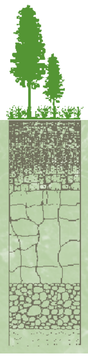
Soil Horizons

– celebrating its 10th anniversary



Issue 15 March 2007

ISSN 1174-0922

Contents

A newsletter communicating our work in soil-related research to end-users, customers and colleagues.

Printed on recycled paper ♻

Are New Zealand pasture soils losing carbon?

A number of research groups within the Sustainable Land Use Research Initiative (SLURI) are currently trying to determine how land-use change and intensification might affect soil carbon stocks, reflecting global interest in this area.

There is more carbon stored in soil than in plant biomass plus the atmosphere above. As a consequence, small changes in soil carbon (a principal component of soil organic matter) could have a major impact on global carbon cycling and the amounts of carbon dioxide in the atmosphere. Soil organic matter is also an important component of soil quality, supporting plant and animal life, filtering pollutants, and maintaining structure.

The last two decades of agriculture in New Zealand have seen large increases in fertiliser inputs to raise production, but little is known about how this intensification might affect soil carbon. To determine whether soil carbon has changed in recent years, we resampled soil profiles at 31 pastoral sites. We measured soil carbon and nitrogen along with bulk density for each horizon (generally to 1 m) and also reanalysed archived soil samples of the same horizons.

On average, profiles had lost significant amounts of carbon (21 tonnes per hectare) and nitrogen (1.8 tonnes per hectare) since initial sampling. Assuming a continuous linear decline in organic matter between sampling dates, losses averaged one tonne of carbon and 90 kilograms of nitrogen per hectare per year. We do not clearly understand the reasons for these losses. Soil carbon loss through leaching and erosion was too small to explain the magnitude of loss, suggesting losses from respiration exceed the inputs of photosynthate into the soil profile.

Our results are similar to a wide-ranging study of 2000 sites in England and Wales. This study was also unable to identify a cause for the unexpected losses but suggested global change processes, such as increases in temperature or changes in rainfall patterns, might be responsible. The study also considered that nitrogen deposition from the atmosphere might accelerate organic matter turnover and promote soil carbon losses.

Our current measurements demonstrate significant and widespread losses of soil carbon and nitrogen in New Zealand pasture on flat to rolling land. Are they ongoing? How might they be extrapolated across landscapes to determine the implications for New Zealand's carbon dioxide emissions? What are the consequences of these soil carbon and nitrogen losses?

Louis Schipper
Schipper@waikato.ac.nz
07 838 4466 extn 8531

Roger Parfitt
ParfittR@LandcareResearch.co.nz
06 353 4946

Craig Ross
RossC@LandcareResearch.co.nz
06 353 4807

Landcare Research
Manaaki Whenua

CELEBRATING 10 YEARS

New Zealand soils research – what's on the horizon?

The usual advice about predicting the future is "don't do it", particularly in science where we like to deal in specifics. The problem is that we can only extrapolate from our current understanding and any truly original breakthroughs and events simply are not predictable and become a lottery of guesses that could be wildly wrong. So when I was asked to write this article for this 10-year anniversary issue of Soil Horizons, I decided cautious extrapolation was the safer route. Where will we be in another 10 years?

Given the importance of soils to the New Zealand primary economy, environmental services, landscape characteristics and scenic beauty, I continue to be surprised at the low level of awareness about soils in New Zealand – both in the general public and the funding agencies. How many times at social events have I been asked about my interests and training and I enunciate clearly "Soil scientist", to be rewarded with a blank stare – "Is that something to do with oil?"

So what of the future? My guess is for static or declining funding from central government and little change in industry support. That will mean greater competition between current soil science organisations and individuals for a shrinking cake. It will also make succession planning and new recruitment difficult.

This article is Soil Horizons contribution to the International Union of Soil Sciences drive to stimulate thinking about future directions for Soil Science. The IUSS have recently published a booklet **The Future of Soil Science** that can be freely downloaded from their website http://www.iuss.org/future.htm

This anticipated lack of capacity will come at a time when soil scientists are needed more than ever. There will be greater pressure on productive land as farmers follow the market-driven forces for greater intensification. The cow, and the infrastructure that goes with it, is a huge environmental polluter - all that dung and urine, nitrous oxide emissions, methane emissions, and energy consumption to turn milk into products. The country is undergoing substantial land-use change with little regard to the future and possible environmental consequences. Who would have thought we would be ripping out pine trees planted since 1995 and converting the land to dairy farming?

There are likely to be more extreme weather events in the future, and we should be trying to conserve our soil resource, not allowing it to fall off the hillside and for the sediments to clog dams and waterways.

