Welcome to the Soil News

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In this issue...

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

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Updates: Soils Conferences & World Soils Day

The joint Australia New Zealand Soil Science Society Conference that was scheduled for December 2020 in Cairns has now been moved to **June 27 - 4 July 2021**. For further updates see the conference website: https://www.soilscienceaustralia.org.au/2021-joint-conference/. The meeting will be held then, regardless, and a virtual online option will be available.

World Soils Day Celebration 4 December 2020

Please keep the 4th of December free to join our World Soils Day celebration and to participate in the NZSSS awards and BGM. We plan to hold an on-line webinar with three top speakers, in collaboration with our Australian colleagues. Presuming we are back to level one we will hold events at Waikato, Massey, and Lincoln to watch the webinars and participate in the BGM. There will be some appropriate refreshments and a chance for social networking, as a change from the social distancing that we are currently experiencing.

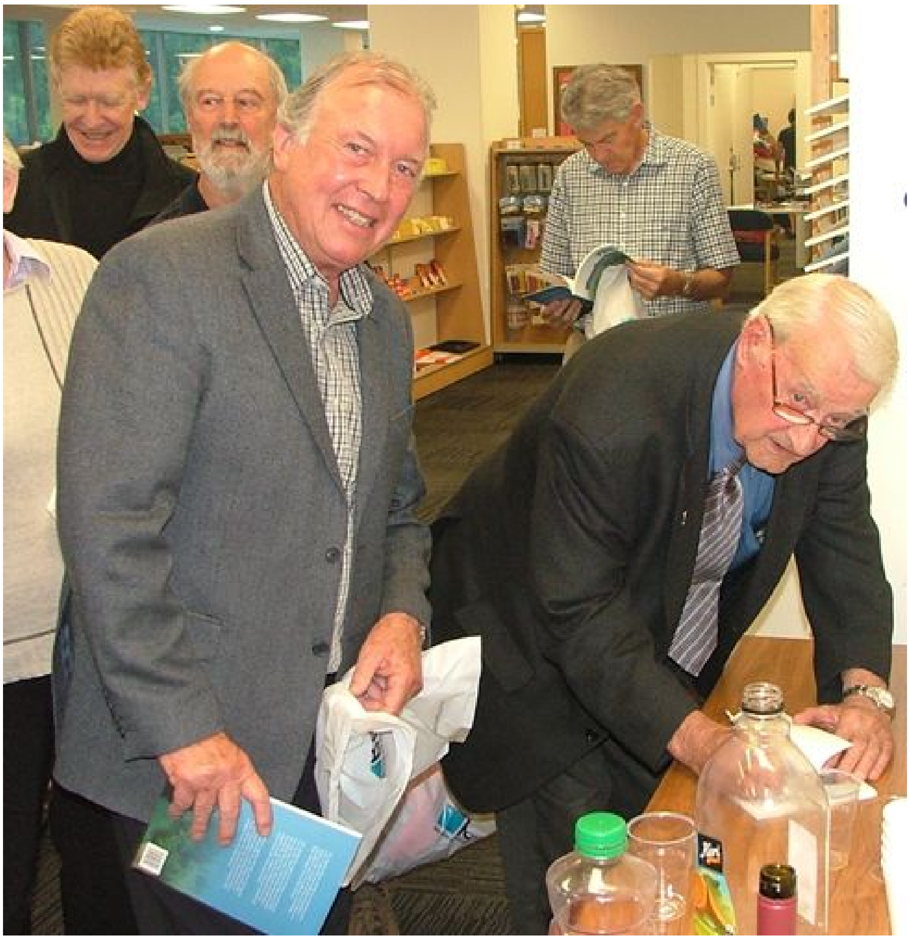
NZSSS Conference 2022

Plans are underway for our regular NZ Soil Science conference to be held in Blenheim in the last week of November, 2022. If you are interested in helping on the organising committee for that meeting please contact our current Society president megan.balks@earthbrooke.co.nz or vice president Timothy.clough@lincoln.ac.nz.

Obituary

Richard Chapman (1943 – 2020)

We are saddened to advise readers of the passing of Richard Chapman in Hamilton on the 30th of June this year. Since 2000, Richard, based in Hamilton, was consultant and director of his company “Soil and Land Evaluation”. Prior to this, Richard developed a substantial career at the University of Waikato, initially as a senior tutor in the Department of Earth Sciences and then with the BSc (Tech) programme in the School of Science. He excelled in all these roles partly because of his supportive, sound, and empathetic nature and partly because of his farming-related background in both the UK and New Zealand.



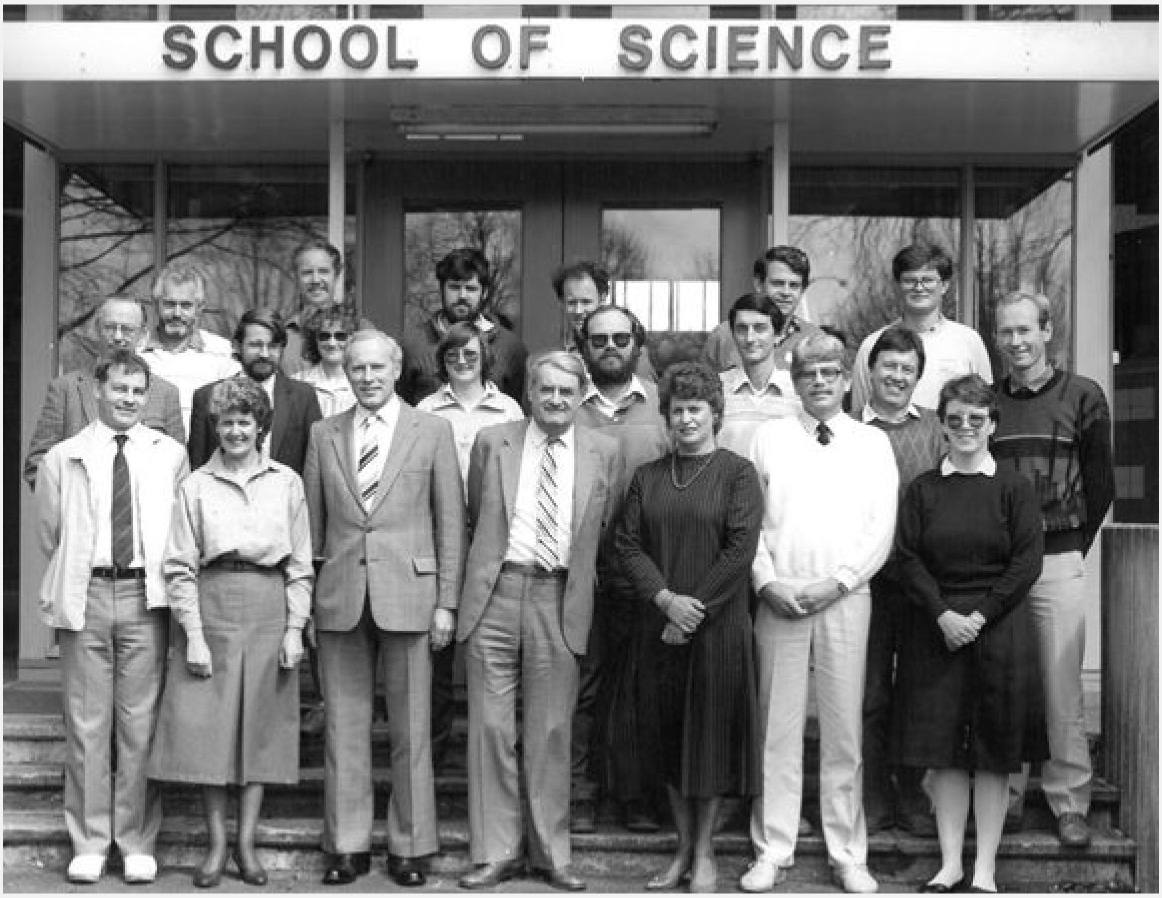
Richard (left) with John McCraw in December 2011 at a book launch of ‘The Wandering River’

Richard was born in Yorkshire, UK, on 25 April 1943, and grew up on the family farm, gaining valuable, life-long experience. He augmented that experience with study at the Newton Rigg Agricultural College in Cumbria and then took the decision to immigrate to New Zealand (by sea) in 1969 with his wife, Kate Newbould, whom he had married in 1966. Richard was appointed as a livestock officer in the Department of Agriculture and took up a position in Hamilton from January 1970. He undertook part time study at the local polytechnic (now Wintec) and took some University of Waikato papers, firstly as his interest in soils and Earth sciences, at the heart of farming, increased and secondly to gain qualifications to eventually embark on graduate study. Meanwhile he got to know the landscapes and farming people of the Waikato region.

