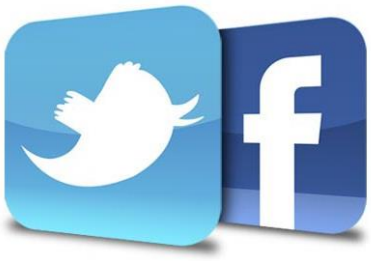
Welcome to the Soil News

August 2023
Issue 3 -Vol 71
ISSN 1178-8968 (Online)

In this issue...

Your contributions are required - New Zealand Soil News is your newsletter

John Drewry
Manaaki Whenua - Landcare Research
Private Bag 11052 Manawatu Mail Centre
Palmerston North 4442
email: drewryj@landcareresearch.co.nz



Have you liked us on Facebook? The NZSSS has a Facebook page and Twitter handle (@NZ_Soil_Soc). If you are already a user, please follow us. You can also keep an eye out for new NZSSS posts by checking the feed from our website

Officers of the NZSSS December 2022-2024

President: Sam Carrick (Manaaki Whenua-Landcare Research)
Vice President: Diana Selbie (AgResearch)
Past President: Tim Clough (Lincoln University)
Secretary: Wei Hu (Plant and Food Research)
Treasurer: Natalie Bartlett (AgResearch)

Council: Chris Anderson (Massey University); Kirstin Deuss (Manaaki Whenua-Landcare Research; Early Career Researcher); Brendon Malcolm (Plant and Food Research; Awards); Tanya O'Neill (Waikato University); Pierre Roudier (Manaaki Whenua-Landcare Research); Haydon Jones (Waikato Regional Council; Policy)

Editorial - Challenges and Opportunities for Soil Science

Emeritus Professor Keith Cameron, Lincoln University

There are huge environmental challenges ahead for Planet Earth and our knowledge and our expertise in Soil Science is needed to address many of these challenges.

For example, the Intergovernmental Panel on Climate Change (IPCC) 2022 have stated that:

“It’s now or never, if we want to limit global warming to 1.5°C”. Similarly, Dr Rod Carr, Chair of the NZ Climate Change Commission has emphasized that: “The way forward is clear – the time for climate action is now”.

Professor James Renwick (climate scientist and member of the NZ Climate Change Commission) has told us that, barring miraculous reductions in emissions in the 2020s, the planet is heading towards 1.5°C. The days we call ‘hot’ now will become the norm, droughts and floods will become more common (as we are already seeing occur) and fire danger will increase. And a range of new pest and diseases will be able to thrive in NZ. Sea level rise will flood many countries and force mass migration. If we want to keep global warming under 2°C we need to cut emissions by 30% by 2030!

Soil Science has an important role to play in reducing GHG emissions and mitigating the impacts of climate change. Soil Science can contribute crucial knowledge, understanding and management technologies to reduce GHG emissions and to mitigate the effects of climate change.

Soils store significant amounts of carbon and there is potential to increase their carbon sink capacity through sequestration. However, soils can also be a source of GHG emissions. The scale of the opportunity is enormous because soils store two to three times more carbon than the atmosphere. Therefore, a slight increase or decrease in carbon stocks can have a significant effect on the climate.

For example, the climate mitigation potential associated with soil science technologies and soil management practices include: creating additional sequestration of carbon through rewetting of peatlands, improving wetlands management, increasing carbon sequestration in arable and pastoral systems, improving precision farming and direct drilling, improving efficiency of low input extensive pasture systems to increase carbon sequestration, improving irrigation efficiency, treating animal effluent to reduce methane emissions, recycling manure, reducing compaction and increasing aeration of soils, using nitrification inhibitors to reduce nitrous oxide emissions from animal urine deposition, and reducing emissions from fertilizers through the use of enhanced efficiency fertilizers (e.g. fertilizers treated with nitrification inhibitors and urease inhibitors).

Soil Science knowledge and understanding is also critical to achieve the Sustainable Development Goals (SDGs) of the United Nations, for example: SDG 2 (Zero Hunger), 3 (Good Health and Wellbeing), 6 (Clean Water and Sanitation), 9 (Industry Innovation and Infrastructure), 11 (Sustainable Cities and Communities), 13 (Climate Action), and 15 (Life on Land). Most of these SDGs require increased understanding of soil processes such as water flow and solute transport, sorption and physical filtration, ion exchange, and biochemical and biophysical transformation, soil fertility and management.

The more we learn about soil the more we find that soil is more complex that we could imagine. It is a unique ecosystem that provides unique functions to support life on Planet Earth.

Soil is no longer just regarded as a medium for plant growth but is also a key component of global biogeochemical cycles, a crucial filter for water, and a moderator of climate change.

The public expects us to improve agricultural productivity but at the same time ensure that it is done in a sustainable manner and that it does not pollute water or increase climate change. No small task!

Crucially for New Zealand our exports need to meet ever increasing scrutiny by our overseas buyers to ensure that our production systems are sustainable. Many other global producers want to exclude New Zealand products by citing claims of unstainable farming practices and especially targeting our agricultural greenhouse gas emissions.

About two thirds of New Zealand's export income is based on soil. Soil underpins our export based primary production economy and the so-called clean, green image that we rely on to maintain market access.

Primary industry exports are forecast to reach a new record high of $56.2 billion in the year to 30 June 2023. However, overseas buyers want to see "hyper-traceability". Consumers want to know that their products are coming from lower carbon emissions sources.

There is a Trade Risk to New Zealand if we do not take action to reduce GHG emissions. For example, Nestlé is NZs largest customer for dairy products. Nestlé aims to reduce their GHG emissions by 50% by 2030 and to be 'net-zero' by 2050 (including emissions from its suppliers). Quite simply, if we want to continue to sell to Nestlé, we need to act now.

The recognition of the importance of Soil Science continues to grow but let us not forget that without soil we would not exist.

Soil is fundamental to our survival and to our civilization. History teaches us that if we do not look after our soil we will not live for long. For example, ancient Mesopotamia grew due to the successful cultivation and irrigation of soils in that region. The ability to increase crop yields to feed the people in that region enabled the invention of writing. However, problems of soil salinity and silting up of irrigation

channels caused agricultural systems to fail leading to the decline of that civilization. Similarly, soils in the Mediterranean region supported ancient civilizations, such as the Phoenicians, Greeks, Romans. However, deforestation, over-grazing and over cultivation caused extensive erosion leaving barren hillsides and loss of food supply.

The soil erosion and damage caused by Cyclone Gabrielle (and previously by Cyclone Bola) to the East Cape of New Zealand is testimony to the fragile nature of our soils.

A less dramatic, but nonetheless insidious, threat to soil is covering highly productive land in houses. Highly versatile and highly productive land is a scarce and finite resource – only 5 percent of New Zealand's total land area is classified as highly versatile and only 15 percent is highly productive.

A recent report by the Ministry for the Environment and Statistics NZ entitled 'Our Land 2021' shows that the loss of Highly Productive Land is a major risk for New Zealand because:

- *The area of highly productive land that was made unavailable for agriculture (because it had a house on it) increased by 54 percent between 2002 and 2019.*
- *Between 2002 and 2019, urban land use increased by 31 percent on land that was potentially available for agriculture.*
- *The area of residential land outside city boundaries (rural residential areas) also more than doubled in this time.*

There is now so much concern about this issue that a National Policy Statement for Highly Productive Land (NPS-HPL) has passed into law. This policy makes it clear that Councils are required to ensure there is enough highly productive land available for primary production now and in the future, and to protect it from inappropriate subdivision, use and development.

Soil scientists have as great an intellectual challenge as that found in any other discipline. There are still major gaps in our basic understanding of soil chemistry, physics, biology, microbiology, and especially in the interaction between them.

The interaction of soil solution with soil components is fundamental to the storage of nutrients for plant growth and the loss of contaminants into the wider environment, especially freshwater. Soil biota is as diverse as any other habitat on Earth. The fate of chemicals and biological components is influenced by the activity of these microorganisms and this area is rightfully receiving greater effort.

Soil health and the influence of this on human and animal health will become more important in the future as consumers reach out for healthy foods. Micronutrients and heavy metals are an essential area of study to ensure food quality standards are met and to protect the environment. Improving understanding of soil conditions is important to aid our efforts to reduce greenhouse gas emissions from soil. Discovery of new technology to mitigate greenhouse gas emissions from soil and agricultural systems is urgently needed to help reduce greenhouse gas emissions and protect water resources.

The future of Soil Science will largely depend on the practical contributions that we can make to address these challenges.

As Prince Charles (now King Charles III) said in his lecture at Lincoln University in 2019: "*What is the point of all this money, if we don't have a planet to live on*".

