# 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 2016-2018

## President's message

Kia ora NZSSS members.

Thank you to all of the members who took the time to voice their preference for the International Union of Soil Sciences (IUSS) election of President. After a very close outcome, the NZSSS vote was made for Prof Alex McBratney from Australia. The outcome of the overall election from all IUSS member organisations was a clear majority for Prof Laura Bertha Reyes Sánchez from Mexico, the current Secretary General of the Latin American Soil Science Society. She will take up the position of President-Elect on 1st January, 2019 replacing Ratan Lal.

Congratulations to Megan Balks who has been appointed to the Intergovernmental Technical Panel Soils (ITPS) as the representative of Australasia. The ITPS is composed of 27 soil experts representing all the regions of the world. The main function of the ITPS is to provide scientific and technical advice and guidance on global soil issues to the Global Soil Partnership. The ITPS will advocate for addressing sustainable soil management in the different sustainable development agendas. It is great to have NZSSS representation at this forum and we can look forward to plenty of future dialogue from Megan with regards to the nature of her discussions and implications for New Zealand.

The 2018 NZSSS biennial conference is almost upon us and we have an exciting week to look forward to. The conference is themed 'Diverse Soils – Productive Landscapes' and offers the opportunity to show case the Hawkes bay as a location where numerous and varied soil and landscape features provide niche environments producing a wide range of high class food and agricultural products. This conference will seek to demonstrate the links between the land and the food we produce. Our keynote presentations will be delivered by Andrew Waterhouse/Mark Shepherd (Co-editors in Chief of the Journal of Food and Agriculture), Simon Upton (Parliamentary Commissioner for the Environment), Brent Clothier (Plant and Food Research & Past President NZSSS) and Celebrity Chief Annabel Langbein, who will discuss the connection between food and its source in the soil. The conference will be closed by Ants Roberts who will deliver the Norman Taylor Memorial presentation for 2018. I am intrigued already with regards to what Ants has in store for us given his talks title - "Is Disruption the New Black? A Luddite's View". I hope that this conference, like other NZSSS events provides an opportunity for our society's diverse membership (researchers, students, academics, policy makers, consultants and advisors) to share ideas and latest finding related so soil science and land use. A big thankyou

to the organising committee (led by Paul Johnstone and Rebecca Withnall) for all of their work to prepare this event.

The Napier conference will mark the end of my two-year period as NZSSS President. The next BGM will be held as part of the conference programme at 4.45 pm on Monday 3rd December. It appears that there will be several vacancies available for roles on the NZSSS council with a few members indicating their intention to stand down at the end of this term. Therefore, I would encourage anyone that is keen or even curious to consider putting your name forward for election. It is a rewarding way to make a contribution to the benefit of our soil science discipline. I would be happy to talk to any individuals that would like to know more about what a role on council looks like. Finally, it has been a pleasure to lead our society which represents an impressive group of Soil Science professionals that are highly valued national assets. I see that soil science now as much as ever will be at the heart of the discussions, debate and decisions that need to be made about the future of NZ land use and primary production activity. See you in Napier

Regards Dave Houlbrooke – NZSSS President

## Letter from the Editor

Welcome to the final Soil News of 2018! It's been an interesting year testing out new ways of putting the Soil News together and getting it out to our readers. I firstly want to thank our steadfast correspondents and Isabelle Vanderkolk for being open to trying new ways of doing things. And I want to thank our readers for your patience with weird formatted emails coming into your inboxes! I must admit that we still have not found the ideal solution, but we'll keep on trying. As always, please get in touch if you have any suggestions, complaints or other thoughts about how to promote communication in the NZSSS. You can email me directly Gina.Lucci@agresearch.co.nz and I will also be at the Soils Conference so please say hello!

## News from the Regions

### Waikato/Bay of Plenty

### Waikato University

**Jonathan Rau** (who recently completed his MSc) and **Megan Balks** travelled to Wairoa for Jonathan to present the results of his research to the Wairoa District Council and the local community. His presentation was well received as locals are keen to seek opportunities to better utilise the soil resources of the Wairoa District. Jonno is now working for Landcare Research.

Megan Balks travelled to FAO in Rome in October to attend a meeting of the ITPS (Intergovernmental Technical Panel for Soils) where she, along with **Siosiua Halovatu** from Tonga, is representing New Zealand, Australia and the Southwest Pacific (see report elsewhere in this issue).

Congratulations to **Manawa Huirama** who won the Tonkin and Taylor Award for best MSc thesis presentation at the School of Science annual graduate student conference. Manawa is researching sediment sources in hill country with NIWA, Vicki Moon, and Megan Balks. **Annette Carshalton** won the Scott Tech Instruments Award for best data acquisition. Annette is working on Antarctic soil climate data with Tanya O'Neill, Megan Balks and Karin Bryan.

**Anne Wecking** won the Vernon Pickett Memorial Award (NIWA) for best presentation in environmental processes. Anne is working with **Louis Schipper** and **Dave Campbell** on eddy covariance measurements of nitrous oxide emissions under intensive grazing.

The Waikato team of Anne Wecking, **Mathew House,** and Annette Carshalton is gearing up for the Soil Judging Competition at Napier and looking forward to meeting the Massey and Lincoln crews.

**Louis Schipper** has just returned from a couple of overseas trips including Arizona and Queensland. He is working with the Department of Agriculture and Forestry to explore where and how denitrifying bioreactors might be used to improve environmental performance of sugar cane and pineapple farming in Queensland. Since he was there a year ago they have installed 10 different bioreactors and have plans for a further 10 this coming year.

*A denitrifying bioreactor site built into the base of a drainage channel in Queensland*

In Arizona, Louis caught up with collaborator **Katharyn Duffy** and her colleagues at Northern Arizona University. Together with **Vic Arcus** (Molecular Biology Prof at University of Waikato) they are working on a project to determine the temperature response of photosynthesis and respiration of global ecosystems. They were also able to fit in some walking in the stunning Arizona landscapes including the Grand Canyon and Sedona national park.

*Vic Arcus and Louis Schipper in Sedona National Park, Arizona while visiting Katharyn Duffy*

We have had a number of thesis completions. Many congratulations to (i) **Dr Sheree Balvert** who defended her PhD thesis entitled: "Can naturally occurring glucosinolate related compounds from Brassica crops act as biological nitrification inhibitors and reduce nitrous oxide emissions?" (ii) Femke Rambags submitted her PhD thesis: "Microbial contaminant removal and alternative nitrogen removal pathways in denitrifying bioreactors". (iii) **Jamie Millar** on her Masterate thesis: "The effects of irrigation on soil carbon and nitrogen stocks of pumice soils".

A number of new masters students have started, including **Matt House** who is working on soil carbon stock changes under maize in collaboration with Manaaki Whenua – Landcare Research. **Kristyn Numa** who is examining the temperature dependence of different carbon compounds added to soil. **Charlotte Robertson** looking the the environmental and economic tradeoffs and benefits of implementing new farm management practices working with DairyNZ.

