Manaaki Whenua
Landcare Research

SOIL HORIZONS

What s inside

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Editorial

It is my pleasure to welcome readers to the first issue of *Soil Horizons,* a publication of Landcare Research, aimed at communicating our work in soil related research to stakeholders, customers and colleagues.

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. *Soil Horizons* is also available on the WWW at http://www.landcare.cri.nz/newsletters/

This publication will cover issues including soil quality, land rehabilitation, impacts of wastewaters, nitrates, pesticides and heavy metals on the environment, cropland erosion and soil degradation, non-point source pollution on land and water resources and greenhouse gases. In the first issue of *Soil Horizons*, we have described our greenhouse gas research - subsequent issues will cover the other research topics in this biannual publication.

***Soil Horizons* is also available on the WWW, at http://www.landcare.cri.nz/newsletters/**

We welcome comments and feedback and hearing from other people who would like to be on the mailing list.

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Nitrate removal in riparian zones: a quick fix?

Landcare Research is mimicking riparian wetland processes to find ways of reducing nitrate pollution of groundwater. Natural wetlands remove large quantities of nitrate from groundwater through the process of denitrification: anaerobic micro-organisms convert dissolved nitrate into nitrogen gases which are then released into the atmosphere. For this process to be effective, large amounts of organic matter - as found in riparian wetlands - are needed as an energy source for microbes.

However, many riparian wetlands were modified when land was developed for productive purposes. The resulting loss of organic matter has limited the capacity of wetlands to process nitrate. In one trial, our researchers have incorporated organic matter into the path of the groundwater to encourage nitrate removal by nitrification.

In January 1996, Landcare Research constructed a groundwater bioremediation trench (GBT). The 35m long, 1.5 m deep trench runs parallel to a small receiving stream. The pasture above the trench was sprayed with dairy factory effluent which contained nitrate. The soil removed from the trench was mixed with untreated radiata pine sawdust and then returned to the trench. It was intended that the sawdust would act as an organic barrier to the groundwater, stimulating denitrification, and protecting downstream surface waters from the increased concentration of nitrate in the groundwater.

In order to test the GBT, we have taken soil samples from immediately above and from inside the trench. These have been analysed for nitrate concentration, denitrifying activity (DEA), and carbon availability. DEA is a relative measure of the activity of denitrifying bacteria.

Groundwater nitrates were reduced from 15 mg N L^{-1} to 3 mg N L^{-1} by use of the bioremediation trench.

Above the trench, nitrate concentrations in the groundwater reached 15 mg N L^{-1}, while in the GBT they never exceeded 3 mg N L^{-1}. The DEA in the trench was up to 1000 times greater than in adjacent subsurface soils, suggesting that denitrification was indeed the prime cause of nitrate removal from groundwater. The raised levels of DEA was attributed to the sawdust which greatly increased the amount of carbon available to microbes. Ongoing studies are determining whether the sawdust will need to be replaced to maintain the present high level of denitrification.

Use of GBTs is probably restricted to land where the groundwater is relatively shallow, and where nitrate loadings are high, such as in land-based effluent treatment systems.

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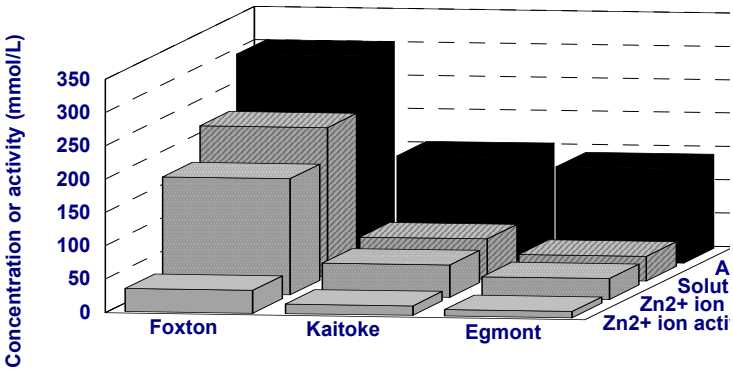
Schema of the groundwater bioremediation trench and sampling sites.