It was as a well-respected mature student that Richard began a masterate in the Department of Earth Sciences, University of Waikato, in the early 1980s. He examined soils on basaltic materials in the Raglan area with respect to cobalt levels and agriculture for his MSc thesis (Chapman, 1983). The family (including children Michael and Sarah by this time) then returned to the UK where Richard was a lecturer at Writtle Agricultural College near Chelmsford in Essex (now Writtle University College) in the UK from 1983 to 1986. At that point the decision to return permanently to life in New Zealand was made. Richard became senior tutor in the Department of Earth Sciences from 1986, his wide experience, depth of knowledge, and friendly and supportive nature being recognised by department head, Professor John McCraw, who made the appointment. In his own words, Richard wrote (in Tonkin et al., 2015):

"As a part-time mature student in the 1970s I was so grateful to Prof McCraw for his teaching and encouragement during my undergraduate and masterate degrees at Waikato University and also when I returned 'jobless' from the UK to Hamilton in 1986, when he offered me a position as a first-year tutor in the Department of Earth Sciences. He was instrumental in supporting my enrolment for a D.Phil. in soil physics research in 1986, which was completed part-time a few years later during a marvellous and exciting growth period in the Department of Earth Sciences, both in student numbers and academic achievement, of which I was privileged to be part."

Richard began his part-time studies towards a PhD on soil physics with supervisor Dr Bob Allbrook. His PhD (Chapman, 1992) included subsoiling trials on the physical properties of soils at Rugby Park (now Waikato Stadium), Hamilton, in preparation for the internationals held there during the Rugby World Cup of 1987 (Chapman & Allbrook, 1987).



Richard was the ultimate team man (especially including his love for cricket). He is in the second row at right in this 1987 staff photo for the Department of Earth Sciences.

Helping with the next generation: Richard (front right) with a 3rd-year pedology class alongside the Waipa River in 1988

With his freshly-minted doctorate, Richard was appointed to the expanding BSc (Tech) programme around 1992 within the School of Science at the University of

Waikato. This four-year degree contained practical, relevant work experience with employers beyond the university. Richard, with his keen interests in the practice of science outside university and his ability to connect with people, was a perfect fit for this role.

Richard continued to invest in the BSc (Tech) degree and, in 1995, became a founding member of the Cooperative Education Unit, eventually becoming the director of the Unit. Under his leadership, the Unit and the BSc (Tech) degree continued to grow and evolve, and the programme developed into an exemplar work placement programme modelled by other universities. In 2018, the University of Waikato implemented a curriculum enhancement project that included the requirement of all undergraduate students to complete at least one paper (15 credit points) of work-integrated learning that implemented many ideas and ideals that Richard had so passionately worked towards. While director of the Unit, Richard had a keen eye for appointing emerging academic staff, providing them an opportunity to carve out a career in academia, with many of these staff going on to hold senior positions at University of Waikato and other universities.

Richard was always an engaging presence. Here he is at the award-winning University of Waikato stand "Soils: extreme close-up" at the National Fieldays at Mystery Creek near Hamilton in 1996.

The year 2000 was an important year. Richard took the decision to form his own consultancy and left the university in July 2000, forming Soil and Land Evaluation Ltd (SALE). He felt ready because of his wide practical experience, strong theoretical understanding, and well established networks. In October that same year, Jeanette Gillespie, who had taken over as the senior tutor in the department whilst studying towards a PhD, tragically passed away, an event that left its mark on Richard who was a mentor for Jeannette as well as for many other students and colleagues.

Richard was known to everyone for his strong love for his family, which was always placed first. It was with enduring sadness that tragedy struck the family in February 2007 when daughter Sarah, an environmental planner and resource management specialist, passed away shortly after giving birth to Alexander.

Final comments

Richard was one of the most decent people one could hope to meet, described by many as a true English gentleman. Extremely supportive, empathetic, understanding, generous, reliable, hard-working, well spoken, knowledgeable, humble, loyal, and loving are all words that apply to him. Richard had the wonderful capacity to talk as an equal with students, farmers, academics, parents, and children with just the right words and manner. Highly respected, he was very supportive of young academics and was an unofficial mentor to many, including the writers, and took a genuine interest in them and their families. Richard continued to attend many events held at the university, including meetings of the New Zealand Society of Soil Science and the Geoscience Society of New Zealand, showing his support and interest to the end. He is greatly missed. We thank Kate and Michael for their help in compiling this obituary.

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Chapman, R., & Allbrook, R.F. (1987). The effects of subsoiling compacted soils under grass – a progress report. *Proceedings Agronomy Society of New Zealand, 17*, 55-58.

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Society News

Awards 2020 – Leamy Award extension
This year NZSSS Council has extended the nomination period for the Leamy Award, with a new closing date of **20 September 2020**. Key details of this award are provided in the table below. Please contact the NZSSS Awards Convenor for full details (Brendon.Malcolm@plantandfood.co.nz).

Award	Presented	Nominations close	Nominee eligibility	Nominator eligibility
The Leamy Award	Biennially (conference year)	20 Sept 2020	Open to the author or authors of the most meritorious New Zealand contribution to soil science, published in the previous three calendar years.	Any two active members of the NZSSS can nominate an eligible candidate(s) from a university, CRI, or other organisation (e.g. a Regional Council).

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News From the Regions

Waikato/Bay of Plenty

Lincoln Agritech

The Environmental Research team at Lincoln Agritech has recently welcomed two new staff members, although Antoine Di Ciacca, taking up the Post Doc position in the Braided Rivers Programme, is still in France, awaiting border restrictions to be eased. James Owers has joined the team as a technician in the Hamilton office, relocating from Christchurch. The team has been particularly busy with fieldwork, catching up on time lost during lockdown.

Understanding the nutrient and flow contributions of different sub-catchment

The MBIE-funded Critical Pathways Programme (CPP) aims to unravel the different pathways of contaminant transfer at the sub-catchment scale. Our two study catchments are the headwaters of the Piako, and the Waiotapu stream catchment. In order to achieve an understanding at the sub-catchment scale, we have recently carried out flow gauging in the Wharepapa and Kopuhurihuri sub-catchments in the Waiotapu catchment (Figure 1). Flow gauging has also been done again across the whole of the Upper Piako catchment. In addition to discharge measurements, field parameters (DO, EC, pH and temperature) were also measured, and samples taken for a wide range of analytes including nitrate, forms of P, and tritium.

Figure 1: James Owers carries out flow gauging of the Wharepapa stream sub-catchment in the Waiotapu stream catchment August 2020

In order to better monitor flow dynamics in various parts of the stream networks, pressure sensors have been installed at key locations in both catchments. They will be gauged periodically to develop rating curves that describe the relationship between water level height and discharge (Figure 2).

Figure 2: A pressure sensor has been installed in the vertical PVC pipe to continuously record water levels while Aldrin Rivas performs a flow gauging to form a relationship between the water level data and discharge.

A lack of reliable meteorological data for our study catchments has necessitated the installation of several dedicated climate stations (Figure 3). The new data on the spatial variation in rainfall and evapotranspiration within our catchments will subsequently feed into our hydrological models.

