Biowastes Project

Issue No.3

December 2011

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Landcare Research Manaaki Whenua

SCION Next generation biomaterials

ESR

News from the Programme Manager

– Jacqui Horswell

Welcome to the Christmas "Biowastes" newsletter! It is hard to believe that another year is drawing to a close. The time has flown by and we have made significant progress towards our research goals this year. I have outlined below some of what we think are our key achievements this year:

- We have been investigating the use of biochar, a form of charcoal, as a tool for manipulating the balance of essential trace elements and leaching of nitrates. Biosolids combined with biochar increased the growth and zinc uptake of most plants species tested. Beetroot and spinach showed the greatest increases and are good candidates for the alleviation of zinc deficiencies in humans and animals. Biochar significantly reduced the nitrate leaching from biosolids.
- Development of shared learning (interdisciplinary and across the Kaikōura and Taupō case-studies) and incorporating key elements of tikanga Māori in our research has embedded the research in these communities and greatly facilitated internal programme integration of the biophysical research strands and social/cultural science to produce a range of synergistic outcomes.
- Members of the biowastes team presented a summary of the last ten years of research including best practice advice at the New Zealand Land Treatment Collective workshop, 'Beneficial use of biosolids'. Over 40 end-users attended with representatives from national, regional and local government. The presentations were well received, especially the final report on the long-term metal salts trials, which included recommendations on changes to limits for zinc in current guidelines.

We have held two very successful hui this year, the first was in February at Kaikōura which was featured in our Autumn/Winter newsletter. In November, the Biowastes programme collaborators from ESR, Scion, Landcare Research and Cawthron participated in a hui at Mokai with representatives from local government and the community. This hui provided an update of research activities including the vermi-composting of the Mokai septic tank waste. It also provided an opportunity for members of our two case-study communities to share ideas and experiences. Raewyn Solomon and Sara Watson from Te Runanga o Kaikōura were able to join us. Many thanks to everybody for your time and efforts – it was a great day! The Biowastes research team would also like to thank members of Tuaropaki Trust and hapū, especially Ngaire George and Mark Ross for their wonderful hosting of the hui. You can read more about the hui in the update from the Social and Cultural Team.

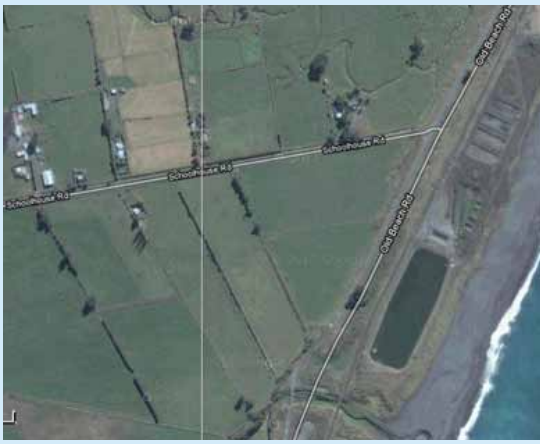
I would like to thank our case study communities, collaborators and research partners for their invaluable contribution to this research programme and I hope that you have an enjoyable festive season.

Very best wishes for the New Year.
Jacqui

Updates from the Social and Cultural Team

Kaikōura case-study update

Lisa Langer, James McDevitt and Alan Leckie



Left: Caption for worm.
Above: Caption for above pic

A Life Cycle Assessment (LCA) will be carried out to determine the environmental impact of the Kaikōura biosolids reuse options for the stockpiled biosolids. The reuse options selected by stakeholders at the second Kaikōura hui include: open-air and vermi-composting, direct application to forest, farm or marginal land and mixture with biochar.

Another stakeholders' hui will be held at the Takahanga marae in mid December 2011 where James McDevitt (Scion) will explain the likely environmental impacts of the different reuse options and Lisa Langer and Alan Leckie will facilitate discussion to encourage the stakeholders to evaluate the areas of environmental impact and prioritise them according to their understanding of Kaikōura's EarthCheck (formerly Green Globe) international status and the needs of the Kaikōura district.

A third Biowastes hui will be held with about 50 representative members of the Kaikōura community on Sunday 4 March 2012 at the Takahanga marae, Kaikōura. The results of the LCA will be presented along with knowledge of the characteristics of the biosolids (i.e. beneficial nutrients and contaminants) and the economic costs and benefits of the reuse options. The aim is to provide the broader Kaikōura community with knowledge to recommend to the Kaikōura District Council the future reuse of the stockpiled biosolids. The results will also be collated into a paper that will be presented at the NZ Land Treatment Collective and the Life Cycle Association of NZ conferences in March 2012.