Soil analyses

Landcare Research's general purpose soil chemistry and soil mineral laboratories are located in Palmerston North. The laboratories' analytical team, acknowledged for its expertise in soil and plant analyses, is led by Brian Daly. Brian is an author of the internationally acclaimed method book for soil analysis ("Methods for Chemical Analysis of Soils"). His team can handle most sample types and is particularly experienced in analysing soils, plant materials, soil solutions and leachates, and natural waters. Instrumentation includes:

- carbon, nitrogen and sulphur analyser;
- autoanalysers (for the rapid analysis of ammonium, nitrate, phosphate and sulphate in soil extracts, solutions, leachates and other samples);
- a total organic carbon analyser for measuring organic carbon contents of soil extracts and solutions, leachates, effluents and natural waters;
- an ion chromatograph (for measuring anions in soil solution), an atomic absorption spectrophotometer (for metal ions in soil solution and plant extracts) and gas chromatographs (for measuring carbon dioxide in soil respiration studies and methane in greenhouse gas work).

The team also uses pH and conductivity meters, a UV/visible scanning spectrophotometer, an autotitrator, and a number of wet chemical digestion techniques.



An example of using chemical analysis- Zinc speciation in soil solution from 100 mmol/kg zinc addition to three different soils.

One of our two main soil physics laboratories and our tracer and mineralogy facilities are also in Palmerston North. In the mineralogy laboratory, which is run by Joe Whitton, several methods (such as X-ray diffraction, differential thermal analysis, infrared absorption analysis, and optical microscopy) are used to determine the mineral composition of soils and raw materials. The soil physics lab is run by John Dando, and is used for analysing particle size distribution, soil water storage and pore size distribution, hydraulic conductivity, and aggregate size and stability of soils. In the tracer laboratory we use radioactive ^{14}C, ^{32}P, ^{31}P, ^{35}S and ^{3}H as tracers to follow nutrient transfer pathways and to assess the turnover of soil organic matter in different ecosystems.

Landcare Research's other main soil physics facility is in Hamilton. This is run by John Clayden. The Hamilton branch deals primarily with soil biochemistry, microbiology, soil physics and solute movement, and with some tracer and heavy metal work - although it is able to handle most of the same analyses as the Palmerston North laboratory. Most frequently, the Hamilton laboratory analyses characterisations of microbial populations, soil biological activity (measuring microbial biomass and basal respiration), carbon (including TOC) and nitrogen status, and trace and heavy metals. The Hamilton soil physics laboratory handles the same kinds of analyses as its Palmerston North counterpart.

These Landcare Research facilities offer a comprehensive range of analyses, and often collaborate to provide the service required by individual clients.

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Hamilton Lab - John Claydon or Bob Lee, ph (07) 838 4441, e-mail claydonj@landcare.cri.nz

Research directions

Our research is relevant to a number of New Zealand statutes and strategies, and international agreements - the Resource Management Act, the National Science Strategies for Sustainable Land Management and Climate Change, the Environment 2010 Strategy, the Framework Convention on Climate Change and the International Geosphere Biosphere Programme. This article deals with research related to greenhouse gas emissions from terrestrial ecosystems. Subsequent issues of *Soil Horizons* will describe other aspects of our research effort.

New Zealand terrestrial ecosystems represent major sources and sinks of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4), three major greenhouse gases. Soils are the major, but also at present the least understood, terrestrial reservoirs of carbon and nitrogen; even small changes in these reservoirs can have a major impact on greenhouse gas emission rates from soils. Studies which have measured various sites in native forests, grasslands, planted forests, and pastures have significantly increased our understanding of the processes which control carbon and nitrogen storage in soils.

Thanks to the development of a terrestrial carbon inventory for New Zealand, and of a process-based model of soil carbon turnover, we can now estimate the amounts of carbon which are taken up and released by our native forests and grasslands.

At Landcare Research, we are also assessing changes in soil carbon which have occurred as a result of

Information on soil greenhouse gas emissions is needed by policy makers.

afforestation of pastural lands. We now know that the carbon content of our soils can remain stable for centuries, and have established that amounts of soil carbon can be quickly reduced once land use is changed.

Nitrous oxide is biologically generated in soil. Its production is enhanced when animal effluent is spread on the land. In overseas studies, the addition of a nitrification inhibitor (dicyandiamide - DCD) to effluent impacted soil has significantly reduced nitrous oxide fluxes from the soil. Our researchers are investigating the use of DCD in New Zealand to provide a means of limiting nitrate movement through soil and the release of nitrous oxide, allowing us to protect our groundwater and the atmosphere.

