmium, chromium, copper, mercury, nickel, lead, and zinc. The occurrence of these metals in the soil varies due to differences in underlying rock types, environmental conditions and human influence.

Jo says knowing the concentrations of metals in our soils for the first time nationally helps us understand where human activities have changed naturally occurring concentrations, and allows us to monitor changes and mitigate their potential impact on human health and the environment.

The maps show elevated levels of lead and arsenic in several urban centres, but this is not unexpected, says GNS Science Geologist Mark Rattenbury. "This is a known phenomenon in cities worldwide, with possible sources including pollution from industrial processes, leaded petrol from our past, disposal of fossil fuel residues and household refuse, and the deterioration and removal of lead-containing paints from older houses."

Note: the maps cannot be used to pinpoint element concentrations for individual properties.

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*The Geochemical Atlas of Aotearoa New Zealand* is available in the GNS Science Online Store:

HTTPS *gns.cri.nz/our-science/environment-and-climate/contaminants/soil/*

*gns.cri.nz/news/new-atlas-maps-metals-and-other-elements-across-aotearoas-soils/*

*Rose Turnbull - GNS Science*

*Dr Mark Rattenbury of GNS Science collects a soil sample for geochemical analysis in the Red Hills, Nelson.*

# Making a game of it

Like any good novel or movie, games also need strong narrative threads and be equally entertaining and engaging. This makes them useful for creating the right conditions for deeper understanding of serious topics, as they can motivate people to learn through play.

Researchers at Manaaki Whenua have tapped into that sense of fun to use games to help explain land-use scenario modelling for spatial planning.

*Manaaki Whenua researchers Drs Dan Richards, Peter Edwards and Alex Herzig prepare material for the land-use board game Peter developed.*

Senior researcher Dr Peter Edwards developed a board game using land-use scenario modelling results from the 'Growing for Good' land-use modelling study (see *Pūtaiao* 15) and additionally produced maps on land-use suitability and catchments under pressure from freshwater nutrient contamination.

Senior researcher and geospatial modeller Dr Alex Herzig then co-ordinated a workshop for several planners and strategy advisors from Environment Canterbury where players, supported by Dr Clemence Vannier and Dr Dan Richards (Manaaki Whenua), had to design 'optimal' land-use configurations (expressed as different area shares of different land-uses) for individual districts in Canterbury. "The objective was to try and minimise greenhouse gas emissions and freshwater impacts through nitrogen and phosphorus losses while considering profitability and land-use suitability," says Alex.

He says the feedback from players was overall very positive. "The game was seen as particularly useful for communicating overall planning challenges involved with tackling complex multi-faceted issues.

"While players were generally aware of the challenges involved, dealing with the explicit modelling results and numerically evaluating their specific land-use configurations really hit home in grasping the magnitude of the problem, and the lack of obvious solutions for some districts," says Alex.

"They recommended this type of game would be educational for councillors and decision-makers in general, and potentially also for members of the public to help engagement with the issue."

The players also expressed an interest in gaining access to the actual modelled scenario data and maps for more detailed information on specific issues and areas.

The workshop showed the combination of serious gaming and spatially explicit land-use scenario modelling has the potential to create significant impact with decision-makers and potentially the wider public by communicating the magnitude of adaptation pressure, the requirement for holistic landscape-scale planning approaches, and the challenge of developing potential planning options for adaptation.

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# Roast beef: how trees could help

Like people keeping cool under beach umbrellas, cattle seek shade as the temperature rises. And for cows, even air temperatures in the low twenties can be too hot, because the animals naturally create a lot of internal heat whilst digesting food or producing milk.

Alert farmers watch carefully for signs of heat stress in their herds: faster breathing, grazing less, drinking more and moving slower. Because cows graze less and use more energy when it's hot, heat stress is known to cause billions of dollars' worth of losses to meat and milk production globally. The economic impact of heat stress on cows is projected to become more severe due to climate warming.

Tree establishment to provide shade in pastoral livestock farming holds a lot of potential as a nature-based adaptation tool to reduce cattle heat stress. To establish trees in the best way to help cows, we must answer a complicated mix of questions – what type/s of tree, planted where, and in what densities? And what are the likely financial benefits of increasing on-farm shade on future milk and meat yields?

Researchers led by Dr Dan Richards at Manaaki Whenua have now developed a general model for the impact of trees on cattle heat stress, carefully piecing together the effects of various climatic elements including air temperature, wind speed and humidity with tree characteristics such as height and leaf density. They have added high-resolution mapping of over 400,000 farm management units to estimate the amount of shade currently available to the beef and dairy herds across New Zealand, and used all this information to model milk and meat production under future climate scenarios at varying scales. The work neatly links to other work currently being done at Manaaki Whenua on the potential benefits of planting mosaics of trees in pastoral landscapes for carbon capture.

