Manaaki Whenua
Landcare Research

SOIL HORIZONS

What's inside

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

Issue 4, January 2000

Printed on recycled paper

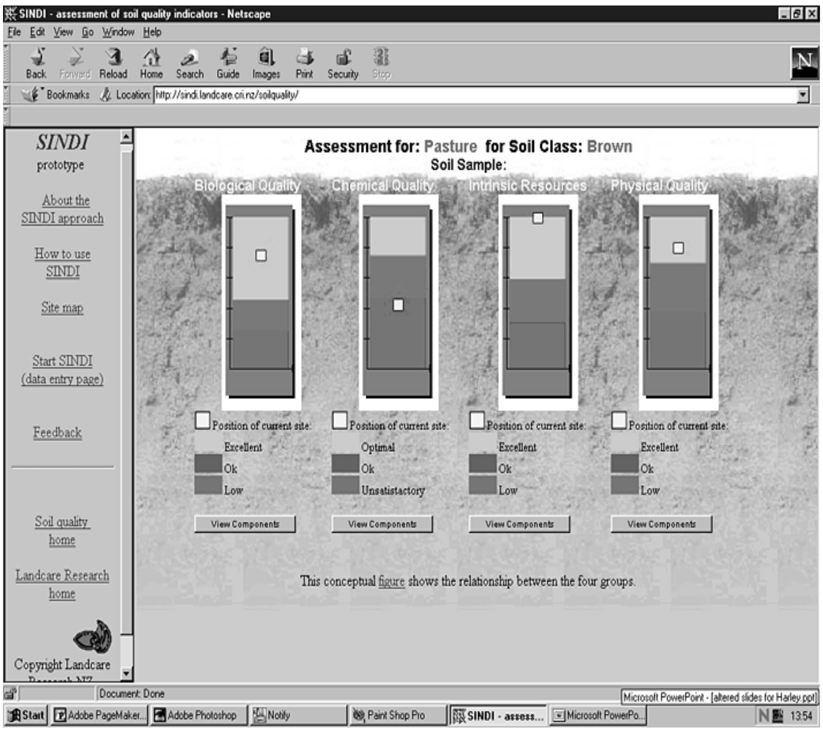
ISSN 1174-0922

Sindi is alive!

Sindi (**S**oil **indi**cator assessment tool) went live at the end of August. Sindi is a software tool designed to allow users to compare and assess the quality of their soil. It builds on work by Graham Sparling to identify and characterise a set of 10 key soil indicators, and by Allan Hewitt to set standards for soil quality (see *Soil Horizons, Issue 3*). Implementation of Sindi, on the World Wide Web, by Roger Gibson, was an ideal way to make the tool widely available.

The 10 soil indicators are: bulk density, macroporosity, total porosity, pH, Olsen P, base saturation, total carbon, total nitrogen, CEC, and anaerobic nitrogen. Sindi explains what each indicator is, how it is measured, and why it is important. A user enters measured values for any soil sample of interest onto the web page.

Two means of comparison are provided. One allows the



Example web page showing bar graphs for the four components of soil quality user to see how their sample relates to data from the National Soils Database (NSD – see *Soil Horizons, Issue 1*) by displaying a box plot. A soil indicator in the lower (or higher) quartile of similar soils signals a possible soil quality problem. However, the NSD does not contain data for all indicators and possible land uses.

The alternative is to view bar graphs, which illustrate an expert interpretation of the four components of soil quality, given soil order and land use. The soil quality rating is adjusted depending on the soil order and land use. If one component is of particularly high or low quality, the user can then choose to view bar graphs of the indicators that make up this component. Information on why a specific indicator might be of low quality, and some management strategies to improve it, can then be viewed.

The team is currently planning the next version of Sindi, so feedback on what you would find useful on this website is very welcome. A link to Sindi can be found on http://sindi.landcare.cri.nz/soilquality

For more information contact Linda Lilburne, ph (03) 325 6700, e-mail LilburneL@landcare.cri.nz

