Welcome to the Soil News

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In this issue...

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

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Officers of the NZSSS 2019-2020

President: Megan Balks, University of Waikato
Vice President: Tim Clough, Lincoln University
Past President: Dave Houlbrooke, AgResearch

Editorial: Prue Williams

Kia ora tatou

It has been awhile since I used a soil corer or published a paper in a soil science journal. However, I have not forgotten my soil research roots! I regularly use a spade in the home garden providing up close reflection on soil structure, organic matter and earthworm activity. Also, in my current role as General Manager Science System, Performance and Investment at MBIE, I get to see soil research reflected across the spectrum of investments.

Soil research contributes to our RSI system in a wide variety of ways from basic research into understanding soil processes and predicting the behaviour of ecosystems under changing environments through to practical technology solutions to improve land and water management. New Zealand needs all of these different types of research which is why we have a range of funding mechanisms from Marsden to the new R&D Tax Incentive.

The Government funds also have different functions including competitive funds that allow for dynamism and researching new ideas (e.g. the Endeavour Fund). Other funds provide stability by providing longer term contracts that help to retain capability and build teams (e.g. the Strategic Science Investment Fund). Another important fund is the National Science Challenges which are targeted at addressing specific research that will benefit New Zealand. Soil research is being carried out across all of these funds. In 2018/19 MBIE is investing approximately $54m per annum on soil science and related environmental research across the Endeavour Fund ($27m), National Science Challenges ($7m) and the Strategic Science Investment Fund ($20m).

The Government is currently working on a Research, Science & Innovation Strategy. You may have seen the draft that was released in September and provided some feedback. The strategy sets out the importance of science for achieving the Government's goal of building a productive, sustainable and inclusive future for all New Zealanders. The strategy is built on three principles of excellence, impact and connections.

Excellence. Excellence in the strategy is not solely about academic excellence as measured by citations. Excellence is just as important to applied research as it is to basic research. So what we are looking for is utilising the best people, ideas and methodology in the research. Diversity of talent is also important to bring together people with different knowledge, backgrounds and experiences.

Impact. Impact is the change that happens as a result of the research. The change is beyond just a contribution to knowledge or the build-up of skills in a research

organisation. A focus on impact is important so that publicly funded research leads to benefits rather than just increasing knowledge for knowledge's sake. The impact may occur in the short or long term. We want researchers to have a 'line-of-sight' to the eventual impact of their work.

Connections. Connections are important to enable the growth of networks of people, ideas and resources both within New Zealand and internationally. The principle of connection is important for both excellence (e.g. connections between researchers) and impact (e.g. connections between researchers and users of the research).
Looking forward, soil researchers have much to contribute to the Government's goal of building a productive, sustainable and inclusive future for all New Zealanders. How New Zealand responds to issues like climate change, biodiversity loss, and management of our land and water resources depends on many. The management choices made by tangata whenua, farmers and land planners, decisions made regulators and rule makers, behaviours of consumers as well as the perceptions of the general public will all contribute. Soil research will inform all of these groups and help them understand the consequences of their actions.

By focussing on excellence, impact and connections you can provide the critical knowledge needed by all. I look forward to benefiting from your research.

Nga mihi
Prue Williams
November 2019

Society News

Research Symposium
"Phosphorus Cycling and Management in Terrestrial Systems"

Tuesday 04 February 2020
Lincoln University (Commerce 2)
9.00am to 5.15pm

9.00-9.30: Welcome. **Professor Leo Condron, Lincoln University.**
9.30-10.00: Research on soil phosphorus dynamics: from understanding processes to sustainable resource management. **Professor Emmanuel Frossard, Swiss Federal Institute of Technology Zürich (ETHZ), Switzerland.**
10.00-10.15: Influence of cover crop inclusion on soil phosphorus dynamics and crop uptake. **Phuong Nguyen, Lincoln University.**
10.15-10.30: Rhizosphere processes and phosphorus dynamics and availability under different abiotic conditions. **Driss Touhami, Lincoln University.**

10.30-11.15: Morning Tea [Commerce 2]

11.15-11.45: Exploring molecular tools to elucidate mechanisms of active organic phosphorus cycling in soils - case studies from Canada and New Zealand. **Professor Kari Dunfield, University of Guelph, Canada.**

12.00-12.15: Deep learning on time series of remote sensing data to predict the occurrence of soil water repellency in dryland pastures. **Mohamed Bayed, Lincoln University.**

12.15-12.30: Effect of soil moisture and pH on agronomic performance of rock phosphate fertilizers. **Meryem Drief, Lincoln University.**

12.30-12.45: Soil pH effects on phosphorus-related processes in the rhizosphere of different lupin species. **Moussa Bouray, Lincoln University.**

12.30-1.45: Lunch [Commerce 2]

1.45-2.15: Nutrients as mediators of soil organic matter dynamics in agricultural soils. **Dr Alan Richardson, CSIRO, Australia.**

2.15-2.30: Increasing phosphorus efficiency in tropical and subtropical cropping systems. **Bianca Das, University of Queensland, Australia.**

2.30-2.45: Characterising the chemical nature of legacy phosphorus in agricultural soils of Western Australia. **Dr Gustavo Boitt, University of Western Australia, Australia.**

2.45-3.00: Characterising legacy phosphorus stores within a watershed: impact of land use and landscape position. **Dr Rosalind Dodd, Lincoln University.**

3.00-3.45: Afternoon Tea [Commerce 2]

3.45-4.15: Does phosphorus control algal growth in rivers globally? **Professor Richard McDowell, AgResearch/Lincoln University.**

4.15-4.30: Sediment-mediated phosphorus cycling in streams. **Zach Simpson, Lincoln University.**

4.30-4.45: Risk of phosphorus loss and mitigation strategies for soils receiving dairy factory wastewater. **Carolina Lizarralde, Lincoln University.**

4.45-5.00: Estimating and modelling the risk of redox-sensitive phosphorus loss from saturated soils. **Genevieve Smith, Lincoln University.**

5.00-5.15: Conclusion. **Professor Leo Condron, Lincoln University.**

News From the Regions

Waikato/Bay of Plenty

AgResearch

Dave Houlbrooke and Rich McDowell (together and other relevant theme leaders) have been travelling around the country during October undertaking reviews of Tranche one Our Land and Water National Science Challenge programmes. Aside from the obvious C footprint involved, the exercise this was a useful way of engaging in a targeted manner with each programme to discuss programme successes around science advancement, impact, stakeholder engagement and Matauranga Maori. At the same time, it proved a useful conversation to understand the challenges of working in a mission led transdisciplinary science programmes as well the opportunity to consider future research gaps and priorities. The OLW NSC is now contracting an initial wave of science research as part of Tranche 2 in the areas of land use suitability, visualisation of land use options, rewarding land

use practice through value chains, register of sustainable land use actions and business and governance models that promote wide ownership in decision making. A strategic prioritisation process is now underway to help determine the next wave of OLW investment that will initially be delivered through the formation of collaborative working groups and think pieces.

