Welcome to the Soil News

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In this issue…

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PhD opportunity: Soil structural degradation and nitrous oxide emissions

Soil structural degradation is a significant threat to both NZ and global ecosystems. This degradation has profound consequences, including loss of production, and increased risk of soil erosion, nutrient loss, and GHG emissions.

Current methods for assessing soil structural vulnerability rely on traditional, non-functional properties. These provide inadequate predictions for soil ecosystem services like plant production and GHG mitigation.

With funding from the New Zealand Smart Ideas programme, this project will focus on the dynamic functional properties of soil structure (e.g. relative gas diffusivity) and their relationship with greenhouse gas emissions (GHG) with a focus on nitrous oxide emissions. Through experimentation and modelling, the candidate will evaluate how dynamic functional properties and N_2O emissions respond to soil compaction.

The PhD candidate will be embedded in a team of experts comprising soil science, environmental science, biophysical modelling, and crop production, and be based in the Lincoln Research hub. The supervisory team comprises of Prof. Tim Clough and Dr Chamindu Deepagoda (Lincoln University), Dr Wei Hu, and Dr Rogerio Cichota (Plant & Food Research), along with an advisory team: Dr Brent Clothier (Plant & Food Research), Dr John Drewry (Manaaki Whenua – Landcare Research), and Prof. Stephan Peth (Leibniz University Hannover, Germany). The candidate will contribute to new knowledge in soil and environmental science through the development and application of skills in several of the following areas: soil physics, soil mechanics, stable isotope techniques, nitrogen cycling and GHG emissions, molecular biology, data analysis and modelling.

A tax-free annual stipend of $40,000 (NZD) per year, for up to three years, and Lincoln University tuition fees, for up to three years, will be provided.
The candidate should be ready to commence their studies 20th January 2025.

How To Apply
To apply please send your CV and cover letter via email by 30th November 2024.

Prof. Tim Clough
Soil and Physical Sciences
Faculty of Agriculture and Life Sciences
Lincoln University
New Zealand
Email: Timothy.Clough@lincoln.ac.nz

Entry requirements:
Preferred candidate's skills and experience:

- Good time management of tasks and deadlines.
- Curiosity and a willingness to learn.
- Creativity and problem solving.

- An ability to formulate a hypothesis.
- Background/undergraduate study in soil science or related fields.
- Ability to collaborate effectively with colleagues and peers.
- The ability to critique and synthesis literature, analyse data and the ability to produce scientific written outputs.

Are you eligible?

- The PhD is open to those who meet the entry level requirements for a PhD at Lincoln University, New Zealand, and is open to New Zealand citizens, residents and international candidates who can meet the appropriate visa requirements.
- The programme will be looking for a diversity of skills across the successful applicants.
- PhD applicants must be eligible at the time of application to register as a candidate for a Doctoral degree at Lincoln University or expect to become eligible by January 2025

Candidates who already have a doctorate in an applicable/related field are not eligible for consideration.

https://www.lincoln.ac.nz/study/scholarships/find-a-funded-postgraduate-research-project/soil-structural-degradation-and-nitrous-oxide-emissions/

Climate change as a symptom

Climate change as a symptom: problems of modern agriculture and a future role for soils

Jock Churchman, Adelaide, South Australia

We cannot escape climate change. Whether always attributed or not, it is playing out its role daily and internationally. It bears considerable responsibility for increased and more severe flooding, for wild fires, for droughts, and, of course, for almost unbearable heating. As I write, in early October 2024, the news is reporting America's most destructive storm, Hurricane Helene, on the South-East coast while South Dunedin, an early densely settled area, is being flooded as much of Otago has its wettest day in 100 years. Global heating drives these other effects, and many more besides, including ocean acidification, the migration, and also the loss of species on land and in the sea.

Soils

As soil scientists, we may have had some reasons for feeling smug about it all. We have heard often about how soils can sequester excess greenhouse gases, especially carbon dioxide, albeit that deeper analysis of this claim does not always support it[1]. As well, soils house bacteria that can help manufacture new forms of protein to take the pressure off scarce land and also methane-producing animals[2]. And we can take some pride in the fact that land managers can be guided to design soil surfaces which can lower the emissions of greenhouse gases, other factors being equal[3].

Emissions

But climate change continues apace, and, in most parts of the industrial world, emissions which are the drivers of the problem, continue to rise. Many are deluded about the efficacy of soils and even of trees, especially replanted trees, to bring them down. And we know that burning fossil fuels is a root cause of these harmful emissions, and have been told by any manner of authorities, scientific (e.g. the IPCC) and political (e.g. the Secretary-General of the United Nations), that we must curb their use and certainly not seek new sources of them. Even the Australian Government, while a vast step change from their predecessors on climate action, are still approving new sources of both coal and gas. And the new New Zealand government will pursue them unashamedly as would Donald Trump if he were elected in the US. Climate policy for almost all governments is just another policy, to be balanced against others like the economy and defence when it should be clear that it constitutes an exponential threat to all humans and to all life that we value on Earth.

Nature

Considerable reading and listening, especially on YouTube, has pretty well convinced me that climate change is but a symptom of a deeper malaise in mainly Western countries. It comes down to a denial of the fact that we are a part of nature, neither above the rest of it, or, as some extremists have claimed, a parasite on all other living things. Several sources have led me to this view. They include thinkers and practitioners cited in my earlier articles here[1,2] like George Monbiot, Allen Savory, Rudolf Steiner, Wes Jackson, Peter Andrews, Bill Mollison, David Holmgren, and Charles Massy. All believe that the answer to meeting climate change while still practicing agriculture, lies in designing and working with nature, not against it, as has often been the case in the past. The situation we now have on the planet is that human-made objects may now outweigh all of the living beings on Earth[4]. As a species, we may be relatively lightweight (only ~0.1% of the biomass of the planet[5]) but we sure make a huge difference.

A new approach

Many others, outside of agriculture, have come to this view for technology overall. One of these is an American environmental philosopher by the notable name of Daniel Schmachtenberger. He is a middle-aged original thinker, with many contributions on You Tube but neither an academic post nor a book to his name. It may be significant that he was home-schooled, so can think outside the educational box. He once worked for Greenpeace and was active in campaigns to bring back whaling and against French atmospheric atomic bomb tests at Mururoa Atoll, among other campaigns. Although thinking his own thoughts, he echoes those of many others such as George Monbiot, Jared Diamond, Fritjof Capra (philosophical physicist), David Suzuki, Tim Flannery and many others in locating humans as an integral part of nature. Daniel S., with others, has begun a project called the Consilience Project[6] that attempts to flesh out what has gone wrong with humanity and to develop principles that can enable a less destructive path for us in the future.

Technology and its side-effects

The Consilience Project (hereafter CP) asks above all, what is progress? Progress has brought us the Anthropocene, where humanity is the dominant influence on earth. And it is our technological inventions and their applications that give us the power to be so dominant. However, it is the contention of the CP that we human beings, having found a solution to a particular problem, tend to go enthusiastically into applying that solution both blind to and ignorant of any side-effects that the newfound solution might bring along with it. We forget the externalities that almost invariably accompany any new application.

An example that is given by the CP is that of "engine knocking" in petrol-powered vehicles. This effect limited engine performance and damaged engine components. In 1921, it was solved through the addition of Tetra Ethyl Lead to the petrol. Although this solved the knocking problem, the solution resulted in lead being released to the atmosphere. Lead is a potent neurotoxin that is harmful to all life and especially causes cognitive problems in children. In 2015, it was estimated that the lead released in this way probably led to an overall loss of about a billion points in IQ and increased the rate of violent behaviour[7]. And, as is typical of side-effects to technologies, new detrimental effects continue to be found. It has been estimated that the number of people who died of heart disease caused by lead poisoning has exceeded those from smoking and nutrition[8].

And then there are Thalidomide, Vioxx and asbestos, among many other examples of technologies developed to solve a specific problem that had disastrous secondary complications, not to mention the introduction of cane toads to Australia. Indeed, the central problem of global heating is the unintended result of an excess of carbon dioxide produced from burning coal that underwrote the industrial revolution, petrol and similar products of oil that power transport on land, sea and in the air, and natural gas that even helps us to cook, beside other uses.

Progress

So how to avoid further instances of what the CP calls "Naïve Technological Optimism" where fools rush in without giving due thought to possible side-effects? Progress, it says, can be immature, or blind to its downsides, or mature, where both upsides and possible downsides are considered before action takes place. The authors of the CP write:

"If we continue to measure and optimize progress against a narrow set of metrics—metrics focused primarily on economic and military growth, which do not account for everything on which our existence depends—our progress will remain immature and humanity will continue its blind push toward a civilizational cliff edge."

Their point is that almost every human activity has been progressed in an immature fashion. This even includes agriculture and its apparent success in increasing yields of food and potentially feeding the world (politics aside). It is identified that the greatest leap forward in achieving an apparently endless supply of food was the development in 1913 of the Haber-Bosch process for the fixation of atmospheric nitrogen in synthetic fertiliser to supply essential nitrogen to plants at a much more rapid rate than achievable by "natural" plant-based methods. Surplus food became available, leading to a boom in population, and to a burst of economic activity that has continued to this day. Food was no longer a limitation and even conflicts between groups over food supplies decreased.