Fate of a microbial tracer applied to effluent-irrigated soils

Land treatment of animal or human waste can result in chemical and microbial contamination of shallow groundwater and/or waterways. Research has largely focussed on the fate of the chemical load of such effluents. Using 50 cm diameter undisturbed soil cores, Malcolm McLeod, and co-workers, investigated the fate of a host-specific Salmonella bacteriophage that was applied to four widely distributed soils commonly used for land disposal of effluent. The soils were a poorly drained clayey Gley Soil from Hauraki Plains; a well-drained Pumice Soil from Taupo; a well-drained Allophanic soil developed in volcanic ash from near Matamata; and a well-drained Recent Soil developed in dune sand from Waitarere. Thirty mm of water containing the bacteriophage and a non-reactive chemical bromide tracer (Br^-) were applied to the soil at a rate of 5 mm/hr, followed by simulated rainfall at the same rate. Leachate collected at a depth of 70 cm was analysed for the bacteriophage and bromide tracer. Collection of leachate continued until at least 1 pore volume (approx. 80 L) had been collected. Bromide moved uniformly through the Allophanic and Pumice Soils with peak concentration appearing at about 1 pore volume, but the bacteriophage was present only at very low levels. In contrast, both the Br^- and bacteriophage tracers moved rapidly through the Gley and Recent soils, appearing in the leachate at high levels within the first five litres and then tailing off. Such flow patterns are indicative of preferential flow. Coarse, well-defined soil structure in the Gley Soil and finger flow due to water repellency in the sandy Recent Soil are considered to be responsible for the preferential flow observed in these two soils. Allophanic and Pumice soils have finer, more porous soil structure, leading to a predominance of matrix flow over preferential flow. Furthermore, allophanic clay has a very high surface area and a positive charge that adsorbs negatively charged bacteriophage.

This study highlights the need to select soils carefully when land treatment of effluent is being considered.

For more information contact Malcolm McLeod, ph (07) 858 3700, e-mail McleodM@landcare.cri.nz

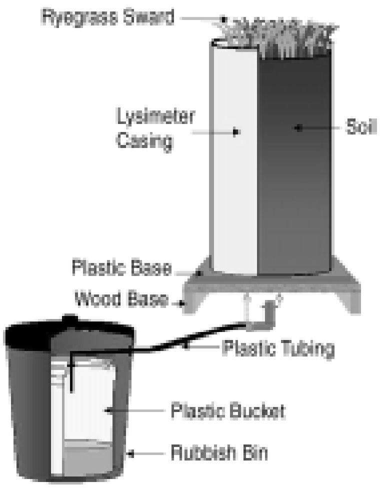
Land-based effluent treatment: Which soils are best?

In New Zealand, land-based effluent treatment systems have become increasingly popular. However, it is not always clear which soils should be used in these systems, or why. Land application of effluent can adversely affect ground and surface water quality if effluent constituents, in particular nitrogen and phosphorus, are not removed by the soil before they reach ground water. Louise Barton and Landcare Research co-workers have initiated a new study that investigates the ability of different soils to remove nitrogen and phosphorus from domestic, secondary-treated effluent.

They irrigate large, intact soil lysimeter cores with secondary-treated domestic effluent on a weekly basis, and test the resultant soil leachate for nitrogen and phosphorus. Soil lysimeters have been collected from four soils (Pumice, Allophanic, Gley and Recent soils) and transported to Hamilton where they are housed in a facility adjacent to the Temple View treatment ponds. These soil types range in texture, carbon content and phosphorus retention. Pumice, Allophanic, Gley and Recent soils are either currently being used, or being considered for use, in land treatment systems in New Zealand.

At the lysimeter facility, the lysimeters have been oversown with ryegrass, and fitted with a drainage collection system at the base. Half the lysimeters are irrigated weekly with effluent from the nearby pond (50 mm week^{-1}, i.e. 450 kg N ha^{-1} yr^{-1} and 110 kg P ha^{-1} yr^{-1}), while the remaining lysimeters receive only rainfall. By comparing nitrogen and phosphorus loading rates with leachate quality, Louise and colleagues will be able to rank the ability of the soils to treat effluent. In addition, soil properties thought to influence effluent-N and effluent-P renovation will be monitored and compared with leachate quality. In collaboration with Lincoln Environmental, these data will be used to test models that will help predict how other soil types, not included in the study, renovate effluent.

When the study is complete the group will have identified soil types and characteristics that maximise effluent treatment, and hence minimise groundwater pollution.



Lysimeter faculty

This information will help land treatment system designers assess the suitability and capability of a particular soil to treat domestic effluent.