The future of GE crops in NZ is at present uncertain, but again this could change in the future. I have concerns, not for the use of GE per se, but because the presumed productivity gains are anticipated to derive from the genetic manipulation of plants and animals, rather than from improved management of the existing soil. What is the role for the soil scientist here? And more production means more demand on the soil and more wastes to treat.

– a brief selection of research topics reported in Soil Horizons over the last decade

1997	1998	1999	2000	2001
Denitrification walls reduce leaching of nitrates to groundwater	Soil Structural Vulnerability Index for sustainable land use	Soil quality monitoring aids regional councils	Practical management techniques to reduce soil compaction	Visual Soil Assessment (VSA) – an effective and easy tool for all users

OF SOIL HORIZONS

To get our message across I think soil science will need to continue to become more integrative, with much closer links to the animal and plant sciences.

There is a great need for soil scientists to be able to convert their knowledge about soils into financial consequences that politicians and policy makers can understand. What is the true value of the ecological services provided by soils? And what is the true cost of soil degradation and pollution – not just the immediate effects of on-site production but for the whole community?

So are there going to be enough future soil scientists here for a small country like New Zealand? Barely so, in my opinion. Government policies over the last 15 years have pushed soil science along a particular direction, with short-term goals. There needs to be a phase of rebuilding for the future, because all the prognoses are that pressures on land and soils are going to get more intense, and we need the knowledge and people to respond.

Graham Sparling
07 859 3734
SparlingG@LandcareResearch.co.nz

A Wellington perspective on the need for regular updates on soil research

I am pleased to provide some comments for this issue of Soil Horizons that marks 10 years of communicating soil research undertaken by Landcare Research. I am pleased on two counts. The first is the recognition of my starting this newsletter, and the second is that having lived and worked in Wellington for the past 3 years I now have a slightly different perspective on the need, and content, of such a newsletter.

When Soil Horizons was first produced in April 1997 our philosophy was to have both a hard-copy and web versions of the newsletter, to be able to communicate work in soil-related research to stakeholders, customers and colleagues. To quote Maggie Lawton's editorial (April 1997): "We consider it essential that the end users of our research, whether fellow scientists, regulatory authorities, policy makers or members of the public who have an interest in land-based environmental issues, are able to access and utilise our work to assist New Zealand's environment and economy".

This philosophy is as valid now as it was 10 years ago. I believe topics described in Soil Horizons should reflect stakeholder needs in terms of the application of current and past research results. It can take up to a decade from when research is undertaken and first published, to when there is operational and/or policy uptake of the research effort and results. This delay in uptake is further exacerbated by staff turnover, in that current staff are often unfamiliar with the earlier research and commercially related work that has been undertaken based on the research knowledge.

I look forward to receiving future issues of Soil Horizons.

Peter Stephens
Ministry for the Environment
February 2007

2002	2003	2004	2005	2006	2007
TillThen – a web-based tool assisting Manawatu farmers	Rain-gardens reduce urban storm-water runoff	LENZ launch for ecosystem mapping	Soil nitrous oxide/ methane assessed for Kyoto Protocol	Soils Portal goes on-line	Assessing sustainability of soil carbon

More details can be found at http://www.landcareresearch.co.nz/

The Sustainable Land Use Research Initiative

The Sustainable Land Use Research Initiative (SLURI) is the national centre for maintaining and managing our soils. It carries out research on the sustainable management of land, develops new tools for regulators and land managers, and provides key knowledge to shape policy and prepare New Zealand for the future. SLURI's Governance Council, which provides oversight and direction, comprises representatives from central and regional government agencies, as well as from the farming sector. The Council is chaired by Alistair Polson, a farmer from Wanganui and New Zealand's Special Trade Envoy. Alongside the SLURI science team sits an Advocacy Group of about 25 representatives from end-user groups and stakeholder interests. This Group provides the pathway to implementation of SLURI's research results.

> Science and innovation are a means to ensure a profitable and sustainable future for New Zealand's land-based industries.
>
> ---
>
> SLURI is a science partnership between four crown research institutes: Landcare Research, Crop & Food Research, HortResearch and AgResearch.