This research has been made possible thanks to funding from the Kaikōura District Council and the Sustainable Initiatives Fund Trust (SIFT).

Mokai case-study

Jinny Baker, Mark Ross and Jamie Ataria

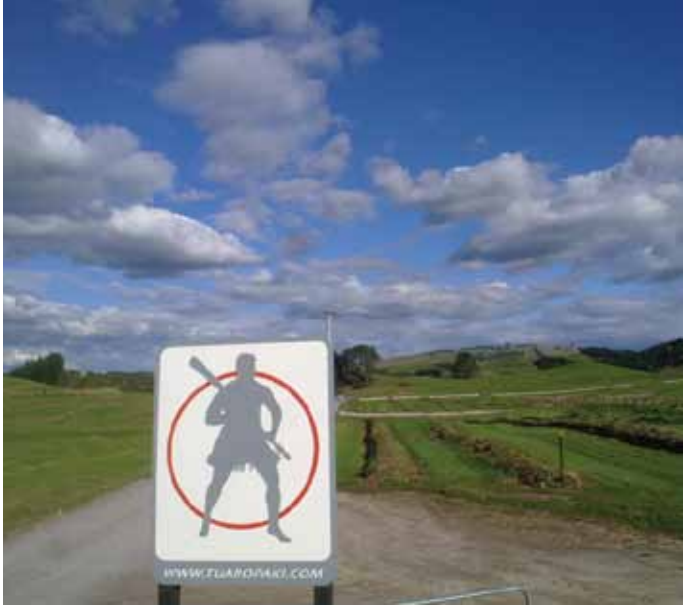
In our Taupō, (Mokai) case study we are working with the Tuaropaki Trust to investigate sustainable waste management options that would best support the cultural values that underpin their hugely successful business model.

Tuaropaki Trust is the result of a 1952 amalgamation of lands owned by members of the seven Mokai hapū – Ngāti Parekaawa, Ngāti Te Kohera, Ngāti Wairangi, Ngāti Whaita, Ngāti Moekino, Ngāti Haa and Ngāti Tarakaiahi. These hapū have tribal affiliations to both Ngāti Tuwharetoa and Ngāti Raukawa. The lands at Mokai are 30kms North West of Taupō. The vision of Tuaropaki Trust is "to be at one with our customary land and taonga" as expressed in the saying: "Look after the land and the land will look after you". The Trust's vision is further reflected in the expression: "He Oranga Mutunga Kore" – translated simply to mean 'life without end' or 'people being able to live on the whenua and survive in a manner that perpetuates and sustains the bounty of life'.

Tuaropaki lands total 3,900 hectares primarily used for sheep, cattle, and deer, as well as a large scale dairy farm. Some 25 hectares of land has been set aside for horticultural development (glasshouse) and around 30 hectares for steamfield wells, pipelines and electricity generating plant. The land not suitable for pastoral farming has been set aside for conservation areas. Tuaropaki Trust manage a variety of waste streams including septic tank waste from the Mokai marae and community, horticultural factory waste, dairy effluent, and dairy wastes from the newly built Miraka dairy processing factory.

It was agreed early on that given the importance of Tuaropaki Trust's horticulture export business, and market sensitivities and perceptions relating to food production with biosolids, the discussions around biosolids reuse would be 'hypothetical', where the korero and reflection on the programmes scientific findings would inform anticipatory planning for viable on-site waste management systems to support community and business growth for Tuaropaki. To date the potential areas of interest by Mokai/ Tuaropaki Trust in the Biowastes project include:

- Gaining expert information on options for the sustainable management of various wastes produced from activities on Trust lands.
- Identifying options for a local waste management solution rather than exporting these waste streams elsewhere.



- With increasing business activity on Trust lands and associated population growth, are there cost-effective & sustainable alternatives to septic tanks for managing local sewerage in the future?

Early this November, the Biowastes programme collaborators from ESR, Scion, Landcare Research, Lincoln University and Cawthron participated in a hui at Mokai along with representatives from local government and the community. About 45 people attended the hui which provided an update of research activities, including initial results from a recently established vermi-composting trial, sited at Scion Rotorua, that uses the septic tank waste from the Mokai marae and community. This focus is a significant step in the biophysical science programme exploring a septic tank waste stream and better responding to the needs of smaller communities in achieving sustainable waste management.