Figure 3: Climate stations have been installed in both study catchments

So far, continuous flow recorders and nitrate sensors have been installed at two of the four sub-catchment outlets (Figure 4). This high-resolution data will help us understand the relationship between flow and nitrate concentrations and how they change over time.

Figure 4: Continuous flow via a radar sensor and continuous nitrate using a TriOS NICO sensor have been installed at two locations in our upper Piako study catchment.

University of Waikato

The big news in this report is the retirement of Peter Kamp on 30 June 2020 after 43 years on the Earth Sciences academic staff in the School of Science at the University of Waikato, Hamilton. The notes below come mainly from Nelson and Lowe (2020).

Peter (standing at left) about to receive a special commemorative certificate with embedded zircon and apatite crystals at his standing-room-only retirement function in Friday 26 June. In the middle is Margaret Barbour (Dean, School of Science) and at right is Adrian Pittari with the certificate. Peter was also given a drone (which he is holding).

Peter came to Waikato University in 1972 to undertake a BSc degree in Earth Sciences, and followed this with MSc research on the sedimentology and paleoenvironments of the Pleistocene deposits exposed along the Kidnapper's cliff section in Hawke's Bay. After being made a Junior Lecturer in Earth sciences in 1977, Peter completed his MSc degree and soon embarked on a novel PhD study (for the time) by attempting to unravel the Cenozoic tectonic development of New Zealand in the southwest Pacific region. During his PhD, in 1980, Peter won a tenured lectureship in Earth Sciences, and thereafter over the years he rose quickly through the academic ranks to become a full professor in Earth sciences in 1999.

Peter's teaching role over more than four decades covered mainly the fields of stratigraphy, sedimentology, structure/tectonics, sedimentary basin analysis, thermochronology, and petroleum geology. His extremely wide personal knowledge of New Zealand geology enabled him to bring these topics alive through his many own field and research experiences, with well-illustrated examples in lectures and 'real-world' New Zealand practical exercises in laboratory classes. Perhaps Peter's most persuasive teaching contribution was during the many dozens of field trips and field courses that he was associated with, or led, including Port Waikato, North Taranaki, Hawke's Bay and Whanganui regions.

Peter's standout contribution in the School of Science over at least the past 25 years has been in establishing and leading very substantial research groups and in attracting very significant funding to support them. In this time, he attracted about $25 million of research funding from both contestable government (e.g. FRST, MBIE, MSI) and private sources, a record for any academic at the University of Waikato. The funding allowed Peter to supervise numerous post-graduate students and early-career researchers, to mentor them and employ some, and to provide opportunities for them to advance their careers and ultimately take up positions in academia, geological surveys and geo-resource industries, both in New Zealand and overseas.

Peter (left) in a polar tent with David Lowe in late 1978/early 1979 during Waikato University's 1978-79 expedition to the Darwin Mountains and Britannia Range that was led by the late Michael Selby.

Over the years Peter has received a number of awards, including (with Mark Tippett) 'Best Paper of the Year' in the journal *Earth Surface Processes and Landforms* (1995), a University of Waikato Staff Merit Award (1996), the prestigious McKay Hammer Award of the Geological Society of New Zealand (2002), and Lifetime Achievement Awards from the Hamilton Science Excellence Awards Trust (Kudos) and the University of Waikato (2017). A few weeks ago it was announced that Peter had been appointed, fittingly, an emeritus professor of the University of Waikato.

Despite his interests mainly in geology, Peter joined the NZ Society of Soil Science in 1975 and has loyally maintained his membership and interest ever since (45 years). In his retirement, Peter has a number of projects still running. He is currently seeing through to final publication, incredibly, 26 geological maps at a scale of 1:50,000 from the pioneering and very detailed stratigraphic studies and mapping he and his students have undertaken across central and southern North Island.

Reference

Nelson, C.S., Lowe, D.J. 2020. Retirement of Peter Kamp, University of Waikato. *Geoscience Society of New Zealand Newsletter* 32 (in press).

Manawatu

Plant & Food Research

Brent Clothier, President-Elect of the Royal Society Te Apārangi, was welcomed onto the whenua of the Royal Society Te Apārangi at a pōwhiri in Thorndon, Wellington on 6th August. Barney (Puku) Anderson (Ngāti Maniapoto), the kaumātua of Plant & Food Research, is (now) seated on the left, after having 'loaned' Brent to the Royal Society Te Apārangi for four years on behalf of PFR, the gathered whānau of Science New Zealand and the CRIs, along with Brent's own whānau. Brent is currently President-Elect, and he will begin his three-year term as President on 1st July 2021. The kaumātua of the Royal Society Te Apārangi, Peter Jackson (Te Ati Awa), is 'accepting' Brent, along with the tāngata whenua of Kahu Hotere (Ngāti Maniapoto, Māori Director, Royal Society Te Apārangi) and Professor Wendy Larner (Current President, Royal Society Te Apārangi). Dr Andrew Cleland, the Chief Executive of the Royal Society Te Apārangi, is on the right. New members of the Council of the Royal Society Te Apārangi, Professor Charlotte MacDonald, Dr Cate McInnes-Ng, and Jenny Pollock, were also welcomed.

Brent Clothier has also been engaging in hui at Omaio and Cape Runaway in the Eastern Bay of Plenty region for PFR’s Growing Futures programme.

Aleise Puketapu and Brent Clothier were welcomed, by powhiri, onto the Rutaia Marae at Omaio on Saturday 18th July for a hui with the Rutaia, Nuku, Te Ehutu, and Kaiaiao hapū from Te Whānau a Apānui. This hui was convened by Leo Gage, and chaired by Katarina Edmonds, the iwi chairperson. Representatives from all four hapū attended the hui.

Aleise, Katarina and Brent in front of the whare nui of the Rutaia hapū

Kūmara growing was formerly a tradition in this rohe and the history and stories of large kumara māra in the region still ring true for mana whenua. Recently other land-uses, such as maize and kiwifruit, have taken hold. There is an iwi and hapū desire to re-establish kūmara growing and other māra kai, across the rohe.

At Whangaparaoa, Māori land owners are seeking new land use options, by working with Ministry of Primary Industries and PFR. MPI is supporting this through MABX - their Māori AgriBusiness Cluster programme. Aleise, Brent and Nigel Perry attended a hui there wānanga there on the suitability for horticulture and bioactive natural products from ngahere (bush).

Manaaki Whenua – Landcare Research

We are delighted to announce that Ahmed El-Naggar was awarded the Doctor of Philosophy degree on 10th June 2020 by Massey University. This was for his thesis "An evaluation of the role of precision irrigation methods in maximising freshwater use efficiency and crop yields." Ahmed's supervisors were Carolyn Hedley, Pierre Roudier, Dave Horne and Brent Clothier.

Ahmed developed some new sensing methods to improve irrigation scheduling decisions, with a focus on variable rate irrigation systems. The sensing methods included precision sensor mapping of soil differences, as well as the application of real-time soil moisture and daily crop water use sensing methods to field situations. Ahmed's trial sites at the Massey University experimental VRI pivot and at a Hawke's Bay farm provided good contrasting sites – and Ahmed had to cope with flood to drought conditions during his irrigation trials!

In his first year of trials at Massey University, Ahmed was able to show that waterlogging of a soil due to intense rain during the irrigation season depressed yields by 58% compared with an adjacent freely draining soil. Meanwhile the pivot in Hawke's Bay was having a hard time keeping up with drought conditions. However, in Ahmed's final year of trials, Palmerston North turned on some drought conditions and his field trial results showed that real-time soil and crop sensing could be used to irrigate to a threshold of 60% AWC without yield penalty compared with a 40% threshold.

Ahmed's research has provided some effective and practical tools that farmers can adopt to improve irrigation water use efficiency. We wish Ahmed all the best in his new role with the AgResearch soils group at Invermay.

