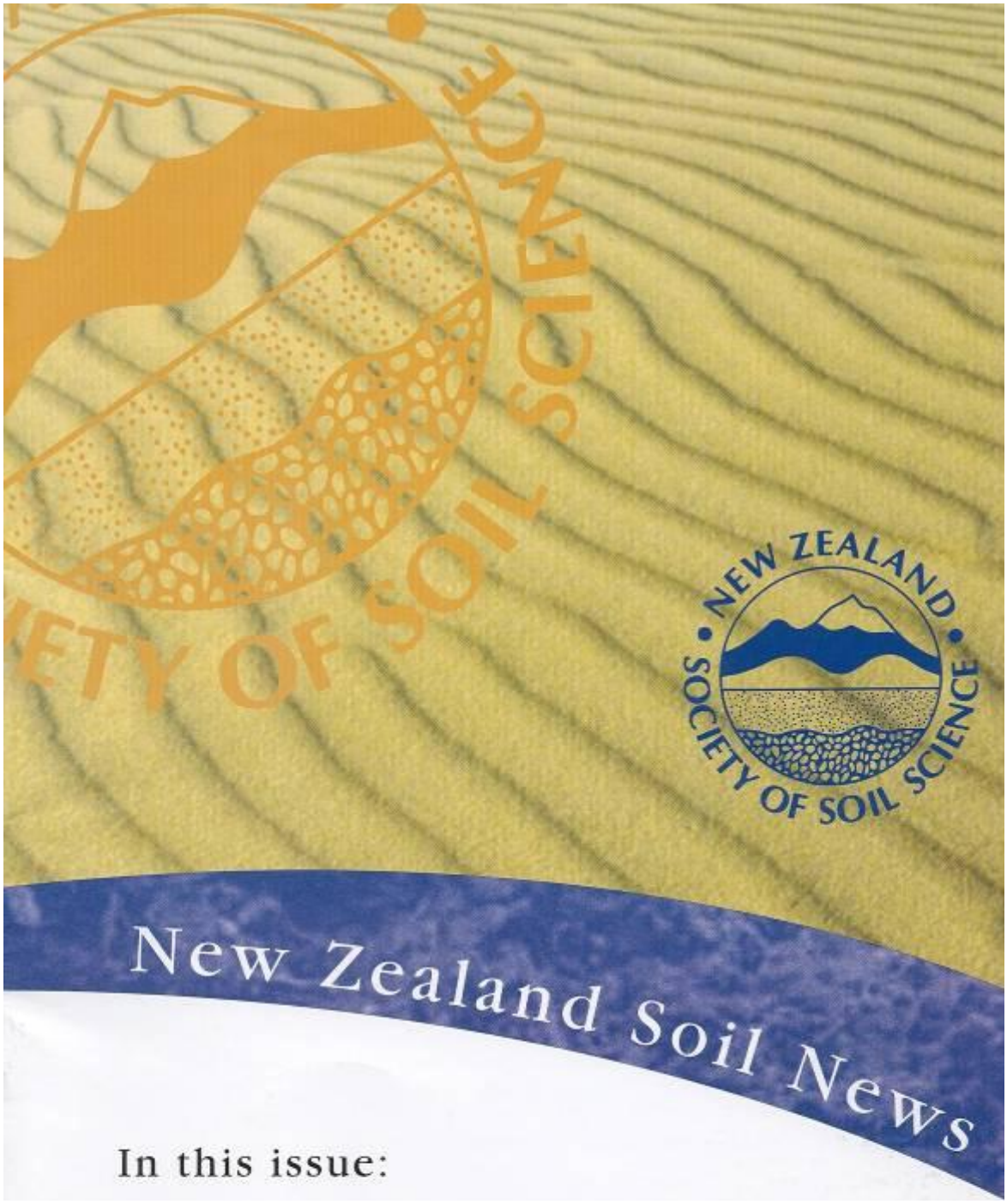

- **Editorial – The Regional Council Soil Scientist – Reece Hill**
- **Outcomes of the Second Plenary Assembly of the Global Soil Partnership**
- **IUSS pre-congress Japan Volcanic Soil Tour**

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New Zealand Soil News

Newsletter of the New Zealand Society of Soil Science

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Contents

			Page
Editorial	The Regional Council Soil Scientist	*Reece Hill*	128
NZSSS	Conference Update		129
	Soils as Art		129
Article	Outcomes of the Second Plenary Assembly of the Global Soil Partnership	*Marta Camps*	131
Article	IUSS pre-congress Japan Volcanic Soil Tour	*Megan Balks*	132
IUSS	App for World Reference Base for Soil Resources		134
	New publications		134
ASA-CSSA-SSSA			136
Soil Science Australia	News from Soil Crumbs		137
The Dirt			138
News from the Regions			139
Abstracts			147
P Roudier *et al*	Soil visible near-infrared spectroscopy: lessons from the field		
P Pal *et al*	Animal treading damages pastures and affects soil nitrous oxide emissions		
C Ross et al	Disposing greywater on land in a New Zealand coastal community		
K Bryan & D Lowe	How the Marsden Fund has failed to achieve its full potential in the ESA Panel: evidence of limitations in scope, biased outcomes and futile applications		
D Curtin *et al*	Mineralization of soil carbon and nitrogen following physical disturbance: a laboratory assessment		
T van der weerden *et al*	Spatial and temporal nitrous oxide emissions from dairy cattle urine deposited onto grazed pastures across New Zealand based on soil water balance modelling		
H Steppuhn *et al*	Effects of chloride- and sulphate-dominated solutions on the salinity tolerances of barley, canola, tall and green wheatgrasses		
C de Klein *et al*	The effect of nitrogen concentration in synthetic cattle urine on nitrous oxide emissions		
Syers Abstracts	The lifetime contributions of Professor J Keith Syers to International Soil Science – A memorial symposium, held in South Korea		152
Conferences			160

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

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Deadline..... for the **October** issue of Soil News is **Friday 17th October 2014**

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New Zealand Soil News

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New Zealand Society of Soil Science Officers 2012–2014

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Editorial – The Regional Council Soil Scientist

by Reece Hill, Soil Scientist, Waikato Regional Council

Without realising it, I have reached 15 years working as a Soil Scientist at regional council. The role has involved working on a great range of soil and land projects, across industry sectors and alongside numerous researchers – a council Soil Scientist has to be a generalist and a science translator. With my regional council apprenticeship well underway I can now take the opportunity to reflect on the way in which soil science in local government has changed over that period; the resourcing, some key achievements as well as where we are heading. There have been a number of key developments over the years.

It is a little difficult to ascertain exactly how many fully dedicated soil scientists there were and are. This is because many councils have scientists working across several areas. Most commonly, soil conservation land management officers fill the soil scientist role monitoring soil quality and maybe even water and air quality. However, in general regional councils have increased the resourcing of dedicated soil scientists. From just a few (with some being part time), the pool is now around eight. As a result the capacity and range of soil science knowledge in councils has improved.

Several key happenings over the past decade have helped promote soil science in councils and several current initiatives continue to grow recognition of the importance of soil science.

One achievement has been the now well-established soil quality monitoring programmes across regional councils. The 500 Soils project led by Landcare Research paved the way, developing a national approach for councils to identify soil quality issues relating to soil management on a range of land uses and soils across the majority of New Zealand. From an initial 500 sites, the dataset has grown to more than 1500 sites nationally, including sites that have been sampled three times at five-yearly intervals. This data underpins national and State of Environment (SOE) reporting by regions. It has been invaluable for policy development and education for land managers on aspects of soil management. It has also provided background information for new research including soil ecosystems services and assessment of cadmium in New Zealand soils, contributing to the establishment of the Cadmium Management Group.

The Land Monitoring Forum (a soil science-focussed regional council special interest group) has developed national guidelines for SoE monitoring, compiled in the publication “Land and Soil Monitoring: A guide for SoE and regional council reporting”. The guidelines include methods for monitoring soil quality, soil stability and soil trace elements. These guidelines have proven to be a valuable resource for smaller councils and councils starting up soil monitoring programmes. Currently eleven regions have soil quality monitoring programmes.

The introduction of regional council-focussed Envirolink funding, has expanded the scope of applied research topics, spurring on the development of monitoring methods, the support to S-map and models such as the Catchment Land Use Environmental Scenarios (CLUES) and Overseer nutrient budgets. Since 2006 council soil scientists have worked alongside research providers on topics including soil quality indicators, land fragmentation, S-map and soil ecosystem services. More than $2 million in Envirolink funding has been utilised on applied soil science projects.\

Two drivers of demand for soil science in New Zealand are primary production and environmental sustainability (keeping soil on the land and out of the water). The recent push for soil science to inform water quality (via the National Policy Statement for Freshwater Management) is needed but we should not lose sight of the importance of retaining soil on the land, valuing that land and managing it wisely into the future. This work plays an important role in farm profitability - tapping into the soil’s potential to increase profitability by improving long term soil management practices. The move towards “whole farm plans” incorporating soil conservation, nutrient management and farm economics is a positive approach to achieving these goals.

In both the regional council and industry spaces there is an increasing demand for farm planning approaches to continue soil conservation and meet the needs of the National Policy Statement for Freshwater Management (e.g. Horizons Whole Farm Plans and Environment Canterbury’s Farm Environment Plans). This resurgence provides opportunities, with new technology helping to combine nutrient, erosion, water quality and farm economic information to benefit production and environment. All contributors face challenges associated with farm scale data, attaining skilled personnel, applying

consistent approaches, obtaining sufficient funding and ensuring the implementation of plans. Consistent data and protocols for its application are essential to make progress towards the NPS freshwater management goals and monitor the effectiveness of policy comparatively across regions and nationally.

Current initiatives are working towards robust policy for soil management and supporting the National Policy Statement for Freshwater Management driven requirements for farm nutrient plans and regulation. Specific priorities for soil science include retaining high class soils; preventing land fragmentation; supporting ecosystem services; coverage, quality and interoperability of S-map; improved land use information; improving soil quality indicators and improving erosion and sediment generation data for modelling.

Despite new technologies (including digital soil mapping, GPS-informed mapping, the use of unmanned aerial vehicles (UAVs or drones) and satellite imagery) there is still a need for fundamental soil science skills such as soil chemistry and pedology to interpret new data and understand how to apply new approaches to soil mapping appropriately and use this data in models. During a recent farm mapping exercise, I was reminded of the complexity associated with soil description and classification. Although council and industry are working with researchers to boost land managers' soil knowledge, there remains a strong reliance on soil scientists with robust skills.

I have come to realise the importance in working together across councils, given the limitations of individual council resources and to make the best use of our combined soil science skills and knowledge. Collaboration with researchers, non-government organisations and central government ministries (DoC, MfE, MPI and MBIE) and industry is equally vital. All parties have important roles to play in a continuum from robust science, through to workable and well-guided policy and effective implementation and uptake. The involvement of soil scientists will ensure more robust science-based outcomes.

More recently, council soil scientists have been working with researchers through the recently formed National Land Resource Centre (NLRC) and Soil and Land Use Alliance (SLUA) to develop a strategic roadmap for land and water research (Collins et al., 2014). The document builds on an earlier science strategy for regional councils and a project report "Alignment of Land Special Interest Groups and the NLRC Priorities" (Weeks and Collins, 2013). The overall approach is to develop a long-term land and soil research strategy that considers both immediate and long-term issues, bridges the science-implementation gap, works across the land and water domain and promotes collective collaborative efforts between council and researchers.

Regional council Land Special Interested Groups representing soil and land are also working alongside Crown Research Institutes through the NLRC, with the thinking that a soil strategy could guide our way forward. A nationally co-ordinated vision of soil and land use could avoid collision of land-use and lead us into some more robust views about the value of our soils. Together with NLRC we are moving towards a plan for that vision.

