Pūtaiao

MANAAKI WHENUA SCIENCE SUMMARY / ISSUE 21 / FEBRUARY 2025

Loam truths

Science for better soil and land management

Pūtaiao

Science for our land and our future

Tēnā koe and welcome to Issue 21 of *Pūtaiao (Science)*, our quarterly publication showcasing the work of our scientists at Manaaki Whenua.

Each issue of Pūtaiao describes the benefits and impact of our science in helping to ensure a sustainable, productive future for Aotearoa New Zealand (AoNZ). This issue shows the progress we are making in science for our soils and land resources.

Soils are an essential underpinning for all human activities on earth. Some 95% of our food depends on productive, healthy soils. But soils are largely hidden, and most people don't give them a second thought.

Our scientists work across all aspects of soil science and land management, as the following stories show. Our work is trusted and sought for its dependability, upon which sensible and robust resource management decisions can be made, and environmental limits can be set.

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@landcareresearch.co.nz

You can also sign up to our online webinar series LinkOnline, where we share our science with key stakeholders, here: landcareresearch.co.nz/events/linkonline

Cover image: Priscilla Corbett-Lad of Scion Research at the 2024 Moana Oceania Soil Judging Competition held in Rotorua. See page 10 for more details.

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Soil carbon: which on-farm interventions does the science support?

The world's soils have been calculated to contain 1,700 gigatonnes of organic carbon to a depth of 1 metre, which is more than the mass of carbon in the atmosphere and vegetation combined. Because of this, there's been a lot of interest in how soil carbon stocks could help to mitigate global greenhouse gas emissions as well as improve productivity, perhaps the best-known being the "4 per mille" initiative from the Paris Climate Accord of 2015, which set a modest-sounding aim to increase soil carbon stocks by 0.4% annually. However, it is now accepted that achieving this across the globe is not realistic.

AoNZ is fortunate to have relatively high existing carbon stocks. In grazed grassland soils, which comprise about 55% of the national land area, there's an estimated 106 tonnes of carbon per hectare to a soil depth of 30 centimetres. Even so, some AoNZ's soils may have the potential to store more carbon. Maintaining existing carbon stocks and reducing the likelihood of future losses may be our best bet, but until now there have been scant data on which land management practices might achieve the best soil carbon outcomes for AoNZ's productive soils, and it's been similarly unclear how changes to management practices could contribute to mitigating AoNZ's national agricultural greenhouse emissions.

To address this knowledge gap, researchers at Manaaki Whenua and collaborators from several other organisations led by Dr David Whitehead have, for the first time, assessed and quantified the most promising approaches to reduce soil carbon losses or increase soil carbon stocks in AoNZ's productive grassland soils. The assessment collated all known data on nine different on-farm interventions, after which the researchers estimated the land area of AoNZ where these interventions could be realistically implemented, and calculated the potential effect of each on mitigating overall

Grazed grasslands cover about 55% of the national land area.

national agricultural greenhouse gas emissions.

The nine interventions were classed into three groups as follows:

Increasing carbon inputs to soil

- planting deep-rooting and diverse species in grasslands
- reducing forage cropping (which reduces carbon in paddocks where the forage is grown)
- deferred grazing, which allows biomass to build up prior to grazing.

Soil carbon protection

- water table management to reduce emissions from drained organic soils
- reducing cropping on drained organic soils
- full inversion tillage grassland renewal
- addition of active clay minerals to enhance the ability of a soil to store carbon
- enhanced rock weathering for capture of atmospheric carbon.

Integrated systems

- establishment of tree clusters integrated into grassland and agroforestry.

These nine interventions were chosen based on their suitability to be incorporated into existing grassland management practices and the capability of capturing any resulting changes in soil carbon stocks in the national inventory.

Data to confirm changes in carbon stocks from these interventions is scarce in AoNZ, so confidence in the effectiveness of each intervention was scored from "likely" to "possible" or "uncertain".

Overall, the potential contribution of each intervention to mitigating national agricultural greenhouse gas emissions was small, ranging from less than 1% to around 2.5% over 20 years. These contributions are less than planting trees but do allow the land to continue to be used for agricultural production.

The most compelling intervention – and the one with the only "likely" confidence score – was raising water tables to reduce carbon loss from drained organic soils. Further research is required to determine how this could be best achieved and the size of the benefits under AoNZ's unique conditions.

The researchers conclude that reducing further soil carbon losses and achieving modest increases in soil carbon stocks are possible but will require economic and political incentives that encourage the integration of multiple interventions at the farm scale.

Funding for this work was provided by the New Zealand Agricultural Greenhouse Gas Research Centre and additional funding to Manaaki Whenua – Landcare Research for the Trees in Landscapes *programme from the Ministry of Business, Innovation and Employment Endeavour Fund.*

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HTTPS *doi: 10.1111/sum.13113*

Springtail safari: a field-based assessment of agrichemical use

Soil fauna are an essential component of virtually all terrestrial ecosystems. They are usually categorised by size into microfauna (2 to 200 µm), mesofauna (200 to 2,000 µm) and macrofauna (over 2,000 µm). The most dominant microfauna are nematodes, with springtails and mites the most dominant mesofauna and earthworms the best-known macrofauna, but macrofauna also include ants, beetles, millipedes and many other taxa. Soil fauna support ecosystem functions by directly contributing to decomposition and nutrient cycling, and indirectly through activities such as altering soil structure

However, there is little robust field-based information about the abundance and diversity of soil fauna in AoNZ, or about the effects of common agrichemicals on them. These knowledge gaps have the potential to hamper management decisions in the production sector – as the following example shows.