Ahmed El-Naggar and Carolyn Hedley at the 2018 Irrigation NZ conference held in Alexandra

Ahmed harvesting his wheat grain trial under the Massey pivot in 2019

Other news

Benny Theng has signed a contract with CRC Press (Taylor & Francis Group) to prepare a second edition of his award-winning textbook "The Chemistry of Clay-Organic Reactions", published in 1974 by Adam Hilger (London). The deadline for complete manuscript submission is April 2023.

Massey University

New short courses to help meet the need for mandatory Fresh Water-Farm Plans by 2025

Lucy Burkitt, Mike Bretherton and Alan Palmer at Massey University have been busy since lockdown, re-modelling their current Advanced Soil Conservation professional development courses to meet the high demand for Fresh Water-Farm Planners in response to the government's Action for healthy waterways package requiring most New Zealand farms to have Fresh Water-Farm Plans by 2025. The plan is to offer a flexible online Intermediate Farm Environment Plan course which teaches students about the key components of a Farm Environment Plan (FEP) and requires them to develop a desktop FEP to demonstrate their new knowledge. This course can be followed up by an Advanced Farm Environment Plan course, where students will spend a week on a range of farms in order to develop three FEPs across a range of agricultural industries. For more information on pre-requisites or to register your interest, please contact Fiona Bardell F.M.Bardell@massey.ac.nz

Assessing carbon storage when full inversion tillage follows pasture renewal: winter sampling near Maxwell

This last June, after lockdown, the team at Massey University formed by Roberto Calvelo, Quang Mai, Ian Furkert, Bob Toes and Ross Wallace spent a well-deserved day at Gerard & Kate Lynch's Farm near Maxwell, sampling soils. This experimental site (established in October 2017) is part of the GPLER-funded trials set up between 2016 and 2018 in the North and South Island to assess the potential of pasture renewal using full inversion tillage to increase soil carbon storage compared to other common renewal practices. North Island Team is led by Mike Hedley and Roberto Calvelo (Massey University), whereas in the South Island Mike Beare and Sam McNally (Plant & Food Research) lead the party.

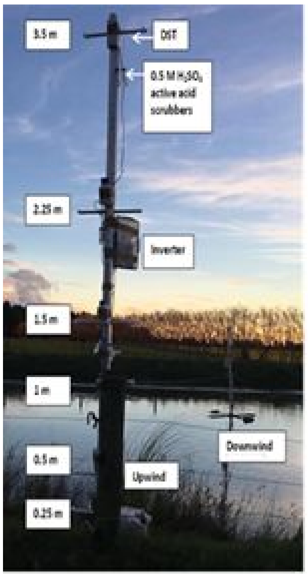
A long day in the field, post lockdown; note the beautiful spot and how weather changed drastically. Inset, some cores showing signs of carbon storage at depth (arrows) more than two years after full inversion tillage; the 4.5 cm diameter cores were difficult to take in these Allophanic and Allophanic soil intergrades because the subsoil is easily compacted; therefore, all cores were carefully weighed, and carbon stocks will be compared on an equal soil mass basis. Photos: Roberto Calvelo.

The Massey team had a busy day coring the Allophanic soil under a very unsettled weather. Samples taken will provide information on the short-term changes in soil carbon stocks, particularly at 25-35 cm depth, after pasture renewal using full inversion tillage. Intense monitoring done at this and other benchmark trials around New Zealand has provided key information allowing the evaluation of agronomic and environmental benefits and risks caused by pasture renewal using full inversion tillage. Future monitoring of these sites will evaluate how inversion tillage impacts long-term soil carbon storage.

Congratulations to new PhD graduates

Jay Howes successfully defended his PhD thesis very recently (Targeted Duration Controlled Grazing – The Effect of Timing of Grazing on Nitrate Leaching and Treading Damage). Jay undertook this research while he was a staff member in the Soils Group at SAE, Massey University. He is now the Soil Science Specialist with PGG Wrightsons.

Khadija Malik also successfully defended her PhD thesis (An Investigation into Measuring Ammonia Loss During the Operation of a Freestall Dairy Barn) last July. Practising duration-controlled (DC) grazing using temporary housing systems (naturally ventilated barns) can reduce urinary load to paddocks and N loss to water but there is a concern that ammonia (NH_3) loss to atmosphere can occur during housing, manure storage and re-application to land. These NH_3 emissions may simply result in pollution swapping i.e. decreasing N loss to water while, increasing the greenhouse gas emission footprint of dairying. Khadija's research focused on developing cost-effective techniques to monitor, mitigate and minimise the NH_3 gas emissions from a duration controlled grazing system practiced in Manawatu region of NZ. A combination of laboratory and field work assessed the main components of DC grazing are feed, housing, storage and slurry reapplication to land. Along this journey, Khadija was supervised by Prof. Surinder Saggar, Mike Hedley and Peter Bishop.



Stanislav Garbuz has successfully completed his PhD studies at Massey University working on the project "Linking soil functional biodiversity and processes to soil ecosystem services", under the supervision of Maria Minor (Wildlife & Ecology, Massey University), Marta Camps-Arbestain (Soil Science, Massey University), and Alec Mackay (AgResearch Grasslands, Palmerston North). The research involved the investigation of the effects of biochar, made from willow at 350°C, on soil ecological and biochemical processes within an ecosystem services modelling framework, in a sil-andic Andosol in Taranaki and a dystric Cambisol in the Manawatu under both glasshouse and field conditions. The research has shown that biochar addition caused a significant (i) increase in soil total nitrogen, organic carbon and Olsen phosphorus contents beyond those expected from that added with biochar, (ii) a decrease in soil bulk density, again more than can be explained by the reduced density of the biochar added, (iii) an increase in bacterial and fungal biomass carbon and (iv) an increase in plant productivity. The research provides evidence that adding biochar to these two pasture soils can positively affect the soil food web, nutrient cycling, soil structure, and stimulate root growth – a key contributor to organic C input to soil – and thus support the use of this amendment as part of sustainable farming practices.

Photos: Top, left to right, Manawatu site, Taranaki site. Bottom, left to right, glasshouse experiment details, soil cores preparation (field experiment), cores set up (field experiment), Stanislav Garbuz on the day of the oral examination. Photos courtesy of Stanislav Garbuz.

Brian Levine passed his PhD examination in early July. Brian undertook an exciting and industry-relevant study in the Lake Rotorua catchment looking at The Ability of Detainment Bunds to Mitigate the Impact of Pastoral Agriculture on Surface Water Quality. Brian's research found that detainment bunds (DB) prevented an estimated 51-59% of the annual suspended sediment loads, 47-68% of the annual total phosphorus loads, and 57-72% of the annual total nitrogen loads delivered to the DBs in runoff, from reaching the lake. Soil infiltration of an estimated 43-63% of the annual surface runoff delivered to the DBs, was the main driver of these impressive sediment and nutrient loss reductions. Brian's research validated a critical mitigation strategy which will offer an important tool in reducing the impact of pastoral farming systems on water quality in New Zealand. Brian was supervised by Lucy Burkitt (Massey University), Dave Horne (Massey University), Leo Condron (Lincoln University) and Chris Tanner (NIWA) and the project was part of the Phosphorus Mitigation Project Inc. run by John Paterson. It's worth noting that Brian completed his PhD in 3 years and submitted his thesis during level 4 lockdown. Brian must also be commended for his dedication to publishing, with 1 paper published, 1 accepted and 3 submitted and under review from his PhD research. Brian even had time to engage in other activities (see our special on *Student's initiative: Spotlight on a Soil Scientist*, February 2020) coordinating a space for staff and students to share insights on life and science. One unforgettable moment of Brian's time at Massey was his active participation in performing CPR on a Massey faculty member, which resulted in saving the person's life. Brian has secured a post-doctoral position with Dr Kevin King from the USDA ARS in Columbus, Ohio, USA. All the best for this new adventure, Brian!