We are presently determining processes which control carbon losses from indigenous forest and scrub. Our findings should enable us to account more accurately for carbon stocks and for the impact of carbon changes on New Zealand's national carbon balance.

Researchers are using data from permanent plots which have been regularly measured over the last few decades in order to assess medium term changes in carbon storage in live trees in New Zealand's indigenous forests. Results underline not only the continuing deterioration of some of our forests, but also indicate that to assess such changes accurately, we need a long-term plan to measure plots regularly.

Micrometeorological measurements and modelling studies are being developed to measure methane fluxes from sheep, and have also provided new insights into the effects of scale and the role of nitrogen nutrition of vegetation on surface-atmosphere exchange processes. Our results show that the impact of atmospheric turbulence extends across the leaf - air boundary layer to affect the mass transport of water in trees. The origin and fate of carbon compounds in vegetation and in the atmosphere are also being investigated. Our research has led to a new understanding of the energy balance and carbon sequestration rates in dryland *Pinus radiata* forest in New Zealand.

Greenhouse gas inventory - making a difference

Landcare Research has been contracted by the Ministry for the Environment to improve information on carbon stored in New Zealand's soils and in its indigenous forest and scrub. Landcare Research is collaborating with the Forest Research Institute to complete this three year project, which has been funded from the "green package." The project aims to update the 1990 baseline figure for carbon stored in soils, indigenous forest and scrubland, and aims to develop a national system for monitoring carbon changes in all soils and in these particular vegetation types. The updated information will make a significant contribution to New Zealand's greenhouse gas inventory and to the country's reporting commitments under the Framework Convention on Climate Change. The national monitoring system will include a spatial information system which will contribute to other projects funded through the "green package" and the Environment 2010 strategy.

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SPACNET

The **S**outh **P**acific **A**gricultural **C**hemistry Laboratory **Net**work now has a newsletter. Brian Daly, Chemistry Laboratory Manager, Landcare Research, Palmerston North, is the Network coordinator and the newsletter editor. The goal of the Network is to help develop sustainable agricultural systems in the South Pacific by assisting laboratories to accumulate reliable soil and plant testing analytical data. The newsletter is intended to raise awareness about SPACNET, to act as a communication vehicle for those involved directly or indirectly in the Network, to promote quality assurance in the region's laboratories, and to provide regular updates about the Network. SPACNET's activities are funded by the NZ Ministry of Foreign Affairs

and Trade through the International Board for Soil Research and Management (IBSRAM) PACIFICLANDS projects. Landcare Research has been contracted by IBSRAM to act as a consultant for the Network.

As Network coordinator, Brian's first task was to visit the laboratories he will be working with. In February, March and April he flew to Papua New Guinea, the Solomon Islands, Vanuatu, New Caledonia, Fiji, Tonga and Western Samoa. During his trip, Brian assessed the demand by agricultural researchers and farmers for laboratory services. He also made suggestions for further staff training, for improving soil and plant analytical methods and equipment, and for enhancing quality control programmes.

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Soil quality indicators

Soil researchers are keen to develop indicators for "state of the environment" monitoring. It is not practical to measure all the possible (over 100) land and soil indices, but selecting a useful subset has proved difficult. Interpreting data and defining standards remain problematic tasks. For example, virtually all sets of soil indicators include a measure of soil organic matter, yet there are very few instances where we can state what the "normal" soil organic matter level is, what the critical "trigger points" are, and what constitutes good or bad quality under different land uses.

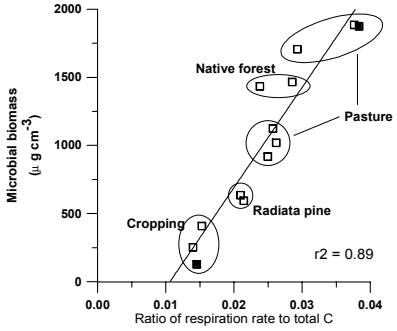
Landcare Research is now working on a project funded by the Ministry for the Environment; the Waikato, Auckland and Canterbury Regional Councils; and the Foundation for Research, Science and Technology. The project's aims are to develop indices of soil quality by measuring key biological, chemical and physical properties of soils, and to establish which properties are most sensitive to land use management practices.