For more information contact Louise Barton, ph (07) 858 3700, e-mail BartonL@landcare.cri.nz

SOIL HORIZONS

Visit the Landcare Research Soil Quality website at http://www.landcare.cri.nz/science/soilquality

Stormwater management — a new research initiative

When rain falls in urban regions, impervious surfaces such as car parks, roads and roofs generate enormous volumes of surface runoff over a short time. Usually this runoff is discharged through stormwater drainage networks directly into urban streams and waterways, with numerous adverse consequences. Where runoff volumes combine further downstream, typical results can be flash-flooding, scouring and erosion of waterways, and the destruction of natural aquatic habitats. Over time, the reduced volume of infiltrating rainwater leads to depleted groundwater reserves, and to reduced stream flows during dry periods. Urban stormwater also contains various pollutants (heavy metals, bacteria, pesticides and herbicides, oil and other hydrocarbons) detrimental to the health of the receiving waterways.

While engineering provides some solutions to these problems, it is possible to use natural soil-plant systems (e.g., grassed or forested areas) to receive and treat stormwater close to its source. This approach is used in New Zealand alongside some motorways. As well as reducing infrastructure costs and maintenance, there is the benefit of groundwater recharge and the reduction of the impact on urban streams. Furthermore, the provision for natural ecosystems in the urban environment will benefit birds and local wildlife.

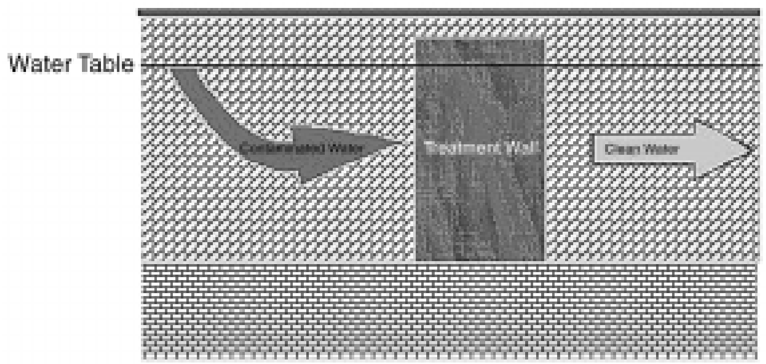
Little is currently know about the fate of stormwater contaminants once they enter the soil-plant ecosystem. As part of the NIWA lead programme, *Stormwater and transport effects on urban aquatic ecosystems*, a new research initiative based in Auckland will investigate the effectiveness of soil-plant systems for removing pollutants from stormwater. The intention is to focus on soil processes and their ability to remove contaminants from road-runoff, with emphasis on comparing grassed and native vegetation systems. This work will provide the scientific basis for using soil-plant systems to reduce the effects of stormwater runoff.

For more information contact Julie Zanders, ph (07) 858 3700, e-mail ZandersJ@landcare.cri.nz

Groundwater treatment wall

A treatment wall is a structure for removing contaminants from water. As the contaminated water passes through the wall, the contaminants are trapped by or transformed into harmless substances. These walls may be made with different materials as some fillings are better at removing different types of contaminant, e.g., groundwater treatment walls filled with limestone effectively remove the metals lead and chromium, while those filled with iron granules are effective at removing chlorinated solvents. Different types of filling work through different chemical, physical and biological processes. Another virtue of treatment walls is that they are cheap to run — they require no mechanical equipment, such as pumps.

Treatment walls may also be used to treat surface waste water and other types of contamination, for example, road runoff. The ability of five different fillings to remove heavy metals and trace organics from artificial road runoff has been examined by Matthew Taylor, Surya Pandey and Bob Lee (Landcare Research).



A groundwater treatment wall.

The fillings tested were commercially available *Sphagnum* moss, crushed limestone, waste wood pulp, fly ash and waste wool felt.

Wall fillings were tested by packing 600 by 60 mm drainpipes with the different fillings to make a column. Artificial road runoff was applied at <100 mL min^{-1} to the top of the column in 8 applications. The artificial runoff contained contaminants (see Table) chosen to represent common pollutants found in road runoff. Concentrations for the contaminants copper (Cu), lead (Pb) and zinc (Zn) are based on runoff from the Auckland Motorway. Poly aromatic hydrocarbons (PAHs) are a product of burning petrol and diesel. Pyrene and fluoranthene were chosen to represent PAHs as they were found to be the most abundant in Christchurch esturine cockles and the most toxic in motorway runoff in the United Kingdom.

