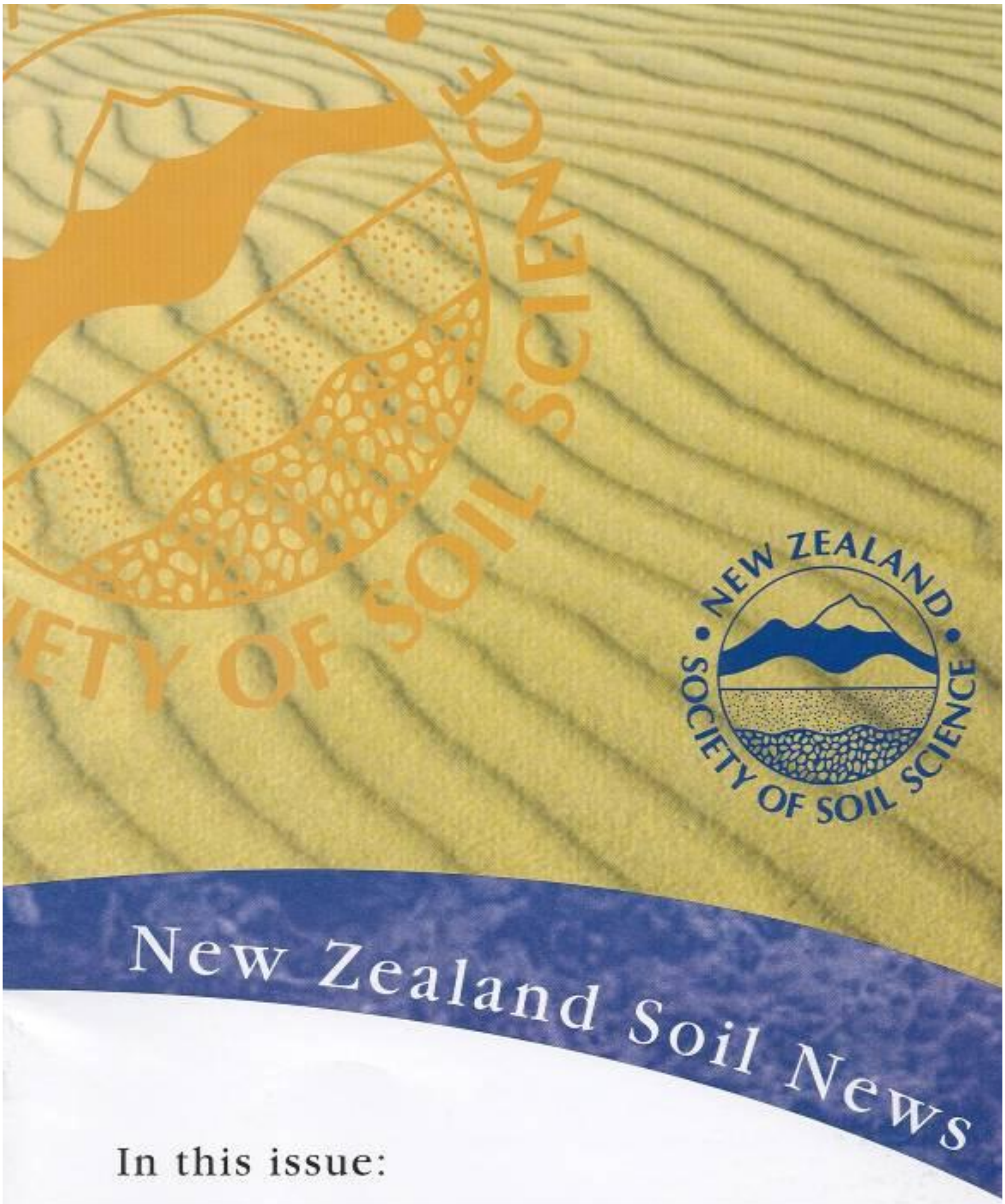

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Deadline............. for the **April** issue of Soil News is **Monday 7th April 2014**

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New Zealand Soil News

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Editorial – The urine patch: New Zealand's number one nitrogen nuisance. by Diana Selbie

Introduction

And now for something completely different… urine patches! Oh no! Ohhh yes. Probably the least 'sexy' area of soil science research in New Zealand. In the conclusions of Haynes and Williams' seminal paper on nitrogen in grazed pasture systems (1993), they stated: "Nutrient transformations in the excretal patch areas are of central importance to the fertility and productivity of grazed pastures." Is this statement still relevant? You bet it is. So what next? Do we have the solution? Do we understand the problem? What are we missing?

The basics

Animals all need to pee, us included. We excrete what we don't use. Farmed animals in NZ eat mostly grass while grazing outdoors, which usually contains far more nitrogen (N) than the animal needs for metabolism and growth (read: making meat and milk for us). So, a lot of N is excreted, and mostly in the urine rather than the dung. Here's the issue, right here: animals pee this extra N they don't need in one spot, a.k.a. the urine patch. Like the animal, the grass in the urine patch doesn't need all the N, and the excess can be lost into the environment. Ideally, all the N would be recycled through the pasture and consumed by the animals again, completing an efficient cycle.

The 'typical' urine patch

In the last 25 years, there has been a large body of soil-based research carried out on urine patch N dynamics, so we are certainly getting to a point where we have a pretty good grasp on the fate of N in the urine patch. We also have good knowledge through animal-based research of the amount of N excreted by animals, from N partitioning studies. For ease of designing experiments and communication, we have assumed a 'typical' urine patch which, for a dairy cow, is assumed to be 2 litres of urine with a N concentration of 10 grams per litre deposited over an area of 0.2 metres squared, equating to a N loading rate of 1000 kilograms of nitrogen per hectare. This 1000 kg N/ha loading rate has been almost solely derived from the Haynes and Williams paper in 1993, which interestingly, has received 530 citations to date (Scopus, 22 Feb 2014). In reality however, there is high variability in the N concentration, volume excreted and area of the urine patch, which in turn results in a wide range in urine N loading rates in the field. Therefore, by assuming a typical urine patch, we may be under or over-estimating the N loading rate. This is particularly important for the timing of urine deposition. A urine patch deposited in spring is likely to have very different attributes to one deposited during autumn, for example due to N content of the pasture, amount of N consumed, water intake, urine volume and the area of the pasture over which the urine is deposited. Improved information on these urine patch characteristics will link very well with information on seasonal pasture N utilisation and N leaching. First accepting that this variability in urine patch characteristics occurs, and then attempting to quantify it using appropriate experiments, might help us to identify mitigation options and *when* these mitigations are appropriate.

Systems thinking?

As researchers we can become very focussed on a particular pathway or process, or component of the farm system, and sometimes I think that we may miss the full picture.

Looking at the issue from another angle can provide new insights and solutions. I call this 'systems thinking', and it can apply a range of scales, from the urine patch to N cycling on a global scale. To use the example of a urine patch, looking at the fate of N in all of the possible pathways gives a different picture to focussing on a single pathway, such as N leaching. If we view a urine patch as a system of its own, we can better understand how it fits in the soil-pastoral system e.g. do we get a net uptake or removal of N in the soil in a urine patch? Another example closer to home is the use of OVERSEER® Nutrient Budgets *(Overseer)*, as a *farm system*. At the very least, *Overseer* highlights where the nutrient issues are in a farm system. Assuming you are modelling your farm appropriately (…), a large N leaching value for a dairy farm is usually related to urine deposition by the cows during grazing. People do question, argue, and criticise the model, but in the process of modelling nutrients at a farm system level, we are learning and accepting the fact that urine is the main problem (for nitrogen). Additionally, modelling at the farm scale can show us where emissions swapping may occur. If we bring all the animals off the pasture, are we simply swapping a leaching/water quality issue for an ammonia and greenhouse gas emission issue? The new knowledge and progress we can achieve when looking at things in a systems context is, in my opinion, exciting. Perhaps this type of thinking could be applied to any of our research, by taking a metaphorical step back and seeing its place in a 'system'.

A silly a-side

A common solution to solving issues between people is improved communication. What if farmers could communicate with cows? Imagine what we could achieve! Putting ourselves in their hooves could solve all the urine problems:

- Solution 1: Reducing urine patch overlap
  - Farmer: "Excuse me madam, would you mind terribly moving a little to your left; you urinated in that spot just this morning."
  - Cow: "Why certainly, when you ask so nicely."
- Solution 2: Reducing N excretion with diverse pastures
  - Farmer: "Have you been eating a balanced diet recently, or have you ignored my advice and selected the green bits?"
  - Cow: "I'm sorry! I have been trying to include variety, but its just so tempting when the delicious green grass is right there in front of me."
- Solution 3: Urine spread over a greater area.
  - Cow (urinating): "What? What are you looking at?"
  - Farmer: "I just wondered if you might, sort of, move around a bit, so the urine is spread out a little more."
- Solution 4: Dilution of urinary N
  - Farmer: "You should be drinking 20 L of water a day for your metabolism."
- Solution 5: Animals off the pasture in N loss vulnerable periods
  - Farmer: "This coming 2 months are going to be tough. I need you to hold on until you get to the shed. Will you do that for me? There will be incentives."
  - Cow: "Let's compromise. You give me a house, I'll stop peeing in the paddock."

Lessons learned

We are seeing more and more evidence of the benefits of including feed structures on farms to improve nutrient management. Slowly we are edging our farm systems (especially dairy) closer to a European-style, housed farm system where it is simpler to account for nutrients, and urine deposition to pasture in N loss vulnerable periods can be avoided. At the same time we seem to encounter resistance; we want our animals to range around freely and behave as they would in nature, rather than being cooped up in sheds. If we agree that we want to increase productivity, reduce environmental footprint and feed a growing global population, then the trade-off is likely to be a change in farming system to incorporate housing and improved effluent management. A Stuff.co.nz reader poll recently asked: Do you think it is okay for dairy cows to be housed in herd sheds? From the 609 votes, 30% said 'no', 27% said 'yes' and 43% said 'yes, but only through winter'. A small cross-section of the population, yes; but it shows at the very least that our opinions are mixed.

The bigger picture

While we're on the topic; do we actually want to increase production? The majority of our agricultural products are exported overseas. The opening slide of the key note speakers at each international conference I attend states that we *need* to feed a growing global population. But do we as New Zealanders really want this? And where does the attitude of 'increase, increase, increase' come from? Purely from a need to feed the world (for others), because we are required to do it (for government), or is it more the pursuit of the 'ideal' lifestyle (for ourselves)? But that's an article for another day.

In summary, are urine patches still relevant? Absolutely; as long as we still have animals grazing pasture, managing nitrogen in urine patches will be important. We can learn a lot more from the things other countries have done right, and wrong. Thinking of our research in a systems context can provide new insight and inspiration. And don't forget, we could solve all the urine nitrogen problems if we could communicate with cows!

------*Diana Selbie*

References:

Haynes, R.J., Williams, P.H., 1993. Nutrient cycling and soil fertility in the grazed pasture ecosystem. Advances in Agronomy 46, 119-199.

<u>Other notes</u>

Take home message. Urine patches continue to be the main problem for nitrogen in NZ. We should be learning more from others e.g. Europe.

Selling the topic, more people interested and willing to work in the area. How can we make urine sexy?

Systems thinking, combining expertise from a range of areas. Community involvement – it can work. As scientists – be very clear about what we do know, and also about what we don't know. The message we put across can be confusing. Science communication.

Other notes:

How many times have you read in a paper, 'animals were observed…'? How would you feel being watched eating and going to the toilet.

Points to keep in mind:

- Urine patch role in full GPS – scale
- Central issue is the hotspot of N, too much
- Urine N main driver of N leaching, in Overseer. Most effective mitigations are where animals (urine) are removed from pasture.

Obituary – Professor Kuan Meng Goh

Professor Kuan Meng Goh
MAgrSc, PhD, JP, ONZM, FRSNZ, FNZIC, FNZSSS
25 May 1935 - 10 January 2014

Emeritus Professor Kuan Meng Goh died at Christchurch Hospital aged 78 years. His death was unexpected, as he was understood to be in good health and was anticipating a trip with his wife Nancy to Vietnam and Cambodia. He had retired from Lincoln University in 2008 after 37 years in Department of Soil Science, although retirement meant a change in focus to other related activities. The culmination of his international recognition came in 2005 when he contributed six chapters to a joint United Nations FAO/IAEA book entitled *Carbon Isotope Tracers in Investigating Soil Carbon Sequestration and Stabilisation in Agro-ecosystems.* This book was a major contributor to Kyoto-era science. Subsequently he was one of five international experts reviewing the role and worldwide contributions of the FAO/IAEA Agriculture and Biotechnology Laboratories – Soil and Water Management and Crop Nutrition, Plant Breeding and Genetics, Animal Production and Health, Insect and Pest Control and Food and Environmental Protection. Professor Goh's expertise was in the field of soil organic matter and soil nutrition using a wide range of isotopic techniques.

The following is from the oration given on behalf of the Lincoln University community at Professor Goh's funeral. The occasion was attended by a large gathering of City dignitaries including the Mayor of Christchurch Lianne Dalziel, family and friends from the Chinese and Multicultural communities in Christchurch and elsewhere, friends, academics, scientists and colleagues from Lincoln University.

In Kuan's words - "The soil is the basis of all things Natural. You can make anything grow from soil. I grew up loving soils as my parents owned a rubber plantation in Kajang back in the days when Kajang was still very rural".

Professor Goh first came to New Zealand in 1957 from Malaysia as a student under the Colombo Plan, undertaking an intermediate year at Auckland University College prior to enrolling at Massey Agricultural College. He graduated BAgSc in 1961, was awarded a Senior Scholarship and completed his MAgSc in 1962 with a specialization in Soil Science. Returning to Malaysia with his New Zealand wife Nancy, he was appointed Junior Lecturer and then Lecturer in Soil Science in the Faculty of Agriculture in the University of Malaysia. There he taught courses in tropical soil fertility, soil conservation and soil chemistry. During this time the Goh's met up with two New Zealand couples. Bruce Ross was at the University and his wife Gill worked with Nancy at the New Zealand High Commission. Arthur Adams from Lincoln's Soil Science Department was on secondment to the University of Malaysia and he and wife Margaret formed a strong friendship with Kuan and Nancy. These relationships were renewed many years later at Lincoln College (now Lincoln University).

In 1965, Kuan was granted leave to take up a Fulbright Scholarship at the University of Illinois at Champaign-Urbana to study for a PhD in Soil Organic Chemistry under Professor F.J. Steveson. This University is one of most famous of the Land Grant Universities in the mid-western USA and noted for its academic prowess in Agronomy and Soil Science. Kuan completed his PhD in 1969. He was for a time a Teaching Assistant in Biometrics – a branch of statistics that was a mainstay of his later research career.

At this point Kuan had options of returning to Malaysia or coming to New Zealand. In an interview he explained, "I chose New Zealand for various reasons. I felt I could do more in my career over in New Zealand and I liked the environment and wanted to raise my family there. It's safe and green. Also Nancy is from New Zealand." In 1969 Kuan accepted a position as a soil organic chemist in the Soil Bureau DSIR at Taita in the Hutt Valley. He was only in this position from 1969 to 1971. The then Director Dr Bruce Millar was impressed with the manner in which Kuan organized, conducted and published his research. He published several papers on soil organic matter including a study of Kelp extracts. This later resulted in Kuan appearing as an expert witness in a legal case of the Crown versus Maxicrop in which Dr Doug Edmeades had a key involvement. Doug was one of Kuan's earlier PhD students at Lincoln College.

In 1971 Kuan accepted a position as a Senior Lecturer in Professor Tom Walker's Department of Soil Science at Lincoln College. Kuan's arrival coincided with a revitalization of the teaching and research program in the Department. His efforts were recognized with promotions to Reader (now Associate Professor) in 1978 and to Professor in 1991. This was a Personal Chair and the first awarded to a soil scientist in a New Zealand University.

It is hard to summarize Kuan's contribution to the University and to Soil Science. His Curriculum Vitae (CV) runs into more than thirty pages. On the research side he has a list of some 300 publications. In addition to his own work these resulted from the studies of postgraduate students he supervised. These included 19 PhD, 9 Masters and 14 Honours students, 4 Post-Doctoral and Research Fellows, as well as overseas scientists with whom Kuan collaborated. Some of his students have gone on to establish themselves in New Zealand as soil scientists, academics, advisors and as administrators, such Associate Professor Paul Gregg, Dr Doug Edmeades, Dr Mary Wallis (formerly Williams), Associate Professor Robert Sherlock, Professor Leo Condron, Dr Philip Hart and Dr James Buwalda and in South Africa Professor Dick Haynes. Then there are the others who returned to their countries of origin on completion of their doctoral studies. The topics covered Professor Goh's research career were wide ranging stemming from areas of soil organic matter chemistry and dynamics, soil carbon sequestration and climate change, the cycling of soil nitrogen, soil phosphorus and soil sulphur. He used innovative techniques in his research that included isotope chemistry, nitrogen-15 and sulphur-35 isotope research, radiocarbon dating, and nuclear magnetic resonance spectroscopy using carbon-13 and phosphorus-31. These studies were applied to agriculture, horticulture and forestry.

As a postgraduate supervisor Kuan had a particular style that at times led to conflict with some of his students. This often arose from his demand for well replicated and statistically validated experiments. This could mean a lot of extra work for the students. At times raised voices would ring down the corridors as the battle raged in Kuan's office. On later reflection these students would acknowledge the robust way Kuan would approach a scientific problem and the importance he placed on the appropriate use of statistics in both the design and interpretation of experiments. He was a good supervisor and always available to discuss anything and guide students through the PhD process, something often realised after the event. He taught the importance of publishing work believing this was the true measure of research quality.