Haber-Bosch and its side effects

But the side-effects of the success of the Haber-Bosch process have proven to be many, albeit that several of them have taken considerable periods of time to be identified as such. The CP identifies some of these as affecting human health:

- A reduction in food diversity, leading to many chronic diseases, including cancers, cardiovascular damage and nervous system impacts.
- Bioaccumulation of heavy metals in animals and humans. These can cause cognitive effects, as well as a variety of damaging health effects.
- Expansion in the use of pesticides and herbicides, with multifarious effects of human health. An increasingly common likely effect is the rise in Parkinson's disease, as outlined in a recent issue of *The New Zealand Listener*[9].
- Micronutrient deficiencies, leading to effects on cardiovascular disease, type 2 diabetes and the immune system.
- Damage to the development of our teeth and jaws through the emphasis on growing simple grains.
- An increase in chronic disease and pain as "diseases of abundance".

- Surface and groundwater pollution, impacting human health via contamination of drinking water.
- Maltreatment of animals and choice of few key species for meat production.
- Overuse of antibiotics to treat animal diseases.
- Acceleration of climate change via direct emissions from agriculture of methane, nitrous oxide and other greenhouse gases.
- Air pollution from volatile ammonia in fertilised fields.
- An increase in the use of phosphorus fertilisers alongside nitrogen fertilisers, leading to eutrophication in waterways, contamination of drinking water and production of algal toxins.

Some also affect society:

- Population growth leading to overuse of resources, increase extraction from the natural world, increased waste and pollution.
- Greater yields required more industrial farming equipment, more water and new agricultural practices, such as pesticides, tractors, mechanical threshers and pumps. Farming became more complex, more reliant of supply chains.
- Reduction in phytochemicals and other bioactive plant nutrients that are advantageous to human health in crops, including due to harvesting of fruits and vegetables prior to ripening.
- Deposition of nanoplastics from use of plastic tools, e.g. tunnels, irrigation piping, greenhouses, associated with intensive farming. These can accumulate in crops.
- Concentration on major cereals at the expense of minor cereals. fruit and vegetables, so leading to deficiencies in requirements for health.

And some affect the biosphere:

- Nitrogen pollution in waterways, leading to eutrophication, driving algal blooms that reduce oxygen in water and generate “dead zones” for marine life. Nitrous oxides can also cause acid rain.
- Industrial farming practices can cause ecosystem and habitat destruction, species extinction and losses in biodiversity as well as loss of soil organic matter and soil structure.
- Development of high-yielding crop varieties at the expense of unique ancient crop varieties.
- Secondary ecosystem disruption from changes in biodiversity, leading to problems with pollinator populations, water purification and regulation of plant and animal diseases.
- Expansion in the use of synthetic pesticides and herbicides, with a vast and complex range of impacts on plant and animal life and human health as well as degradation of soil microflora, and increased alkalinity and salinity.
- Herbicide-driven disruption of the soil biome – the diversity and prevalence of soil bacteria with roles in nutrient production, besides other roles.

- Excessive use of groundwater for irrigation, leading to possible water shortages.
- Loss of traditional practices and knowledge.
- Socioeconomic changes, including a shift from rural to urban living, with attendant impacts on psychologies and mental health, including of children.
- Acquisition of smaller farms into larger commercial ventures as farming costs increase.
- A loss of seasonality and regionality in our food, with a larger carbon footprint of year-round production bringing global supply chains.
- Resource depletion and market volatility. Haber-Bosch is dependent on reliable supplies of natural gas and hence on supply chains. There was disruption of supplies of synthetic fertiliser during COVID-19, leading to major regional crop failures.
- Novel problems arising from the externalities (side-effects) of agricultural industrialisation. An important example is clearcutting in the Amazon rainforest to meet the demand for high-intensity cattle farming. ThIs affects one of the world's most important hydrological pumps with consequences for global weather systems. It is an instance of a "cascade effect": a single technological innovation generating many new problems increasing in scale of impact and intensity.

As it is spelled out in the CP:

"How can there be so many costs associated with one of the most frequently cited examples of technological progress? Could anyone have known that solving famine would simply kill us, in a set of new and unusual ways?"

Agricultural alternatives

A very good question, as politicians scrambling for an answer on TV, might say. But, the CP continues, we already know how to do better. This is through regenerative agriculture, in which we recover the reasons why ancient and traditional agricultural practices brought benefits[1,2]. As stated furthermore in the CP, referring to the dependence of modern farming on the use of pesticides:

"Is it progress to build a world in which we avoid famine by producing food covered in poisonous residues and lacking in the elements of nature that probably contributed to the development of our unique ingenuity in the first place?"

And, readers, here it is that soil comes to the rescue! The CP maintains:

"Soil is one of the critical differences between Mars and the Earth"

To me, that is a statement in slogan form equivalent to the old Soil Bureau standbys like "Never treat soil like dirt". Indeed, the main point made in the Project is that soil is a living organism. Healthy soil can facilitate nutrient cycling, stabilise the hydrological cycle and maintain ecological balance. Regenerative farming practices aim to continually enhance the soil, both in quality and quantity. As stated again in the CP:

“When we take action to improve topsoil, the plants that grow from the land are improved as a second-order effect - a positive externality.”

Compost and natural fertilisers replace synthetic fertilisers in regenerative agriculture, with attendant benefits to human health besides other effects like the maintenance of water quality. It is an ecological approach which draws inspiration from natural systems. As they say in the CP:

“In natural systems, each element serves multiple purposes and each purpose is served by multiple elements.........It is an approach rooted in stewardship (as opposed to exploitation) of the biosphere.”

New Zealand agriculture

So, how does New Zealand agriculture stack up against these ideals? Figure 1 shows the amount of nitrogen sold as a fertiliser over 28 years from 1991 (data from Stats NZ).

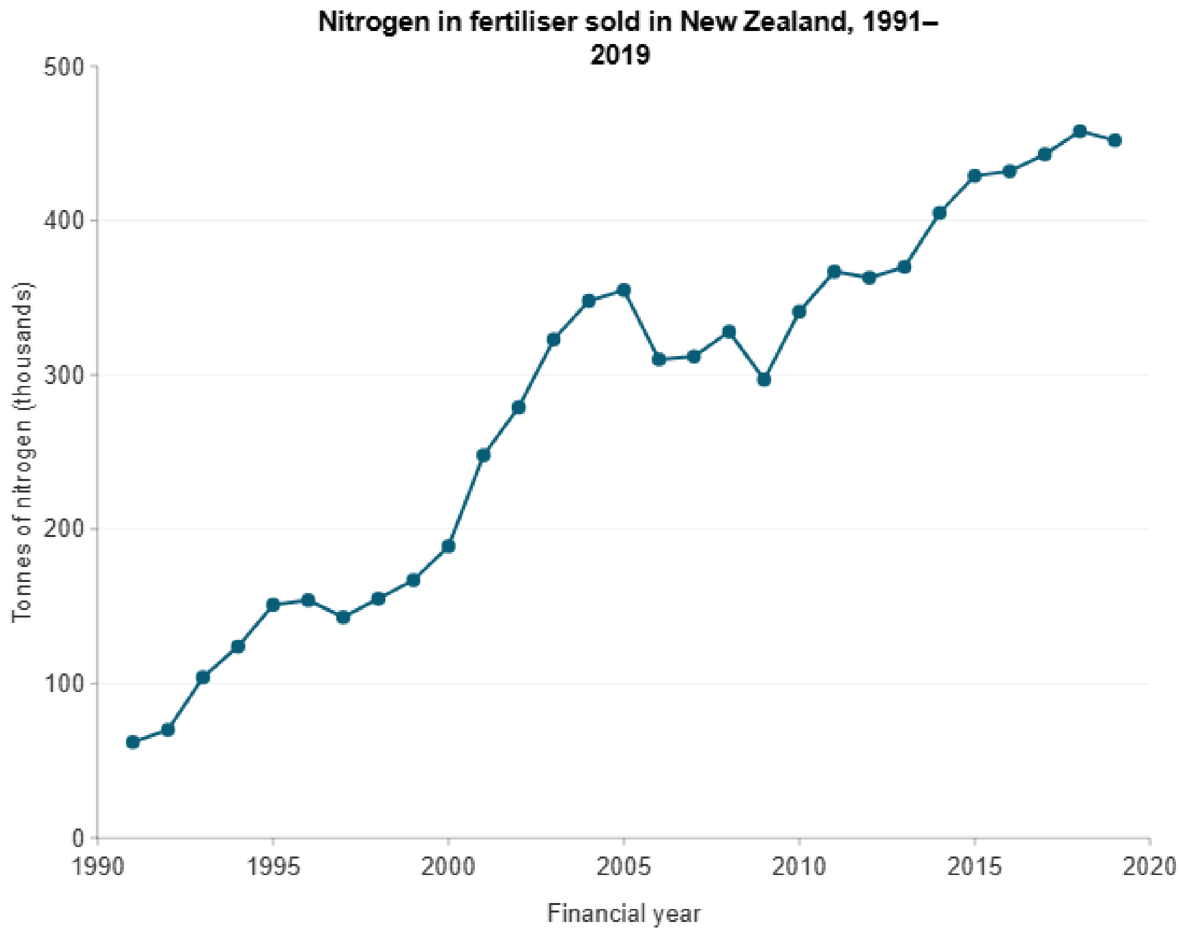

Figure 1. Nitrogen sold (as thousands of tonnes/year) for fertiliser in New Zealand 1991-2019

Clearly there has been a huge increase in the use of synthetic nitrogen fertiliser in New Zealand agriculture over that period. Haber-Bosch has found a welcoming home on New Zealand’s paddocks.