Biography

Emeritus Professor Keith Cameron, Lincoln University, was President of the New Zealand Society of Soil Science from 1992 to 1994. In 2022, he was awarded the L. I. Grange Medal for 'Outstanding Service to NZ Soil Science'. Keith is a Fellow of the NZ Society of Soil Science, Fellow of the Royal Society of New Zealand, and Fellow of the NZ Institute of Agricultural Science. In 2021, Keith and Professor HJ Di were awarded the Pickering Medal by the Royal Society of NZ. In 2008, he and Professor Di were appointed as 'Officers of the New Zealand Order of Merit' (ONZM) for 'Services to Agricultural Research'. Keith says that he is immensely proud of the major contributions that his students have made to Soil and Environmental Science and is grateful to them and his colleagues for many years of enjoyable and worthwhile research and teaching together.

New Zealand Society of Soil Science and Soil Science Australia Joint Conference

Save the date! The Joint New Zealand-Australian Soils Conference is coming to Rotorua, 2-5 December 2024.

The organisation committee is already busy to try and make sure this edition will be the most successful to date.

We need your help!

As part of this effort, your help is needed: the Science Program Committee is looking for help to review the abstracts and contribute to the high-quality standard of the scientific program of the conference.

Please contact Pierre Roudier (roudierp@landcareresearch.co.nz) or Sam Carrick (carricks@landcareresearch.co.nz) if you are interested to take part.

A farmer's observation and persistence led to high impact in New Zealand agriculture

John Drewry

Last month I came across an article in the New Zealand Journal of Agricultural Research – the title got my attention. It was about a determined farmer and a perennial ryegrass ecotype.

Trevor Ellett was a dairy farmer in Mangere, Auckland and he became aware that Grasslands Ruanui (a perennial ryegrass variety) did not persist as well as the ryegrass sown with seed harvested from 40- to 60- year-old paddocks on his own farm.

The article by John Caradus and others, tells the story of how Trevor Ellet had the observation and discovery from his own farm, vision and persistence, so that Mangere ryegrass became an important part of ryegrass cultivar development with high impact in New Zealand agriculture. A key point is that there was also coincidently the discovery of a fungal endophyte that is crucial for perennial ryegrass persistence under drought, heat and insect pressure.

The article states "This ecotype, referred to as Mangere ryegrass, has since become the basis of many ryegrass cultivars bred by both government and commercial plant breeders over the past 50 years".

The 'Ellet' ryegrass was later bred as 'Yatsyn 1'. The article indicates that 'Ellett' and 'Yatsyn 1' ryegrass made up 90% of the proprietary dairy pasture seed market in New Zealand.

The article reports other aspects of his life and career. Trevor Ellet also lectured at Massey University. The article reports aspects of the development of the cultivar, among many challenges, including a company going into liquidation, and a group of staff being made redundant.

There is plenty of detail in the article, but some key points that could be applicable today in our own research include (parts below are copied from or abridged from the article):

- The importance of public and private commercial independence and the use of unbiased, well designed and managed experiments that were supported by realistic field observations, and farmer-led trials.
- The importance of a comprehensive and forward-thinking commercial agreement, and marketing and sales that was based on trust, mutual respect, and a common aspiration.
- To recognise and credit the contribution of agricultural science, the professional connections and collaborations in problem solving and interpreting and understanding complex and diverse fields, leading to a paradigm shift and new technologies.

- The enduring contribution and cooperation between both parties, in the face of much adversity and risk.
- Determined belief and resilience.

Back around the 1980's in my early teens, I lived in Auckland and was interested in a career in something with agriculture – but I was not sure what. I recall meeting Trevor Ellet, who farmed near the airport at Mangere. I don't recall the details of the discussion all these years later, but I definitely remember his name, that he was enthusiastic, and well regarded as a very good farmer. I've no doubt that something about education was discussed. I also recall something about a ryegrass variety he discovered – but that might be information from the intervening years.

I recommend the article as a very positive, well-told New Zealand science story, taking readers on the journey from farmer observations in paddocks, some careful thought, a great deal of persistence and vision, and much collaboration, resulting in high impact for New Zealand agriculture.

The open access article is:
Caradus JR, Duder R, Kerr GA, Stewart AV, Thom ER 2023. Mangere to mainstream – the story of a perennial ryegrass ecotype, a determined farmer, and a progressive seed company. New Zealand Journal of Agricultural Research: 1–17.
https://doi.org/10.1080/00288233.2023.2238674

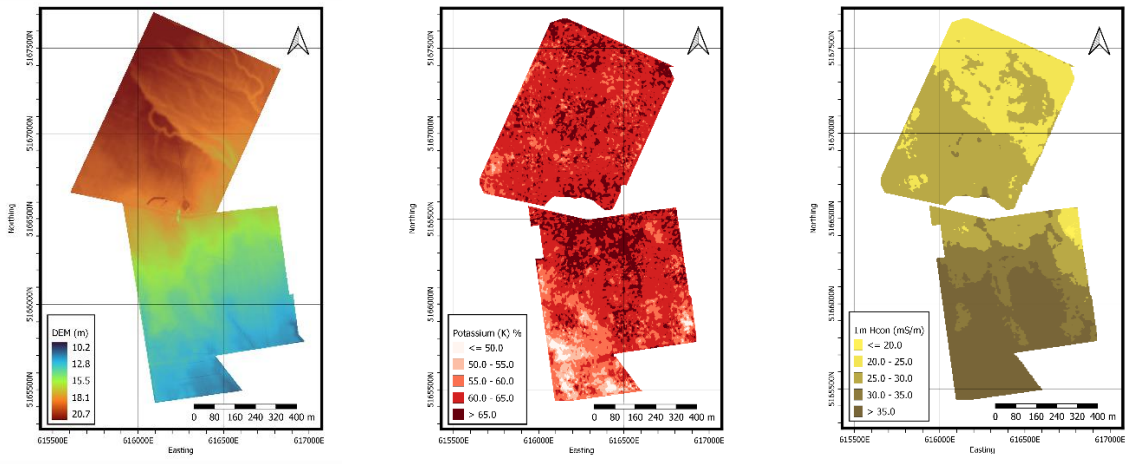
4 per 1000 – can it be done?

John Triantafilis, Manaaki Whenua – Landcare Research.

The world's soils contain 2 to 3 times more carbon than the world's atmosphere, and have huge potential for carbon storage. The International "4 per 1000" initiative, launched by France in December 2015 at COP 21, estimates that if the amount of soil organic carbon (SOC) in the top 30-40 cm of the world's soils could be increased by just 4 parts per thousand per year, this would nearly compensate for the annual global increase in CO2 in the atmosphere.

According to soil scientist Dr Sam McNally and colleagues at Manaaki Whenua, the mineral surface area (MSA) of a soil is a good indicator of how much carbon a soil can store. The best soils for carbon storage are known to have higher contents of clay – the fine particle size of clays translates to larger mineral surface area – and soils within a farm that have higher surface area could promote carbon storage. However, Dr John Triantafilis says that to determine the best places to potentially store carbon in soil requires extensive sampling and laboratory analysis of a farm, which can be time-consuming and expensive. This is because soil characteristics, such as the mineral surface area (i.e., average clay, silt and sand sizes) can vary over very small areas, often within individual paddocks and certainly across large farms.

In response, John, Sam and colleagues investigated various non-invasive proximal soil sensing digital data acquisition instruments and modelling methods for mapping the MSA of soil at the 160-hectare Lincoln University Dairy Farm in Canterbury. Digital data included (Figure 1); LiDAR, gamma-ray spectrometry and electromagnetic (EM) data were explored in combination and alone, and the minimum number of actual soil samples needed to calibrate these datasets was also determined.



LIDAR Gamma-ray EM

Figure 1. LiDAR, gamma-ray spectrometry and electromagnetic (EM) data

The resulting digital soil map (DSM) of MSA (Figure 2) showed a broad change from north to south across the farm, with small mineral surface area synonymous

with Pallic soils – with higher sand content - to the north and larger mineral surface area Gley soils – with higher clay content – to the south. The map therefore indicates that the best place to store C is in the southern part of the farm.