In 2023, the New Zealand Environmental Protection Authority (EPA) updated its assessment of hydrogen cyanamide, a plant growth regulator widely used by the kiwifruit industry for the promotion of bud growth. Hydrogen cyanamide is applied as a spray once a year over August to September. The reassessment identified a high in-field risk for springtails (*Folsomia candida*, of the class Collembola), based in part on lab data that suggested hydrogen cyanamide could cause chronic toxic effects in springtails.

Spraying in progress in the kiwifruit orchard. Plastic covers were used to protect the soil surface and provide unsprayed controls.

However, lab-based work does not fully take account of environmental factors such as the likely more rapid degradation of hydrogen cyanamide in the field, and additional interception associated with soil surface coverings such as litter or grass. With better data urgently needed, the kiwifruit industry asked scientists at Manaaki Whenua to assess the potential effects of hydrogen cyanamide spray on Collembola and other soil fauna in a kiwifruit orchard. A field trial was undertaken in August to September 2023 at a conventionally managed green (Hayward) kiwifruit orchard in Te Puke, Bay of Plenty.

Sampling for soil invertebrates and soil chemistry was undertaken three times: pre-spray, within 24 hours of spraying, and 6 weeks post-spray. Control plots were temporarily covered with plastic sheets during the spraying.

The most obvious finding was a marked increase in Collembola abundance, and other soil fauna, at 6 weeks post-spray, which was attributed to seasonal variation. Critically, there were no significant differences in total Collembola abundance or type, or other soil fauna including mites (Acariformes) and ants (Formicidae), between control and treatment plots at any time-point during the study – suggesting that hydrogen cyanamide did not have any effect on soil fauna in this field study. There was minimal variation in most soil characteristics between individual plots, between control and treatment plots, and over time. Soil chemistry was generally within established soil quality target values.

These preliminary field results suggested that the in-field risk of hydrogen cyanamide for soil organisms was lower than the EPA had thought. These new findings were submitted to the EPA and presented to the EPA decision-making committee for the reassessment in February 2024, which subsequently concluded that with controls in place, the risks to in-field soil organisms from the application of hydrogen cyanamide to orchards are indeed negligible.

This type of field study is important for assessing the impacts of agrichemicals in other horticultural and agricultural systems, including better understanding of the wider potential effects of different management practices.

Funding for this study was provided by New Zealand Kiwifruit Growers Incorporated and by Zespri.

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Sampling for soil invertebrates using a split-corer.

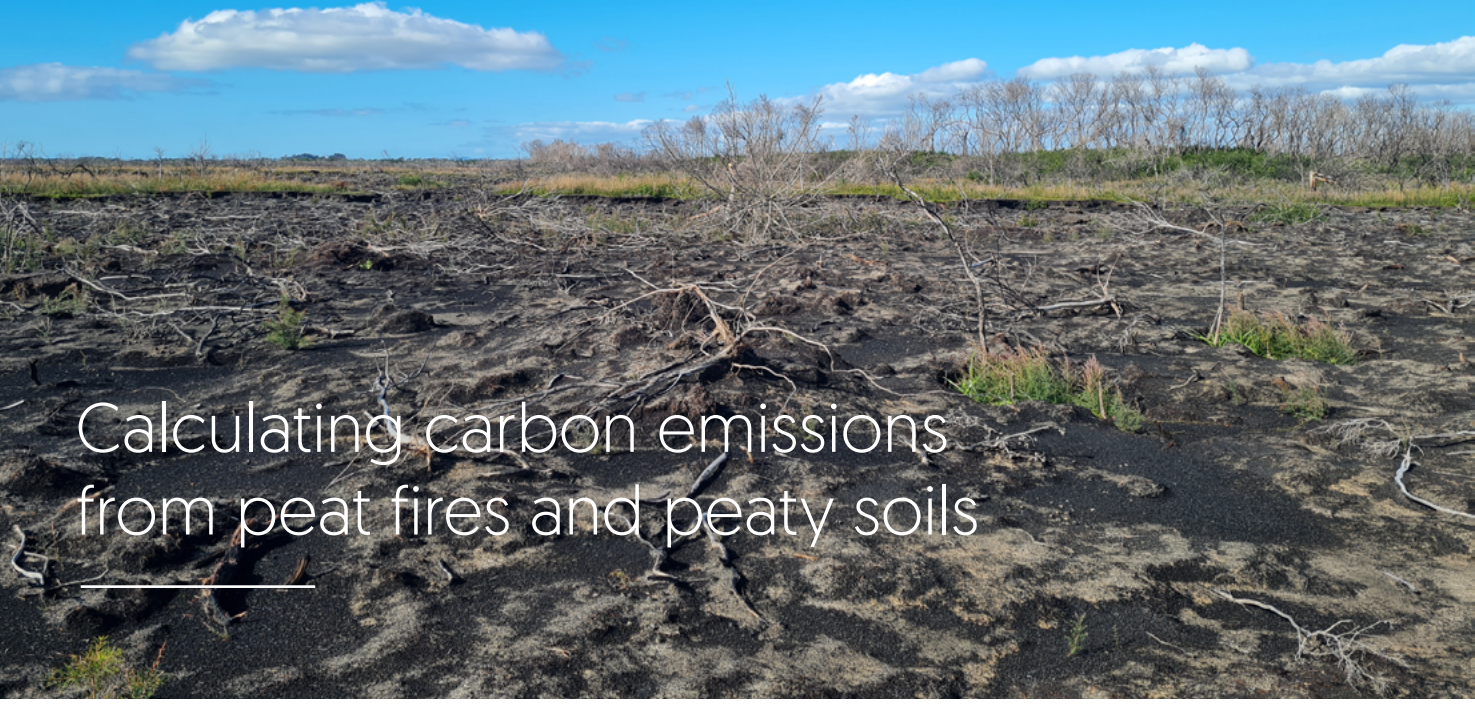
Analysis of pesticide residues in soils from the Greater Wellington region