Rob Sherlock remembers, that when Kuan first arrived at Lincoln he had an abacus on his desk that he used for calculations, later to be replaced by an old adding machine with a paper tape that he saved from being dumped. It was thought he only gave up this machine when paper tapes could no longer be obtained and so he eventually moved on to an electronic calculator. For many years Kuan wrote his research papers in long hand, to be typed by secretary Lynn Mason. At times there were problems with the arrangement of typescript, figures and diagrams that Kuan insisted had to be fitted on to a page. Again this resulted in some discussion and Lynn would plead with Kuan but to no avail, it had to be done his way. Kuan had an amazing memory that he kept honed by adopting his own unique cataloguing system. Over the years he amassed a library of reprints on various research topics that he stored in cardboard file boxes. His system however had no labels, and he amazed his students in knowing where everything was filed. When ask how he did this he would smile and say "you just have to train your memory". Paul Gregg was Kuan's first PhD student and recollects that although they were only three years different in age they got on very well. Kuan had little practical field experience but was keen to assist Paul with his field trials. Paul has a lasting memory of Kuan using a rotary mower to measure the plot yields on one of his field trials. "Not that familiar with a rotary mower, Kuan failed to stop at the end of the plot and ended up taking out a fence enclosing the trial area. Nonplussed he picked himself up and continued with yield measurements. Unlike me, he did not see the funny side at all!"

Kuan taught courses in soil management and the role of fertilizers and their application. His emphasis was on the management of vegetable and other horticultural crops and orchards. He taught courses to both Degree and Diploma students in Horticulture and Agriculture. Of particular significance was his role as an International Student Advisor. The annual International student evening where food was a feature reminded Kuan of his days in Malaysia. Although not a good cook he missed Malaysian food. Kuan has had various administrative roles mostly relating to academic matters within the University and was at times acting head of the Department of Soil Science. Both within and more specifically outside of the University he had a significant role as a Justice of the Peace.

Outside of the University Kuan was active in extension programs, from courses for home gardeners, farmers, horticultural growers, and for field staff of fertilizer companies. In addition he provided technical advice to consultants, Crown Research Institutes and Regional Councils. From time to time he was called as an expert witness in court cases involving litigation. Kuan maintained a varied number of international connections with academic and research groups, particularly in the People's Republic of China, Japan, South Korea, Thailand and Malaysia. These have involved invited lectures, being a keynote speaker at conferences, and as a consultant and reviewer of academic and research programs in horticulture and agriculture. His reputation has led to him acting as reviewer for some 42 international and national scientific journals and publications.

In his career Kuan received a number of Honours and Awards as an acknowledgment of his status as a Soil Scientist. Only a few of these are mentioned here. He was a Fellow of the New Zealand Institute of Chemistry (1976), the Royal Society of New Zealand (1994) and the New Zealand Society of Soil Science (1995). In 1997 he was awarded the Soil Science Societies highest acknowledgement, the Norman Taylor Memorial Lecture. He received a Special Achievement Award in Research and Creative Activity from Lincoln University in 1994 and an A grade (World Class) in Performance Based Research Fund Assessments (PBRF) in 2003. In 1999 he became an Officer in the New Zealand Order of Merit (ONZM) in the Queen's birthday honours for services to Soil Science and to the Chinese community in New Zealand.

When Kuan first arrived in New Zealand he thought it was to study Natural Science. Not knowing what Natural Science was he asked a Ministry of Foreign Affairs Officer and was told, "it was to be Natural". Thank you Kuan for your dedication to Soil Science as a teacher and researcher and contributor to the World community – and as you came to appreciate this made you a significant and widely respected Natural Scientist.

Contributed by Dr Philip Tonkin on behalf of Professor Goh's colleagues in Soil Science at Lincoln University.

Tribute to "the Big KMG"

By Dick Haynes

No doubt this issue will feature a story about Kuan Goh (the big KMG) who died in January at the relatively young age of only 78. I remember him as both my Honours and PhD supervisor, many, many, years ago. When I was an honours student (1975), Soil Science was still in the old building along with some prefabs up the road. TW Walker (or "the old man" as Kuan often referred to him in a respectful way) was the Head and Arthur Adams was the Reader (and administrator). Kuan had an office on the bottom floor with a mechanical adding machine (with bits that went round and round) on his desk. Yes, younger readers, there were no personal computers in those days. In fact Lincoln College had a big mainframe computer in a building adjoining the Hilgendorf Wing and it was so big they craned it in there and then built the roof of the building over the top. I'm sure the whole thing didn't have the power of a normal PC of today. Anyway when you did statistical analysis of data you had to get heaps of punch cards that told the computer what to do and which contained all the data. Then you got someone to feed them into this big machine and sometimes results came out overnight. Kuan circumvented the use of the mainframe computer by working out Analysis of Variance and other statistical analyses by hand with the aid of this adding machine. The machine seemed to disappear the next year when Soil Science moved into the new Burns Wing.

Kuan had a very good sense of humour and wasn't the boring archetypal academic at all. He could play that part if he wanted to. He found people making fun of the Chinese accent on TV particularly funny. Benny Hill (an English comedian for younger readers) used to do silly skits on his TV show including ones as a chinaman. When the Englishmen couldn't understand the accent he would say "silly irriot" and Kuan would often call me the same! When any piece of equipment, including his adding machine, went wrong he would call it a "bloody ting"; much to my amusement. During the late 70s there was a new kind of frozen meat and vegetable patty brought out in NZ (by Birds Eye, I think) called a "frying saucer". The extremely non-PC advertisement of the time featured "cookie boy" an asian (Chinese) stereotypic young man doing some cooking on the barbeque and throwing one of these things in the air like a flying saucer and he exclaimed "Ive discovered a frying saucer!" Kuan thought it was very amusing. He also found it terribly funny that TW ("the old man") carried a hip flask filled with whisky in his jacket pocket on student field trips (particularly in the winter) and took a swig of it every now and then just "to keep warm"! One year (in the early 80s I think) Kuan was asked to do the summing up for the NZFMRA conference in Auckland. It ended up as a one man comedy show - with a serious scientific side as well. It was so well presented, I still remember it!

Kuan was really into statistics (biometry for younger readers) since he did his PhD at Illinois State University and Stats was part of the compulsory course work. His experiments always ended up being very big (because of the high number of treatments and replicates) and it was part of the system for his students to argue him down so the experiment became of manageable size! Being a cheeky upstart and a bit anti-establishment myself, I was quite good at it!! I must say Kuan was exceptionally tolerant and seemed to take it all in his stride. He was particularly tolerant of me even though sometimes I may not have deserved it. However, I did end up with a very large number punch cards to do statistical analysis on my honours project (a whole box full, I seem to remember)!

Kuan had an amazing work ethic and was always ambitious to become a Professor. He would get up in the middle of the night and work until morning writing a scientific paper. Kuan was, in fact, promoted very rapidly up the ranks and this was a testament to his incredible capacity for hard work (I remember him telling me hard work never hurt him). I tell my students that too! He had an ethos that scientific outputs counted for almost everything and talk for very little. He therefore had an innate respect for people such as TW and RS (Roger Swift) because they were undoubtedly good scientists. He had little time for people who took "the easy way out" and I was told not to do that on numerous occasions (especially when trying to reduce the size of my experiments)!

Kuan lectured to undergraduates – especially the horticulture students. Like TW, he always stressed the importance of organic matter management as an integral part of soil fertility management but didn't have a lot of time for the alternative (organic) side of agriculture. He was well-known for appearing as an expert witness in the famous Maxicrop case. His lectures were straightforward and logically presented, the exams fair and the marking also fair. He was always approachable and had no problem in chatting to the students before and after lectures. As a supervisor of postgraduates Kuan was characteristically available. You could walk into his office and he would make time for you then and there – that's something I really appreciated and that I practice with my postgraduate students today. He also spent a lot of time to go through the text of a thesis line by line and word by word! I guess that was part of "not taking the easy way out" as some supervisors tend to do. Kuan never seemed to talk down to students; he had a common touch and a desire to help (even if we didn't always seem to appreciate that at the time).

Kuan also contributed to the wider community in a substantial way and took these roles very seriously. He was a JP from 1983-2002 and used to serve in the District Court on weekends. He was also a marriage celebrant and presided at the marriage of at least one of his former students. He was also very active in the New Zealand Chinese Association and the Christchurch and New Zealand Ethnic Councils. For his contributions in both soil science and community service he was awarded Officer of the New Zealand Order of Merit in 1999.

Most of his students from my era found their way into top jobs over the years including in the university system (Professors Leo Condron and Patma Vityakon, Associate Professors Rob Sherlock and Paul Gregg), in research organisations (Drs Phil Hart, Long Nguyen, Mike Phillips), private enterprise (Drs KK Kee, Doug Edmeades and Sammy Heng) and science administration and the public service (Dr James Buwalda). I'm sure there are also many more success stories from later in his career. So, if an academic staff member is judged partly on the success of his students then Kuan did pretty OK! Although I wouldn't like to admit it too much, I'm sure he had a large impact on my career and I gratefully acknowledge his influence.

Dick Haynes
Professor of Soil and Environmental Science, The University of Queensland

The Dirt

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

The success of the nutrient budgeting model Overseer® has led to an exciting new opportunity for two of the lead scientists working on its development. David Wheeler and Mark Shepherd have accepted an offer by the Mongolian government to develop Genghis Overseer and will spend the next 2 years travelling around the country and acquainting themselves with Mongolian farm systems. Mark Shepherd says that he is looking forward to

following the camel herders of the Gobi desert, but not sure how the typical nomadic lifestyle will translate into management blocks used in Overseer ®. As he says “They raise and graze basically the same animals as they do here: sheep, goats, cattle, horses, camels, and pigs. So I don’t think we will need to make a great deal of change to the model –except for the camels …and the yaks”. David Wheeler is also very keen about the move and enthused “at least it’s not Lincoln or Palmerston North!”

News from the Regions

Waikato/Bay of Plenty

AgResearch Ruakura

Stewart Ledgard was in Rome once again to attend a two day meeting with FAO to develop up the Guidelines on environmental benchmarking of small ruminant systems and products globally. Closer to home, **Jiafa Luo** and **Dave Houlbrooke** helped to host a group of scientists from the Shandong Academy of Agricultural Sciences. Also, in January was the first gathering of the Hamilton Land & Water Scientists that Socialize (or the Hamilton Social Scientists for short). Around 20 scientists from AgResearch, NIWA, Landcare Research, Waikato University and Waikato Regional council met at the Ruakura campus club for a drink and chat after work. Next meeting is Thursday March 27th @ 5pm at the Ruakura campus club.

Dave Houlbrooke and **Anwar Ghani** have begun working with **Paul Johnstone** and **Mathew Norris** from Plant and Food as part of the new MBIE programme run by DairyNZ entitled ‘Forages for reduced nitrate leaching’. The collaboration relates to the use dairy effluent solids (i.e. manures and slurries) and their re-use on cropping paddocks in order to undertake closed loop nutrient management. The key issue to understand relates to the release of organic N to supply plant growth from a range of different effluent types and farmer decision making support.

The Massey University FLRC workshop in Palmerston North was well attended AgResearch Ruakura scientists with presentations given by **Natalie Watkins** (Overseer), **David Wheeler** (Overseer**), Dave Houlbrooke** (dairy effluent), **Bob Longhurst** (dairy effluent) and **Diana Selbie** (nitrogen leaching). The event again provided a useful context of the nutrient management issues facing NZ agriculture and some potential pathways forward.

A new face among the team at Ruakura is **Jeerasak Chobtang**. Jeerasak is a Massey University PhD student based at Ruakura and supervised locally by **Stewart Ledgard** & **Marlies Zonderland-Thomassen**. Jeerasak's project is aimed at assessing environmental sustainability of milk production systems in New Zealand by using a Life Cycle Assessment approach in a combination with relevant modelling approaches, taking into account the effects of land use and land use change. Jeerasak earned his B.Sc (Agriculture) and M.Sc. (Animal Science) from Prince of Songkla University, Thailand. He also has an M.Sc. (Animal Production Systems) from Wageningen University, the Netherlands. Before coming to Massey, Jeerasak was a researcher and extension officer at Department of Livestock Development, Ministry of Agriculture and Cooperatives of Thailand.

And finally, congratulations to **Diana Selbie** who successfully defended her PhD thesis entitled *The fate of nitrogen in an animal urine patch as affected by urine nitrogen loading rate and the nitrification inhibitor dicyandiamide*. Her supervisors are **Keith Cameron**, **Hong Di** and **Jim Moir** (Lincoln University) and **Karl Richards** & **Garry Lanigan** (Teagasc). Well done!

Waikato University

We welcome Prof **Noah Fierer** (University of Colorado, Boulder) on sabbatical for six months being hosted by **Louis Schipper**. Noah is an extremely accomplished young scientist and has a wide range of interests focusing on ecology of bacteria, fungi, and archaea in both natural and engineered systems. Three other visitors (in sedimentary geology) from the UK and China (2) are also spending sabbaticals in the department at present. We also welcome **Mahdiyeh Salmanzadeh** from Iran who has arrived to commence a PhD study with **Megan Balks, Adam Hartland,** and **Louis Schipper**. **Emma Bagley** has commenced her masterate fieldwork on a study of pasture pulling on Pumice Soils.

We farewell **Nadia Laubscher** who is in the final stages of completing her MSc study on the effects of soil flipping on moisture holding capacity of Pumice Soils. **Courtney Ruffell** and **Staci Boyte** worked with us over the recess as summer students on environmental controls of CO_2 production from soils and litter. Staci examined temperature controls of soil respiration and Courtney investigated photo-degradation of plant litter in restiad bogs. They made a beautiful cake based on an instrument they both used – an infrared gas analyser (Fig. 1).

Fig. 1. Courtney Ruffell and Staci Boyte and their infrared-gas-analyser-like summer cake. *Photo*: Louis Schipper.

New staff

Meanwhile in other news we have appointed three new staff. **Chris Morcom** was appointed late last year as a technician in the department helping in part with carbon group research and coastal marine research. Dr **Hazel Needham** has been appointed as a senior tutor for our big first-year ‘flagship’ papers, and began in early February. Finally, **Dr Bethany Fox** has been appointed as our new lecturer in sedimentary geology, replacing **Cam Nelson** who retired in mid-2012. Beth, scheduled to arrive in early April, has degrees from Cambridge University, the Open University, a certificate from the University of Helsinki, and a PhD from the University of Otago where she worked on a 100-metre-long lake sediment core from Miocene-aged Foulden maar near Dunedin.

Semi-centenary, sesquicentenary, and septingentenary

This year, 2014, is the year of anniversaries in this neck of the woods. The **University of Waikato** is celebrating its 50th anniversary. The semi-centennial events kicked off with an afternoon tea and birthday function on Friday 14th February – the 50th anniversary of the university’s first Council meeting on 14 February 1964. More than 400 former and current staff attended. Former vice chancellors, **Dr Wilf Malcolm, Bryan Gould**, and the current VC **Professor Roy Crawford**, were present (Fig. 2). (Founding VC, **Sir Don Llewellyn**, passed away in 2004.) A book about the university’s first 50 years *Ko Te Tangata* by Emeritus Professor *Noeline Alcorn was launched at the event (Fig. 3). The founding professor of the Department of Earth Sciences, Emeritus Professor John McCraw, and founding staff member Emeritus Professor Michael Selby, were also present at the function (Fig. 4). Both were appointed in 1969 to prepare for the first intake of science students in 1970.*

Fig. 2. Three **VCs:** current Vice-Chancellor Prof Roy Crawford (left) with former VCs Dr Wilfred Malcolm (middle) and Bryan Gould (right) with the university’s 50th anniversary birthday cake. *Photo*: Univ. of Waikato.

Fig. 3. Book author Emeritus Professor Noeline Alcorn with university Chancellor Jim Bolger (left) and Vice-Chancellor Professor Roy Crawford (right). *Photo*: Univ. of Waikato.

Fig. 4. The first and the last at the semi-centenary of the University of Waikato (14 February 2014). Emeritus Professor John McCraw (right), foundation professor and head of the Department of Earth Sciences, with Professor David Lowe (left), the current and last chair of the Department of Earth and Ocean Sciences. The latter is finishing as a separate department on 31 March 2014. *Photo*: Maria Lowe.

Hamilton city is commemorating the sesquicentenary of its European founding in 1864, appropriately enough attaining a sesquicentennial-like population currently of 150,000.

But perhaps the 'biggest' anniversary is that of the Kaharoa eruption that took place at Mt Tarawera 700 years ago in the winter in 1314 AD (± 12 years) (Hogg et al. 2003). This year is its septingentenary. (Yes, that's a real word meaning 700th anniversary – you read it in Soil News first!) The Kaharoa eruption is important for several reasons.

Firstly, it is the most recent rhyolite eruption in New Zealand. Following very explosive phases that resulted in a swath of siliceous tephra being deposited over much of North Island and beyond (Pullar and Birrell 1973; Pullar et al. 1977; Lowe et al. 1998), several steep-sided rhyolite domes were emplaced forming the modern morphology of Mt Tarawera (Fig. 5) (Nairn et al. 2001, 2004). The eruption was followed by a 'break-out flood' event from Lake Tarawera (Hodgson and Nairn 2005). Basaltic eruptives during the well-known 'Tarawera eruption' punched through the Kaharoa rhyolite domes on 10th June 1886.

Fig. 5. Birthday boy: Mt Tarawera in its septingentenary year as viewed across Lake Tarawera (3 Feb, 2014). Brilliant white sandy beach comprised mainly of (reworked) Kaharoa pumiceous tephra. *Photo*: Maria Lowe.