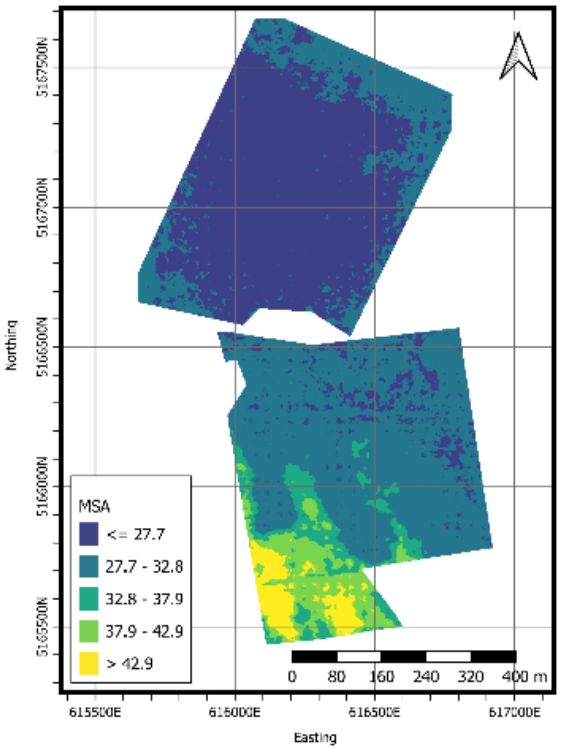


Figure 2. Digital soil map of mineral surface area

Digital soil map of mineral surface area

The modelling showed that only one physical soil sample is needed every 4 hectares to enable effective calibration of the digital data. As well as MSA, the team are exploring the potential to map other soil conditions using proximal sensed digital data, including cation exchange capacity and pH (chemical), field capacity and permanent wilting point (hydrological), and carbon and nitrogen (biological).
While the methods being employed are preliminary, the development of DSM of soil condition will provide insights to farmers and land managers into how soil capability might be improved in terms of precision application of fertilisers and ameliorants, irrigation water use efficiency and monitoring carbon stock. The capital value in improvement of soil capability and in terms of cost-benefit of developing DSM will also be investigated.

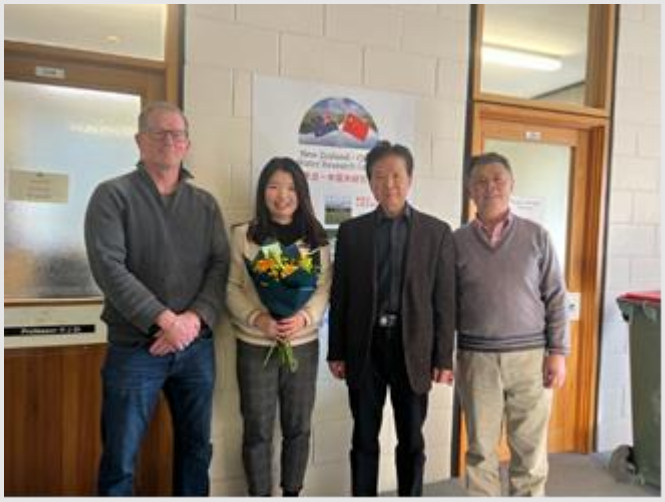
(Part of this article was also published in Pūtaiao, August 2023)
https://www.landcareresearch.co.nz/publications/putaiao/

News from the Regions

Waikato/Bay of Plenty

AgResearch

Keren Ding successfully defended her PhD (Dinitrogen (N_2) and nitrous oxide (N_2O) fluxes from grazed pasture soil after cattle urine deposition) at Lincoln University in early August. Congratulations Keren!



The Environmental Science North Team based at Ruakura is excited to announce that we have a new Scientist joining the team – Dr **Marta Alfaro**. Marta hails from Chile and comes with a wealth of experience. Marta's main research area is nutrient losses and transfer from soil to water and air in grazed systems, with an emphasis on N cycling and GHG emissions from soils.

Brendon Welten (Senior Scientist) has returned from the UK as a visiting scientist based at Rothamsted Research (North Wyke, Okehampton Devon) for 2.5 months. The primary purpose of his trip was to extend international contacts related to nitrogen cycling in

grazed pasture systems. Brendon was hosted by Dr Jordana Rivero (Grazing livestock systems specialist, Net Zero and Resilient Farming) and was involved in a wide range of nitrogen cycling related projects with a range of key scientists including Dr Laura Cardenas (Atmospheric chemist) who is leading research on N2O/CO2 emissions research and Dr Alison Carswell (Agricultural scientist) investigating N emissions and N use efficiency predominantly from fertilisers. Brendon also visited Teagasc research facilities (Johnstown Castle and Moorepark, Ireland). Brendon was hosted by Karl Richards (Head of Environment Soils & Land Use Department) at Teagasc and met with a wide range of researchers.

Photo: Brendon Welten visiting researchers at Teagasc Moorepark in Ireland.

DairyNZ and AgResearch (**Stewart Ledgard** and **Lisa Box**) are working with the LURDF (Lincoln University Research Dairy Farm) in the Low N Systems Research Programme to investigate the potential for stacked technologies that reduce nitrogen (N) leaching on dairy farms. The farmlet aims to reduce N leaching by at least 40% compared to a conventional best practice Canterbury dairy farm by using a range of mitigation strategies from prior research 'stacked' together in one system.

Mitigation strategies include, using a diverse pasture which includes plantain and Italian ryegrass, reducing N fertiliser use, feeding low N supplements at certain times, and replacing the use of a winter crop with pasture-based wintering. To better understand the N leachate losses on the LURDF milking platform, Ceramic Cup Collectors have been installed (technical team from Ruakura – lead by **Amanda Judge**) to measure N leaching

over time. A total of 672 collectors were installed in fourteen paired paddocks (28 paddocks in total) in June 2023. Each pair of paddocks consists of a control (standard pasture) paddock and a treatment (stacked technologies) paddock and will has a similar soil type, history of use and irrigation. The desired outcomes of the low N farm systems are to support practise change towards better outcomes (environment, welfare and profit).

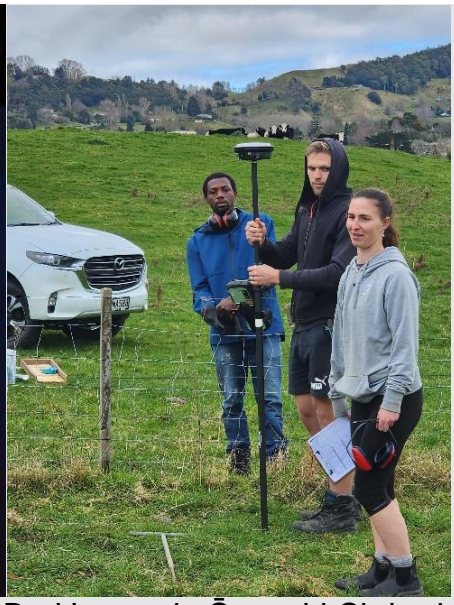
University of Waikato

Soil Science Australia conference in Darwin, June 2023

David Lowe and **Megan Balks** received the J.K. Taylor OBE Gold Medal at a special conference dinner ceremony during the Soil Science Australia national conference held in Darwin (NT) on 28 June 2023. The medal award (previously announced on 7 December 2022) was for the book “The soils of Aotearoa New Zealand” (Springer 2021) written by (the late) **Allan Hewitt**, Megan Balks, and David Lowe. Both Megan and David were given the opportunity to make a few comments on receipt of the medal, and Allan’s role as lead author was emphasised.

Wonderful harbour-side venue of the conference dinner, Darwin. Photo: D.J. Lowe

In late July **Madison Farrant** (MSc student with **Tanya O'Neill**) presented her masters research at the New Zealand – Australia Antarctic Science Conference in Ōtautahi Christchurch. Madison was also invited to present her recent Antarctic experience at the 'Antarctic After Dark' event on Friday 29th of August. The public event, hosted by Te Radar, included seven other speakers from a range of disciplines and some with vast Antarctic experience, was in a Pecha Kucha (Japanese: ぺちゃくちゃ, *chit-chat or bite-sized*) storytelling format; where Madison shone. Congratulations Madison on your two first research presentations, vastly different in format and audience; very well done!



Left - Madison Farrant at a recent 'Antarctica After Dark' event in Ōtautahi Christchurch. Photo: Deborah Diaz, Antarctica New Zealand. *Right* - Henry, Seager and Holly collecting soil samples to 60 cm under fence lines and adjacent paddocks.

Henry Ota has joined the WaiBER team from Nigeria to undertake a PhD funded by the Global Research Alliance with **Louis Schipper** and **Aaron Wall**. Before coming to New Zealand, Henry was working to investigate the impact of land use and land cover change on soil chemical and physical properties in Nigeria. Initially, Heny will compare soil carbon stocks between adjacent grazed and cut-and-carry pastures in the Waikato, before comparing carbon balances of the two contrasting farming systems including the use of eddy covariance to measure CO_2 exchange.