Pollutant	**Concentration (µg L^{-1})**
Cu	110
Pb	880
Zn	440
Fluoranthene	42
Pyrene	18

Concentrations of pollutants in artificial road runoff

After the artificial road runoff was applied, the columns were allowed to drain by gravity and the effluent collected in darkened bottles. Analysis was carried out using graphite furnace atomic absorption spectrometry with Zeeman background correction, flame atomic absorption spectrometry and gas chromatography.
Lime and fly ash removed Cu, Pb and Zn and PAHs very effectively. These two fillings increase the solution pH, making these three metals less soluble and increasing the microbial decomposition of PAHs. PAH removal could also be due to adsorption of PAHs onto the filling.

Sphagnum was almost as efficient as lime and fly ash at removing Cu and Zn from the artificial road runoff as *Sphagnum* has a large number of adsorption sites capable of rapidly binding metals. *Sphagnum* is less efficient at removing Pb, probably due to mobilisation of Pb by dissolved organic matter. PAH removal was also lower. Hydraulic conductivity for *Sphagnum* was very high, which resulted in a short residence time within the column. This short residence time allowed little opportunity for the filling to react with contaminants.

The other fillings, waste wood fibre and waste felted wool, were less efficient than the others tested but their ready availability as waste by-product may be very cost effective.

All five fillings removed Cu, Pb and Zn from artificial road runoff but varied in their ability to remove PAHs. Lime, fly ash, and *Sphagnum* were the most effective.

For more information contact Matthew Taylor, ph (07) 858 3700, e-mail TaylorM@landcare.cri.nz

Sorption of copper and cadmium by allophane-humic complexes

Increased emphasis on research into sustainable management of NZ soils and their role in environmental protection has focused attention on processes that occur in topsoils. One important process is the interaction of topsoils with introduced heavy metals such as copper (Cu) and cadmium (Cd) from domestic, industrial, and agricultural sources. Sorption by soil particles affects retention and mobility of heavy metals in soils. Clay and humus (organic matter) fractions of soil are the most reactive constituents. These are closely associated to form a clay-organic complex, so their contributions to heavy metal sorption capacity of soil are difficult to assess separately.

Guodong Yuan, Harry Percival and Benny Theng have prepared clay-organic complexes with a wide range of organic surface coverage that can act as surrogates for topsoils in metal sorption experiments. Allophane was selected as the clay component. This clay-size aluminosilicate is a typical short-range order mineral that is widespread in NZ soils. Allophane is very reactive to heavy metals but the underlying mechanism is not well understood. Humic acid (HA) was used for the organic component as it represents one of the most abundant fractions of organic matter in soil. Allophane-HA complexes with organic carbon (OC) contents of 14–123 g/kg were prepared.

The sorption of Cu and Cd metal ions (at 2 mmole/L concentration) by allophane alone and allophane-HA complexes was carried out at pH 5.0, 5.5 and 6.0. Substantial amounts of Cu were sorbed (Fig. 1). At each pH, Cu sorption increases linearly with the OC content of the allophane-HA complexes. Cd showed a similar behaviour but much less was sorbed under the same experimental conditions (Fig. 2). Sorption of both Cu and Cd is pH-dependent and increases with pH.

There appears to be a level of organic surface coverage below which clay mineral exerts a dominant influence, and above which it plays only a subsidiary role. These levels vary with the pH. At pH 5.5, for example, the allophane and HA components would make an equal (50/50) contribution to Cu sorption when the complex contains about 87 g OC/kg. For Cd, the equivalent value is about 6 g OC/kg. Above these values, the HA in the complex contributes more to Cu or Cd sorption than does the allophane component.

Sorption patterns are currently being interpreted in terms of surface charge, complex formation, and Cu and Cd ion in aqueous solution.

For more information contact Harry Percival, ph (06) 356 7154, e-mail PercivalH@landcare.cri.nz

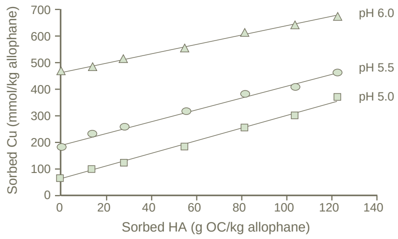


Figure 1: *Sorption of copper by allophane and allophane-humic complexes*

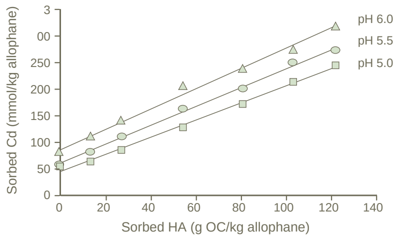


Figure 2: *Sorption of cadium by allophane and allophane-humic complexes*

Factors controlling soil organic carbon in pasture soils

Soil organic carbon (OC) is a key indicator of soil quality, and important for sustaining agricultural production. Harry Percival, Roger Parfitt and Neal Scott have used the National Soils Database (NSD - see *Soil Horizons Issue 1*) to determine factors controlling long-term soil OC accumulation in pastures across a range of climatic conditions and soil types.