Meanwhile Gina Lucci, Stewart Ledgard, Gerald Cosgrove and Stewart Collie were hosting visitors from Ireland and Denmark as part of a Catalyst Seeding project: "Investigating alternative uses for pasture". Visitors from Teagasc (Ireland) included Maeve Henchion, JJ Lenehan and Susanne Barth, and were joined by Ramesh Padamati from Trinity College Dublin and Lene Lange from LLa Bioeconomy (Denmark)(all pictured below). The visitors were mainly based in Hamilton, but also visited Tuaropaki's *Ngaire George Sustainability Centre* in Mokai and SCION in Rotorua. The following week Gina presented a paper at the NZ Grasslands Conference in Napier entitled *Beyond ruminants: Opportunities for alternative pasture uses in New Zealand*, summarising the findings of the consortium.

Photos: Left: Visitors being shown around the Scion's Rotorua campus; Right: visitors being show a LIDAR machine for measuring pasture volume at Ruakura.

Plant & Food

Mike Cummins gave a presentation to local students during Conservation week at Waiwhakareke reserve, Hamilton. He talked about the importance of soil as a natural resource and some of the fundamental properties of soils that make them so unique, important, and varied. Waiwhakareke reserve is situated around a peat lake at the bottom of a hill, so Mike was able to auger several cores and show the different soils we can encounter in such a small area. Students and teachers were able to assess soils based on their texture, appearance, and talk about their origin. After looking at some examples of different soil types, Mike did a demonstration to highlight how different soils, their textures and depth from which they are found, can affect the time it takes for water to filter through a soil profile. Using an isotonic water solution to represent a pollutant, he was able to demonstrate how the soil actually helped filter the water – turning it from blue to clear. The students got to engage by developing a hypothesis on which soil texture would filter the water more efficiently and which was the most effective at filtering. The event was a great opportunity to contribute to community outreach work and help students get excited about science.

Mike Cummins with his display showing the filtering capacity of different soils and local soil core samples during Conservation week at Waiwhakareke reserve.

Manaaki Whenua-Landcare Research

Manaaki Whenua – Landcare Research welcome CJ Crawford, a BSc Tech student from the University of Waikato, who has joined us for a 3-4 months working with Nadia Laubscher and Scott Fraser on S-map and other projects. The team are busy out in the field collecting soils for the Soil Health project lead, by Bryan Stevenson, comparing paired long-term pasture and maize sites to understand how land use affects particularly inherent soil properties.

Photo: CJ and Nadia on their way to collect Ultic soil samples at Hangawera Hill (Photo: Scott Fraser)

Jack Pronger, Jonno Rau, CJ Crawford and Scott Fraser have been busy in the central and northern Waikato digging soil pits to 1 m depth and collecting cores for soil physical and chemical characterisation. The work is aligned with S-map development underway for Waikato Regional Council Plan Change 1 and is targeted at improving pedotransfer functions used to predict soil hydraulic properties for S-map data sheets. This soil hydraulic information is critical for a wide range of soil management applications including irrigation scheduling and leaching, runoff and production related water balance modelling. We are currently targeting soils that are underrepresented in the national soils data base repository (NSDR) including Ultic, Granular, Pumice and Organic Soils among others. The Ultic Soils have been particularly challenging to collect (consider a Densipan Ultic Soil) and analyse in the lab where very slow and sometimes inconsistent hydraulic behaviour, likely related to shrink swell clays, have been problematic. We suspect these soils are underrepresented in the NSDR for good reason. On the bright side, the work has taken us into some older Waikato landscapes where complex soil patterns and profiles provide for thought provoking discussion. We would like to thank the many farmers who have allowed us onto their properties for this work and the Hamilton soil physics lab staff (Pip Rhodes, Danny Thornburrow, John Claydon) for their perseverance with some challenging samples.

Photo: Hill country landscape north of Morrinsville with soil pit (Perch Gley Albic Ultic Soil) under pop up tent looking north east over the Hauraki Basin towards the Eastern Ranges (Photo: Jonno Rau).

Photo: Perch Gley Albic Ultic Soil north of Morrinsville (Photo: Jonno Rau).

Suzanne Lambie has been working with James Sukias and Brandon Goeller (NIWA) collecting soil/sediment, humic layers and water samples from a range of constructed wetlands. The objective of the work is to compliment aquatic and terrestrial diversity data being collected by NIWA by determining microbial diversity in the three dominant physical phases of constructed wetlands, the water, the sediment/soil at the bottom of the ponds, any humic layers present in the system and soil within the filtration zones of these complex treatment systems. Microbial phospholipid fatty acid data will be combined with water and soil/sediment

chemical data to assess microbial groups present, and potential processes they are contributing to, in each component of the wetland systems.

Photo: Constructed treatment wetland near Lake Kaituna in the Waikato (Photo: Suzanne Lambie)

Suzanne Lambie also attended a New Zealand Landcare Trust Information Day run by Nardene Berry. The Information Day focus on different mitigation options for various sites within the Piako catchment looking at bioreactor and constructed wetland treatment systems as well the importance of managing peat soils for shrinkage and electromagnetic surveys for improving water quality from intensively farmed systems. The day had great presentations and lots of information sharing between attendees and interesting site visits around the Tatuanui area.

Suzanne Lambie and Mike Marden visited Maungataniwha Pine Forest near the Napier-Taupo Highway. Maungataniwha is a former *Pinus radiata* plantation that is currently being converted to native regeneration. We discussed the various regeneration strategies with Trustee/site manager Peter Shaw, Mark Mitchell and Tim Norris (Hawkes Bay Regional Council) and Adam Forbes (Forbes Ecology) for an EnviroLink project with HBRC. The regeneration strategies have evolved in response to varying levels of re-population by the pines and proved to be an interesting visit.

Photo: Re-population by Pinus radiata (area in the red circle) at harvested forestry compartments at Maungataniwha Pine Forest (Photo: Suzanne Lambie).

Manawatu

Plant & Food

Congratulations to Brent Clothier, who has received several international honours in recognition of his internationally leading research and educational activities. He has been appointed as an adjunct Professor in Water Management at the Centre of Agricultural Water Research, College of Water Resources & Civil Engineering, China Agricultural University. He has also been elected as an Academician (Foreign Member) of the Chinese Academy of Engineering (Agricultural Division), and becomes the first New Zealand member in the CAE.

We bid farewell to Adrian Hunt from Hawke's Bay and wish him the all the best in his new role in Melbourne as productivity R&D manager with Horticulture Innovation Australia.