Prior to about 1990, superphosphate was the main type of fertiliser applied to New Zealand soils, which generally lacked phosphorus. Nitrogen was supplied “naturally” in earlier times, through the growth of clover hosting *Rhizobium* nodules to fix N from the air. It was found that addition of synthetic nitrogen fertilisers greatly boosted productivity, particularly for dairy production. The country’s main local source of nitrogen fertiliser has been via urea. It is made from natural gas from the offshore Māui gas field. The plant was part of Prime Minister Robert Muldoon’s ‘Think Big’ policy of industrial development. Maybe we can extend the idea of an immature technology in this case arising from a short-term political policy devised by a very combative prime minister. Muldoon’s electoral ambitions hijacked Haber-Bosch technology, leaving New Zealand with the multifarious side effects already discussed herein. Figure 2 shows how the adoption of this technology has powered the transition of New Zealand agricultural production from mainly sheep products to increasing dairy products (data from Stats NZ).

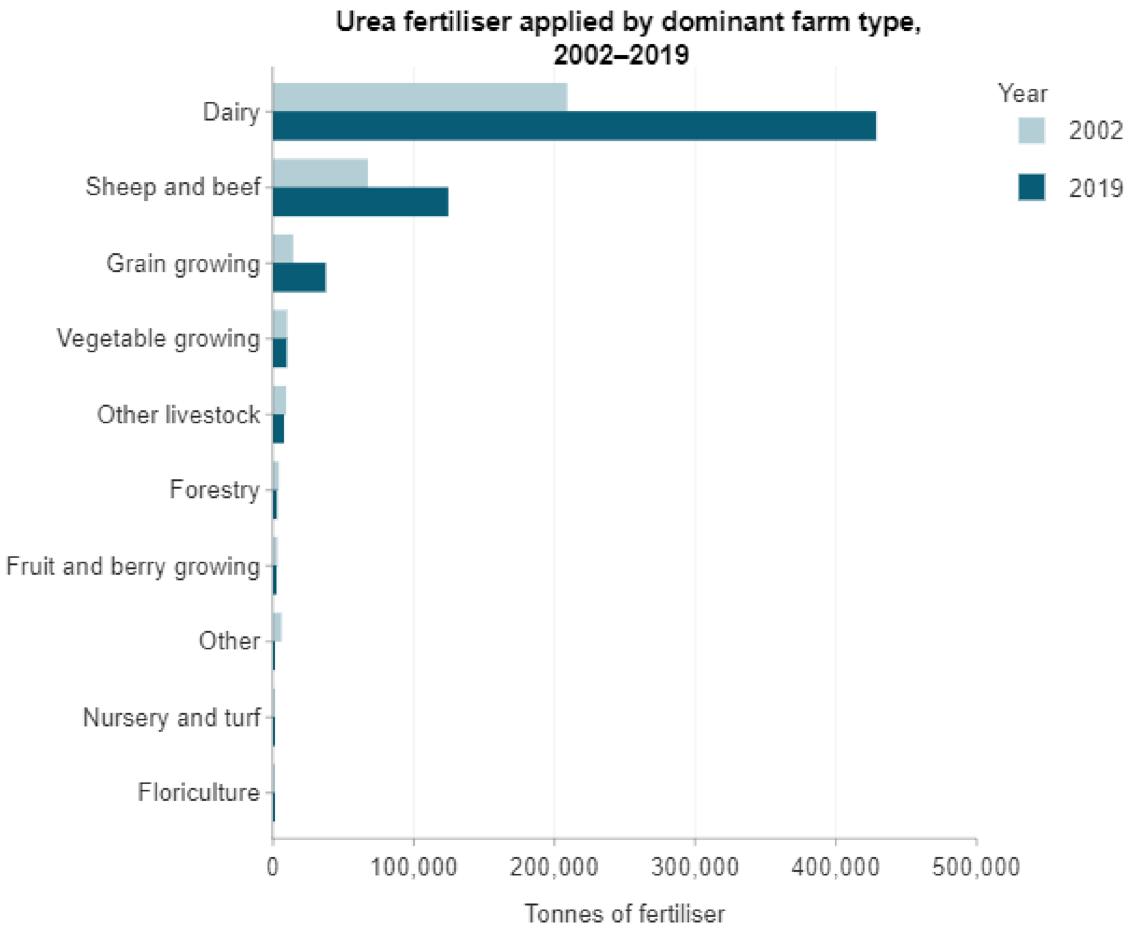

Figure 2. Change in urea fertiliser applied (in tonnes/year) from 2002 to 2019 for different farm types in New Zealand

Metacrises

What, you may ask, has this got to do with climate change? Together with so many other examples of “naïve technological optimism” leading to progress that is immature because it ignores side-effects, it tells us that it is this naïve “shoot first and find out the consequences later" approach that is responsible for a whole range of current crises, of which climate change is just one. Daniel S., and others, characterise the situation as a "metacrisis". And the reason why we have these crises simultaneously is that we have pushed, or are pushing, our planet beyond its limits in several different aspects. Renowned climate scientist, Johan Rockstrom, from the Potsdam Institute for Climate Impact Research in Germany, has developed the concept of planetary boundaries of different types, pictured as separate segments of a circle representing the planet. Figure 3 is a recent representation of these boundaries from Dr Rockstrom's own institute.

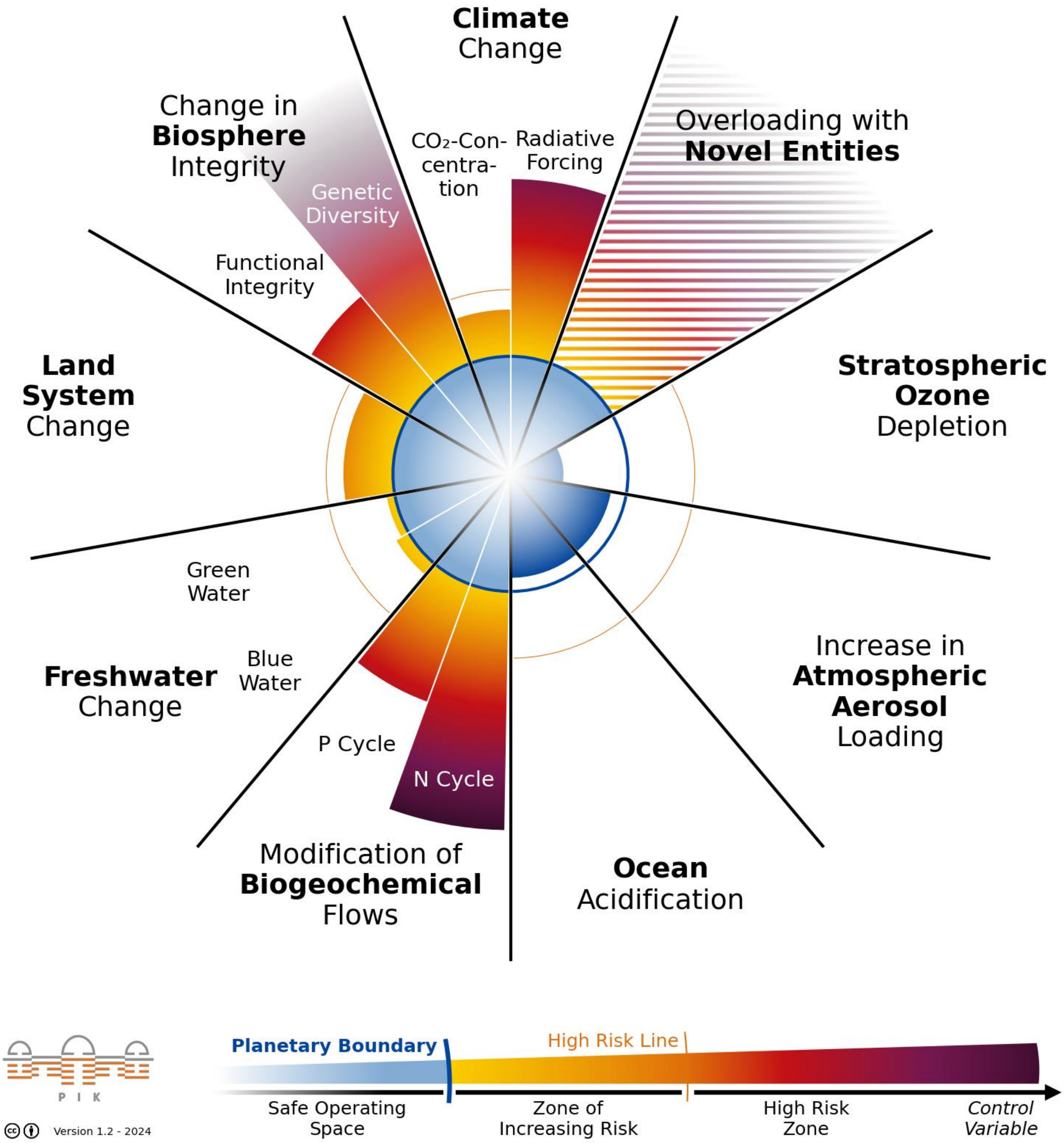

Figure 3. Diagram representing the safe limits for human pressure on the nine critical processes which together maintain a stable and resilient Earth.

Figure 3 shows that the planet is in a high-risk zone for several dangerous aspects of human activity. For climate change, radiative forcing, which is an integrating measure of anthropogenic effects on the climate occupies a high-risk zone, even if carbon dioxide concentration is in a less risky zone, for the moment. It is noted that the nitrogen cycle in particular falls into a high-risk zone of biogeochemical flows. Global overuse of Haber-Bosch is indicated here.