Manaaki Whenua's experts in soil contaminants were recently asked by Greater Wellington Regional Council to analyse and interpret data on pesticide residues at 100 non-urban State of the Environment soil quality monitoring sites.

Sites sampled included dairy, drystock, perennial horticulture, arable cropping, vegetable cropping, lifestyle, plantation forestry and indigenous vegetation. Soil samples collected between 2020 and 2024 were analysed for pesticide residues including organochlorines, non-organochlorines and glyphosate by Hill Laboratories and AsureQuality. Our role was to collate the data, identify "nominal concentrations of concern" (NCOCs) and to assess whether any of the samples showed readings above NCOCs, and to advise on ongoing sampling.

Pesticide residues were present in 70 of the 100 samples across all land-uses. Only 12 sites across all land uses had any residues above NCOC. Consistent with general patterns of pesticide use in New Zealand, these sites were confined to arable, vegetable and perennial horticulture. It was noted that results could have been influenced by pesticide application close to the time of sampling. Overall, pesticide concentrations were judged unlikely to cause any negative environmental impacts.

This work will enable the council to decide whether further monitoring or research is needed to understand the implications of pesticide use in land management.



Calculating carbon emissions from peat fires and peaty soils

View of Kaimaumau wetland a few months after the 2022 fire, showing some regrowth of vegetation.

Huge amounts of carbon were lost in recent human-caused fires at two of AoNZ's most important wetlands – the Kaimaumau-Motutangi wetland in Northland and the Awarua wetland in Southland.

Working with scientists at Manaaki Whenua and supported by local iwi, in particular Ngāi Takoto and Awarua Runaka, in October 2024 the Department of Conservation published the first detailed study on carbon emissions from these peatland fires.

Peatlands are a type of wetland with an incredible ability to store carbon in peat, built up over tens of thousands of years. However, peat wetland soils are highly flammable when water levels are low, which can occur during extended dry periods and be exacerbated by drainage of surrounding agricultural land. In Kaimaumau the burnt area was over 2,900 hectares, and at Awarua it was 980 hectares. The fires also caused a loss of most of the above-ground vegetation.

Estimated carbon emissions from the 2022 fires were large, with more than 500,000 tonnes of carbon dioxide emissions from Kaimaumau and more than 100,000 tonnes from Awarua. If these losses had to be paid for, the estimated cost would have been about NZ$32-$36 million based on current carbon markets.

Manaaki Whenua Senior Researcher Dr Jack Pronger says the loss of carbon due to the two fires represents about 5% of AoNZ's annual reduction target for the 2026-2030 period relative to the previous emissions budget – and that this is likely to be a conservative estimate of the total loss.

Researchers at Manaaki Whenua, the Department of Conservation, Waikato Regional Council and the University of Waikato are currently determining whether it is possible to determine carbon losses from the more recent Whangamarino wetland fire that occurred in October 2024.

In other work on peatlands, Manaaki Whenua's researchers have been working to improve emissions accounting for Organic Soils (funded by the Ministry for Primary Industries) and estimating the potential additional contribution that could be coming from peaty mineral soils (mineral soils that include a peaty layer), as part of the *Maximising Carbon in Soils* programme funded by the Ministry for the Environment. Preliminary estimates demonstrate these peaty mineral soils may be contributing emissions of 1.0 to 2.4 megatonnes of CO_2 equivalents per year to AoNZ's greenhouse gas emissions, large enough to require reporting to the UN Framework Convention on Climate Change as a significant source of emissions.

We are working on potential mitigation actions to reduce emissions from Organic Soils through multiple collaborations including with the University of Waikato and Waikato Regional Council and Irish partners who face similar issues. Future mitigation research is being planned in collaboration with the NZ Agricultural Greenhouse Gas Research Centre.

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SedNetNZ erosion modelling now powered by LiDAR data

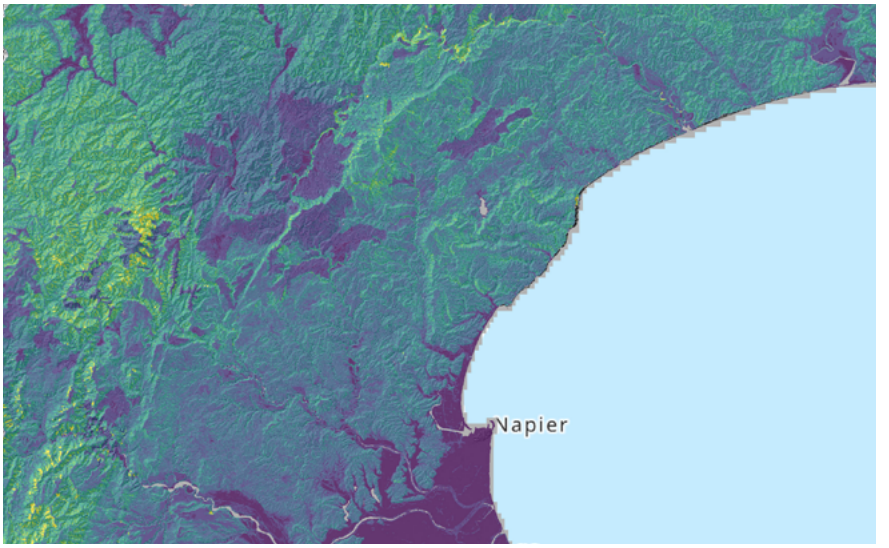
SedNetNZ is a soil erosion model developed by Manaaki Whenua that predicts the generation and transport of sediment through river networks, based on representation of hillslope and channel processes at the sub-catchment scale.