Manaaki Whenua – Landcare Research

Carolyn Hedley was invited by the Foundation for Arable Research (FAR) Australia to give a talk on soil moisture monitoring and variable rate irrigation in Tasmania recently. This was part of a large field-day organised by FAR Australia to present results from their hyper-yielding cereal project to local farmers. Over the last three years the project has successfully lifted the benchmark for grain yields in Tasmania from approximately 5 t/ha to at least 10 t/ha by introducing new cultivars and changed agronomy (including earlier planting date; fungicides) as well as irrigation. The grain is required by the local farmers who had previously been importing it from the mainland. Soil moisture monitoring is being used to guide the timing of

irrigation from overhead sprinklers, and methods were discussed that could improve scheduling decisions using more detailed soil information.

Photo: The Foundation for Arable Research Australia field day in Tasmania.

Gerard Grealish (MWLR Palmerston North) in October participated in the Global Soil Partnership (http://www.fao.org/global-soil-partnership/en/) working sessions of the International Network of Soil Information Institutions (INSII) and Pillar 4 Working Group on Information and Data. Manaaki Whenua have a leadership role, particularly in the Pacific region, and provide strategic technical input regionally and internationally. Much of the GSP work involves developed countries providing structures and capacity development for developing countries, and making available national soil data at a global level for global models and decisions. Ongoing activities include:

- GloSIS (Global Soil Information System) - design and spatial data infrastructure; data exchange model; and specifications for Tier 1 and Tier 2 soil data. To allow data sharing between partners of national and international institutions, while preserving intellectual property of the original data providers.
- Global data products planned for 2020 are – global soil organic carbon map (v1.5); global soil salinity map; global soil erosion map; global soil organic carbon sequestration potential map; global black soil distribution map.
- Discussion on establishing the technical framework for global soil grids of soil properties and soil threats.
- Preparation of the new Pillar 4 Information and Data implementation Plan (2020-2030)

John Drewry presented a paper on several irrigation case studies at the New Zealand Grassland Association conference in Napier, as part of the now completed Maximising the Value of Irrigation programme.

Andrew Manderson has been appointed the new Science Team Leader for the Soils and Landscapes team, across Manaaki Whenua. Many thanks to Jackie Aislabie, who previously lead the team, and now leads the newly formed Land Use and Ecosystems team.

Massey University

Students on the spot

End of the year 2019 is close, lectures finished (unless Summer Semester is entertaining you), and at Massey we celebrate more Doctorates. Thangavelautham Geretharan (Gere) successfully defended his PhD thesis entitled “Impact of phosphate fertiliser derived fluorine on soil microbiology and white clover (*Trifolium repens* L)”. This study involved assessing the toxic effects of fluorine on nitrogen-fixing bacteria and its interaction with white clover – a widely cultivated pasture legume in New Zealand. Gere was supervised by Professor Christopher W.N. Anderson, Dr Paramsothy Jeyakumar (Jeya) and Dr Michael Bretherton. His research was funded by the Fertiliser Association of New Zealand.

Photo: Gere and supervisors practising selfie techniques (Photo: Paramsothy Jeyakumar, Jeya).

Congratulations also to Grace Chibuike, who defended successfully her PhD thesis titled “Investigating Nitrate Attenuation Capacity and Processes in Pastoral Hill Country Landscapes”. Grace’s PhD programme was supervised by Lucy Burkitt, Marta Camps, Mike Bretherton, Ranvir Singh and Peter Bishop, all from Massey University. Grace has pursued a research focusing on those agricultural nutrients, particularly nitrate, that degrade water quality in New Zealand and thus pose serious environmental and health issues. As there is limited understanding of the capacity of pastoral hill country landscapes to attenuate nitrate for improved water quality, Ms Chibuike investigated the influence of hill country landscape features on dissolved organic carbon concentration and the potential for nitrate loss via denitrification. She found that the Ramiha soil type has a high nitrate attenuation capacity due its high capacity to store carbon, resulting from the presence of allophane. She also found that hill country seepage wetlands have a significantly higher capacity to attenuate nitrate compared to other hill country features, and represent a valuable landscape feature which could be enhanced to improve water quality leaving hill country farms. Her research findings provide information that is critical for improving hill country nitrogen management for better water quality outcomes in New Zealand.

Recently, Grace has been very busy preparing a bunch of publications detailing all the aspects of her work, as is indicated in the “Abstracts” section of this number of Soil News; do not miss the chance to read the full story there if interested.

Visiting students from Northwest Agriculture and Forestry University, China

Professor Christopher W.N. Anderson and Dr Paramsothy Jeyakumar (Jeya) from the Environmental Sciences Group at Massey University, hosted a group of 15 students from Northwest Agriculture and Forestry University, China, from July to October 2019. During their stay at Massey, the students were engaged with class room lectures, glasshouse and laboratory experiments, and many agricultural and animal science field visits.

Photo: Jeya and the students from Northwest Agriculture and Forestry University, China enjoying the visit to Manawatu Campus; (Photo: Paramsothy Jeyakumar, Jeya)

“Hyperspectral and Thermal Remote Sensing” workshop in the Manawatu

As part of the Catalyst Seeding Research Program, Massey University has organized a workshop on “Hyperspectral and Thermal Remote Sensing” at Massey University Palmerston North campus. The workshop, coordinated by Dr Gabor Kereszturi, was held on the 1 October 2019. Overall, the workshop received more than 120 registrations from universities, regional and district councils, government organizations, crown research institution and companies. At the time of the workshop, we hosted three overseas experts from the Geo-Information Science and Earth Observation of the University of Twente, Netherlands.


Photo: Massey Postgraduate students Cecilia Rodriguez (left) and Rupsa Chakraborty (right) presenting at the workshop, in a dark and vigilant room; (Photos: Gabor Kereszturi).

The one-day workshop, Hyperspectral and Thermal Remote Sensing: from data to applications, will feature 18 speakers from: The University of Twente in the Netherlands, GNS Science, Manaaki Whenua – Landcare Research, The Xerra Earth Observation Institute, the University of Canterbury, as well as Massey researchers and students involved in spectroscopy-related topics. Speakers covered remote sensing applications in volcano research, soil and environmental management, geothermal and minerals exploration, and natural hazards assessment. More details can be found in the following address: https://www.massey.ac.nz/massey/about-massey/news/article.cfm?mnarticle_uuid=07E4F622-92DE-4207-90A2-09E6D280C3FE

SAE Ph.D. Student Society Symposium

Most of our postgraduate students working on topics related with soil science have contributed to the Massey's School of Agriculture and Environment (SAE) 3rd annual student-led Postgraduate Symposium and job fair, celebrated on the 14th and 15th of November 2019, in Palmerston North. The symposium ran under the theme "Pathways to the Future" and was attended by over 150 participants. The event brought together postgraduate students, and staff under SAE, and various company representatives. Postgraduate students shared their research through oral presentations, posters and rapid research communications, and had an opportunity to link up with various companies, and to learn about the current work taking place in the NZ industry.