The modelling shows that existing tree cover already brings impressive economic benefits to New Zealand. The simulated current contribution of trees to national milk yields is in the order of 500 million extra litres of milk to the overall total of around 20 billion litres per year, which conservatively works out at an additional US$200 million of revenue per year based on 2017 milk prices. For meat production, the contribution of trees is around 8000 tonnes of meat to an annual national total of around 110,000 tonnes – an extra US$37 million of revenue.

Adding more shade trees to pastures could bring even bigger economic returns. The maps in the model estimated that tree shade is currently (as of 2020) not available to around 3 in 10 cows in New Zealand's dairy herd and to around 1 in 5 of the beef herd. If additional trees were established to ensure universal access to shade for cattle and minimise the risk of heat stress, the modelling showed that by 2070-2080 there could be an increase in national milk yields of an average of 350,000 litres per year and an increase in meat yields of an average 2500 tonnes per year, within a range of yields depending on the degree of future climate change.

This big-model approach to nature-based adaptations provides powerful evidence to benefit New Zealand's future farmers, and Dan – an ecologist by training – has learned a lot about cow physiology and behaviour in the process. "We know that the effects of trees on keeping cows comfortable and productive are context-dependent and multi-dimensional, varying with wind speed, solar radiation, cloudiness, tree species and leaf density, as well as dominance within herds and cow breed," he says. "In the future we will refine these parameters and customise the model so that it can zoom in and predict what trees will do across a region or even at the farm scale, so that we can make specific, evidence-based recommendations to farmers around what to plant and where."

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# LiDAR project a 'real step-change' for Hawke's Bay land management

Hawke's Bay Regional Council (HBRC) and researchers from Manaaki Whenua have worked on a ground-breaking project using LiDAR to enhance their understanding of the region's landscape.

Manaaki Whenua programme lead Dr Sam Carrick says this initiative marks a significant step forward in helping the region manage land resources, address erosion, and improve environmental strategies.

The project, a result of a longstanding partnership with HBRC, leverages the power of LiDAR (Light Detection and Ranging) to produce high-resolution, regional maps of land and vegetation information.

Digital elevation models (DEMs) provide an unprecedented level of detail about the region's topography, enabling more accurate assessments of erosion and sediment loads in rivers. Manaaki Whenua researcher Dr Hugh Smith says one key aspect of the project involved upgrading existing models with the new LiDAR data. "This update enhances the accuracy of predictions related to rainfall-triggered landslides, allowing for more targeted and effective tree planting initiatives. The high-resolution topographic data from LiDAR has also been integrated into the SedNetNZ model, which estimates erosion rates and suspended sediment loads in rivers.

"This model is crucial for evaluating various land management scenarios and understanding the impacts of climate change," says Hugh.

The project's success extends beyond scientific advancements with the collaboration between scientists and policymakers at HBRC fostering a deeper understanding of the practical applications of these models says HBRC senior land scientist Ashton Eaves. "By working together, both groups have developed tools and products that are immediately useful for the council's decision-making processes."

Another researcher in the Manaaki Whenua team, pedometrician Dr Nathan Odgers says one of the innovative applications of the new LiDAR data is in analysing the slope of the land. "Slope plays a critical role in water movement and erosion risk. The detailed slope data, now available at five-metre intervals compared to the previous 25-metre intervals, enhances the accuracy of land use capability assessments and assists in implementing recent intensive winter grazing rules."

The project also focused on producing high-resolution vegetation class layers and fine-scale canopy structure information. "We applied our state-of-the-art software workflows leveraging recent developments in computer vision and deep learning to process raw point cloud data and turned it into a comprehensive and detailed spatial cataloge of vegetation features comprising forests, shelter belts, exotic (pine) forests, fields, and individual trees. This layer also vastly surpasses the spatial detail of previous large-scale land cover products such as the Land Cover Database of New Zealand", explains Manaaki Whenua researcher Dr Jan Schindler.

The purpose of this work was not only to generate one-off data products, but to create baseline methods and data sets which can be updated and refined in the future and used for change detection." Jan adds.

Former HBRC science manager, Anna Madarasz-Smith says the collaboration has proven mutually beneficial, allowing scientists and policymakers to develop practical solutions that directly address the region's environmental challenges. "The partnership with Hawke's Bay Regional Council highlights the importance of combining scientific expertise with local knowledge to achieve impactful results," she says.