At present, we are using a number of soil measurements to monitor future changes in soil quality. Soil biological parameters measured were the rate of soil respiration, the soil's microbial biomass, and the quantity of potentially mineralisable nitrogen. Soil chemical characteristics were assessed by measuring the total C content, the total N content, cation exchange capacity, soil pH, and derived measurements such as base saturation. Each soil's physical properties were analysed for bulk density, hydraulic conductivity, moisture release characteristics, and particle size. Soil samples were taken from land used for arable cropping, dairy, beef and sheep farming, market gardening, radiata forestry and from native forests.

The selected soil quality parameters were found to differ clearly according to land use. In general, the biological indices were more sensitive to differences in land use than the physical indices. To allow for comparisons of soils of different types, and from different land use and geographical areas, a biological quality scale was developed, where microbial biomass was plotted against the ratio of respiration rate:total carbon.

The x-axis (ratio of respiration rate:total carbon) indicates the availability of the organic matter to soil organisms, allowing for comparison of soils with different quantities of organic matter. The graph shows whether the microbial biomass is consistent ("in balance") with the amount and quality of organic matter. If the graph revealed an unexpectedly low microbial biomass in relation to the soil's respiration:total C ratio, it would indicate that the soil biology was not in balance.

Work continues on various soil indices, and results so far are promising: the present approach requires comparatively little data, and the suggested methods are relatively straightforward, cost effective, and have been internationally recognised. The presentation of the data appears applicable to many ecosystems, soils and land uses in New Zealand. Using this method of ranking soils according to their quality, researchers can more easily distinguish between similar soils which have been put to different uses, and between different soil types which are used for similar purposes.



The balance between resources and microbial biomass in New Zealand soils. ■ indicates an "across the fence" comparison of the same soil under cropping and pasture use.

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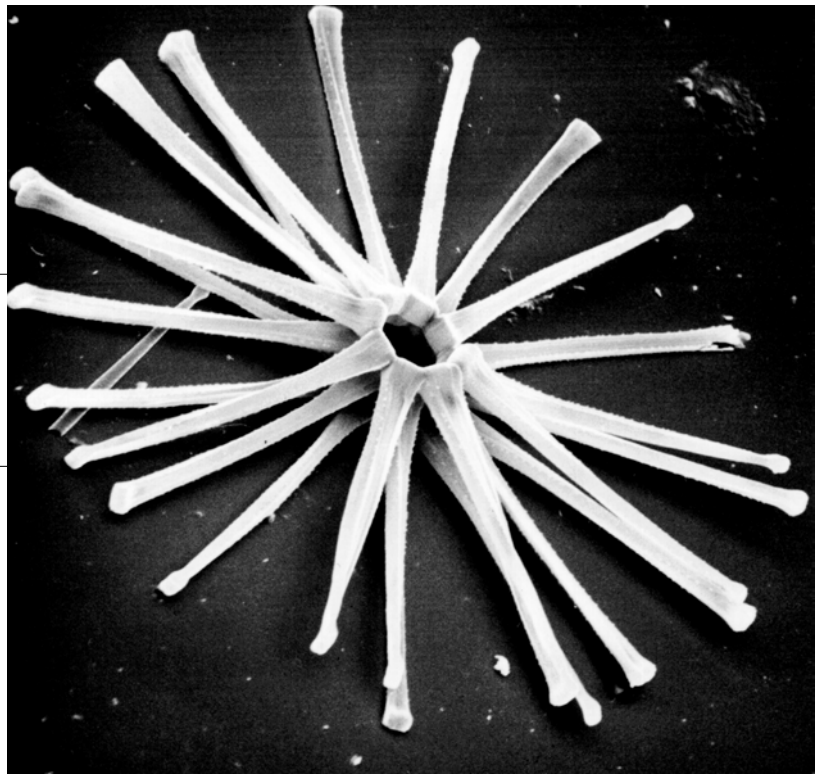
Erosion assessment

Last November, Les Basher was invited by the International Atomic Energy Agency to attend a workshop in Vienna on the use of radionuclide techniques for erosion and sedimentation assessment. The workshop was a planning meeting for a Cooperative Research Programme (CRP) run by the Agency. The CRP aims to further the development of radionuclide techniques, and provide a network of key researchers working on environmental applications of radionuclides. The network hopes to transfer the extensive experience of scientists in developed countries to developing countries (which are only beginning to use radionuclide techniques), and to help scientists in developed countries to improve the use of these techniques.