*Shane Stoner helping out with soil carbon sampling*

We have hosted a number of international visitoring stduents **Shane Stoner** from Max Planck Institute for Biogeochemistry spent a week at University of Waikato with Louis. Shane is undertaking a PhD with **Prof Susan Trumbore**. He came to sub-sample soils from the Winchmore long-term pasture grazing trial for subsequent measurement of bomb carbon.

**Bryan Maxwell**, a PhD student, visited from North Carolina State University where he is working on enhancing the performance of denitrifying bioreactors. Louis Schipper is one of his supervisors. Bryan brought with him a technique that allow multipoint continuous measurements of nitrate along the length of a bioreactor buit by Roland Stenger, Greg Barkle and colleagues.

**Shaun Brooks**, a PhD student, visited from the University of Tasmania, Institute of Marine and Antarctic Studies, where he is assessing various aspects of human footprint in Antarctica. Shaun was visiting **Tanya O'Neill** on an Antarctic Science Bursary grant where they began to formulate a publication linking visible terrestrial disturbance with impacts to biota and natural processes in Antarctica.

## AgResearch

**Mark Shepherd** and colleague Dr **Julie Cakebread** (Dairy Foods team) were part of a 6-person, 1-week visit to France in October to gain insight into research on precision agriculture. Colleagues from Plant and Food Research and Manaaki Whenua were also part of the group, which was organised by the French embassy. The group convened as a whole in Montpellier and spent 2 days hosted by the Digital Agriculture Convergences Lab (Digitag), and then each of our three separate CRIs dispersed to different parts of France to meet relevant contacts. There is every chance that there are other reports on the visit in this newsletter, so here is Mark's personal take:

It was an intensive but really enjoyable week and I thank the Embassy, AgResearch and the hosting research institutes for giving us this opportunity. It was enlightening to see how other research organisations are using digital technologies to advance

their science and to help deliver solutions to farmers. The Digitag initiative is a fantastic example of a multi-partner research collaboration between research institutes and industry, and came about through French Government recognition that new and emerging technologies have the potential to transform agriculture.
I learnt so much during the week that my head was hurting, but I've managed to distil it down to three headline messages that resonated with me:

- Precision Livestock Farming - Combining a range of datasets from regular and intensive animal monitoring, enabled by the growth in portable and cheap sensors and analytics, allows us to answer questions and drive scientific insight that we could not otherwise achieve.
- Complex problems need inter-disciplinary teams to address them. Include in the mix the 'technology ecosystem' - a web of specialist technology providers working in combination to efficiently develop & deliver solutions. Should CRIs deliver some of these specialist skills in house or is it more efficient to form new collaborations with non-traditional partners? Discuss!
- Terroir as a means to add value to products other than wine? Not my area of expertise but fascinating to discuss the concept of terroir, the science behind it and how terroir affects taste and quality of cheese and meat. Where do digital technologies fit? Of course, in helping address some of the complex science between terroir and food quality. But potentially also in providing the consumer with proof of product provenance.

My photo collection from the visit seems to comprise of either shots of powerpoint slides or historic buildings. However, the attached photo clearly demonstrated to me how the French do value the diversity of produce and its provenance. There was a huge market in Montpellier where the whole of the town seemed to be queueing up to buy their cheese, meat, fruit and veg:

**Stewart Ledgard** and colleagues have been working on a SLMACC project using LCA to assess the fossil energy use efficiency of New Zealand livestock products to overseas markets. This involves joint research with China examining energy use of NZ and Chinese milk. The project includes an online survey of energy use on NZ dairy farms. Stewart also attended the LCA Food Conference in Thailand, as a member of the Scientific Committee, and where he presented on joint research with China on effects of dairy intensification on the nitrogen footprint of milk.

At the end of October, **Gina Lucci** and **Jiafa Luo** were in China to present at the *International Symposium on Efficient Utilization of Agricultural Resources and Sustainable Development,* held in honour of the 40th anniversary of the

establishment of the *Center for Agricultural Resources Research* (CARR) in Shijiazhuang. They also met with colleagues in Beijing and Jinan to discuss an upcoming project in dairy effluent treatment.

***Photos**: Field trip to the Luancheng Agro-ecosystem Experimental Station*

## Lincoln Agritech

Lincoln Agritech and collaborators are very pleased that their **Critical Pathways Programme (CPP)**, aiming to unravel sub-catchment scale nitrogen delivery to waterways, was successful in the recent MBIE investment round. The research team from Lincoln Agritech, Aqualinc Research, Manaaki Whenua Landcare Research, Lincoln University, GNS Science, AgFirst, and Ian Kusabs & Associates, will introduce an innovative multi-scale measurement, data analysis and modelling approach in two pilot catchments. Collectively, it will enable the team to unravel the typically shallow and relatively fast pathways between a parcel of land and a local stream or small river.

Key innovations include a novel suite of airborne and ground-based geophysical measurements and innovative techniques for the analysis of the resulting 'Big Data' that in combination allow gaining currently unavailable information on structural, hydrological, and chemical characteristics of the shallow subsurface (particularly the upper 20 m). The resulting new understanding will be integrated into advanced nested models that make it possible to utilise high-resolution data in those sub-catchments where it can be gained.

This new approach will be tested in two intensively farmed catchments with contrasting characteristics. The Waiotapu Stream (Wp) catchment (approx. 300 $km^2$) on the North Island's Central Plateau represents a baseflow-dominated upland catchment with large groundwater store in young volcanic deposits. In contrast, the Piako Stream (Pi) headwater catchment is a lowland catchment (approx. 100 $km^2$) in the upper part of the Hauraki Plains with aquifer deposits of lower transmissivity and a high quickflow fraction in the stream hydrograph.