National papers such as "Land: Competition for future use" (Mackay et al., 2011) and the overseas adoption of soil strategies (e.g. Safeguarding our Soils - A Strategy for England) over recent years have led the way towards recognition that a national soil science strategy would benefit New Zealand's investment in its land. A recent call for a soil management review by the Ministry of Primary Industry and the changes afoot via the Environmental Reporting Bill (and its indicators) are steps towards a more co-ordinated policy direction.

A collaborative approach including community, primary sectors, local government and central government can only help us all get on the same page with regard to the value of our soils.

Given the growing focus on better land management and increasing productive demands on our finite land and soil resources, demand for soil scientists in all areas is rising. Soil scientists and practitioners are a limited commodity; I would even go as far to say that they are becoming hot property. Soil science continues to play a vital role in maintaining a vibrant productive economy.

A.D. Mackay, S. Stokes, M. Penrose, B. Clothier, S.L. Goldson and J.S. Rowarth (2011) Land: Competition for future use. *New Zealand Science Review Vol 68 (2).* pp 67-71.

Collins A., Weeks E.S., Leckie C., Stokes S. and Hill R. (2014) Strategic *Roadmap for Land and Water Research*. National Land Resource Centre, Landcare Research, Palmerston North.

Weeks E.S. and Collins A. (2013) *Alignment of Land Special Interest Groups and the NLRC Priorities*. National Land Resource Centre, Landcare Research, Palmerston North.

NZSSS Conference Update

2014 NZSSS Conference update

Final call for abstracts

A reminder that the deadline for abstracts for the 2014 NZSSS conference is September the 1st. The conference will be held at the University of Waikato from December 1 to 4 with a theme of 'Soil science for future generations'. We are encouraging abstracts from any related soil topic. The list below covers our suggested themes; however final conference themes will be determined by the scope of abstracts received. More information about the conference and the abstract submission process can be accessed from the conference web link. http://www.nzssconference.co.nz/

- Education, outreach, extension, employment/career advice
- Catchment-scale soil water management
- International influences – global food, water scarcity, regulatory requirements
- Soil carbon and greenhouse gasses
- Soil contamination and remediation
- Soil ecosystems/biology
- Soil fertility, nutrient management and plant nutrition
- Soil quality and function
- Soils in the landscape (pedology) – past, present and future
- Soil water management
- Sustainable management – paddock to catchment scales
- Valuing natural capital (ecosystem services)

Launch of twitter

The NZSSS conference is now on **Twitter**. You can follow us @NZSSS2014 for updates, fun facts and related news. If you have any comments, photos or questions about the conference please tag them with #NZSSS2014.

NZSSS – Soils as Art

Soils as Art: Call for expressions of interest from the soil science community

Art is potential a means of engaging an audience with the importance, variety, and beauty of soils, that may not be much interested in soil science. We are planning to hold an exhibition of soil-related art works, *created by YOU the soil science community*, in conjunction with the NZ Society of Soil Science conference in Hamilton in December 2014. We want to share our love of soils and show the wider world that scientists are multi-talented people who are about a lot more than white coats and "incomprehensible" conversations. To make this a success we need you to contribute.

We are interpreting art-works in the widest possible sense. The artwork may be any media and any size (within reason). Media may include photography, drawing, painting, printmaking, sculpture, textiles or artwork made from soil itself. The artwork should relate to, or feature, soil in some way. You may have a great photo or two, paintings that feature or have some connection with the soil/earth, sculptures made from clay or other soil materials…, soil peels, poems, posters – we are open to your suggestions.

The exhibition will be on display-panels and tables in the NZSSS conference venue for the duration of the Conference from 1st-5th December 2014.

If you are interested in further information or have some art/sculpture work that you would like to exhibit please can you email either Megan Balks (m.balks@waikato.ac.nz) or Peter Singleton (peter.singleton@waikatoregion.govt.nz) so we can plan in more detail. We will be looking for final confirmation of contributions in October. So get your thinking caps on and your pencils sharpened – the more contributions we have the better it will be!

Article – Outcomes of the Second Plenary Assembly of the Global Soil Partnership – by Marta Camps Arberstain, Massey University

The second meeting of the Plenary Assembly of the Global Soil Partnership (GSP) was held in Rome at FAO headquarters on 22-24 July 2014. The session was well attended, with noticeably more participants from non-governmental partners, which is a positive sign of expanding GSP outreach. The Assembly took note that the Intergovernmental Technical Panel of Soils (ITPS) had held two sessions (in July 2013 and April 2014; Photo 1) since it was established in June 2013.

Photo 1. ITPS members at the second ITPS session in Rome in April 2014.

The major achievement of the Plenary Assembly session was the approval of four Plans of Actions under the GSP Pillars, previously endorsed and transmitted by the ITPS, after a revision process through which more strategic and consolidated recommendations were agreed (pillar 1, pillar 2, pillar 4 and pillar 5). The next step will be the development of the implementation plans. These plans will require substantial financial support, and thus highly focused resource mobilization efforts will need to be put in place through the Healthy Soils Facility.

Another key outcome of this Plenary Assembly was the endorsement of a revised World Soil Charter (whose first version was approved more than 30 years ago by the FAO Conference in 1981). An editorial team, including an ITPS member, improved the text. The further formal reviewing steps, up to the final approval of the World Soil Charter, include the 24th session of the FAO Committee on Agriculture (COAG) (29 September to 3 October 2014), the 150th session of FAO Council (1-5 December), and ultimately the 39th session of the FAO Conference (6-13 June 2015).

The Assembly commended the many valuable activities undertaken under the aegis of the ITPS over nearly one year of operation. It expressed particular appreciation for the initiation of work on a new, seminal report entitled —Status of the World Soils Resources (SWSR). It noted the intent to issue the first version towards the end of 2015, with the active involvement of a large number of contributors.

The Assembly received oral reports by representatives of several of the Regional Soil Partnerships (RSPs) on the current status in their respective geographical areas, i.e. the Near East and North Africa; Central America, Mexico and the Caribbean; Africa; Europe (including the associated Eurasian RSP); South America; and Asia.
The South West Pacific Regional Soil Partnership is intended to be launched this October.

IUSS pre-congress Japan Volcanic Soil Tour 2-7 June 2014.

by Dr M.R. Balks, University of Waikato, New Zealand.
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The 2014 IUSS preconference tour of Japan attracted an international audience with participants from Australia, Austria, Belgium, Bulgaria, France, Germany, Iran, Italy, New Zealand, Poland, Portugal, Switzerland, Thailand, UK, and USA, as well as a strong contingent from Japan. For many of us it was our first visit to Japan and we were impressed, even before we arrived in Japan, with the excellent organisation and clear communication of our trip leaders.

The trip was organised by a team of 12 led by Dr Yagi Kazuyuki from NIAES (National Institute for Agroenvironmental Sciences). The tour was also supported by NARO/ARS (National Agriculture and Food Research Organisation, Agricultural Research Centre, the Japanese Society of Soil Sciences and Plant Nutrition, and the Japanese Society of Pedology.

We set off on day one to drive around the outskirts of Tokyo, past Yokohama, to our first stop at the Nihon University in Fujisawa city, Kanagawa Prefecture. Here we met our first Japanese Andosol, (a Pachic Melanudand) and for the first time the famous "Fuji Black" which I knew from photographs and talks that I had seen when Prof. Hiroshi Takesako and his group visited us in New Zealand. However, the soil exceeded all expectations when viewed in the field. Fuji Black is a distinct dark paleosol that is formed from eruptive materials from Mt Fuji dating to about 5 000 - 8 000 YPB. The "Melan" part of the USDA soil classification name refers to the spectacularly deep black colours of the soil epipedon (Figure 1) which were unlike anything I had seen previously. The deciduous trees, with an understory of small bamboo and grasses, had roots extending to over two meters deep in the rich, friable soil. I was interested to learn that before the use of P fertilisers these soils were regarded as fairly infertile in spite of their excellent physical properties.

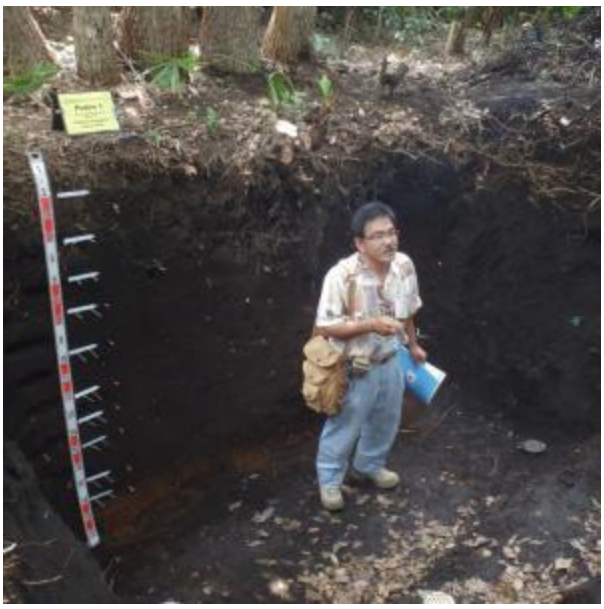


Figure 1. Our irrepressible field leader, Dr Toshiaki Ohkura introduced us to our first Japanese Andosol with its spectacular depth of dark, organic matter rich soil.

We then visited a Typic Udivitrand at Hadano in Kanagawa Prefecture. The outstanding feature of Pedon 2 was the distinct upper meter or so of material erupted from Mt Fuji over a two week period in 1707. The first material erupted was pumice, followed by scoria. I was also interested to see the range of lush vegetable crops that were being grown there. Pedon 3 (a Humic Udivitrand) was on the lower flanks of Mt Fuji at Yamanakako in Yamanashi Prefecture. Here, close to the source volcano, the exposed profile was over 3m deep with the Fuji Black layer evident about 2 m below the surface and deep layers of younger tephras above. With the elusive Mt Fuji remaining hidden in the clouds we headed north to Mt Asama. Mt Asama is a highly explosive and active volcano. Near the Asama Volcano Museum a walk among lava fields of the Onioshidashi lava flow, erupted in 1783, proved a real highlight. With

the hard basalt lava, and relatively high altitude (the top of Mt Asama is 2 542 m, though we were far from the top) only incipient soils have formed in cracks and hollows in the lava. Moss and lichens are common and the pioneering plant community was beautiful and fascinating with maples, rhododendrons, azaleas (Figure 2), and hydrangas among the plants that I have previously only seen in gardens. The 1783 eruption included lava, lahars, pyroclastic flows, and tephra fall-out and killed over 1400 people, burying several villages. It has been suggested that this eruption, along with one from Iceland in the same year, caused cooling which may have precipitated the "Little Ice Age".

Figure 2 An azalea flowering among the 1783 lava flow on Mt Asama.

Pedon 4 (a Pachic Melanudand) was near Tsumagoi Village in Gunma Prefecture. Here the sole crop was large-scale cabbage production. The cool high altitude climate was particularly conducive to growing cabbages where one crop per year is produced and the area lies under snow for about 4 months in winter. It was evident that some recontouring of the ground surface has been undertaken in much of Japans agricultural areas to provide relatively flat areas for horticultural production and water containment for rice growing. Pedon 4 (Figure 3, left side) was on an exposed face that was formed as a result of land recontouring. It comprised mainly erupted material from Mt Asama with the dominant pumice horizons erupted in 1108 AD and about 11 000 YBP. The lower part of the profile (about 4 m deep) comprised water deposited volcanic mudflow (lahar) material.

Figure 3. Pedons 4, 5, and 6 illustrate the rich colours and varied volcanic materials that form the soils in the Kanto Region of Japan.