During the first half of the workshop, researchers presented individual projects. The second half of the workshop consisted of critical discussions on the principles and limitations of the caesium-137 technique, on field sampling and laboratory analysis protocols, and on the analysis of techniques for calibrating caesium-137 measurements with estimates of erosion rates. Les found that the most interesting discussions dealt with the calibration question (the biggest difficulty we face in New Zealand), with the effective operation of a gamma spectrometry laboratory (including the need for standard laboratory intercomparisons), and with experimental work on direct field measurement of caesium-137. Issues related to the last could revolutionise the use of the caesium-137 technique.

The invitation to join the CRP and attend the workshop reflects the recognition of the work of New Zealanders with caesium-137. Les's participation provided him with an opportunity to discuss technical issues with some of the leading researchers in the field of radionuclide techniques. As a result of the meeting, Landcare Research will be provided with the latest software for calibrating caesium-137 measurements with erosion rates.



Microscopic diatom (Supplied by Dr Vivienne Cassie Cooper, Research Associate, Landcare Research)

National Soils Database

Landcare Research operates and maintains the New Zealand National Soils Database (NSD) at its Palmerston North site. The database comprises a collection of soil profiles, site descriptions, and chemical, physical and mineralogical characteristics for nearly 3000 soils in New Zealand and the Pacific Islands. More than two thirds of the data relate to New Zealand soils. Maintenance of the NSD is funded by the Public Good Science Fund (PGSF) through the Land Resource Information Systems Programme.

Data compiled between 1964 and 1992 is held in Paradox for Windows, a PC-based relational database. Pre-1964 data is held in a card filing system, in which analyses date back to 1939. Some pre-1939 analyses carried out by the Cawthron Institute are also available.

The kind of information held in the NSD for each soil profile varies. Methods of analysis change over the years, and shifts of scientific focus need to be considered when interpreting data. Sets of analytical data for soils collected and analysed since the early 1980s are generally more complete than earlier ones. Prior to 1980 scientists focused on soil chemistry and mineralogy. During the 1980s, soil physical data became more highly valued, and analyses of NZ soils began to reflect this. Since the mid-80s full chemical, mineral and physical analyses have been carried out on all soil survey samples.

The NSD plays a vital role in our PGSF research programmes and in investigations conducted on behalf of clients. In recent years the database has been used in many programmes, including:

•Land Resource Information Systems Programme: The NSD is being used to characterise soil map units which, when linked to the New Zealand Land Resource Inventory (NZLRI), will show the spatial distribution of selected soil attributes.

•Land Monitoring Programme: The NSD was used to develop soil degradation indices, and particularly soil structure and chemical vulnerability indices. Data from the NSD also helped establish soil property class limits for defining and mapping high class soils in NZ.

•Soil Quality and Land Management Programme: On the basis of relevant NSD data, soil quality indicators are being predicted by means of regression analysis.

•Reactive Surface Characteristics and Interactions Programme: The NSD was used to relate CEC to total carbon and % clay, and is currently being used to relate the occurrence of aluminium-humus compounds in soils to relevant soil factors.

•Greenhouse Gases and Terrestrial Ecosystems Programme: Data from the NSD was linked to the NZLRI database to show the spatial distribution of soil carbon content for two depth ranges of New Zealand soils.

•Soil Organic Matter Dynamics and Land Management Programme: The NSD was used to relate the estimated organic matter content of soils for two land uses (pasture and forestry) to several soil factors (such as % clay, aluminium and drainage).

•Soil Nutrient Dynamics and Land Use Programme: Soil pH data has been linked to the NZLRI to plot a pH map which shows the spatial distribution of soils in which aluminium toxicity is a potential deterrent to crop growth.

Regional Councils undertaking public good projects have shown interest in the database. In one case, the NSD provided information on background levels of heavy metals in soils. Universities are using the NSB for teaching. Some engineering consultants have been using data from the NSD for their consultancy work, investigating, for example, effluent discharge on to land and hydrocarbon retention in soils. Consultants are also interested in using the NSD to estimate pipeline corrosion for local authorities, and underground tank corrosion for oil companies.

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Soil contamination baseline

Harry Percival and Trevor Webb (researchers from our Landcare Research sites in Palmerston North and Lincoln, respectively), and Tom Speir from the Environmental Science and Research Institute (Lower Hutt), recently completed a study for the Canterbury Regional Council. This study was an assessment of the background (baseline) concentrations of selected constituents in a range of Canterbury soils so that future changes in constituents can be monitored and soil contamination levels determined.