A selection of current research topics include:

- Soil carbon loss under pasture (see this Issue, page 1)
- Soil health and soil-quality indicators (see Soil Horizons 14)
- Soil porosity and its effect on surface and subsurface runoff
- Soil nitrogen saturation levels (see Soil Horizons 12)
- Sediment yield to streams from highly erodible land (see Soil Horizons 14)
- Cumulative effects of storm events on vulnerable pasture slopes
- Valuing the natural capital of soils and their ecosystem services (e.g., in Soil Horizons 12)
- Future land-use scenario modelling

Setting a new precedent, a team of top scientists from across SLURI have been working together to take Landcare Research's Soil Services programme through to the next FRST-investment cycle. The recently submitted proposal focuses on advancing fundamental understanding of how soils buffer and filter. The research, if funded, will develop understanding of what soil properties and conditions are necessary for resilient nutrient cycling, particularly of nitrogen, and the fate and behaviour of emerging contaminants such as pathogenic microbes, steroid hormones and veterinary antibiotics. Using a variety of traditional and novel techniques, such as laboratory-based sorption and isotope studies, skills in tomography and microbial-community studies, as well as lysimeter experiments, field monitoring across multiple enterprises, analysis of archived soils and spatial extrapolation, the team will measure and then model soil buffering and filtering processes. Using these critical data, the research will be implemented and used through the broader SLURI programme and to enhance and refine *Overseer®.

SLURI uses fundamental data and knowledge generated from FRST programmes, such as the one referred to above, to assist in developing policy and industry best practice. As an example, the team has recently been employed to use their fundamental knowledge of nutrient cycling and contaminant transport to help set best-practice nutrient-loss targets and contaminant-management strategies in Horizons' 'One Plan' policy statement (Farm strategies for contaminant management: a report for Horizons Regional Council February 2007).

Through SLURI's unique structure soil science in New Zealand promises to get better and better over the next 10 years.

Alison Collins
06 353 4809
CollinsA@LandcareResearch.co.nz

**Overseer® is the accepted tool used by farmers, industry, and policy agencies to manage the use of nutrients through best management practices.*

see www.SLURI.org.nz

A case for preserving versatile soils under the Resource Management Act

Over the 15 years since the advent of the Resource Management Act there have been many more losses than gains in the effort to conserve our best land for future generations. Our cities seem to be expanding at an increasing rate, and lifestyle blocks are proliferating on the urban fringe. It is time to take stock of what is happening and address this issue on a national scale.

Historically, two main principles, derived from the RMA (1991), are used to justify the conservation of versatile soils. These are 'safeguarding the life-supporting capacity of soil' and 'sustaining the potential of natural and physical resources to meet the reasonably foreseeable needs of future generations'. Environment Canterbury, in its regional policy statement, has formulated a policy to protect land containing versatile soils from 'irreversible effects that may foreclose future land use options that benefit from being located on such land'.

Versatile soils are deep loamy soils that are not poorly drained and occupy slopes less than 12 degrees. Most versatile soils in the South Island occur on river terraces; in the North Island they also occupy extensive areas of flat to rolling land, mantled with volcanic ash (particularly in Waikato and Bay of Plenty). There are also small areas of versatile soils on flat to rolling land developed from basaltic rocks, mostly south of Auckland and Oamaru.

I have been involved for over 30 years as an expert witness in cases involving loss of versatile soils brought before council hearings and the Environment Court. Canterbury has a very thin record of cases where development has been curtailed on the basis of the loss of versatile soils.

My task as an expert witness has been to:

- define the soil resource identified as 'versatile soils'
- show that versatile soils are a resource of significant value to future generations
- show that versatile soils are a finite resource of limited extent
- determine the extent and significance of loss of versatile soils under development proposals.

The protection of versatile soil is needed to support a wide variety of viable land-use options for future generations, preserve ecosystems that confer the greatest natural protection to the environment, and facilitate sustainable production of food and fibre.

The preservation of land for arable use is of prime importance in the issue of conservation of versatile soils. Suitability for arable use confers capability to produce a wide range of crops – the key issue of versatility. In Canterbury the area currently used for arable production exceeds the area of versatile soils available for arable use. Further loss of versatile soils from potential arable use limits the options for this generation, and future generations, of undertaking arable production on land that is most suitable and sustainable for this purpose.

The recent trend in 'lifestyle' subdivisions is arguably the greatest threat to the loss of versatile soils. 6800 new lifestyle blocks are registered on the Valuation Roll annually. This equates to just over 37 600 ha per annum converted to lifestyle blocks. Land that is subdivided below 4 ha buries greater and greater proportions of soils beneath buildings and hard surfaces, and a greater percentage of land area is made unavailable to productive use.

In my view there is an urgent need to show that loss of this high-quality land is a significant issue facing New Zealand. We need to determine 'How much land is being lost annually?' and 'What is the cost of this to society?'

Trevor Webb
03 321 9830
WebbT@LandcareResearch.co.nz

The urban fringe encroaches on versatile soils of farmland in northern Taranaki (Q. Christie in Molloy, 1998).