Henry's PhD research will also contribute towards a wider project, including work by MSc student **Holly Hay** who started in July on a joint project with **Roshean Woods** (DairyNZ). Holly is exploring the importance of dung returns for the soil carbon stocks by comparing soil carbon stocks to 60 cm under fence-lines (little dung deposition) and adjacent paddocks.

Another recent addition to the WaiBER team is **Eady Manawaiti**, who this semester is undertaking a special topic graduate paper on soil carbon sampling supervised by Louis and Aaron. Later he will start an MSc thesis integrating mātauranga Māori and soil carbon for the measurement of stocks on Māori owned land.

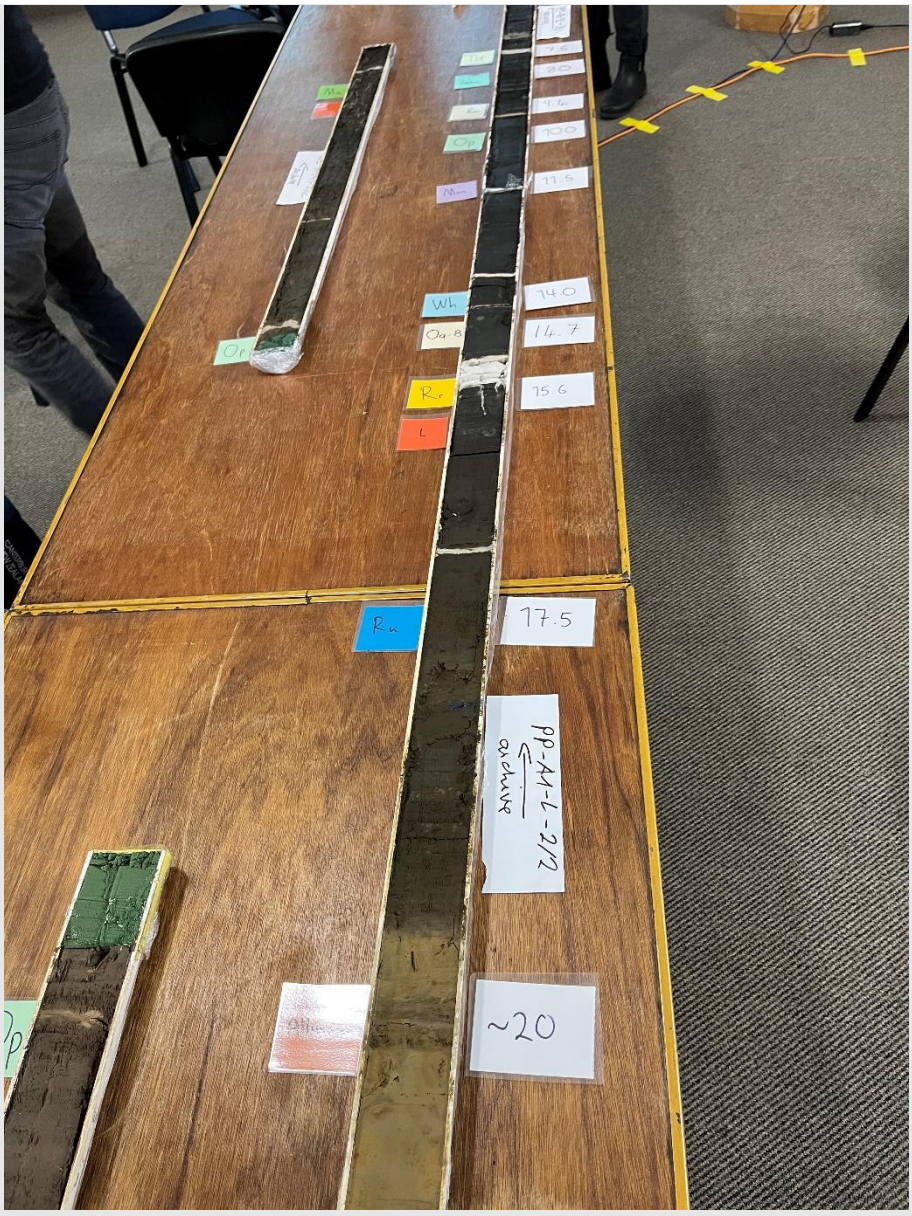
Congratulations to **Brandan Taoho** who submitted his MSc thesis at the end of July focussing on enhancing phosphorus removal and inclusion of mātauranga in design of woodchip bioreactors. Finally, Louis recently gave an opening address to the Foundation for Arable Research conference: "Stewardship of soil carbon in agriculture".

Hui on tephra seismites project

The University of Waikato School of Science "Tephra Seismites group" (https://tephra-seismites.com/) ran a very successful hui, entitled "Our earth-shaking discoveries so far!", for supporters, mana whenua partners, and stakeholders, on Tuesday 25 July 2023. Around 30 attended and enjoyed the presentations and discussions.

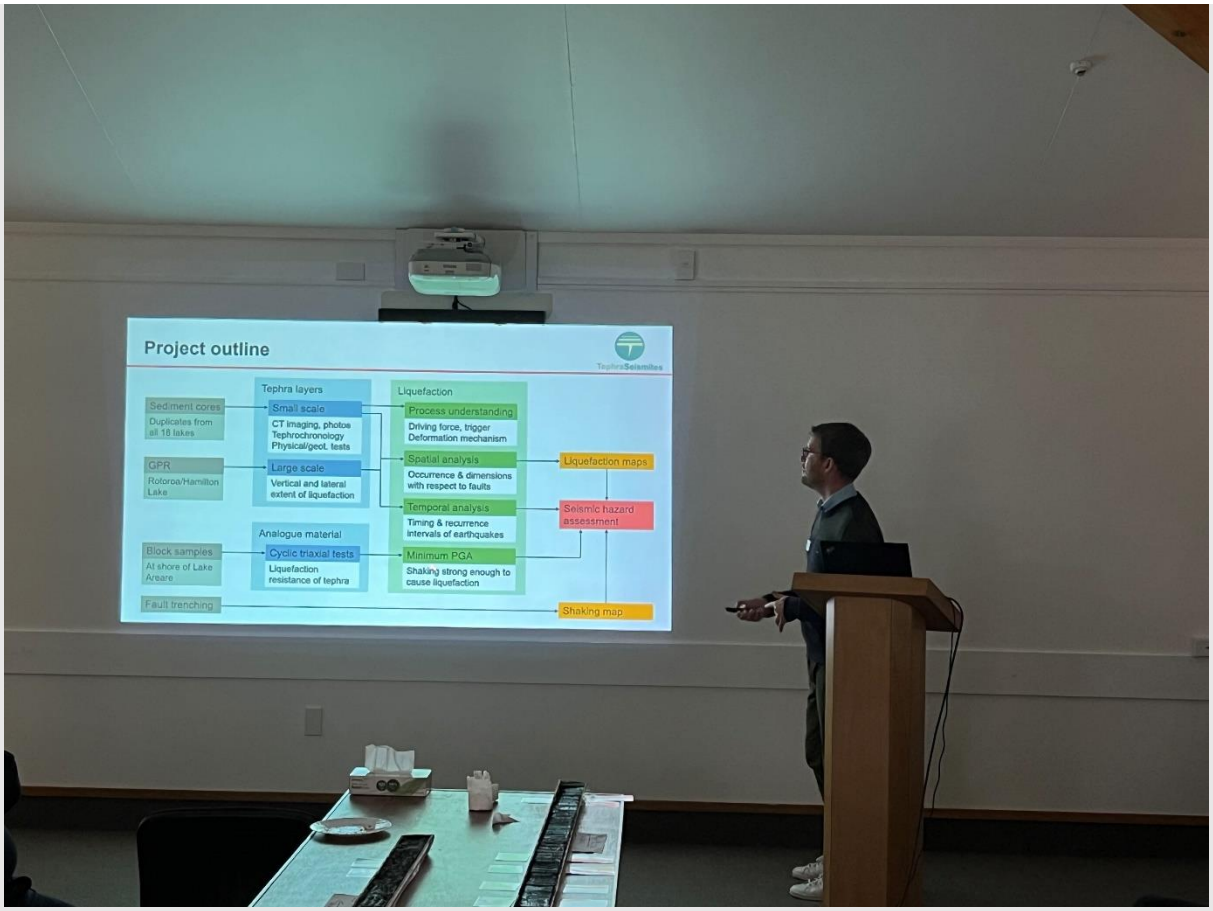
The group, led by **David Lowe** and funded by MBIE Endeavour Fund and Marsden Fund, is studying the past earthquake history of the Hamilton lowlands area using liquefied lacustrine tephras in 20,000-year-old lakes as a newly developed paleoseismic tool. After an introduction to the project, David led a workshop, “Core blimey!” where opened lake cores were displayed and discussed.