This analysis is complicated enough. In a sense, it puts climate change in its rightful place, as just one of the risky forces pushing the planet beyond its survivable risks. This is not to say, of course, that it lessens the existential threat that climate change poses to us, to other living species and to our liveable environment in any way. But what it does is to suggest that the only feasible way to halt, hopefully even reverse, climate change, is to remove the forces that are driving planetary boundaries beyond repair. And, just to emphasise that the forces involved affect more than climate change, recent research has discovered that PFASs, the so-called forever chemicals, have now been found in water everywhere on earth, including in snow and rainwater, from the Arctic to Antarctica[10].

The limitations of technology

This analysis tells us that technology won't fix climate change. Indeed, following this analysis, any technology, unless thoroughly field-tested (where?) for damaging side-effects, will only make things worse, probably in unexpected ways. However, let us remember the basic fact about global warming leading to climate change, i.e. most of it is caused by the burning of fossil fuels and the side-effects that this thoroughly powerful form of energy has wrought upon our planet. We must stop burning fossil fuels, and therefore extracting them in solid, liquid and gaseous forms as soon as is possible.

There are no excuses or exceptions to this required course of action. Certainly not the economy. Daniel S., in a particularly telling You Tube presentation "An introduction to the metacrisis" given to the Swedish Norrsken Foundation in Stockholm is 2023 https://www.youtube.com/watch?v=4kBoLVvoqVY is adamant that it is the economy, world-wide, that is powerfully resisting real action on all of the causes of the dangerous state that the planet is in. The world economy and each of our national economies have become more recalcitrant since globalisation, which has had the consequence of setting up globe-spanning supply chains for much of what we need and want. The COVID-19 pandemic, which halted world trade, illustrated the extent of our dependence of these supply chains. We have to ask, as does Daniel S., why "literally no country, no company on Earth wants climate change", yet we have it and it is accelerating in effects. But, as he says,

"we're orienting to it so fast and we can't stop and nobody can stop it because we all want stuff that requires energy"

Neither do we want species extinction nor automated AI weapons, but we're racing towards those too, he says. Even the services sector requires products. Worst of all, the economy has an in-built need to grow. According to Daniel S., this occurs at the behest of the powerful financial sector because there is a need to keep up with interest that drives the sector and hence the economy. The trouble is, this mad race to keep up with interest that drives the economy to keep expanding is against a backdrop of a biosphere that provides the raw materials for the growth so can only diminish at the same time.

Money

It comes down to money in the end. Money has no intrinsic value but is a token for what is valued. It confers "optionality" by enabling us to purchase whatever we need from the economy. The values it buys are "measurable, extractable and exchangeable". But, in a novel way of expressing an old truth, Daniel S. says:

" all the types of value that on your deathbed you'll really care about are not measurable, extractable and exchangeable".

Personal reflections

A lot of the thoughts expressed by Daniel S. and his collaborators in the Consilience Project have made sense to me in assessing not only the state of the world but also the trends over my scientific career of the way scientific research is now organised. For the world, I can well remember in the early 1980s, when it was clear that computers were going to have a large role to play in the future, particularly with the possibility of more automation, less repetitive desk work and increased speed of calculations, I thought – and discussed with others – that people generally would be released from the drudgery of their work to spend time instead on creativity, whether at work, or in their leisure time, which was sure to expand. It has remained curious to me that the opposite has occurred. Work has become more frenetic and time-consuming.

Towards the end of my time in CSIRO in Australia, for instance, I had become a project leader as a result, no doubt, of years of experience "at the bench". Aside from the fact that I never wanted to be a "manager" and was never trained properly as such, one-day courses aside, I found that dealing with the funding, reporting and occasional personal needs of my small group of about 12 occupied my whole working day so that any actual research, at that stage mainly writing papers – the very things on which my advancement or even retention depended – had to be done at night or in the weekend. So much for work-life balance. I also recall a meeting I had early on in my time (in 1973) at the Soil Bureau, DSIR, with the Director, the late Bruce Miller. He asked me what I was doing in research and I told him. Being polite, I then asked him how was he managing with the funding for all of our research (management was very light, with not even a Deputy Director for a staff of about 100). His words were, to the effect of "don't you worry about that. That's my job, you just get on with your research". Hard to believe by anyone under about 60!

Reorganisation of science

Which brings me to the way that science could be organised better. There is no justification for returning to the 70s and earlier when a staff member could go his whole 30-40 years career in DSIR producing just two papers in just the local journal, or another involved in local body work on the side who could stay away from work for months on end, but, by sheer charm, persuade the boss that he was still worth having on the staff. However, much has been lost that should be reconsidered if we are to do research that leads to mature progress in technologies, if not to actual scientific novelty. We had eccentrics in science back then, people who could hardly speak in public, refused to do management inspired paperwork, but absolutely loved what they were doing, so that, in one instance I remember, the scientist effectively lived within the microscopic world he was studying. Not all of us were completely eccentric, I hasten to add. Now, however, scientists have to develop a sales pitch, and be prepared to seek out and speak to anyone who might have money to support their research. They also have to produce pretty reports, both during and at the end of the project. And there is always a time limitation. It may be just me, but I often found that I found it hard to leave a project in my mind and would often have the best thoughts about its objectives long after the report had been delivered and I had to move on to another round of proposal writing, seeking funding, buttering-up possible funders and, more often than not, having the proposal rejected and moving on to a new round of proposals and new "clients". Something between advertising and gold mining. On top of that, managers – often, I suspect, former "second eleven" scientists, had to be persuaded of one's plans. Trust was desirable but was often lacking in these top-down relationships. Perhaps the main shortcoming of these processes is they are "one size fits all" when we are dealing with quite different people whose way of working was often quite different, even unique.

The CP actually underlines what is wrong with a method of organising scientific research that requires there to be funders, who, inevitably (except in the case of rare Marsden funds and the like) want an answer to a problem they have or a problem that you, as an entrepreneurial scientist (today's favoured breed?), have persuaded they may have. You will have limited time to crack the problem, so, of course, you won't have time to explore the side effects of any solution you devise. You may have made immature progress, but who knows what other problems will result from the application of your recommended solution? No-one will fund you to find out. And if they did, as Esso did in the 1960s when it was first suggested that burning fossil fuels could lead to global warming, and the designated scientists confirmed that this was so, the results were suppressed because they didn't suit the company's business of selling oil. (Climate change politics is rife with secrecy, manufactured doubt and denialism).

Feeding the world

The specific challenge of a perceived need to confine Haber-Bosch to the history books and shift agriculture back to regenerative farming methods that feed the soil inevitably raises the question of whether enough food could be produced this way to feed the billions of people now on Earth. This is a question that occupies many minds, as a search on Google shows. In 2014, Ed Landa from the University of Maryland, USA and I were able, with the help of many experts from a number of countries, to assemble a book[11] that asked this very question. Many of the authors included therein showed some optimism about the prospects for the future of food from soils, given the many challenges including climate change, erosion, and pollution. Undoubtedly, the future prospects depended on regarding agriculture and soils ecologically as parts of nature. One author (Karl Ritz) writes that 'Life on Earth thus clearly relies on life in earth". Water is also a key. As summarised in the Introduction to the book, concluding author, Garrison Sposito's "wide-ranging analysis of the prospects for the considerable increase in food production that a global population will demand":

"concludes that neither increasing areas of land under cropping, nor increased use of water for irrigation (with the so-called 'blue water') can contribute much at all. Nonetheless, prospects for the more effective accumulation and use of the so-called 'green water', or the water retained within soil from rainfall, give cause for optimism……"

But that was in 2014, ten years ago, and there is no doubt that much has changed even in that time. Climate change, particularly, but even politics. And current systems that are profitable, like Haber-Bosch based systems, come with lobbyists who want to keep it that way for as long as possible. The prospects for humans for the future may need to go wider than just the productivity of agricultural systems, with large changes in the nature of our diets, such as towards fermented microorganisms[2]. The topic is a large and complex one and not our main focus here.

Climate change as a symptom

The main thrust of this analysis is that we face a number of different crises as a species and a planet. Climate change is one, and, although not unique, remains existential for us and all life on Earth. There are no easy answers; while cutting the use of fossil fuels to an absolute minimum is a necessary step, it is not sufficient as a solution. The main point to take on board as we try to navigate our way back to a liveable world is that technology is a double-edged sword. It won't save us, unless, as is historically unlikely, we are aware of the effects of both sides of its blade. It is our whole way of living that needs to change to give us hope for a decent world into the foreseeable future.

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Editor's note: Jock says it is 50 years since he first had an article in Soil News (1974)!

Disclaimer: any opinions expressed are those of the writer.

Journal of New Zealand Grasslands - out now

The latest annual edition of Journal of New Zealand Grasslands is published.