Secondly, the Pumice Soils that developed in the Kaharoa tephra in the Bay of Plenty were, like those on Taupo tephra, deficient in metals including cobalt and thus stock on them suffered "bush sickness" until the remedy was discovered in the mid-1930s (Lowe and Palmer 2005). It was L.I. Grange's connection between the occurrence of bush sickness and the soils formed in Kaharoa (and Taupo) tephras that resulted in Soil Survey become a separate division of DSIR in 1936 rather than effectively an 'add-on' to Geological Survey as it had been (Tonkin 2012).

Thirdly, the Kaharoa tephra forms a 'settlement datum' for the timing of earliest Polynesian settlement in North Island (Newnham et al. 1998; Hogg et al. 2003; Lowe 2011) and has an important role in late Holocene stratigraphy and geoarchaeology (Lowe et al. 1998, 2000, 2002).

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Manawatu/Hawke's Bay

Massey University, Palmerston North

The following is a report by Magret Damaschke's, PhD student in Soil and Earth Sciences following a recent field excursion:

Blasts from Taranaki's Past

In the rolling green farmland surrounding Mt. Taranaki, we are looking into the volcanic history by investigating volcanic ash layers (i.e. tephras) within the base of swamps and lakes. By collecting several high-quality sediment cores we expect to gain a new view into the time-varying dynamics of the volcano and its magmatic system with unprecidented detail. Using the principle that "the past is the key to the future" these studies will help us to understand and update our probabilistic forecasts of eruption onset and ash-fall thickness onto pastures, cities and infrastructure, with support of the New Zealand Natural Hazards Research Platform.

Percussion hammer operated by David Feek and carefully observed by PhD student Magret Damaschke.

Triple manpower by Shane Cronin, David Feek and Alan Palmer. Dairy Farmer Steven Styger (to the right) gave his OK!

In December 2013 and January 2014 Shane Cronin, Kat Holt, David Feek, Alan Palmer and PhD student Magret Damaschke spent several days in the Taranaki region to recover "the past". Swamp and lake environments, especially in areas with little fluvial influx, are renowned for their continuous sediment accumulation over long periods and their high preservation potential for volcanic ash layers, ranging from tens of cm to less than a mm-thick. The very large Eltham and Ngaere swamps, situated 27km south-east of the volcano between the volcanic ring plain and the rolling hill country, as well as the smaller Tariki and Midhirst swamps east of the mountain, were sampled with a percussion coring system. A steel core barrel with an inserted PVC-tube of 1 m length was hammered into the peaty ground using a hydralic percussion system. A hydraulic jack and triple manpower were needed to extract the core barrel afterwards, especially once below 10 m! The longest sediment-core measured 12 m and spans at least 36,000 years of volcanic and environmental history.

The Richmond-Rd Lake with Mount Taranaki in the background.

Another exciting lake, located 25km north-east of Mount Taranaki, aroused great interest among the science team due to its position in a very old landscape, and below the main dispersal axis of major tephra falls (on their way to Auckland). This new archive not only gives us the opportunity to improve and extend the eruption record of Mt. Taranaki but also enables us to link to existing tephra records such as nearby Lake Umutekai, Lake Rotokare, and other sites that encircle the volcano. Our broad network of coring sites will help us to examine the variations in tephra dispersal caused by paleo wind-direction shifts from the last Glacial to the present day. We recovered 5.68m of lake-sediment from the deepest part of the lake using a raft and a hand-operated Livingstone piston corer. Unfortunately, several of the coarse tephra layers, up to 10 cm thick and with cm-sized fragments, jammed our equipment. Our next challenge will be to adapt our coring system to penetrate these tough areas and ultimately reach greater depths to produce a more detailed volcanic eruption record of Mount Taranaki and hopefully link the Taranaki region core data with that collected from the older sequences within Auckland maar craters.

The project is part of Magret Damaschke's PhD research, which is funded by a Massey University Doctoral Scholarship. Magret Damaschke completed her Diplom Geology at the University of Cologne in Germany.

A recent article from the NZ Farmer *(courtesy of Fairfax NZ News):*

Massey University's cows look happy in their huge new barn - but they're not there just for their own comfort. The barn, at Massey University's No 4 dairy farm, is part of a research effort to reduce dairying's environmental footprint and to improve productivity.

The barn cost $1.4 million to build and houses more than 200 cows in stalls. The ends are open to allow feed to be brought in, and effluent is deposited in aisles which have automatic scrapers. Project manager and agricultural research officer Christine Christensen said 200 cows go in the barn for part of the day. Currently, researchers are evaluating bedding uptake by the cows. The cows aren't being housed fulltime, rather the research is exploring how the barn might best be used as a management tool to increase the amount of pasture grown and harvested by the cows, and reduce the environmental footprint by better timing the collected effluent being redistributed onto paddocks.

Photo courtesy of WARWICK SMITH/Fairfax NZ

IMPROVING PRODUCTIVITY: Cows are being housed in a new barn at Massey University’s No 4 dairy farm. The project co-ordinator is agricultural research officer Christine Christensen.

The building will partly house cows, particularly in winter and spring, to combat the wet soils and treading damage at that time of the year, and through the autumn months for reducing urine patch deposition and consequently nitrate leaching. Dr Christensen said there were two herds of 200 cows each, one being partially housed with the other being managed using a standard feedpad system. The housed cows' effluent would be pumped out of the shed into a new pond being constructed alongside the barn. "The effluent will be collected in winter, stored and then re-applied evenly in spring." She said at the moment the cows were trialling beddings of sand, covered foam, and rubber to see which the cows felt most at home on.

Dr Christensen said the building was built to high animal welfare standards and was a state-of-the-art barn. "Sometimes cows will be in here for 24 hours a day. So it has to meet all the animal welfare considerations, and it does."

The research is part of Pastoral 21, a collaborative venture between DairyNZ, Fonterra, Dairy Companies Association of New Zealand, Beef + Lamb NZ and the Ministry of Business, Innovation and Employment. Its goal is to provide solutions for profitably increasing pastoral production while reducing farms' environmental footprint. Dr Christensen said Massey University's No 4 dairy unit was a commercial farm, and an objective of the research was to recoup the money spent on the barn, through less treading on wet pasture with its loss of feed, combined with more even and carefully timed applications of effluent.

The 27th Annual Workshop held by the Fertilizer and Lime Research Centre (FLRC) on 18-20 February was attended by more than 270 delegates from New Zealand and Australia representing universities, CRI's, fertiliser industry, private consultancies, regional councils, national policy-makers and farmers. The theme this year focussed on 'Nutrient Management for Farm, Catchment and Community'.

The week was the warmest of the Manawatu summer so far, with temperatures up to 33°C on the Wednesday, putting pressure on the air conditioning in the lecture theatres but making for a glorious evening at Wharerata for the 160 who attended the dinner.

Eighty two papers were presented in the three days programme with four invited speakers delivering keynote addresses:

> **Dr Cameron Gourley - Dept of Environment and Primary Industries, Victoria, Australia**
> Project Leader of the 'National Accounting for Nutrients Project' in Australia – gave an address on the efficiencies of nitrogen use on Australian dairy farms
>
> **Dr Warwick Dougherty - Dept of Environment and Primary Industries, New South Wales, Australia**
> Contributor to the 'National Accounting for Nutrients Project' in Australia – gave an address on the efficiencies of phosphorus use on Australian dairy farms
>
> **Professor Steve Raine, University of Southern Queensland, Australia**
> A leading Australian researcher in the area of soils and irrigation – gave an address about advances in intelligent and autonomous systems to improve irrigation and fertiliser efficiency
>
> **Associate Professor John Fulton - University of Auburn, Alabama, USA**
> Research and Extension Specialist in Biosystems Engineering - gave an address about US experience of research and extension associated with improving granular fertiliser application on-farm

Proceedings will shortly be published on the FLRC website at http://flrc.massey.ac.nz/.

Plant & Food Research – Palmerston North

Steve Green & **Brent Clothier** have recently completed a field campaign of research in the United Arab Emirates to determine how much water date palm trees use, and to quantify the allocation requirements for irrigation water across the Emirates for a range of trees and crops. The project is funded by the New Zealand Ministry of Foreign Affairs and Trade and Environment Abu Dhabi. Plant & Food are contracted through Maven Consultants. They put in TDR probes to measure the changing pattern of soil water content in the root zone of the palm tree. Heat-pulse sap flow probes were also installed in the trees to determine directly, every 30 minutes, how much water the trees are actually using. The next phase of the project is to develop a decision support tool for Environment Abu Dhabi to enable them to allocate their scarce irrigation water reserves for a range of crops, soils, and climates across all of the Emirates.

Brent Clothier and Wafa Faisal Al Yamani of Environment Abu Dhabi insert Time Domain Reflectometry (TDR) rods into the soil of the irrigation basin around a date palm tree.

The experimental set-up with sap-flow probes in the date palm trees and TDR sensors in the surrounding soil. Sun, sand and sapflow

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Canterbury

Lincoln University

Congratulations to **Laura Buckthought**, who successfully defended her thesis entitled “Interactive effects of nitrogen fertilizer and animal urine on nitrogen efficiency and losses in New Zealand dairy farming systems”. Laura was supervised by Prof. Tim Clough, Dr Mark Shepherd (AgResearch, Ruakura) Dr Val Snow, Prof. Keith Cameron and Prof. Hong Di.

Diana Selbie was also successful in her PhD defence on the topic of Environmental emissions from varying cow urine loadings to soil and the effect of DCD under Irish farming conditions. Diana is a Lincoln University graduate who continued on to study for a PhD degree. Diana was funded by a ‘Walsh Fellowship’ from the Irish Government and most of her research work was conducted in Ireland. Diana has been appointed as a Post-doctoral Soil Scientist with AgResearch in Hamilton. She was supervised by Keith Cameron, Hong Di and Jim Moir; as well as by Karl Richards and Gary Lanigan of TEAGSC in Ireland. Congratulations Dr Diana Selbie.

Otago/Southland

AgResearch Invermay

Invermay has kicked off to a busy start to the year. **Seth Laurenson** has recently started a new trial monitoring sheep movements using GPS devices. The trial aims to determine how long sheep spend in and around streams.

Ross Monaghan and **Richard McDowell** are busy developing a proposed framework for the National Science Challenge around Land and Water. **Tony van der Weerden** has continued with investigations relating to gas emissions from soils in response to irrigation and compaction.

Ros Dodd and **Col Gray** (AgResearch Lincoln) have carried out two groundwater transport experiments in conjunction with ESR. This work aims to investigate the transport time of phosphorus compounds, originating from either a mineral fertiliser or effluent source, through a gravel aquifer. The experiments involved injecting an orthophosphate or effluent solution into the groundwater along with a conservative tracer (NaBr) and sampling monitoring wells 2, 6, 12 and 40 m down-gradient of the injection well over a period of 48 hours. We are now eagerly awaiting the results which we hope will make up for the long night shifts.

Tom Orchiston applying compaction treatments to irrigation trial using the 'hoofinator' on loan from Plant & Food Research.

Compaction of pasture plots to ~300 kPa pressure to simulate a walking cow.

Measuring nitrous oxide emissions from compaction + urine treatments applied to irrigation trial using automated chambers. Shade house is used for excluding rainfall from plots

Selai Letica part has recently returned to work as part of the Agriculture and People Team following a 'relaxing' maternity break. Selai is currently working in the Primary Innovation project looking at methods and systems to improve 'the way we innovate' within the agricultural sector, with particular focus on Maori agribusiness.

Publications

The Soil Underfoot – Infinite possibilities for a finite resource. Edited by Jock Churchman and Edward Landa. For release in April 2014. More information http://www.crcpress.com/product/isbn/9781466571563

ASPAC Trouble Shooting Guide 1: Colwell and Olsen P Methods This document provides trouble shooting advice for the Colwell and Olsen soil P tests (Methods 9B & 9C, Rayment and Lyons 2011) and has been prepared by the ASPAC Methods Committee: Paul Milham Dave Lyons and Chris Gendle.

Geopedology. Elements of geomorphology for soil and geohazard studies. J.A. Zinck. 2013. ITC, Enschede, The Netherlands. ISBN 978-90-6164-352-4. Ebook, 127 pages. Geopedology attempts to integrate elements of geomorphology and pedology for soil survey. Following a short review of the various ways soil geomorphology is considered by practitioners, the geopedologic approach is described in conceptual, methodological and operational terms. The bases for building a hierarchical taxonomy of geoforms able to support soil surveys of different orders are laid down. The most common geoforms are distributed over the six categories of the classification system. The attributes used for identifying and describing the geoforms are analyzed. English and Spanish versions can be downloaded for free from: http://www.itc.nl/Pub/Home/library/Academic_output/ITC-Special-Lecture-Notes-Series.html

Soil and Water Contamination, 2nd Edition. By Marcel van der Perk. 2013. CRC Press. ISBN: 978-0-415-89343-5. Hardcover, 450 pages. Price $89.95. This textbook provides an overview of transport and fate processes of environmental contamination, in such a way that the reader can both understand and predict contaminant patterns in soil, groundwater, and surface water. In contrast to most existing texts, soil and water pollution are treated as integrated environmental matter from a geographical/spatial perspective at point, local, regional, and catchment scales. The spatial approach links up with recent developments and trends in environmental legislation and other integrated catchment management initiatives. The new edition contains several re-written parts, new material on pesticides and pharmaceutical contaminants and a greater number of exercises, case studies and examples. A lecturer package with worked solutions and exams, will be made available upon adoption. It consists of four coherent parts: 1. Introduction to soil and water contamination; 2. Source, role, and behaviour of substances in soil and water; 3. Transport and fate processes of substances in soil and water; and 4. Patterns of substances in soil and water.

Soil Colloids: Properties and Ion Binding. Series: Surfactant Science. By Fernando V. Molina. 2013. CRC Press. ISBN: 978-1-43-985114-2. Hardcover, 544 pages. Price $179.95. The fundamental problem of ion binding to natural colloids is a multidisciplinary research field which raises special challenges. These come mainly from the heterogeneous and sometimes ill-defined nature of natural colloids, especially humic substances. Soil scientists and colloid chemists tend to have different views of the problem. This book presents the latest advances in this active research field. The first part reviews the fundamentals of colloid science, the second covers soil composition and the characteristics and properties of main soil components, and the third provides in-depth coverage of ion binding to soil colloids, including recent advances.

Biofuel Crop Sustainability. Bharat Singh (Ed.). 2013. Wiley-Blackwell. ISBN: 978-0-470-96304-3. Hardcover, 480 pages. Price $199.95. Biofuel Crop Sustainability brings together the basic principles of agricultural sustainability and special stipulations for biofuels, from the economic and ecological opportunities and challenges of sustainable biofuel crop production to the unique characteristics of particular crops which make them ideal for biofuel applications. This book will be a valuable resource for researchers and professionals involved in biofuels development and production as well as agriculture industry personnel. Chapters focus the broad principles of resource management for ecological, environmental and societal welfare, the sustainability issues pertaining to several broad categories of biofuel crops as well as the economics and profitability of biofuels on both a local and international scale. Coverage includes topics such as utilizing waste water for field crop irrigation and algae production, reliability of feedstock supply, marginal lands, and identifying crops with traits of significance for survival and growth on low fertility soils. The development of production practices with low external inputs of fertilizer, irrigation, and pesticides is also covered.

IUSSS

Nominations - IUSS President

This year we need to elect the IUSS President for the period 2017-2018. As its Senior Officer, the President of the IUSS will provide leadership, focus and direction both within and outside of the Union. The President will Chair meetings of Council, the Executive Committee and the President's Committee and will be responsible for the proper conduct of the business of the Union. The person nominated should be an outstanding soil scientist of high international stature and have very strong interpersonal skills to carry out these duties in an exemplary manner. The appointment represents a total of six(6) years commitment to the IUSS by serving two years each as President-Elect (2015/16), President (2017/18) and Past-President (2019/20). More details on the position and how to be nominated can be found at www.iuss.org Nomination **close 28th February 2014** and the elected President will be presented at the World Congress of Soil Science in Korea in June 2014.

90 years IUSS 1924-2014 – Please send us your pictures

The ISSS (now IUSS) was established in 1924 and this year we celebrate our 90th anniversary. At the World Congress of Soil Science (WCSS) in jeju, Korea in June there will be a photo exhibition on all the congresses. If you have any WCSS pictures that you would like to share please send them to wcss@20wcss.org and hartemink@wisc.edu

New Publications

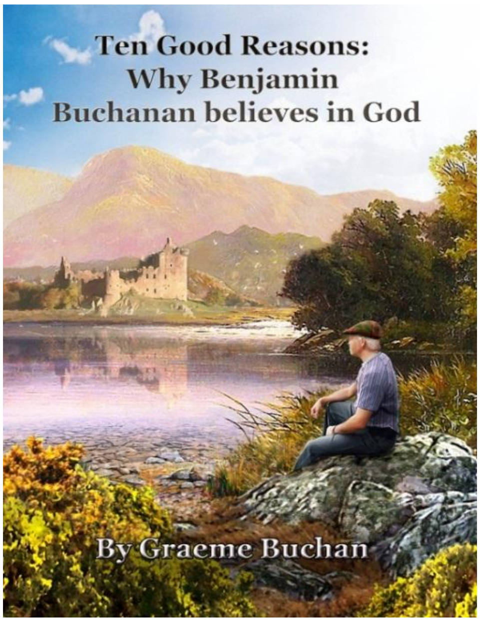
Sustainable agroecosystems in climate change mitigation. Edited by: Maren Oelbermann. 2014, ± 328 pages. ISBN: 978-90-8686-235-1. Price €76.This book bridges our current knowledge gaps and recognizes the contribution of sustainable agricultural practices as a way forward in reducing the global carbon and nitrogen footprint. It suggests that policies and practices integrating microbial technology, modern crop cultivars, conservation practices, increased manure application, organic farming and agroforestry have a greater capacity to sequester carbon and reduce carbon-based greenhouse gases, leading to more robust agroecosystems compared to conventional agriculture. It is argued that empirical models can represent powerful tools for assessing how mitigation and adaptation strategies can be used to optimize crop yield and minimize greenhouse gas emissions under future climate change scenarios.