Photo: Family reunion picture including most of the people attending the Massey's School of Agriculture and Environment (SAE) 3rd annual student-led Postgraduate Symposium and job fair in November; (Photo: SAE Ph.D. committee).

Photo: Interactive discussions with various company representatives during the job fair held at the SAE Symposium; (Photos: SAE Ph.D. committee).

The SAE PhD student society routinely holds events every year to provide peer to peer support, and mentorship to postgraduate students, and engages multi-stakeholder participation in its events. The SAE Ph.D. committee is a smart mixture of students and staff committed to organize a variety of activities during the year. We applaud their initiative and effort, well done!

Final words to congratulate students, staff and multiple collaborators contributing to the publications highlighted later in the "Abstracts" section.

Canterbury
Lincoln University

Lincoln success at 7th Australian National Soil Judging Competition

Over the weekend of 3-7 October, 3 student teams (1 PG, 2 UG) plus Carol Smith, Judith Butel and Josh Nelson travelled to Adelaide to compete at the 7th Australian National Soil Judging Competition. While soil judging has been a part of the soil science curriculum in North American universities since the 1960's, it has only recently become an annual event in Australasia. Soil judging involves university students competing (against other university teams and also as individuals) to correctly identify soil features, classify soil profiles, and interpret soil capability. It is a highly effective way to build practical pedology field skills and teamwork skills for both undergraduates and postgraduates. It is very effective experiential learning and a great way to meet other aspiring soils professionals. The teams invested over 50 hours of their own time working with soils staff during Semester 2 in preparing for and competing in this event.

This year, the competition was hosted by the South Australian Branch of Soil Science Australia. Based in the Fleurieu peninsula, and close to well-known viticulture locations (think McLaren Vale) we were guaranteed soils totally different to anything we see in New Zealand (think highly weathered, lots of clay and sodium salts). Two practice days allowed all the teams to become familiar with the range of soils in the area. The competition was held over one day with 2 team pits and one individual pit. Fifteen teams from 11 universities and 65 students competed.

Team results: Lincoln 1 (Kirsten Deuss, Julie Gillespie, Louisa Hall and William Talbot) 6th , Lincoln 2 (Jack Dixon, Rachelle Ingham, Amy McIlraith, Cameron Sinclair) 9th, Lincoln 3 (Kathy Hill, Virginia Hogan, James McIlraith, Jono Williams) 14th.
Individual results: Kathy Hill 2nd.

These were great results for the students, due in no small part to their hard work and enthusiasm. The students also raised money during the year to support the trip.

Who said soils aren't fun? Left: Team Lincoln in the brown kurosol the individual competition pit with Mottley, the Australian soil mascot, Right: Jack Dixon concentrating hard in the pit (brown Sodosol)

Student Ambassador

Current soil science PhD student, Carmen Medina Carmona, recently attended the 7th International Symposium on Soil Organic Matter, in Adelaide. Carmen is studying the influence of irrigation on soil C stabilisation and loss under ryegrass white clover pastures, with supervisors Tim Clough and Mike Beare at Plant and Food Research. Carmen was sponsored by Lincoln as a "student Ambassador" for this event. As an ambassador, Carmen co-chaired a major session, worked with a mentor during the symposium; was involved with the organisation of an international symposium, while also promoting Lincoln University.
Carmen also met up at the symposium with Yuan Li (current Lincoln PhD who was presenting his research) and Manjula Premaratne –ex-soils staff and now studying for a PhD at UWA in Perth. Yuan (co-supervised by Gabrial Moinet and David Whitehead of Manaaki Whenua-Landcare Research) presented his research on ecosystem carbon exchange response to irrigation frequency in C4 grassland.

Photo L to R: Yuan, Manjula and Carmen

DGT2019, the 6th conference on Diffusive Gradients in Thin Films

Lincoln University's Dr Niklas Lehto and PhD students Moussa Bouray and Driss Touhami attended the first European League of Life Sciences (ELLS) summer school on *High-resolution Chemical Imaging of Solutes in Soils and Sediments* held at the Vienna University of Natural Resources and Life Sciences (BOKU) campus in Tulln, Austria between September 12th - 18th. Niklas was one of the course instructors, while Moussa and Driss were active participants among 17 other students, hailing from 12 different Universities. The course covered the theoretical background and practical application of two-dimensional solute visualisation techniques, which allow for multi-analyte visualization of a broad range of solute parameters (metal(loid)s, oxyanions, O_2, pH, enzyme activity) in soils and sediments at high spatial and temporal resolution. Some pictures of the summer school participants and outputs are included below. After the summer school, Niklas went on to give an invited keynote lecture at DGT2019: the 6th conference on Diffusive Gradients in Thin-films, Vienna, titled: "What does DGT measure in soils? A (mostly) mechanistic perspective".

Lincoln University (Peter Almond), NIWA, Plant and Food, Environment Canterbury (ECan), Manaaki Whenua-Landcare Research and AgResearch are involved in a catchment hydrology in the loess downlands of South Canterbury. Interest from ECan was originally related to groundwater recharge in loess landscape with Pallic Soils, but the involvement of the other institutions has broadened the study to include aspects of water quality and irrigation efficiency. The study area is on a dairy farm that uses centre-pivot irrigation. At this stage the site is instrumented with a flume and gallery for measuring overland and subsurface flow at the drainage basin outlet; a comprehensive meteorological station; soil moisture sensors; and runoff plots. The partners have set the study up on internal funds and are seeking significant external funding to lever off what is in place. The local water zone committee is convinced of its value and is a strong advocate. Anyone interested in getting involved should make contact.

Plant and Food Research staff setting up runoff plots at the south Canterbury loess landscape hydrology study site. Photo Plant and Food.

Peter Almond is working with Megan Balks to provide a pre- and post conference field trip to the delegates of the first Southern Hemisphere Conference on Permafrost (SouthCOP) in early December. The pre-conference field trip will take participants from Christchurch to Queenstown for the conference, after which the post-conference trip will take another group over the Haast Pass, up the West Coast and on to Christchurch.

Manaaki Whenua – Landcare Research

Southland soil sampling

For Gwen Grelet's Regenerative Agriculture project, a team of Manaaki Whenua Lincoln soil ecologists travelled to the deep South to sample. On the team were Kara Allen, Nina Koele, as well as Jason Nolan (Kara's partner and casual field technician) and Fin Proebst (Lincoln Uni student and casual field tech). Scientific and moral support were provided by Gwen, Kate Orwin and Paul Mudge (MWLR Hamilton), and further support came from Karen Boot, and Nicole Schon at AgResearch Lincoln.

After eight weeks of rain in Southland and several postponed attempts, farmers on the project reported that their paddocks had drained of standing water, temperatures were on the rise and soil biology getting active.