In the NSD there were data for 122 soils under permanent grass that could be used to calculate OC content and contents of selected soil properties in t/ ha. For each soil, data were extracted to give a single value for the 0–20 cm layer. Soil properties were levels of clay, silt, extractable iron and silicon, and both pyrophosphate and oxalate-extractable aluminium (Al). The corresponding concentrations (g/kg soil) of OC and the soil properties were also calculated, weighted over the 0–20 cm depth. There were 167 pedons for which concentration data were available. The relationships between OC content or concentration and climatic and soil properties were analysed using linear and multiple regression techniques for both individual and combined soil orders.

Overall, clay and silt content and climatic factors (precipitation and temperature) by themselves related poorly to OC across all soils and within each soil type, and were not good predictors of OC. Clay and silt concentration also correlated poorly with OC. Pyrophosphate-extractable Al in the form of Al 'gel' related the most strongly to OC, and explained the largest amount of variation in OC content (55 %) and concentration (60%) across all soils. It also explained the greatest amount of OC variation within each soil type. For all the soils combined, multiple regression analysis did not greatly improve the amount of variation in OC content or concentration explained by extractable Al alone. For Allophanic Soils and Gley Soils alone there were some significant improvements but for all other soil orders no multiple regression model was significant.

The extractable Al 'gel' is thought to arise from the dissolution and dispersion of Al and organic matter from Al-humus complexes. Much of the NZ landscape was previously forested, with substantial replacement of forest by grasses and legumes in the 1800s. Most of the soils could therefore have had high extractable Al because of their low pH and the large quantity of Al-bearing minerals. The soils generally are acid, and pH values of the uppermost soil horizons are commonly between 5 and 6.5. Soils with one of the subsoil horizons having a pH less than 5.0 occur in about 65% of NZ's land area. Under these conditions, Al dissolves from soil minerals and is available for complexation with soil organic matter.

This study suggests that in NZ soils, chemical stabilization of organic matter is the key process controlling OC accumulation, and that clay content or concentration relates poorly to long-term OC accumulation. It also emphasizes the importance of land-use history as a factor influencing OC storage.

For more information contact Harry Percival, ph (06) 356 7154, e-mail PercivalH@landcare.cri.nz

Withholding fertilizer influences soil organic matter and nutrient dynamics

In NZ, superphosphate has historically played a vital role in sustaining productivity of legume-based pastures. In the mid-1980s, depressed agricultural commodity prices and sharp increases in single superphosphate (SSP) prices resulted in reduced fertilizer inputs and decreased potential productivity. What happens to soil organic matter dynamics and nutrient sustainability when fertilizer applications are withheld?

Surinder Saggar, Landcare Research, examined the effect of soil P status and N addition on the decomposition of ^{14}C-labelled glucose so that this information could be used to determine whether withholding fertilizer applications influenced the 'quality' of organic matter inputs. The two soils used in this study varied widely in P fertility (640 and 820 mg P kg^{-1}) and productivity (4868 and 14120 kg DM ha^{-1}), due to the withholding of SSP fertilizer inputs from one of them.

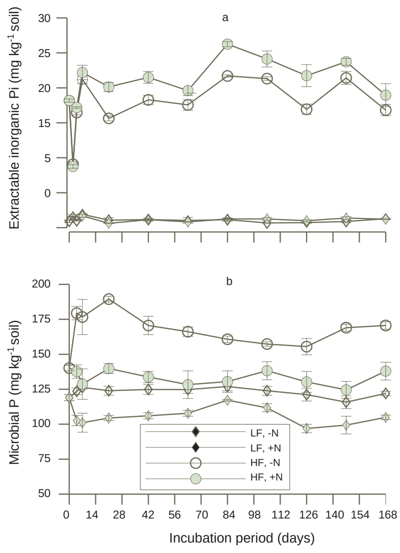


Figure 1: ***a)*** *Residual ^{14}C and* ***b)*** *^{14}C microbial biomass at various stages of decomposition in Low and High Fertility soils with and without N addition.*