Soil testing for balanced fertilisation: technology-application-problems-solutions. Edited by Dr HLS Tandon. 2014. ISBN: 81-85116-69-5. Pp. 170+xiv Fertiliser Development and Consultation Organisation, 204-204A Bhanot Corner, Pamposh Enclave, New Delhi110048 (India). Price US$60 (Inclusive of airmail despatch). Contact tandonhls@gmail.com. This book is devoted to soil testing as a research-based tool for making fertilizer recommendations and its various aspects ranging from various technologies, their application, problems and possible solutions. Its nine chapters deal with (i) various methodologies for developing soil-test based fertilizer recommendations from conventional approaches to GIS based tools (ii) the agro-economical evaluation of soil test based fertilizer recommendations, (iii) special features of soil testing in coordination with plant analysis for horticultural tree crop (iv) initiatives required for rejuvenating soil testing services (v) government initiatives and programmes for expanding and strengthening soil testing services, (vi) Field level experiences, problems and solutions for making soil testing a more widely usable facility as outlines by a state government and a fertilizer company involved in soil testing for many years and finally (vi) an introduction to the various analytical instruments being used or for potential use in modern well equipped, appropriately staff soil testing laboratories.

Remote Sensing of Energy Fluxes and Soil Moisture Content. By George P. Petropoulos. 2013. CRC Press. ISBN: 978-1-46-650578-0. Hardcover 562 pages. Price $139.95. Discussing the state of the art in the remote sensing of surface turbulent heat fluxes and soil surface moisture content, this book offers the most up-to-date understanding of the natural processes of Earth systems and their interactions with man-made activities. Identifying effective, accurate, and practical methods, it allows researchers to obtain much-needed data on the soilscape at decreased cost: both reducing the amount of field data collection and increasing coverage area. An all-inclusive overview of methods and modeling techniques, it provides case studies and considers future trends, prospects, and scientific challenges.

Soils in Natural Landscapes. By Earl B. Alexander. 2013. CRC Press. ISBN: 978-1-46-659435-7. Hardcover 319 pages. Price $99.95. In any complete investigation of terrestrial ecosystems, rocks and soils must be considered. Soils are essential resources, providing water and nutrients for vascular plants, and mitigating the flow of water from the land. In addition, soil diversity is critical for biotic diversity. While there are many references on the agricultural perspective of soils, there is a need for a basic soils book for those concerned with natural landscapes and ecosystems. The text fills this niche, providing a thorough introduction to the physics, chemistry, and biology of soils and their roles in local to global systems. The book begins by describing the field of soils and the major roles of soils in natural landscapes. The chapters that follow cover a range of topics: Soil parent material, Architecture of soils, Temperature and soils, Water, air, and climate, Classification of soils, Soil landscapes, Plant nutrition, Soil organisms, Organic matter in soils. The author also discusses global issues such as water and carbon cycles, global warming, and acid rain. He addresses land management for different uses, soil quality, and soil degradation. Using an interdisciplinary approach, this book provides practical insights for the evaluation of soils in natural environments and their non-intensive management.

Graeme Buchan's book



It is a little over a year (December 2012) since our late colleague, Associate Professor Graeme Buchan passed away. A month before his death he completed his book, *Ten Good Reasons: Why Benjamin Buchanan believes in God.*

Known to many of us, Graeme was a staff member in the Department of Soil and Physical Sciences at Lincoln University for 26 years. Graeme's physics education was firmly founded in the School of Natural Philosophy at Aberdeen University in Scotland - an aptly named department, since the very essence of physics is to develop a *philosophy* of nature. Following his PhD in quantum physics Graeme, seeking better ways to help the world, made a 'quantum jump' into strongly applied areas of physics, especially environmental physics. He became active in wider environmental science, and in education for sustainability, giving him the opportunity to see the 'bigger picture' of world development.

Graeme was inspired to write this book because he essentially wanted to give a reasoned argument for the faith that was in him. It weaves together in his own unique way the three strands of philosophy, passionate physical and environmental scientist, and man of (Christian) faith. As a highly respected academic, Graeme was able to integrate readily these three elements. His book is a distillation of his thoughts, brought together in the last year of his life, which he hoped might be of benefit to others.

From the back cover:
This book provides, through the semi-fictional character Benjamin Buchanan, strong but simply presented evidence for the existence of God. Benjamin's '10 good reasons' are argued from the perspective of a scientist and a Christian. They are based on a combination of logical reasoning and his observations on the awesome (literally!) combination of factors which have combined to make life possible on planet Earth. …The book should inspire readers to see Earth, its rich resources and life forms, from a more reverential perspective - essential in an environmentally and socially stressed planet.

The appendix includes Graeme's 3 science-based papers, ***Ode to Planet Earth***, ***Ode to*** H_2O and ***Ode to Soil***. These papers reverence the wonders of planet Earth and its resources.

Marketing material sent to the publisher includes:
It is unique in the way the author presents the results of his own philosophical and scientific thought, influenced by his treasured Scottish background and quirky sense of humour. Although the author is unequivocal about his Christian faith, it is written in a manner that allows people to make their own considered conclusions and decisions …. For the person of faith, this book is an encouragement that faith, reason and scientific perspectives can be authentically held together and there is no need for them to park their spiritual dimension outside the laboratory or lecture room door.

The trustees for Graeme's book are his son Matt and the senior chaplain at Lincoln University, Rev'd Glenda Hicks.

Copies may be ordered from Glenda.Hicks@lincoln.ac.nz
The cost is $35.00 + p & p.

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Abstracts

Clay minerals in South Australian Holocene basaltic volcanogenic soils and implications for halloysite genesis and structure

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Abstract
The clay mineralogical composition was determined of eight soils formed from pyroclastic ejecta (tephra) from adjacent 5000-year old basaltic volcanoes at Mounts Gambier and Schank in South Australia. Both nanocrystalline (short-range order) and crystalline aluminosilicates and also Fe oxides and hydroxides were identified in the soils. Allophane generally occurred to a greater extent in the four soils derived from glass-rich Mt Schank tephra than in most of those from glass-poor Mt Gambier tephra. Ferrihydrite occurred along with allophane. Smectite, kaolinite, illite, and an interstratified kaolinite-smectite comprised the crystalline minerals in these soils. There was no evidence for halloysite. Unlike in New Zealand, decreased leaching resulted in Si-rich allophane, rather than halloysite, forming in place of the Al-rich form of the same mineral. This result may indicate that ferrous iron is an essential impurity in halloysite. It was likely absent from these soils because their high pH due to underlying calcareous rocks precludes its occurrence. The probable requirement of Fe(II) as an essential component of halloysites may have been overlooked because of oxidation consequent upon the inevitable drying of samples prior to analyses.

In: Gilkes, R. (ed.), *Proceedings of the 23rd Biennial Australian Clay Minerals Society Conference*, University of Western Australia, Perth (3-4 February, 2014), pp. 3-6.

Molecular characteristics of permanganate and dichromate oxidation resistant soil organic matter from a Black C rich colluvial soil

M. Suarez-Abelenda, J. Kaal, M. Camps Arbestain, H. Knicker, F. Macías Vázquez (2014)

Samples from a colluvial soil rich in pyrogenic material (Black C, BC) in NW Spain were subjected to K2Cr2O7 and KMnO4 oxidation and the residual soil organic matter (SOM) was NaOH-extracted and analyzed using analytical pyrolysis gas chromatography mass spectroscopy (Py-GC/MS) and solid-state 13C cross polarization magic angle spinning nuclear magnetic resonance (13C CP MAS-NMR) in order to study the susceptibility of different SOM fractions (fresh, degraded/microbial, BC and aliphatic) towards these oxidizing agents. NaOH extracts of untreated samples were also analyzed. Py-GC/MS and 13C NMR indicated that KMnO4 promotes the oxidation of carbohydrate products, mostly from degraded/microbial SOM and lignocellulose, causing a relative enrichment of aliphatic and aromatic structures. Residual SOM after K2Cr2O7 oxidation contained BC, N-containing BC and aliphatic structures. This was corroborated by a relatively intense resonance of aromatic C and some signal of alkyl C in 13C NMR spectra. These results confirm that dichromate oxidation residues contain a non-pyrogenic fraction mainly consisting of aliphatic structures.

Soil Research. In press

Carbon storage and DNA adsorption in allophanic soils and paleosols

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Abstract

Andisols and andic paleosols dominated by the nanocrystalline mineral allophane sequester large amounts of carbon (C), attributable mainly to its chemical bonding with charged hydroxyl groups on the surface of allophane together with its physical protection in nanopores within and between allophane nanoaggregates. C near-edge X-ray absorption fine structure (NEXAFS) spectra for a New Zealand Andisol (Tirau series) showed that the organic matter (OM) mainly comprises quinonic, aromatic, aliphatic, and carboxylic C. In different buried horizons from several other Andisols, C contents varied but the C species were similar, attributable to pedogenic processes operating during developmental upbuilding, downward leaching, or both. The presence of OM in natural allophanic soils weakened the adsorption of DNA on clay; an adsorption isotherm experiment involving humic acid (HA) showed that HA-free synthetic allophane adsorbed seven times more DNA than HA-rich synthetic allophane. Phosphorus X-ray absorption near edge structure (XANES) spectra for salmon-sperm DNA and DNA-clay complexes indicated that DNA was bound to the allophane clay through the phosphate group, but it is not clear if DNA was chemically bound to the surface of the allophane or to OM, or both. We plan more experiments to investigate interactions among DNA, allophane (natural and synthetic), and OM. Because DNA shows a high affinity to allophane, we are studying the potential to reconstruct late Quaternary palaeoenvironments by attempting to extract and characterise ancient DNA from allophanic paleosols.

Chapter 17 (10 pp.) *In* A.E. Hartemink and K. McSweeney (eds.), “Soil Carbon”, *Progress in Soil Science*, Springer International Publishing Switzerland 2014 (DOI 10.1007/978-3-319-04084-4_17).

Landslides in sensitive soils, Tauranga, New Zealand

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Abstract

In the Tauranga region sensitive soil failures commonly occur after heavy rainfall events, causing considerable infrastructure damage. Several notable landslides include a large failure at Bramley Drive, Omokoroa, in 1979, the Ruahihi Canal collapse in 1981, and numerous landslides in May 2005; recently the Bramley Drive scarp was reactivated in 2011. These failures are associated with materials loosely classified as the Pahoia Tephras – a mixture of

rhyolitic pyroclastic deposits of approximately 1 Ma. The common link with extreme rainfall events suggests a pore water pressure control on the initiation of these failures. Recent research on the structure of the soils shows a dominance of halloysite clay minerals packed loosely in arrangements with high porosity (51–77 %), but with almost entirely micropores. This leads us to conclude that the permeability is very low, and the materials remain continuously wet. The formation of halloysite is encouraged by a wet environment with no episodes of drying, supporting this assumption. A high-resolution CPT trace at Bramley Drive indicates induced pore water pressures rising steadily to a peak at approximately 25 m depth; this depth coincides with the base of the landslide scarp. We infer that elevated pore water pressures develop within this single, thick aquifer, triggering failure through reduced effective stresses. The inactive halloysite clay mineral results in low plasticity indices (13–44 %) and hence high liquidity indices (1.2–2.4) due to the saturated pore space; remoulding following failure is sudden and dramatic and results in large debris runout distances.

In: Chin, T.Y. (ed), "Hanging by a thread – lifelines, infrastructure, and natural disasters". *Proceedings of the 19th New Zealand Geotechnical Society Geotechnical Symposium, Queenstown* (20-23 November 2013), Vol. 38, Issue 1 (GM), pp. 537-544. (ISSN 0111-9532).

Experimental evidence for sequestering C with biochar by avoidance of CO_2 emissions from original feedstock and protection of native soil organic matter.

H.M.S.K. Herath, M. Camps-Arbestain, M.J. Hedley, M.U.F. Kirschbaum, T. Wang, R. Van Hale (2014).

There is a need for further studies to compare the decomposition of biochar to that of the original feedstock and determine how these amendments affect the cycling of native organic matter (NOM) of different soils to improve our understanding of the resulting net C sequestration potential. A 510-d incubation experiment was conducted (i) to investigate the evolution of CO_2 from soils amended with either fresh corn stover (CS) or with biochars produced from fresh CS at either 350 (CS-350) or 550 °C (CS-550), and (ii) to evaluate the priming effect of these amendments on NOM decomposition. Two soil types were studied: an Alfisol and an Andisol, with organic C contents of 4 and 10 %, respectively. Except for the controls (with no C addition), all treatments received 7.18 t C ha^{-1}. We measured C efflux in short-term intervals and its isotopic signature to distinguish between C evolved from C_4 amendments and C_3-dominated NOM. Emission rates were then integrated for the whole time period to cover total emissions. Total CO_2-C evolved from the original C in fresh CS, CS-350 and CS-550 was greater in the Andisol (78, 13 and 14 %) than in the Alfisol (66, 8 and 7 %). For both soils, (i) no significant differences (P>0.05) were observed in the rate of CO_2 evolution between controls and biochar treatments; and (ii) total accumulated CO_2 evolved from the uncharred amendment was significantly higher (P<0.05) than that from the other treatments. In the Alfisol, a significant (P<0.05) net positive priming effect on NOM decomposition was observed when amended with fresh CS, while the opposite was detected in biochar treatments. In the Andisol, no significant (P>0.05) net priming effect was observed. A C balance indicated that the C lost from both biochar production and decomposition "broke even" with that lost from fresh residue decomposition after <35 wk. The "break-even" point was reached earlier in the Andisol, in which the fresh CS mineralises faster. These results provided experimental evidence for the potential of biochar to sequester C and avoid CO_2 emissions from original feedstock while protecting native soil organic matter.

Global Chance Biology and Bioenergy. In press.

Nitrous oxide emissions from grazed hill land in New Zealand

Jiafa Luo, Coby Hoogendoorn, Tony van der Weerden, Surinder Saggar, Cecile de Klein, Donna Giltrap, Mike Rollo, Gerald Rys

Abstract

Sheep and beef cattle grazed hill land represents a potentially large source of nitrous oxide (N_2O) emissions globally. However, N_2O emissions and associated emission factors for the dominant nitrogen (N) source of excreta N (EF_3) are thought to be highly variable due to spatial differences in soil conditions across hill land units (HLUs; defined according to slope, aspect and soil type). Variability is also determined by animal grazing and resting behaviour affecting excretal-N deposition. Knowledge of spatially different EF_3 values could be used to improve estimates of N_2O emissions from grazed hill land. This paper presents N_2O emission factors for sheep urine (SU) and dung (SD) and for beef cattle dung (BD) determined in four regions in New Zealand (NZ) (Waikato, Southern Hawkes Bay, Manawatu and Otago). Urine (spring 2009) or urine and dung (autumn 2011) was applied to low (< 12°) and medium (12° - 25°) slopes in each region. N_2O emissions were measured for 3-4 months for urine and for a whole year for dung using a static chamber technique. There were large variations in EF_3 between seasons, between regions and between slope classes within a region and season. Over all regions, there was a marginally significant (P = 0.08) difference in EF_3 for spring 2009-applied SU on low and medium slopes, with EF_3 values averaging 0.46% and 0.08%, respectively. In the autumn 2011 trial, there was no significant slope effect, with EF_3 averaging 0.12% and 0.11% on low and medium slopes, respectively. By combining the datasets, EF_3 for low slopes (0.24 with 95% confidence intervals of between 0.14 and 0.40) was significantly greater ($P < 0.05$) than for medium slopes (0.07% with 95% confidence intervals of between 0.02 and 0.14). EF_3 values for BD and SD were not significantly different. The contribution of sheep excreta to NZ national N_2O emissions, based on a spatial framework model that disaggregates excreta deposition according to slope class and using the current inventory EF_3 values of 1% for urine and 0.25% for dung and assuming that all NZ sheep grazed on hill land, was 6.08 Gg N_2O in 2012 in NZ. This is considerably higher than the 1.02 Gg N_2O estimated using the measured EF_3 values, 0.24% for urine and 0.06% for dung, from this study. These results suggest that the current IPCC GHG inventory methodology is likely to overestimate N_2O emissions from animal grazed hill land.