It was first applied in the Manawatū catchment in 2013 as part of the *Clean Water Productive Land* research programme. Since then it's been taken up by nine of AoNZ's 11 regional councils, whose land and water managers find it invaluable to model sediment loads, to calculate reductions in load required to reach freshwater targets, and to set freshwater objectives.

Senior Researcher Dr Hugh Smith says that over time SedNetNZ has undergone several updates, including improvements to better represent processes such as riverbank erosion. New modelling functions have also been added to estimate the potential effects of climate change on erosion rates and sediment loads under different policy scenarios.

The focus of this work has been consistently on developing data-driven modelling approaches to support better targeting of erosion control at the regional, catchment and farm scales.

With regional LiDAR data now widely available in New Zealand, a new, high-resolution LiDAR-based version of SedNetNZ was completed in June 2024. This updated version was first applied in the Hawke's Bay region as part of a partnership project with the Hawke's Bay Regional Council.



LiDAR-based SedNetNZ model predictions of net sediment yield from surface erosion in the Napier area. Green and yellow colours show more sediment yield.

Incorporation of the LiDAR data has allowed improved erosion and sediment model parameterisation and predictive performance, because it gives a much more accurate representation of topographical features such as slope angle and curvature, as well as better representation of the stream network itself including stream channel shape, slope and bank height.

The upgraded version of SedNetNZ can also produce higher resolution layers for selected erosion processes – for example, showing at a finer scale than previously possible which areas of land are most susceptible to shallow landslides. This information can then be used by land managers to better target tree planting in areas of pastoral land most affected by slope instability.

Recognising its use in supporting better land and water planning, the upgraded LiDAR-based model is now being applied in a project with Waikato Regional Council.

For more information, including how to upgrade SedNetNZ to the latest LiDAR version, contact the core development team: Dr Hugh Smith, Dr Andrew Neverman and Dr Simon Vale, at the emails below:

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Small tree patches: big impact on carbon storage in New Zealand grasslands

A new study reveals small tree patches can have mighty environmental, economic, and cultural benefits in grassland landscapes across AoNZ.

The research highlights the critical role these small patches, each less than one hectare in size, play in carbon storage and sequestration, biodiversity support, and climate adaptation.

Led by Manaaki Whenua Senior Researcher Dr Dan Richards, the study used high-resolution satellite data to map over 1.6 million small tree patches.

These patches collectively cover up to 188,000 hectares of AoNZ's grasslands. The researchers estimated the aboveground carbon stock stored in these patches to be between 11.6 and 29.3 million metric tonnes, with annual sequestration of up to 0.8 million tonnes of carbon.

Small tree patches sequester carbon equivalent to 2.9–7.8% of AoNZ's agricultural emissions.

The market value of carbon sequestered by these patches could reach NZ$237.6 million annually, underscoring their economic potential.

Despite their contributions, current policies exclude small tree patches from regulatory carbon markets like the Emissions Trading Scheme (ETS). Researchers agree that the next step would be to age the patches to determine the "additionality" required by carbon markets.

S.Graham

Small tree patches such as this one in Canterbury could have significant carbon market value.

"Small tree patches are often overlooked, yet they provide vital functions and cultural benefits, particularly within the Māori worldview of kaitiakitanga" says Dr Nikki Harcourt, who was involved in the study.

"Including these patches of trees in climate policies could significantly enhance carbon sequestration efforts while supporting biodiversity and cultural heritage." says Dr Richards.

The study calls for policy adjustments to protect and incentivise the establishment of small tree patches. These include revising afforestation incentives and integrating these patches into emissions reduction frameworks.

"By doing so, New Zealand can align its environmental and economic goals with indigenous values and global climate targets."

This research highlights the importance of rethinking grassland management and leveraging the potential of small-scale natural solutions to combat climate change.

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HTTPS *doi:10.1080/14693062.2024.2427710*

Digging for treasure: AI tool to help scientists access soil research under development

Callaghan Innovation and Manaaki Whenua are digging into artificial intelligence to develop a tool to help scientists uncover a treasure trove of soil research insights.

The AI tool, named *SoilInsights*, will help Manaaki Whenua scientists seeking to access its extensive digital library, enabling them to ask, and get answers to, research questions from 40 years of unseen soil data and reports.

The project team expects to have the first version of a pilot focusing on public-facing research outputs ready by the end of this year. They are working closely with soil data experts and other data scientists from Manaaki Whenua to help guide and improve the tool's development.