David explaining the cores and their important cargo of tephras and tephra seismites (seismically liquefied tephra layers). Photo: S.J. Lowe



Cores on display at the hui: top left, Lake Ngārotoiti; bottom left, Lake Rotoroa/Hamilton Lake; right, Lake Pikopiko. Coloured labels give the tephra names; the numbers on the right give the tephra/sediment age in thousands of years. A tephra seismite can be seen by the yellow label Rr (Rotorua tephra) in the Pikopiko core at right; another (less clear) is evident by the green label Ma (Mamaku tephra) in the Ngārotoiti core at top left. Photo: D.J. Lowe

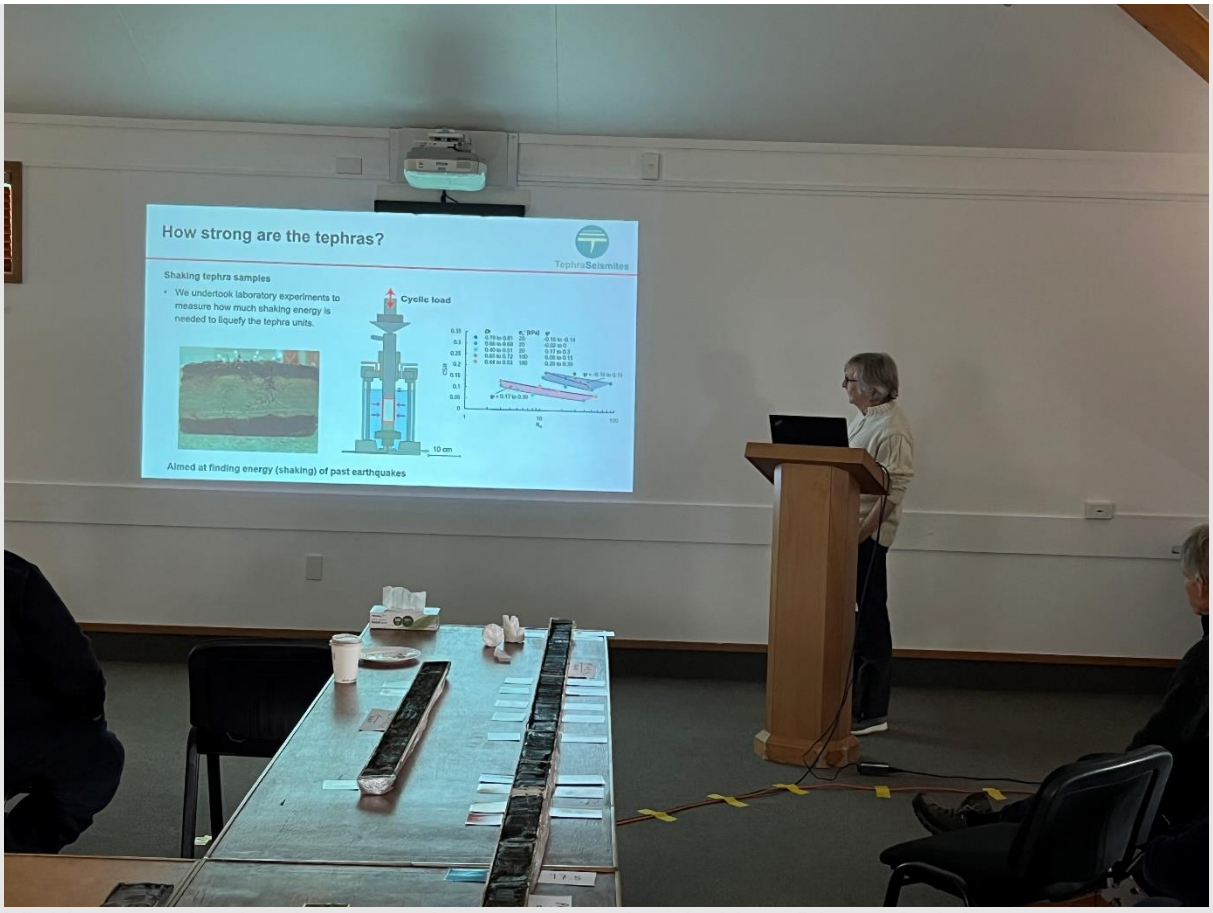
The group members presented seven talks after the workshop. Dr **Max Kluger** led with *'Towards understanding seismic hazard in the Hamilton Basin'*, an overview of the entire project and key findings to date.



Max presenting his keynote talk, an overview of the project and its development and achievements so far. Photo: D.J. Lowe

Six shorter talks focused on different areas of the project: *'Cores on a fine scale: using CT scans to understand lake sediments'* (Dr **Tehnuka Ilanko**); *'Messing about in boats: investigating distribution of liquefaction features in lake sediments using ground-penetrating radar'* (Richard Melchert); *'Our precious lakes'* (Prof. David Lowe); *'Not our fault: Te Puninga Fault near Morrinsville'* (Josh Hughes); *'Using laboratory liquefaction testing to estimate past earthquake shaking'* (Jordanka Chaneva).

The hui was completed with a summary talk by Dr **Vicki Moon** that examined modelling past earthquake shaking entitled '*Summary overview and next steps'*.



Vicki presenting her latest work on earthquake shaking. Photo: D.J. Lowe

Waikato Regional Council

Malcom Mcleod is working on MfE freshwater plans - land use classification, a review of our soil moisture monitoring network, and an investigation of pugging risk index. Alice Wheatley-Wilson is responding to reviewer comments on the organic soils report and the end of the GHG inventory is in sight.

Tim Norris is working on all things riparian. He is out in the field a lot helping finish the riparian survey, while the soil stability survey is ongoing. The permanent soil sediment site is going ahead depending on the weather. Helen Anderson reports the Region SoE report is nearing completion. Haydon Jones is involved in highly productive land mapping for the region, lots of meetings, contributing to the GHG inventory along with Alice, and preparing for the next LMF meeting.

The team at Waikato Regional Council have put together stories showing what they are doing.

Scientists expand knowledge of vulnerable peatlands

Article reproduced in part from: https://waikatoregion.govt.nz/story-hub/scientists-expand-knowledge-of-underlooked-taonga/

“I was amazed at how it’s a living ecosystem, growing and accumulating down there. When you’re moving the probe through, you can feel the ground move beneath your feet.” - Kristina Orpia

It can be tough work inserting a measurement probe into spongey peatland, but difficulty is a good sign of substance depth. Kristina Orpia, who helped undertake a comprehensive peat resources survey for Waikato Regional Council this year, says some peat sites, such as at Rukuhia, gave her back aches, but “it’s exciting to lift the probe up and see the material, like all our hard work had paid off”.

Peat depth information had not been collected for the Waikato region since a national survey by the Ministry of Works was conducted in 1976. The council replicated the survey to get up-to-date information to better understand the vulnerability of our local peatlands for future management decisions. The project sits within a wider peatland strategy to update local peat resource information, prioritise peatlands for investigation and action, test possible mitigations to reduce subsidence and greenhouse gases, investigate alternative land uses for peat, and to develop a good practice guide for future peatland management. Field assistants surveyed a total of 786 peatland sites.

Kristina, who is studying a Master of Environmental Natural Resource Management, says getting peat depth measurements essentially required digging a small hole and then jamming a long steel probe through the peat until a solid layer of sand or clay is hit. For one measurement in Orini, Waikato district, the team probed their way through 13 metres of peat, unable to push further to retrieve the true depth due to obstruction of sticks. The average peat depth across the region was 3 metres.

The Waikato has about 83,000 hectares of organic soils, including the 90 km^2 Kopuatai Peat Dome. Of this total area, more than 65,000 hectares have been drained, mostly for productive purposes such as pastoral agriculture, cropping, horticulture and peat mining.

Drainage and cultivation have resulted in ongoing peat subsidence, greenhouse gas emissions and, if left unchecked, will lead to the loss of our peat resource. Unsurprisingly, some of the sites surveyed and mapped as peat in 1976 no longer had a peat resource, generally at the perimeter of existing bogs in the Hauraki area. On average peat depths decreased by 1 metre. Peatlands upstage tropical forests in their speed and capacity to store carbon. But the key for wetlands to work their magic is for us to keep them wet. When carbon losses are extrapolated across the entire area of drained peatland in the Waikato, they represent over 10 per cent of the region’s gross GHG emissions. Worldwide, drained peatlands contribute to around 5 per cent of global anthropogenic carbon dioxide emissions.