Manaaki Whenua – Landcare Research

Soil health

Bryan Stevenson and Garth Harmsworth continue to co-lead the soil health programme in Manaaki Whenua, *Soil health and resilience: oneone ora, tangata ora*. The science programme has three main strands: the science to understand soil resilience and soil health, a Māori theme on Māori perspectives of soil health and thirdly an integration theme bringing all the work together in a unified framework to support planning and policy and enhance long term soil health and resilience.

Soil health is an increasingly important topic as soils continue to be degraded globally and nationally, and environmental sustainability and standards, food production and human wellbeing become international and national priorities. Within New Zealand, we have continued to maintain and enlarge existing pathways and establish new opportunities with a large range of policy makers, sectors and industry groups, researchers and scientists, Māori and landowners.

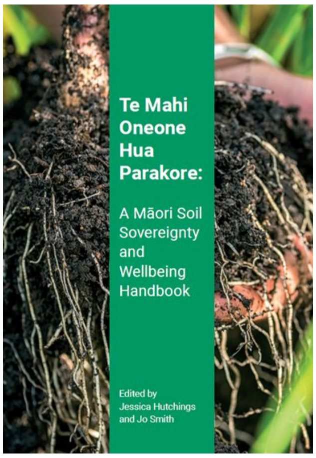
Defining soil health from a Māori world view

This research explores an understanding of soil health from a Te Ao Māori perspective. The research has engaged widely with Māori across Aotearoa-New Zealand. A large number of hui/workshops (wānanga), collaborative projects, and interviews have been carried out over the past 3 years and many interviews were transcribed and documented. This kaupapa Māori and mātauranga Māori based research (ancient, traditional, historic, contemporary knowledge) has been incorporated into a book, edited by Dr Jessica Hutchings (Ngāi Tahu, Ngāti Huirapa, Gujarati), Dr Jo Smith (Kāi Tahu, Kāti Māmoe, Waitaha) and Emma Johnson editor at Freerange Press Christchurch.
Since 2017 we have contracted a large number of Māori researchers into the soil health programme many who wrote chapters for the new book alongside our Manaaki Whenua Māori researchers.

Māori perspectives of soil health: a new book
The new book "Te Mahi Oneone Hua Parakore: A Māori Soil Sovereignty and Wellbeing Handbook" has been published within the soil health programme: Hutchings J and Smith J. 2020. Te Mahi Oneone Hua Parakore: A Māori Soil Sovereignty and Wellbeing Handbook. Christchurch, Free Range Press. ISBN 9780473516192. 187p.

The web link is:
https://shop.projectfreerange.com/item/pre-order-te-mahi-oneone-hua-parakore-a-mori-soil-sovereignty-and-wellbeing-handbook
The book gives a range of practical insights, illustrations and examples from across Aotearoa-New Zealand to demonstrate strong links between soil ecosystems, soil properties, soil health, food/kai, mana (authority, status, self-determination) and human wellbeing. It has brought many Māori researchers and practitioners together from many different fields of expertise, to develop a community of practice and build Māori capacity in soils, food security, Māori values, health and wellbeing. Please explore the web link to see chapter topics and authors.

Due to Covid-19, publication of the book was delayed in 2020. The book launch planned for Papatūānuku marae, Auckland, late August 2020 was again postponed.



Carbon sequestration by soils revisited

– Jock Churchman

Introduction
Given the seriousness of the climate emergency facing us all (hidden behind the Covid-19 alarm), I wonder if it is time for research on carbon sequestration in soils in New Zealand (and elsewhere) to be treated as mainly an academic topic? And there is nothing wrong with that; we need fundamental studies to advance our science[1].

However, it can hardly be justified as a possible significant solution to climate change. And the climate needs our urgent attention.

Climate emergency
(Sir) David Attenborough has said, in his latest film “we’ve not just ruined the planet, we’ve destroyed it”[2] and (Dame) Jane Goodall has said that “humanity is finished if it fails to adapt after Covid-19”[3], referring equally to the challenges of climate change. The top Australian climate scientist (Emeritus Professor Will Steffen of the ANU) has said, recently, that ‘collapse of civilisation is the most likely outcome’ of current human activity[4]. Temperatures are on the rise world-wide, terrible bushfires have raged in Australia and also California just this last year, island nations like Kiribati and Tuvalu are being swamped by rising oceans, and glaciers are melting everywhere. As well, cyclones are getting stronger by the year. To stress the urgency of the issue, the chief of the International Energy Agency has just (June 2020) stated “The world has only six months in which to change the course of the climate crisis”[5].

Carbon sequestration – history and principles
Carbon sequestration has been a major topic for soil researchers for some years now. Many members of our profession have proposed that soil organic matter (SOM) can be used as a “managed” sink for atmospheric carbon gases and particularly carbon dioxide. Rattan Lal, the recent President of the International Society of Soil Science (and latest awardee of the World Food Prize), has been one strong proponent of carbon sequestration in soils[6]. And our proposal has been heeded. Politicians and others in public life have seen carbon sequestration as a solution to the problems that increasing emissions of these gases cause for the climate. As examples, the NZ Listener carried a several-page feature on the topic (“Black gold: can soil save the climate”) in 2017[7] and the excellent Science Show on radio in Australia also featured it (“Soil carbon a ‘saviour’ in locking up carbon’) in 2017[8]. It is time to take a reality check to ask whether our claims can be justified. Does the answer really lie in the soil in this case?

The idea that carbon can be incorporated and sequestered (over a longer time) in soils is based on the apparently logical conclusion from world-wide observations of the draw-down of carbon (SOM) levels in soils as a result of agricultural practices. Some of these, e.g. annual cropping, are more destructive of carbon than others, e.g. pastures, but even pastoral farming generally lowers soil C levels relative to forestry, especially native forestry, that may have preceded it.

However, carbon draw-down over the years may also have accompanied loss of soil by erosion and the possibility of storing C also needs to consider the state of SOM in soils. SOM is generally associated with minerals in soils and it is a fallacy that these often-strong associations can be restored easily or quickly. Organic matter in soils is held by physico-chemical bonds (adsorption) to (clay) mineral surfaces or else incorporated and protected within microaggregates with these minerals. The strength of these associations varies in different soils, and volcanic soils containing highly reactive allophane attract and hold SOM particularly strongly[9]**.** Nonetheless, not all organic matter added to even highly reactive soils is retained for any length of time; there is an equilibrium and a portion is released immediately[10].

Carbon sequestration - prospects
Among the many publications on this topic, some attract because of their quirky titles. Possibly the quirkiest is for a 2013 review "The knowns, known unknowns and unknowns of sequestration of soil organic carbon"[11], which has 24 international authors. It points to the prospects and also the uncertainties of this "technology". More pointed, perhaps, is a 2017 review "Soil carbon 4 per mille"[12], which has 10 more (34) international authors. In both of these multi-authored papers, national summaries about the prospects for increasing C are given, but are mostly not very encouraging.

The 4 per mille proposal is an attractive aim, but one has to ask if it really can be achieved world-wide. It may be mainly "aspirational".
The reason given[12] for choosing the particular aim of 4 per mille, annually, for increases in C sequestration world-wide is that annual greenhouse gas emissions from fossil carbon are estimated as 8.9 giga tonnes and a global estimate of soil C stick to 2m of soil depth is 2400 giga tonnes. Their ratio is 4 per mille, the annual uptake of C by soils to enable the offset of about 30% of global gas emissions. There has been considerable criticism of this approach, most recently by Baveye this year (2020)[13]. French calculations in 2002 found that carbon sequestration in soils could only amount to about 1-2% of French greenhouse gas (CHG) emissions. Indeed, in 2014 they were found to only compensate for about 9% of the emissions resulting from agriculture.