Manaaki Whenua Senior Pedologist Dr Thomas Caspari says Manaaki Whenua has a plethora of potentially interesting soil information for AI training. "Aotearoa New Zealand's early soil information, spanning from 1920 to 1960, remains a largely untapped treasure. "This pilot will help us explore how to unlock decades of valuable pre-database insights that are still waiting to be uncovered and shared."

Callaghan Innovation Head of Digital and AI Whare Sarah Sun says recent advances in generative AI have opened up myriad new use cases. "We were thrilled with the recent reaction to GovGPT, which has helped start several conversations," she says.

Manaaki Whenua soil scientists analysing soils in a Marlborough vineyard.

GovGPT is an AI conversational companion pilot that accesses several Government websites to provide information on funding and support to businesses much faster.

Like GovGPT, *SoilInsights* is being developed in partnership with Microsoft. The tool will use a technique called Retrieval Augmented Generation (RAG) to enhance the accuracy and reliability of the AI model tasked with summarising the research outputs. It will also provide links so scientists can check results against original sources.

"We know AI is a gamechanger for business productivity, but examples like this show the huge scope to support our scientific and environmental ambitions as well," says Vanessa Sorenson, Managing Director for Microsoft NZ.

"By giving researchers instant access to insights and summaries from decades of untapped soil science data, it's helping empower faster and more informed decisions on our future – from the way we use our land for food, primary resources and infrastructure, to how we respond to climate change. We're proud to be part of this project and look forward to seeing how *SoilInsights* benefits researchers, businesses and people across Aotearoa."

Once the pilot tool has been built it will be tested and validated by Manaaki Whenua researchers in January. "Subject to the results of the trial, we may consider developing a public-facing version of the tool, so that researchers outside Manaaki Whenua have access," says Sarah Sun.

"Ultimately, we envisage a future where an AI tool could help to make our research more widely accessible to the communities we serve," says Manaaki Whenua Head of Digital Strategy, Nick Spencer.

Profile update: when soil science gets competitive

Manaaki Whenua's soil scientists are leaders in their field – especially below the ground surface! Many are also active in the New Zealand Society of Soil Science, including Dr Pierre Roudier (the society's incoming president for 2025-26), Dr Sam Carrick (immediate past-president), and Dr Kirstin Deuss (early-career representative).

Formed back in 1952, the Society promotes the advancement of soil science and its members include professional soil scientists, environmental scientists, ecologists, geographers, agricultural scientists, foresters, engineers, policy-makers, farmers, teachers, and consultants.

In December 2024 the Society jointly hosted the Rotorua Soils 2024 conference with Soil Science Australia, bringing together around 390 soil and land science professionals from AoNZ, Australia, and the South Pacific. World Soils Day fell on the last day of the conference, with a plenary talk given to open the day by the Parliamentary Commissioner for the Environment, Simon Upton.

Rotorua also played host to the regular Soil Judging Competition, which organisers say is a fun way to upskill soil skills across the industry.

Soil profile analysis as part of the 2024 Soil Judging Competition.

Across three days, the international event saw aspiring and experienced soil practitioners not only compete as an individual or team member, but also develop their professional skills in the identification of soil features, soil classification, and land capability assessment.

More than 200 current and emerging researchers, students, environmental consultants, policy and extension specialists took part in the competition, from 23 universities, nine regional councils, six private consultancies, 12 research institutes/ societies, and seven government ministries.

The competition aims to equip participants with the soil description and classification skills vital for interpreting the best management and land use for any given soil. These skills are urgently needed in New Zealand and Australia to address soil protection, climate, environmental, and land use challenges, say the organisers, co-led by Manaaki Whenua's Dr Kirstin Deuss and Associate Professor Carol Smith from Lincoln University.

To find out more visit:

www *soilscience.org.nz/sjc*

S-map Online: wider coverage, better decision-making

AoNZ is internationally recognised as having a high diversity of soil types, with our online soil mapping tool S-map identifying 4,844 soil siblings (types) in the 11 million hectares of the country mapped so far. This represents around 73% of the multiple-use land of AoNZ (in Land Use Capability classes 1 to 4).

S-map Online continues to be widely used, with over 13,000 active users downloading 65,000 soil fact sheets, which is additional to the direct use of S-map data within end-user tools of organisations such as fertiliser companies, banks, councils and the Overseer nutrient budgeting tool.

Through a funding collaboration between the Ministry for Primary Industries, the Ministry for the Environment, and 12 regional councils, in August 2024 Manaaki Whenua completed an extra 507,000 ha of new soil mapping coverage across some of the country's best food-producing land. A further 363,000 ha of legacy mapping was replaced with a new soil survey. The partnership is on track to deliver a further 700,000 hectares of new mapping over the next year.

The newly mapped areas in this update to S-map include:

- 201,660 ha in Wellington – Wairarapa east coast.
- 9,656 ha in Marlborough – upper Wairau River valley.
- 27,655 ha in Tasman – Tapawera valley and Moutere River valley.
- 64,625 ha in Otago – Moa Flats.
- 45,999 ha in Southland – Chatton (north of Gore) and Curio Bay, Catlins.
- 158,000 ha in Northland – Kaikohe, Dargaville and Pouto Peninsula.

Updated mapping of lower-quality legacy mapping includes:

- 123,698 ha in Bay of Plenty – the Kaituna and Maketu water management areas.
- 240,000 ha in Tasman – Motueka hill country.