Kristina says there needs to be more awareness of the value of peat. “It’s definitely an important area of environmental management that needs ongoing scientific research.”

Further articles are available at: https://waikatoregion.govt.nz/story-hub/

Mātauranga Māori scientist maps volcanic history of Karioi

Few people would associate Raglan with volcanoes. But less than 10 kilometres southwest of the town centre sits Mt Karioi, the central figure in a rich and ancient history. Waikato Regional Council Scientist Dr Oliver McLeod traversed the maunga’s slopes, met its people and listened to their stories to produce a remarkable map that

plots the geology and whakapapa of Karioi side by side. The full article is available at: https://waikatoregion.govt.nz/story-hub/matauranga-maori-scientist-maps-volcanic-history-of-karioi/

Some greatest shoreline changes since monitoring began
Cyclone Gabrielle caused some of the greatest shoreline changes at more than half the sandy beaches in the Coromandel Peninsula since monitoring began by Waikato Regional Council. The council has monitored shoreline change (erosion and accretion/beach building) at 102 sites on 27 beaches in the peninsula since the late 1970s, and measurements taken after the cyclone showed significant erosion at 14 of the 27 beaches. Some dunes had eroded back the furthest since monitoring began. The full article is available at: https://waikatoregion.govt.nz/story-hub/some-greatest-shoreline-changes-since-monitoring-begun/

Manawatu

Manaaki Whenua – Landcare Research

It has been a long and somewhat tortuous journey for Benny Theng. He is very pleased to say that he has submitted all materials for the book “The Chemistry of Clay-Organic Reactions”, 2nd edition. Benny wishes to acknowledge Liyin Liang for helping him to transfer the voluminous text and figures to the editorial manager of CRC Press. Keep a look out for the new book!

Massey University

Massey Open Day Wednesday 2nd August 2023

Massey staff from the Environmental Sciences Group and the Farmed Landscapes Research Centre (FLRC) set up soil and landscape related displays at a university Open Day in Palmerston North on the 2nd of August 2023. The aim was to stimulate young

people and grow their interest in soils, geology and the environment. There is a shortage of people who understand soils and landscapes here in New Zealand despite a growing need for this knowledge to support wise land use and land management decisions. The government wants all farms to have a Freshwater Farm Plan by 2025. It is essential people are trained to describe and understand soils to ensure Freshwater Farm Plans are underpinned by a strong understanding of a farm's physical resources and work towards good environmental outcomes.

The Open Day soil display captured people's attention and created a talking point by contrasting blocks of Levin silt loam, a highly prized, well-drained Allophanic Brown soil from the Horowheuna beside some poorly drained Pallic Ohakea silt loam from Palmerston North. Levin silt loam is an important soil for market gardening, providing good, resilient structure and plant available water. Ohakea silt loam on the other hand has major limitations to use including high susceptibility to pugging and compaction and low plant-available water.

This provided the perfect opportunity to get people thinking and talking about highly productive land and limitations to use. Students and staff were able to explore the relationship between climate, parent material, position in the landscape and processes of soil formation. The relative risk of overland flow vs deep drainage and how that can be influenced by management practices was also considered. The focus was around understanding the potential loss of sediment, nutrients and pathogens from the farm to freshwater.

Students took the lead in conducting a visual soil assessment. This began by dropping a 20 cm cube of topsoil into a bin from waist height to shatter the soil, before sorting out the aggregates on a bench to assess soil structure. Soil was soon strewn all over the lab floor much to the student's delight. As the students picked their way through the pile of aggregates placed on the table, they slowly collected earthworms and set about identifying these using resources from the Great Earthworm Survey by AgResearch.

Students were then offered a chance to win sweets and a Soil Orders of New Zealand poster if they could correctly identify soil texture by hand using a flow chart for guidance. To begin, they were given pure sand, silt and clay to calibrate themselves. Then they were set loose with some tricker textures to see if they could correctly determine the relative proportion of sand, silt and clay in a sample. The result was a very messy bench and floor covered in soil, sweets and soil posters all round and faces covered with grins. Needless to say, the students promptly left at the end of the session bound for farm tours and the campus cafeteria, leaving staff to clean up. A small price to pay for the opportunity to get some students stuck in, hands first, into the world of soil science.

Students and parents helping staff from Massey's Environmental Sciences Group and the Farmed Landscapes Research Centre (FLRC) to sort soil aggregates as part of a Visual Soil Assessment (VSA) structure layout.

Students exploring thin sections from a diverse range of rock types.

Students counting and identifying earthworms using resources from the Great Earthworm Survey by AgResearch.

Whenua Haumanu – Dairy Australia visit

Massey University's Whenua Haumanu (Nurturing the land through exploring pastoral farming) program hosted Dairy Australia National Program leaders for Soil and Irrigation (Cath Lescun) and Feedbase and Nutrition (Dr Rodrigo Albornoz) along with key researchers working on diverse pasture projects at Melbourne University (Dr Helen Suter) and the Tasmanian Institute of Agriculture (Dr Adam Langworthy) at a research methods workshop in Palmerston North in July. The aim of the workshop was to align methodology in the diverse pasture research space and develop opportunities for collaboration between both countries. The workshop involved Whenua Haumanu researchers, technicians and post graduate students and included presentations, farmlet visits and technical discussions about methodological approaches.

If you want to find out more, please see our see our Whenua Haumanu program webpage.

Dairy Australia National program leader for Feedbase and Nutrition Dr Rodrigo Albornoz discussing the Feedbase program with the Whenua Haumanu team.

Whenua Haumanu program leader Professor Danny Donaghy explaining the sheep farmlet pasture treatments to the visiting scientists.

Catchment Solutions Tiaki Wai project – Dairy NZ field day

The Catchment Solutions Tiaki Wai project is being funded with $3 million over the next three years by the Ministry for the Environment (MfE), as part of a $56 million pool of funding for the protection of lakes, rivers and streams across Aotearoa New Zealand.

Professor David Horne and Associate Professor Ranvir Singh from Massey's Environmental Sciences Group and Farmed Landscapes Research Centre (FLRC) lead the project, aiming to educate and provide training for farmers and iwi, including resources and educational materials, to support their on-farm work. A vital part of the project involves Massey's leading research in edge-of-field technologies.

The project team hosted Dairy NZ staff on Wednesday 28th of June 2023, providing an overview and field trip to Massey's No.4 Dairy Farm where a woodchip bioreactor is being used to control potential contaminants moving from the farm to freshwater.

The No.4 Dairy is underlain by Tokomaru silt loam, a poorly drained Perch-gley Pallic soil that is highly susceptible to pugging and compaction. Excess winter moisture drains only very slowly from the soil, being hindered by a clay pan over an extremely compact and impermeable fragipan from 0.8 – 2 m depth. Mole and tile drains are used to help shed

excess water through the wet season, providing more safe grazing days in spring and decreased hoof and traffic damage to pastures. Mole and tile drainage water can be enriched in nutrients, particularly as the soil profile first wets up and the tile drains flush moving into the wet season. The ability to capture and direct this drainage through a woodchip bioreactor can reduce potential contaminant loads leaving the farm to freshwater environments.

If you want to find out more, please see this story on the Massey University website.

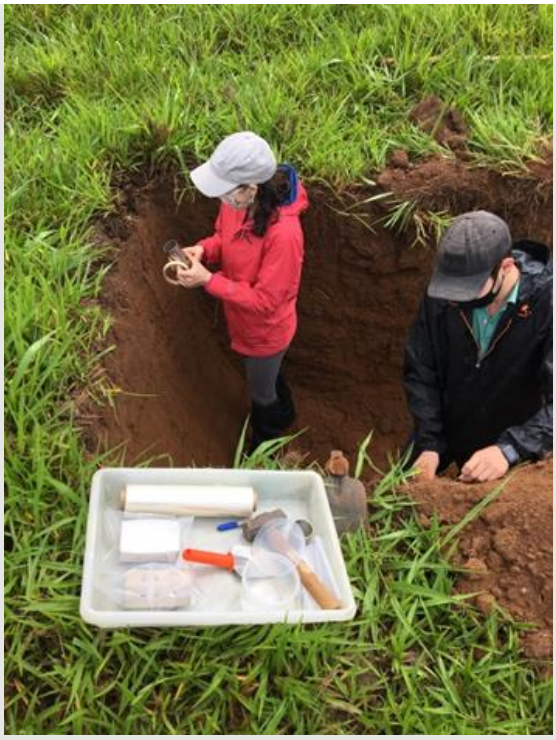
Catchment Solutions Tiaki Wai project team Mike Smith, Tamsin Laird, Dave Horne, David Feek, Ranvir Singh, Ross Gray, Liza Haarhoff and Fernando Avendaño

The Catchment Solutions Tiaki Wai project team explaining the woodchip bioreactor on Massey's No.4 Dairy Farm.