I was particularly interested in Pedon 5 (a Humic Vitriudand, Figure 3, centre) in Showa Village, Gunma Prefecture which had a topsoil that included scoria from the Mt Asama eruption of 1783 (Mt Asama is about 80 km from this site) over a distinct pumice lapilli horizon erupted from Mt

Haruna in the 6th Century. The distinct paleosol had evidence of cultivation occurring at this site prior to the eruption about 1500 years ago. At depth below this profile is a distinct tephra erupted from the Aira Caldera about 1000 km away in southern Kyushu about 28 500 YBP. The pumice lapilli near the surface is similar to some soils I have been studying recently in New Zealand and I was interested to learn that the farmers in Japan, like those in New Zealand, are finding that removing the pumice lapilli layer can give improved yields.

I think the most beautiful, and certainly most colourful soil we visited was Pedon 6 (a Melanic Andosol (FAO-ISRIC) in Imaichi in the Nikko Canton). Here the red-purple coloured 14 000 YBP weathered scoria at the base of the profile was a source of fascination with an extremely low bulk density. The very high porosity of the scoria had been preserved even though the rock had weathered to clay material. The pores were water-filled so that when squeezed water could be extruded from the soil. Our last two soils were at the Tsukuba NIAES campus where contrasting red and black coloured soils were observed within a few meters of one-another, a result of micro-topographic differences.

At the Tskuba campus we visited the NIAES soil museum. I found the collection of soils both impressive and attractive and was particularly interested in some of the early soil maps of Japan that show how long and strong a soil science heritage there is in Japan. I would really like to see New Zealand develop such a great historical and educational facility – the NIAES museum is a great example for us. We participated in a formal international workshop entitled "Andosols Revisiting – genesis and classification of volcanic ash soil (Andosols) and its utilization in Monsoon Asia." The workshop proved to be a great follow up to the fieldtrip as it gave an opportunity for us to gain a deeper understanding of some aspects of the soils we had just seen in the comfort of a lecture theatre.

Overall I found this trip and associated visit to NIAES in Tskuba to be most enjoyable and valuable. The supporting fieldtrip guide and workshop programme were excellent. Given that Mt Fuji eluded us and hid in the clouds I think that was just a subtle trick to ensure I have to return to see more of this beautiful country and its people.

IUSSS

App for WRB

The recently released new edition of the World Reference Base for Soil Resources 2014 has now a support tool. It is an application for a smartphone that allows the user to browse step by step the key for reference soil groups and then to include the principal and supplementary qualifiers. The "help" button allows revising the definitions for each qualifier. The application has been developed by Denis Orlov under request of the Division 1 of the IUSS. The app works under Android, the versions for Windows-based smartphones and iPhones are coming soon. The app can be downloaded at http://www.fao.org/soils-portal/soil-survey/soil-classification/world-reference-base/en/

New Publications

3rd edition of World Reference Base for Soil Resources (WRB) was presented at the 2014 World Congress of Soil Science. It is a follow-up of the first (1998) and second edition (2006). It is available as pdf and as app for Android at the WRB homepage on the FAO site: http://www.fao.org/soils-portal/soil-survey/soil-classification/world-reference-base/en/. This third edition provides a system for naming soils and creating legends for soil maps. The central concepts of most of the 32 Reference Soil Groups have been maintained

12th edition of the Keys to Soil Taxonomy created an opportunity to update Soil Survey Technical Note No. 10 – Buried Soils and Their Effect on Taxonomic Classification. The buried soil concept was originally proposed in soil taxonomy to cover soils subject to catastrophic events like flooding on flood plains and burial by volcanic eruptions, and though recent interest in human-transported materials and subaqueous soils has expanded the application of the buried soil concept. This and other Soil Survey Technical Notes are available online at http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_053566. Soil Taxonomy was recognised as an international system of soil classification at the 2014 World Congress of Soil Science.

World soil distribution educational poster, IUSS Working Group WRB 2014, Published by European Commission Joint Research Centre, IUSS, UN FAO and NSW Office of Environment and Heritage. Prepared by J. Gray, J. Deckers, B. Murphy and S. Dondeyne. Free download (2 or 26 MB file) from the JRC website: http://eusoils.jrc.ec.europa.eu/events/Conferences/20wcss.html This free educational poster aims to convey some fundamental principles of soil formation and to graphically illustrate how different environmental factors give rise to different soils. The main feature is two central charts that graphically present the distribution ranges of 23 of the 32 World Reference Base (WRB) soil groups according to the factors of climate, parent material and topography. It also includes supporting information on the five main factors of soil formation, a table on WRB soil attributes with correlation to Soil Taxonomy and a number of soil profile and landscape photos. The poster is primarily intended as an educational tool, particularly for students but also for many practicing soil and environmental scientists.

Antarctic Terrestrial Microbiology: Physical and Biological Properties of Antarctic Soil Habitats. Edited by D. Cowan. 2014. Springer. ISBN: 978-3-642-45212-3. Hardcover, 299 pages. Price $189.00. This book brings together many of the world's leading experts in the fields of Antarctic terrestrial soil ecology, providing a comprehensive and completely up-to-date analysis of the status of Antarctic soil microbiology. Antarctic terrestrial soils represent one of the most extreme environments on Earth. Once thought to be largely sterile, it is now known that these diverse and often specialized extreme habitats harbor a very wide range of different microorganisms. Antarctic soil communities are relatively simple, but not unsophisticated. Recent phylogenetic and microscopic studies have demonstrated that these communities have well established trophic structuring, and play a significant role in nutrient cycling in these cold, and often dry desert ecosystems. They are surprisingly responsive to change, and potentially sensitive to climatic perturbation. Antarctic terrestrial soils also harbor specialized 'refuge' habitats, where microbial communities develop under (and within) translucent rocks. These cryptic habitats offer unique models for understanding the physical and biological 'drivers' of community development, function and evolution.

Biological Control of Plant-Parasitic Nematodes: Soil Ecosystem Management in Sustainable Agriculture. By G.R. Stirling. 2nd Edition. 2014. CABI. ISBN: 978-17-806-4415-9. Hardcover, 496 pages. Price $240.00. Plant-parasitic nematodes are one of multiple causes of soil-related sub-optimal crop performance. This book integrates soil health and sustainable agriculture with nematode ecology and suppressive services provided by the soil food web to provide holistic solutions. Biological control is an important component of all nematode management programs, and with a particular focus on integrated soil biology management, this book describes tools available to farmers to enhance the activity of natural enemies, and utilize soil biological processes to reduce losses from nematodes.

Science News

Departments of Agriculture and Energy announce bioenergy research projects
The U.S. Department of Agriculture (USDA) and the U.S. Department of Energy (DOE) announced the selection of 10 projects that are being awarded funding aimed at accelerating genetic breeding programs to improve plant feedstocks for the production of biofuels, biopower, and biobased products. The investment is part of the Obama Administration's broader effort to diversify the nation's energy portfolio and accelerate development of new clean energy technologies designed to decrease dependence on foreign oil, providing a more secure future for America's energy needs and enhancing rural economies. Read the release here and learn more about the program here

GMOs could be better received if consumers knew benefits
If given the information that genetically modified organisms can produce foods which provide better nutritional value, 9 out of 10 Iowa grocery shoppers say they would be more likely to buy them, according to research prepared for Iowa Farm Bureau Food and Farm Index by Harris Poll. The research, conducted online, found that 84%of Iowa grocery shoppers would be influenced to buy GMO foods once they learn that GMOs can reduce pesticide use, and 82% would be influenced to buy if they found that GMOS could provide food with better texture or flavor. Read the full article.

"Peak soil" threatens future global food security
The challenge of ensuring future food security as populations grow and diets change has its roots in soil, but the increasing degradation of the earth's thin skin is threatening to push up food prices and increase deforestation. While the worries about peaking oil production have been eased by fresh sources released by hydraulic fracturing, concern about the depletion of the vital resource of soil is moving center stage. Read the full article.

National Academy of Science to produce GMO study
Claims and research that extol both the benefits and risks of GE crops have created a confusing landscape for the public and for policy makers. An upcoming National Research Council study intends to provide an independent, objective examination of what has been learned since the introduction of GE crops, based on current evidence. The study will assess whether initial concerns and promises were realized since the introduction of GE crops and will investigate new concerns and recent claims. Read more.

Climate change and air pollution will combine to curb food supplies
Many studies have shown the potential for global climate change to cut food supplies. But these studies have, for the most part, ignored the interactions between increasing temperature and air pollution — specifically ozone pollution, which is known to damage crops. A new study involving researchers at MIT shows that these interactions can be quite significant, suggesting that policymakers need to take both warming and air pollution into account in addressing food security. Read the full article.

New tool eases task of simulating aquifer refill
How quickly a lake fills after water is drawn for irrigation or drinking is easily measured, but that's not true for underground water reserves, called aquifers. Because it takes place belowground, groundwater replenishment—or recharge—can't be directly observed. Scientists must estimate it, often by using complex mathematical models. A new screening tool may now ease the task. In a study published in the Vadose Zone Journal, scientists describe a method for identifying timeframes and regions where the seepage of water into an aquifer is likely constant, rather than fluctuating with rainfall patterns or climate. Read the full article.

Launch of Food Resilience theme of Climate.Data.Gov
To help communities and individuals plan for the risks of drought, floods, and other climate-change-related impacts, the U.S. Government is releasing today a collection of datasets containing information relevant to the effects of climate change on the food system. These data are also being made available via mapping services on Geoplatform.gov. Find out more.

Scientists trot out dueling analyses of deadly landslide
One of the deadliest landslides in U.S. history was unleashed when part of a mountain collapsed onto a rain-sodden slope, sending a wall of mud shooting through a Washington state neighborhood, according to a federal landslide expert. The new account from the U.S. Geological Survey (USGS) differs from the explanation offered by the Geotechnical Extreme Events Reconnaissance (GEER) Association. The difference revolves around a critical question: What caused a hillside with a history of relatively minor landslides to suddenly turn into a tsunami of mud and debris that sped about a kilometer across a valley? Read the full article.

International Corner

Global plans of action endorsed to halt the escalating degradation of soils
Urgent action is required to improve the health of the world's limited soil resources and stop land degradation, so as to ensure that future generations have enough supplies of food, water, energy and raw materials, government representatives and experts meeting at FAO warned last week. The Global Soil Partnership has endorsed a series of action plans at its plenary assembly in Rome to safeguard soil resources which provide the basis for global agricultural production. Read the full article.

June 2014 was Earth's warmest on record as ocean temperatures surged
The National Oceanic and Atmospheric Administration reports that June was the globe's warmest in 134 years of records following its report that May was also the hottest on record. These reports are feeding anticipation that 2014 could become the warmest year on record. Primarily, it was the oceans of the world that pushed the mercury into the red zone. According to the report, June was the first time that the monthly global ocean temperature difference from average was higher than 1.08°F. Read the full article.

Australia repeals carbon tax
The Australian Senate voted last Thursday to repeal the country's carbon tax; this measure was approved earlier in the week by the House of Representatives. Australia is one of the world's largest producers of carbon emissions, and the tax, which was effective in 2012, required their largest companies to pay about $25 AU per metric ton of carbon dioxide. Read the full article.

Saving soil: digging for solutions beneath our feet
One of the most overlooked ingredients in farming exists right beneath farmers' feet—healthy, fertile soils. Unfortunately, this vital ingredient is being degraded and eroded at unprecedented rates across the world. According to the U.N. Food and Agriculture Organization (FAO), 25 percent of the planet's land is highly degraded, and only 10 percent is improving. All continents are experiencing land degradation, and the loss of soil quality is not only an issue for farmers, but for all of us. Read the full article.

OECD-FAO Agricultural Outlook
The twentieth edition
of the Agricultural Outlook provides market projections to 2023 for major agricultural commodities, biofuels and fish across 41 countries and 12 regions: OECD member countries (European Union as a region), key non-OECD agricultural producers (such as India, China, Brazil, Russian Federation and Argentina) and groups of smaller non-OECD economies in a more aggregated form. This edition includes a special focus on India. Read the full report.