In addition, in April 2024 the soil water attributes of S-map soils were also significantly upgraded for the first time since 2020. The updated modelling is based on just under 6,000 samples (on 796 sites) held in the National Soils Data Repository, compared with only 4,641 samples (on 684 sites) in the 2020 model. This has much improved the ability of S-map to estimate soil water retention and profile-available water (PAW), including for Pumice, Granular and Allophanic soils previously not well represented in the modelling.

PAW to a depth of 60 cm is used by tools such as OverseerFM. Soils with a low PAW can provide less water to plants than those with a high PAW. The latter tend to be deep, silty, stone-free soils, and the former might be sandy, shallow or stony soils.

For more information visit:

HTTPS *smap.landcareresearch.co.nz*

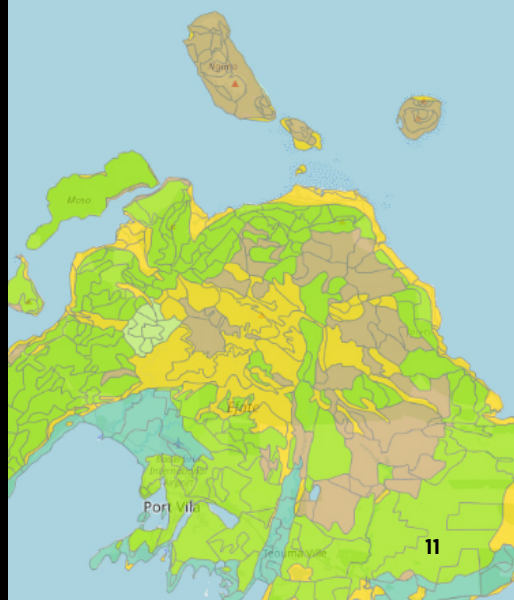
And Vanuatu makes six

The Pacific Soils Portal has had an upgrade: Vanuatu has become the sixth island nation to be covered by this popular service, with Vanuatu's national soil dataset now saved from potential loss, and readily available for use.

The Pacific Soil Portal is a collaboration between Pacific Island nations, Manaaki Whenua, Australia's Centre for International Agricultural Research (ACIAR), and the Commonwealth Scientific and Industrial Research (CSIRO). The Pacific Soil Portal is a major initiative of the Pacific Soil Partnership, and through partnering with the Pacific Community's Land Resources Division, was endorsed by the Heads of Government Departments from 23 Pacific Island Countries and Territories (PICTs) at the regional meeting of the Pacific Heads of Agriculture and Forestry Services.

You can access the portal at:

HTTPS *psp.landcareresearch.co.nz*



Good practice winter grazing adopted by farmers

Strategic grazing in practice: critical source areas of run-off are protected, cows are grazing towards the critical source area and baleage has been placed in the high points of the paddock. Image: DairyNZ.

Intensive winter grazing of livestock is a common practice in AoNZ. Livestock are grazed on an annual forage crop such as swede, kale, fodder beet or oats to feed stock over winter when pasture growth is reduced, particularly in colder southern regions. The typically high densities of livestock on winter forage crops can lead to soil pugging (compacting and waterlogging due to trampling), increased risk of soil erosion, especially on sloping paddocks, and subsequent reductions in catchment water quality.

Research into how to solve these issues is ongoing, and there is much sector interest in improving farming practice and providing science-informed guidance for farmers. Fortunately, farmers are quick to adopt worthwhile measures, as shown by a recent survey of the latest advice on "top-down" winter grazing.

Developed by AgResearch and partners, top-down grazing, as the name suggests, gradually moves livestock from the top of a slope downwards, using temporary electric fences to restrict their grazing activity, thus providing a buffer for water quality. Top-down grazing is one of several improved farming practices together known as "strategic grazing", which is associated with reduced sediment and nutrient losses from paddocks, and which could translate into significant improvements in water quality.

As part of the national-scale Survey of Rural Decision-Makers run by Manaaki Whenua in 2023, around 650 farmers indicated that they undertook winter grazing, mostly on sloping ground. In more detail, the researchers were encouraged to find that 52.5% of respondents who grazed winter forage crops on slopes, grazed top-down. Location had a modest impact on this decision, with Otago respondents being 17–24% more likely to graze top-down than those from other regions.

Māori farmers were 30% more likely to graze top-down than non-Māori farmers. Profitability was also positively correlated with the top-down technique – farmers who had adopted it were more likely to report that their farm was profitable or break-even.

The study concluded that the adoption of top-down grazing practices on slopes for winter forage crops is widespread, with just over half of the farmers surveyed grazing winter forage crops top-down. This knowledge will help planners and scientists to refine water quality modelling, and help policy-makers to evaluate the uptake and impact of information and policies intended to improve environmental outcomes.

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HTTPS *doi.org/10.1080/00288233.2024.2409761*

Understanding cultural values and the impact of sediment in and around the Wairoa River

Following the devastation of Cyclone Gabrielle, Wairoa was described as a town under mud. The town, about 100km south of Gisborne, was cut off from Tairāwhiti, as well as Hawke's Bay, after the destruction of the Putorino bridge connecting it to Napier. The river which runs through the town was heavily impacted by sediment.

As part of Our Land and Water's *Whitiwhiti Ora* programme, Manaaki Whenua partnered with the Wairoa Tripartite (Tātau Tātau o te Wairoa, Hawke's Bay Regional Council, Wairoa District Council) to gain a better understanding of the relationship between sediment and cultural values in and around Te Wairoa Hōpūpū Hōnengenenge Matangirau – the Wairoa River.