AgResearch

In May a team of four from AgResearch Grasslands spent a week mining for soil carbon at the Southern Dairy Hub. **Mike Dodd, Brian Devantier, Gustavo Pereira Valani** and **Paul Candy** took the mighty LUV hydraulic corer on a tour of 44 paddocks across the three main soil types: Waikiwi, Pukemutu and Makarewa. The weather was particularly favourable with crisp mornings and fine days, and only packed up on the last day once we were cleaning up. The main research at the Hub involves four dairy farmlets with differing wintering systems – pasture, bales and crops, with plans for a covered feed pad for the next iteration. The 349-ha farm was originally three blocks, bought by DairyNZ, AgResearch and the Southern Dairy Development Trust (i.e., regional dairy farmers) in 2016 for conversion and a complete re-grassing https://www.southerndairyhub.co.nz/. The assessment of soil carbon stocks is intended to complement other research on GHG emissions profiles for the farmlet systems and provide a baseline for future reference in terms of the potential impacts of winter management.

Gustavo Valani is a PhD student from University of Sao Paulo doing a research placement at AgResearch Grasslands supervised by **Estelle Dominati** and **Alec Mackay**. Their work studies the condition of the soil resource and soil-based ecosystem services from different grazing systems, from pasture only to partial and fully integrated crop-livestock-forest systems, all located on one of the Brazilian Agricultural Research Corporation (Embrapa) Research Farms. Preliminary results are expected to be presented at the NZGA conference in November “Condition of natural capital and soil-based ecosystem services from a Brazilian Oxidic soil under conventional and integrated livestock-based systems”.



Integrated livestock-forest system in São Carlos, Brazil (left); Soil sampling (2020).

Cyclone Gabrielle Baseline Sampling 2023 – Alec Mackay
Extract from the Interim Report – 3rd July 2023 for MPI "Cyclone Gabrielle Baseline Soil Sampling 2023". An overview of data collected post Cyclone Gabrielle prepared by Alex Dickson, Landwise Inc.

On the 13th of February Cyclone Gabrielle tore a war path across the Northland and the East Coast of the North Island, causing devastation across much of the regions. The cyclone decimated homes, productive land, and livelihoods, with the estimated cost of rebuilding in the billions of dollars. This cyclone was the third in a series of serious storms to hit New Zealand in the previous two months. Across Hawke's Bay, Wairoa, Gisborne and Northland highly productive cropping land, orchards, vineyards, and pastoral land have been buried under sediment, or inundated with water after rivers burst through stop banks and shifted their courses.

Figure 1 NZ map of areas impacted by Cyclone Gabrielle

Following Cyclone Gabrielle a group of organisations came together to discuss how to capture the impact of the cyclone on farmers, growers, and their productive land, and document the lessons that could be learnt in how to recover from a disaster such as this one. This group of organisations included LandWISE Inc., AgResearch, Massey University, Hawke's Bay Regional Council, Gisborne District Council, Plant and Food Research, and Vegetables NZ, alongside the Ministry for Primary Industries and several of the national producer groups including NZ Apples and Pears.

After the 2004 Southern North Island storm event impacted (Manawatu, Rangitikei, Horowhenua, Wairarapa and Wanganui Regions), information from farmers was collated on successes and failures of regrassing sediment deposits (silt). Around 50 farmers were involved in this study. The data was collected a year after the event predominantly from pastoral farmers, and does not provide information specific to cropping farmers, vegetable growers, orchardists or viticulturalists. The aim of collecting baseline or benchmark information in the months after the event is to build on this previous work, update information, and inform the creation of tools that cover all land uses for the next time a community is impacted an extreme weather event.

Figure 1 Hawke's Bay impacted areas, sweetcorn, and apple orchard.

The collection of baseline data as soon as possible (before any significant remediation is carried out) has been a priority, with the idea that this information will address the gaps in the data sets collected in 2004 and inform a longitudinal study over the coming years. This initial information was collected from the four most impacted areas, Hawke's Bay, Tairawhiti, Wairoa and Northland.

Funding was sought from MPI for laboratory analysis at a commercial lab for nutrients and contaminants, as well as labour and advisory costs. Costs have been managed through Vegetables NZ internal channels. AgResearch, Massey and Plant and Food Research provided staff supported by internal funds, as did the Gisborne District Council. The focus of the sampling has been on cropland and orchards, which were the land use types most significantly impacted, however did extend to some impacted pastoral land.

The number of laboratory samples completed at the end of June was 151, a breakdown of where these samples were taken is given below. To date, there are sites that were targeted but not sampled as access was challenging. If possible, these should be sampled when sediment dries and can be accessed, most likely in the spring.

Region	Number of samples
Hawke's Bay	82
Gisborne	55
Wairoa	6
Northland	8
Total	151

Sites were selected to capture information in impacted catchments, with samples collected at different points along the river flow pathways. Different land uses were

captured including orchards, vineyards, pasture and cropland. Different sediment depth classes were measured, as well as textural types. There were eight key characteristics captured across sites including sediment depth, nutrient analysis, contaminant analysis (on selected sites), visual soil assessment. bulk density, earthworms, texture, EDNA.

Sampling Hawke's Bay was completed by LandWISE Inc (Alex Dickson and Dan Bloomer), AgResearch (Alec Mackay, Brian Devantier, Mike Dodd), Plant and Food Research (Stephen Trolove) and Massey University (Alan Palmer). Sampling in Gisborne and Wairoa was completed by Gisborne District Council (David Sluter, Bryce McLoughlin). Sampling in Northland was completed by Luke Posthuma for Northland Kumara Growers.

Over the coming months analysis on the baseline sampling will be completed and reported. While collecting the samples, we made additional measurements to establish baselines that could support a longitudinal study of site recovery. It would allow us to develop understanding of how to ***build soils back better to increase land resilience to mitigate future events*** and prepare resources that can be quickly accessed by those in need.

Canterbury and Otago

Lincoln University

Welcome to Dr. Chamindu Deepagoda our new soil and environmental physics Senior Lecturer. Chamindu comes to us from the University of Peradeniya in Sri Lanka. He has extensive international experience, ranging from his MSc at Saitama University, Japan and completing his PhD in environmental engineering at Aalborg University, Denmark. Chamindu has held Postdoc positions at Aarhus University, University of Copenhagen and the Colorado School of Mines. Many of you will remember Chamindu when he was a Learn Post Doc here at Lincoln with Tim, back in 2018-2019. Chamindu has research interests in greenhouse gas emissions and modelling; water, nutrient and colloidal transport mechanisms in soils; soil physical characterisation of agroecological systems.

Australian Soil Judging Competition

Last weekend, June 23rd and 25th, twelve students from Lincoln University competed in the 11th Australian Soil Judging Competition in Darwin, Australia. The students were assisted by three Staff (Josh Nelson, Josie Mazzetto and Roger McLenaghen) from the department of Soil & Physical Sciences. The first day consisted of travel to Melbourne and then Darwin arriving at 2 AM. Friday and Saturday were practice days with Sunday the competition day. On Monday we travelled home, leaving a balmy 32°C arriving on Tuesday at 3 AM to a chilly 5°C.

The scope of the soil judging contest is for participants to use their knowledge and practical skills to describe, understand and interpret soil characteristics in the field. The occasion was a great opportunity for students, researchers and people interested in soils to interact and experience the landscapes and soils of Darwin in the Northern Territory of Australia. And with great satisfaction, two undergrad students, Carys Luke and Meila Picard, got 1st and 2nd individual placings out of nearly 60 competitors.

Manaaki Whenua – Landcare Research

Hadee Thompson-Morrison has joined Manaaki Whenua – Landcare Research in the Land Use and Ecosystems team as a Land Scientist with a focus on environmental contaminants. Prior to this, she was part of the Land Resources Science team at Environment Canterbury and has recently completed a PhD in Environmental Science at the University of Canterbury, where she looked at trace element fluxes through oil palm production systems in Indonesia. This included work looking at trace elements in palm kernel expeller and potential impacts for New Zealand's dairy industry through the import of this product. Says Hadee: "I'm passionate about soils and their sustainable management and I'm excited to be working here on some projects that I hope will be impactful in that space." Outside of MWLR work, Hadee spends a fair bit of time in the non-profit sector working with some community- and

wildlife-focused groups in Indonesia and other wild places, and generally tries to spend as much time in the outdoors as possible.