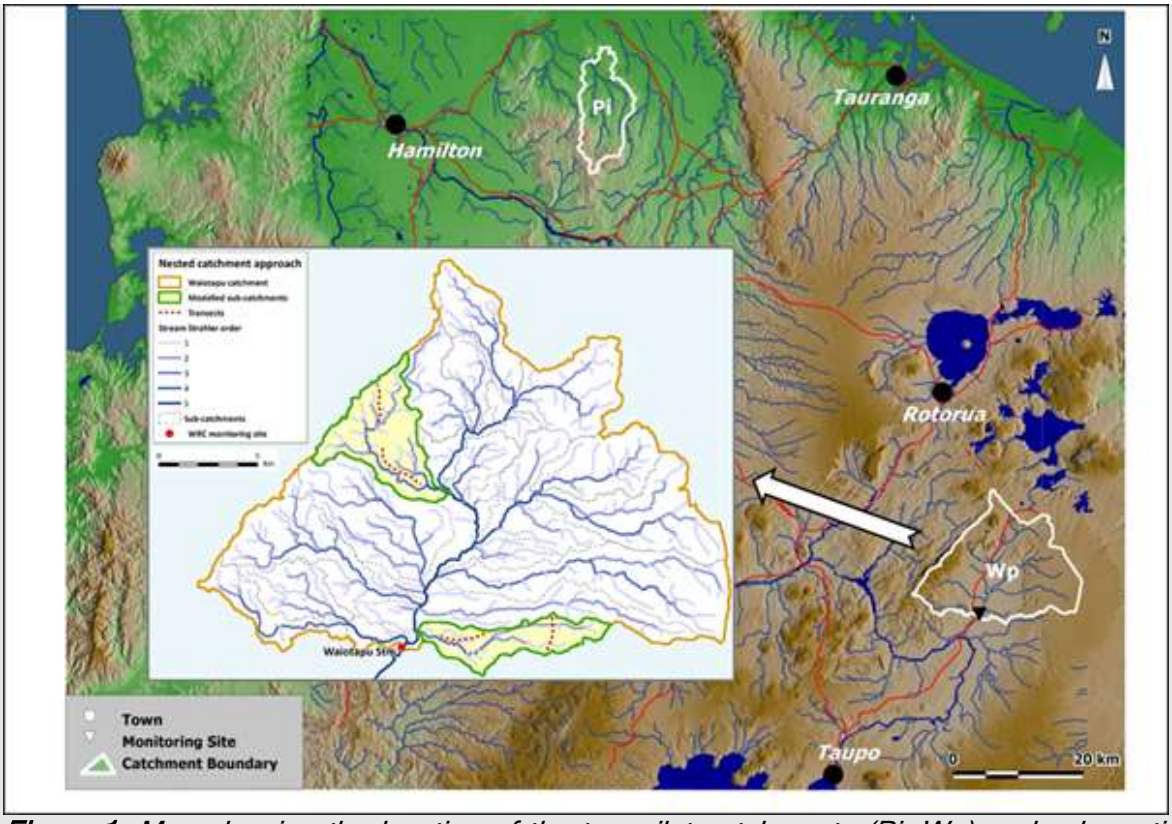



***Figure 1:*** *Map showing the location of the two pilot catchments (Pi, Wp) and schematic illustrating the nested sampling and modelling approach, stretching from the transect scale via the sub-catchment scale to the catchment scale.*

The Interdisciplinary Conference on **Land Use and Water Quality 2019** (www.luwq2019.dk), taking place in Aarhus, Denmark, from 3-6 June 2019, has attracted considerable interest by New Zealanders. Based on the submitted abstracts, it appears about two dozen NZ resource managers and scientists may be attending the event. If you would like to have a conversation with a local member of the Scientific Advisory Committee, please feel free to contact Roland.Stenger@lincolnagritech.co.nz.

## Manawatu

### Plant & Food Research, Palmerston North

**Steve Green** and **Brent Clothier** have been continuing their work on irrigation requirements in the United Arab Emirates (UAE). Irrigation is essential in the UAE to support the growth and development of food crops, amenity trees and natural green spaces. Many farmers in the UAE are applying large amounts of irrigation to their field crops and this is threatening the sustainability of the groundwater resources. The Government of Abu Dhabi recently passed Law 5 to restrict groundwater use. Under that Law, all groundwater extractions will be monitored by the Environment Agency – Abu Dhabi (EAD) and all farmers will need to operate within their allocation limits.

Plant and Food Research (PFR) developed the Crop Calculator Decision Support Tool (DST) to help EAD to define water allocation limits for groundwater takes. The tool uses the standard FAO-56 guidelines approach for calculating crop water requirements (Allen et al, 1998). The model's input parameters include default values for the crop coefficients which are untested in the very hot and dry climate conditions of the UAE.

In order to establish more appropriate model inputs, the PFR team has been carrying out a collaborative research program with EAD, starting in 2014 with date palms and forestry. More recently, they have been working with EAD and the Abu Dhabi Food Control Authority (ADFCA) on field experiments examining a range of vegetable crops (cabbage, capsicum, cucumber, eggplant and tomato) grown under outdoor conditions. The crop water balance is measured using weighing lysimeters to provide a precise measurement of crop evapotranspiration, irrigation, rainfall and drainage.

*Left panel shows the flow meter (Sensus model) used to record irrigation volumes. This device produces one electronic pulse for every litre of water. Right panel shows the eggplant crop a few weeks after planting. Irrigation is regulated using a pressure-compensated dripper (4 L/h) for each plant. The black pots on the right panel are the four lysimeters that are buried below the soil, to a depth of about 70 cm.*

New knowledge of crop water use has been obtained from these field experiments. This data has been used to derive local values of the crop coefficients, for the crops we have studied. The situation for other vegetable crops grown under shade or in greenhouses is currently getting underway in a new project at the International Centre for Biosaline Agriculture (ICBA) near Dubai.

Verifying the Crop Calculator DST against local field data will enable EAD to have more confidence in the water allocation numbers. EAD should also now be able to benchmark model outputs against grower records of irrigation water use to demonstrate the water savings possible by matching irrigation use to plant water demands. The Crop Calculator DST is strategic (for allocation) rather that tactical (for management) but it could be adapted for such purposes to aid growers and irrigation consultants in their decision-making process.

**Brent Clothier** gave the opening keynote presentation at the Global Cleanup Congress 2018 in Coimbatore, India, on 21 October, 2018. The Congress was sponsored by CRC CARE (Centre for Assessment & Remediation of the Environment) and Tamil Nadu Agricultural University (TNAU). Brent's talk was on "*Measuring & Modelling Landscape-Scale Contaminant Transport Processes & Valuing Ecosystem Services*".


*The opening the Global Cleanup Congress 2018 in Coimbatore, India.* ***Brent Clothier*** *(right), Dr S. Mahimairaja, Dean of Agriculture, TNAU (second from right), and Prof. Ravi Naidu, CEO of CRC CARE (third from left), are all PhD graduates from Massey University! The respective graduation dates were 1977 (Brent), 1985 (Ravi) and 1989 (Raja).*

**Robert Ward** and **Ian McIvor** have been working on the effect of giant willow aphid on willow root growth. Fifteen 90cm willow poles (12x *Salix nigra* and 3x *Salix matsudana x lasiandra*) were planted in large boxes in February 2018, three poles per box. The boxes were filled from the bottom with 40% river stones, 30% sand and 30% silt. Four of the boxes have one Perspex side allowing the growth of roots to be observed and tracked. Black plastic sheets cover the Perspex to minimise the effect of sunlight striking the roots directly. Approximately every two weeks since May 2018 photos have been taken of the roots of the twelve poles (10x *Salix nigra* and 2x *Salix matsudana x lasiandra*) and these roots have been traced using SmartRoot, a plugin for ImageJ, an image analysis software package. This program allows, with some assumptions, the length, diameter, volume and ontology of individual roots to be tracked over time. Data can be exported into spreadsheets to allow further analysis.