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The Journal of New Zealand Grasslands publishes peer-reviewed papers with a focus on temperate grassland research. The scope of the journal includes all aspects of pastoral research including agronomy, soils, animals, agricultural extension and farm-systems research. Below is a selection of titles on soil and environment, but there are many more:

- Influence of diverse pasture species and reduced nitrogen fertiliser inputs on soil health on four irrigated Canterbury dairy pastures
- Investigating the impact of treading damage on the plantain (Plantago lanceolata L.) content and performance of a plantain/ perennial ryegrass (Lolium perenne L.) pasture over two years.
- The environmental performance of a pasture and baleage wintering system on a poorly drained soil in southern New Zealand
- Can additives or controlled release coating improve the nitrogen use efficiency of urea fertiliser
- Nitrogen leaching losses from pasture and winter forage crops in the West Matukituki Valley
- Copper requirements of animals and pastures in New Zealand pastoral agriculture - a review

News from the Regions

Waikato/Bay of Plenty

AgResearch

Jiafa Luo recently visited the College of Grassland Resources at Southwest Minzu University in Chengdu, China. During his visit, he had discussions with professors and students about how changes in plant diversity, functional identity, and life history influence soil biota and nutrient transformations over the transition from natural grassland ecosystems to cultivated grasslands.

Jiafa also held a series of meetings with faculty members to explore the impacts of various cultivated grassland systems and plant diversities on soil nitrogen transformations and nitrogen losses.

Additionally, he visited a sheep and goat farm that practices intensive livestock systems. He was particularly impressed by their advanced manure management, composting, and biogas recovery systems. He sees potential for adapting some of their waste reuse practices in New Zealand, offering promising pathways for sustainable livestock management.

Jiafa with college members and postgraduate students at Southwest Minzu University.

Jiafa engaged in discussions with lecturers and students on research topics of common interest.

Jiafa enjoyed a cheerful moment with a goat during his visit to a farm.

The Environmental Science North Team based at Ruakura, welcomed a new Scientist in October – **Marianne Hull Cantillo**. Marianne is from Costa Rica, she grew up on a horticulture, beef and dairy farm. Marianne will be largely working on LCA projects during a 1 year fixed-term maternity leave cover role. Marianne's background includes agricultural science, biotechnology, chemistry, chemical engineering and business management. Marianne holds a PhD from Waikato University on "Systems approaches to dairy effluent management". Mariannes worked focussed on the design, technoeconomic assessment and LCA of anaerobic digestion and algae bioremediation systems to treat dairy effluent; and the development of a calculator predictive of dry matter content in dairy effluent based on different feeds for Archway group.

University of Waikato

Franco Gonzales and **Dorisel Torres-Rojas** have been busy testing new Leuning-like samplers to measure ammonia emissions from urine deposits by cows on the field site that has a chronosequence of organic matter oxidation. Franco is a PhD student with Dori, and he is working on understanding the role of organic matter in the retention of ammonia nitrogen as organic N. Franco is establishing several sampling towers across the chronosequence of organic matter oxidation and seeing how the quality and quantity of the OM influences ammonia emissions. More to come in the following months of fieldwork.

Franco is also working with Dori to determine what proportion of the nitrogen emitted is re-deposited within the local environment. This work is just the beginning of a more extensive research programme into quantifying ammonia emission and deposition within NZ and the effects of the N input on ecosystems.

Figure 1 A. Franco, setting up the Leuning in triplicate at the top of one of the towers. B. Tower with Luening samplers at two heights near the milking cowshed. C. Tower with samplers at two heights in a paddock recently grazed by cows. D. Eluting samplers in the lab to measure ammonium.

Louis Schipper is on sabbatical in Ireland with Matt Saunders at Trinity College Dublin. He has been enjoying seeing new peatlands and hearing about the challenges faced as a large proportion of Ireland's greenhouse gas emissions come from drained and cutover peat bogs. He also visited Hlynur Óskarsson at the Agricultural University of Iceland, again visiting drained peatlands with the same underpinning issues. The underlying drivers of greenhouse gas emissions in both these countries are more or less the same as in New Zealand – drainage allows oxygen to enter and accelerates decomposition. However, the land use and social cultural issues differ between all three countries. He also gave a seminar at ETH Zurich while visiting Johan Six

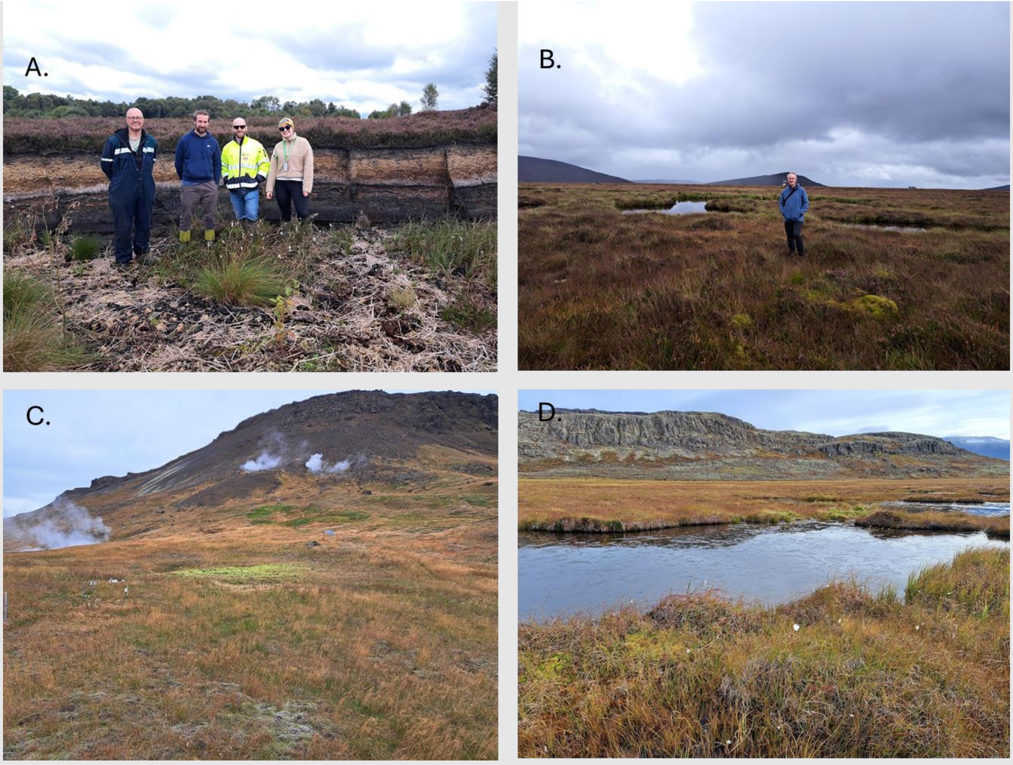


Figure 2 A. Cutover peat bog, note behind people is a bank of peat representing the original peat surface and the face is old peat, B. Near pristine Irish blanket bog, C. Geothermal soil centre (light green vegetation) where surface soil were over 40°C, D. blanket bog Iceland.

Manawatu

AgResearch

The Sustainable Agri-systems team in Grasslands (**Estelle Dominati** and **Duy Tran**) came together with Te Pū Oranga Whenua (Irirangi and Lisa Warbrick), Ngaporo Waimarino Forest Trust, Pipiriki Inc, Tukua Studio's and local kaumatua for a Wananga 14th June on soil health at Aramahoe reserve. AgResearch staff conducted some VSA with the trustees to compare soils under native forest, pine forest and harvested pine blocks. They also took some soil core samples which were taken back for analysis. For the trustees involved it was informative and gave those trusts confidence to see how the research can be used in the future to support and determine suitable land use changes post exotic forestry. Acknowledgements were given to the trustees and kaumatua for karakia throughout the day and sharing their matauranga and knowledge of the area. This outing is one of several which will build videography for case study."