European Soil Data Centre News

Soil microbial diversity across Europe - DNA Bacteria and Fungi

The dataset includes 16S and ITS raw DNA sequences for 885 samples collected as part of the LUCAS 2018 Soil survey biodiversity module. It is based on measured DNA and soil biological data. Based on this analysis the EUSO, in collaboration with other research Institutes, has developed a first-ever assessment of soil microbial diversity across Europe. This assessment shows interplaying effects of vegetation, climate and soil properties on microbial communities and the associated potential functions. The results have been published in a Nature Communications paper.

Zinc concentrations in EU topsoils

Zinc (Zn) plays a crucial role in various biological processes and is an essential micronutrient. Zinc can also be toxic when present in excess. In this research paper published recently, we applied a machine learning model on 21,682 soil samples from the LUCAS topsoil 2009/2012 database to assess the spatial distribution in Europe of topsoil Zn concentrations measured by aqua regia extraction, and to identify the influence of natural drivers and anthropogenic sources on topsoil Zn concentrations.

Abstracts

Impacts of long-term phosphorus and nitrogen fertiliser application on soil biology: a New Zealand perspective

Soil biology encompasses a vast diversity of organisms contributing to soil processes and functions that underpin the delivery of soil ecosystem services. We review the response of soil biology to long-term phosphorus (P) and nitrogen (N) fertiliser application, focusing on trials conducted at Winchmore and Ballantrae Research Stations under sheep grazing. Application of P and N fertiliser increases soil fertility and pasture production and can have impacts on soil biology. Higher earthworm abundance was associated with increasing P, but not N fertiliser application. Microbial biomass or respiration tended to increase with P application but decrease with N application. Both P and N fertiliser decreased fungal biomass. The few microbial functional groups studied also appear responsive to fertilisation. A decline in soil pH may have driven some of these changes and could have been mitigated with lime. Other factors, such as plant composition, may also be

important to the soil biology but have received limited attention in these studies. There are currently few indicators that can be used on-farm to assess soil biology. We discuss these as well as measures that can be used in a research context to inform the impacts of fertiliser use on soil biology and its functioning.

Schon NL, Stevenson BA, Fraser PM, Shi S, Anderson C, Mansfield S, Simpson R, Cavanagh J, Orwin KH, Gray CW and others 2023. Impacts of long-term phosphorus and nitrogen fertiliser application on soil biology: a New Zealand perspective. New Zealand Journal of Agricultural Research: 1-25. https://doi.org/10.1080/00288233.2023.2215532

The influence of spatial patterns in rainfall on shallow landslides

Understanding how rainfall events influence the pattern and magnitude of landslide response is an important research focus from geomorphological and hazard planning perspectives. Few studies quantitatively relate spatial patterns in rainfall and landslides, largely due to difficulties in acquiring landslide inventories and data on rainfall patterns for individual storm events. However, the increasing availability of frequent, high-resolution satellite imagery and weather radar is overcoming these impediments. Here, we aim to a) identify which factors most influence susceptibility to shallow landslides at the event scale and b) assess how the spatial density of landslides varies in relation to rainfall. We combine landslide inventories spanning study areas located across the upper North Island of New Zealand with rainfall estimates from weather radar to assess the influence of different explanatory variables using a logistic regression model. We found land cover and slope exert the largest influence on landslide susceptibility ahead of intra-event rainfall intensities and pre-event rainfall accumulations. Of the rainfall variables, maximum 12-h rainfall normalised by the 10-y recurrence interval intensity and the 10-d pre-event accumulation normalised by mean annual rainfall had the most influence on susceptibility. Forest cover reduced the sensitivity of landslide spatial density to variations in slope, rainfall, and rock type, in contrast to pasture. We observed a 3.5-fold increase in mean landslide density once the maximum 12-h intensity was ≥25 % above the 10-y recurrence interval intensity for pastoral land on weak sedimentary rocks. This threshold is consistent with the increase in 12-h rainfall by late century under the highest levels of projected warming in New Zealand, which suggests that the landslide response to storm rainfall could be significantly amplified by climate change. Our study demonstrates the insights gained from combining event inventories with spatial rainfall data to better understand factors influencing landslide susceptibility.

Smith HG, Neverman AJ, Betts H, Spiekermann R 2023. The influence of spatial patterns in rainfall on shallow landslides. Geomorphology 437: 108795. https://doi.org/10.1016/j.geomorph.2023.108795

A review of the effectiveness of sediment traps for New Zealand agriculture

Agricultural expansion, intensification and overgrazing are recognised as some of the key contributing factors to increasing sediment loss above natural levels. One strategy to mitigate such losses is the use of sediment traps, designed to slow overland flow velocity and trap sediment. The objectives of this study were: (1) to determine if the available scientific literature justifies the use of such structures as viable options to mitigate sediment loss and (2) to identify sediment trap characteristics that determine their effectiveness. Reviewing the published literature on sediment traps identified a total of 21 publications, from which we could extract 16 annual average data points on sediment trapping efficiency in agricultural catchment contexts, 4 modelling data points and 6 data points for roadside runoff. Our review found the annual sediment trap effectiveness (STE) was highly variable, with results ranging from 10% to 98%. Average annual STE across the measured data from agricultural catchments was 59%. The key design metric presented in the literature was the storage ratio; volume of the sediment trap relative to the size of the catchment. Our analysis suggests a storage ratio of at least 120 m^3 ha^{-1} is required to deliver a STE of 55% or better.

Smith CL, Muirhead RW 2023. A review of the effectiveness of sediment traps for New Zealand agriculture. New Zealand Journal of Agricultural Research: 1-18. https://doi.org/10.1080/00288233.2023.2184838

Linking the uptake of best management practices on dairy farms to catchment water quality improvement over a 20-year period

Intensive land use, such as dairying, can impair water quality. Although many guidelines exist on how to mitigate the loss of dairy-associated contaminants from land to water through best management practices (BMPs), few datasets exist on the success of implementation on-farm. Five dairy-dominated catchments (from 598 to 2480 ha) in New Zealand were studied from 2001 to 2020. The first period, from 2001 to 2010, involved comprehensive “extension” advice to farmers consisting of workshops, stream water quality and flow monitoring, farm practice surveys, and identified solutions to address site-specific contaminant losses. In the second period (2011−2020), termed “post-extension”, only water quality monitoring and farm practice surveys were continued. Of the water quality contaminants (including dissolved reactive phosphorus (DRP), total phosphorus (TP), ammoniacal-nitrogen, nitrate-nitrite-nitrogen [NNN], suspended sediment and *E. coli*), 83 % of water quality trend directions were either improving (n = 16) or showed no change (n = 9) during the extension period. Over the 20-year dataset, which included the post-extension period, 20 out of 30 contaminant-catchment combinations (67 %) were improving, but nine were degrading, dominated by NNN (n = 4), DRP (n = 2) and *E. coli* (n = 2). Abrupt decreases in contaminant concentrations, were correlated with on-farm practice changes mainly associated with transition from direct discharge of farm dairy shed effluent to waterways to land application, and the capture of effluent from off-paddock facilities (like stand off or feed pads). Best management practices reduced phosphorus (P) forms, *E. coli* and sediment concentrations. Increase in NNN concentrations was caused by

transitioning from flood to spray irrigation and a commensurate increase in cow numbers and NNN leaching. These data indicate that extension advice and on-farm practice change have helped to improve overall water quality over time. Nevertheless, recent regulatory threshold values for some contaminant concentrations are not being met, meaning that more actions are required, over and above the BMPs implemented.

McDowell RW, Macintosh KA, Depree C 2023. Linking the uptake of best management practices on dairy farms to catchment water quality improvement over a 20-year period. Science of The Total Environment 895: 164963. https://doi.org/10.1016/j.scitotenv.2023.164963

Deadline..... for the November 2023 issue of Soil News is 13 November

We are the New Zealand Soil News:
Editor: **John Drewry** – drewryj@landcareresearch.co.nz
Correspondents: **T. Caspari,** Landcare Research (Lincoln); **C Smith,** Lincoln University; **C Rees**, Massey University; **J Drewry**, Landcare Research, (Palmerston North); **S Lambie**, Landcare Research (Hamilton); **T O'Neill**, Waikato University; **M Taylor**, Waikato Regional Council (Hamilton); **N Schon**, AgResearch (Lincoln); **J Clague**, Lincoln Agritech (Hamilton); **R Gillespie**, Plant & Food Research (Lincoln); N Bartlett, AgResearch (Hamilton); **M Norris**, Plant & Food Research (Ruakura); **S Smaill**, Scion Research