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A Novel Approach To Quantify The Impact Of Soil Water Repellency On Run-Off And Solute Loss

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We developed a laboratory-scale *r*un-*o*ff *m*easurement *a*pparatus (ROMA) to quantify for the first time directly the impact of soil water repellency (SWR) on run-off from undisturbed soil slabs in the laboratory. We tested and evaluated the performance of ROMA with multiple consecutive run-off experiments using water followed by a fully-wetting liquid, namely an ethanol solution. We found that a 30% (v/v) ethanol solution was needed to ensure that the soil hydrophobicity had no influence on the infiltration rate of the liquid. The results demonstrated the ROMA is a robust and reproducible tool that performs at a high standard with instrument errors below 2%. We conducted ROMA run-off experiments with air-dried soil slabs (480 mm long×190 mm wide×50 mm deep) collected from four pastoral sites, representing three major soil orders in the North Island, New Zealand. They were the Kashmir-Recent Soil (Fluvisol), Hawke's Bay-Recent Soil (Fluvisol), Taranaki-Gley Soil (Gleysol), and Taranaki-Organic Soil (Histosol). These soils had a high degree and persistence of SWR. The contact angles were 97, 97, 98 and 104°, the potential water drop penetration times (WDPT) were 4, 42, 54 and 231 min, and the run-off fractions were 16, 19, 28, and 96% respectively. However, even the extremely hydrophobic Taranaki-Organic Soil, which had a runoff coefficient of 96%, only lost 13% of the applied bromide via run-off. This demonstrates that run-off occurred in rivulets covering only a small fraction of the surface. Multivariate regression analyses showed that the soil organic carbon content and the degree of SWR explained 89% of the variability of the run-off coefficients. We identified difficulties around the meaningfulness of the persistence of SWR, as determined by the WDPT test, since it just measures SWR at a single point. Alternatively, our ROMA experiments integrate the spatial variability of SWR of an undisturbed soil slab. In addition, the method is faster for extremely hydrophobic soils once the ROMA is set up.

Geoderma

http://www.sciencedirect.com/science/article/pii/S0016706114000172

The following are a selection of abstracts from the 27th Annual FLRC workshop at Massey University, on the 18th, 19th and 20th February 2014

A COMPENDIUM OF NEW ZEALAND PASTURE FARMLET EXPERIMENTS MEASURING NITROGEN LEACHING

Natalie Watkins and Mark Shepherd
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Farmlet experiments aim to mimic a farm system but at a smaller, experimental scale, and are generally used for testing hypotheses relating to the effects of management practices on productivity, profitability and, when incorporating environmental measurements, sustainability. They are also valuable for developing and testing farm system models. This paper provides a summary of New Zealand pasture farmlet experiments that have involved measurements of nitrogen (N) leaching losses and which could be used for comparing those measured losses with OVERSEER® Nutrient Budgets' (*Overseer)* modelled losses.

The majority of New Zealand farmlet experiments have been undertaken in the Waikato, Manawatu and Southland regions, with a small number undertaken in the Bay of Plenty, Canterbury and Otago regions. Within these farmlet experiments, the method of measurement of N leaching has generally been a function of the soil-type; porous ceramic cups/lysimeters on free draining soils (e.g., Waikato, Canterbury) or hydrologically isolated plots on drained clay soils (e.g., Manawatu, Southland). It is important to understand the implications of methodology for assessment of measurement error.

The typical duration of the experiments is 2 - 5 years. However, significantly longer trials have occurred, for example, Tussock Creek (Southland), where N leaching measurements have been undertaken for 13 years. The range of management factors tested on these farmlet sites include stocking rate, N fertiliser application rate, grazing management practices, use of nitrification inhibitors and effluent management. The majority of farmlet experiments have been undertaken on dairy farm systems, with fewer on sheep/beef farm systems.

Farmlet experimental data can be considered as representing the farm block scale within *Overseer*, not the total farm. There are practical and theoretical challenges of comparing data from farmlet experiments with whole farm system modelled data. Nitrogen leaching losses from a farm system are a result of many complex interrelated processes; therefore it is important to ensure that relevant supplementary farm system data are available (e.g., feed intake and drainage) to add robustness when comparing modelled with measured outputs.

The uncertainties associated with model outputs are generally accepted as increasing as the differences between a modelled site and calibration and validation sites increase. More sites with different environments/soils would decrease uncertainties and increase the reliability of N leaching estimates for such locations. However, this benefit has to be balanced against the cost of running complex long-term experiments.

THE MATRIX OF GOOD MANAGEMENT: DEFINING GOOD MANAGEMENT PRACTICES AND ASSOCIATED NUTRIENT LOSSES ACROSS PRIMARY INDUSTRIES

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Across New Zealand, regional authorities are taking steps to maintain or improve the quality of freshwater. Although regional differences exist in the approaches being taken, the need to define agricultural good management practices (GMP) and understand the impacts of GMP on freshwater quality is a recurring theme. However, there are no commonly agreed definitions of GMP and there has been no systematic attempt to estimate nitrate and phosphorus losses associated with farms operating at GMP.

Environment Canterbury aims to address this through a collaborative project with agricultural industries (dairy, sheep and beef, horticulture, arable, deer and pork) and research agencies.

The main output from the project will be industry defined GMP and a table of nitrate and phosphorus loss benchmarks for a range of farming systems operating at GMP across Canterbury's soils and climates: the 'Matrix of Good Management'. Results are expected by July 2015.

In Canterbury, this will inform community deliberations regarding freshwater quality targets by setting out nitrate and phosphorus losses that are achievable by farmers operating at GMP; enable improved estimates of total catchment loads of nitrogen and phosphorus associated with diffuse losses from agriculture by quantifying these for current farm systems and provide clarity to farmers regarding industry agreed benchmarks for nutrient losses.

Nationally, the project will demonstrate a collaborative approach to defining agricultural GMP and a robust process for quantifying the associated nitrate and phosphorus losses. These aspects of the project will have applicability beyond Canterbury.

NITROGEN LOSSES FROM LAKE ROTORUA DAIRY FARMS - MODELLING, MEASURING AND ENGAGEMENT

Simon Park[1], Tanira Kingi[2], Sharon Morrell[3], Lee Matheson[4] and Stewart Ledgard[2]

[1]Headway Ltd, [2]AgResearch, [3]DairyNZ and [4]Perrin Ag Ltd

Dairy and drystock farmers in the Lake Rotorua catchment need to make large reductions in farm nitrogen (N) loss to meet the annual catchment target of 435 tN by 2032. Dairy farmers initiated a Sustainable Farming Fund Project in 2011 to promote adoption of N mitigation methods using three approaches: (i) differential N rate fertiliser trials on-farm; (ii) farm system modelling; and (iii) farmer engagement. These three strands of work were led respectively by AgResearch, Perrin Ag Ltd and DairyNZ.

Farm trials: Interim results from the N-rate plot trials on the Parekarangi Trust farm have indicated smaller pasture production differences than expected between the standard, strategic and nil N fertiliser treatments, with indicative fertiliser N response rates of 5.7-7.6 kg DM / kg N applied. Pasture composition is relatively consistent across treatments, with little indication yet of reversion to low productivity grasses in the strategic and nil N treatments. In contrast, a separate farm system trial at Parekarangi has shown that changing from regular to nil N fertiliser use has more than halved the nitrate-N leachate concentration.

Farm modelling: Three dairy farms were modelled in Overseer and Farmax for status quo and future mitigated scenarios, based on each farmer's perspective on what mitigation practices they could adopt. This analysis was expanded to nine dairy farms (plus three drystock farms) with additional BoPRC support, and extrapolated across all pastoral land in the catchment. Potential changes to land management were generally much more cost effective than land use change options, with average respective costs (capitalised) of $171 and $559 per kg N mitigated. Surveyed farmers also had a clear preference for management changes, compared with land use change. Based on farmer preferences, the overall cost of achieving the assumed pastoral share of catchment N reduction (270 tN/yr) was estimated at $88.1 million with additional capital value losses accruing to drystock farms.

Farmer engagement: A series of farm discussion groups and field days have been run throughout the project. Farmer participation has varied during the project and it is too early to determine what level of practice change has occurred on-farm. Rural professionals have been regular attendees. Recurring messages from Rotorua dairy farmers include: practical, local and long-term farm trials and modelling are both important to understand N mitigation options; policy proposals need to be accompanied by explicit costings that are relevant to their farm situation.

LONG TERM INFLUENCE OF MANAGEMENT PRACTICES ON NUTRIENT SUPPLY POTENTIAL OF A SILT LOAM SOIL

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Land management practices can influence soil fertility in several important ways. The amounts of nutrient applied in fertiliser and removed in harvested products differ depending on land use. Land use may also affect soil organic matter content (SOM) which, in turn, can alter the soil's potential to supply nutrients (particularly N) via mineralisation. The retention and leaching of nutrient cations (Ca, K, Na) may also change if SOM changes. Changes in soil fertility may occur relatively slowly and, often, long term data are needed to quantify fertility trends. The objective of this work was to evaluate long-term effects of land use (sheep-grazed pasture vs arable cropping) and tillage practices on biological and chemical components of soil fertility. In 2013, soil samples were collected (0-7.5, 7.5-15, 15-25 cm depths) from five treatments in a long term tillage trial at Lincoln, Canterbury. The trial, which is on a Wakanui silt loam, was established in 2000 to quantify the effects of management (tillage type; summer and winter crops) on soil quality following the conversion of long term pasture to arable cropping. The sampled treatments were: long-term ryegrass-clover pasture; an arable cropping rotation, managed using either intensive, minimum, or no-tillage cultivation practice; and a continuous chemical fallow (plots maintained plant-free since 2000 using herbicides; not cultivated). The pasture treatment, which represents the pre-trial land use, was maintained within the trial as a control. Nitrogen (and C) mineralisation potential were determined by incubating samples for 98 d (25^{o}C, -60 kPa water potential). The effects of the treatments on chemical fertility were evaluated by using standard soil tests (Olsen P, pH, available cations, cation exchange capacity (CEC)). Under arable cropping, N mineralisation potential declined by 22 to 28% compared with long-term pasture. Tillage type had little effect on total N mineralised in the top 25 cm, but it did affect the vertical distribution of mineralisation (more concentrated near soil surface under no-tillage; uniform depth distribution in intensively tilled plots). Mineralisation was least in the long-term fallow (67% less than in pasture), which had negligible inputs of fresh organic matter in the 2000-2013 period. As a result of a decline in soil organic matter under arable cropping and long-term fallow, there was a decrease in CEC (pH 7) up to 22% at 0-7.5 cm depth. There was substantial decrease in available cations under arable cropping, with K decreasing by 46 to 73% and Mg by 36 to 52%. Although most indicators of nutrient availability were low in the fallow treatment, it had highest levels of Olsen P, presumably due to accumulation of mineralised P. The implications of these findings for soil fertility management under continuous arable cropping will be discussed.

MONITORING EFFECTS OF SOUTHLAND DEMONSTRATION FARM ON STREAM WATER NITRATE

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The objective of this research work was to monitor the effects of the Southland Demonstration Farm on the concentration and amount of nitrate in the Tomoporakau Creek. The creek runs through the central area of the farm and drainage outfalls discharge directly into this stream.

A detailed GPS topographical survey was conducted to confirm the drainage catchment area and hydrology of the site. Groundwater piezometers were established adjacent to the stream in order to monitor groundwater levels and compare those to stream water levels. Detailed surveys of the stream bed, stream surface, groundwater levels, and stream bank geometry were also conducted. Stream flow rate measurements are continuously monitored using “Sontek” Doppler flow equipment installed in concrete box culverts at ‘up-stream’ and ‘down-stream’ monitoring sites. Stream water is pumped continuously from the monitoring sites using submerged samplers that send water to an instrument base-station at the dairy shed. The water nitrate concentration from each site was monitored in real-time using flow-through UV absorption spectrometer sensors. This system does not require any reagents as it measures the water nitrate concentration by detecting the UV light absorption by nitrate**.** These sensors also measure a full spectrum adsorption in order to automatically ‘correct’ for light absorption due to particulate material and/or other chemicals in the water.

COMPARISON OF APSIM AND NZ-DNDC MODELS WITH PLANT N UPTAKE AND WATER AND NITRATE LEACHING DATA

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Two process-based models, APSIM and NZ-DNDC, were compared with measurements over 3 years of drainage, NO_3-leaching and plant N-uptake. The data came from experiments with urine depositions (1000kgN/ha) in lysimeters under pasture in the Waikato. Two irrigation schedules were applied: low irrigation (rainfall + irrigation ~1100mm/year), and high irrigation (rainfall + irrigation ~2200 mm/yr).

The NZ-DNDC model simulated the drainage and leaching to 50 cm depth while APSIM and the measured values were at 70 cm. While this could make some differences to the timing of drainage and leaching, the cumulative values over the year should be little affected. Total measured drainage ranged from 520±40 mm (2009 low irrigation) to 1580±40 mm (2010 high irrigation). Both models estimated total drainage well (r = 0.93 and 0.87 respectively), although with a slight tendency to underestimation (average relative error –1.1% and –4.3%).

APSIM over-estimated pasture N-uptake from early spring to summer, while NZ-DNDC under-estimated N-uptake over this period. Over the entire year this resulted in an average relative error of +16% for APSIM and (+75 kg N/ha) –33% in NZ-DNDC (-175 kgN/ha).

Both models simulated similar NO_3-leaching losses in 2008 (APSIM 573 and 689 kg N/ha; NZ-DNDC 527 and 697 kg N/ha for low and high irrigation respectively) compared with measured values of 540±70 kg N/ha (low irrigation) and 620±60 kg N/ha (high irrigation). However, both models over-estimated losses in 2009 and 2010. For NZ-DNDC, the over-estimation of NO_3-leaching losses could be partly explained by the under-estimation of plant N-uptake. It could also be that NO_3 adsorption by allophane reduced the amount of NO_3-leaching in the field. When NO_3 adsorption was considered in the APSIM model (also increasing the nitrification rate because of the high soil C), the average error changed from an over-estimate of 41% to an underestimate of 14%.

Although the two models had different methods for simulating soil water, both produced reasonable estimates of total drainage. However, estimation of NO_3-leaching was more challenging as it depends on appropriate representation of other aspects of the N-cycle. Modifications to improve NO_3-leaching simulation will be discussed further at the workshop.

THE FATE OF URINE NITROGEN: A GRASSLAND LYSIMETER STUDY IN IRELAND

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In grazed pasture systems, the nitrogen (N) contained in a cattle urine patch may be up to 1200 kg N ha^{-1}. The majority of this N is in excess of plant requirements and is vulnerable to environmental loss. In this study, cattle urine was applied at five rates of nitrogen, 0, 300, 500, 700 and 1000 kg N ha^{-1} to soil monolith lysimeters in late autumn in Ireland. Measurements of gaseous N emissions, nitrate (NO_3^-) leaching and pasture N uptake were made for a calendar year following urine application in two consecutive experiments. Increasing the rate of urine N applied increased the cumulative nitrous oxide (N_2O) emissions, NO_3^- leaching and pasture N uptake in years one and two, but had little effect on the percentage of N recovered in each pathway. Furthermore, the total recovery of urine N in year one was low, only 63%, so in year two a detailed ^{15}N isotopic balance for the fate of urine patch N attempted to answer the question – where is the missing N? Of the 1000 kg N ha^{-1} urine applied in year two, 27% was recovered in gaseous emissions (predominantly inert N_2), 10% was recovered in the drainage water, 26% was taken up by the pasture, and 23% remained in the soil. The comparison of mass and 15N balance methods suggest that urine may stimulate the release of native soil N.

NITROGEN LEACHING FROM SHEEP GRAZED HILL COUNTRY: MEANS, MEDIANS OR BACK-TRANSFORMED MEANS?

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Nitrogen (N) leaching data obtained from grazed pastures rarely conform to a normal distribution. These data are likely to have a large number of very low values originating from areas with little N leaching (non-urine patch areas), and a smaller number of points with large values (urine patches, including patch overlap). Transformation of the data is often necessary before the appropriate statistical analyses can be performed. Whilst data transformation allows the appropriate testing of treatment effects on N leaching, estimates of the amount leached are of key interest.

For normally distributed data the raw mean is the appropriate estimate of the true population mean, with its standard error being a descriptor of the variability surrounding that mean. However, for non-normally distributed data the raw mean is no longer a valid estimate of the population mean. In this case the appropriate estimate of a population mean is the back-transformed mean and the 95% confidence intervals a measure of variability surrounding that mean. However, in published literature it is not uncommon to find raw means and standard errors presented to describe the results, even though the data was non-normally distributed. If the data distribution is not normal, the value of the raw means will be very different to the back-transformed means.

Nitrate-N leaching data from a recently completed 3 year study in hill country are used to illustrate the effect of using different ways of expressing population means when summarising non-normally distributed data. The study area had a slope class mix of 16, 56 and 28% low, medium and steep slopes (>25°), respectively, and was stocked with sheep at 11 SU ha^{-1}. For that dataset the raw mean, median and back-transformed mean values for nitrate-N leaching were 124, 58 and 29 kg nitrate-N ha^{-1}, respectively, for low slope (0-12°) areas and 16, 1 and 1 kg nitrate-N ha^{-1} respectively, for medium slope (13 – 25°) areas. If we make the assumption that nitrate-N leaching from steep slopes would be negligible, the estimated amount of nitrate-N leached per ha of hill country would be 29, 10 and 5 kg N ha^{-1} using the raw mean, median and back-transformed mean values, respectively. In this paper we discuss the validity of using the raw mean, median or back-transformed mean as estimates of population means and the implications this may have on interpreting N leaching results.

UNDERSTANDING PHOSPHORUS, NITROGEN AND CADMIUM TRANSFER THROUGH A YOUNG STONY SOIL

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In Canterbury land-use intensification, particularly irrigated dairy expansion, is occurring on stony soils, but concerns exist about the ability of these soils to sustain intensified land-use, whilst maintaining nutrient leaching within discharge limits. Environmental models consistently predict stony soils as having a high vulnerability to leaching under intensive land use, but it is recognised there is little experimental research to validate the model predictions. This paper presents scoping experiments to quantify the degree of leaching vulnerability of young stony sand soils, and to determine what are most likely to be the key drivers for leaching.