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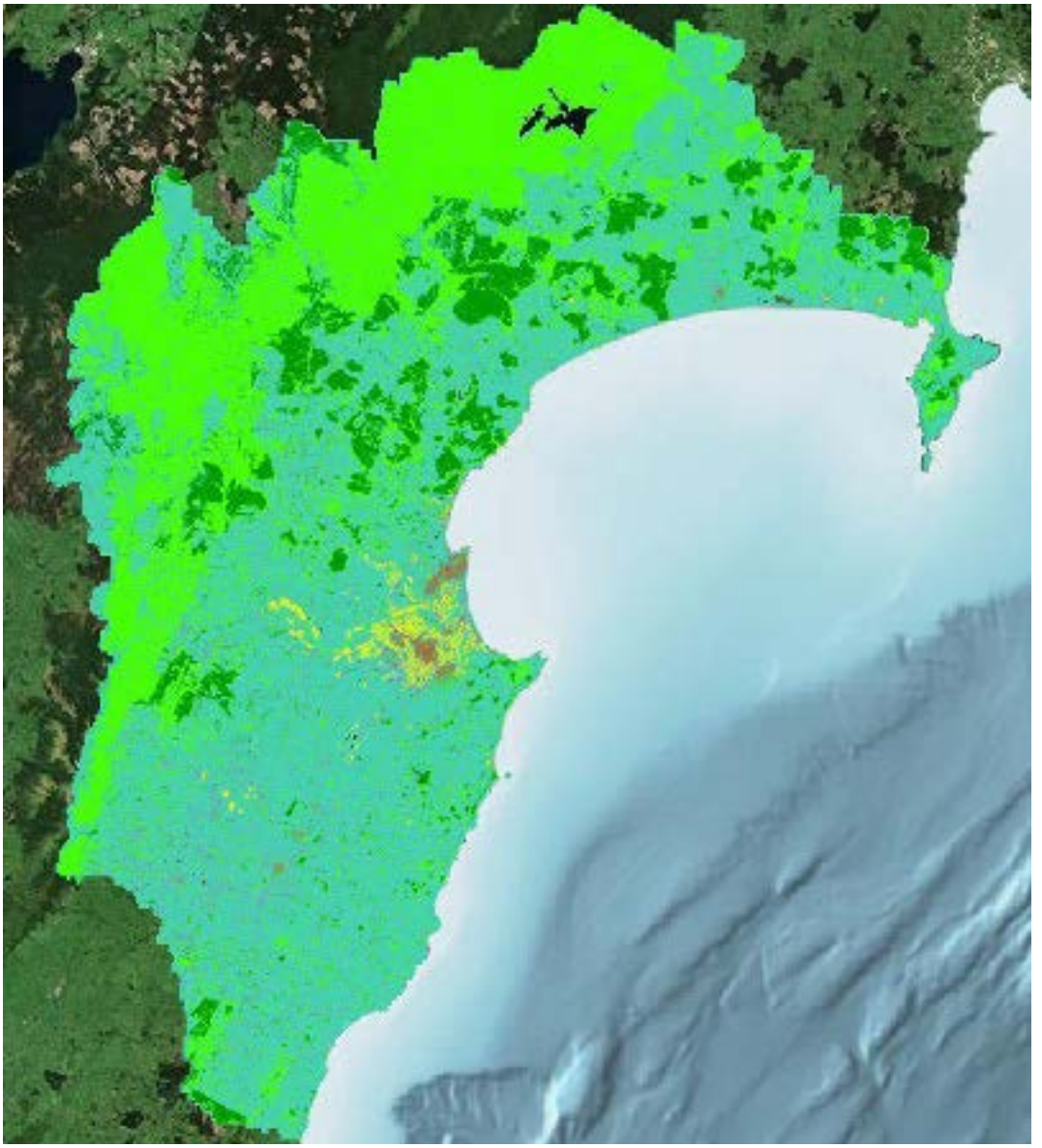
*LiDAR images showing daylight and shadow images overlaid over canopy height layers.*



*Overview and extent of region-wide vegetation layers for the Hawke's Bay region depicting forest cover in bright green, low vegetation in pale green, fields in yellow and pine forest in dark green.*

# Forests and fungi, a match made in Havelock

*A fungi sample ready for cataloguing.*

The 36th annual Fungal Foray took place in Havelock at the top of the South Island this year with the forests providing a generous haul of fungi to the foragers.

Organised by FUNNZ, the Fungal Network of New Zealand, and supported by Manaaki Whenua, the week is an opportunity for researchers to collectively advance the knowledge of fungi in New Zealand, of which about 80% of species remain unknown.

The mycologists scoured the forests around Pelorus Bridge, Mt Richmond Forest Park, and various scenic reserves around Ngakuta and Momorangi Bays hoping to find as many specimens as possible. "Every year we find at least one new species," says Dr Mahajabeen Padamsee, Manaaki Whenua researcher and New Zealand Fungarium (PDD) Te Kohinga Hekaheka o Aotearoa curator.

During the week, all the fungi were photographed, with some dried and packed up to be added to the national fungal collection in Auckland. Researchers also dissected specimens, prepared material for DNA extraction and generated cultures from species of interest.

By the end of the week at least 200 samples were packed up for the Collection. "This event allows us to add information about what's found in a particular area which is useful information that we can use to monitor what's here from a conservation perspective," says Mahajabeen.