News from Soil Crumbs (Soil Science Australia)

Reuters article "Peak Soil' threatens global food security
http://www.reuters.com/article/2014/07/17/us-peaksoil-agriculture-idUSKBN0FM1HC20140717

Global plans of action endorsed to halt the escalating degradation of soils
http://www.fao.org/news/story/en/item/239341/icode/

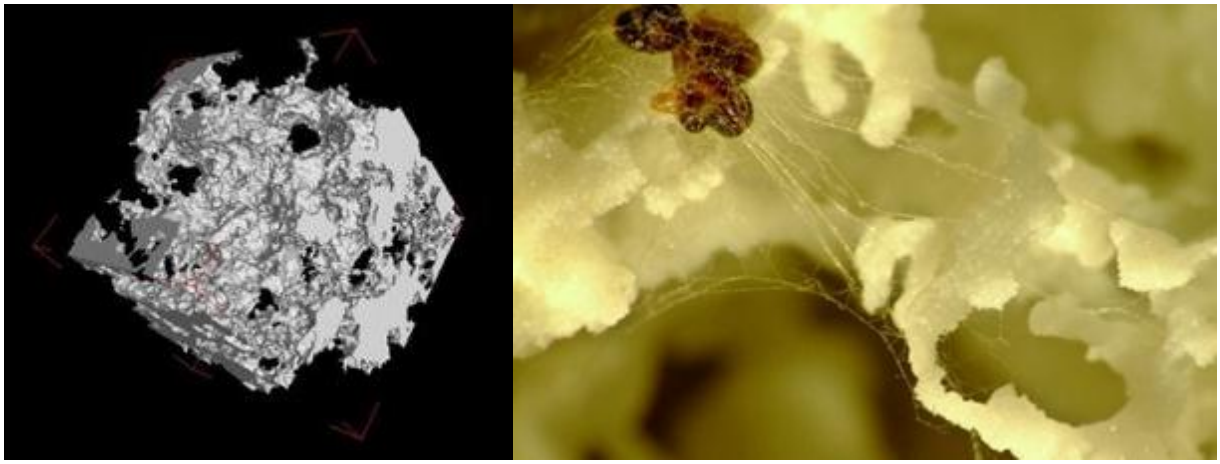
New World Soil Museum ISRIC has opened the new World Soil Museum in Wageningen, The Netherlands. ISRIC, founded by a proposal of the ISSS (now IUSS) has hosted an international soil museum since 1966. In the new World Soil Museum, visitors can learn about the role of soils in life and ecosystems and get an impression of the variation in soils of the world, from the colourful volcanic ash soil from Indonesia to the Terra Preta soil from the Amazon. The museum displays soil monoliths with accompanying data including a full profile description, soil chemical and physical data, and information on the landscape and land-use. For more information click here [IYS soil tour will visit the ISRIC museum in 2015]

The Dirt

A collection of soil-related oddities from Godzone and around the world

3D Soil Printing

I think most people would agree that 3D printing is very cool, but how can we get our CRI/University/patrons to buy one? Soil scientists at Abertay University in Scotland may have found the answer. Researchers have printed out 3D blocks of plastic soil to study the movement of fungi and bacteria move through the soil. The team began by first creating a 3D image of soil using X-ray Computed Tomography (CT scanning) showing the elaborate, pore structure of undisturbed soil.



Once the soil blocks were printed out (as plastic cubes), the scientists inserted soil microorganisms and were able to observe how fungi and bacteria move through the pores, find food sources and interact. As Professor Otten explains: "By printing out the structure of the soil in 3D, we are now beginning to find out exactly what is going on in the soil".

http://www.abertay.ac.uk/about/news/newsarchive/2014/name,15497,en.html

More Space Dirt

China has their eye on lunar soil. Later this year, China is planning to launch a spacecraft destined for the moon. This mission is part of preparations to recover a sample of lunar soil in 2017. Why is China so interested in lunar soil? Do they want to see if they can put dairy cows on the moon? Apparently they are after an isotope called Helium 3, which does not exist on earth and is thought to be the key for clean, limitless fusion energy.

http://rt.com/news/179296-china-moon-orbiter-test/

Waikato/Bay of Plenty

University of Waikato

We welcomed back **Susanna Rutledge** from maternity leave as a research fellow. Young Benjamin (Fig. 1) is now 6 months old, a strong young man and perhaps a budding soil scientist. Suus is back working a 4-day week on approaches to increase soil carbon in pastures exploring the potential of diverse pastures with deeper rooting plants for increasing carbon inputs to soil.

Fig. 1. Suus Rutledge and Benjamin.

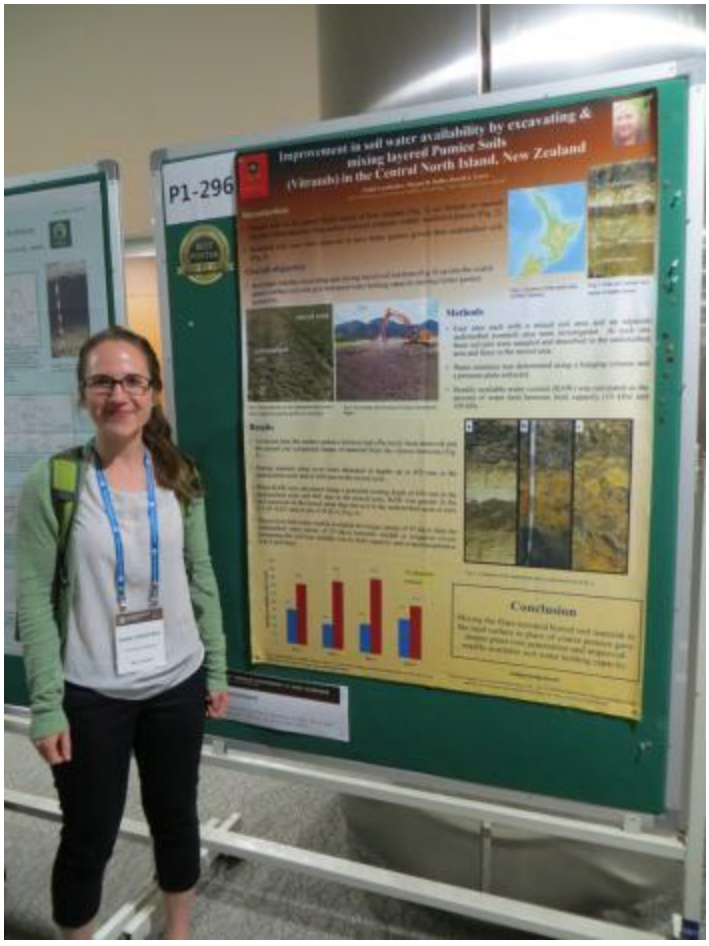
The **Waiber** (Waikato Biogeochemistry and Ecohydrology Research) team of the University of Waikato is continuing data collection at a Waharoa dairy farm. The New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) has contracted us to test whether conversion to a diverse sward (with more and deeper roots) will result in more carbon storage in soils under pasture. For three years now we have been measuring the carbon balance of three blocks: one was re-grassed back to rye grass and clover, one was re-grassed to a diverse sward, and one received no treatment. Measurements include the exchange of CO_2 between the surface and atmosphere, imports of carbon in supplemental feed and manure and exported carbon in milk and silage. In Fig. 2, research technician **Aaron Wall** is doing cage cuts to determine above-ground productivity and botanical composition while being closely supervised by a group of friends!

Fig. 2. Aaron Wall and admirers in the Waikato

Tim Norris (supervised by Louis Schipper) submitted his MSc thesis, "Detection of differences in soil carbon and nitrogen stocks between paired dairy and drystock pastures". Tim developed and tested a new soil coring approach for measuring differences in soil carbon and nitrogen between land uses. In keeping with new tradition, Tim made a research cake (Fig. 3) as an edible abstract of his work. He was justifiably proud not only to complete his thesis but also bake his first cake. Reviews of the cake were overwhelmingly positive but unfortunately will not count towards his final grade (pending).

Fig. 3. Tim Norris celebrates completing his thesis with a research cake!

Jack Pronger (supervised by Louis Schipper) and **Mahdiyeh Salmanzadeh** (supervised by Megan Balks) both presented their 6-month PhD proposals and have been confirmed for full enrolment. Jack will examine water use and water use efficiency of different pasture swards using eddy covariance techniques coupled to natural abundance carbon isotopes. Mahdiyeh will examine Cd accumulation in different soils potentially also using new isotope methods.
Noah Fierer (university of Colorado) and family have turned to the US after a 6 month sabbatical based at the University of Waikato hosted by Louis Schipper. Noah travelled widely in New Zealand and met with researchers throughout the country and leaves with several continuing collaboration well underway.



Megan Balks attended the 20th World Congress of Soil Science in Jeju, South Korea, and a preconference fieldtrip in Japan. Megan convened the cryosol session of the conference. **Nadia Laubscher** (a recently completed MSc student who is now working for Dairy NZ) presented the results of her work on the effects of soil flipping on soil moisture holding capacity in Pumice Soils. Nadia won a prize for her poster (Fig. 4). **Doreen Huang** (PhD student with David Lowe and others) also attended the congress and presented an oral paper on her Marsden-funded research attempting find ancient DNA in buried paleosols on tephras.

Fig. 4. Nadia Laubscher and her award-winning poster at Jeju. Photo: Megan Balks

On a field trip on Jeju, Doreen

photographed an Andisol (Fig. 5) and ubiquitous 'rock sculptures' made from volcanic rock and locally referred to as 'stone grandpas' (Fig. 6).

Fig. 5. An Andisol on Jeju. Photo: Doreen Huang

Fig. 6. "Stone grandpas" on Jeju. Photo: Doreen Huang

David Lowe meanwhile headed to Scandinavia in June-July and contributed several papers to the 20th annual conference of the New Zealand Studies Association, entitled "Across the Pacific", which was held at the Maritime Museum, Oslo. Notable participants included Professor Dame Anne Salmond (Auckland University), Witi Ihimaera (formerly Auckland University), Wiremu Puke (stone-tool carver, Hamilton) (Fig. 7), and Thor Heyerdahl, Jr. The last named, son of the famous Pacific raft voyager of 1947, a very entertaining speaker and retired oceanographer, revealed that his father could not swim and had been very frightened of water following a childhood incident. As well as *Kon-Tiki*, Nansen's and Amundsen's polar ship, *Fram*, was on display. Visitors could go on board and explore the entire ship. David took time out to visit other parts of Norway including Bergen and Tromso (Fig. 8) as well as Stockholm (Sweden), and Aarhus and Copenhagen (Denmark).

Fig.7. Wiremu Puke, Anne Salmond, and David Lowe in Oslo. Photo: Maria Lowe

Fig. 8. David on snowy slopes above Tromso, northern Norway. Photo: Maria Lowe

AgResearch Ruakura

A few of our scientists have been out and about the last few months. **Jiafa Luo** (pictured below) was in China to give a talk to a forum organized by the China-NZ Dairy Exchange Centre on dairy effluent production and reuse (as invited by Fonterra China). This forum included discussions about regulations, farm practices, research, and future effluent management directions. Jiafa also attended a dairy expo organized by the Dairy Association of China, in Xian, China.

Stewart Ledgard and **Mark Shepherd** attended the 18th Soil Nitrogen Workshop in Lisbon, Portugal. Stuart gave a talk about life cycle assessment of NZ milk and sheep meat and nitrogen footprinting. This work was highly topical as there were many other papers on food's N footprint ahead of the release of a large EU report. He also had a poster on the team's work on salt as a mitigation to reduce nitrogen leaching in grazed pastures. After the Conference he headed for the hills in Spain where he went hiking for a week.

Mark presented a paper on DCD and was met with questions like:

1. Why is NZ "so enthusiastic about DCD" (exact words - European questioner)?
2. Why introduce another chemical into the environment?
3. Are there other alternatives to DCD?