Barrel lysimeters (460 mm in diameter by 700 mm deep) of intact soil columns were collected of a young stony sand soil. Four lysimeters were used to study the preferential leaching of nitrogen (N), phosphorus (P), and cadmium (Cd) from a pulse (25 mm depth) of dairy shed effluent (DSE) followed by continuous artificial rainfall – both applied at 5 mm/h. A further two lysimeters were used to study the preferential leaching of N, P, Cd, and carbon (C) under simulated irrigation (12–18 mm depth applied every 3–4 days). Sequential treatments of superphosphate, cow urine, and DSE were applied, with intervals of at least one pore volume (>200 mm) of drainage between each treatment.

The constant-rate experiment demonstrated that these soils have the potential for rapid leaching of N, P and Cd from an application of DSE. In contrast, no unequivocal increase in P, N and Cd leaching occurred after the DSE treatment in the simulated irrigation experiment, indicating strong sensitivity of these soils to the management practice of DSE application.

The simulated irrigation experiments indicated that under irrigated dairy pasture, urine deposition will be the key driver of leaching. Both the superphosphate and DSE applications resulted in low leaching. In contrast the urine treatment showed increased leaching of N, P, C, and Cd starting within 20–90 mm of drainage following the urine application.

The results of this scoping study confirm predictions that young stony sand soils have high potential leaching risk, and we argue that these results urgently justify a larger-scale research programme given the intensification of agricultural development on these vulnerable soils.

EFFECTIVENESS OF *ECO-N* IN REDUCING NITRATE LEACHING LOSSES AT HIGH RATES OF N FERTILISER WITH AND WITHOUT URINE ADDITION

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There is increasing concern that nitrate (NO_3^-) leaching from intensive agriculture can degrade water bodies and may threaten human health. Nitrogen (N) inputs from fertilisers, effluents and the urine of grazing animals in particular can cause increased NO_3^- leaching from dairy farm systems. Questions have therefore been asked about the effect of high rates of N fertiliser application on leaching losses from grazed pastures and if these effects can be mitigated by using a nitrification inhibitor. This study used two N fertiliser rates (300 kg N/ha and 500 kg N/ha) with and without urine, and with and without the nitrification inhibitor DCD 'eco-n'. Results show that increasing the fertiliser application rate from 300 kg N/ha to 500 kg N/ha increased the peak concentration of NO_3^- leached from 2.4 NO_3^--N/L to 11.2 NO_3^--N/L. However these values are significantly lower than those from N fertilisers <u>plus</u> urine, where peak the concentration of NO_3^- leached exceeded 220 NO_3^--N/L, 20 times that of fertiliser alone. Similarly, the total amount of NO_3^- leached was highest in the fertiliser <u>plus</u> urine treatments where the amount of NO_3^- leached was on average 45 times the loss from the N fertilisers alone. This confirms that urine addition is the main source of NO_3^- leaching in grazed pastures, even with the high N fertiliser application rates used in this study. The application of eco-n reduced the total NO_3^--N leaching losses by 42% in the fertiliser plus urine treatments. This indicates that eco-n has the potential to significantly reduce the environmental footprint of intensive dairy pastures even at high N fertiliser application rates.

DIGITAL ELEVATION MAPS FOR SPATIAL MODELLING OF SOIL SERVICES

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Valuable soil information can be obtained from digital elevation maps (DEMs) because the derived terrain attributes inform and improve spatial prediction of key soil attributes (e.g. moisture status and organic matter) that impact on soil function and the services that soils provide.

While the publically available national 25-m resolution DEM is well suited to catchment-scale studies, recent technological developments have been enabling the availability of DEMs at much higher resolutions (≤10m).

DEMs derived from electromagnetic (EM) and LiDAR surveys are suited to paddock- and farm-scale spatial prediction of topography-controlled soil properties. Soil EM surveys can provide DEMs at an approximate 10 m resolution, and airborne LiDAR surveys provide DEMs at ≤1 m resolution.

Quantitative analysis of DEMs to derive primary terrain attributes, such as slope and aspect, and secondary terrain attributes, such as flow accumulation pathways, is conducted in software packages using sophisticated algorithms. For example, a multiple flow direction algorithm assesses upslope area for any one pixel and allows this accumulated upslope flow to be distributed among all downslope directions.

The two case studies presented in this paper are:

An EM-derived DEM is used to investigate soil available water-holding capacity (AWC) and topsoil depth at a North Otago irrigated paddock on rolling downlands (90 ha). AWC varied between 10 and 19% (v/v) at 9 stratified sampling positions and showed some correlation to terrain attributes. Topsoil depths ranged between 0 and 76 cm, and a random forest model was used to produce a map of topsoil depth (r2 0.5; RMSE 9 cm).

A LiDAR-derived DEM is used to produce a soil organic carbon (SOC) map for Massey University Tuapaka hill country farm (476 ha). The map is a surrogate for soil quality, because organic matter provides essential AWC, structure, cation exchange capacity (CEC) and nitrogen (N) stores. It also provides the dissolved organic carbon (DOC) to drive N attenuation in surface and sub-surface soils to waterways. SOC ranged between 42 and 194 T/ha to 30 cm soil, being highest for the Ramiha soil series at the highest elevations, formed from a mixture of loess and volcanic ash, and lowest for the Tokomaru soil series at lowest elevations, formed predominantly from greywacke-derived loessial deposits.

ROOT ZONE LOSSES ARE JUST THE BEGINNING

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Minimising root zone losses has rightly been the main focus in recent years of measures to reduce agricultural land use impacts on freshwater quality. However, root zone losses are just the beginning, as far as managing to water quality limits is concerned. To be able to fully explore all potentially available management options, the entire *'source → transport/transformation → impact'* chain needs to be understood.

Where, when, and to what extent the root zone losses impact on freshwater bodies depends on the transport and transformation processes occurring in the vadose zone – groundwater – surface water continuum. We will be demonstrating these processes using a combination of New Zealand and European examples.

Understanding the '*where*' requires investigating the relative importance of the various subsurface flow paths (e.g. artificial drainage, interflow, shallow and deeper groundwater). Modelling of the subsurface hydrological system also helps to define the groundwater catchments that contribute water (and the nitrate it carries) to a monitoring site. These groundwater catchments do not necessarily match the topographically defined surface water catchments.

Regarding the '*when*', it is essential to consider the lag times, both in the vadose zone and in the groundwater system. Depending on the relative importance of the various flow paths, not all nitrate lost from the root zone will reach a surface water body at the same time. The resulting distribution of transfer times further complicates establishing the link between an impact observed in a surface water body and the land use activity that has caused it.

As for the '*extent*' to which root zone nitrate losses impact on freshwater bodies, it is critical to account for attenuation processes occurring along the flow paths. The two key nitrate attenuation processes are mixing/dilution and denitrification (occurring below the root zone).

While groundwater denitrification has to date received relatively little attention in New Zealand, its potentially substantial role is recognised by many European drinking water supply companies and regulatory authorities. Accordingly, new policy initiatives in Europe have started taking account of the spatially variable nitrate reduction along the flow paths from the *source* to the *impact* zones.

MACROPORE NETWORKS AFFECT THE FILTERING FUNCTION OF SOILS

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Soils can deliver the ecosystem service of filtering. But filtering capacities differ between soils such that the quick transport of agrichemicals into aquifers cannot be excluded. We hypothesized that a soil's filtering capacity depends on its macropore structure, which is linked to soil texture. Tension disc infiltrometry can be used to measure hydraulic properties near saturation. The differentiation between hydrologically active and non-active pores at a given tension is an indirect method to characterize macropore continuity. Water flow through macropores is a function of the macropore size distribution, tortuosity and the connectivity of macropores. These characteristics can directly be derived by 3D X-ray computer tomography (CT). Our objective was to analyze the macropore network and to characterize the resulting filtering performance of soils with contrasting structures.

For this purpose, two soils under pasture with known filtering behaviour for microbes were selected. The soils were an Allophanic Soil (excellent filter) and a Gley Soil (poor filter). Each soil was separated into three horizons assuming that each horizon had a specific macropore structure. In March 2011, infiltration near saturation was measured in the field; hydraulic conductivity K_0 and flow-weighted mean macropore diameter α for each soil horizon were derived. We extracted intact soil cores from the centre of the infiltration areas and determined the macropore architecture by X-ray CT. The results were validated with bromide leaching experiments through intact soil cores. Dye tracer experiments visualized flow patterns in situ. Our results confirmed the better filtering capacity of the Allophanic Soil. The soil's comparatively low macroporosity was coupled with a high connectivity of the smaller macropores which led to a more homogeneous matrix flux. Similarly, all measurements confirmed the poorer filtering capacity of the Gley Soil, which had a bi-modal pore system with a few very large, but well connected macropores. This resulted in preferential flows. We identified the macroporosity, mean pore diameter and connectivity as the relevant 'form' parameters to describe the 'function' of agrichemical transport.

BENCHMARKING N AND P LOSS RISK FROM DAIRY EFFLUENT DERIVED NUTRIENT SOURCES

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Farm dairy effluent (FDE) is generated in a number of locations around a dairy farm including the milking shed, off-paddock animal confinement facilities, stock laneways and silage stacks. The storage and management of this effluent, with respect to the specific attributes of the farm (e.g. soil type, proximity to water, topography and climate) has a huge bearing on the proportion of the nutrients (and other potential contaminants) that are lost. However, the relative contribution of nutrients that are lost from the various points of FDE generation, storage, distribution and land application are not widely documented.

This study assessed the risk of nutrient loss that is associated with a given management decision or defect in the design and/or maintenance of the effluent infrastructure on a typical or average Waikato farm. We have distinguished between the 'at risk' components, i.e., the total quantity of nutrient that could potentially be lost (worst case scenario), and, an 'attenuated loss', which is the quantity that is actually lost given best case soil attenuation potential. The 'at risk' and 'attenuated losses' of nutrients from a number of individual contributing factors have been reported. This approach highlights the potential non-compliance magnitude and enables farmers to prioritise management efforts toward the most influential factor contributing to overall farm losses. We suggest the greatest gains in reducing nutrient loss from effluent sources on dairy farms can be achieved by preventing pond discharges, ensuring adequate capture of effluent from off-grazing systems and employing sound irrigation practices when land applying effluent.

EFFECTS OF ACIDIFICATION ON NITROGEN TRANSFORMATIONS IN STORED DAIRY EFFLUENT

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Good practice management typically requires storage of farm dairy effluent (FDE) during periods when conditions are not conducive for land application. This strategy is effective for decreasing runoff and drainage losses of FDE nutrients; however, a compromise is that ammonia (NH_3) can be volatilised from the stored FDE. Lowering of the pH of FDE increases the ratio of ammonium (NH_4^+) to NH_3; further lowering of the pH can also impair microbial and enzyme (e.g. urease) activity which decrease the quantity of NH_3 available for volatilisation

In a trial commissioned by MPI and Ballance Agri-Nutrients, the effectiveness of adding sulphuric acid to fresh dairy effluent for preserving nitrogen (N) during storage was determined. Acidified (pH 2.5, 5.0, 5.5 and 6.0) and control effluent (pH 7.8) were placed in open containers, outdoors, undercover, in early autumn. At regular intervals during the 81 day trial period, the effluents were stirred and samples collected and analysed for pH and N fractions.

During the trial the effluent total N decreased in all treatments, the largest loss was observed from the control treatment (62%) at day 81, as the effluent pH lowered, the magnitude of N losses decreased, the statistically different losses ranged from 14 to 59% in acidified effluents in comparison.

The trial showed that the pH of the effluents adjusted to 5.0, 5.5 and 6.0, rapidly increased to that observed in the control. Frequent addition of acid to maintain a lower pH may be more effective for controlling N loss.

However, the effluent acidified to pH 2.5 behaved differently. It appeared to adsorb NH_3 lost from the other treatments giving an increase in measured total N over the first 40 days. Also urea, which was hydrolysed almost immediately in other treatments, remained until day 56; this led to a slower rise in pH and NH_4^+ levels and greatly reduced overall NH_3 volatilisation. These factors combined to make effluent adjusted to pH 2.5 retain much more N than the other rates.

GREENHOUSE GAS EMISSIONS FROM SOLID DAIRY MANURE DURING STORAGE AND FOLLOWING LAND APPLICATION

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Wintering dairy cows in animal shelters is becoming more common. This is particularly apparent in southern New Zealand where the main alternative is winter foraging of brassica crops, a practice associated with high N leaching loss and soil structural damage.

Information on greenhouse gas (GHG) emissions associated with manure storage and land application in New Zealand is extremely limited. Therefore, we conducted a study to quantify greenhouse gas (GHG) emissions (nitrous oxide, N_2O; methane, CH_4) and ammonia, NH_3, an indirect source of N_2O emissions, from storage and land application of dairy manures collected during winter housing in southern New Zealand.

Following the end of the wintering period (generally mid-late August), manure is typically stored on-farm for *ca* 2 months prior to being applied to land in late October. However, a small proportion of farmers will store manures for up to 5 months. We collected manures from three storage facilities on commercial dairy farms and measured gaseous emissions over 1, 2 and 5 months' storage. Storage facilities included (i) the bunker of a wintering barn with slatted-floor (bunker), floor of a deep litter barn (deep litter), and the solid fraction of a weeping wall system (weeping wall). We also quantified GHG emissions from two manure types (bunker and weeping wall) following its application to pasture at three rates (1.5, 3.0 and 4.5 t dry weight/ha).

A METHOD FOR MEASURING THE EFFECT OF DAIRY AND DRYSTOCK GRAZED PASTURES ON SOIL CARBON STOCKS

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Soil is the largest terrestrial store of carbon (C) with some 2000 Pg to a depth of 1 m compared to 500 Pg in the atmosphere. The Intergovernmental Panel on Climate Change recommends that C stocks be measured using the depth based approach where the C stock (tC. ha^{-1}) is the product of sample depth (m), bulk density (t.m^{-3}) and percent C. However, soil properties such as bulk density may vary spatially and temporally in response to land use change and management practices. For greater accuracy in determining the effects of land use change on soil C, a mass based coring approach coupled to equivalent soil mass calculations (ESM) of soil C stocks may be more accurate as it accounts for differences in bulk density.

Barnett et al. (2014, Agriculture, Ecosystems & Environment 185, 34-40) used a paired pit approach to sample 25 adjacent dairy and drystock pastures to a fixed depth of 0.6 m and showed that drystock grazed soils had about 8.6 t.ha^{-1} more C in the top soil than adjacent dairy sites ($P<0.05$). However, there was no significant difference between land uses when C was accumulated to 0.6 m.

Our objective was to test a more accurate method for estimating C stocks between dairy and drystock grazed pastures. We resampled the paired dairy and drystock sites to a depth of 0.6 m by taking 5 soil cores from each of two plots (5x5 m) within a paddock of each land use. Soil C was measured using an Elementar (Isoprime 100 analyser) on bulked soil samples from each plot in depth intervals (0-10, 10-25, 25-40, 40-60 and 60-65 cm) and total C stocks were calculated using ESM. Such an approach takes into account the inherent spatial variability in C stocks, thus giving a more accurate estimation of the field mean and increasing the power to detect small differences in C stocks between land uses. Furthermore, C stocks can be estimated efficiently and cost effectively which is important for C monitoring and accounting purposes.

COMPARATIVE ROOT C INPUTS UNDER A MIXED SWARD AND CONVENTIONAL RYEGRASS/CLOVER PASTURE

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There is significant interest in the potential for roots to increase soil carbon (C) under pastures. Roots are considered to contribute more to soil C and subsequent stabilisation than inputs of above-ground plant biomass. Therefore, increasing root biomass or depth distribution of roots in the soil profile are potential strategies for increasing soil C.

New Zealand agriculture is dominated by a ryegrass-clover based pasture, which is typically shallow rooting. Mixed sward pastures (including species such as chicory, lucerne and plantain) have more species than conventional ryegrass-clover swards. Increasing species richness may increase biomass and rooting depth, which could increase C inputs to soil. However, little is known about the rooting characteristics of these mixed swards in comparison to traditional ryegrass clover swards. Our objective was to determine whether mixed swards had greater root biomass, rooting depths, and annual inputs of C to soil than a conventional ryegrass-clover pasture.

We sampled root biomass (to 30 cm) in mixed sward and ryegrass-clover paddocks (n=6) at DairyNZ Scott farm four times through a year. There was greater root biomass under mixed pastures compared to ryegrass-clover for all seasons with an average difference of 980, 1700, 700, 3700 kg/ha root biomass (autumn, winter, spring, summer) to 30 cm depth. Root biomass in the 10-20 and 20-30 cm depth fractions was significantly greater (p<0.05) under mixed swards compared to ryegrass-clover swards with an annual difference of 650 kg/ha and 300 kg/ha root biomass respectively. The 0-10 cm depth was not significantly different, except for in summer when there was 2000 kg/ha more root biomass under the mixed sward.

In addition, using the observed seasonal root biomass changes, root turnover was predicted to be greater under the mixed sward pastures with a difference in inputs to soil of 2117 kg dry matter/ha root biomass (847 kg/ha C). However, ryegrass-clover swards had a greater root surface area, specific root length and lower mean root diameter than the mixed swards. These root parameters need to be considered along with total biomass when estimating C stabilisation in soil and are currently under investigation.

STRATEGIC CAPTURE OF EFFLUENT TO REDUCE N LEACHING ON DAIRY FARMS WITH FREE DRAINING SOILS: ASSESSING IMPLICATIONS FOR EFFLUENT MANAGEMENT AND COST

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Standing cows off pasture is a practice dairy farmers use, particularly on poorly drained soils, to reduce treading damage to pastures and/or reduce losses of nutrients and contaminants in surface runoff and drainage. Wet soil conditions prone to treading damage mostly occur in winter and spring, whereas, summer and autumn are the most effective seasons to stand cows off pasture to reduce nitrogen (N) leaching. Adopting greater standoff increases the cost (capital and maintenance) of standoff facilities and creates new management challenges, particularly in effluent management.