Below-ground ecological services

The critical importance of soil biota in driving soil processes was recently underlined by Gregor Yeates, Landcare Research soil zoologist, in the 2006 NZ Soil Science Society Norman Taylor Memorial Lecture. Gregor gave some specific examples of how the activities of underground soil animals and microbes largely control nutrient cycling and above-ground productivity. Excerpts from Gregor's presentation are presented here:

Earthworms

New Zealand has some spectacular native earthworms (Figure 1), the largest being up to 1.4 metres in length. They are found mainly under native vegetation. However, it is the introduced lumbricid earthworms (Figure 2) that benefit agriculture most. Research has shown that over 23 years, topsoil-mixing earthworms can increase pasture production by 10–30% and soil organic matter by 26%, and can double soil infiltration rates.

Photo: B Boag

Figure 3: A terrestrial flatworm, Newzealandia sp., *length about 4 cm*

Many advocate spreading topsoil-mixing earthworms more widely. However, earthworm burrows differ – while topsoil-mixing earthworms have 'beneficial' effects, deep-burrowing species need to be flagged as their burrows have potential for by-pass flow.

Flatworms

Flatworms (Figure 3) are soil animals, 0.5 to 10 cm in length, commonly predating on a range of small animals including slugs, snails, earthworms, and other soil invertebrates. One New Zealand flatworm (*Arthurdendyus*

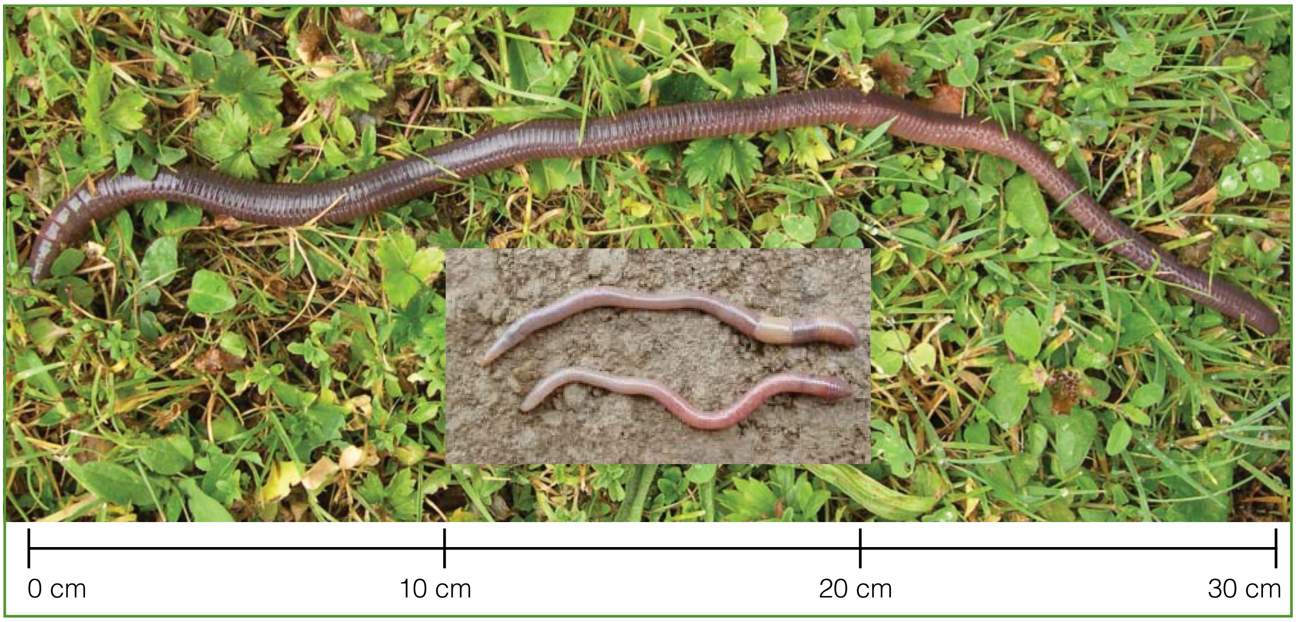
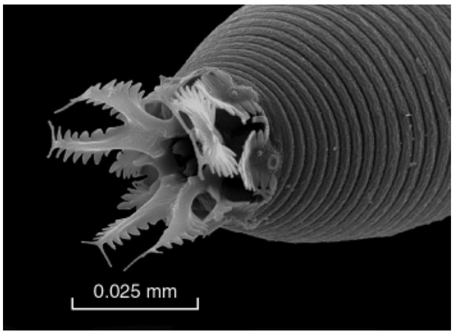