The audience was certainly split on whether we should be using nitrification inhibitors (not just DCD, work was also reported in a number of papers on DMPP) as a tool to control N losses.

More facts about the N workshop: The first N workshop was held in Rothamsted in 1982, basically a get together at the time for UK-based soil scientists; this was in fact the 17th N workshop; the Dutch organised the '13th workshop' but refused to call it the 13th, so it became the 14th!
Extended abstracts are available at: http://www.nitrogenworkshop.com/abstracts/4585708037

Faith Mtandavari (Wintec) has started her research project in AgResearch under the supervision of post-doctoral soil microbiologist **Maria Tourna**. The aim of Faith's project is to estimate the diversity of sulphur oxidizing bacteria (SOB) in different types of soil and to follow SOB community dynamics during elemental sulphur oxidation using Denaturing Gradient Gel Electrophoresis (DGGE). This will enhance our understanding of the links between soil biology, functionality (meaning sulphur oxidation) and environmental parameters in pasture soils; fundamental for better nutrient use efficiency in agriculture.

And finally, the Nutrient Management and Environmental Footprinting team is very pleased to welcome back **Jie Li** from the Chinese Academy of Science (supervised by Jiafa Luo).

Manawatu/Hawke's Bay

Plant and Food Research, Palmerston North

Brent Clothier and **Steve Green** have just returned from another field campaign in the Central Highlands of Kenya with Plant & Food's New Zealand Aid project to alleviate poverty amongst the many small-holder avocado farmers. Nearly half the farmers are women. Their avocados are destined for pressing for oil by Olivado at their factory in Murang'a just north of Thika. The 5-year project's goal is to the increase avocado production and oil yield for the small-holders to sustain and enhance their revenue stream.

Brent & Steve with avocado farmer Hannah & her husband near Kangari at 2,200 m in the Central Highlands.

The purpose of this trip was to determine soil properties, monitor tree water-use, and initiate a tree pruning programme to reduce tree size. Shrinking the size of the old trees has the advantage of reducing water use to enable drought avoidance between the rainy seasons, to enhance fruit yield and oil content, and to enable easier, safer and better harvesting of the fruit.

Michael Gitahi from Olivado (Kenya) explains the soil physics' details of a mini-disc permeameter (foreground) to Jacinta, an avocado farmer at Mangu near Thika.

Two forms of rehabilitative pruning strategies have been adopted. We've adopted the more gentle removable of the top of the crown to reduce tree height and enhance light penetration, and the more brutal stag-horning to enable complete re-establishment of a more manageable tree form.

Steve Green checking the sap-flow measurements of tree transpiration in the 'top-pruned' avocado tree in the foreground (left). In the background can be seen the 'stag-horn' pruned tree. One of Jacinta's goats (left background) is keeping a watchful eye on proceedings. Indeed at one of our other sites, a flock of goats 'ate our homework'.

The Plant & Food team will return in October to track progress of tree re-growth and to assess reductions in tree water use as the weather warms. Training programmes for farmers and Olivado have been initiated.

Ian McIvor and **Trevor Jones** attended the International Poplar Symposium (IPS) that was held in July at UBC in Vancouver, Canada. A feature of the environmental applications of poplar and willow trees was their use in the bioremediation of wastewater streams, including the treatment of protein and ammonia nitrogen in food processing and municipal effluent, and in landfill leachate. Bioremediation is an alternative to aerobic mechanical waste water systems, which cost more capital, require more operating energy, and emit more greenhouse gases. The research at the conference included: field-scale and laboratory studies to quantify the year-round nitrogen transport and cycling dynamics in the rhizosphere of a poplar plantation treating waste protein nitrogen in effluent; and the biomass growth and tolerance of poplar and willow clones to irrigation with domestic wastewater, municipal effluent, and landfill leachate.

The post-conference bus tour included a visit to the municipal waste facilities at Salmon Arm in BC, Canada. The methane gas from a retired landfill at the site is being collected for commercial use, and the leachate from the landfill is being treated by irrigating a poplar plantation planted on top of the retired landfill (Figures 1 and 2). The landfill produces enough methane gas to meet the energy requirements of 300 homes, and a prototype plant has been built a partnership with FortisBC to process and upgrade the methane gas to pipeline quality, for distribution to homes and businesses in Salmon Arm.

Figure 1. Landfill leachate pond and a prototype plant to capture and pressurise methane gas for commercial use, at Salmon Arm in BC, Canada.

Figure 2. Application of the landfill leachate with spray irrigation to a plantation of hybrid poplar trees (*P. trichocarpa* × *P. deltoides*) growing on top of the retired landfill site, at Salmon Arm in BC, Canada.

Canterbury

Plant and Food

Dirk Wallace has recently started at PFR Lincoln and is here to commence work on his PhD project which will be focussing on the relationships between soil management practices and soil water movement and storage of shallow stony soils. Dirk will be based at Plant and Food Research Lincoln and supervised by Peter Almond (Lincoln University), Sam Carrick (Landcare Research) and Steve Thomas (Plant and Food Research) the project will be funded by Plant and Food Research, Landcare Research and the Foundation for Arable Research.

Lincoln University

Congratulations to **Jen Owens,** supervised by Prof. Tim Clough, who won 3rd place in the recent LU Postgrads Conference (7-8 July 2014).
Jen's presentation was entitled "the effects of irrigation frequency on nitrous oxide emissions and denitrification potential from urine treated soil".
Students provided 10 minutes presentation and answered questions from judges and attendants. They were judged on their technical presentation skills and their ability to present their research in a way that is accessible to an audience from a range of different disciplines, with clear outcomes and conclusion.

Jack Lee successfully defended his PhD thesis via video conference from the UK - "*Niche and neutral processes in aquatic bacterial communities: Are all things equal?*'. The examining committee has recommended award of PhD subject to minor amendments being made to the thesis. Jack's supervisors were Gavin Lear and Hannah Buckley.

Queen Elizabeth II Technicians' Study Awards
Manjula Premaratne Technical Officer in the Department of Soil & Physical Sciences has received a grant to undertake training in isotope ratio mass spectrometry at UK.

Lincoln University Soil Society
On Saturday 26th July students led by Assoc. Prof Peter Almond enjoyed a lovely day at Rakaia Gorge looking at the geomorphology of the area, and had a go at digging some holes to see some soil close up. It was a fun day, Jet boating added a bit of adventure and a good opportunity to get to know other students interested in soil science.

Otago/Southland

AgResearch Invermay

Ross Monaghan and **Seth Laurenson** have been busy collating and summarising findings from the P21 research underway at Telford Dairy Farm in South Otago. The science and farm teams have been challenged with identifying farmlet systems that can deliver more profit but with significantly lower environmental footprints. Results from the 2 full seasons completed thus far suggest that improved cow wintering practices can deliver the environmental targets sought, although some of these practices incur significant cost, particularly those that require use of Herd Shelter structures for keeping cows off-paddock. A specific focus for the teams is to now see if the Herd Shelter can be used during the shoulders of the up-coming season to maximise cow performance and farm profit."

Abstracts

Presented at the World Soil Congress in Korea, 2014:

Soil visible near-infrared spectroscopy: lessons from the field

Pierre Roudier, Carolyn Hedley and Leo Valette
Landcare Research, Palmerston North

A major recent development in the field of pedometrics is the utilisation of visible near-infrared spectroscopy (VNIR) to rapidly collect more soil data and predict soil chemistry, in particular soil organic carbon (SOC). While the spectra collection often occurs in the lab, on air or oven-dried, sieved soil samples, the portable nature of the equipment also allows soil spectra to be collected in the field. In this paper, we investigate some of the associated benefits of in-situ field spectroscopy, in particular the depth resolution at which soil information can be produced.

Soil spectral data were collected from a drystock farm located in the Manawatu region of New Zealand. The farm is divided in two distinct parts: flat land on the floodplains of the Manawatu River and adjacent dissected hill country, with slopes typically greater than 15 degrees. The elevation increases from 50m on the floodplains to 360m on the summit.

A digital elevation model obtained from LiDAR was used to derive a suite of terrain attributes: slope, aspect, annual global solar radiation, topographic wetness index, SAGA wetness index and geomorphological features. Associated with the parent material map and national climatic data layers (rainfall and monthly water balance), these soil covariates were used to select 50 soil sampling positions, using conditioned Latin Hypercube stratified sampling.

Intact, fresh soil cores were extracted from the 50 sampling positions and scanned with a VNIR spectrometer at field conditions, at 1-cm intervals along the length of the field moist core to 30 cm. The ASD FieldSpec 3 collects spectra in the range 350 to 2500 nm. The cores were then subsampled at 5 cm intervals to 10 cm and then at 10 cm intervals to 30 cm soil depth. The subsamples were then air dried, mixed and 2 mm sieved, before being scanned by the VNIR spectrometer for a second time, this time in an air-dry state.

The collected spectra were used to predict the SOC volumetric content [kg/m3] under the two conditions (fresh, field condition and sieved, air-dried, lab conditions). The field spectra are collected at a 1-cm depth resolution whereas the lab spectra are collected at the depth resolution of the subsample (either 5 or 10cm thick). The 1-cm field spectra were aggregated to match the subsample intervals of the air-dry samples analysed using lab SOC measurements. Two partial least square regression (PLSR) models were then trained, the first one using the aggregated field spectra, and a second one using air-dry spectra. The PLSR model trained on aggregated field spectra was then applied to the original 1-cm depth resolution field spectra to predict SOC along the core.

The results are twofold. First, using field moist spectra gave a more accurate prediction model than using air-dry spectra. Direct collection of soil spectra from intact soil in the field captures features that are normally destroyed by conventional lab analysis soil processing methods. Some of these soil features (such as ped surfaces and surface roughness) are related to SOC content, which can explain why better results are achieved using field condition spectra. Collecting VNIR spectra at field condition also eliminates the cost and time required with sample preparation at the lab (air-drying and sieving).

Additionally, the ability to predict at 1-cm intervals provides new data, previously unobtainable by conventional methods of assessing soil chemistry, to explore and study SOC variations along the soil profile. Depth variations are commonly modelled using mathematical tools, such as negative exponential functions or spline interpolators. Field VNIR spectroscopy provides a new method to more directly model SOC variation with depth. From a pedology point of view, showing the variation of soil attributes with depth in an almost continuous way at a marginal cost would also allow to better understand the

effects of pedological processes such as alluvial deposit or hill slope processes. From a management perspective, the method can be used to assess mitigation strategies aiming to increase SOC stocks (e.g. introduction of deeper rooting grass species for deeper allocation of SOC; introduction of deep burrowing earthworms for deeper allocation of SOC).