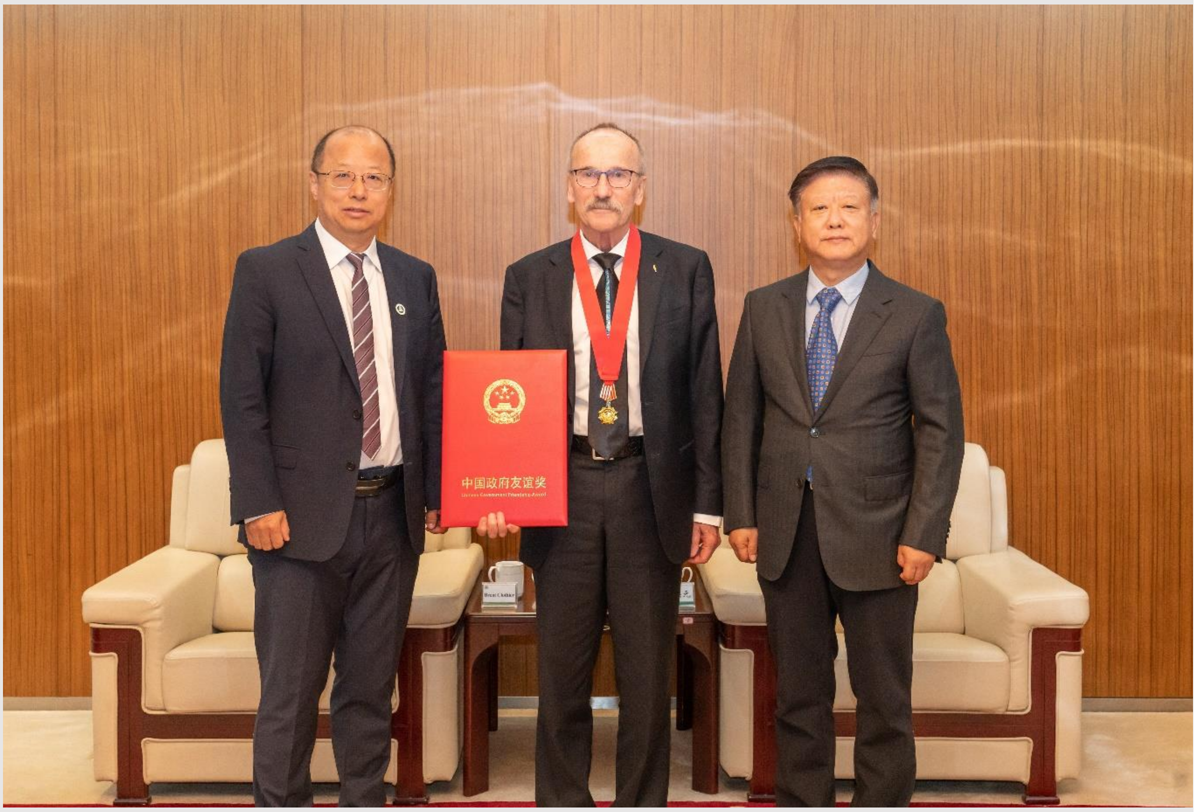
Plant & Food

PFR Hawke's Bay

We welcomed Dadirai Chauruka to Plant & Food Research Hawkes Bay in October. Dadirai is a PhD student from Chinhoyi University of Technology, Zimbabwe studying the impact of plant growth promoting rhizobacteria on greenhouse gas emissions in tobacco production. She was awarded a CLIFF-GRADS research scholarship for a 6-month research stay to work on the project 'Benchmarking nitrous oxide emissions in apple orchards' as part of PFR's Simulating Orchard Ecosystems programme.

PFR Palmerston North
Brent Clothier from Cropping Systems and Environment was presented a Chinese Government Friendship Award in Beijing on 30 September. Brent is a Principal Scientist based in Palmerston North New Zealand.

The Chinese Government's Friendship Award is the People's Republic of China's highest award for "foreign experts who have made outstanding contributions to the country's economic and social progress". This year there were 73 awardees from 26 countries who the "… Chinese government recognised as foreign experts who have made outstanding contributions to China's modernization drive, reform, and opening up." The awards were presented in the Great Hall of the People in Beijing by Her Excellency Shen Yiqin, State Councillor and President of the All-China Women's Federation. Brent's wife Penny was a guest at the ceremony. Following the awards ceremony, the awardees and their guests were invited to join 2000 dignitaries for dinner in the Great Hall of the People to celebrate 75 years of the People's Republic of China. The celebratory dinner was hosted by President Xi Jinping. Brent's wife, Penny accompanied him to China.



Celebration of Brent's Chinese Government Friendship Award with the Chair of Beijing Forestry University, Mr Wang Hongyuan (right), and the University President Prof. Li Zhaohu (left).

Brent has worked with Chinese collaborators for nearly 20 years, having especially close links to Beijing Forestry University (BJFU) and China Agricultural University where Brent has Adjunct Distinguished Professorships. Brent has published some 20 papers with Chinese collaborators on soil-water dynamics, plant physiology, plant water-use, climate change, and water resources. Brent was elected an Academician (International) of the Chinese Academy of Engineering in 2019. Brent is the only Academician (International) in the CAE from Aotearoa New

Zealand. Ian Ferguson, PFR's former Chief Scientist, received a Friendship Award in 2013. Established in 1991, some 1900 foreign experts have been presented Friendship Awards.

As well, Brent and Penny attended the wedding of one of Brent's PhD students from BJFU, Yang Liu. Brent provided the wedding blessing and a testimony. Brent has co-authored papers with both Yang, and his wife Ma Xu.

Manaaki Whenua – Landcare Research

Dr. Liyin Liang visited the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Science (CAS) from September 9 to October 10, 2024, supported by the China-New Zealand Scientist Exchange Program. Hosted by Prof. Shuli Niu, this visit aimed to enhance scientific collaboration between China and New Zealand, focusing on understanding the interactions between biogeochemical processes, environmental factors and management effects on grassland ecosystems under a changing climate.

During his visit, Liyin had a field trip to the West of China (Qinghai-Tibet Plateau) to see the Hongyuan – Zoigê National Observation and Research Station (3600m ASL), exploring research facilities related to the effect of warming on carbon-nitrogen cycles in alpine peatlands. Similar to the context of New Zealand, peatlands in the Qinghai-Tibet Plateau were drained for decades for yak farming since the 1980s or earlier. A few photos of the Hongyuan – Zoigê regions are below.

In addition, there is a whole-ecosystem warming experiment setup from Prof. Niu's group in natural peatlands. There is a detailed description of the setup in a commentary from Shuli's group, published in New Phytologist this year. https://nph.onlinelibrary.wiley.com/doi/full/10.1111/nph.20131. This station is impressively well-maintained to fight against the harsh environments in this high-altitude region, providing valuable measurements in understanding the response of soil carbon stock, nutrient cycles, plant community and soil microbes to climate warming.

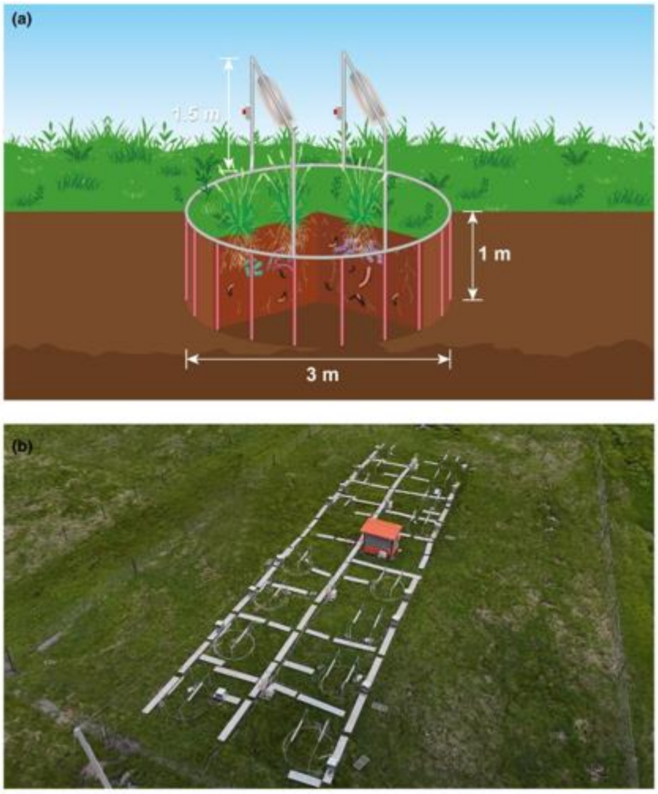


Photo credits: Some pictures are from the published paper or from Jinsong Wang and Liyin Liang.

Final issue of STEC News

The Smarter Targeting of Erosion Control (STEC) programme officially ended on 30 September 2023. Nine months on, the last of several projects have wrapped up and their outputs completed. Two PhDs are still to be completed.

Check out their final issue of STEC News:
https://www.landcareresearch.co.nz/discover-our-research/land/erosion-and-sediment/smarter-targeting-of-erosion-control/stec-news/final-issue-of-stec-news/

The final issue also contains:

- Cost-effectiveness of erosion mitigation to meet water clarity targets in the Manawatū-Whanganui Region of New Zealand
- Environmental factors influencing the survival of poplar material planted for erosion control on hill-country farms in New Zealand
- Trees for slip prevention: reflections on STEC from an international PhD student
- Contributions from Salzburg
- Visual clarity regime of the Manawatū River

The STEC team also published a recent paper (see abstracts section for details):

Polyakov M, Walsh P, Daigneault A, Vale S, Phillips C, Smith H 2024. Cost-effectiveness of erosion mitigation to meet water clarity targets in the Manawatū-Whanganui Region of New Zealand. Journal of Environmental Management 359: 120991. https://doi.org/10.1016/j.jenvman.2024.120991

They also have further information at the link: [Cost-effectiveness of erosion mitigation to meet water clarity targets in the Manawatū-Whanganui Region of New Zealand » Manaaki Whenua (landcareresearch.co.nz)]

Editor's note: further information is available from the link and the paper on marginal costs of achieving water clarity targets (copied below, see paper for references). Note what the marginal cost refers to:

We estimated the marginal costs of achieving water clarity targets using the SedNetNZ outputs (Vale et al. 2023), region-specific mitigation costs from the Horizons Regional Council's Hill Country Erosion Programme, and opportunity costs from the NZFARM model (Daigneault et al. 2018). *The marginal cost of achieving the water clarity bottom line refers to the cost of achieving the bottom line in an additional metre of streams and rivers*. These marginal costs vary significantly due to the variability of baseline sediment loads and the type of mitigation measure.

The median marginal costs for achieving the water clarity bottom line vary significantly: $23/m for gully tree planting, $59/m for space-planted trees, $569/m for bush retirement, $660/m for afforestation, and $4,967/m for riparian retirement. These differences reflect the varying effectiveness and costs of the mitigation measures, and the sediment load and erosion characteristics of the landscapes where they are applied. For instance, gully tree planting is the most cost-effective due to the high sediment load from gullies. In contrast, riparian retirement is the least cost-effective because it is more expensive and typically applied to flatter areas with lower sediment generation.

Soil Horizons

Soil Horizons is our annual web-based newsletter updating stakeholders on recent soil and environmental research. This issue of *Soil Horizons* showcases upgrades to S-map, and recent research on soil carbon benchmarking, carbon sequestration, and nutrient losses under variable-rate irrigation.