Harry, Trevor and Tom undertook a desk-top assessment of the available information on chemical concentrations at the surface and sub-surface levels of soil from selected areas. They assessed concentrations of arsenic, barium, bromide, cadmium, chromium, cobalt, copper, cyanide, fluoride, lead, mercury, nickel, sulphur, tin, and zinc.

The National Soils Database (NSD - see elsewhere in this issue), as well as reference works in the Landcare Library and in University Libraries, provided data on the typical background concentrations of these constituents in Canterbury soils. The NSD contains a number of profiles of Canterbury soils (mainly from the Canterbury Plains). However, not all of the constituents relevant to the report had been analysed for each profile held in the NSD. The most complete profiles came from soils sampled since 1980.

Ten Canterbury region soils were identified for which there was relevant data for all the constituents except for arsenic, bromide, cyanide, fluoride, mercury, and tin. Data from all sources were tabulated in a report which provides information for four depth ranges.

Researchers assess baseline concentrations of chemicals for future soil contamination monitoring.

Most of the constituents were relatively uniformly distributed down the soil profiles, and are essentially immobile under current soil conditions. In the Canterbury Region, most background concentrations of the constituents appear to occur naturally. Most constituents have been inherited from parent rocks, although in some cases surface soil contents suggest the presence of other natural soil-forming processes, for example podzolisation.

The background concentrations for each constituent were compared to the 1992 Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines (which help assess and manage contaminated sites), and to the recently revised criteria from Holland which were supplied by the Canterbury Regional Council. Most of the constituents in the soil groups (and at all depths) for which data was available fell within the ANZECC guidelines and fell below the revised Dutch values. Several constituents exceeded the guidelines, but only in some soils. For example, barium contents in all assessed soil groups exceeded those set out by the guidelines; however, on the basis of international soil information, the authors of the report question the validity of the barium guideline.

The researchers recommended that concentrations of three constituents for which data was not available - arsenic, mercury, and fluoride - be assessed.

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Nitrogen cycling in forested catchments

In September 1996, Neal Scott and Roger Parfitt (from our Palmerston North site) attended the Chapman Conference in Sunriver, Oregon. The conference was sponsored in part by the American Geophysical Union. The conference provided Neal and Roger with an opportunity to gain new insights into research on the impacts of air pollutants on soils and terrestrial ecosystems, and on the importance of hydrology as a factor determining the fate of these pollutants. The focus of studies in this field has shifted from acid rain and sulphur inputs to nitrogen inputs in forested ecosystems.

At the conference, research findings on nitrogen inputs into various countries' ecosystems were compared. In the Netherlands, up to 70 kg of nitrogen per hectare per year enter forest ecosystems through wet and dry deposition. In the USA, nitrogen inputs vary from 1 or 2 kgN/ha/yr. in relatively unpolluted places like Oregon, to 15kgN/ha/yr. Although research findings regarding the effects of nitrogen on ecosystems are inconclusive, it is believed that in some parts of the world (mainly in Europe) high nitrogen inputs lead to higher concentrations of nitrate in stream water. It has also been suggested that very high nitrate rates may lead to decreased forest productivity.

Oregon's nitrogen inputs are comparable to New Zealand's; yet despite New Zealand's relatively low overall nitrogen inputs some New Zealand catchments receive higher than average quantities. In the Taupo/Rotorua region, for example, some catchments receive approximately 6kgN/ha/yr. Taupo/Rotorua catchments have been found to "leak" nitrogen into the stream water which is unusual, since forest catchments occupied by mature forests normally retain their nitrogen.

The nitrogen enrichment in the Taupo/Rotorua area may be caused by ammonium from volcanic fumaroles. It is possible that ammonium enters ecosystems close to volcanoes through rain, and that ammonium is subsequently stored in the already nitrogen-rich soil humus pools of these ecosystems. Future research at Landcare Research will examine the impact of this elevated nitrogen deposition on forest ecosystems.

IUFRO Workshop

The travelling International Union of Forest Research Organisations (IUFRO) workshop held in New Zealand in January 1995 was organised by David Whitehead (from our Lincoln site). About 120 participants from around the world participated in the twelve day workshop which consisted of paper presentations and visits to research sites. The workshop started at Lincoln, where discussions dealt with forest response to elevated CO^2 concentration and with estimating forest carbon balance. Participants were then taken to Franz Josef where issues related to complex native forest ecosystems were debated. Finally, the workshop moved to Rotorua to discuss processes in production forestry.