Presently, only observations of the roots are being taken, but from January 2019 half of the trees will be inoculated against giant willow aphid while the other half will be colonised with giant willow aphid. Observations of the roots will continue in order to determine the effect of giant willow aphid on root development and in May 2019, the trees will be excavated and whole plant root data will be collected.

*Figure 1: Boxes with willow poles. The red circle indicates the tree used as an example for Figure 2 and Figure 3.*

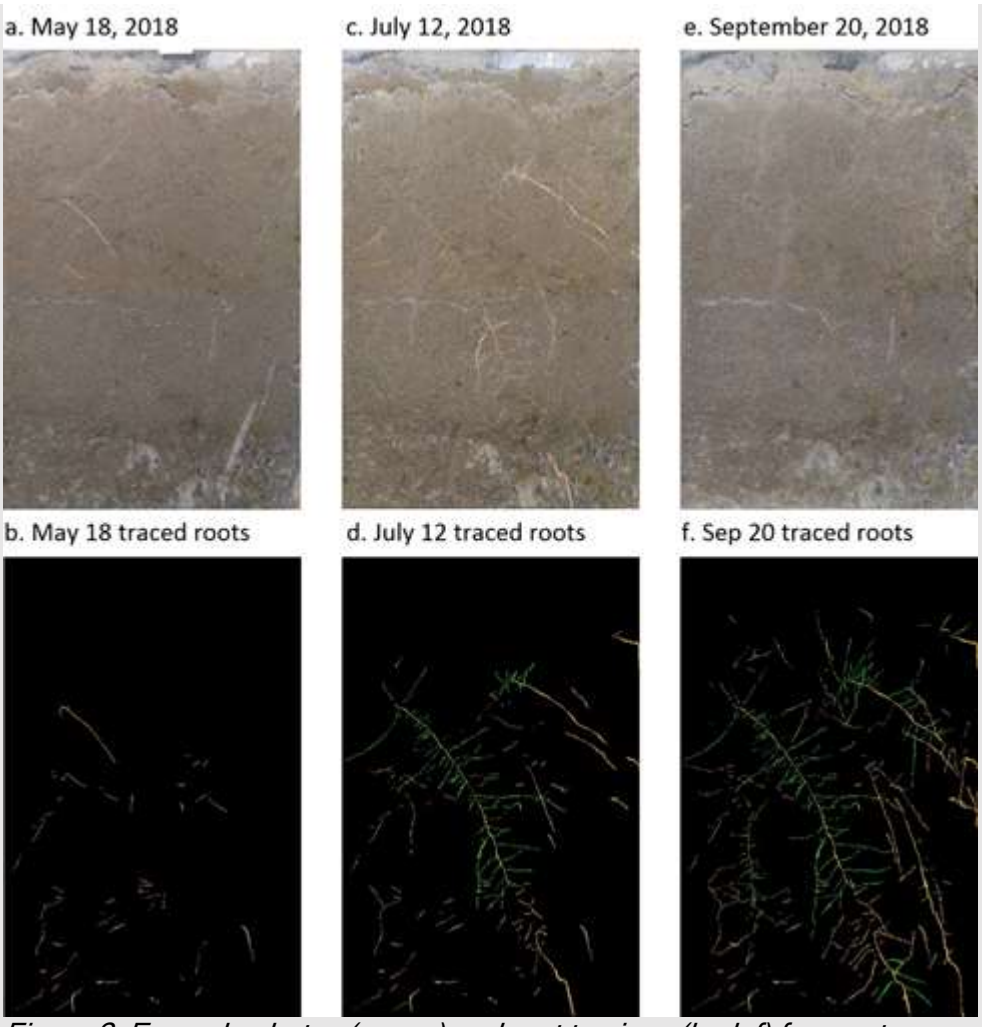



*Figure 2: Example photos (a, c, e) and root tracings (b, d, f) for one tree over a four month span.*

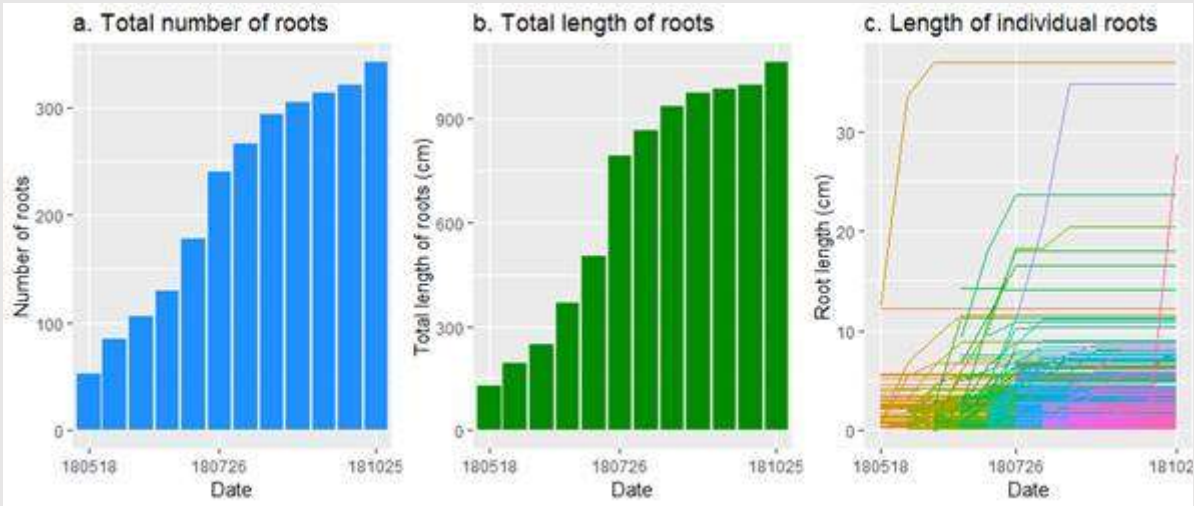



*Figure 3: Statistics for one tree since the start of the trial: a. total number of roots visible; b. sum of the lengths of all visible roots; c. lengths of individual roots.*

Welcome to **Liyin Liang**, who joins us from Waikato University to work with Miko Kischbaum and Donna Giltrap in the greenhouse gas modelling department. Liyin has already shown his prowess in the darts competition – as well as GHG modelling! **Pierre Roudier** recently hosted Dominique Arrouays and Anne Richer de Forges from INRA, France. Dominique gave a very interesting talk on their soil monitoring scheme. The scheme is now providing thirty years of soil data for exploring trends in soil carbon and other soil properties.