We had sampled deep soil cores and soil pits on 6 farms earlier in May 2019, and now added 6 more farms. Half of the farms sampled were regeneratively managed, the other half conventional, and all were pastoral systems. In addition to soil samples for carbon and nitrogen, we now also sampled and measured a range of other variables on all 12 farms, including infiltration, Visual Soil Assessment, earthworms, nematodes, eDNA, soil moisture and temperature, tea-bag decomposition, clover analysis, aggregate stability and soil compaction.

The goal of these efforts is to gather baseline data on soil health under different management styles. All farmers were very interested in our efforts and agreed that such baseline data are needed, especially for soil biology. Some farmers found time in their busy schedules to help us and document our efforts. In the area around Clinton, where we sampled 4 farms, word spread through social media and apparently farmers are lining up to be part of the study!
In Hedgehope we partook in the school's "pet day" and learned through casual chats that most farmers had tried regenerative additives as promoted by one passionate individual.

We encountered a lot of hospitality down South, including coffee with fresh regenerative milk and puppies to cuddle. In a last hailstorm we finished just in time for the Labour day weekend.

The crew sitting/lying in a plot, from left to right measuring infiltration, counting earthworms, and sampling clover

Farmer Mark Anderson and his kids Florence (7) and Beau (5) helped collecting earthworms (Photo Mark Anderson)

Counting earthworms in between remnants of the VSA and infiltration measurement

Setting up the final plot in the last remaining South Island hailstorm

Related Society Notices

http://www.fao.org/world-soil-day/en/

Soils matter!

Soils are important for our well-being and keep terrestrial ecosystems in balance. Soils are the very basis for the food we grow as well as for the production of feed, textiles, wood and other materials. They provide us with clean water, host biodiversity, cycle nutrients, regulate climate and are part of our landscapes and cultural heritage. The EU's soil health and food "mission" aims to raise awareness on the importance of soils, engage with citizens, create knowledge and develop solutions to address the various types of soils, soil uses and soil challenges in Europe.

At political level, a mission in the area soil health and food will contribute to implementing the new priorities of the European Commission (a "Green Deal") as well as to meeting international commitments on Climate and Sustainable Development.

Find out more about the EU's Horizon Europe soil health and food mission.

Would you like to know more on EU-sponsored research and innovation on soils? You can check out DG AGRI's **AgriResearch factsheet on Soils.**

Measuring soil functions with the soil navigator

Horizon 2020 multi-actor project LANDMARK's "Soil Navigator" takes into account: primary productivity, water purification and regulation, carbon sequestration and climate regulation, nutrient cycling and biodiversity and habitat provision. The Decision Support System (DSS) is able to assess these aspects simultaneously and to provide management recommendations for improved soil functions. Read more and watch the video tutorial.

Abstracts

Biochar addition can reduce NOx gas emissions from a calcareous soil

The effect of biochar (BC) addition on NOx gas emissions to soil was investigated from a calcareous soil. Application rates of zero (BC0), 1 BC1), 2 (BC2), 5 (BC5), and 10 (BC10) per cent weight/weight were used. The NOx emission flux was measured in a dynamic flux chamber. The flux was generally higher in the BC0 than in the amended plots. The total NOx emission from BC1, BC2, BC5, and BC10 fell by 50.3, 75.3, 80.4, and 79.6%, respectively, relative to BC0. The emission flux from the BC5 plot showed a minimum average of 21.1 ± 13.5 µg

N/(m2•h) for NO, −0.81 ± 1.31 μg N/(m2•h) for NO2, and 20.6 ± 13.8 μg N/(m2•h) for NOx. By comparison, the measured maximum average emission flux from the BC0 was 107.2 ± 30.98 μg N/(m2•h) for NO, −2.31 ± 2.56 μg N/(m2•h) for NO2, and 105.3 ± 45.3 μg N/(m2•h) for NOx. The results indicate that biochar amendment can potentially reduce NOx emissions.

Bing Wang, Xinqing Lee, Benny K.G. Theng, Like Zhang, Hongguang Cheng, Jianzhong Cheng, Wenqiang Lyu. Biochar addition can reduce NOx gas emissions from a calcareous soil. Environmental Pollutants and Bioavailability, 31: 38−48, 2019

Assessing the effect of pyrolysis temperature on the molecular properties and copper sorption capacity of a halophyte biochar

The capacity of biochar to take up heavy metals from contaminated soil and water is influenced by the pyrolysis temperature. We have prepared three biochar samples from Jerusalem artichoke stalks (JAS) by pyrolysis at 300, 500 and 700 _C, denoted as JAS300, JAS500, and JAS700, respectively. A variety of synchrotron-based techniques were used to assess the effect of pyrolysis temperature on the molecular properties and copper (Cu) sorption capacity of the samples. The content of oxygen-containing functional groups in the biochar samples decreased, while that of aromatic structures and alkaline mineral components increased, with a rise in pyrolysis temperature. Scanning transmission X-ray microscopy indicated that sorbed Cu(II) was partially reduced to Cu(I), but this process was more evident with JAS300 and JAS700 than with JAS500. Carbon K-edge X-ray absorption near edge structure spectroscopy indicated that Cu(II) cations were sorbed to biochar via complexation and Cu-π bonding. With rising pyrolysis temperature, Cu(II)-complexation weakened while Cu-π bonding was enhanced. In addition, the relatively high ash content and pH of JAS500 and JAS700 facilitated Cu precipitation and the formation of langite on the surface of biochar. The results of this investigation will aid the conversion of halophyte waste to useable biochar for the effective remediation of Cu-contaminated soil and water.

Jing Wei, Chen Tua, Guodong Yuan, Ying Liua, Dongxue Bi, Liang Xiao, Jian Lu, Benny K.G. Theng, Hailong Wang, Lijuan Zhang, Xiangzhi Zhang. Assessing the effect of pyrolysis temperature on the molecular properties and copper sorption capacity of a halophyte biochar. Environmental Pollution, 251: 56−65, 2019

Temporal trends in soil physical properties under cropping with intensive tillage and no-till management

Improved process understanding of temporal change in soil hydraulic, water retention, and soil physical properties is required to improve modelling of soil-water dynamics. This study reports on temporal trends in soil physical properties for intensive till and no till irrigated wheat, from autumn sowing to summer harvest. There were significant temporal trends for bulk density, readily available water capacity, and unsaturated hydraulic conductivity (at three matric potentials). Using a simple two-parameter exponential model for unsaturated hydraulic conductivity, the model coefficients appeared to increase over the first 10 weeks, followed by a

decrease and later increase, but the temporal effect when using this model was not significant given the parameter uncertainty. Daily rainfall, irrigation, and evapotranspiration were evaluated as possible explanatory variables, but these were not generally significant in explaining temporal trends of soil properties. An implication is the need to provide temporal data to parameterise hydrological models for more accurate modelling, including irrigation scheduling.