While much of the specimen haul is still to be processed, there were some unusual finds.

Mycologist Dr Bevan Weir says one was identifying specimens of the *Tubaria* species. "This is commonly called *Tubaria rufofulva* (as used in

Australia), but DNA sequences from this foray show that it is a related, but undescribed endemic species."

Some lumpy blobs found on rotting wood at Pelorus Bridge were interesting for mycologist Dr Peter Johnston, a specialist in the study of ascomycetes, a class of fungi characterised by their spore-producing structures called asci. They could potentially have been an unnamed genus. "The black fruiting bodies are distinctively sculptured with a series of ridges extending from a tiny pore at the centre. Its morphology indicated it could perhaps be related to the New Zealand endemic, monotypic *Induratia apiospora*, a genus and species known from only one collection made from rotting wood in the Waipoua Forest, way back in 1982."

Which is where DNA technology proves its worth. Once researchers had DNA sequences from the cultures, the fungi were identified as *Rimaconus coronatus*, a relatively newly described species in New Zealand.

Every year the researchers also hope to inspire a new generation of mycologists with visits to the foray headquarters by schools in the area. Manaaki Whenua mycologist Dr Peter Buchanan helped a group of Year 6-8 students from Havelock School take a close look at the specimen table. Dr Buchanan says the visits are important because they open new worlds for the students. "Children are typically curious and with their sharp eyes, and being closer to the ground, fungi are very accessible. It would be nice to see children become as observant of fungi as they are of birds and insects."

*PDD Curator Mahajabeen Padamsee in the forest at Pelorus Bridge Scenic Reserve.*

*At the 2024 Fungal Foray the fungi are photographed, with some dried and packed up to be added to the national fungal collection, the New Zealand Fungarium (PDD) Te Kohinga Hekaheka o Aotearoa in Auckland. Researchers also dissect specimens, prepare material for DNA extraction and generate cultures from species of interest.*

# Hoverflies take on wasps in battle for Top of the South

A batch of hoverflies have our pesky invasive wasps in their sights. The release of 20 European *Volucella inanis* hoverflies at two sites in Marlborough and Tasman in May marked the end of a long journey in the search for a natural enemy to the common and German wasps in Te Tau Ihu/Top of the South Island.

Manaaki Whenua scientist Dr Bob Brown released the hoverflies on a farm in Rai Valley with support from local iwi, Marlborough District Council and Kotahitanga mo te Taiao (KMTT) Alliance. More hoverflies were released at a site in Wainui, with the release attended by Tasman District Council, iwi and the KMTT.

The hoverfly is a wasp-predator and the females lay their eggs in wasp nests. Once hatched, the fly larvae feed on wasp larvae and pupae. The flies have come a long way to help out. Bob collected an initial cohort of hoverflies in the south of England and brought them all the way to Lincoln's Insect Containment Centre for testing.

"The hoverflies only feed on wasps," says Bob. "They are not interested in bees or other insects."

He cautions any noticeable success from the hoverfly releases may not be apparent for at least 18 months, and it is unlikely that vespid wasps will be eradicated from the district altogether. "However, it is hoped that the hoverfly will adapt to its new environment and cause wasp densities to decrease in the Top of The South," says Bob.

German wasps were first found in Aotearoa New Zealand in 1945, and the common wasp first recorded in 1978. Since then, they have spread throughout the country, with the beech forests in Te Tauihu/Top of the South Island having the highest densities of wasps in the world. The impact on native wildlife is staggering as they attack everything from butterflies, moths, and spiders to bees as well as fledgling birds. It is estimated wasps cost Aotearoa up to $130 million per annum in damages and management.

The Vespula Biocontrol Action Group, which is made up of a wide range of stakeholders, from primary industries to councils to community groups, as part of a Ministry for Primary Industries Sustainable Farming Fund (SFF) grant started the process to look for a biocontrol agent in 2014.

Bob says the next step is to monitor the establishment progress of the hoverflies and then work towards further releases to build a sustainable population. "We've chosen sites that are a good distance apart in case unforeseen natural disasters destroy any of the sites, so we have a backup," he says.

"It is not unusual to require several releases for a biological control agent to successfully establish."