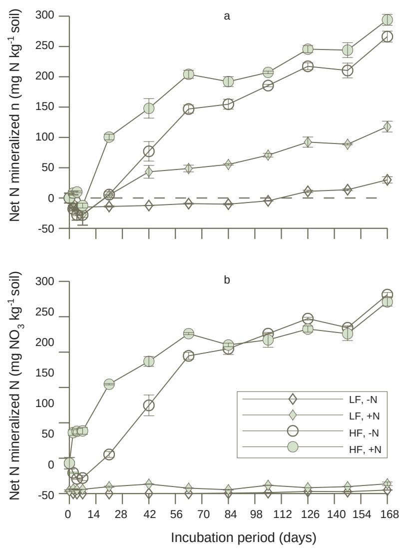


Figure 2: ***a)*** *Extractable inorganic P (Pi) and* ***b)*** *net mineralised N concentrations in Low and High Fertility soils with and without N addition.*

Withholding fertilizer P had a significant impact on C mineralization in these pasture soils. The $^{14}CO_2$ evolution rates were higher in High Fertility (HF) soil than LF soil; the addition of N further enhanced $^{14}CO_2$ evolution rates in both soils (Fig. 1a). A higher proportion of ^{14}C substrate was transformed to microbial biomass in LF soil than in HF soil, suggesting that initial growth of soil microbes was not restricted by the supply of inorganic P and N (Fig. 1b). However, the turnover of microbial biomass did not follow quite the same relationship and was strongly influenced by P and N availability. Constraints on glucose decomposition in LF soil may be due to a lack of P and N for microbes. Fluctuations in inorganic P were small in LF soils compared with those in HF soils (Fig. 2a), and suggest that P was cycling more slowly and tightly through microbes in LF soil. Net N mineralisation and nitrification rates were also low in LF soils (Fig. 2b), and support the concept of a slow turnover of microbes in LF soils because of limited nutrient supply.

The degree of accumulation of organic matter depends on the difference between C input and decomposition rates. In the present study, the soils differed only in fertilizer application, which resulted in widely different pasture production. Other recent studies on these soils by Surinder Saggar and co-workers showed that withholding fertilizer reduced C inputs to soil. Furthermore, the 'quality' of inputs was different between the two sites. Twice as much C was incorporated in HF soils as in LF soils, but their total C concentrations were fractionally different. This suggested that a higher proportion of C inputs decomposed in HF than in LF soils. Withholding fertilizer restricted nutrients supply to microbes and slowed organic matter decomposition. Net N mineralization rates were also low, and little P was mineralized in LF soil. Addition of N to regularly fertilized HF soil increased N and P mineralization.

This research demonstrated that reduced nutrient supply can restrict microbial turnover, lower the rate of C loss and slow nutrient cycling.

For further information contact Surinder Saggar, ph (06) 356 7154, e-mail SaggarS@landcare.cri.nz

SOIL HORIZONS

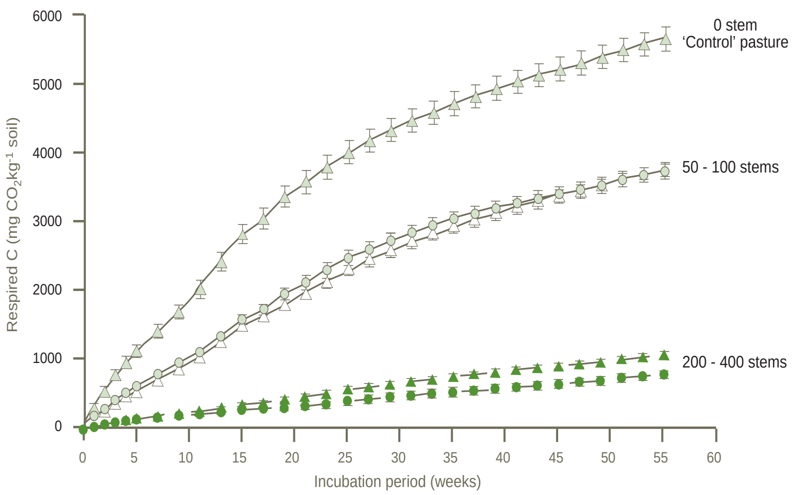
Soil Horizons is on the web
http://www.landcare.cri.nz/information_services/publications/newsletters/soilhorizons/

Soil biological parameters in agroforestry regimes

Agroforestry profitability in NZ varies as relative returns from livestock farming and forestry alter. Additionally, agroforestry seems to improve hill country stability. Research by several groups of NZ scientists has shown that agroforestry has the potential to alter microclimate and acidify soils.