Drewry JJ, McNeill SJ, Carrick S, Lynn IH, Eger A, Payne J, Rogers G, Thomas SM. 2019. Temporal trends in soil physical properties under cropping with intensive tillage and no-till management. New Zealand Journal of Agricultural Research. https://doi.org/10.1080/00288233.2019.1684323

Maximising the value of irrigation through improved use of soil resources and sensor technology

This paper presents a case-study approach focussing on variability of soils, soil physical properties, and how the use of proximal sensor surveys and soil moisture monitoring can be used to improve irrigation management at fine spatial scales (< 10 m). Proximal sensor survey data have been used to map soil variability and statistically derive management zones, which are then correlated with S-map siblings using soil moisture release curves. At the first case study site, soil moisture monitoring of these management zones showed the poorly drained soil had wetter conditions than the other zones, which is likely to have been a factor contributing to reduced barley yield. Less irrigation could therefore have been applied to the poorly drained soil, with a saving in cost and yield penalty. In the second case study, we provide an overview of research focussing on practical applications of near real-time soil moisture monitoring and visualisation through smart phone apps, enabling new irrigation software and hardware to be matched to specific farm circumstances, so soils and crops can be managed to reduce water and nutrient losses.

Drewry JJ, Hedley CB, Ekanayake, J. 2019. Maximising the value of irrigation through improved use of soil resources and sensor technology. Journal of New Zealand Grasslands 81: 223-230. https://doi.org/10.33584/jnzg.2019.81.376

Denitrification Capacity of Hill Country Wet and Dry Area Soils as Influenced by Dissolved Organic Carbon Concentration and Chemistry

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Wetlands, in press, https://doi.org/10.1007/s13157-019-01223-1.

The quantification of the nitrate attenuation capacity of pastoral hill country wet areas, especially seepage wetlands, would aid in the proper management of hill country farms for improved water quality outcomes. This study investigated the denitrification capacity, dissolved organic carbon (DOC) concentration and

chemistry of wet areas and adjacent dry areas soils in a hill country landscape in New Zealand. Soil samples were collected during spring (November 2017) from different soil depths down to 100 cm. The results showed that the mean DOC concentration in the surface 30 cm soil depth was in the order: seepage wetland (498 mg kg^{-1}) > hillside seep (172 mg kg^{-1}) > dry area (109 mg kg^{-1}). The denitrification capacity of the seepage wetland within the 0–30 and 30–60 cm soil depths was 7 and 69 times greater ($p \leq 0.05$), respectively, than that of the dry area. The high concentration of readily-decomposable (e.g. lower molecular weight) DOC in the seepage wetland soil could have contributed to its higher denitrification capacity. The contrasting nitrate attenuation capacities of the seepage wetland soil versus that of the dry area soil highlight the important contribution of seepage wetlands to water quality improvement in pastoral hill country landscapes.

Chibuike G, Burkitt L, Camps-Arbestain M, Singh R, Bretherton M, and Bishop P. 2019. Denitrification Capacity of Hill Country Wet and Dry Area Soils as Influenced by Dissolved Organic Carbon Concentration and Chemistry. Wetlands, in press, https://doi.org/10.1007/s13157-019-01223-1.

Effect of forage crop establishment on dissolved organic carbon dynamics and leaching in a hill country soil

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Soil Use and Management, available online. https://doi.org/10.1111/sum.12497

Intensive agricultural activities could affect the dynamics and leaching of dissolved organic carbon (DOC) and nitrate from agricultural soils to receiving waters. This study investigated soil DOC dynamics immediately (0–12 days) after spraying a hill country perennial pasture with agrochemicals to establish a winter forage crop for supplementary feed production. Two treatments were examined—perennial pasture (without agrochemicals) and swede (Brassica napobrassica Mill.) cropping (after spraying with agrochemicals), both growing on a Typic Eutrudept. Soil samples were collected from various depths down to 1 m, before the application of agrochemicals (day 0) and 1, 6 and 12 days thereafter. Dissolved organic carbon concentration below the surface soil (<5 cm) was generally not altered by the agrochemicals. This was further proved by the isotopic monitoring of DOC leaching on this soil. Conversely, the agrochemicals significantly ($p = 0.03$) increased DOC concentration within the 0–5-cm soil depth on day 1, due to the direct contribution of organic molecules and/or displacement of organic compounds at adsorption sites by the agrochemicals; and on day 6, due to root necromass decomposition. The increase of nitrate in soil solution at this depth (0–5 cm) on days 6 and 12 suggests that the agrochemicals may have also enhanced nitrogen (N) mineralization in the surface soil. However, the significantly ($p = 0.04$) higher DOC/nitrate (molar ratio) of the agrochemical treatment suggests that the agrochemicals used for clearing

out pasture before forage crop establishment could lead to a short-term increase in surface soil denitrification.

Chibuike G, Burkitt L, Camps-Arbestain M, Bishop P, Bretherton M, and Singh, R. 2019. Effect of forage crop establishment on dissolved organic carbon dynamics and leaching in a hill country soil. Soil Use and Management, available online. https://doi.org/10.1111/sum.12497

Dissolved organic carbon concentration and denitrification capacity of a hill country sub-catchment as affected by soil and slope

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New Zealand Journal of Agricultural Research, 62 (3), 354-368.
https://doi.org/10.1080/00288233.2018.1508041

Characterising the dissolved organic carbon (DOC) concentration and denitrification capacity of the soils and slopes in hill country is important in order to manage the leaching and availability of nitrate in ground and surface waters. This study investigated the DOC concentration and denitrification capacity of the soils and slope classes of a sub-catchment within a hill country farm, in Palmerston North, New Zealand. Fifty locations comprising of 2 soil orders (Pallic, Brown), 8 soil types (3 drainage classes) and 3 slope classes were sampled from different soil depths down to 1 m. The results suggest that compared to slope, soil type had a greater effect on denitrification capacity within the sub-catchment. The Ramiha soil had the highest DOC concentration (105 mg kg^{-1} within 0.3–0.6 m depth) and moisture content, and hence the highest denitrification capacity (10 μg kg^{-1} h^{-1}). This suggests that farms or catchments with similar soil types may have a greater capacity to attenuate nitrogen losses to the environment.