Photo: R Gray

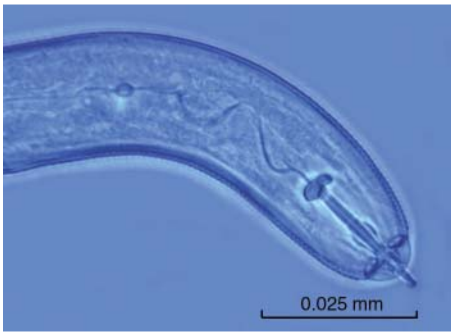
Figure 1: A native earthworm from the West Coast, NZ

Figure 2 (inset): An introduced earthworm, Aporrectodea caliginosa

Figure 4: Nematodes are classified by their feeding apparatus



(a) head structure of a bacterial-feeding nematode (photo: Nemapix)



(b) spear of a plant-feeding nematode (photo: Nemapix)

(c) a plant-feeding spiral nematode, widespread in New Zealand pastures, body length about 1 mm (photo: Nemapix)

triangulatus) was accidentally introduced into Great Britain, and in places has had severe detrimental effects by decimating existing earthworm populations in agricultural soils. Gregor found that flatworms are also detrimental under zero-tillage operations in the Manawatu. Maize residue on the soil surface, which had been zero-tilled for 15 years, provided shelter and protection for flatworms that preyed on earthworms. Discretion is now exercised in zero-till recommendations.

Nematodes

Every square metre of New Zealand pasture soil has on average several million nematodes in the top ten centimetres. Ecologically, nematodes are extremely important, helping to complete the nutrient supply loop. They are extremely diverse and are classified on a basis of their feeding apparatus (Figure 4). They feed on microbes, which increases microbial turnover, making more nutrients available for plant growth. However, in one experiment, superphosphate application to a pasture was increased by a factor of 4, but grass production did not increase at all. Scientific investigation showed that the population of root lesion nematodes also increased by a factor of 4, reducing the life span of roots and increasing root turnover. As a result, the plants were putting their energy into producing new roots, instead of directing it into shoots. By applying fertilizer, farmers were actually feeding the nematodes below ground.

Challenges for the future

The above-ground impact of current intensive land management regimes includes reduced soil quality, (e.g., soil compaction and reduced soil organic matter levels) as well as reduced water quality in our rivers and lakes. These impacts can be clearly seen in the landscape and are accepted and acknowledged. The challenge for soil zoologists is to assess the impact of intensive land use on underground soil biological processes.

Research that addresses this challenge is our work in hill country at AgResearch, Ballantrae. Here we are assessing the effects of urea nitrogen applications on nematode diversity in a region where nitrogen fertilisers were not traditionally applied, the farming systems being less intensive and symbiotic nitrogen fixation relied on to drive pastoral production. Current results show that nematode diversity is consistently lower in the urea-treated plots. As nematodes play pivotal roles in nutrient cycling, this decreased diversity may indicate less resilience among soil biological processes.

Other research is addressing the effects of increasing carbon dioxide levels in the atmosphere associated with climate change. At a site where pasture has been growing under elevated carbon dioxide since 1997, numbers of the plant-feeding nematode, *Longidorus*, have increased more than four fold, and this has increased root turnover. Increased root turnover means decreased root life span, suggesting any increased productivity and carbon sequestration under future elevated atmospheric carbon dioxide levels could be largely counteracted by increased nematode grazing.

Gregor Yeates
06 353 4915
YeatesG@LandcareResearch.co.nz

Pastoral soils help offset New Zealand's methane emissions

Earlier editions of Soil Horizons (Issues 11 and 14) discussed the important role of soil bacteria in consuming methane, a potent greenhouse gas in the atmosphere. Soils in which this methane consumption by bacteria is greater than any production are called methane sinks. These sinks offset methane emissions from other sources to the atmosphere. Methane in New Zealand is produced mostly (88%) by exhalation from ruminant cattle and sheep during digestion. Colleagues at Landcare Research found that New Zealand indigenous forest soils may be among the strongest methane sinks in the world (up to 10.5 kg methane per hectare per year). They have also discussed (Issues 11 and 14) how intensification of farming and land-use change affects soil methane oxidation and our greenhouse gas accounting.

Zheng Li and Francis Kelliher recently examined methane oxidation rates in freely and poorly drained soils on an intensively managed dairy farm in the Waikato region following a cattle urine application (650 kg of nitrogen per hectare) over 100 days during autumn and winter. Their findings support previous findings by Landcare Research colleagues. They found that:

- methane oxidation rate in the freely drained soil (1.8 kg methane per hectare per year) was three times higher than that in the poorly drained soil (0.6 kg methane per hectare per year)
- the freely and poorly drained soils' methane oxidation rates decreased by 39 and 67% on average, respectively, after urine application, and this disturbance effect could last for up to 2 months
- in the control plots, methane oxidation rate in the freely drained soil did not change significantly with changes in water content
- methane oxidation rate in the poorly drained soil reduced substantially as the soil became wetter, and this soil sometimes emitted methane to the atmosphere during very wet and cold weather conditions.