We give an overview of recent results from New Zealand's national soil carbon monitoring programme, in which 504 sites were established to determine a robust baseline of soil organic carbon stocks for agricultural land. These results provide spatially representative data to feed into national soil carbon inventory reporting. We provide stories on enhancing S-map (New Zealand's digital soil map), which now covers 11 million hectares. The S-map team has recently completed an extra half a million hectares of new soil mapping across some of our best food-producing land. New Zealand is internationally recognised as having a high diversity of soil types – find out how many have been mapped so far.

We report on modelling upgrades to soil profile-available water, which is used by many stakeholders via tools such as OverseerFM. Significant efforts have been made to improve the modelling of soil water storage for Pumice, Granular and Allophanic soils, which in turn supports better decision-making on the farm.
We also report on the first assessment in New Zealand of the practical applicability of enhanced rock weathering as a potential mitigation to help reduce carbon dioxide in the atmosphere, and on a study of leaching losses under two contrasting soils for a mixed cropping system.

https://www.landcareresearch.co.nz/publications/soil-horizons/

Massey University

Nitrate leaching under standard and diverse pastures and contemporary and regenerative management

Led by Massey University, Whenua Haumanu is the cornerstone of the Ministry for Primary Industries portfolio of regenerative agriculture projects. It's New Zealand's most comprehensive programme on the effects of contemporary and regenerative pastoral practices. This seven-year project brings together universities, Crown Research Institutes and industry partners to assess the suitability and relevance of regenerative agriculture in New Zealand. Our researchers are exploring contemporary and regenerative farming practices across both standard and diverse pastures on several research sites at Massey University and Lincoln University.

Udara Wittahachchi's Masters research is focused on measuring nitrate leaching under the dairy farmlet treatments at Massey University. Massey has installed trench lysimeters on well-drained sedimentary soils, using the GroundTruth design of Samuel Dennis. An array of suction cups is also being used to compare nitrate leaching with the lysimeters over the 2024 drainage season and these results will be available once the drainage season has ended.

In the first full drainage year of the study (2023), there was no significant difference in nitrate leaching between the three treatments of A. standard (ryegrass/white clover) under contemporary management, B. diverse pasture (multispecies pasture) under regenerative management and C. diverse pasture under contemporary management.

Contemporary management is described as having lower post-grazing residuals and the use of mineral fertiliser and chemicals as required. Regenerative management is described as having longer grazing intervals, higher post-grazing residuals and low to no mineral fertiliser and chemical use. For more information on the wider programme please see the Whenua Haumanu website.




Changes in soil physical properties under standard and diverse pastures and contemporary and regenerative management

Yuehui (Emily) Ma Masters research is also being undertaken as part of the Ministry for Primary Industries funded Whenua Haumanu project at Massey University. Emily's project is examining the broader impact of pasture species (diverse vs standard ryegrass clover pastures) and contemporary and regenerative management on soil compaction measured using bulk density and penetrometer resistance. To date there is no significant effect of pasture species or grazing management on soil bulk density.

Emily is also examining the short-term impact of contemporary and regenerative dairy grazing management on pugging damage and compaction on the Manawatū sandy loam soil under saturated conditions. In September 2024 she undertook bulk density, penetrometer, pasture production (rising plate meter) and pugometer measurements on paddocks immediately prior to grazing. She then repeated these measurements after a grazing event which coincided with heavy rain. She is currently in the process of analysing these data.

For more information on the wider programme please see the Whenua Haumanu website.

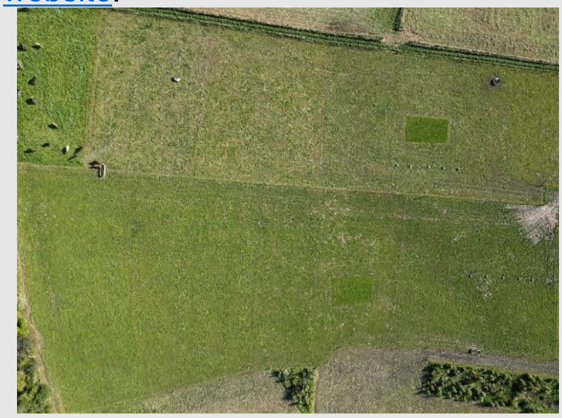


Figure 1. Aerial image of the standard pasture treatment under contemporary grazing management being strip grazed by dairy cattle.

Figure 2. Aerial image of the diverse pasture treatment under regenerative grazing management.

Figure 3. Yuehui (Emily) Ma soil sampling.

Canterbury and Otago

Manaaki Whenua – Landcare Research

Ian Lynn retired at the end of June this year. We celebrated Ian's retirement and the contribution he made during his 49 plus years with Manaaki Whenua Landcare Research (and predecessor organisations) with an afternoon tea early November. More detail to follow next issue of Soil News.

AgResearch

A number of past and present AgResearch colleagues joined the 75th Invermay Reunion, held on Saturday 2nd November. The occasion was great fun and a chance to catch up on colleagues across a range of teams and disciplines. A few new and many past stories of various escapades emerged or were retold. Thankfully, the weather gods smiled on the gathering, allowing a commemorative tree planting and campus tours to occur without attendees getting drenched. The day began with an assortment of speakers re-capping some of the key research highlights that have occurred at or near the Invermay campus. Following a BBQ lunch, a tree was ably planted by Hilary Allison (wife of the late Jock Allison) and Sue Bidrose with Peter Fennessy, Ken Drew and Peter Johnstone in attendance (the latter all starting at Invermay in the 1960s or early 1970s). A small plaque commemorating the event will be placed beside the black beech planting. For many, the day finished with privately organised evening meals for various teams who wished to socialise into the evening.

Conferences

11th IAG International conference on Geomorphology
2 - 6 February 2026, Christchurch

We look forward to welcoming you to Christchurch New Zealand for the International Conference on Geomorphology in 2026. Tectonically-active, in the 'Roaring 40s' and geologically-young, Aotearoa New Zealand offers world-class geomorphology with some of the world's fastest rates of uplift and erosion.

Below are the proposed programme themes for proposals:

- Aeolian and arid landscapes
- Anthropogenic geomorphology
- Catchment processes and management
- Coastal and marine environments
- Cryosphere and cold landscapes
- Education, outreach, and ethics in geomorphology
- Landscape hazards, risks, and society
- Landscape response to climate change
- Planetary geomorphology
- Surface and subsurface processes and landscape evolution
- Technological advances in geomorphology
- Tectonic and volcanic geomorphology
- Other

Further information is available: https://www.confer.co.nz/icg2026/

Abstracts

Cost-effectiveness of erosion mitigation to meet water clarity targets in the Manawatū-Whanganui Region of New Zealand

Soil erosion is a significant environmental issue worldwide. It affects water quality, biodiversity, and land productivity. New Zealand government agencies and regional councils work to mitigate soil erosion through policies, management programmes, and funding for soil conservation projects. Information about cost-effectiveness is crucial for planning, targeting, and implementing erosion mitigation to achieve improvements in sediment-related water quality. While there is a good understanding of the costs of erosion mitigation measures, there is a dearth of literature on their cost-effectiveness in reducing sediment loads and improving water quality at the catchment level. In this study, we estimate the cost-effectiveness of erosion mitigation measures in meeting visual water clarity targets. The analysis utilizes the spatially explicit SedNetNZ erosion process and sediment budget modelling in the Manawatū-Whanganui Region and region-specific mitigation costs. The erosion mitigation measures considered in the analysis include afforestation, bush retirement, riparian retirement, space-planted trees, and

gully tree planting. We modelled two scenarios with on-farm erosion mitigation implemented across the region from 2021 to 2100, resulting in a 48% and 60% reduction of total sediment load. We estimate the marginal costs to achieve the visual national bottom line for water clarity, as assessed by the length of waterways that meet the clarity targets. We also estimate the marginal costs of improving average water clarity, which can be linked with non-market valuation studies when conducting a cost-benefit analysis. We find that gully tree planting and space-planted trees are the most cost-effective mitigation measures and that riparian retirement is the least cost-effective. Moreover, cost-effectiveness is highly dependent on current land use and the biophysical features of the landscape. Our estimates can be used in cost-benefit analysis to plan and prioritize soil erosion mitigation at the catchment and regional levels.

Polyakov M, Walsh P, Daigneault A, Vale S, Phillips C, Smith H 2024. Cost-effectiveness of erosion mitigation to meet water clarity targets in the Manawatū-Whanganui Region of New Zealand. Journal of Environmental Management 359: 120991. https://doi.org/10.1016/j.jenvman.2024.120991

A 10-year evaluation of management practices and nutrient losses from dairy farms in New Zealand – Trends and drivers

Good management practices (GMPs) on dairy farms have been shown to reduce contaminant losses and improve water quality. Few national long-term datasets exist globally on management practices on dairy farms over time and their effect on nutrient losses. Here, we examine 50 parameters across a 10-year period (from 2013 to 2022) thought to influence estimates of nitrogen (N) and phosphorus (P) losses (kg ha^{-1} yr^{-1}) to water from dairy-farmed land in New Zealand. The number of farms in our database increased from 137 in 2013 to a total of 378 in 2022. The years from 2013 to 2017 were classed as ‘period 1’ and from 2018 to 2022 as ‘period 2’, which aligned with more intensive extension of GMPs. Nationally, there was a small increase in median N and P loss rates (38 – 40 kg N ha^{-1} yr^{-1} and 1.1 – 1.2 P kg ha^{-1} yr^{-1}), fertiliser applied 140 – 141 kg N ha^{-1} yr^{-1} and total milk solids produced by 11 % between periods. However, between 1 – 42 % of farms exhibited decreasing N loss trends regionally, which were related to (in order of decreasing importance): N fertiliser applied, irrigation type, and forage establishment (cultivation) practice. Similarly, 1 – 25 % of farms with decreasing P trends regionally, trends were related to soil order, P fertiliser applied, and effluent storage method. We also found that these farms showed increased adoption of effluent and forage establishment method GMPs between periods, for example, the use of low-rate effluent application, direct drill, and minimum tillage, and increased effluent storage practice. These data suggest good management practices shown to decrease N and P losses from dairy-farmed land to water in New Zealand are being adopted; however, continued uptake on all farms will be required to achieve further improvement.