## Canterbury

## Scion (Rotorua/Christchurch)

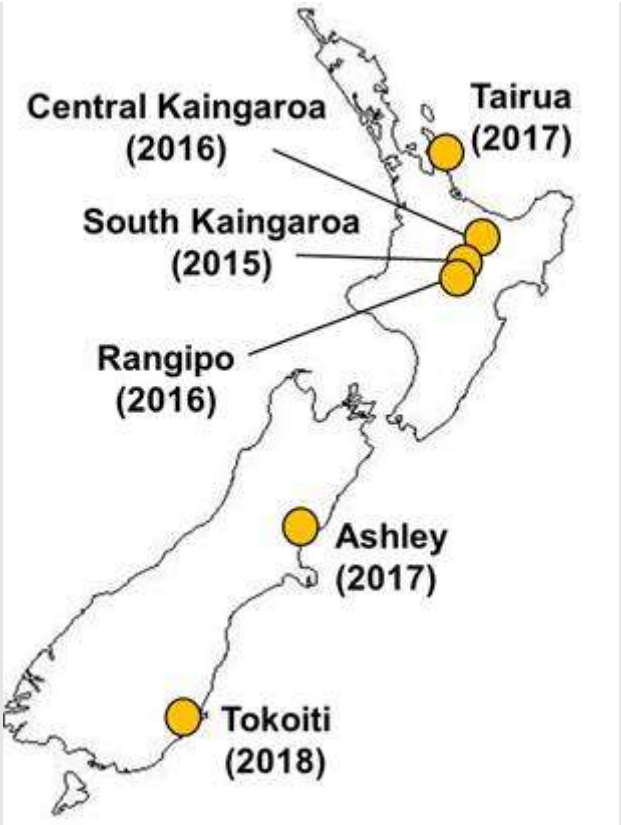
It has been a busy time for the Scion soil scientists, including the completion of initial soil sampling at a new trial series, and travel to various national and international events. We're also looking forward to catching up with colleagues at the upcoming NZSSS Conference in Napier.

### Forest soil science on the small screen

Aspects of the soil science performed by Scion were recently highlighted in an episode of "Forest Call". **Amanda Matson** introduced some of the research Scion is doing to assess the extent and rates of nitrogen leaching in amended forest soils in a stable nitrogen isotope study, while **Simeon Smaill** discussed some of the mycorrhizal research Scion has undertaken in nursery soils that has had significant effects for tree growth in the plantation. The episode can be viewed online at https://www.youtube.com/watch?v=WIRtwF95UQA&t=393s

### Establishment of the Accelerator Trial series

Scion has recently established the 6$^{th}$ and final Accelerator Trial, which is part of a network of large study sites designed to identify the limits of sustainable radiata pine productivity. The overarching concept behind these trials is to remove all barriers to growth until the thermodynamic potential for a given site is realised. Soil factors, such as nutrient pools, water storage capacity and the availability of beneficial microbial species, are critical factors in the performance of radiata pine, and consequently have formed a large component of the research that has been carried out to date, or will be examined in the future. To support this, an extensive soil sampling campaign has just been completed to capture the initial state of these sites in great detail. The Scion scientists leading this work are interested in enhancing the value of this work by establishing collaborative research ventures involving the wider NZ soil science community. Please contact Simeon Smaill or Loretta Garrett if you wish to know more about these sites.




*Location of the six Accelerator trials throughout New Zealand, with year of establishment. Each trial is comprised of 108 subplots with approximately 81 trees per subplot. The exceptions to this are Central Kaingaroa (72 subplots) and Rangipo (144 subplots).*

### Forest Growers Research Conference 2018 (Tauranga, 16-18 October)

Scion soil scientists were well represented at this large annual event, reporting the outcomes of various operational scale trials and studies to the attending forest owners and managers. The majority of the soil research has been carried out under the "Growing Confidence in Forestry's Future" programme, which is a highly integrated programme funded by MBIE and the Forest Growers' Levy Trust. The soil research presented at the conference touched on many subjects, including the potential for long term changes to soil capital with harvest intensification, the deployment of novel nutrient amendments, and analysis of the impact of different radiata pine genotypes on the activity of beneficial soil microbes. These presentations were well received, extending various interim results that have already prompted significant new sector-led trials. In addition, Simeon Smaill received the Research Award for Innovation that Enhances Sector Value for several soil-based research projects, confirming the value placed on soil science by the New Zealand forestry sector.

### Scion scientists at the 4th International Congress on Planted Forests (Beijing, 23-27 October)

The critical connections between soil and plantation forests was well established at this well attended event. Scion staff led several sessions, and **Tim Payn** gave a Sub-plenary talk outlining the ecosystem services provided by planted forests, including the conservation of the soil capital. Other Scion presentations provided detail on:

- The proper matching of tree genotype to site based on interactions with soil biota

- The need to re-evaluate tree breeding programmes to account for the potential effects of climate change on soil processes and capital
- Opportunities to stimulate the beneficial effects of the tree microbiome
- The long-term implications of nursery soil management on the benefits provided to young trees by mycorrhizal fungiThe integration of biological indicators into assessments of forest soil quality and health

A keynote of particular significance was provided by **Monique Barbut** (Executive Secretary of the United Nations Convention to Combat Desertification) who described recent efforts to stabilise soil in Central Asia through the planting of 71.5 billion trees. Although the principal goal of this planting differs from the current afforestation efforts in New Zealand, the engagement process through which the planting occurred is very relevant.


SCION
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Integrating 'biology' into forest soil quality assessments

Graham Coker[1], Mathis Richard[2], Karen Bayne[1], Loretta Garrett[1], Simeon Smaill[1], Steven Wakelin[1,3]
[1]Scion Research, New Zealand; [2]AgroSup Dijon, Cedex, France; [3] BioProtection Research Centre, Lincoln University, New Zealand

Introduction

Assessment of soil quality (alt. 'health') is an important component of land use monitoring. It provides an understanding of how soils, and soil functions, change over time and across management practices. The information can be used to determine if soils and soil functions are stable, degrading, or improving. This information is important for Regional Councils (reporting under the Resources Management Act), land owners and managers.

Furthermore, consumers are increasingly demanding that food, fiber, and other products are produced in a environmentally sustainable manner. Despite the inherent importance of 'biology' and 'biological processes' in supporting soil function (Figure 1), explicit biological metrics are not currently included in soil quality monitoring in New Zealand. Increasingly this is reducing our ability to more effectively assess and manage land use for sustainable production, puts us behind our international trading partners, and poses risk to market access and consumer selection.

Before formally integrating biological metrics into soil quality assessment, it is important to know which ecosystem services are most valued by various forest stakeholders. As such, the aims of this study were to identify and query stakeholders of New Zealand's planted forests for the values they place on a range of soil ecosystem services.