In catchments with N leaching limits, farms on free draining soils have the same imperative to reduce N leaching as those on poorly drained soils, but treading damage is not nearly as critical. The requirement to stand cows off will, therefore, be mostly confined to the summer/autumn period. This raises the interesting question as to whether relatively low cost modifications could be made to an existing feedpad to allow greater standoff of cows later in the lactation season to adequately mitigate N leaching. To evaluate the feasibility of such a change, it will be important to assess the implications for effluent management and cost, particularly capital cost.

This paper explores the potential to retro-fit free-stalls to a dairy farm's existing uncovered feedpad, to allow cows to be stood off pasture for longer periods in summer and autumn. A farm in an Upper Manawatu River catchment within the Tararua District was selected for this assessment. OVERSEER® was used to estimate the likely reduction in N leaching as a result of standing cows off. With the increased time cows spend on the modified feedpad, more effluent will be captured. A number of tools (Effluent Storage Calculator, Effluent System Comparison Framework) were used to investigate the options and issues associated with the management of the extra effluent generated. Finally, the costs of this initiative are considered.

USING AN ECOSYSTEM SERVICES APPROACH TO ASSESS THE COST OF SOIL EROSION AND HOLISTIC VALUE OF SOIL CONSERVATION IN HILL COUNTRY

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Resource management in many countries is looking more closely at an ecosystem services approach to inform policy makers and the community.

This paper describes a methodology to operationalize a natural capital-ecosystem service framework to quantify and value the ecosystem services lost from a sheep and beef grazed pasture following a land slide; characterise the recovery of the provision of ecosystem services in the years following the land slide and to quantify and value the services from a grazed pasture following the introduction of wide-spaced trees as part of a soil conservation scheme to limit erosion.

This provides new information to inform benefit cost analysis of the wide-spaced tree soil conservation practice, as an ecological infrastructure investment.

The total value of the ecosystem services provided by a grazed sheep and beef pasture was for uneroded flat and rolling land $5,085/ha/yr and $3,717/ha/yr for uneroded steep land. Following an erosion event, the total value of the services provided by the steep land dropped by 64%. Recovery of ecosystems services after the erosion event was slow. After 50 years recovery was at approximately 61% (in dollar value) of the uneroded land. Planting conservation trees to reduce the risk of soil erosion increased the total value of the services of the resulting tree-pasture system by 23%, 20 years after planting.

A traditional cost benefit analysis of soil conservation shows planting trees isn't profitable unless the trees are harvested for timber, and low discount rate (<5%) is used. However, when considering the value of the extra provision of ecosystem services provided by the trees, in addition to the reduced risk of soil erosion, the Net Present Value of the investment is greatly positive regardless of the discount rate (0-10%).

This study addresses a real conservation issue and shows how an ecosystem services approach can be integrated to advance existing governance frameworks and to provide a more complete economic analysis for decision makers.

WINTERING CATTLE IN HILL COUNTRY:
MONITORING THE IMPACTS ON THE SOIL RESOURCE

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Cold and wet conditions in winter and spring are a challenge to winter management of beef cattle in hill country. In these landscapes, cattle are generally at liberty to roam across large paddocks when soils are wet. While the effect of treading damage by cattle on hill country soils and pasture has been studied at the small scale, there have been relatively few attempts to quantify the extent of soil and pasture damage at the paddock scale or to relate the extent of this damage to cattle movement and behaviour. In turn, cattle traffic patterns may be explained by reference to differences in micro-climate in hill country. A major research initiative has been established at Massey University's Tuapaka farm to the study effects of wintering cattle on soils, pasture and water quality.

Typical hill country paddocks are large and are comprised of a complex range of slopes, soil types and micro-climates. This scale and complexity makes it difficult to measure, monitor and record these variables, particularly with regard to their effect on cattle movement and the extent of treading damage. At Tuapaka, remote sensing technologies are being employed to provide spatial and temporal information to assist in the definition and characterisation of the variables associated with soil damage by cattle grazing in hill country. These include tracking cattle movement with GPS collars and the mapping of damaged areas using GPS units. Furthermore, LIDAR data for the study site has been procured. Information from these sources may be integrated to give a detailed picture of soil treading damage at the paddock and farm scale. Results for the first two years of the trial will be reported.

PRELIMINARY FINDINGS ON THE EFFECT OF TREADING DAMAGE AND URINE APPLICATION ON N LOSSES
IN MANAWATU HILL COUNTRY

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Hill country represents an important pasture base for sheep and beef grazing in New Zealand. Due to steep terrain, exposed slopes and sometimes fragile soils, traditional beef breeding and bull beef production can create significant areas of tread damaged soils with reduced pasture cover. In 2012, the extent of animal treading damage at the study location was mapped as part of an associated study. On average, approximately 43% of the 2 paddocks mapped, had varying degrees of treading damage. Animal treading can impact on nutrient transformations within soil and little is known about the quantitative impact of animal treading on soil N transformations, N uptake by pasture and N leaching in this steep hill country.

Animal treading commonly reduces the macroporosity of soils, affecting a plant's ability to take up water and nutrients and reducing plant growth. Reduced plant growth is likely to lead to a build-up of soil nitrate and ammonium concentrations. However, denitrification and nitrous oxide emissions have been shown to increase following treading and compaction in New Zealand lowland soils (Menneer *et al.* 2005; Bhandral *et al.* 2007). Elevated soil nitrate and ammonium concentrations due to reduced N demand by pasture, decreases in soil aeration and elevated soil water content are the likely reasons for higher denitrification rates. In addition, the concentrated deposition of urine is likely to increase denitrification rates due to increased soil nitrate concentrations. These processes are important as enhanced denitrification rates may lead to a reduction in soil nitrate concentrations and a lower risk of nitrate leaching. The physical damage cause by treading is likely to reduce water infiltration rate and could also lead to decreased nitrate leaching. However, to our knowledge, the effect of treading damage on nitrate leaching has not been widely studied. This paper presents a preliminary examination of the effect of urine application and treading damage on denitrification and nitrate leaching on a hill country soil in the Manawatu region.

ASSESSMENT OF DENITRIFICATION POTENTIALS OF GRAZED PASTURE SOILS

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In pasture systems, grazed by dairy and beef cattle, large fluxes of both urine N and C occur in the soil associated with urine patches. Various field and lysimeter studies have shown that urine patches enriched in N, whilst covering only 30% of the grazing area per annum are estimated to create 50% of the pasture growth, 50% of the N leached and 68 % of the N lost to the atmosphere by volatilisation (55%) and denitrification (13%). Leaching losses of NO_3-N to water and incomplete denitrification releasing N_2O-N to atmosphere impact adversely on the environment. Complete denitrification under soil conditions where micro-organisms can create low redox potential has the potential to reduce both nitrate leaching to waterways and greenhouse gas emissions.

Our knowledge of the spatial distribution of highly denitrifying conditions in soils is limited, and would be improved by extensive field surveys. One limiting factor constraining the extent of field surveys is the lack of a rapid technique to assess denitrification activity and potential for a soil horizon.

This paper summarizes field work undertaken to evaluate whether soil Vis-NIR spectroscopy can be used to predict both denitrification activity and potential activity.

PEDO-TRANSFER FUNCTIONS FROM S-MAP FOR MAPPING WATER HOLDING CAPACITY, SOIL-WATER DEMAND, NUTRIENT LEACHING VULNERABILITY AND SOIL SERVICES

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Recent modelling developments within S-map (New Zealand's soil survey data information system) have been designed to support nutrient management at multiple scales. A chain of models has been developed, implemented and tested. Firstly, statistical analysis of water content data held in the

National Soils Database has resulted in a set of pedo-transfer functions (ptfs) that estimate key points on the water retention curve for each soil sibling in S-map. With this information, the profile available water can be derived. This in turn is a key parameter in a soil-only model (or ptf) of vulnerability to nitrate leaching – one of a set of models that spatially describe risks related to other mechanisms of nutrient loss (e.g. runoff, by-pass flow). The nitrate leaching model can be recast in terms of ecosystem soil services, in this case as the 'regulation of N filtering' service. These soil-based models can be extended to account for spatial variation in rainfall and potential evapotranspiration, by running a daily water balance for each soil to estimate annual accumulated drainage; thus creating a spatial layer of leaching vulnerability based on soil and climate. Another output of this stage of the modelling is 'water demand', which can assist in the development of new irrigation schemes. Finally, information about land management (i.e. nutrient inputs) can be added into the vulnerability ptfs to estimate nitrate leached.

This suite of ptfs or models within S-map has a range of uses in farm nutrient management. The water content and other pedological information from S-map can be entered into nutrient budget models (e.g. OVERSEER), mechanistic nutrient leaching models (e.g. Apsim, Spasmo), irrigation models (e.g. IrriCalc), effluent management systems (e.g. FDE), all for use at the farm scale.

The soil- and soil–climate-based vulnerability models are useful for district- and regional-scale analyses where education or even regulation is needed to limit the potential for significant nutrient losses, or conversely to support the design of new irrigation schemes to maximise water and nutrient use efficiency. The soil–climate–land management models are used to predict catchment nutrient loads – an essential step in setting water quality objectives. These models have been used to help communities understand the likely impacts of possible land use changes, irrigation developments, or policy constraints on water quality.

EARTHWORMS IN SHEEP-GRAZED PASTURES

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Earthworms beneficial to New Zealand pasture agriculture are all exotic, having arrived accidentally with the first European settlers. Today the distribution of earthworms and their three functional groups (epigeic, endogeic and anecic) remains patchy and it is estimated that up to 6.5 million ha of pastures in New Zealand, may benefit from the introduction of the deep burrowing, anecic earthworms. The two types of surface active earthworms (epigeic and endogeic) are reasonably widespread and abundant. This study explores the distribution of all earthworm functional groups from existing studies in sheep-grazed pastures and looks at what soil functions they contribute to.

Earthworm functional diversity is found to be low in sampled sheep-grazed pastures, with anecic earthworms often absent. Pasture conditions in hill-country pastures are generally suitable for anecic earthworms and it is likely that the anecic earthworms are often absent from hill-country pastures because they have not yet reached these pastures. In pastures where the anecic earthworm, *A. longa*, has been introduced initial rates of spread are less than 4 m annually, with rates of spread reaching 12.5 m/year as the time since introduction increases.

The presence of all three earthworm functional groups present in a pasture improves the functioning of the soil. This is reflected in greater amounts of organic matter incorporated from the soil surface to depth in the soil, also increasing the availability of nitrogen to plants. The presence of anecic earthworms moderates the nitrous oxide emissions generated by the surface active epigeic earthworms, reflecting in part differences in pore structure. Anecic earthworms have more continuous and deeper burrows to aid preferential flow in comparison to endogeic earthworms, and a study found gas diffusion to be most efficient when both endogeic and anecic earthworms were present. All this would explain the increased pasture growth during autumn when anecic earthworms were introduced into pastures already containing surface active epigeic and endogeic earthworms. There is also evidence to suggest that with all three functional groups present, soils and pastures are more resilient to treading pressure and extremes of climate.

Anecic earthworms while absent from many sheep-grazed pastures are easy to establish. A fully functional soil should contain all three types of earthworms for sustained production throughout the year. To gain a better understanding of earthworm functional diversity a comprehensive nationwide survey is required, along with more research on their contribution to soil ecosystem services.

OCCURRENCE OF SOIL WATER REPELLENCY IN NORTH AND SOUTH ISLAND UNDER PASTURE

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Soil water repellency (SWR) has been reported worldwide in diverse soils and climatic conditions ranging from pastoral and cropping systems to natural forests. Several studies reported SWR in New Zealand, but its spatial extent in pastoral systems has not been studied. Therefore, we conducted a survey on the occurrence of SWR in the top 4 cm of soils under pasture across New Zealand. We hypothesised that SWR is influenced by soil order and climatic factors such as drought proneness of top-soils and summer rainfall. Our sampling sites represented a combination of eleven major soil orders of New Zealand, six classes of drought proneness and three summer rainfall classes resulting in a total of 76 sampling sites. We found at least a moderate persistence of SWR in 47 out of 76 sites (62%) at field moist conditions and a moderate potential persistence of SWR in 67 out of 76 sites (88%) after air drying the soils. Both the degree and persistence of SWR were greatest for the soil orders Podzol and Organic, followed by Recent and Pumice, and least for the soil orders Allophanic and Pallic. We also found that the summer rainfall significantly influenced the degree of SWR ($P=0.004$). However, we did not observe any relationship between SWR and drought proneness. The survey indicated that the degree of SWR was positively correlated with the soil organic carbon ($R=0.49$) and nitrogen ($R=0.47$) contents, and negatively ($R=-0.5$) with bulk density. The persistence of SWR for field-fresh samples was negatively correlated with the soil water content ($R=-0.55$). We found a significantly positive relationship between the degree and potential persistence of SWR ($R=0.88$, $P<0.0001$). Soil water repellency was at least moderately persistent in a soil with a contact angle larger than about 93.6°. Hence, we propose that the critical contact angle might serve as a relatively quick and cost-effective measure for the likelihood that SWR may occur in New Zealand pastoral soils.

ONE NUTRIENT BUDGET TO RULE THEM ALL – THE OVERSEER® BEST PRACTICE DATA INPUT STANDARDS

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As was demonstrated at this Conference last year for the Lincoln University dairy farm, user selection of the input parameters can have a major effect on the estimates of nutrient cycling for the described farm systems and hence the ultimate reported estimates for all outputs, including N losses and P loss risk. The purpose of providing OVERSEER® Best practice Data Input Standards (the Standards) is to reduce inconsistencies between different users when operating OVERSEER® to model individual farm systems. The Standards were not developed to teach users how to use OVERSEER®. For any one farm, the aim is to have one base nutrient budget which best describes the way nutrients cycle into, around and out of the farm.

The Standards were developed, at the request of the OVERSEER Owners, by a group of seven technical expert users, who drew on their personal knowledge and experience plus the DairyNZ Input Protocol, the AgResearch Expert User Group Guidelines and the Waikato Regional Council Protocol for Variation 5 (West Taupo catchment). The Standards are the consensus view of the seven technical expert users. A wider stakeholder advisory group, consisting of agricultural industry (dairy, sheep and beef, arable) representatives, regional councils, the Ministry for Primary Industries, the Ministry for the Environment and Irrigation New Zealand critiqued and endorsed the Standards.

OVERSEER DATA INPUT TIMESCALES – USING ANNUAL AND AVERAGE DATA

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Overseer Nutrient Budgets (*Overseer*) farm management input data can be obtained for individual years, while the underpinning climate databases within *Overseer* are based on long-term averages. Since *Overseer* does not restrict users to any specific combination of timescales for climate and farm management data inputs, this paper reviews the various options available, specifically in the context of nitrogen (N) loss estimates.

Use of long-term (e.g., greater than 20 years) average climate data with average ('typical') farm management input data will provide an estimate of what N loss would be in the long-term with this management and level of productivity. It fits closest to how the N model has been developed and calibrated using average N loss from experimental sites, generally 2-5 years in duration, with the long-term climate distribution pattern. However, there is no current prescription for an appropriate period for averaging farm management data.

It would be consistent with *Overseer's* framework to average a minimum of three years' annual farm management data, provided that that is combined with commensurate climate data. One individual year's output data from *Overseer* should generally not be derived using long-term average climate data because the management and productivity for a particular year will frequently not be commensurate with the average climate. For example, inputting management data for a drought year such as 2013 with long-term climate data is an extreme but useful example of such a potential mismatch that would produce erroneous estimates of nitrogen leaching for that period.

When considering the use of annual climate data, it is important to note that *Overseer* currently does not have the capability to input individual climate year characteristics for a location. The long-term average inputs can be modified to some extent by entering annual rainfall, average temperature and further modifying rainfall distribution and potential evapotranspiration through advanced options.

The over-riding consideration for choice of timescale combination for farm management and climate inputs is that it must be consistent with a commensurate realistic farm system and be appropriate to the use of the model output. Further work is required to evaluate some of the implications of data input choices.

S-MAP @ THE FARM SCALE? TOWARDS A NATIONAL PROTOCOL FOR SOIL MAPPING FOR FARM NUTRIENT BUDGETS

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Data that characterise land resources are fundamental to improving both agricultural productivity and environmental quality. Increasing agricultural productivity whilst minimising the impacts of intensive land use on fresh water is a national priority, with central and regional government policies, as well as industry initiatives, demanding quality soil information. Soil survey information has long been a key component of resource management studies at regional and national scale, but new policies and upcoming consenting requirements indicate that in coming years there will be widespread implementation of Farm Nutrient Budgets and Farm Environment Management Plans (FEMP), which will greatly increase the need for accurate farm-scale soil information. Whilst these budgets and plans are targeted at individual farms, collectively they contribute to catchment and regional objectives. Within this context it clearly makes sense to ensure that accurate farm-scale soil information is provided in a consistent and auditable manner across a catchment.

Farm-scale soil information can be sourced from site observations, chemical and physical laboratory measurements of soil samples, electro-magnetic surveys, and detailed soil survey in addition to coarse-scale land-use capability (LUC) maps. We propose a national protocol for providing farm-scale soil information. We argue that establishment of a national protocol has great advantages, providing clarity and certainty to those investing in farm-scale soil information, ensuring equitable and consistent outcomes from Farm Nutrient Budgets and FEMP, as well as making it possible to scale up farm data to catchment-level modelling.