This research has allowed the researchers to estimate that New Zealand pastoral soils oxidize 14 Gg (thousand tonnes) of methane per year. This is approximately 14% of the increased national emissions since 1990, and consequently a significant offset for New Zealand's greenhouse gas accounting.

Zheng Li
03 321 9795
LiZh@LandcareResearch.co.nz

Francis Kelliher
03 321 9711
KelliherF@LandcareResearch.conz

A twist to the methane story – plants emit methane

In a highly publicised paper[1] last year, there was a remarkable observation that terrestrial plants produce methane in aerobic environments, leading others[2] to postulate that in countries like New Zealand where grazed pastures have replaced forests, the forests could have produced as much methane as the ruminants currently grazing these areas.

Landcare Research scientists, led by Francis Kelliher[3], with colleagues from AgResearch[4] and MAF, were quick to assess methods used by these researchers. They contend that scaling up the original results to obtain global methane emissions from vegetation involved a calculation that might not be the most appropriate. This involved the net primary production, and assumes that total vegetative biomass (shoots and roots) emits methane at the same rate as leaves do.

In contrast, Kelliher and colleagues used leaf mass per unit ground area to scale the postulated leaf methane emissions to indigenous forest and grazed grassland ecosystems. They also included the balancing effects of soil methane consumption, the methane being used by soil microbes as an energy source. Their analysis showed that indigenous forest emits around five times more methane per unit area than ungrazed pasture, but only about three times more when the soils oxidative ability is taken into consideration.

The next step was to include methane emissions from up to 85 million ruminants grazing throughout the year, using data compiled for New Zealand's official inventory of dairy cattle, beef cattle and sheep. Kelliher points out that this is a challenging calculation with considerable uncertainty[5].

On average, the methane emission rate of grazing ruminants is estimated to be about 10 g per square metre per year, six times the corresponding estimate for an indigenous forest canopy. The forest's soil is estimated to oxidise about 1 g of methane per square metre per year more than soils under grazed pastures. Therefore, taking into account plant and animal sources and the soil's oxidative capacity, the net methane emission rates of grazed ecosystems (9.8±2.6 g/m2/y) are about sixteen times greater than those of our indigenous forests (0.6 ±1.1 g/m2/y).

The conclusions from these calculations are that New Zealand's indigenous forest did not produce as much methane as that of ruminants currently grazing the land – it was possibly only about 6% of the current emissions from our current grazed pastures.

Francis Kelliher
03 321 9711
KelliherF@LandcareResearch.co.nz

---

[1] *Keppler et al. (2006, Nature 439: 187–191)*

[2] *Lowe (2006, Nature 439: 148–149)*

[3] *Kelliher et al. (2006, Functional Plant Biology 33: 613–615)*

[4] *Parsons et al. (2006, TRENDS in Ecology and Evolution 21: 423–424)*

[5] *Kelliher et al. (2007, Agricultural and Forest Meteorology 143: 146–150)*

Steroid hormones in dairy farm waste

While steroid hormones occur naturally in dairy waste, their form and amount vary greatly. Our FRST-funded research is helping to assess this variability and rank these naturally occurring hormones on the basis of their retention in different soil types.

It is well documented that estrogenic steroid hormones are endocrine disrupting chemicals (Soil Horizons 10), that is, they have the potential to cause abnormalities in wildlife. In mammals, these estrogens not only occur in the active free form but also combine with other molecules such as sulphate, which increases their water solubility. These water-soluble forms are called conjugated estrogenic hormones. While free estrogens are released via faeces, conjugated estrogens are released as urine. We are investigating potential risks posed to the environment by the free and conjugated estrogens naturally excreted by New Zealand's approximate 60 million livestock.

Steroids are fat-soluble organic compounds with 17 carbon atoms arranged in four rings. Hormones are chemicals produced in one part of the body and released into the blood to trigger or regulate particular functions in another part of the body. For example, insulin is a hormone made in the pancreas that tells other cells when to use glucose for energy. Steroid hormones are steroids that act as hormones.

Earlier findings showed that free hormones are moderately to strongly retained by a range of soils (Soil Horizon 12). However, no information is available on the behaviour of hormone conjugates in the environment.