The analysis of possibilities for increases in soil C for 20 countries has been carried out in relation to the 4 per mille proposal. They include New Zealand and Australia. These two neighbours have vastly different soils, geomorphology and climate, so represent a range of conditions for testing the possibility of carbon sequestration.

It is noted that New Zealand soils generally have high C contents. Some local increases in soil C have been measured at ~ 0.3-0.6 t C ha^{-1} $year^{-1}$. This sounds promising since the 4 per mille aim requires an increased rate of ~0.4 t C ha^{-1} $year^{-1}$ but losses from erosion and draining wetlands have also been measured. The best prospects may lie in the creation of wetlands.

For Australia, with generally much lower concentrations of soil C than NZ, the 4 per mille aim requires an increase of 0.22 t C ha^{-1} $year^{-1}$. Local increases in C of this order have been found to occur as a result of the imposition of management changes such as to stubble retention and reduced tillage. However, the idea of implementing C sequestration at desirable rates over large parts of the continent would ultimately fail because of the paucity of rainfall (which is probably getting worse).

To understand the capacity of soils for C sequestration, it is important to realise the way that soils take up gases, particularly CO_2. CO_2 is added to soils through the growth and subsequent decomposition of plants. This constitutes sequestration only if the new SOM thus created is held in the soils for a long time, several decades at least.

Carbon sequestration - effectiveness
Uptake of C in soils does not necessarily constitute its sequestration. A better prospect for removal of C from the atmosphere, although only short-term, is through enhancing plant growth. Indeed, a major role of SOM is to enhance plant growth. And we (the planet) do need to increase plant growth where this is possible. The seven, rising soon to ten, billion people need to continue to be fed. Soil science is a key to the achievement of this important aim. Under the heading, “We’re treating the soil like dirt. It’s a fatal mistake, as our lives depend on it”, leading environmental journalist , George Monbiot, wrote, in 2015, “War, pestilence, even climate change, are trifles by comparison. Destroy the soil and we all starve”[14].

There has been much debate about whether sequestration of C is even desirable. Janzen in 2006[15], published a ‘point-of-view’ paper with the questioning title “The soil carbon dilemma: Shall we hoard it or use it?”, followed by a review paper in 2015 with an answering title “Beyond soil sequestration: soil as a conduit of solar energy”[16]. More recently (2019), Chenu and others[17] argue that our aim should be to increase soil organic stocks, ‘carbon storage’, rather than carbon sequestration, i.e., withdrawal of carbon.

Carbon sequestration has been good for soil science. This is a time of rapid acceleration in the number of research publications on soil organic carbon (SOC) largely as a result of its pursuit. Tracking two search engines (‘Scopus’ and ‘Web of Science’), McBratney and co-workers[18] found that there had been a rise from ~200 publications on SOC per year in the year 2000 to around 1000 per year in 2012 and the trend is a rising one.

Now, however, there is a need to face up to the small contribution, if any, that efforts to sequester C in soils can make to the mitigation of climate change. It is problematic for a number of reasons besides those already mentioned here. They include the probability that C can be released from soils by the warming that is taking place through global climate change[19]. They also entail the difficulty of measuring changes in soil C[11]. Some have proposed that solid organic wastes can be added to soils to enhance C sequestration. But this ignores that these wastes already sequester C so their addition to soils provides no net gain in C removal from the atmosphere[20]. Further, soils have a limited capacity for organic C[21]. The idea proposed in the aspirational goal of 4 per mille is that C is continually sequestered in soils from GHGs which continue to be produced by society. Baveye's 2020 opinion piece[13] concludes that "a 0.4% annual increase in soil carbon worldwide, over a sufficiently long time frame, is absolutely unattainable". He further argues that there is a risk that "the hype about the potential of carbon sequestration in soils could cause further inaction about climate change".

Solutions to climate emergency

Fixing the climate emergency is not an academic goal. It is an urgent aim to preserve the future of our "Goldilocks" Earth with its biodiversity and as a sustainable home for burgeoning humanity. It challenges us personally, technologically (and also agriculturally) and also institutionally. With its increasing urgency, it calls on us to make the big changes -technological, agricultural and institutional first, while not forgetting the personal aspect; that is for each of us to determine and rationalise.
For the big changes, we need to consider each society or country. Everywhere, the generation of energy and its use need rapid changes. For energy generation, the surge in the availability (and reasonable costs) of renewables, like rooftop – and other- solar, and wind generation, has been remarkable.

As Dr Alan Finkel, Australia's Chief Scientist, wrote in 2019[22], "Energy is the foundation of civilisation. To meet future demand while avoiding the by-products of our current energy sources we have to find alternatives." He went on to point to specifics, including a hope for the near future, writing "these will be a mix of primary energy sources such as solar and wind electricity, and secondary energy carriers, of which hydrogen will make an essential contribution as a high-density, zero-emissions fuel". Of course, there are other primary renewable sources, such as hydro-electric and geothermal power, respectively important and useful in New Zealand.

Even so, it is the generation of transport fuels that is probably most challenging. Electric vehicles are coming in greater numbers, but they do rely on sustainable generation of electricity for their viability.

The main challenge overall is to replace fossil fuels – coal, oil and natural gas. As a "transitional" fuel only, gas may be reluctantly tolerable over a short term.

New Zealand is a special case where an important and damaging component of CHGs, methane, is a major contributor to the total amount of CHGs generated. Agricultural emissions (which include nitrous oxide from pastures) make up 48 per cent of New Zealand's emissions today[23]. They have increased 17 per cent since 1990, consistent mainly with the growth of the national cattle stock. Their abatement within a pastoral farming system is a challenge – almost a wicked problem[24].

There could be a (relatively minor) place for the extraction of GHGs. This may be done through tree planting, albeit that land for food production should not be sacrificed. In Australia, tree planting is not a very favourable option following this year's disastrous and widespread bush fires.

CHGs may also be held, to an extent, in seaweed and in mangroves[25], among other natural sinks. And technological methods – CCS (carbon capture and storage)[26] and CCU (carbon capture and utilisation)[27] continue to be proposed, albeit both expensive and mostly untested. Both deal with point sources of CO2, rather than dispersed sources such as transport. Just to hand as I was writing this I heard about a new technology for the use of CO2 (by CCU) with water for generating synthetic fuel (e-fuel) to achieve climate neutral transportation[28]. This raises the possibility of extraction of harmful emissions (of CO2) to provide transport fuels with greatly reduced emissions. For example, emissions from aircraft would be cut by ~50%, giving at least a transitional transport fuel. There is room for optimism, and research goes on!

Conclusions

Soils are not a proven long term receptacle for greenhouse gases to act as a means of substantially limiting climate change as we run out of time to prevent disastrous – and permanent - climate change. The answers lie in the soil when it comes to (eventually) solving global hunger, but they lie elsewhere when it comes to (urgently) solving climate change.

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Abstracts

Soil sensing technology improves application of irrigation water

El-Naggar, A. G., Hedley, C. B., Horne, D., Roudier, P., and Clothier, B. E.
Dynamic irrigation scheduling for Variable-rate irrigation systems is essential to accurately estimate the spatiotemporal pattern of irrigation water requirement. Real-time, sensor-based and soil-water balance scheduling methods were compared on a trial under a Variable-rate center pivot irrigation system. The soil-water balance scheduling used the FAO56-ET model to calculate daily soil-water deficits and to determine crop water requirements using climate data from a local climate station. The sensor-based scheduling system used a wireless soil moisture sensing network to trigger irrigation when soil water deficit reached a critical value in a web-based user interface. The scheduling was conducted on pea and French bean crop trials under one center pivot, with two delineated irrigation management zones at Massey University's No.1 Farm, Palmerston North, New Zealand. The results showed variation between the two scheduling methods where the soil water balance assumed that the soil is well drained. The sensor-based scheduling technique delivered 27–45% less water. As there were no significant crop growth and yield differences between the two approaches, irrigation-water-use efficiency was greater under the sensor-based scheduling regime. Further research is planned to assess the feasibility of including this monitoring system in a precision irrigation control system.