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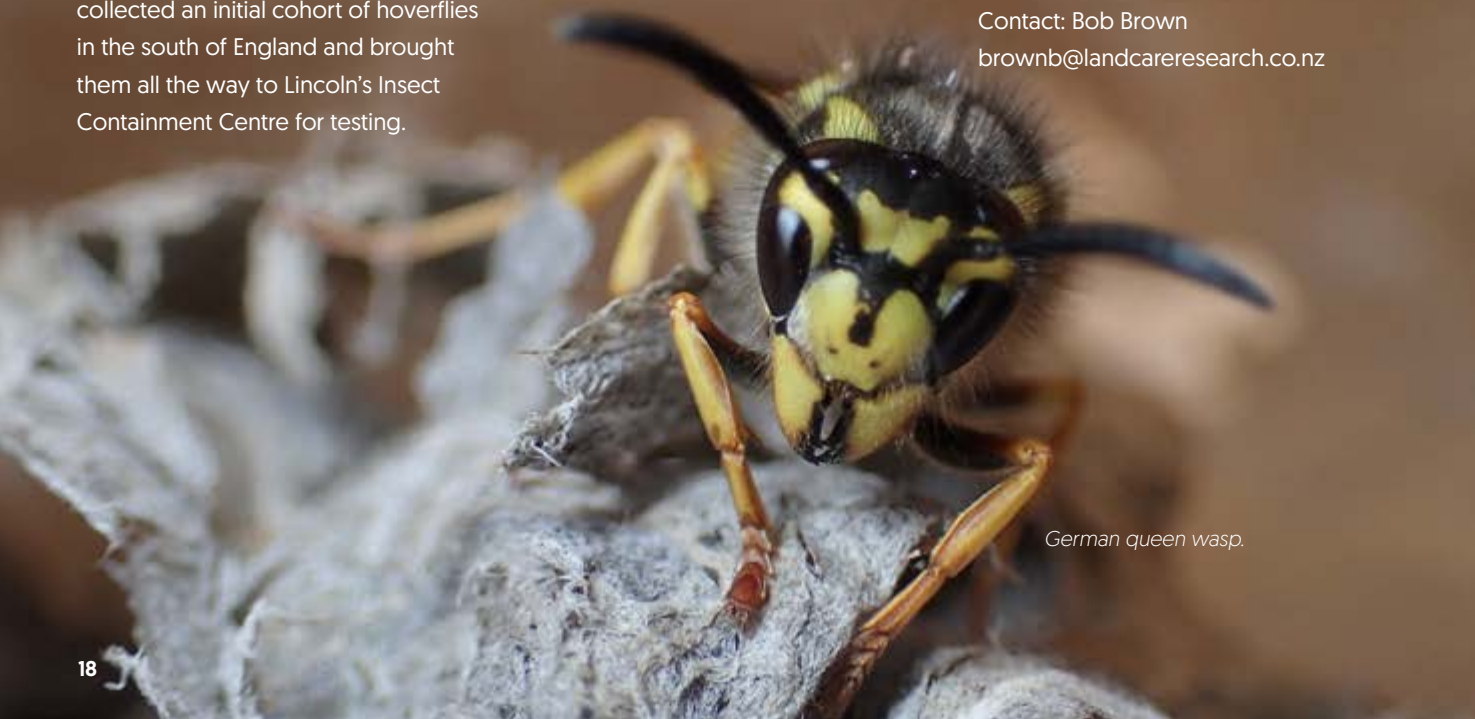

*German queen wasp.*

# Changing our SOCs – a progress report

Soil organic carbon (SOC) is critical to soil health. It's the basis of the soil food web and it plays an important role in maintaining soil structure, retaining water and nutrient cycling. Soils are also large reservoirs of carbon, and globally contain more carbon than the atmosphere and vegetation combined.

It's important we know what's happening to soil carbon levels in New Zealand, because a small increase or decrease could have significant impacts on carbon footprints at farm, industry and national scales. The National Soil Carbon Monitoring Project, a collaboration between Manaaki Whenua and the University of Waikato, and funded by the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC), is currently assessing whether soil carbon stocks under New Zealand's agricultural land are increasing or decreasing, and whether land use influences any change that may be occurring. Data will also improve our ability to predict how SOCs are likely to change when land use changes via improvements to the national soil carbon inventory model.

Benchmark sampling at 500 sites across New Zealand, which began in 2018, has now been completed and final data analysis and a journal manuscript on the benchmark sampling are close to completion – watch this space for results. Resampling of sites has also commenced and initial results of whether changes are occurring will be in hand within a year.

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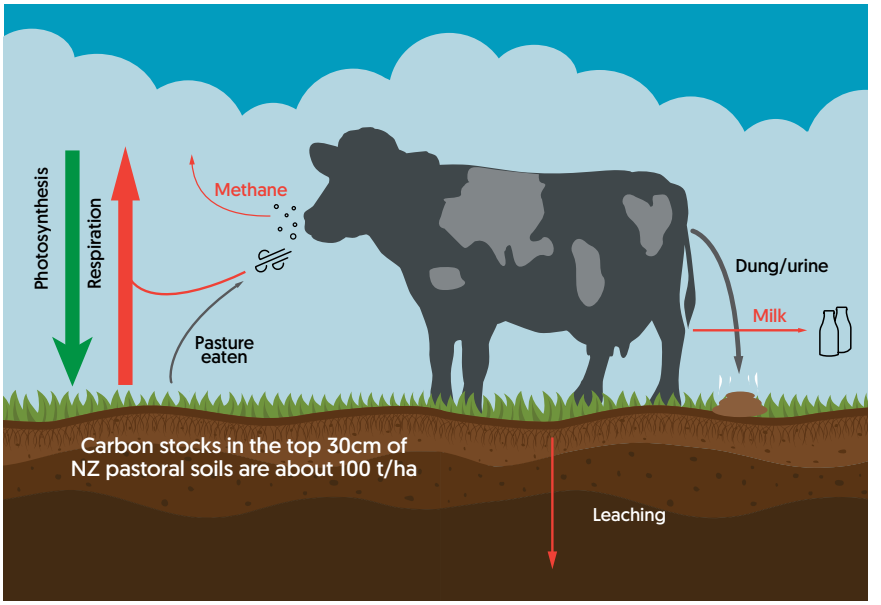