*Excerpt from a poster prepared by Steve A Wakelin to describe a collaborative study into stakeholder perceptions of soil ecosystem services and the role of the soil biota in maintaining those processes.*

**Forest Dialogue event (Rotorua, 29 October – 2 November)**

Scion and Toi Ohomai Institute of Technology hosted one of the international series of The Forests Dialogue's 'Tree Plantations in the Landscape' events. These bring together international and national specialists over a week to discuss aspects of plantation forestry, including soil resource management. Following on from dialogues in Chile and Brazil this dialogue focussed on sustainable intensification of plantations, forests and climate change mitigation, the 1 Billion Tree initiative, and Māori Forestry. Tim Payn led the organising committee and **Peter Clinton** was one of the four co-chairs leading the dialogue. Visits to Kaingaroa forest, and Lake Taupo Forest Trust formed the backdrop for the discussions. The insights provided will be woven into global forest management practises and the links developed are likely to lead to new research collaborations and future joint activities with participants. For more information on this initiative, please visit: https://theforestsdialogue.org/initiative/tree-plantations-landscape-tpl

*Dialogue participants visiting a recently harvested site.*

## In the news...

[The Dollars and Cents of Soil Health: A Farmer's Perspective]
Conservation practices such as cover crops and no-till are widely recommended to build soil health over time, but do these practices actually improve crop yields and lead to stable profit margins? To answer this question fully we will rely on universities, private scientists, government researchers and those most directly impacted: farmers themselves.

[Quantifying Impacts of Precision Agriculture Technologies]
In a paper recently published in *Agriculture & Environmental Letters*, a research team evaluated the economic and environmental impacts of tractor guidance (TG) based on three on-farm scenarios. Researchers found that TG impacts are crop specific, scale-dependent, and equipment or input-use specific.

[Systemic Challenges to Agbiotech: Lessons from Londrina, Brazil]
When it comes to agricultural biotechnology for international development, we're at a unique time. On one hand, research teams are developing a new generation of poverty-reducing crops ranging from wilt-resistant, vitamin A-fortified bananas in Uganda, to drought-resistant maize in Southern Africa to insect-resistant eggplant in Bangladesh. On the other hand, farmers around the world have cultivated genetically engineered (GE) crops since 1994, giving us two decades of successes and challenges from which to learn.

[Solar panel shade increases soil moisture and pasture biomass]
This paper compared soil moisture and biomass growth between pasture both with and without photovoltaic solar panel arrays. While average soil moisture was similar across the fields with and without solar panels, the field with the solar panels had

more variable soil moisture: directly underneath the solar panels, persistent stores of soil water were available throughout the growing season. Without solar panels, the pasture experienced water stress in the middle of summer.

VIDEO: The natural capital approach: ecological and economic perspectives
Governments, businesses and NGOs are developing new metrics and tools to value and measure social, environmental and economic change in the context of Sustainable Development Goals and planetary health. Current approaches face limitations in addressing temporal and spatial dimensions of natural capital value. This talk will address emerging methodologies to measure natural capital and enable us to assess and measure ecological services and benefits more fully in economic analysis. The speakers will bring perspectives from the ecological science and economics.

## Related Society Notices

### Living Soil Film Released!

Today, the Soil Health Institute released Living Soil, a 60-minute documentary about soil health featuring innovative farmers and soil health experts from throughout the U.S. The film is freely available to download and stream at www.livingsoilfilm.com. Accompanying lesson plans for college and high school students will be available on World Soil Day on December 5th. A link to the full press release can be found here.


**Living Soil: A Documentary for All of Us**

Our soils support 95 percent of all food production, and by 2060, they will be asked to give us as much food as we have consumed in the last 500 years. They filter our water. They are one of our most cost-effective reservoirs for sequestering carbon.

They are our foundation for biodiversity. And they are vibrantly alive, teeming with 10,000 pounds of biological life in every acre. Yet in the last 150 years, we've lost half of the basic building block that makes soil productive. The societal and environmental costs of soil loss and degradation in the United States alone are now estimated to be as high as $85 billion every single year. Like any relationship, our living soil needs our tenderness. It's time we changed everything we thought we knew about soil. Let's make this the century of living soil.

This documentary was directed by Chelsea Myers and Tiny Attic Productions based in Columbia, Missouri, and produced by the Soil Health Institute through the generous support of The Samuel Roberts Noble Foundation.

A special thanks to Dawn Bentley, Brian Berns, Keith Berns, Bill Buckner, Mimo Davis, Dan DeSutter, Miranda Duschak, James "Ooker" Eskridge, Barry Fisher, Liz Graznak, Steve Groff, Jerry Hatfield, Trey Hill, Larkin Martin, Bianca Moebius-Clune, Jesse Sanchez, Larry Thompson, John Wiebold, Kristen Veum, Kevin Mathein, Ben Harris, Tim Pilcher, Josh Wright, Haley Myers, Rob Myers and Josh Oxenhandler

## International Union of Soil Sciences

### From the desk of Rattan Lal:

"The Soil-Centric Agricultural Reformation"
http://iuss.boku.ac.at/files/soil-centric_agricultural_revolution_11012018.pdf

"Global Food and Nutritional Security"
http://iuss.boku.ac.at/files/iuss_10012018.pdf

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## Report of the Ninth Working Session of the Intergovernmental Technical Panel on Soils held at FAO headquarters in Rome, Italy, 10 - 12 October 2018

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The Intergovernmental Technical Panel on Soils (ITPS) was set up under the auspices of the GSP (Global Soil Partnership) in 2013 to provide scientific and technical advice and guidance on global soil issues to the GSP primarily and to specific requests submitted by global or regional institutions. The ITPS advocates for addressing sustainable soil management in the different sustainable development agendas. The first meeting of the third ITPS was held in FAO headquarters in Rome from 10-12 October 2018. Twenty five of the 27 panel members were present, five representing Africa, five from Latin America, one from North America, four from Asia, five from Europe, and myself and Dr Siosiua Halavatau (Tonga) from the South-west Pacific. The meeting was supported by 14 GSP Secretariat staff from FAO (Food and Agricultural Organisation of the UN).

The major focus of the meeting was to brief the new ITPS members (23 out of 27) and bring them up to speed with the previous achievements of the GSP and the proposed work-plan for the upcoming three years.

Upcoming events of particular interest to NZ, Australia, and Pacific Island nations include:

1. a Global Symposium on Soil Erosion to be held at FAO in Rome from 15-17 May 2019 which it is expected will lead to development of global soil erosion maps and development of guidelines for prevention and remediation of soil erosion.
2. Proposal to get work underway related to salt-affected soils.
3. Proposed global map of soil carbon sequestration potential.
4. We can expect a "push" to develop a regional soil laboratory network to ensure standard methods as part of GLOSOLAN the Global Soil Laboratory Network. A South Pacific Agricultural Chemistry Laboratory Network (SPACNET) was previously active but needs to be re-activated.
5. A Global Symposium on Soil Biodiversity is planned for 2020.