El-Naggar, A. G., Hedley, C. B., Horne, D., Roudier, P., Clothier, B. E. (2020). Soil sensing technology improves application of irrigation water. Agricultural Water Management, 228, 105901. https://doi.org/10.1016/j.agwat.2019.105901

Contrasting subsurface denitrification characteristics under temperate pasture lands and its implications for nutrient management in agricultural catchments

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Subsurface denitrification plays a key role in the reduction or 'attenuation' of nitrate contamination of groundwater and surface waters. We investigated subsurface denitrification characteristics in the vadose zone and shallow groundwater at four sites under pastoral farming in the Manawatū River catchment, located in the lower part of North Island, New Zealand. The denitrification potential of the vadose zone was determined by the laboratory incubation assays measuring the denitrifying enzyme activity (DEA) in soil samples collected from different soil horizons (up to 2.1 m below ground surface), whereas denitrification rates in shallow groundwaters were measured in situ by single-well, push-pull tests conducted in piezometers installed at multiple depths at the study sites. Soils and underlying geology, defining hydrogeologic settings, appear to influence the spatial variability of subsurface denitrification characteristics at the study sites. Where the vadose zone is thin and composed of coarse-textured soils, percolation of nitrate was evident in observed high nitrate-nitrogen concentrations (>5 mg L^{-1}) in oxic and young shallow groundwaters, but low nitrate-nitrogen concentrations (<0.05 mg L^{-1}) were observed in the reduced shallow groundwater found underneath the fine textured soils and/or a thick vadose zone. This was confirmed by the push-pull tests measuring denitrification rates from 0.08 to 1.07 mg N L^{-1} h^{-1} in the reduced shallow groundwaters (dissolved oxygen or DO < 0.5 mg L^{-1}), while negligible in the oxic groundwaters (DO > 5 mg L^{-1}) found at the study sites. These contrasting subsurface denitrification characteristics determine the ultimate delivery of nitrate losses from agricultural soils to receiving waters, where the fine textured thick vadose zone and reducing groundwater conditions offer nitrate reduction in the subsurface environment.

Journal of Environmental Management, 272, 111067.

Increasing phosphorus solubility by sintering igneous Dorowa phosphate rock with recycled glass

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The lack of low-cost phosphorus fertilizers is a major limitation for food production on Zimbabwe’s many smallholdings. A thermally fused magnesium phosphate could be manufactured from the local Dorowa phosphate rock (PR) but would be expensive because of the high cost of required additives and energy. This paper investigates the phosphorus solubility of mixtures of igneous Dorowa PR with either recycled glass or magnesium silicates, before and after thermal alteration at sub-fusion temperatures. The thermal behavior and chemical transformation of Dorowa PR and various additives were investigated by thermo-gravimetric and differential scanning calorimetric analysis and X-ray powder diffraction. Thermal transformation of Dorowa PR + serpentine and Dorowa PR + dunite mixtures resulted in decomposition of calcite, kellyite, lizardite, and chrysotile present in the original mixtures and recrystallization of dehydroxylated metachrysotile to forsterite. The final products of air-cooled Dorowa PR + glass mixtures sintered at 1173 K contained ahrensite ($Fe_2(SiO_4)$), wollastonite ($CaSiO_3$), quartz (SiO_2), and hydroxy-fluorapatite. Compared to the unamended Dorowa PR, thermal alteration of Dorowa PR + glass mixtures at 1173 K led to a 62%, 73%, and 44% increase in citric soluble phosphorus when mixed at 1:2, 1:1, and 2:1 (Dorowa PR:glass), respectively. This increase in the citric soluble phosphorus content increases the agronomic value of Dorowa PR and is likely the result of substitution of $PO^{3-}{}_4$ in hydroxy-fluorapatite by $SiO^{4-}{}_4$ and or Mg^{2+}/Na^{+} for Ca^{2+} and Fe^{2+}.

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Nitrate removal and secondary effects of a woodchip bioreactor for the treatment of subsurface drainage with dynamic flows under pastoral agriculture

Rivas, A., Barkle, G., Stenger, R., Moorhead, B. Clague, J.

While enabling economically viable use of poorly drained soils, artificial subsurface drainage has also been found to be a significant pathway for nutrient transfers from agricultural land to surface waters. Thus, mitigating the impacts of agriculture on surface water quality needs to address nutrient transfers via subsurface drainage. Woodchip bioreactors are a promising mitigation option as demonstrated under arable agriculture in the idwest of the USA. However, research is needed to ascertain their efficiency in removing nutrients from very flashy drainage flows common in New Zealand (NZ) pastoral agriculture and any possible pollution swapping (e.g. reduction of leaching losses vs. greenhouse gas emissions). Accordingly, a lined 78-m3 woodchip bioreactor was constructed on a dairy farm in the Hauraki Plains (Waikato, NZ) with a drainage area of 0.65 ha. Rainfall, flow, hydrochemistry and dissolved gases in the inflow and outflow were monitored for two drainage seasons (part of 2017, 2018). Based on the nitrate-N fluxes, the estimated

nitrate removal efficiency of the bioreactor was 99 and 48% in 2017 and 2018, respectively. The higher removal efficiency in 2017 could be attributed to two reasons. Firstly, the substantially longer hydraulic residence time (HRT) of the water in the bioreactor (mean = 21.1 days vs 4.7 days in 2018) provided more opportunity for microorganisms to reduce the nitrate. A strong positive relationship between HRT and removal efficiency was also observed within the 2018 drainage season. Secondly, denitrification was supported in 2017 by greater electron donor availability. Evidence of this was the higher mass of DOC discharge from the bioreactor (318 mg C L-1 of bioreactor volume vs 165 mg C L-1 in 2018). Removal rates in the bioreactor varied from 0.67–1.60 g N m-3 day-1 and were positively correlated with inflow nitrate loads. Pollution swapping was observed during the start-up phase of the bioreactor in both years (DOC, and DRP only in 2017) and during periods with very long HRTs (hydrogen sulphide (H_2S) and methane (CH_4) production). Substantially elevated discharges of DOC and DRP, as compared to inlet conditions, occurred during the initial start-up phase of the bioreactor in 2017 (3 to 3.5 pore volumes of the bioreactor), but only slightly elevated DOC and decreased DRP discharges were observed when drainage flow resumed at the start of the 2018 drainage season. Unexpectedly, cumulative DRP removal during the 2018 drainage season amounted to 89% of the DRP inflow into the bioreactor. Long HRTs (> 5 days) enabled high nitrate removal efficiency (≥59%) and promoted complete reduction of nitrate to harmless dinitrogen gas but also promoted strongly reduced conditions, resulting in the production of H_2S and CH_4. On the other hand, short HRTs (< 4 days) only allowed for moderate nitrate removal efficiency (≤43%) and constrained complete reduction of nitrate resulting in higher nitrous oxide concentrations in the outflow as compared to the inflow. Thus, nitrate removals above 50% were not able to be achieved without inducing H_2S and CH_4 generation. However, it may be achievable when the microbial community is provided with an additional source of readily available carbon during the critical periods when hydraulic flow and concomitant N load peaks occur.

Rivas, A., Barkle, G., Stenger, R., Moorhead, B. Clague, J., (2020) Nitrate removal and secondary effects of a woodchip bioreactor for the treatment of subsurface drainage with dynamic flows under pastoral agriculture. Ecological Engineering 148 (2020) 105786. (https://doi.org/10.1016/j.ecoleng.2020.105786)

Likely controls on dissolved reactive phosphorus concentrations in baseflow of an agricultural stream
McDowell, R.W., Depree, C., Stenger, R.