Recent investigations by Surinder Saggar and Gregor Yeates show that 25 years of agroforestry declined soil organic C (~15%) and N (~25%), and had a significant influence on soil biological parameters. They found microbial soil processes under agroforestry to be profoundly different from those under adjacent grassland. There was less microbial C (mostly bacteria and fungi but including some microfauna and algae) and N in soils under *P. radiata* than in soils under grassland. With increasing tree stocking rate there was a shift in the composition of nematode fauna. Bacterial feeding nematodes dominated grasslands, and the proportion of fungal feeding nematodes doubled as tree stocking rates increased.

Soil C decomposition and microbial activity were measured by trapping carbon dioxide produced by soils over a 60-week period. Results (Fig. below) showed soil C decomposition rates were one and a half times as



Carbon mineralisation in soil (0-10 cm) after 25 years of Pinus radiata *agroforestry regimes. The lines represent the accumulated amount of soil carbon respired during a laboratory incubation.*

much (*ca* 15 mg CO_2-C kg^{-1} soil) in grassland as in 50–100 trees / ha (*ca* 10 mg CO_2-C kg^{-1} soil), and were further reduced to one half (*ca* 5.5 mg CO_2-C kg^{-1} soil) in 200–400 trees / ha. Soils under *P. radiata* gave off less carbon dioxide per unit of biomass (the metabolic quotient) than soils under grassland. In other words, there were fewer 'bugs' in soils under *P. radiata*, and those bugs were working slowly. These shifts in microfauna, microbes and metabolic quotients appear to be associated with differences in the quantity and 'quality' of inputs, and SOM decomposition rates. Populations of topsoil-mixing earthworms showed similar trends.

This research demonstrated that increased tree density can alter microbial processes and lower the turnover rate of C and nutrient cycling. Given the ability of soil microfauna and microbes to recolonise depopulated areas after tree harvest, no problems are seen in restoring populations of these soil organisms after tree felling, provided adequate adjustments to soil pH are made.

For further information contact Surinder Saggar, ph (06) 356 7154, Gregor Yeates, ph (06) 356 7154 e-mail SaggarS@landcare.cri.nz e-mail YeatesG@landcare.cri.nz

Soil bacterium to degrade DDE

The insecticide DDT was once used extensively to control both agricultural pests and disease vectors. Although many countries stopped using DDT over 20 years ago, its residues still persist in the environment, predominantly as DDE, DDD, and 2,4'-DDT, as well as unchanged DDT. Among these residues, DDE is the most toxicologically significant as it blocks the action of androgens in rats, and has been implicated in male reproductive abnormalities in alligators. In New Zealand topsoils, the presence of DDT residues, often as DDE, limits land-use options and may impact on the trade of agricultural products. Cost-effective remediation methods for widespread low level contamination are therefore required. While bacterial degradation of DDE has recently been reported in a recombinant strain that degrades biphenyl, it is not known how widespread this capacity is in nature. So Jackie Aislabie attempted to isolate DDE-metabolising bacteria from DDT residue-contaminated agricultural soils. The presence of organisms with this degradative capacity in contaminated soil may be beneficial in developing treatment options.

A Gram-positive bacterium, *Terrabacter* sp. strain DDE-1, which is able to metabolise DDE when induced with biphenyl, was isolated. This is only the second report of extensive metabolism of DDE, and the first report of this metabolism in a Gram-positive organism. This study provides evidence for the usefulness of biphenyl-metabolising bacteria for *in situ* remediation of DDE-contaminated agricultural soils. To enhance degradation of DDE in soils, information is needed on the *in situ* abundance and distribution of bacteria with this type of metabolism, and on the substrates that will induce the expression of the catabolic pathway for DDE degradation. While biphenyl has proved a useful substrate for isolating *Terrabacter* sp. strain DDE-1, the application of biphenyl to soils is not desirable as it is on the US EPA priority pollutant list. Fortunately, a number of plant terpenes, including cymene and limonene, have been shown to stimulate degradation of polychlorinated biphenyls. Whether these compounds also induce DDE degradation in *Terrabacter* sp. DDE-1 has yet to be determined.

Although remediation of DDT residue-contaminated soils is difficult, the isolation of a bacterium with the ability to degrade DDE from such a site indicates that microbially mediated processes for cleanup of DDT residue-contaminated soils are worth further investigation.