The next ITPS meeting will be organized together with the Global Symposium on Soil Erosion, on 15-17 May 2019, at the FAO Headquarters in Rome. For further information see http://www.fao.org/global-soil-partnership/intergovernmental-technical-panel-soils/en/ or you are welcome to contact Megan.balks@earthbrooke.co.nz

## Abstracts

**Indirect Methods to Elucidate Water Flows and Contaminant Transfer Pathways through Meso-scale Catchments – a Review**
Shailesh Kumar Singh & Roland Stenger

We provide a critical review of indirect methods to elucidate water flows and contaminant transfer pathways through meso-scale catchments, as the proliferation of such methods in recent years has made it very difficult for potential users to evaluate their relative merits. We focus on agricultural contaminants such as nitrogen, phosphorus, faecal bacteria and sediment, as there is a substantial risk for them to contaminate waterways wherever agriculture exists. While direct measurements may be feasible at the plot/farm scale, their high resource demands make them prohibitive at the catchment scale. Water flows converging at the catchment outlet offer the opportunity to employ indirect methods to interpret hydrological and/or chemical data observed there as integrative signatures reflecting the various pathways through a catchment. We focus on meso-scale catchments (≈ 10-103 km2) as the surface water monitoring data required for indirect methods is typically available at this scale. We reviewed the literature to provide an overview of the numerous methods used (e.g., hydrograph separation, concentration-discharge analysis, pollutograph/loadograph analysis, end-member mixing analysis).
Particular attention is given to the spatial scale the methods have been applied to, and their data needs (type of data, required temporal and spatial resolution). Advantages and disadvantages in terms of data availability and underlying assumptions are highlighted to facilitate the selection of a suitable method. While no single indirect method will provide all the answers, well-informed selection of one or

more has the potential to greatly advance our understanding of water flows and contaminant transfers at the catchment scale.

Environmental Processes https://doi.org/10.1007/s40710-018-0331-6

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**Bayesian chemistry-assisted hydrograph separation (BACH) and nutrient load partitioning from monthly stream phosphorus and nitrogen concentrations**
Simon J. R. Woodward & Roland Stenger

A Bayesian chemistry-assisted hydrograph separation (BACH) approach was developed, based on calibration of a three component recursive digital filter, that requires monthly water quality data only. This enables BACH to be applied to the large number of rural catchments for which continuous flow records and monthly water chemistry time series exist from 'state of environment' monitoring programmes, but little supplementary data required for more sophisticated analysis techniques. As well as estimating fast, medium, and slow flow components, BACH also estimates for each flow component a time-invariant concentration of the chemical tracers chosen, allowing flow path-specific loads to be calculated. The method was demonstrated using 15 years of total phosphorus (TP) and total nitrogen (TN) data from eight mesoscale catchments in the Waikato region of New Zealand's North Island. Calibration was done separately for three 5-year data periods, and validated against data from the following 5-year period. Flow path separation and concentration predictions were consistent between data periods, indicating that the TP-TN combination contained sufficient information to reliably identify three flow paths in each catchment; an event-response near-surface flow path with high concentrations of both phosphorus and nitrogen, a seasonal shallow groundwater flow path with lower concentrations of TP but high concentrations of TN, and a deeper slower groundwater flow path characterised by generally low concentrations of both TP and TN. Based on this analysis, the catchments were able to be grouped in three hydro-types. This shows that commonly available water quality data can support robust, objective flow separation and nutrient load apportionment, even in the absence of other supporting data, provided appropriate modelling methods are used.

Stochastic Environmental Research & Risk Assessment https://doi.org/10.1007/s00477-018-1612-3

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**Vertical stratification of redox conditions, denitrification and recharge in shallow groundwater on a volcanic hillslope containing relict organic matter**
R. Stenger, J.C. Clague, U. Morgenstern, T.J. Clough

Natural denitrification in groundwater systems has been recognised as an ecosystem service that reduces the impact of agriculturally-derived nitrate inputs to surface waters. Identification of this ecosystem service within the landscape would permit spatially differentiated land management and legislation. However, spatial variation in groundwater redox conditions poses a significant challenge to such a concept. To gain understanding of the small-scale mosaic of biogeochemical and

hydrological controls on denitrification, we established a well field consisting of 11 multilevel well (MLW) clusters on a hillslope containing relict organic matter buried by volcanic deposits 1.8 ka before present. Based on site-specific redox classification thresholds, vertical redox gradients and denitrification potentials were detected at 7 of the 11 sites. Palaeosols or woody debris, which had previously been identified in laboratory experiments as resident electron donors fuelling denitrification, were visually recognisable at 4 of the 7MLWsites with vertical redox gradients. Moderately enhanced groundwater dissolved organic carbon (DOC) concentrations occurred where resident electron donors were evident. DOC concentrations were lower where anoxic and nitrate-depleted groundwater was found but with an absence of resident electron donors. In these instances, it was assumed that nitrate reduction had occurred somewhere upgradient of the sampled well screen along the lateral groundwater flow path, with the proximate electron donor (DOC) largely consumed in the process, since no evidence was found for denitrification being fuelled by inorganic electron donors. Due to high variability in the isotopic signature of nitrate in oxidised groundwater, the nitrate dual isotope method did not yield firm evidence for denitrification. However, realistic vertical patterns were obtained using the excess N2 method. Tritium-based age dating revealed that oxic conditions were restricted to young groundwater (mean residence time ≤ 3 y), while anoxic conditions were observed across a wider age range (3-25 y).

*Science of the Total Environment* https://doi.org/10.1016/j.scitotenv.2018.05.122

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**The influence of a flood event on the potential sediment control of baseflow phosphorus concentrations in an intensive agricultural catchment**

Richard W. McDowell, Zach P. Simpson, Roland Stenger & Craig Depree

Purpose. The growth of periphyton in streams is enhanced by phosphorus (P) in baseflow. The likely control of P concentrations in baseflow can be approximated by the equilibrium P concentration ($EPC_0$) of bed sediments. However, sediment composition changes with spatial scale and flood events. It is unknown if this affects $EPC_0$.

Materials and methods. We sampled sediments in a main stem and headwater tributary of an agricultural catchment in Reporoa, New Zealand, before and after a scouring flood event (99th percentile of flows recorded since 1962). The tributary was chosen for its low slope and predominantly single land use (intensive dairying), which minimised the number of factors likely to affect the influence of the storm event.

Results and discussion. $EPC_0$ values were significantly correlated to dissolved reactive P (DRP) in baseflow before, and after, the flood event, despite a decrease in the proportion of fines and total P in bed sediments. Both $EPC_0$ and DRP concentrations increased towards the catchment outlet. This increase likely reflected new P-enriched sediments from dairy-farm runoff, but hyporheic zone samples suggested that shallow groundwater may also have played a role in supplying P to the water column. Despite diel variations in dissolved oxygen, DRP concentrations showed little variation during the day and matched $EPC_0$ estimates.