Purpose High baseflow phosphorus (P) concentrations increase the likelihood of periphyton blooms. Several physical and chemical factors can control baseflow P concentrations such as hydraulic exchange with groundwater, particle size-sorting, redox chemistry and different sediment sources. We hypothesized that of these sources, anoxic sediments would allow P-rich groundwater to influence baseflow P concentrations the most and that the measurement of the equilibrium P concentration (EPC0) of sediments under oxic conditions would not predict P release in anaerobic sediment or baseflow P concentrations.

Materials and methods At four locations along an agricultural stream, we measured dissolved reactive P (DRP), pH, iron, manganese, sulphate, nitrate and dissolved oxygen in streamflow and hyporheic water at 0–200, 200–400 and 400–800 mm depths and P fractions and EPC0 in sediment samples from the 0–200, 200–400 and 400–800 mm depths.

Results and discussion Concentrations of DRP in streamflow and shallow hyporheic zone water increased downstream and were mirrored by concentrations in shallow sediment, EPC0 measurements of oxic sediments and deeper hyporheic waters. Groundwater samples and the EPC0 in deeper sediments did not show a pattern or residence time consistent with the supply of P to baseflow despite deeper sediment being anoxic and less likely to sorb upwelling P. There was also no change in pH or particle size downstream ruling out the degassing of groundwater or sediment size-sorting as an influence. However, the composition of sediment and underlying lithology of the catchment pointed to sediment downstream that was different to upstream sediment in that it could store and release more P.

Conclusions Given the strong influence of sediment source on baseflow P concentrations, efforts to decrease the likelihood of periphyton blooms under baseflow should focus on reducing the erosion of P-rich sediment. Furthermore, the presence of oxic conditions in surface sediment meant that there was a relationship between EPC0 and hyporheic water P concentrations. However, mixed oxic/anoxic conditions in deeper layer may require EPC0, or release rates, to be measured under reducing conditions.

McDowell, R.W., Depree, C., Stenger, R. (2020) Likely controls on dissolved reactive phosphorus concentrations in baseflow of an agricultural stream. Journal of Soils and Sediments (https://doi.org/10.1007/s11368-020-02644-w)

Contrasting subsurface denitrification characteristics under temperate pasture lands and its implications for nutrient management in agricultural catchments
Rivas, A., Singh, R., Horne, D.J., Roygard, J., Matthews, A., Hedley, M.J.

Subsurface denitrification plays a key role in the reduction or ‘attenuation’ of nitrate contamination of groundwater and surface waters. We investigated subsurface denitrification characteristics in the vadose zone and shallow groundwater at four sites under pastoral farming in the Manawatu River catchment, located in the lower part of North Island, New Zealand. The denitrification potential of the vadose zone was determined by the laboratory incubation assays measuring the denitrifying enzyme activity (DEA) in soil samples collected from different soil horizons (up to 2.1m below ground surface), whereas denitrification rates in shallow groundwaters were measured in situ by single-well, push-pull tests conducted in piezometers installed at multiple depths at the study sites. Soils and underlying geology, defining hydrogeologic settings, appear to influence the spatial variability of subsurface denitrification characteristics at the study sites. Where the vadose zone is thin and composed of coarse-textured soils, percolation of nitrate was evident in observed high nitrate-nitrogen concentrations (>5 mg L 1) in oxic and young shallow groundwaters, but low nitrate-nitrogen concentrations (<0.05 mg L 1) were observed in the reduced shallow groundwater found underneath the fine textured soils and/or a thick vadose zone. This was confirmed by the push-pull tests measuring denitrification rates from 0.08 to 1.07 mg N L 1 h 1 in the reduced shallow groundwaters (dissolved oxygen or DO < 0.5 mg L 1), while negligible in the oxic groundwaters (DO > 5 mg L 1) found at the study sites. These contrasting subsurface denitrification characteristics determine the ultimate delivery of nitrate losses from agricultural soils to receiving waters, where the fine textured thick vadose zone and reducing groundwater conditions offer nitrate reduction in the subsurface environment.

Rivas, A., Singh, R., Horne, D.J., Roygard, J., Matthews, A., Hedley, M.J. (2020) Contrasting subsurface denitrification characteristics under temperate pasture lands and its implications for nutrient management in agricultural catchments. Journal of Environmental Management 272 (2020) 111067. (https://doi.org/10.1016/j.jenvman.2020.111067)

High-frequency, in sit sampling of field woodchip bioreactors reveals sources of sampling error and hydraulic inefficiencies
Maxwell, B.M., Birgand, F., Schipper, L.A., Barkle, G., Rivas, A.A., Helmers, M.J., Christianson, L.E.

Woodchip bioreactors are a practical, low-cost technology for reducing nitrate (NO3) loads discharged from agriculture. Traditional methods of quantifying their performance in the field mostly rely on low-frequency, time-based (weekly to monthly sampling interval) or flow-weighted sample collection at the inlet and outlet, creating uncertainty in their performance and design by providing incomplete information on flow and water chemistry. To address this uncertainty, two field bioreactors were monitored in the US and New Zealand using high-frequency, multipoint sampling for in situ monitoring of NO3–N concentrations. High-frequency monitoring (sub hourly interval) at the inlet and outlet of both bioreactors revealed significant variability in volumetric removal rates and percent reduction, with percent reduction varying by up to 25 percentage points within a single flow event. Time series of inlet and outlet NO3 showed significant lag in peak concentrations of 1–3 days due to high hydraulic residence time, where calculations from instantaneous measurements produced erroneous estimates of performance and misleading relationships between residence time and removal. Internal porewater sampling wells showed differences in NO3 concentration between shallow and deep zones, and “hot spot” zones where peak NO3 removal co-occurred with dissolved oxygen depletion and dissolved organic carbon production. Tracking NO3 movement through the profile showed preferential flow occurring with slower flow in deeper woodchips, and slower flow further from the most direct flowpath from inlet to outlet. High-frequency, in situ data on inlet and outlet time series and internal porewater solute profiles of this initial work highlight several key areas for future research.

Maxwell, B.M., Birgand, F., Schipper, L.A., Barkle, G., Rivas, A.A., Helmers, M.J., Christianson, L.E. (2020) High-frequency, in sit sampling of field woodchip bioreactors reveals sources of sampling error and hydraulic inefficiencies. Journal of Environmental Management 272 (2020) 110996. (https://doi.org/10.1016/j.jenvman.2020.110996)

Conferences

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

Eurosoil 2020 has been postponed and will take place in Geneva (Switzerland) in **23-27 August 2021**. 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 policy 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 Sustainable Development Goals (SDGs) of the United Nations. https://eurosoil2020.com/.

The joint Australia New Zealand Soil Science Society Conference that was scheduled for December 2020 in Cairns has now been moved to **June 27 - 4 July 2021**. For further updates see the conference website https://www.soilscienceaustralia.org.au/2021-joint-conference/. The meeting will be held then, regardless, and a virtual online option will be available.

World Soils Day Celebration 4 December 2020

Please keep the 4th of December free to join our World Soils Day celebration and to participate in the NZSSS awards and BGM. We plan to hold an on-line webinar with three top speakers, in collaboration with our Australian colleagues. Presuming we are back to level one we will hold events at Waikato, Massey, and Lincoln to watch the webinars and participate in the BGM. There will be some appropriate refreshments and a chance for social networking, as a change from the social distancing that we are currently experiencing.

Make a note in your diaries: LuWQ 2021 has a new date!

International Interdisciplinary Conference on
Land Use and Water Quality
Agriculture and the Environment
Maastricht, the Netherlands
Now scheduled for: 13th - 16th Sep 2021
Abstracts due by 8th Feb 2021

https://www.luwq2021.nl/

NZSSS Conference 2022

Plans are underway for our regular NZ Soil Science conference to be held in Blenheim in the last week of November, 2022. If you are interested in helping on the organising committee for that meeting please contact our current society president megan.balks@earthbrooke.co.nz or vice president Timothy.clough@lincoln.ac.nz

Deadline.............. For the November 2020 issue of Soil News is Friday 20 November

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