For more information contact Jackie Aislabie, ph (07) 858 3700, e-mail AislabieJ@landcare.cri.nz

The role of wheel track compaction on cropland erosion at Pukekohe

Erosion is a major challenge to sustainable vegetable production at Pukekohe. Past research has established the rates of soil redistribution within fields, and the net loss of soil into streams. Present research aims to understand the mechanisms of erosion and provide vegetable growers with practical management techniques for reducing erosion.

Many of the vegetable crops are grown in beds, and the wheel tracks between the beds appear to be the key zones for initiation of surface runoff and erosion because they are sites of water convergence, and the soils are highly compacted, which limits water infiltration. Control of water movement along the wheel tracks may be a key to reducing rates of erosion.

In the spring and summer of 1998, Les Basher and Craig Ross (Landcare Research) undertook the first investigation in the Pukekohe area of the role of wheel tracks in the management of erosion. They compared erosion and infiltration rates on cultivated and uncultivated wheel tracks at two fields. While the trial was able to demonstrate how cultivating wheel tracks can improve water infiltration, there were few significant storms during the trial period, and so no conclusion was reached on the value of this practice in reducing erosion. Cultivating the wheel tracks increased infiltration rates by two orders of magnitude. Infiltration rates in the uncultivated tracks were on average <5 mm/hr. The slow infiltration rate clearly indicates that the compacted wheel tracks are key areas for generation of runoff. In the cultivated tracks infiltration rates averaged >350 mm/hr. Although there was a very wide range for individual infiltration rate measurements (4–1715 mm/hr), most measurements exceeded 100 mm/hr and were greater than typical rainfall intensities.

A current investigation aims to confirm the role of cultivating wheel tracks in improving infiltration, and to measure differences in erosion rates through the winter and spring periods that were not sampled in the 1998 trial. Observations in the previous trial and after a rainstorm in January 1999 suggest that the effect of compaction of wheel tracks on infiltration (and hence runoff and erosion) reduces as the surface soil dries and cracks. For example, in the severe storm in January 1999, wheel tracks did not appear very significant in the initiation of erosion. This suggests that once surface cracking occurs there may be no need to cultivate wheel tracks to improve infiltration.

Infiltration rates will be measured at three times to test this idea. Results of infiltration rate measurements in June and October clearly demonstrated the low infiltration rates in wheel tracks, how track cultivation can increase these rates, and that infiltration rates in the onion beds are well in excess of rainfall intensities. Results also suggest infiltration rates in the uncultivated wheel tracks are increasing. Preliminary measurements show erosion rates from the uncultivated tracks are at least 10 times higher than from cultivated wheel tracks. Shallow cultivation of wheel tracks using a single tyne is an effective and practical technique to reduce erosion rates.

The Franklin Sustainability Project and the Foundation for Research, Science and Technology have funded this work.

For more information contact Les Basher, ph (03)325 6700, e-mail BasherL@landcare.cri.nz

Snow fields

Landcare Research staff Barry Fahey and Kate Wardle assessed the extent to which vegetation and soil have been disturbed by snow grooming at Treble Cone ski field near Wanaka for the Department of Conservation. Field visits to three west Otago ski fields (Coronet Peak, The Remarkables, and Treble Cone) showed that cushion fields appeared to be the most vulnerable to damage from snow grooming. Permanent 30-m transects were established across cushion fields and inter-tussock areas that were groomed and skied, and also on non-groomed slopes to serve as controls. Data were collected to estimate percentage ground cover for six vegetation classes, and to establish the percentage frequency of plant species in each class. Information was also collected on the depth of the A-horizon, bulk density, and penetration resistance.

Although there were no differences in species composition, groomed slopes had a higher proportion of bare ground. There were no statistically significant differences in soil bulk densities or penetration resistance. A subsequent investigation in the winter on some of the same transects showed the snow pack on groomed slopes to have higher densities and equivalent water contents than the snowpack on non-groomed slopes.

Provisional results indicate that disturbance to vegetation at Treble Cone is not excessive. However, it is widespread, and may be on-going. Overseas research suggests that the types of changes in snow properties on groomed slopes observed at Treble Cone may be sufficient to inhibit soil bacteria and litter decomposition in the near-surface soil horizons. Temporal trends in vegetation disturbance are being investigated.

For further information contact Barry Fahey, ph (03) 325 6700, e-mail FaheyB@landcare.cri.nz

SOIL HORIZONS Contacts

Published by
Landcare Research
Private Bag 11052
Palmerston North
New Zealand

Telephone: (06) 356 7154
Facsimile: (06) 355 9230

Editors: Peter Stephens
Anne Austin

Layout: Nicolette Faville

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