The hui was also an opportunity for members of our two case-study communities to share ideas and experiences. Raewyn Solomon and Sara Watson from Te Runanga o Kaikōura joined Ngaire George and Sam Andrews from Mokai in a panel discussion to explore the connections between the Taupō and Kaikōura case study. Many shared values were affirmed, including the importance of hapū and communities wanting to be responsible for managing their own waste, of 'walking the talk' to ensure that a clean green environment would be preserved for future generations, and finding viable waste management solutions for smaller isolated communities.

We were grateful also to have Richard Wyeth and Dennis Collins from Miraka dairy processing company, (a new business that is backed by a number of Maori trusts and incorporations and built on Tuaropaki land), talk about the implications of biosolids reuse in the food chain for securing sales of high value products in international markets. These discussions confirmed the findings from the Taupō case study social/cultural research to date; that from cultural and industry perspectives, the use of biosolids in the food chain needs to be cautiously considered. Finally Mark Ross facilitated a very informative session on cultural frameworks for managing biosolids waste raising questions of how something transitions from tapu to noa, and how to deal with issues of blood and body fluids.

A great day was had by all, and the Biowastes research team would like to thank the members of the Tuaropaki Trust and hapū, especially Ngaire George and Mark Ross for their wonderful hosting of this hui. It was really neat to see many familiar faces again including Mark Day from Taupō District Council, and Bella Tait, now with the Te Arawa River Iwi Trust. It was great to see a number of new faces too, and we would like to extend our sincere thanks to everybody attending the Mokai hui for making this a very lively and informative day.

Updates from the Ecotox Team – *Louis Tremblay*

The ecotoxicology team has made some progress to assess the risk of micro-contaminants present in biowaste. The team has collated more information on levels of micro-contaminants present in New Zealand biosolids, including Taupō and Kaikōura. Three emerging contaminants commonly detected in biosolids from the two study sites were selected for testing using standardised earthworm toxicity tests. Triclosan, a broad-spectrum antimicrobial agent, carbamazepine, a psychiatric drug and the plasticizer bisphenol A were tested in a 56-day long test. The test method involves exposing earthworms to the chemicals at various concentrations and measuring the number of neonates produced. The toxicity of individual chemicals is being evaluated and so far triclosan appears to be the most toxic as it most reduced the number of neonates. The next series of experiments will involve testing these chemicals in various combinations to assess their toxicity in mixtures as this is how they are most likely to be found in the environment. In addition to counting the number of neonates, scientists will also assess the effects of those chemicals on the immune system of the earthworm. To do this, colleagues from Scion are using a sophisticated machine called a flow cytometer that can separate earthworm immune cells and provide an indication of how stressed the animals are and whether the chemicals are making them more susceptible to diseases. This research aims at investigating the effects of mixtures of pollutants so that they can be better managed.

Another research component of the project uses a different approach to characterise the toxicity of biosolids micro-contaminants. Biosolids are extracted by chemical methods and tested in the laboratory by a suite of bioassays to provide more specific information about their effects. The results so far indicate that all biosolids contain a cytotoxic component. The biosolids extracts all contained estrogenic activity. This means that there are chemicals that can mimic the effects of the natural estrogen hormones. The wider implications of this on the receiving environment remain unknown.

Members of the team have developed a document to assist regional authorities to get a better understanding about emerging contaminants. Examples of emerging contaminants include pharmaceuticals and personal care products (PPCPs) that have been identified in biosolids. One of the aims of the document was to raise the profile of this new research area and coordinate resources and capability across organisations and government departments. Ultimately, it could lead to a wider national strategy to assess the potential risk associated with emerging contaminants on our unique environment and fauna.

From left: Maxie Christison, Joanna Goven, Lisa Langer, Alan Leckie, Mark Christison, Mike Bourke

A Biowastes "thanks" to Christchurch City Council Water and Wastewater team!

Since 1996, Scion Staff in Christchurch have worked very closely with the Christchurch City Council Water and Wastewater team. An excellent relationship has been built up with Mike Bourke, Mark Christison and others. In recent years the Waste to Resource and Biowastes Social and Cultural groups led by Lisa Langer with Alan Leckie (Scion), Joanna Goven (University of Canterbury), and James Ataria (Cawthron Institute), have been very successful with social and cultural research projects in Christchurch and Little River.