Chibuike G, Burkitt L, Bretherton M, Camps, M, Singh R, Bishop P, Hedley C, and Roudier P. 2019. Dissolved organic carbon concentration and denitrification capacity of a hill country sub-catchment as affected by soil and slope. New Zealand Journal of Agricultural Research, 62 (3), 354-368. https://doi.org/10.1080/00288233.2018.1508041

The interactions between biochar and earthworms, and their influence on soil properties and clover growth: A 6-month mesocosm experiment

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Applied Soil Ecology (in press). https://doi.org/10.1016/j.apsoil.2019.103402

A six-month mesocosm experiment was conducted to investigate the joined effect of biochar and earthworms on soil properties and plant (white clover) growth in two contrasting soils – a dystric Cambisol and a sil-andic Andosol, both soils with pH-H_2O<6. Treatments were (i) biochar amendment (1% weight basis), (ii) a positive control (lime added at the liming equivalence of the biochar application), and (iii) a negative control (no amendment). Each treatment had two variants: with or without earthworms (*Aporrectodea caliginosa*). Soil chemical and biological properties were measured before the start of the experiment and after 6 months of incubation. Earthworms were associated with higher ammonium-N and nitrate-N concentrations, lower pH, higher fungi:bacteria ratio, higher abundance of Collembola, and higher clover biomass in mesocosms. The influence of biochar on plant productivity was overshadowed by earthworm activity, yet a significant positive effect of biochar on clover biomass was observed in the absence of earthworms; this effect was not related to the liming potential of biochar. Synergistic effects of biochar and earthworms were observed for increasing abundance of Collembola and soil fungal biomass. The interaction between biochar and earthworms was soil-type specific – for example, on their own, biochar and earthworms increased clover growth more in the Cambisol, while the positive synergistic effect of biochar and earthworms on soil biochemical processes and clover growth was more evident in the Andosol. Combined use of biochar and earthworms has good productivity potential for acidic soils, and can be part of sustainable soil management.

Garbuz S, Camps-Arbestain M, Mackay A, DeVantier B, Minor M. 2019. The interactions between biochar and earthworms, and their influence on soil properties and clover growth: A 6-month mesocosm experiment. Applied Soil Ecology (in press). https://doi.org/10.1016/j.apsoil.2019.103402

Field performance assessment and calibration of multi-depth AquaCheck capacitance-based soil moisture probes under permanent pasture for hill country soils

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Agricultural Water Management, 217, 332-345.
https://doi.org/10.1016/j.agwat.2019.03.002

The use of accurate and near real time volumetric soil moisture (θ_v, $m^3\,m^{-3}$) measurements informs not only precise irrigation scheduling but also decisions regarding fertiliser applications, feed supply and stock management in non-

irrigated farming systems. To assist θ_v monitoring, capacitance-based AquaCheck (AquaCheck, South Africa) sensors are being increasingly used in precision agriculture applications. However, the performance of these sensors have not been investigated extensively under field conditions with dynamic soil moisture regimes. For evaluation, 20 probes (4 sensors/unit) were installed in predominantly silt loam soils on a pastoral hill country farm in the southern east coast of the North Island of New Zealand. Raw readings, and θ_v derived from a manufacturer-recommended calibration, were compared with 400 reference θ_v values over a one-year timespan (01/11/2016 – 01/12/2017). In addition, three custom calibration methods were developed and assessed, each tailored to suit the availability of soil information. Over all depths (100 to 400 mm), the manufacturer calibration resulted in θ_v readings with a mean RMSE of 0.106 $m^3 m^{-3}$, a mean MBE of -0.099 $m^3 m^{-3}$ (indicating underestimation), and a coefficient of determination (R^2) of 0.58 when correlated to reference θ_v values. A single custom formula, relevant to the local soils resulted in an improved RMSE of 0.039 $m^3 m^{-3}$ and $R^2 = 0.58$, while probe-specific calibrations achieved an RMSE of 0.029 $m^3 m^{-3}$ and R^2 of 0.77. The application of sensor-specific calibration resulted in an RMSE of 0.019 $m^3 m^{-3}$ with $R^2 = 0.9$. Temporal sensor responses to the magnitude of rainfall events closely agreed. Sensor performance and accuracy errors were observed to vary as a function of soil wetness, bulk density (ρ_b gcm^{-3}) clay and total organic carbon (TOC) content. Increasing clay content and ρ_b resulted in increased raw output for a given θ_v whereas TOC demonstrated the opposite trend. These effects were significant (P value < 0.001) but eliminated by the sensor-specific custom calibration.

Hajdu I, Yule I, Bretherton M, Singh R, and Hedley C. 2019. Field performance assessment and calibration of multi-depth AquaCheck capacitance-based soil moisture probes under permanent pasture for hill country soils. Agricultural Water Management, 217, 332-345. https://doi.org/10.1016/j.agwat.2019.03.002

Variation in saturated hydraulic conductivity at the outcrop scale, the Whanganui Basin, New Zealand

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Groundwater, accepted for publication. https://doi.org/10.1111/gwat.12948

Groundwater flow and contaminant transport are strongly influenced by hydrogeological spatial variation. Understanding the textural heterogeneity of aquifer and aquitard units is critical for predicting preferential flow pathways, but is often hindered by sparse hydrogeological data, widely spaced data points, and complex stratigraphy. Here we demonstrate the application of a relatively new air permeameter technology, providing a cost-effective, rapid alternative for haracterizing hydrostratigraphic units in the field. The aim of this research is to (1) characterize the variation of saturated hydraulic conductivity across shallow-marine

hydrostratigraphic units of the Whanganui Basin, New Zealand, and (2) assess the variation of saturated hydraulic conductivity within individual hydrostratigraphic units and relate these changes to facies and depositional environments. Results suggest heterogeneity within fine-grained aquitard units is controlled by bioturbation, whereby burrowing, ingestion and defecation results in grainsize segregation and differential micrite cementation. Coarse-grained heterolithic aquifer facies display sharp changes in permeability across laminae to crossbed sets, related to current and wave energy fluctuations within shallow-marine depositional settings. Bedding plane orientation creates high permeability zones that promotes down dip subsurface flow. Down dip gradation of coarse-grained nearshore facies into fine-grained shelf facies along the paleo shoreline-shelf transect is suggested to promote lateral and vertical groundwater flow within the basin fill. Air permeameter techniques have potential for application within groundwater basins around the world, providing datasets that facilitate greater understanding of groundwater systems, informing practices and policies for targeted water quality management.