Macintosh KA, McDowell RW, Thiange CXO (2025) A 10-year evaluation of management practices and nutrient losses from dairy farms in New Zealand – Trends and drivers. Agriculture, Ecosystems & Environment 377 109261. https://doi.org/10.1016/j.agee.2024.109261

Influences affecting adoption of management to mitigate impacts of intensive winter grazing of forage crops

Intensive winter grazing on forage crops helps overcome winter feed shortages but is associated with soil pugging and high rates of sediment and nutrient losses. A recently recommended approach to intensive winter grazing management – grazing from the top of the slope downwards ('top-down') – can substantially reduce sediment and nutrient losses as part of a suite of practices called 'strategic grazing'. We hypothesised that this new management has had significant uptake and that a farmer's risk preferences, values, and demographics influence adoption of these practices. Using a national-scale survey of farmers from 2023, we found that 52.5% of respondents who grazed winter forage crops on slopes, grazed top-down. Location had a modest impact on this decision, with Otago respondents being 17-24% more likely to graze top-down than those from other regions. Māori farmers were 30% more likely to graze top-down than non-Māori farmers. Profitability was positively correlated with this decision. We conclude that the adoption of top-down grazing practices on slopes for winter forage crops is widespread, with just over half of the farmers surveyed grazing winter forage crops top-down.

Drewry JJ, Stahlmann-Brown P. 2024. Influences affecting adoption of management to mitigate impacts of intensive winter grazing of forage crops. New Zealand Journal of Agricultural Research (on-line early). https://doi.org/10.1080/00288233.2024.2409761

Linking land value to indicators of soil quality and land use pressure

Soil quality is used to assess the soil's ability to maintain ecological and environmental quality as well as agricultural productivity. A unique indicator associated with land use pressure is agricultural land value. Because land value is assessed at a property scale and regularly updated, we considered land value to be a good proxy for agricultural intensification. We therefore tested whether a relationship exists between land value per hectare, point-scale soil quality, other land pressure indicators (stock numbers, dominant land use), and catchment characteristics, as this has not been tested previously. We used soil quality from a national soil quality monitoring dataset, and land pressure indicators across 192 catchments (31% of land area) in New Zealand. We tested an array of models with the random forest model exhibiting the best goodness-of-fit metrics. The most important explanatory variable in predicting land valuation per hectare in the random forest model was catchment elevation (mean decrease in the mean square error; 0.92), followed by catchment potential evapotranspiration (0.78). Similarly, the fraction of dairy (0.28) and arable (0.27) land use had a relatively important effect, as did soil pH (0.32), the C:N ratio (0.31), and carbon concentration (0.30). We conclude that that land value per hectare has a well-defined relationship with land use and some soil quality measures, though expressing soil quality data at a catchment scale presented some challenges. Although the relationship was complicated, this study indicates that further work to determine if land value could act as an integrating proxy for land intensification is warranted.

Drewry JJ, McNeill SJ, McDowell RW, Law R, Stevenson BA. 2024. Linking land value to indicators of soil quality and land use pressure. Geoderma 450: 117054. https://doi.org/10.1016/j.geoderma.2024.117054

Modelling to identify direct risks for New Zealand agriculture due to climate change

Climate change will affect New Zealand's diverse range of climatic systems in different ways. The impacts on agriculture are expected to vary with geographical location and the specific biophysical requirements of different crops and agricultural systems. To improve our understanding of these impacts, key biophysical vulnerabilities for the main farming systems in New Zealand were identified and modelled using the daily projected climate scenario data. Results show high spatial variability but a general pattern of suitability ranges for crops moving south, and animal health issues intensifying and also moving south. Sediment loads are projected to increase, particularly in soft-rock hill country areas in the North Island. The modelling approach offers opportunities for analysing the temporal significance of projected changes, such as the timing and duration of drought, the effect on timing of phenological stages, the timing of pasture growth and the effect on animal farm systems.

Lilburne L, Ausseil A-G, Sood A, Guo J, Teixeira E, Vetharaniam I, van der Weerden T, Smith H, Neverman A, Cichota R and others Modelling to identify direct risks for New Zealand agriculture due to climate change. 2024. Journal of the Royal Society of New Zealand: 1-18.

Comment on 'An examination of the ability of plantain (Plantago lanceolata L.) to mitigate nitrogen leaching from pasture systems

In their review: *An examination of the ability of plantain (Plantago lanceolata* L.*) to mitigate nitrogen leaching from pasture systems*, Eady et al. (2024) dispute both the historic estimates of typical urine patch nitrogen (N) load and leaching and the evidence for the N leaching reduction mechanisms of plantain; and question the recommended levels of plantain required to achieve N leaching reduction. We reject the suggestion that the urine patch has little influence on N leaching, and that average annual N leaching from dairy farms is 6 kg N/ha. We agree that the low dry matter content of plantain is the dominant and best documented effect of plantain on urine N dilution. We reject that there is no evidence for the effect of plantain on nitrogen partitioning to urine, and on potential nitrification rate in the urine patch. We point to empirical evidence of statistically significant reductions in nitrate leaching from plantain at paddock scale, at levels as low as 21% plantain of dry matter eaten. Current research will improve understanding of the mechanisms and magnitude of the effect of plantain on N loss, paving the way for recognition of other forage-based N loss reduction options, and ongoing development of mechanistic models that are adaptable to other forages.

Fransen KE, Gard SM, Pinxterhuis I, Minnée EMK, Peterson ME, Mudge P, Woods RR, Al-Marashdeh O, Horne D, Beukes PC and others 2024. Comment on 'An examination of the ability of plantain (Plantago lanceolata L.) to mitigate nitrogen leaching from pasture systems'. New Zealand Journal of Agricultural Research: 1-13. https://doi.org/10.1080/00288233.2024.2398149

Interpreting and evaluating digital soil mapping prediction uncertainty: A case study using texture from SoilGrids

Soil information is critical for a wide range of land resource and environmental decisions. These decisions will be compromised when the soil information quality is unsatisfactory. Thus, users of soil information need to understand and consider the uncertainty of the available soil information and be able to judge whether it is fit for purpose. The uncertainty information provided with the SoilGrids 2.0 product was examined in a case study. We hypothesised that the soil property predictions for the Netherlands (NL) might be less uncertain than those of New Zealand (NZ) because there were more relevant training data for NL than for NZ. The study objectives were to: 1) understand whether the provided uncertainty information is correct for both countries; 2) explore spatial patterns and relationships in the prediction error and uncertainty information using quantitative tools and new graphical analyses; 3) analyse whether these patterns and relations can be explained; and 4) explore how the uncertainty information and insights derived from graphical analyses might assist an end user to determine whether a map is suitable for their purpose. The study focused on soil texture. Independent datasets showed that the SoilGrids 2.0 uncertainty information was too optimistic for sand and too pessimistic for clay for both countries. The graphical analyses confirmed the initial assumption that NL predictions were more accurate than those for NZ, but they also indicated that some locations in NL have high uncertainty. The graphical analyses allowed only a limited identification of the four sources of uncertainty in digital soil maps, but were quite insightful in helping us to better understand the reliability of the information. A set of recommendations was developed for both producers and consumers of digital soil mapping (DSM) products. This includes the provision of a summary map of accuracy classes. We suggest that more research and educational effort is needed to ensure that digital soil maps are used appropriately.

Lilburne L, Helfenstein , Heuvelink GBM, Eger A. 2024. Interpreting and evaluating digital soil mapping prediction uncertainty: A case study using texture from SoilGrids. Geoderma 450, 117052.
https://doi.org/10.1016/j.geoderma.2024.117052

Modelling E. coli runoff concentrations from sheep and cow grazed pastures in New Zealand: challenges and future research needs

A model of *Escherichia coli* concentrations in the runoff from grazed pastures was developed to increase our knowledge and ability to predict the relative impact of both cow and sheep grazing on water quality. Input parameters to the initial model were derived from published data and model outputs were compared with measured *E. coli* runoff concentration data from both sheep and cow grazed pasture. The model was designed to represent the complexities of year-round rotational grazing farm system. For cow grazing, the model estimated runoff *E. coli* concentrations in the same order of magnitude as the measured data.

However, for sheep grazing, the model underestimated the measured runoff *E. coli* concentrations by 1.5 orders of magnitude. To understand this negative result, Monte Carlo simulation techniques were used to conduct a sensitivity analysis of the input parameters. This analysis identified that runoff concentrations were highly sensitive to inputs of the *E. coli* concentrations in the dung and the mobilisation rates of *E. coli* from the dung. This modelling study demonstrates that significant gaps and uncertainties remain in our understanding and prediction of the mobilisation and transport of *E. coli* from grazed pasture systems.

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