*Carbon flows in a simplified dairy farm system. The green arrow shows carbon inputs via photosynthesis, grey arrows internal cycling, and red arrows the various pathways by which carbon can be lost. Arrow thickness is proportional to the carbon flow. Increasing soil carbon requires increasing inputs, decreasing losses, or both.*


*Zach Dewhurst and Hamish Maule carbon sampling near Ashburton.*

# Data supermarket on land use open for hungry minds

An online data 'supermarket' is open to anyone hungry for information about the food and fibre we can grow in Aotearoa New Zealand – now and in the future.

The Whitwhiti Ora land use opportunities website hosted by Manaaki Whenua is free and stocked full of datasets that provide a broad understanding of the benefits and consequences of a wide range of land use opportunities.

Dr Linda Lilburne, principal scientist in spatial data science at Manaaki Whenua, says a large team of researchers from multiple institutes and scientific disciplines produced these datasets as part of the Land Use Opportunities: Whitiwhiti Ora research programme funded by the Our Land and Water National Science Challenge.

The datasets hosted on the website were created between 2020 and 2023 to provide information on social, environmental, and economic costs and benefits of a range of land use options.
"The datasets provide a snapshot of land-use information across Aotearoa – it is national-scale data, so the purpose is to provide users with an initial picture of information they can use to undertake their own further research," says Linda.

For example, the website has datasets on crop suitability and how that changes over time with the impact of climate change.

"You see that in some places where apples, cherries, or avocados grow well now will not be optimal land in the future due to the impacts of climate change – some of the datasets can be quite eye-opening," says Linda.

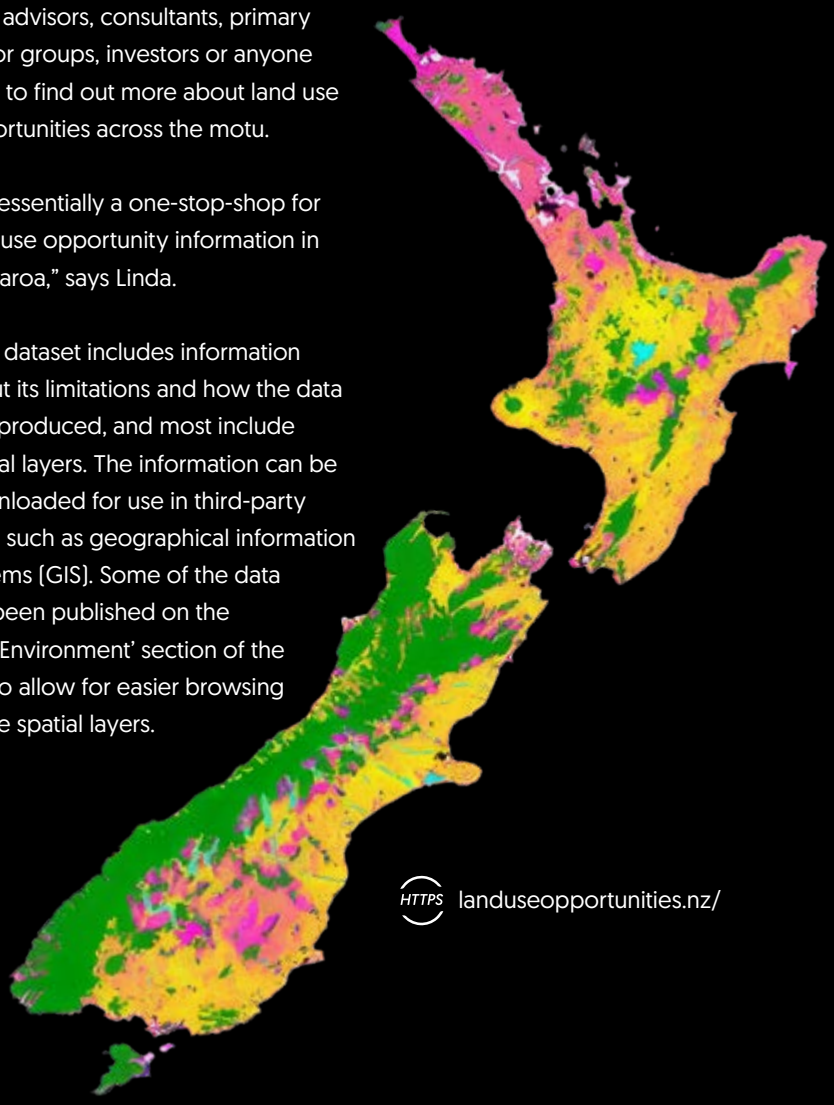
The researchers intend that the site will be used by a range of users, such as mana whenua, regional councils, farm advisors, consultants, primary sector groups, investors or anyone keen to find out more about land use opportunities across the motu.