We suggest that the S-map data and informatics system, together with the National Soils Database (NSD), is ideally structured to support farm-scale mapping that follows a national protocol, and we highlight some key development initiatives to achieve this vision. We have characterised the various methods for obtaining soil information into four quality levels, along with a description of the minimum standard for each method. Policymakers can then determine the most appropriate level that is acceptable given the context in which the soil information will be used. Freely available S-map data may be suitable for most situations, whilst intensive land use in highly sensitive catchments may require a higher level of information, such as site-specific measurements of key soil attributes.

WAIKATO SOIL WINDOWS
– TAKING S-MAP DOWN TO THE FARM

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S-map is the new national soils database that aims to provide a seamless digital 1:50,000 scale soil map coverage for New Zealand. Mapping for S-map is underway across the Waikato Region. A concurrent project, Waikato Soil Windows, has been initiated with the aim of (1) formalising soil–landscape relationships developed and used by pedologists undertaking S-map soil mapping, and (2) increasing the accessibility and uptake of soil information by land managers for farm management decision making. This paper describes how S-map information can be used to help achieve these goals. During recent S-map soil surveys in the Waipa and Upper Waikato catchments, detailed soil–landscape models have been, or are currently being, developed. Pedologists develop soil–landscape models while undertaking soil surveys to help them understand the relationships that control and explain the soil pattern within a land region. However, the models are not always explicitly communicated to the end user or other pedologists. Capturing and articulating these relationships will document the ideas used to determine soils in the landscape and will assist pedologists with further soil mapping in the future. There is growing interest in making use of the soil information contained in S-map for farm management decision making. At a scale of 1:50,000, the resolution of the spatial information in S-map may be too coarse to be useful for farm- or paddock-scale management without additional, detailed soil data (sibling data) and an understanding of the soil-landscape relationships. A well-presented and communicated soil–landscape model can be thought of as a 'window' that provides land managers with an insight into the soil pattern within a particular area. Moreover, these models (or 'soil windows') could facilitate the development of farm-scale soil maps by suitable skilled professionals that could then be linked to sibling data in S-map. The soil information held in the sibling database, captured and linked to the online 1:50,000 soil polygons during the S-map survey process, can be used at multiple scales. Greater value could potentially be derived from the sibling data if it were made more accessible to land managers. These data have multiple uses in the management of nutrients, water, effluent, cultivation, and grazing.

RESTRICTED GRAZING OF WET SOILS:
FROM CONCEPT TO SYSTEM

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Intensive grazing by cattle on wet soil can have a negative effect on soil physical quality and pasture production. Damage generally occurs when soils are wet, due to the lowered bearing strength. Soil pugging usually causes direct damage to the pasture sward, while soil compaction impacts on several soil functions, including transportation and storage of air, water and nutrients, which in turn may lead to reductions in pasture production.

The Proctor compaction test has been used to identify a critical soil moisture content (CMC) beyond which soil structure will be damaged in response to a known force, such as a cow hoof. At 2 sites we assessed whether implementation of a farm management approach, termed 'restricted grazing', in which dairy cattle grazing was restricted when soil moisture content exceeded the CMC, improved pasture production and soil structure. At the North Otago study site, experimental plots (10 m x 25 m) were monitored for three years to assess the direct effect of a restricted grazing regime on soil structure and pasture production. A similar management strategy was employed on a dairy farm in South Otago to assess the implications of a restricted grazing management regime on the whole farm system, i.e. including effluent management, feed supply and general practicality. Although the two study sites have a similar soil type, the climate and landscape varies considerably. Here we critically assess the benefits and challenges of such management practices using results and practical considerations obtained from both sites.

DURATION-CONTROLLED GRAZING ON DAIRY FARMS: DECISION SUPPORT FOR TIMING OF SLURRY RE-APPLICATION

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Duration-controlled (*DC*) grazing management, which involves standing cows off pasture to ruminate and rest rather than allowing them to remain in the paddock after grazing, is able to decrease the amount of nitrate-nitrogen leached from grazed dairy pastures by more than 50%. The standoff facility employed by the *DC* system will accumulate on average 167 kg N/ha/yr in dung and urine, which requires uniform reapplication to the farm as slurry. The nutrient content of the slurry varies with the nature of the standoff facility (roofed or un-roofed), the cows diet, and whether standoff slurry and farm dairy effluent are combined, or stored separately. The variables interacting to influence slurry volume, nutrient concentration and the rate and timing of reapplication are complex. Decision support software is required to plan and implement the most cost effective slurry treatment systems. In addition, the software should assist timing of slurry reapplication to maximise its fertiliser value and minimise any adverse effects, such as runoff. In this paper, we model the rate of accumulation and nutrient concentration of slurry generated in a freestall barn. The requirements for slurry storage are also modelled based on rates of slurry generation and the timing of soil moisture-limited, slurry re-application. Secondly, the growth response caused by slurry reapplication to *DC* managed pastures is reviewed by examining 5 years of plot trial data.

EFFECT OF URINE AND POTASSIUM APPLICATION ON PASTURE PRODUCTION FROM A DICYANDIAMIDE-TREATED FREE-DRAINING CANTERBURY DAIRY PASTURE SOIL

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A cut-and-carry trial was conducted on a low quick-test-potassium (QTK ≤4) Lismore soil during 2012-13 in Springston, Canterbury to test the responsiveness of a dairy pasture to urine, dicyandiamide (DCD) and potassium (K) applications. Over the full year, the applications of urine-only, urine+K, urine+DCD, and urine+DCD+K increased pasture production significantly over the non-urine control treatment by 23%, 29%, 36% and 42%, respectively. Applications of K, DCD and DCD+K significantly increased production over the urine-only treatments by 5%, 10% and 15%, respectively, for both spring and full-year totals. There was only one significant interaction for total DM overall (urine x DCD) with no significant increases to K or DCD applications for non-urine treatments.

The pasture responses to K and DCD applications were attributable to maintaining better balanced plant nutrition, rather than to soil K deficiency per se, as urine application maintained QTK levels to recommended values for the duration of the trial. Whilst these differences were considered to have their roots, at least partly, in K nutrition, it may also reflect differences that are particular to cut-and-carry trial management and measurement where large off-takes of nutrients in harvests can indirectly influence treatment responses. A relative absence of clover meant that this pasture fraction was not a major contributor to the response. The findings of this trial show that regular K application increased pasture DM responses to the N retained in soil by the use of a nitrification inhibitor (DCD) even when soil K levels were considered adequate.

EFFECT OF APPLICATION TIMES OF UREASE INHIBITOR (AGROTAIN®) ON NH_3 EMISSIONS FROM URINE PATCHES

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In grazed pastures about 80% of urine N in the form of urea is rapidly hydrolysed and is subjected to ammonia (NH_3) losses. The use of urease inhibitors (UI) has been used as a mitigation tool to decrease the rate of NH_3 volatilization from fertilizer urea and animal urine. In previous New Zealand trials the UI effect in reducing NH_3 emission from urine has been measured by applying urine mixed with the UI to the pasture soil thus increasing the chance to better inhibit the urease enzyme. However, these trials do not represent a realistic grazing scenario where only urine is deposited on to the soil.

Therefore, to determine the effect of UI Agrotain® in reducing NH_3 losses from urine deposition by grazing animals, a field experiment was carried out at Massey University dairy farm # 4 by spraying UI before or after urine application. The data on changes in NH_3 emission, soil pH and mineral-N from this experiment is processed and the results will be presented and discussed at the Workshop.

SOIL CADMIUM – REVIEW OF RECENT DATA IN RELATION TO THE TIERED FERTILISER MANAGEMENT SYSTEM

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Accumulation of cadmium (Cd) in New Zealand agricultural soils is a known long-term management issue. This accumulation is primarily driven through the incidental application of Cd contained in phosphorus fertilisers. Consequently, to manage soil Cd accumulation, the 'Tiered Fertiliser Management System' (TFMS) which imposes increasingly stringent fertiliser management practices as soil Cd concentrations increase, is an integral part of the national Cadmium Management Strategy.

The first step for implementing the TFMS is assessing on-farm soil Cd concentrations. Engaging with farmers to provide clear, sound information and advice is critical to the uptake of the programme. Many farmers have limited understanding of Cd and testing for it introduces a cost with few immediate benefits. Increasing regulation on soil contaminants has been signalled and voluntary uptake of responsible management of soil cadmium under the TFMS is encouraged and supported.

This paper provides a summary of national soil Cd concentrations from soil test data, including that collected on-farm under the first year of the TFMS, and perspectives from farmers and fertiliser industry staff as to the implications for managing soil Cd under the TFMS. Since 2007, around 3700 soil Cd samples have been analysed which form the basis of this update on our national soil Cd status. This includes approximately 1500 samples collected under the TFMS since its inception. Soil Cd concentrations reported over this time period range from <0.01 to 2.7 ppm, with large differences apparent between soil type and land use. The majority of soil samples that make up this database have been taken to 0-75 mm, or 0-100 mm soil depth, rather than the TFMS 'definitive' 0-150 mm soil sampling depth; hence results will be biased upward. The reason for this is that the TFMS allows for 'screening' to take place using conventional, routine soil fertility assessment so as to minimise initial additional labour and sampling costs. This increases the soil cadmium dataset while providing a precautionary approach for assessment of soil cadmium levels.

A BOUNDARY LINE APPROACH FOR ESTIMATING THE RISK OF N_2O EMISSIONS FROM SOIL PROPERTIES

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Agricultural greenhouse gas (GHG) emissions are the largest contributor to New Zealand's (NZ's) total GHG emissions. Nitrous oxide (N_2O) emissions represent approximately one-third of agricultural GHG, with animal excreta being its main source. For inventory purposes N_2O are currently estimated based on a Tier 2 methodology that employs disaggregated emissions factors (EF's) for dung and urine, with emissions from urine being greatest due to N being deposited in a readily available form. However, such EF's are insensitive to soil and climate factors that influence emissions. To reduce N_2O emissions, a better understanding of the factors driving emissions and an evaluation of mitigation strategies is required. While deterministic models can be used to evaluate how heterogeneity in climate and soil affect these emissions and identify mitigation options, site specific validation and parameterisation of such models is often lacking, limiting the accuracy of the models. An alternative is to consider empirical models, which are based on more easily available input data, as the one developed by Conen et al. (2000) for estimation of N_2O emissions. Their approach is based on a boundary line and using the soils' water filled pore space (WFPS), temperature SoilT and mineral nitrogen content (nitrate and ammonium). Following this approach, we determined boundary lines (or limits) for low, medium, and high N_2O emissions for two regions of NZ (Waikato and Otago), and four different soil types (Horotiu, Te Kowhai, Wingatui, and Otokia). The analysis was based on measured N_2O emissions, and modelled values of WFPS, SoilT, and soil nitrate and ammonium content using the Agricultural Production Systems Simulator (APSIM). These boundary lines were then used to estimate the likely risk of N_2O emissions throughout the year for the two different regions and four soils based on long-term modelling over a period of 20 years.

Conferences:

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Important Dates

- Papers due: **31 March 2014**
- Acceptance of papers emailed: 23 June 2014
- Provisional program available: 21 July 2014
- Presenter & early bird registration: 25 August 2014
- Final papers due: 25 August 2014

This international workshop will bring together scientists who can explain the critical changes in soils, particularly during the past century of increasingly intense land use. Soil Change Matters will include dialogue between policy makers and scientists to clarify policy needs, as well as the current capability of soil knowledge systems and soil monitoring approaches. We invite you to be part of this international workshop organised by the Victorian Government's Department of Environment and Primary Industries, and supported by Soil Science Australia and the International Union of Soil Sciences.

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March 2014

SSSA Specialized Conference- Soil's Role in Restoring Ecosystem Services. Sacramento, CA, USA on March 6-9, 2014. www.soils.org/meetings/specialized-conferences/ecosystem-services

Resources and the Environment: The Next Ten Years. Science, Regulation and Social License. Freemantle Western Australia 31 March – 1 April 2014. www,aig.org.au

April 2014

Carbon Management, Technology and Trade Conference 4-6 April Istanbul Turkey
http://www.carbonmeetings.com/

International Scientific Conference Geography: challenges of the XXI century . Vernadsky University (8 – 12 April, 2014).
http://geo80.crimea.edu or contact geokonferenciya@ukr.net

Soil Security Laboratory Digital Soil Mapping Training Workshop 22-24 April 2014 University of Sydney ATP For More Information:
Contact Budiman E: Budiman.minasny@sydney.edu.au, Ph. +61 2 8627 1131.

European General Assembly April 27 – May 2 2014 (EGU2014) Austria Centre Vienna
http://meetingorganizer.copernicus.org/EGU2014/provisionalprogramme

May 2014

Socio-economic indicators of climate change, impacts of climate changes on sustainable development of natural resources. Egyptian Society of Soil Science Kafr El-Sheikh, Egypt May 5-8
www.esss.org.eg

International Agricultural Consulting Conference May 8 The Pavilion, Brisbane
www.aginstitute.com.au/events/qld

International Conference on Chemical, Biological, and Environmental Sciences (ICCBES'14) 12th to 13th May 2014, Kuala Lumpur, Malaysia
http://iaast.org/2014/05/13/38

4th National Acid Sulfate Soil Conference 20-21 May 2014 Rendezvous Hotel Perth WA.
www.scu.edu.au/nationalassconference

June 2014

20th World Congress of Soil Science Soils Embrace Life and Universe. June 8-13 2014 Jeju Korea http://www.20wcss.org

5th International Conference on Sustainable Irrigation and Drainage: Management, Technologies and Policies 17 - 19 June, 2014
http://www.wessex.ac.uk/14-conferences/sustainable-irrigation-2014.html

International Conference on Biogeochemical Processes at Air-Soil-Water Interfaces and Environmental Protection, June 23-26, 2014, Imola, Italy
http://aswep-essc.unibo.it/)

July 2014

XVII Conference of the International Soil Conservation Organisation 8-13 July 2013 Medellin Columbia http://iscocolombia2013.com/ingles/index.html

XI International Symposium on Enchytraeidae Georgsmarienhütte near Osnabrück, Germany, July 25-27, 2014. More information see: www.ect.de

Phytoremediation of Polluted Soils – current research and main aspects of usual pollution. Vigo Spain 29-30 July 2014phytorem.congress@uvigo.es

"3rd International Conference on Earth Science & Climate Change" (Earth Science-2014) July 28-30, 2014 San Francisco, USA hosted by OMICS Group Conferences. http://www.omicsgroup.com/earth-science-climate-change-conference-2014/index.php

August 2014

9th International Symposium AgroEnviron, 3-7 August 2014 in Goiânia, Brazil. "Impacts of Agrosystems on the Environment: challenges and opportunities. Abstracts submission is open at www.agroenviron2014.com

II Curso latinoamericano – Micromorfologia de suelos y técnicas complementarias (CLMSTC) Bogota (Colombia) from 04 to 10 August 2014. The Objectives are to extend the knowledge of micromorphology to the Spanish-speaking audiences in Latin America (it is a course taught in Spanish). This course is part of IUSS Commission 1.1 Soil Morphology & Micromorphology activities Information: jcloaiza@unal.edu.co; willyposada@yahoo.es

Phosphorus in Soils and Plants 5th International Symposium 26-29 August 2014 Le Corum Montpellier France http://psp5-2014.cirad.fr/

September 2014

21st General Meeting of the International Mineralogical Association (IMA 2014) 1-5 September South Africa

ELS 2014 - the Earth Living Skin: Soil, Life and Climate Changes, under the auspices of the Soil System Sciences Division of the European Geosciences Union, 21 – 25 September 2014 in Nova Yardinia, Italy (www.els2014.eu).

XII Congress of the Croatian Society of Soil Science Dubrovnik, in the independent Republic of Croatia, the 28th EU member, from September 22-26, 2014. More information see: www.congress-csss.org

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

EcoForum Conference and Exhibition. 29-31 October 2014. The Abstract Submission Deadline is 15th March 2014.
http://www.ecoforum.net.au/program.html

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

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

December 2014

http://www.nzsssconference.co.nz

From 1 – 4 December 2014 visitors will descend on Hamilton to attend the New Zealand Society of Soil Science (NZSSS) Conference with the theme: **"Soil Science for future generations".**
The four day conference will incorporate the full range of oral presentations and poster sessions similar to the Society's pervious conferences. However this conference will be a notable event for the soil science profession in New Zealand, being the first hosted conference since 2008. The previous conference was attended by more than 200 of NZ's leading soil scientists, students and practitioners. The intervening period has presented many primary production and environmental challenges that have seen the discipline of soil science (and its practitioners) play a vital role in finding solutions and answers. As New Zealand rises to the challenge of increasing its primary industry exports whilst improving its environmental footprint, it is becoming clear to policy makers, industry bodies, and stakeholders that our country's soil resources will be a critical component to be understood and managed going forward. This conference offers an excellent opportunity to take stock of our progress to date and to define future needs while raising the awareness of the wider community to soil science. Furthermore, this conference also presents a timely opportunity to focus on our need to foster and support the development of the next generation of soil scientists who will continue the progress made by those who have gone before them.

The aim of the conference is to bring the New Zealand soil community together across a wide range of soil science disciplines and institutes covering research, education, policy, and extension to present their latest science and discuss its implications for our environment, now and into the future. In-line with the theme of the conference, we seek to attract and encourage the involvement of the next generation of soil scientists by making the event highly accessible and relevant to our student population.
The programme will include an opportunity to present and learn across a wide range of soil related topics such as nutrient management, water quality, soil fertility & plant nutrition, soil quality & function, greenhouse gases, pedology, land application of wastes, microbial biology and soil carbon.
On behalf of the Organising Committee, we look forward to welcoming you to Hamilton this December.

David Houlbrooke – AgResearch
Conference Chair