Animal Treading Damages Pasture and Affects Soil Nitrous Oxide Emissions

Pranoy Pal[1], Tim J. Clough[2] and Francis M. Kelliher[3]
[1]Ecosystems and Global Change, Landcare Research, New Zealand
[2]Department of Soil & Physical Sciences, Faculty of Agriculture & Life Sciences, Lincoln University, New Zealand
[3]Land & Environment Group, AgResearch, Lincoln Research Centre, New Zealand

Intensively managed grazed pastures are significant sources of nitrous oxide (N_2O) due to regular fertiliser nitrogen (N) inputs, animal excreta and soil compaction resulting from animal treading. Animal treading also damages pasture, however, the subsequent effect of this damage on N_2O emissions is not known. During and after grazing uneaten pasture, along with the pasture damaged by treading, may become incorporated into the soil. Under winter conditions when soils are very wet, we postulated soil compaction and pasture incorporation could affect N_2O emissions. A field experiment was conducted to determine the effects herbage on emissions and soil inorganic-N dynamics. A factorial experiment simulated animal treading (presence/absence) in the absence and presence of herbage, on a poorly drained Temuka clay loam soil, located at a pasture site in Canterbury, New Zealand (43°38.50′ S, 172°27.17′ E). Pasture species were dominated by perennial ryegrass (*Lolium perenne* L.) and white clover (*Trifolium repens* L.). Treading resulted in reduced pasture dry matter yield and soil nitrate (NO_3^-) and ammonium (NH_4^+) concentrations. However, the soil's water soluble carbon concentration increased. Maximum N_2O emissions occurred 2 d after imposing treading to nil-herbage plots. After 47 days, N_2O emissions were higher from the trodden plots irrespective of herbage presence with cumulative emissions ranging from 9 to 17 mg N_2O-N m^{-2}. Emissions of N_2O from the nil-herbage-trodden treatment were higher probably because of partial anaerobic conditions created due to treading as evidenced by lower soil NO_3^- under treading. When ^{15}N-labelled fertiliser was used to label the soil inorganic-N pool, it was observed that a major fraction of the emitted N_2O originated from the antecedent soil-N and/or from plant root-N decomposition under treading. This study uniquely indicates that the enhanced N_2O emissions observed under treading are not only the result of antecedent inorganic-N being denitrified but they are also comprised of either soil organic matter-N or root-N made available as a consequence of treading. Future work needs to quantify the mineralisation of soil organic matter-N/root-N resulting from animal treading.

Keywords: animal treading, N_2O, ^{15}N, compaction, perennial ryegrass, white clover

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Presented to the New Zealand Land Treatment Association 2014 Conference, Hamilton, 26 – 28 March 2014

Disposing Greywater on land in a New Zealand coastal community

Craig Ross[1], Alma Siggins[2], Vanessa Burton[2], Hamish Lowe[3], Jacqui Horswell[2]
[1] Landcare Research, Palmerston North; [2] Institute of Environmental Science and Research (ESR) Ltd, Kenepuru Science Centre, Porirua; [3] Lowe Environmental Impact Ltd, Palmerston North

ABSTRACT
The reuse of domestic greywater (wastewater from laundries, showers/baths, and bathroom sinks) is important, both in NZ and worldwide. Greywater is a variable wastewater stream containing a complex mixture of microbes and chemicals. There is limited information on the diversion methods, environmental impacts, and risks greywater poses to human health. Homeowners often practice

unregulated greywater diversion with home-made systems as basic as the outlet pipe from a washing machine going out onto an area of lawn, garden, or into a rock pit. The areas where such practices are carried out are typically rural, often in environmentally sensitive areas such as coastal settlements.

A North Island coastal community provided a case study on the impacts of more than 15 years of unregulated greywater disposal systems. Soil and microbial impacts from greywater included increased soil pH; Olsen P, soil carbon, and exchangeable calcium on some properties but not others; and increased microbial activity. Electrical conductivities were unaffected and very low at all sites. Increased *E. coli* from greywater was found in some surface soils. These results suggest unmanaged greywater re-use has the potential to adversely impact on environmental and public health, which highlights the need for a national guideline.

How the Marsden Fund has failed to achieve its full potential in the ESA panel: evidence of limitations in scope, biased outcomes, and futile applications

Karin R. Bryan and David J. Lowe
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Abstract
We have analysed the scope of proposals funded by the 'Earth Sciences and Astronomy' (ESA) panel of the Marsden Fund for the period 2004 to 2013. The scope of proposals funded is very limited and does not reflect the full remit of the panel: the successful projects fail to encompass the quality and quantity of research being undertaken within the Earth sciences community in New Zealand, and a number of sub-disciplines that seek to address fundamental and important problems within the Earth sciences are largely excluded. Moreover, nearly 50% of the funded proposals for the past decade have been made to just two institutions. To address these limitations, we suggest that: (1) a review is undertaken to examine and widen the scope of the panel to encompass sub-disciplines that demonstrably are never or rarely funded; (2) the composition of panel members be examined and modified to reflect a much wider scope of sub-disciplines within the Earth sciences; and (3) a review of the wide discrepancies in funding distributions on an institutional basis be undertaken. We want to ensure that a more representative range of sub-disciplines, in keeping with modern and realistic definitions of the Earth sciences, is funded through this panel, and so we also recommend the formation of a new panel for 'Environmental and Earth-system Sciences' that could encompass the research involving modern-day processes so that applications in these sub-disciplines are not pointless. In addition, it is clear that a very substantial increase in funding to the Marsden Fund must be sought.

New Zealand Science Review (2014) 71, 3-9 [http://www.scientists.org.nz/journal]

Mineralization of Soil Carbon and Nitrogen Following Physical Disturbance: A Laboratory Assessment

Curtin, D., M. H. Beare, C.L. Scott, G. Hernandez-Ramirez, and E. D. Meenken

Uncertainty persists regarding the influence of physical disturbance on mineralization of soil organic matter. This study examined how disturbance affects mineralization in soils with different management histories and textures. Results from a 100-d incubation (20°C, −10 kPa) using cores (0–15 cm deep; 5-cm diameter) from a field trial at Lincoln, New Zealand with different agronomic treatments in the previous 5 yr (pasture, arable cropping, and chemical fallow) confirmed that mineralization is strongly influenced by management history (C mineralized ranged from 390 mg kg^{-1} in fallow soil to 1570 mg kg^{-1} under pasture). However, there was no difference in C or N mineralization between disturbed (sieved <4 mm) and intact cores. In another experiment, comparisons of mineralization in intact and disturbed (<4 mm) cores from 14 arable and pasture fields with either silt loam or clay loam texture also showed no effect of

disturbance. In a final experiment, large, air-dry aggregates (19–40 mm) from two soil types (silt loam and clay loam) were fragmented using a compressive force and the resulting subaggregates separated into size classes (<0.25, 0.25–1, 1–2, 2–4, 4–9.5, and 9.5–13.2 mm) by dry sieving. Mineralization increased only when aggregate size was below a certain threshold value (~3 mm diameter); mineralization was ~25–50% greater in fine (≤1 mm) vs. large (4–40 mm) aggregates, likely due to exposure of previously-occluded organic matter. Unless a substantial quantity of fine aggregates is generated, the influence of physical disturbance may be small.

Spatial and temporal nitrous oxide emissions from dairy cattle urine deposited onto grazed pastures across New Zealand based on soil water balance modelling.

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Abstract
Nitrous oxide emissions from urine deposited onto soils during grazing are captured within the New Zealand national inventory by employing an annual average country-specific emission factor (EF_3) of 1%. However, soil moisture is a key driver of N_2O emissions, and we propose a soil water balance model can be used to determine spatially- and temporally-disaggregated emission factors to refine and improve the emissions estimate. We constructed a GIS-based water balance model that operates on regional and monthly scales and developed a predictive relationship between soil water content and EF_3. Combined with estimated monthly cattle urine excretion, we calculated annual N_2O emissions for four years, ranging between 6.6 – 7.5 Gg y^{-1}. The associated, annual mean EF_3 value was 0.9 to 1.0%. This is very similar to the currently employed country-specific EF_3 value, which results in an annual N_2O emission of 7.0 – 7.7 Gg y^{-1}. Within-year variability in regional and monthly EF_3 was much greater than the between-year variability in country-wide annual average EF_3, reflecting a strong averaging affect across temporal and spatial scales.

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Effects of Chloride- and Sulfate-Dominated Solutions on the Salinity Tolerances of Barley, Canola, Tall and Green Wheatgrasses

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Agricultural salinity stems from salts dissolved in soil solutions. Although root-zone salinity can reduce crop yield, some crops tolerate saline rooting environments better than others. The ability of a crop to maintain substantial product yield while subject to root-zone salinity, ranging from negligible to severe, defines a cropâ€™s salinity tolerance. Yield response data derived from carefully-designed salinity tests have rated crops according to the Salinity Tolerance Index: STIndex = C_{50} + s C_{50}. This index is based on (1) the salinity, which causes a 50% loss in relative crop yield, C_{50}, as measured by the electrical conductivity in dS m^{-1} equivalent to a soilâ€™s saturated paste extract, EC_e, and (2) a factor, s C_{50}, describing the steepness of the yield response from zero to C_{50}, where s equals the absolute value of the

average unit decline in relative yield per unit increase in salinity at or near C_{50}. The index is considered dimensionless and can be approximated by visual inspection or calculated with values derived from response data using the modified discount function, $Y_r = 1 / [1+(C/C_{50})^{exp(s\ C50)}]$, where relative crop yield, Y_r, for each measure of salinity, C, equals the absolute yield scaled by the yield obtainable in the absence of salinity. The inherent salinity tolerances of crops have been calculated from a large number of tests and arrayed within published lists designed to assist producers and extension specialists in selecting crops to maximize production from saline soils. Salinity affects crops by generating adverse osmotic gradients, introducing toxic ions, and causing nutrient deficiencies. The type of anion dominating a soil solution, as well as the solutionâ€™s total salt concentration, fundamentally influences a cropâ€™s response to root-zone salinity. Tests conducted in sand cultures at Canadaâ€™s Salinity Testing Lab and salinized with either Cl or SO_4 salts, respectively, resulted in STIndices of 7.33 and 7.61 for Harrington Barley, 7.13 and 7.82 for Hyola 401 Canola, 11.17 and 11.73 for Orbit Tall wheatgrass, and 12.51 and 12.92 for AC Saltlander Green Wheatgrass. The STIndices for these crops increased by 3.8%, 9.7%, 5.0%, and 3.3%, respectively, when derived with solutions salinized primarily with sulfate rather than with chloride salts.

The effect of nitrogen concentration in synthetic cattle urine on nitrous oxide emissions

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Abstract
This study determined a relationship between N concentration in synthetic cattle urine and the nitrous oxide (N_2O) emission factor (EF_3; N_2O-N emitted as % of urine N applied) under field conditions. The results will improve the assessment of the efficacy of N_2O mitigation options that affect urinary N concentration and deposition rates. Field studies on two free draining soils and one poorly draining soil were conducted using synthetic urine with N concentrations of 0, 2, 4, 6, 8, 10 and 12 g N L^{-1} (equivalent to application rates of 0 to 1200 kg N ha^{-1}). The study on the poorly draining soil also included a urine N concentration of 14 g N L^{-1} (1400 kg N ha^{-1}). N_2O emissions were measured for up to 18 weeks after urine application using a static chamber methodology. The EF_3 values ranged from 0.03 to 0.34% of urine N applied on the free draining soils and from 0.5 to 0.9% on the poorly draining soil. There was a statistically significant ($p < 0.05$) trend of increasing EF_3 with increasing N application rate on the free-draining soils, with EF_3 increasing 3- to 4-fold between the lowest and highest N rate. No such trend was found on the poorly draining soil, indicating that for this soil the N_2O emission factor was independent of the N application rate. These results suggest that the urine N concentration only affected the N_2O emission factor when values were very low. We therefore conclude that mitigation strategies which reduce the urine N concentration in individual urination events, but not the overall total amount of urine N excreted over the whole farm system, may have limited impact on reducing total direct N_2O emissions.

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The Lifetime Contributions of Professor J.Keith Syers to International Soil Science - A Memorial Symposium, held at the 20th World Congress of Soil Science, Jeju Island , South Korea.

The World Congress theme was "Soils Embrace Life and Universe", which was very fitting for the Memorial Symposium organized and chaired by Dr. John Ryan, formerly of the International Center for Agricultural Research in the Dry Areas, Aleppo, Syria, who had been a close colleague of Professor Syers. Dr John Ryan and his co-convener Dr Tony O'Donnell sought presentations from scientists who were privileged to work with Professor Syers and who could provide both a scientific and personal perspective on Professor Syers's wide ranging contribution to the discipline of soil science. The objective of the symposium was to highlight the various phases of the career of Professor Syers in terms of subject matter and institutional and geographic influences.

Dr Ryan, opened the Memorial Symposium with a brief summary of Keith's career, mentioning his strong mentoring role that initiated the careers of many successful leading soil scientists around the world.