The river and tributaries are significant to the iwi and hapū of Te Rohe o Te Wairoa and are valued ecologically and for recreation and mahinga kai (food gathering/cultivation).

The project team (Dr Melissa Robson-WIlliams, Dr Nikki Harcourt and Laise Harris) worked with scientists who deliver sediment modelling (Dr Hugh Smith, Dr Simon Vale, and Dr Andrew Neverman), ecological knowledge (colleagues from NIWA), and with local Māori researchers – who adapted a kaupapa Māori-based conceptual framework for assessing the health of cultural values, using it to collect a baseline of cultural health.

How does sediment affect cultural values in and around the river? "In the project, insights from mātauranga Māori and Western science were brought together to understand how this sediment affects cultural values in and around the river, while looking at what can be done to improve the situation," says project lead Dr Robson-Williams.

The team found that sediment in and around the river impacts on cultural values in three ways:

- Directly, with a number of indicators in the cultural values framework that specifically reference aspects of ecological health like water clarity.
- Sediment and erosion in and around the river affect mahinga kai species (e.g. through smothering of spawning habitats of inanga/whitebait).
- Sediment in and around the water affects cultural practices, including dimensions such as loss of traditional knowledge of harvest methods, loss of site access, and ability to enact core values (e.g. Whanaungatanga, Manaakitanga and Kaitiakitanga are all compromised by excessive sediments).

These impacts are going to get worse with climate change, the team says.

The project modelled current sediment losses and losses under several climate change scenarios. This modelling showed that under the best-case scenarios, sediment losses are predicted to increase by up to 10% by mid-end of the century and under the worst-case scenario, erosion is predicted to increase by 37% by mid-century and 69% by end of century.

"When thinking about what could be done to improve the situation, we modelled different land uses and practices which showed a big improvement, but we also found that the connection between mana whenua and the river is not contingent solely upon the physical state of the environment.

"This was one of the most important insights that we got from the entire project," says Dr Robson-Williams. Sediment reduction, despite being the main contaminant in the river, is not the only way to improve cultural values in the Wairoa catchment, she says.

"Values relating to connection to and relationship with the environment, knowledge of cultural practices and intergenerational knowledge transfer about these practices, and the ability to practice the cultural ethics of Manaakitanga, Kaitiakitanga and Whānaungatanga can all be strengthened, as well as by reduction of erosion and sediment loads.

"This opens a lot of opportunities for improvements, "she adds.

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News in brief

Hui-ā-iwi

In November, kaimahi from our Manaaki Taiao team traveled to Kaikōura to attend Hui-ā-iwi, showcasing our research to 2,000 Ngāi Tahu whānau.

The biannual event, this year hosted by by Te Rūnanga o Kaikōura, is a chance for Ngāi Tahu whānau, hapū and iwi to congregate and hear updates from Te Rūnanga o Ngāi Tahu, celebrate with Kapa Haka, kai, and kōrero, and learn about different businesses at market stalls.

This year, our Chief Advisor Te Tiriti Strategy Holden Hohaia, Senior Kairangahau Laise Harris, Senior Technician Paula Godfrey and Māori Communications Advisor Pip Swift travelled to Kaikōura. The team's tech-savvy stall included showcasing our QGIS capabilities to whānau, as well as a Virtual Reality experience and a fun predator stamp activity for tamariki.

We also had flyers for whānau, highlighting our ability to partner with mana whenua on pest control projects, and helping them to understand more about the plants on their whenua.

Many constructive conversations were had with whānau, and we look forward to following up with these potential new partners.

Never treat soils like dirt

In contracted work for the Parliamentary Commissioner for the Environment (PCE) we recently provided an assessment of the impact of primary sector activities on AoNZ's soil, and implications for the ongoing productive capacity and sustainability of this resource. This is part of the PCE's wider investigation into the environmental pressures associated with the extraction, processing, use, and disposal of natural resources.

We also contributed to a workshop at the Wasteminz conference with on sustainable management of surplus soils with contaminated land practitioners, central and local government as to the best ways to manage soils that are disturbed through land development processes.

Dr Ani Kainamu joins Kaihautū team

Our team of dedicated Kaihautū Māori Research Impact Leaders has grown stronger recently with the addition of Dr Ani Kainamu.

Ani, who is Ngāpuhi, Ngāti Kahu ki Whangaroa, joined us last year from Te Kūwaha, the National Centre of Māori Environmental Research, at NIWA.

Her areas of interests are Indigenous food systems and environmental management approaches, using holistic and multi-disciplinary approaches.

Ani completed her PhD titled "*Ma uka ma kai, Ki uta ki tai: The ecological, social and cultural values of estuarine shellfisheries in Hawai`i and Aotearoa*" within the School of Biology and Ngāi Tahu Research Centre, at Canterbury University and Hawai'i Pacific University in 2017.

Ani has joined Dr Nikki Harcourt and Dr Shaun Awatere, forming a strong trio of Kaihautū, who along with our GM Māori Partnerships Dr Nancy Garrity support and facilitate our strong partnerships with mana whenua.

Ani Kainamu.

Farmer-friendly infiltrometer now available

Weather events over recent years have motivated farming, industry, and environmental protection authorities to search for ways to minimise environmental pollution. One way of achieving this goal is to increase agricultural water-use efficiency and manage storm water generation more efficiently on-farm. To do this, it is essential to understand soil water infiltration rates in farm catchments. The ideal device is simple, portable, and ready for use by research personnel, consultants, and farmers anywhere, with or without mobile phone coverage.