Much of the workshop's success resulted from its itinerant nature, and from the alternation of presentations with field visits. Workshop proceedings were published as a special issue of *Tree Physiology* published in January 1996. The next workshop will be held in South Africa in May 1997.

BOREAS field campaign

In August 1996, David Whitehead was invited to take part in the international Boreal Ecosystem-Atmosphere Study (BOREAS) programme which was held to determine fluxes of greenhouse gases and carbon storage in the Boreal forests of northern Canada. This was the largest campaign ever mounted in a Boreal forest, involving more than 120 scientists working for two years at six sites throughout northern Saskatchewan. The programme was funded principally by NASA, with contributions from the Canadian Government and the European Community.

At the sites, scientists conducted a range of physiological and environmental physics analyses of single leaves, canopies, stands and extensive areas, using remote sensing technology and sophisticated aircraft-borne instruments.

David's task was to estimate the contribution of understorey shrubs and mosses to stand carbon balance in an old black spruce stand. David's work contributed to the finding that immediately following rain, the understorey which is dominated by moss could contribute up to 10-20% of the forest's total carbon uptake. However, after a few days of dry conditions, the moss's uptake of CO_2 ceased, and the understorey became a net producer of CO_2.

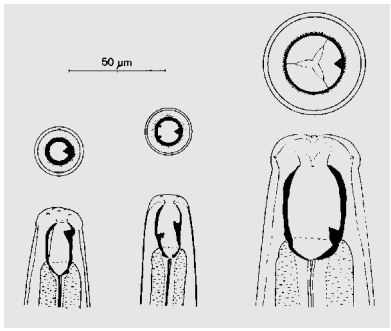
Synthesis of the vast datasets from the project is now well underway, and NASA is planning its next field campaign at 20 sites spread across the extensive tropical forests of Brazil.

Nematode parasites of sheep

Treating grazing livestock with anthelmintics to control gastro-intestinal parasites has significant disadvantages, including cost to graziers and the development of resistant parasites. In Australia several regional programmes have been established to reduce drench use and to vary the types of drenches given to sheep flocks. Administering nematode-trapping fungi to sheep via salt-lick blocks represents a novel approach to parasite control, but its environmental impact has to be assessed.

Thanks to a Fellowship under the OECD Co-operative Research Programme for Biological Resource Management for Sustainable Agricultural Systems, Gregor Yeates was able to spend three months with the Commonwealth Scientific and Industrial Research Organisation's, Division of Animal Production in Armidale, NSW, where he assessed the environmental impact of such deployment of nematode-destroying fungi.

Gregor identified over 40 taxa of plant and soil nematodes in soil samples which he took at monthly intervals. The samples came from paddocks in which nematode parasites of sheep were controlled either by drenches or by nematode-destroying fungi. Both methods achieved similar rates of parasite control.



Range of head structure in a group of predacious soil nematodes

The paddocks in which the drenched sheep and those in which the undrenched sheep were grazed revealed no significant difference in soil nematode faunae. However, Gregor observed considerable differences between the nematode faunae of ungrazed natural grassland and those of ungrazed developed grassland. Developed grassland showed an increase in total nematode counts and a marked reduction in nematode diversity.

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58 years of soil records

Landcare Research is the custodian of the National Reference Soils Collection, a collection of soil samples taken from documented reference soil profiles. The samples were collected over 58 years, and now comprise several thousand jars of air-dried, sieved <2 mm soil stored in 218 crates and 176 cardboard boxes in Palmerston North. The soil samples may be used for soil studies in New Zealand and overseas. The amounts of soil vary from about 100 g to about 1 kg. The oldest soil sample - an A horizon (0-5 inches) of a Mataurau silt loam from Hawkes Bay - was collected by the late Harry Gibbs in 1939.

The earliest samples were collected before global atomic bomb testing had begun, and many were taken before mineral fertilizer had been applied to the land. The samples represent many different land uses, and many have been dealt with in published DSIR soil survey bulletins, reports and other publications. Chemical, mineralogical and physical data on the samples are recorded in the National Soils Database (see article on the NSD in this issue).

Samples from the collection are available to bona fide researchers. There is no charge for using samples from the collection, although shipping costs for bulky, multiple samples may have to be paid by the recipient.

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Manaaki Whenua: To cherish, conserve and sustain land - a place to stand, the source of life, food and wealth.

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