"It is essentially a one-stop-shop for land use opportunity information in Aotearoa," says Linda.

Each dataset includes information about its limitations and how the data was produced, and most include spatial layers. The information can be downloaded for use in third-party tools such as geographical information systems (GIS). Some of the data has been published on the 'Our Environment' section of the site to allow for easier browsing of the spatial layers.

The data is open-access and suitable for New Zealand use only. To explore the data supermarket visit: landuseopportunities.nz

*The Whitiwhiti Ora website is a collaboration between Manaaki Whenua, AgResearch, DairyNZ, Scion, Land Water People, NIWA and Plant & Food Research. It is funded by the Our Land and Water and Deep South Challenges.*



HTTPS landuseopportunities.nz/

# News in brief

## Manaaki Whenua supports climate commission workshops for Māori experts

Manaaki Whenua Kaihautū Māori Research Impact Leader Dr Shaun Awatere (Ngāti Porou) has recently participated in workshops with other Māori advising the Climate Change Commission to develop Pae Tāwhiti Pae Tata, the te ao Māori-specific chapter for the Commission's first national adaptation plan monitoring report.

This report assess progress towards meeting the emissions budgets and the 2050 target, and the adequacy and implementation of current emissions reduction plans by government. Shaun says institutions such as the Commission are essential for monitoring the Government's progress towards meeting the objectives of the National Adaptation Plan including the need for the Government to support hapū, iwi, and Māori to better realise their aspirations for wellbeing and mitigate the impacts from a changing climate.

*Dr Shaun Awatere..*

*The agar plate on the Love Food Hate Waste campaign billboard.*


## Growing awareness of a mouldy problem

Aucklanders were able to see the growth of mould in real time thanks to an innovative advertising campaign made possible by Manaaki Whenua researchers.

Senior mycologist Dr Bevan Weir worked with technician Diana Lee to create several giant agar plates measuring a metre in diameter that were affixed to billboards around the city as part of a campaign to highlight the extent of household food waste.

The plates were inoculated with a mould fungus like that found in blue cheese.

"I chose this organism as a very safe fungus to use. It is considered a Generally Recognised as Safe, or GRAS, food additive by the American Food and Drugs Association. The agar was PDA or Potato Dextrose Agar, just boiled up potatoes, sugar, water, and agar," says Bevan.

Advertising agency TBWA's Love Food Hate Waste campaign billboards carried the message that households waste more than $3 billion of food every year by not eating it before it goes off. The agar plates were placed over images of bread and oranges giving passersby a close look at what happens to all the wasted food in our fridges.

People were able to see the mould growing in real time across the agar plates.

As part of the campaign, Bevan, or the 'mould man' as he's affectionally become known, was also invited to give the staff fridge in the Seven Sharp studios in Auckland's TVNZ building a thorough inspection, and advise viewers what was still good to eat and what should definitely be headed to the bin.

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# Regenerative dairy farm project mooving along

The tools are in the ground and data collection is in motion at Aotearoa New Zealand's second-largest regenerative farming research project.

The 8-year research project, Te Whenua Hou, Te Whenua Whitiora (The New Land, the New Horizon) led by Ngāi Tahu Farming, has been established on two dairy farms in North Canterbury, side by side, to compare the performance and impacts of their different practices. One 286-hectare farm uses regenerative farming practices while the adjacent 330-hectare farm uses conventional methods.

As partners in this project, Manaaki Whenua researchers aim to answer the big questions about environmental impacts: do regenerative practices reduce emissions of the greenhouse gases nitrous oxide and methane? Do they increase soil carbon and nitrogen? Do they reduce irrigation needs? And do they reduce nutrient losses and groundwater pollution?

In addition, Manaaki Whenua staff are documenting how the multi-species pastures' composition evolves over time, providing clues to their viability and influence on the environmental impacts. Manaaki Whenua project lead Dr Johannes Laubach says baseline data is now being collected on various aspects of the project. The biggest effort was to install six lysimeters - enclosed columns of undisturbed soil from which water and nutrient losses can be collected and measured - on each farm.