Introduction (by Dr John Ryan).

In 2011, Professor J.Keith Syers died suddenly while still working in Thailand. His extraordinary career spanned five decades, having worked for significant periods in the USA, New Zealand, UK and Thailand. He had exceptional influence in many countries around the world as a soil scientist, research leader, administrator, and educator, especially in Asia, where he spent two extended periods in Thailand and considerable time in China. He was renowned for his contributions to soil chemistry and soil fertility, especially phosphorus, crop nutrition and soil management. He was a leading figure in the inter-phase of agriculture and the environment, in particular phosphorus losses to water and heavy metals. He was a champion of the fertilizer industry and serve for many years as Chairman of the Scientific Advisory Committee for the World Fertilizer Industry (IMPHOS). Following retirement from normal academic life as Professor and Dean at Newcastle University, he spent several years in academic administration in two universities in Thailand. Professor Syers received numerous awards and recognitions for his contributions to agriculture, soil science and science in general, especially Fellow of the Soil Science Society of America, and the International Soil Science Award. Shortly before his death he was notified that he was to receive the Soil Science Distinguished Service Award; the award was accepted on his behalf by Dr John Ryan, a friend of many years and a colleague on the IMPHOS Scientific Advisory Committee. Professor Syers' legacy to soil science is not only reflected in his publications that documented advances in various areas related to soil science, but also to the legions of graduates students he mentored and who are now leaders in their respective fields around the world. Professor Syers was a major contributor to international meetings around the globe, including world soil science congresses.

Figure 1. Keith Syers Memorial Symposium authors and friends celebrate Keith's life. From left to right (second Left) John Ryan (Convener), Tony O'Donnell, Leo Condron, Ravindra Naidu, Mike Hedley, David Manning, Cynthia Grant, Bob Gilkes, Ben Turner and Nanthi Bolan).

Figure 2 Keith Syers' last visit to New Zealand in the IAE, Common room at Massey University (From left to right (Vince Neall, Lance Currie, Roger Ball, Keith Syers, Jim Pollok, Fay Pollok, Bob Stewart, Mike Hedley, Mike Tuohy, Warren Woodgyer and Russ Tillman

O5-1

Keith Syers: a Champion for Soils and Agricultural Research across the World

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Keith Syers started his Professional career in 1964 when he was appointed as a Postdoctoral Fellow in the Department of Soil Science at Lincoln College in New Zealand where he worked on soil fertility in pastures. He moved to the University of Wisconsin-Madison in 1967 to work under Professor M.L. Jackson, a pioneer of fundamental studies on soil and fertilizer potassium and phosphorus. His time with Jackson in Wisconsin (1967-1972) was regarded by Keith as one of the most rewarding and stimulating research environments of his career and the experience helped shape Keith's approach and thinking in soil science. In 1972, aged only 33, he returned to New Zealand to the foundation Chair in Soil Science at Massey University where he built one of the world's leading soils teaching and research departments. During this time (1981) he was elected as Fellow of the Royal Society of New Zealand and it was whilst at Massey that he built his reputation as a research leader in the use of fertiliser P and S in agriculture.

He returned to the UK and to Newcastle University in 1986 as Professor of Soil Science and became Dean of the Faculty of Agriculture and Biological Sciences in 1989. During his time at Newcastle he was responsible for reorganising teaching and research in the agricultural and environmental sciences and served on many key national and international committees including the Scientific Advisory Committee of SCOPE Phosphorus Cycling Project, the Royal Society Interdisciplinary Science Committee and the Governing Board of CAB International. In 1995 he was appointed Chair of the Advisory Committee of the World Phosphate Institute.

Keith Syers spent much of his professional career working on problem soils and worked tirelessly through his role on international committees and advisory groups to increase sustainable food and fibre production in the developing world. He believed that the answer to future food security lay in good science and education combined with local knowledge and technology sharing. In 1992 he moved to Thailand on secondment to join the International Board for Soils Research and Management (IBSRAM) as Director of Research before returning to Newcastle in 1995. On his retirement from Newcastle in 2000, he returned to Thailand as Vice President for International Relations at Naresuan University in Phitsanulok.

His outstanding contributions to soils research have been recognised internationally and he was an elected Fellow of the Soil Science Society of America, of the New Zealand Society of Soil Science, and presented the prestigious Russell Lecture for the British Society of Soil Science in 2007. At the time of his death on 16th July 2011, Keith's lifetime contribution to international soils research had already been recognized by the Soil Science Society of America who had honored him with their Distinguished Service Award.

Keywords : *Keith Syers, phosphorus, sulphur, soil and fertiliser chemistry*

O5-2

Nutrient Balances, Food Security and Fertilizer Raw Materials

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At the turn of the century, Keith Syers supervised a PhD student, William Sheldrick, who had spent his entire career working in the fertilizer industry. The project included a global assessment of nutrient balances on a country-by-country basis, comparing inputs and outputs from soil of N, P and K (Sheldrick et al., 2002; 2003; Sheldrick and Lingard, 2004). It was expected that the research would demonstrate that P was the nutrient in shortest supply, but unexpectedly this was not the case; K was shown to be the nutrient in greatest deficit on a global basis. Since then, the concept of 'peak phosphorus' has arisen

(Cordell et al., 2009), highlighting the need to consider mineral resource availability in the context of food security.

Comparison of fertilizer use statistics with nutrient balances confirms the shortfall in K, when considered on a per capita basis. World production of K fertilizers needs to double to compensate for offtake at the present time, raising serious questions about the ability of global K production to feed larger populations in 2050. At the same time, 'peak phosphorus' needs to be reconsidered, given that recent changes to the way in which geological reserves are calculated have led to an increase in the reserve base by a factor of 4, extending reserve life to over 300 years, demonstrating the artificial nature of the concept.

Keith Syers took an interest in alternative sources of K (Riggs et al., 1993), and the use of silicate minerals for this purpose remains controversial. Nevertheless, recent high prices and the restricted geographical location of existing K deposits means that there is still a need to find alternatives that are affordable and available, although they may not be ideal (Manning, 2009). The use of feldspars and feldspar-bearing rocks as a source of K, as envisaged by Syers and coworkers, is still valid. Since publication of his work in 1993, a number of more recent studies have shown that silicate minerals can act as sources of K, provided soil conditions are appropriate. Keith Syers' work and approach remain as valid as ever.

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Keywords : *potash, phosphorus, nutrient balance*

05-3

Contributions of Keith Syers to Knowledge of the Sulphur Cycle

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Sulphur in agriculture was a major theme of the research conducted by Keith Syers over a 30+ year period. This research was wide-ranging and dealt with many soil, plant and animal aspects of the sulphur cycle. In the late 1970s Keith's sulphur research commenced in New Zealand, where he supervised experiments evaluating "Biosuper", made from Christmas Island phosphate rock and elemental S, as a potential alternative P and S fertiliser to single superphosphate. In New Zealand and, later, in the UK, Keith and co-workers carried out a series of fundamental sorption studies to explain the variable leaching loss of fertiliser sulphate from a range of soils. Factors influencing sulphate retention (mineralogy, surface charge density, pH, competing anions, ionic strength) in soils were reported on in a series of papers. The strong link between the retention and the mobility/leaching of sulphate was demonstrated in column studies using soils with contrasting mineralogy. Microbial transformations of applied S (elemental S, sulphate-S) formed another important component of his S research. In association with plant scientists, the influence of S on crop yield and quality was investigated. Much of the crop research focused on oilseed rape (Brassica napus L), which, because it has a high demand for S, is particularly sensitive to S limitation. In summary, Keith Syers made seminal contributions to soil and fertiliser sulphur research. Not least of his contributions was the mentoring and stimulation he provided to the students and research associates who collaborated with him in that work.

Keywords : *sulphur, leaching, fertiliser,deficiency*

O5-4

J.K. Syers a Protagonist for the Direct Application of Reactive Phosphate Rocks to Pasture Soils

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In the 1970's, New Zealand and Australia were faced with diminishing supplies of high grade Pacific Island phosphate rock (e.g., Nauru) for single superphosphate (SSP) manufacture. Projections indicated that future SSP manufacturing costs would escalate when lower grade phosphate rocks had to be used and questioned whether the 50% government subsidy for fertiliser application could be sustained. The Primary Production Committee of the National Research Advisory Council (NRAC) in New Zealand set up a working party to report on research required to evaluate the efficiency of phosphate fertiliser use (NRAC 1978). Keith Syers, already on this committee of NRAC (1972-1978), was selected to chair the Phosphate Fertilizer Use Working Party (1978). The working party, recommended the initiation of research into the efficiency of phosphatic fertiliser use, and, that there should be "a substantial increase in the agronomic and chemical evaluation of a representative range of phosphate fertilisers. Materials should include rock phosphates for direct application, mixtures of rock phosphates with manufactured forms and new manufactured forms." This recommendation provided the mandate for the increased government spending and research activity on the evaluation of more reactive phosphate rocks (RPRs) and their derivatives as fertilisers, which occurred from the late 1970s onwards. As a consequence, trial samples of Chatham Rise phosphorite (CRP) that had been mined from the sea bed in 1976 were made into prototype fertilisers and tested against other P sources for agronomic effectiveness. A series of glasshouse and field trials were undertaken by Massey University (Gregg and Syers, 1981) and the New Zealand Ministry of Agriculture and Fisheries (Quin, 1981) which compared products made from CRP and Sechura PR with superphosphate. The glasshouse evaluations (Mackay et al., 1984) of a range of P fertilisers were supported by detailed studies on the chemical characteristics of the rocks and their dissolution rates in soils (Syers and Mackay 1986), which lead to an early model to explain the dissolution of RPR in soils (Mackay et al., 1986). The good agronomic performance of CRP and Sechura PR in the trials and their projection of the wider potential use for RPR in New Zealand (Gregg and Syers, 1982) created keen interest in further work on alternative P fertiliser manufacture and evaluation. In 1983, Keith founded the Fertilizer and Lime Research Centre at Massey University, which went on to make and test RPR /soluble P fertiliser mixtures and develop assay techniques to test their quality (Bolan et al., 1990). This paper examines Keith Syers' role in shaping the concepts for evaluating the agronomic effectiveness of slow release phosphate fertilizers in New Zealand pastures.

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Keywords : *Slow release phosphate fertilizers, reactive phosphate rocks, agronomic evaluation, dissolution*

05-5

Pedogenesis, Nutrient Dynamics, and Ecosystem Development: the Legacy of Keith Syers and T.W. Walker

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In a remarkable article published in 1976, T.W. Walker and J.K. Syers proposed a conceptual model of phosphorus transformations during pedogenesis that has transformed our understanding of nutrient availability and limitation in terrestrial environments. Distilling data from four New Zealand soil chronosequences, they observed that nitrogen is absent from most parent materials, so nitrogen concentrations are low in young soils but increase rapidly during the early stages of ecosystem development through biological nitrogen fixation. In contrast, phosphorus is derived almost exclusively from the parent material, so phosphorus concentrations are greatest in young soils but decline continuously during pedogenesis as phosphorus is lost in runoff at a greater rate than it is replenished by bedrock weathering. At the same time, chemical transformations further reduce the biologically available phosphorus pool by sequestering it in organic and refractory inorganic forms. As a consequence of these changes, the nutrient limiting primary production varies during ecosystem development, with nitrogen limitation on young, weakly weathered soils, co-limitation by nitrogen and phosphorus on moderately weathered soils, and phosphorus limitation on old, strongly weathered soils. These changes have profound ecological implications, determining the biomass, productivity, diversity, and composition of plant and microbial communities. The Walker and Syers model therefore enables us to understand and predict spatial and temporal patterns and consequences of nutrient limitation across the landscape, and remains one of the only theoretical models to unite dynamic changes in biogeochemical cycles with the development of above and below ground biological communities. The model has important implications for the development of novel agricultural systems that seek to optimize inputs of nitrogen and phosphorus fertilizers, and is of increasing importance as we try to understand the consequences of climate change, atmospheric nitrogen deposition, and other anthropogenic disturbances of biological communities and biogeochemical cycles.