Mark Christison is the Unit Manager City Water and Waste, and Mike is the Senior Technician City Water and Waste Planning.

Mark was offered a senior position in Perth, Western Australia and accepted the position. Upon reflection he found that his real desire was to stay in Christchurch and lead the CCC team working to ensure the sewerage system was back working to capacity after being "munted" during the earthquakes.

To celebrate Mark's "farewell and welcome back", Joanna, Lisa and Alan attended and presented both Mark and Mike with a manuka tree to say thanks for all the support over the decades as well as saying we appreciate your staying to help the city during this time of need.

An example of social research being very sociable and not a word of biosolids spoken – Yeah Right!

Updates from the Soil and Micro group

by Jianming Xue

In collaboration with ESR, Landcare Research, Plant and Food Research, Lincoln University and Whenua.biz, colleagues at Scion are conducting a glasshouse pot trial to investigate the impact of two case study biosolids and two vermi-composts on soil biological and plant physiological processes in terms of bioavailability of nutrients (e.g., N and P), heavy metals, and organic carbon content. Two types of biosolids include aged Kaikōura biosolids and fresh Taupō biosolids. Two vermi-composts were obtained through vermi-composting of these types of biosolids with greenhouse tomato pruning. The soil used in this study is low fertility subsoil (pumice soil) from Kaingaroa forest near Taupō. The preliminary results from the current ongoing pot trial demonstrated that application of biosolids and vermi-composts improved the seedling growth of three tree species (radiata pine, manuka and totara) when compared to the control (soil only). Vermi-composts appeared to be better than the biosolids in improving plant growth. Information on bioavailability of soil nutrients and heavy metals and their uptake by plants will be reported in the near future.

Advisory Group Feature:

This quarter we feature Hamish Lowe from Lowe Environmental Impact (www.lei.co.nz). Hamish is a long time proponent of land treatment systems having worked in the waste to land area for coming on 20 years.

He has been an active member of the New Zealand Land Treatment Collective, serving on the Technical committee for 9 years, four of those as chairman. He advises private, industrial, local and central government clients on a range of waste management issues including onsite wastewater, small community wastewater, industrial wastewater and biosolids management. This complements a practical farming and agricultural science side of the business, with the mix allowing for sustainable land application systems to be developing in pastoral, cropping and forestry operations.

Q & A with Hamish Lowe

What is your interest in the Biowaste programme?

We are wasting a valuable resource. The management, environmental effects and

Special Interest Article

Worms and waste – uncovering a potential partnership

Palm fibre waste from the Mokai glass houses is removed and disposed of a couple times a year so re-use is a viable option.

by Jennifer Prosser

As part of the Taupō case-study we have been engaging with the Tuaropaki Trust to investigate sustainable waste management options for the Mokai community. The Trust has a variety of waste streams (including septic tank waste, dairy shed effluent, horticultural factory waste and potential waste from a planned dairy factory). Initial interviews with the Tuaropaki Trust and members of the Mokai marae community have indicated interest in developing strategies to deal with their own waste, enabling them to move away from the current system of Taupō District Council removing the septic tank waste and processing it in their Waste Water Treatment Plant.

Vermi-composting of green waste from the commercial horticultural greenhouses is already undertaken at Mokai. At a hui held in February, attendees expressed an interest in testing the viability (e.g. economics, practicalities, environmental impacts) of vermi-composting a variety of mixed effluent and green wastes from the Mokai community. As a result of this, we are investigating the feasibility and scalability of vermi-composting mixed wastes such as septic tank, green and dairy wastes. The first part of this project involved setting up an experimental trial utilising septic tank waste and green waste from the Mokai community itself.

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Finely chipped tomato prunings, comprising of leaf and stem waste from the Mokai glasshouses.

costs of imported fertilisers is in many cases no different to the use of biosolids. In some instances contaminants are higher and effects potentially more adverse from applying traditional fertilisers when compared to biosolids. So why aren't we using them? Currently engineering advisors to many councils focus on managing the production of a wastewater that can be discharged (often to an aquatic environment). Little regard is given to the production of a biosolid with characteristics suitable for a particular purpose, with the exception of dewatering to enable landfill placement. With more thought, and the consideration of the end user (not just the producer), a material could be produced that is of value and not a cost. The Biowaste programme is critical to demonstrate the value of biowastes, thereby creating a resource and not a headache.