"It is excellent to have all the lysimeters in place. This installation has been complex, and it is satisfying to see them now delivering drainage and leaching data," says Johannes.

We will keep you updated on results as the project progresses.

*The installation of the lysimeters deep into the fields on the Canterbury plains.*

# Celebrating our achievements

**Dr Robyn Simcock** was part of the winning project team for the NZ Institute of Landscape Architects 'He Iti Pounamu' category (small ideas with significant outcomes) for an innovation in creating root zones for native forest regeneration at the O Mahurangi Penlink highway, Auckland. Robyn worked with the O Mahurangi–Penlink Alliance (through Waka Kotahi involvement) to bring and adapt this method from mining to highways, something significantly more complicated than initially envisaged. This active rehabilitation process will result in greater ecological resilience to drought and water stresses, and result in a more natural ecosystem type in the long term.

*Robyn Simcock*

**Dr Suzie Greenhalgh** was a co-author of a 2022 article that was recently announced as the NZ National Champion for the Frontiers Planet Prize 2024. The paper, titled "Social-ecological connections across land, water, and sea demand a reprioritization of environmental management" is one of 23 National Champions selected. The Frontiers Planet Prize celebrates breakthroughs in Earth system and planetary science that address these challenges and enable society to stay within the safe boundaries of the planet's ecosystem.

*Suzie Greenhalgh*

Research Associate **Dr Bev Clarkson** was recently awarded the University of Waikato Medal. The award recognises University and Community service at a local or regional level. In this case, the award specifically recognises Bev's substantial and exemplary contribution to understanding and protecting New Zealand's landscapes and ecology in her work on wetland care and restoration.

*Bev Clarkson*

**Dr Melissa Robson-Williams** and **Dr Nikki Harcourt's** 2023 paper titled "Achieving societal collaboration and impact in Aotearoa-New Zealand through transdisciplinarity" was recognised and selected for inclusion in the 2023 Tour d'Horizon of Literature from the Swiss Academy of Arts and Sciences. The panel highlighted the quality of the paper, specifically identifying the discussion of how mātauranga Māori and Western science currently interact and outlining the social and environmental consequences when mātauranga Māori is marginalised.

*Melissa Robson-Wiliiams*

*Nikki Harcourt*

# Gender and “man-made” disasters: the role of women in recovery

As natural disasters become more frequent, the role of women in recovery needs to be recognised and adequately supported, a senior environmental social scientist says.

Manaaki Whenua senior researcher Dr Suzanne Vallance has spent over 15 years researching disaster recovery, and says she often noticed recoveries were gendered.

This sparked Suzanne’s research, funded by the Resilience to Nature’s Challenges National Science Challenge, to look at the role of women in two disasters: the recent devastation caused by Cyclone Gabrielle (February 2023) and the Kaikōura earthquake (November 2016).

In her work, Suzanne interviewed eight wāhine / women who undertook, and are still undertaking, recovery work from these disasters on behalf of their communities. “It was heartbreaking to hear their stories,” says Suzanne. “But what stood out to me was that their recovery work is not as visible as repaired bridges and new roads, but their restoration of ‘soft infrastructure’ must be better supported.”

For example, Suzanne’s research revealed that pre-disaster work in social, health and education services and voluntary work (such as fundraising for netball clubs and organising tangihanga) helped develop local knowledge, competencies and networks that proved highly useful for disaster recovery.

“It was women who had the connections and networks to look after the elderly, the young, provide safe houses and put the call out for household supplies – they were, and still are, on the frontline of recovery,” says Suzanne.

> “Men see black and white, women see grey. Like when our people said they needed X but I could see that they also needed X and Y. Females look at black, white and grey. We look more further afield, not just at the now.”

Further, globally, ‘natural’ disasters tend to kill more women than men and kill them at a younger age, and the picture for Aotearoa New Zealand is similar, says Suzanne. For example, in the 24 hours following the Christchurch earthquake on February 22, 2011, of the 182 deaths, 63 were male (35%) and 119 female (65%). Of those hospitalised, 33 (36%) were male and 58 (64%) were female.

“We know that disasters amplify pre-existing social trends and norms, some of which discriminate against women and increase their vulnerability: lower pay, less secure housing, job insecurity and domestic violence,” says Suzanne. “Effective disaster risk reduction would proactively address these inequities and not wait for disasters to amplify them.

“Disasters are not ‘natural’ but to call them ‘man-made’ is provocative. Given disasters discriminate based on gender, disaster management cannot be gender-blind,” says Suzanne.

“Given their roles in recovery, the support women need is different to men, and we need to anticipate these needs.”

Recovery conversations need to happen at times and in places that suit women, funding for community-led recovery activities needs to be easier to get, and the strengthening and rebuilding of infrastructure that women and children use needs to be prioritised, says Suzanne.

Next steps in this research include gaining more qualitative data, and Suzanne says she is determined to continue this area of research.

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