As part of an MBIE research programme to develop smarter tools to maximise the value of irrigation, soil scientists Veronica Penny and Dr Jagath Ekanayake at Manaaki Whenua have designed a cost-effective, farmer-friendly infiltrometer to meet these user requirements. It fits easily in a backpack, uses a built-in touch screen to activate, and displays infiltration rates without having to edit or enter details. It's also smartphone-compatible via Bluetooth, allowing time-series data to be downloaded to the phone or emailed to the user once in cellphone range.

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HTTPS *lcrmbei.com/index.php/infiltrometers/*

Celebrating our achievements

The inaugural recipient of the New Zealand Society of Soil Science Early Career Researcher award, recognising outstanding research contributions by a New Zealand-based soil scientist within 8 years of completing their highest qualification, was Manaaki Whenua's **Dr Sam McNally**. Sam works with a wide network of end-users including (to date) the Ministry for the Environment, Ministry for Primary Industries and He Waka Eke Noa, New Zealand Agricultural Greenhouse Gas Research Centre, the Farmed Landscapes Research Centre, Foundation for Arable Research and Marlborough District Council.

Sam McNally.

Dr Peter Heenan has been awarded the Leonard Cockayne Lecture Award by Royal Society Te Apārangi for his decades-long commitment to Aotearoa New Zealand's rich botany, and the sharing of his knowledge with audiences across the country and the world. Peter has unrivalled knowledge of the New Zealand flora and has published over 230 scientific papers. His recent publications range in topic from eco-sourcing, taxonomy, plant colonisation of New Zealand, and phylogenetic clustering and age of formation of plant habitats. In the past year, Peter has visited five Pacific Island nations to assess their needs in plant biodiversity, conservation, and food security. Taking the opportunities provided by this travel, he is currently building a botanical research programme in Niue in partnership with local biodiversity staff.

Peter Heenan.

In December 2024 **Dr Manpreet Dhami** was awarded one of just ten inaugural Mana Tūānuku research leader fellowships by the Royal Society Te Apārangi. Over the next four years Manpreet will study whether optimising the gut microbiome of captive raised endangered Aotearoa New Zealand native birds can improve their survival in the wild.

Manpreet Dhami.

Dr Kieren Mitchell has an honorary role as Associate Investigator with the Australian Research Council Centre of Excellence for Indigenous and Environmental Histories and Futures (CIEHF, https://ciehf.au/). The Centre was created to pursue better environmental outcomes by bringing Indigenous and Western knowledges together to understand the long-term histories and near-term futures of Australia, which closely matches Manaaki Whenua's own ambitions with respect to our commitment to te Tiriti o Waitangi and delivering impact for our Māori partners. Kieren will contribute expert advice in palaeoecology and genomics to the Centre's programmes.

Kieren Mitchell.

The New Zealand Ecological Society's 2024 award for Best Publication by a New Researcher was awarded to **Dr Giorgia Vattiato** for a paper titled *Detectability of ten invasive mammal pests in New Zealand: a synthesis of spatial detection parameters*:

HTTPS *newzealandecology.org/nzje/3552*

Giorgia Vattiato.

Understanding the rongoā potential of your whenua

"*The first teacher of rongoā Māori is the ngahere, te Wao Nui a Tāne, the forest itself*" – Robert (Pā) McGowan

Through understanding how the health and abundance of plant and animal species changes across time according to the type and scale of land-based activities (for example pastoral grazing, horticulture, and forestry), landowners can better manage these activities and minimise their impact on te taiao/the environment.

Manaaki Whenua offers several specialist services to understand the biodiversity of your whenua, such as rongoā mapping to outline the potential health-promoting properties of plants.

Rongoā practitioners recognise that the health-promoting potency of plants varies according to where they are growing on the whenua. Mātauranga Māori tells us that this is because of the physical properties of the taiao, like soil types, climate and position of plants in relation to other plants.

Many plants and mushrooms contain compounds in their leaves, roots, bark, seeds, flowers or fruiting bodies with beneficial or healing properties. These compounds are called 'bioactive' because they have effects on biological functions in our bodies, such as metabolism and immunity.

If you are looking to use or develop products based on the health-giving properties of your plants, we can provide chemical analysis that measures their bioactive content.

This information can help you understand where the most bioactive plants are located on your whenua to ensure that you produce the most potent products. Knowledge can help guide your product development and application, giving you confidence about what chemicals are in your plants and ultimately your product or rongoā rākau/plant medicine.

This involves working with you to determine where and how to take samples from your whenua. This will involve an initial kōrero to discuss the best sampling design so we can confirm the number of samples that need to be tested. We have the laboratory equipment to identify the chemical composition of your samples with sensitive analytical equipment (e.g., chromatography and mass spectrometry).

If you know the compounds you are interested in, we can measure their concentration. If you don't know the compounds in your plants but believe you might have something worth pursuing; we can also discuss this. These methods will be specifically developed with each client based on the sample type, compounds of interest, and budget.

Services we commonly offer include:

- Antioxidant test. Antioxidants are compounds that protect cells from damage and inflammation.
- Antimicrobial test. Antimicrobials are compounds that kill microbes or stop their growth.
- Deliver the data and an interpretation of the data and results as a written report, including recommendations.
- If you need help identifying the types of plants on your whenua, we can visit you.
- For very large areas we have LiDAR remote sensing technology to help map the different plant types in your ngāhere.

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