How do you see the information produced being useful to NZ?

The Biowaste programme has and is still producing valuable information. The recent change of focus which considers peoples expectations is critical to the adoption and use of Biowastes. Many overseas countries have reached a point of environmental and production acceptance, with New Zealand dragging behind as a result of perception. We need to get over the perception barrier and start looking at the positives and not the negatives. On-going work to break down the perception barriers is critical, especially where it can use real examples from both New Zealand and overseas.

What else would you like to see in the programme?

There is a sound understanding of the environmental effects from applying biowastes. Two areas that need to be advanced are a robust summary and strategy for dealing with contaminants of emerging concern (CEC), such as endocrine disrupters, and production gains. CEC are being considered in the current programme. Despite knowing what the effects are, there is a need to demonstrate to potential end users what the benefits are. How do biowaste stack up against traditional fertilisers and soil ameliorants? Can the same crop yields be attained? What impact will there be on soil health. I am of the opinion there should be a shift towards demonstrating value and less forward emphasis on demonstrating effect.

If you had a million research dollars how would you spend them?

I would establish a series of very public trials on typical soils and measure the yield of common crops, being pasture, maize and barley. The trials would apply biowastes at rates that met the appropriate environmental thresholds or agronomic application rates, which ever was the maximum. The output from these trials would be publicised in rural media (as opposed to the engineering media), with the aim of generating interest to drive a demand for the material, rather than the current desire of getting rid of the material.

Hamish Lowe

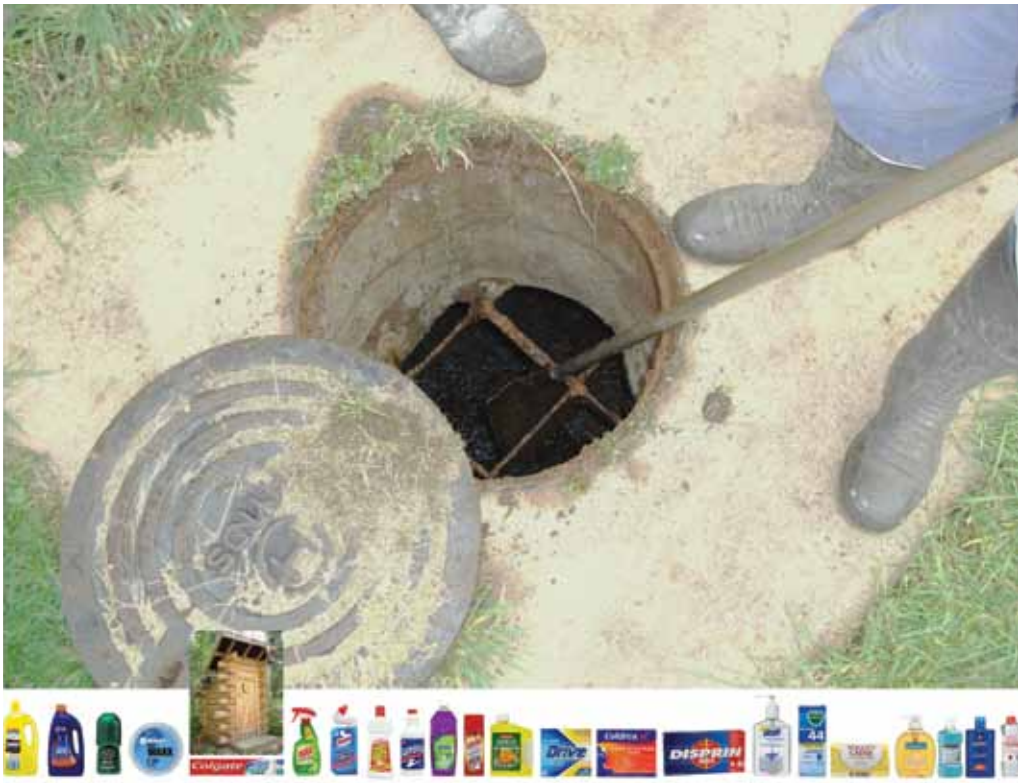
If I could have a second million, I would run a series of comparable trials which enable consideration of oxidation pond sludges, which while a problem of lesser quantity, is of equal importance for smaller rural communities.