Rees C, Palmer A, Palmer J, and Singh R. 2019. Variation in saturated hydraulic conductivity at the outcrop scale, the Whanganui Basin, New Zealand. Groundwater, accepted for publication. https://doi.org/10.1111/gwat.12948

Characteristics and applications of biochar for remediating Cr(VI)-contaminated soils and wastewater

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Environmental Geochemistry and Health, in press, https://doi.org/10.1007/s10653-019-00445-w

Chromium (Cr) is a common environmental contaminant due to industrial processes and anthropogenic activities such as mining of chrome ore, electroplating, timber treatment, leather tanning, fertilizer and pesticide, etc. Cr exists mainly in both hexavalent [Cr(VI)] and trivalent [Cr(III)] form, being Cr(VI) with non-degradability and potential to be hidden, thereby affecting surrounding environment and being toxic to human health. Therefore, researches on remediation of Cr pollution in the environment have received much attention. Biochar is a low-cost adsorbent, which has been identified as a suitable material for Cr(VI) immobilization and removal from soil and wastewater. This review

incorporates existing literature to provide a detailed examination into the (1) Cr chemistry, the source and current status of Cr pollution, and Cr toxicity and health; (2) feedstock and characterization of biochar; (3) processes and mechanisms of immobilization and removal of Cr by biochar, including oxidation-reduction, electrostatic interactions, complexation, ion exchange, and precipitation; (4) applications of biochar for Cr(VI) remediation and the modification of biochar to improve its performance; (5) factors affecting removal efficiency of Cr(VI) with respect to its physico-chemical conditions, including pH, temperature, initial concentration, reaction time, biochar characteristics, and coexisting contaminants. Finally, we identify current issues, challenges, and put forward recommendations as well as proposed directions for future research. This review provides a thorough understanding of using biochar as an emerging biomaterial adsorbent in Cr(VI)-contaminated soils and wastewater.

Xia S, Song Z, Jeyakumar P, Bolan N, and Wang H. 2019. Characteristics and applications of biochar for remediating Cr(VI)-contaminated soils and wastewater. Environmental Geochemistry and Health, in press, https://doi.org/10.1007/s10653-019-00445-w

Water-quality issues facing dairy farming: potential natural and built attenuation of nitrate losses in sensitive agricultural catchments

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Animal Production Science, in press, https://doi.org/10.1071/AN19142

Context: Dairy farming will be increasingly scrutinised for its environmental impacts, in particular for its impacts on freshwater quality in New Zealand and elsewhere. Management and mitigation of high nitrate losses is one of the greatest water-quality challenges facing dairy farming in New Zealand and other countries. Management of critical flow pathways and nitrate-attenuation capacity could offer potential solutions to this problem and help maintain dairy-farming productivity, while reducing its water-quality impacts.
Aims: The present paper reviewed the key water-quality issues faced by dairy farming and assessed potential of emerging edge-of-paddock technologies, and catchment-scale nutrient-attenuation practices, to reduce nitrate losses from dairy farming to receiving water bodies.
Methods: We developed a conceptual catchment-scale modelling analysis assessing potential natural and built attenuation of nitrate losses from dairy farming in the Tararua and Rangitikei catchments (located in the lower part of the North Island, New Zealand).
Key results: This exploratory analysis suggests that a reduction of greater than 25% in the river nitrate loads from dairy-farming areas could potentially be achieved by spatially aligning dairy land with areas of high subsurface nitrate-attenuation capacity, and by managing critical flow pathways using innovative edge-of-field technologies such as controlled drainage, drainage-water harvesting

for supplemental irrigation, woodchip bioreactors, and constructed wetlands in the study catchments.
Conclusions: The research findings highlighted the potential to better understand, map and effectively utilise existing natural and new built-in nitrate-attenuation capacity to significantly reduce water-quality impacts from dairy farming across environmentally sensitive agricultural catchments. This knowledge and tools could help farmers close the gap between what can be achieved with current, in-field mitigation practises and the nitrogen-loss allocation imposed by regulatory authorities.
Implications: However, the research findings presented here are based on a coarse-scale, conceptual modelling analysis, and therefore further research is recommended to develop tools and practices to better understand, map and effectively utilise existing natural and new built-in nitrogen attenuation capacity at farm-scale to achieve productive and environmentally friendly pastoral dairy farming across agricultural landscapes.

Singh R and Horne DJ. 2019. Water-quality issues facing dairy farming: potential natural and built attenuation of nitrate losses in sensitive agricultural catchments. Animal Production Science, in press, https://doi.org/10.1071/AN19142

Updated Characterization of Dorowa Phosphate Rock Mined in Zimbabwe

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Natural Resources Research, in press, https://doi.org/10.1007/s11053-019-09567-5
The physical and chemical characteristics of mined phosphate rock will vary temporally as the location and nature of the ore body changes and as the type of equipment used in the beneficiation processes change over time. For the Dorowa phosphate rock (DPR) in Zimbabwe where economic challenges have affected the viability of phosphate rock mining and led to the closure of the mine twice, there is a need to evaluate if there have been any significant changes in its quality. The current DPR concentrate contained 11% more apatite and about 50% less calcite and other gangue minerals compared to mineralogical modal concentrations earlier reported for the DPR. Total P was found to have increased by 2% from previously reported figures to 16.5% by weight. Previously unreported, the cadmium content was found to be 0.16 mg kg^{-1}. The reactivity of the DPR was similar to previously reported values of 2.1%, 1.8% and 0.88% (w/w) in 2% citric acid, 2% formic acid and neutral ammonium citrate, respectively. Because of this, the DPR has low potential for direct application without modification. We conclude, therefore, that the apatite mineralogy of the ore being currently mined has not significantly changed in the past 25 years, while the beneficiation process has improved.

Tumbure A, Bretherton MR, Bishop P, Hedley MJ. 2019. Updated Characterization of Dorowa Phosphate Rock Mined in Zimbabwe. Natural Resources Research, in press, https://doi.org/10.1007/s11053-019-09567-5

Conferences and Training

New Zealand Trace Element Group (NZTEG)

The conference is scheduled to be held **Monday 10 February - Tuesday 11 February 2020**, with an *optional* workshop to be held on **Wednesday 12 February 2020.** The event will be held at the Avantidrome in Cambridge, NZ. (www.tracenz.org.nz) Early bird registration closes: **December 13th, 2019**

"Phosphorus Cycling and Management in Terrestrial Systems"

Tuesday 04 February 2020, Lincoln University (Commerce 2)
9.00am to 5.15pm
(See "Society notices" for more information)

Eurosoil 2020 - 20th anniversary of the European Confederation of Soil Science Societies

Eurosoil 2020 will take place in Geneva (Switzerland) in 24-28 August 2020. As the conference of the European Confederation of Soil Science Societies (ECSSS), Eurosoil is the soil voice of Europe. Eurosoil 2020 aims at tackling among others the environmental, social, economic and public pol-icy goals related to / impacting soil use and services. In line with the Eurosoil2020 theme "Connecting People and Soil", the conference program will be structured around selected Sustaina-ble Development Goals (SDGs) of the United Nations.
https://eurosoil2020.com/

INI2020: 8th Global Nitrogen Conference

The conference will take place on 3-7 May 2020 in Berlin, Germany. The 8th Global Nitrogen Conference of the International Nitrogen Initiative will follow on from the previous conferences held since 1998. This time, the overall framework will be "Nitrogen and the UN Sustainable Development Goals (SDG)". Most of the SDGs are closely interlinked with the nitrogen cycle. Sustainable nitrogen management is therefore a key element in tackling environmental and societal issues on a global scale.
https://ini2020.com/

Deadline..... For the February 2020 issue of Soil News is 19/2/2020

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