Conclusions. This work suggests that despite changes in sediment composition due to flood events, $EPC_0$ is a useful reflection of daytime baseflow-DRP concentrations

at sites along a stream network. However, further work is required to clarify if sediment-P exchange or groundwater control baseflow-DRP concentrations. These data also inform our understanding of the influence of sediment on delaying farm and catchment efforts to decrease in-stream DRP concentrations.

*Journal of Soils and Sediments*. https://doi.org/10.1007/s11368-018-2063-7.

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**Investigating the Influence of Biochar Particle Size and Depth of Placement on Nitrous Oxide (N2O) Emissions from Simulated Urine Patches**
A.F. Mahmud, M. Camps-Arbestain, M.J. Hedley
http://www.mdpi.com/journal/agriculture/special_issues/biochar_soil_impact

The use of biochar reduces nitrous oxide ($N_2O$) emissions from soils under specific conditions yet the mechanisms through which interactions occur are not fully understood. The objectives of this glasshouse study were to investigate the effect of (i) biochar particle size, and (ii) the impact of soil inversion - through simulated mouldboard ploughing - on $N_2O$ emissions from soils to which cattle urine was applied. Pine biochar (550 °C) with two different particle sizes (< 2 mm and > 4 mm) was mixed either into the top soil layer at the original 0-10 cm depth in the soil column or at 10-20 cm depth by inverting the top soil to simulate ploughing. Nitrous oxide emissions were monitored for every two to three days, up to seven weeks during the summer trial and measurements were repeated during the autumn trial. We found that the use of large particle size biochar in the inverted soil had significant impact on increasing the cumulative $N_2O$ emissions in autumn trial, possibly through changes in the water hydraulic conductivity of the soil column and increased water retention at the boundary between soil layers. This study thus highlights the importance of the role of biochar particle size and the method of biochar placement on soil physical properties and the implications of these on $N_2O$ emissions.

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**Assessing the pore structure and surface area of allophane-rich and non-allophanic topsoils by supercritical drying and chemical treatment**
R. Calvelo Pereira, M. Camps Arbestain, F.M. Kelliher, B.K.G. Theng, S.R. McNally, F. Macías, F. Guitián
Geoderma 337 (2019) 805-811

Abstract: We have investigated the effect of supercritical drying (SD) on the porosity and the BET-N2 specific surface area (SSA) of five allophane-rich and three non-allophanic topsoils. The contribution of organic matter (OM) and short-range ordered (SRO) constituents to the nanoscale porosity (< 100 nm size) and SSA was also evaluated following chemical treatments to oxidise OM and then remove the SRO phase. The average pore volume and SSA of the soils, measured after SD, are greater than the values obtained after air drying. For soils that are rich in SRO constituents, oxidation of OM leads to an increase in SSA. This observation is attributed to the unblocking of pore necks previously covered by OM, while the subsequent removal of SRO constituents causes a sharp decrease in SSA. The SRO constituents containing oxalate-extractable Al, are the major contributors to the SSA of the inorganic fraction. Besides confirming that SD can help preserve the

nanoscale porosity of allophane-rich soils, the results highlight the contribution of SRO constituents to the SSA of soils and their ability to accumulate OM.

## Books

### Clay Mineral Catalysis of Organic Reactions

## The New Biological Economy

The New Biological Economy is the second book that has come out of a project funded by the Marsden Fund in 2009. The first book Biological Economies: Experimentation and the politics of agri-food frontiers (Routledge Hardback 2016,

paperback 2018) had a more academic focus but this one is written for a public audience.
It poses some key questions:

- Do dairy and tourism have a sustainable future?
- Can the primary industries keep growing without destroying the natural world?
- Does the future of New Zealand lie in high tech or in the innovations of a land-based economy?

It explores how high-volume, low value-add industries in New Zealand can continue to grow – and do so sustainably.

***Visit RNZ to hear full interview**: The New Biological Economy: Sustainability, economy and adding value to primary industry commodities.*

## Conferences and Training

### International Interdisciplinary Conference on Land Use and Water Quality' – Agriculture and the Environment:

Aarhus, Denmark, 3-6 June 2019.
LuWQ2019 is conference on the cutting edge of science, management and policy to minimise effects of agriculture and land use changes on the quality of groundwater and surface waters. The conference is aimed at scientists, land and water managers and policy makers involved in water quality improvement. If you consider attending and would like to have a conversation with a local member of the Scientific Advisory Committee, please feel free to contact Roland.Stenger@lincolnagritech.co.nz.
More information: www.luwq2019.dk

### 7th International Symposium on Soil Organic Matter: Soil Organic Matter in a Stressed World

Adelaide, South Australia, 6 – 11 October 2019.
It is of course this amorphous substance, SOM, that draws our interests together and affords us the privilege to invite you to the wonderful city of Adelaide, South Australia, where the 7th iteration of the International SOM Symposium Series will be held from 6th -11th October 2019. The conference follows the amazingly successful editions at Rothamsted Research, UK (2017), Georg-August-Universität Göttingen, Germany (2015), and their four predecessors stretching back to the initiation of the series at Potiers, France, in 2007. It draws together a vibrant mix of established world experts, early and mid-career researchers, and students in order to share knowledge, make new connections, and advance the field of SOM research.
More information: www.som2019.org

### 2019 SSSA International Soils Meeting: Soils Across Latitudes

San Diego, CA. January 6-9, 2019
The Soil Science Society of America wants to be sure you don't miss the first ever SSSA International Soils Meeting as we meet in collaboration with the Canadian Society of Soil Science and the Mexican Society of Soil Science. The meeting

features include cross-cutting sessions, workshops, tours, and over 30 Special and Cross-Divisional Sessions. Join us in San Diego!
More information: www.sacmeetings.org/


## Job Opportunity – Assistant Lecturer

An opportunity exists for a fixed term appointment of an Assistant Lecturer to support research and the delivery of Professional Development courses in the area of Sustainable Nutrient Management in NZ Agriculture. You will have an Agricultural/Soil Science qualification, studied Soil Science to at least the 300 level and a Masters degree in Soil Science. You will be familiar with the OVERSEER Nutrient Budgeting software, have experience of the nutrient requirements of pasture and arable crops, and an understanding of the effect of nutrient management strategies on the environment. You will also have a good knowledge of dairy systems.

Working within a very active research group there is an expectation that you have qualifications and experience that will enable you to embark on a PhD in the area of ‘‘Sustainable Agricultural Systems’’.

Further enquiries should be directed to Professor Chris Anderson, phone +64-6-951 7850 or email c.w.n.anderson@massey.ac.nz

The link to the position is below:
http://massey-careers.massey.ac.nz/10590/assistant-lecturer

## SCAR Visiting Scholars Scheme

Applications for SCAR Visiting Scholars Scheme (previously Visiting Professors Scheme) open: For mid to late career researchers involved in Antarctic research, providing the opportunity to undertake a short-term visit to an institute in another SCAR member country for training and mentoring. **Closing date 3 December**.
More info: https://www.scar.org/awards/visiting-scholars/information/