Keywords : *Phosphorus, nitrogen, pedogenesis, chronosequence*

05-6

Keith Syers and P Use Efficiency in Agriculture

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This presentation will focus on Keith Syers' conviction that when phosphorus (P) is used efficiently in agriculture then this will lengthen the lifespan of the global P resource, ensure the production of optimum crop yields and help minimise the risk of the transfer of P from soil to the aquatic environment, where over-enrichment with P has adverse effects on the biological balance in surface fresh water. Keith's views on P-use efficiency was summarised in "Efficiency of Soil and Fertilizer Phosphorus Use", FAO Fertilizer and Plant Nutrient Bulletin 18, co-authored with Johnny Johnston and Denis Curtin. The unifying concept was that inorganic soil P is present in four pools related to their plant availability and extractability by chemical reagents. Readily plant-available P is that extracted by reagents used in routine soil analysis. The upper limit for the amount of P in this pool is that above which there is no further increase in yield - the critical level. Percentage P recovery/efficiency of added P is determined by a balance method (P output/P input x 100). For soils at or about the critical level, when P is added to replace that removed in a harvested crop, P-use efficiency often exceeds 80-90%.

Keywords : *Phosphorus use efficiency, Keith Syers*

O5-7

J.K. Syers on the Environmental Impact of Agriculture on Water Quality

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Keith Syers arrived at Massey University in 1972, replete with ideas and a vision for evaluating the impact of agricultural management on water quality. Prior to arriving in New Zealand, Keith spent several years at the University of Wisconsin, researching urban and agricultural runoff, which was initiated by a declining quality of the Great Lakes. Once at Massey, Keith assembled a group of keen doctoral and post graduate students to systematically assess the effects of soil phosphorus (P) chemistry, land use, and the fate and transport of P. His leadership produced ground-breaking results on the role of P sorption and desorption of added P in soil, the role of soil P in determining P loss in all flow pathways, and how simple chemical extractants of fluvial sediments and soils could estimate biologically or algal available P. These result are still key today and laid the foundation for a generation of research in the 1990's and 2000's, when the relevancy of P runoff, freshwater eutrophication, and harmful algal blooms focused global attention back to the identification and mitigation of nonpoint sources of P. As we move full circle to the present day, Keith's legacy is still widely relevant and crucial. The drivers of P-related water quality research have shifted from detergents to fertilizers, to manures, and most recently to sustaining efficient P use and recycling given the recent "discovery" that rock P was in fact a finite resource. The enthusiasm and vision of Keith and his unique ability to instill that into those who had the privilege to work with him, has provided a legacy that increased our scientific understanding of the fate of P in agricultural systems, allowed application of those findings to some agricultural production systems that are protective of the environment, and development of technically defensible environmental policy. This presentation will highlight the elucidation of P's role in soils and water quality, giving new and previously unpublished research will be given showing the long and winding road of Keith Syers's scientific contributions to nonpoint source P, which still resonate today.

Keywords: Agriculture, algal-available phosphorus, eutrophicationmanure, nonpoint source, runoff,water quality

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05-8

J.K. Syers on the Issue of Cadmium in Agricultural Systems

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Keith Syers first started researching cadmium (Cd) in agricultural systems the 1970's through his contribution to the development of sensitive analytical methods to measure Cd in soils in New Zealand during his tenure at Massey University in Palmerston North. At the time, concern about Cd was relatively new and improvements in analytical practices were important in ensuring the reliability of measurements of the low concentrations of Cd present in crops and soils. Over the years, Cd in agricultural systems developed into a global issue, with regulations formulated that had a major impact on international trade. In 1999, 25 years after his initial Cd work, Prof. Syers established a project "Environmental cadmium in the food chain – sources, pathways and risks" under the management of the Scientific Committee on Problems of the Environment (SCOPE). Keith co-chaired the Scientific Advisory Committee of this project with Prof. Mike Gochfeld of Rutgers University and organised a workshop in Brussels in 2000 to review the issue of Cd in the food chain, with a follow-up workshop in Ghent in 2003 to discuss management of the Cd issue globally. Keith's broad international experience gave him the ability to critically evaluate the issue from a range of perspectives encompassing the concerns of the developed nations to minimise long-term environmental risks as well as those of the

developing world, where ensuring food security was paramount. He recognised that Cd was a food quality issue where perceptions of health risks likely outweighed actual risks, and where controls on Cd could lead to increases in costs of phosphatic fertilisers and potentially penalise some developing country exporters of phosphate rock. Small-holder farmers could also risk losing important markets if their products were considered to contain excess Cd concentrations. This development was occurring in an era where food production in developing countries critically needed to increase through use of low-cost phosphate rock reserves, so that a balanced assessment of the Cd issue was needed.

The Cd issue in agriculture has developed significantly since 1976 when Keith first started working on measurement of Cd in soils. Analytical instrumentation has obviated the need for pre-concentration procedures like the one Keith and co-workers developed, and it is now routine and relatively simple to measure sub ppm concentrations of Cd in soils and crops. We have a much better understanding of the soil to plant transfer of Cd in agricultural systems, and we have developed agronomic and crop breeding methods to minimise Cd contamination of the food chain. Study of health effects in humans in soils geogenically enriched in Cd in Jamaica have challenged the level of concern shown for low concentrations of Cd in foods, and the World health Organisation has only marginally revised the tolerable intake values originally set in the 1970's. The importance of Cd interactions with other trace elements, both in the soil –plant system and in human and animal nutrition, has also been recognized, allowing more accurate assessment of risk of Cd to human health in a range of diets. We have a much better understanding of Cd balances in many agricultural systems, and these are now driving improvements in fertilizer quality in many countries towards zero net accumulation in soils. Many of these issues were raised at the SCOPE Workshops in 2000 and 2003 that Keith co-chaired. Participants at these meetings commented on Keith's innate ability to mix science of the highest quality with knowledge of policy issues where a delicate balance is needed between conservatism and economics. Keith's skills to bring divergent views to consensus will be missed as the Cd issue in agriculture is one where concerns for human health from contamination must be delicately balanced with concerns for human health by raising the cost or accessibility of essential and finite nutrient inputs for food production.

Keywords : *cadmium Syers environment*

05-9

Phosphorus-Metal (Loid) Interactions in Relation to Soil Remediation

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As land treatment becomes an important waste management practice, soil is increasingly being seen as a major source of metal(loid)s reaching the food chain, mainly through plant uptake and animal transfer. Land treatment of wastes has led to a significant build-up of a suite of metal(loid)s, such as arsenic (As), cadmium (Cd), copper (Cu), chromium (Cr), fluorine (F), mercury (Hg), lead (Pb), selenium (Se), and zinc (Zn). Entry of soil-borne metal(loid)s into the food chain depends on their amount and input sources, reaction with soil components, the properties of the soil, the rate of uptake by plants and the extent of ingestion by grazing animals.

With greater public awareness of the implications of contaminated soils on human and animal health there have been increasing efforts among the scientific community in developing technologies to remediate contaminated sites. Unlike organic contaminants, most metal(loid)s do not undergo biological or chemical degradation and their total concentration in soils persists for a long time. The mobilization of metal(loid)s in soils for plant uptake and leaching to groundwater can, however, be minimized by reducing their 'bioavailability' through chemical and biological immobilization. Recently there have been increasing interests in the immobilization of metal(loid)s using a range of soil amendments such as lime, phosphate (P) compounds, alkaline waste materials, and biosolids.

Regular application of P fertilizers has been identified as one of the main sources of certain metal(loid) (e.g., Cd and F) input to soil. Some of these P fertilizers that act as a source of metal(loid) contamination of agricultural soils have also been found to act as a sink for the immobilization of these metal(loid)s. For example, P amendment has often been proposed as a practical remediation option for sites with Pb-contaminated soils. Traditionally, P-metal(loid) interactions have been examined mostly in relation to P-induced deficiencies of essential elements (e.g., P-Zn interaction) and toxic elements (e.g., P-Al interaction). In this paper, case studies in which these P compounds have been used as a source for the mobilization (e.g., competitive As(V) desorption) and as a sink for the immobilization (e.g., charge-induced cation adsorption and metal precipitation) of metal(loid)s will be discussed. The practical implications of P-metal(loid) interactions are discussed in relation to the potential value of P compounds in the natural remediation of metal(loid)-contaminated soils.

Keywords : *Phosphorus, heavy metal(loid)s, bioavailability, mobility, remediation*

Conferences and upcoming events:

World Science Week New Zealand, 25 August -3 September, Auckland

World Science Week New Zealand brings together more than 2,000 of the world's leading scientists, researchers and government science advisors for an interrelated series of international science summits in Auckland from 25 August to 3 September 2014.

All of these international science summits are taking place in New Zealand for the first time. These include the 31st triennial General Assembly of the International Council for Science (ICSU) and the 6th biennial Open Science Conference of the Scientific Committee on Antarctic Research (SCAR).

Running concurrently with the scientific meetings is a series of public events around science topics, with some of the world's foremost experts sharing their insights.

October 2014

- **Biogeochemical Interfaces in Soil** – Towards a Comprehensive and Mechanistic Understanding of Soil Functions. **6-8 October 2014**, Germany.
  www.spp1315.uni-jena.de

- **9th International Soil Science Congress** on "The Soul of Soil and Civilization"
  14 – 16 October 2014. **http://soil2014.com**

- International Conference on Advances in Agricultural, Biological & Environmental Sciences **(AABES-2014) , Oct 15-16, 2014 Dubai (UAE)**
  http://www.iicbe.org/2014/10/15/51

- **EcoForum Conference and Exhibition. 29-31 October 2014**.
  http://www.ecoforum.net.au/program.html

- **2014 2nd International Conference on Sustainable Environment and Agriculture (ICSEA 2014)**. **October 29 & 30th**, San Diego
  http://www.icsea.org/

November 2014

- Latin America Soil Science Congress, Cuzco Peru **9-15 November 2014**
  http://www.slcs.org.mx/img/XX_Latinamerican_Soil_Science_Congress_Cusco_Peru.pdf

- **6th Global Workshop on Digital Soil Mapping**, **11-14 November, 2014**, Nanjing, China.
  http://dsm2014.csp.escience.cn

- **2nd International Conference on Environment Pollution and Prevention (ICEPP 2014)**
  www.icepp.org
  12th November 2014, **Auckland, New Zealand**

- **National Soil Science Conference-** MCG Melbourne, Victoria Australia
  23-27 November 2014. **www.soilscience2014.com**

December 2014

http://www.nzssconference.co.nz

- **International Conference on Agriculture, Biology and Environmental Sciences (ICABES'14) Dec. 8-9, 2014 Bali (Indonesia) www.iicbe.org**
  8th December 2014

January 2015

14th ISSPA International Symposium, 26th - 30th January 2015, Kona Beach, Hawaii

Abstract Submission deadline is 15th October 2015**.** Topics and submission guidelines are on the symposium website **www.isspa2015.com**

May 2015

18th International Soil Conservation Organization Conference **May 31 –June 5, 2015** El Paso, Texas
http://tucson.ars.ag.gov/isco/index.php

September 2015

LuWQ2015 - 2nd International Interdisciplinary Conference on LAND USE AND WATER QUALITY: *Agricultural Production and the Environment*, Vienna, Austria, 21-24 September 2015
More information is on **http://web.natur.cuni.cz/luwq2015/**
Abstracts are due by 1 February 2015. Abstract submission will be possible by end September 2014.

20th International Soil Tillage Research Organization Conference in Nanjing China **14-18 September 2015**. http://istro2015.csp.escience.cn/dct/page/1