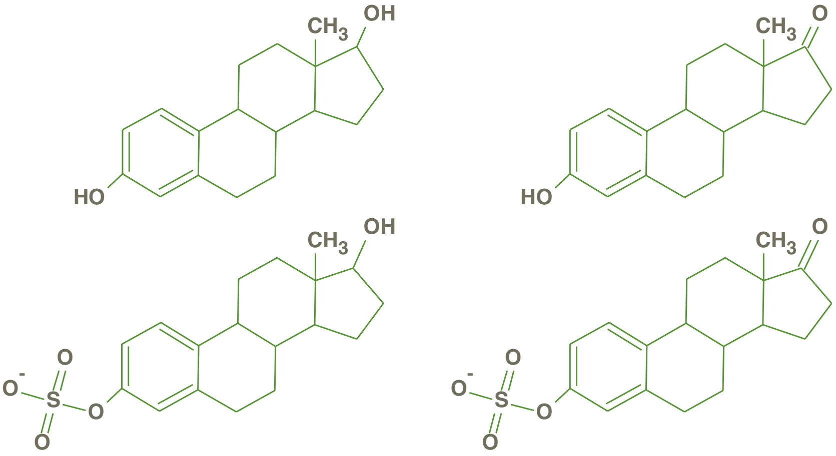


Figure 1: Steroid hormone estrogens (top) and their sulphate conjugates (bottom)

We therefore carried out laboratory studies on selected farm soils (0–5 cm) to obtain data on sorption of the relevant estrogens. We calculated a compound-specific distribution coefficient (K_d), which tells us how well a soil retains a particular compound (Soil Horizons 12). The higher the K_d value, the better the retention capacity of soils for the compounds. Table 1 shows that for free hormones, the K_d values are markedly higher than the values obtained for their sulphate conjugates. In fact, preliminary findings show that the K_d values for the sulphate conjugates are an order of magnitude lower than their free analogues, i.e. they are much less retained by the soil, suggesting a potential to move through the soil and perhaps into groundwater and then the environment.

We plan to conduct additional degradation studies to allow us to evaluate the potential risks that grazing animals' direct excretal input can pose to our ecosystems and health.

Ajit K Sarmah
07 859 3737
SarmahA@LandcareResearch.co.nz

Frank Scherr
07 859 3760

Hormones	Soils	Organic Carbon (%)	K_d (L/kg)
Estrone	Horotiu	4.0	38
	Hamilton	9.9	42
	Te Kowhai	5.0	46
	Matawhero	2.1	14
	Gibsons	1.1	10
Estrone-3-sulphate	Horotiu	4.0	5
	Hamilton	9.9	6
	Te Kowhai	5.0	5
	Matawhero	2.1	0.6
	Gibsons	1.1	1

Table 1: Distribution coefficients (K_d) of the estrogen, estrone and its sulphate conjugate in some NZ soils

How raingardens protect us from road runoff

Roads are sources of contaminants such as sediments, hydrocarbons and heavy metals. Many of the contaminants are from vehicles, such as copper and zinc from tyre and brake wear. These contaminants are mobilized in rain runoff that is usually piped to local waterways and estuaries. Rapid runoff from roads can cause streambank erosion and flush animals from their habitats. Diverting stormwater through soil-plant systems such as raingardens can reduce the magnitude, total volume, and contaminant load of stormwater reaching waterways.

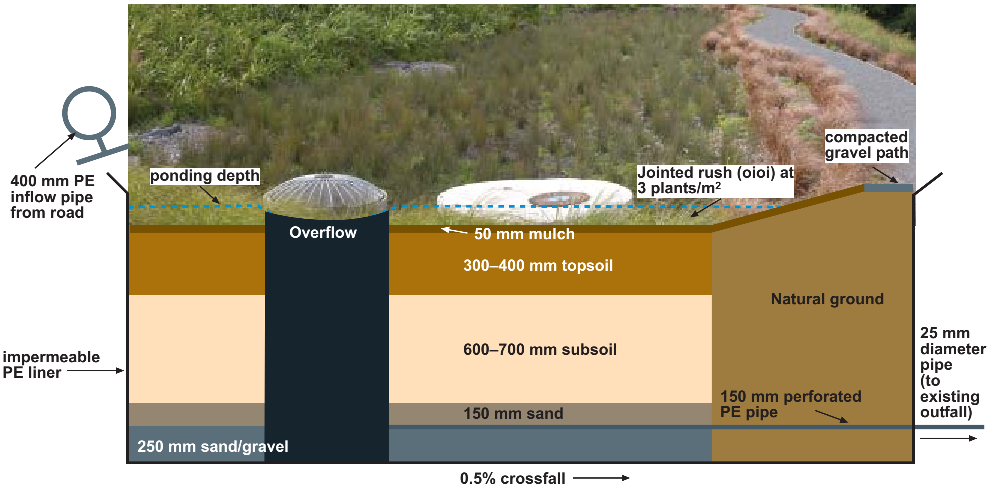


Figure 1: Cross-section of the raingarden

For the past 6 months we have been monitoring a recently constructed raingarden. The 230-m^2 raingarden receives water from a 5000-m^2 light industrial catchment that includes a road travelled by about 15 000 vehicles each weekday. The cross-section (Figure 1) includes three key raingarden layers:

- Mulch: a weed-free, non-floating, long-fibre organic material to suppress weeds and protect the surface from erosion and compaction until plants cover the surface
- Topsoil: volcanic topsoil mixed with 30% sand to achieve high permeability, 2.4% carbon and 29% phosphate retention. An ideal growing medium
- Subsoil: an alkaline, highly anion-retentive mix of subsoil and overburden (87% phosphate retention) from a limestone quarry. Moderate permeability acts as a choke and minimises preferential flow

The raingarden captures the incoming flow, producing a relatively small and constant outflow (Figure 2), except during very large storms when water bypasses the raingarden. The raingarden performance was affected by the seasons. We measured a maximum storage in summer when there was higher evaporation and an absence of continual inflows between storm events, and a lower storage in spring.

Road runoff entering the raingarden was contaminated with sediments, metals (particularly zinc) and occasionally alkaline materials. The raingarden buffered influent pH, reducing peaks of up to 11.9. Capture rates for sediment, zinc, lead and copper exceeded the 75% target (Figure 3). However, the raingarden acted as both a source and a sink of nitrogen, depending on soil aeration and the inflow rate. To help define the performance of the raingarden, monitoring is continuing for about 12 months, aiming to capture at least 15 storm events.

Robyn Simcock
09 574 4153
SimcockR@LandcareResearch.co.nz

Sam Trowsdale
09 574 4152
TrowsdaleS@LandcareResearch.co.nz

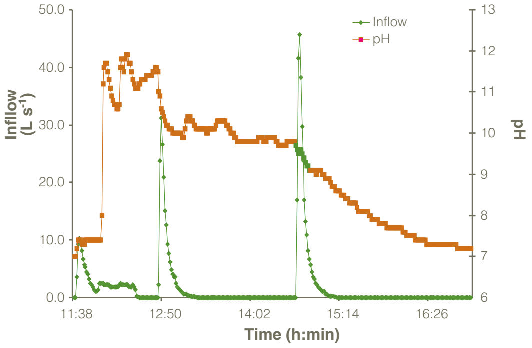


Figure 2: Stormwater inflow (litres/second) and pH of inflow during a small rain event in August 2006 that generated 17 m^3 runoff into the raingarden

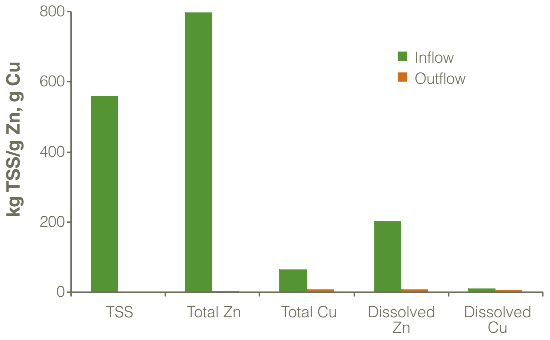
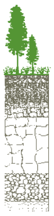


Figure 3: Mass of Total Suspended Sediment (kg of TSS), and total and dissolved zinc and copper (g of Zn and Cu) flowing into,and discharged from the raingarden during five Spring events in 2006



Change of address


Q. Christie in Molloy, 1998

Please let us know if:

- your address/details have changed
- you wish to be removed from the mailing list
- you know of someone who would like to be added to the mailing list

New address/details

Name:..

Position: ....

Address:...

....

....

OR Please remove my name from the mailing list: YES ☐

Please cut and return to:
The Editors
Soil Horizons
Landcare Research
Private Bag 11052
Palmerston North, New Zealand

Or email: soilhorizons@landcareresearch.co.nz

Key contacts

Editors: Carolyn Hedley, Anne Austin and Graham Sparling

Layout: Nicolette Faville

Published by:
Landcare Research New Zealand Ltd
Private Bag 11052
Palmerston North 4442

View online at: http//:www.landcareresearch.co.nz/publications/newsletters/soilhorizons/index.asp

Unless otherwise stated, funds for the research described in this newsletter were provided by the Foundation for Research, Science and Technology.