After much organisation, this initial experiment was set underway in August with the establishment of four vermi-composting treatments, utilising a mix of glasshouse tomato pruning's, palm fibre and Mokai septic tank waste (as well as one treatment substituting septic waste with dairy shed effluent as a control). Treatments were set up in specially constructed vermi-composting containers and stored in sheds at Scion, Rotorua. Each container has been sampled fortnightly, with sub-samples sent to various members of the biowaste team for analysis. The primary aim of this trial was to establish whether vermi-composting of septic tank waste is an economically viable option for treatment for the Mokai community (with particular reference to pathogenic bacteria and viruses), as well as determining whether the process results in a useful end-product. If the process is successful it may provide an environmentally sound means of reusing an otherwise useless waste product.

TK and Brad from Transpacific Technical Services extracting contents of the top tank into the 10,000 litre truck.

. . . we are investigating the feasibility and scalability of vermi-composting mixed wastes such as septic tank, green and dairy wastes.

The fortnightly samples are analysed for a range of chemical and biological parameters that are known to give an indication of the vermi-composting process and its stages (Dehydrogenase enzyme activity, Total *E. coli*, phosphate (Olsen P), nitrate and ammonia). Results so far are interesting and encouraging. We have found a marked decline in the total numbers of our indicator bacterial organism *(E. coli)* as well as overall bacterial activity (represented by dehydrogenase enzyme activity) in the presence of earthworms; indicating the worms (as one part of the composting process) do aid in pathogen control. This has been accompanied with an increase in valuable plant nutrients, and faster overall decomposition when compared to our no-worm control. There are still a few weeks to go before we can conclude the trial is complete and analyse our final results, but it is certainly looking interesting so far. At the end of the trial we will be analysing final samples for an array of pathogenic organisms, heavy metals, organic contaminants and nutritional properties to assess its quality against NZ guidelines, and highlight any potential hazards (if there are any). We look forward to sharing these results in the near future.



What they are looking for . . . .

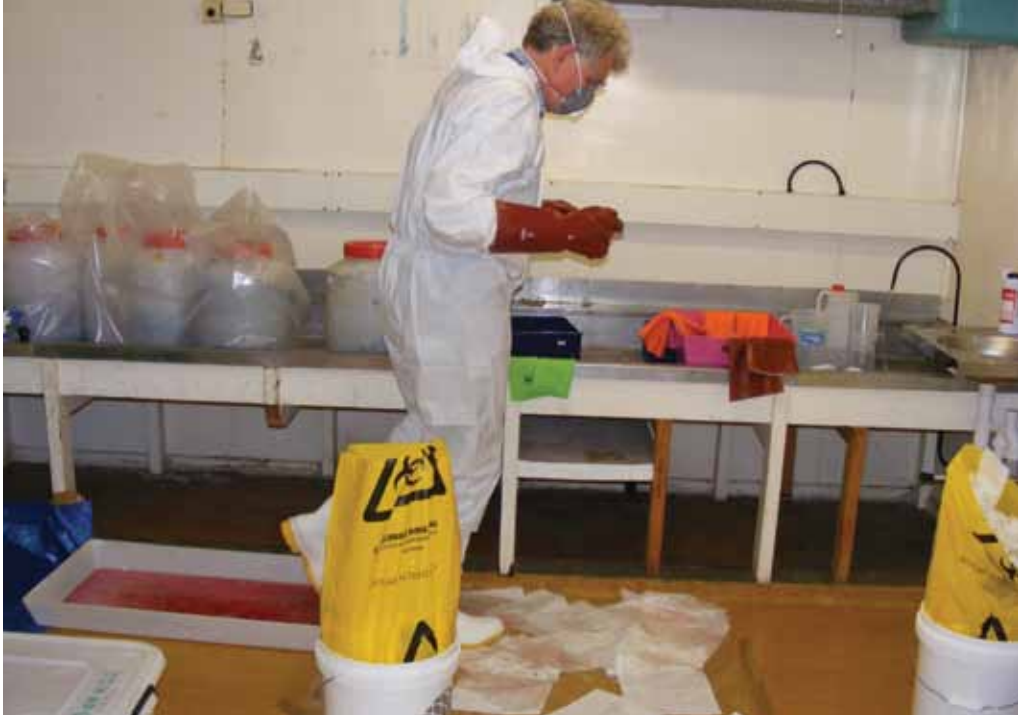
Andrew van Schaik busy weighing palm fibre, tomato pruning's and septic tank waste.

Treatment 1 ready for the buckets.

Worms ready for work.

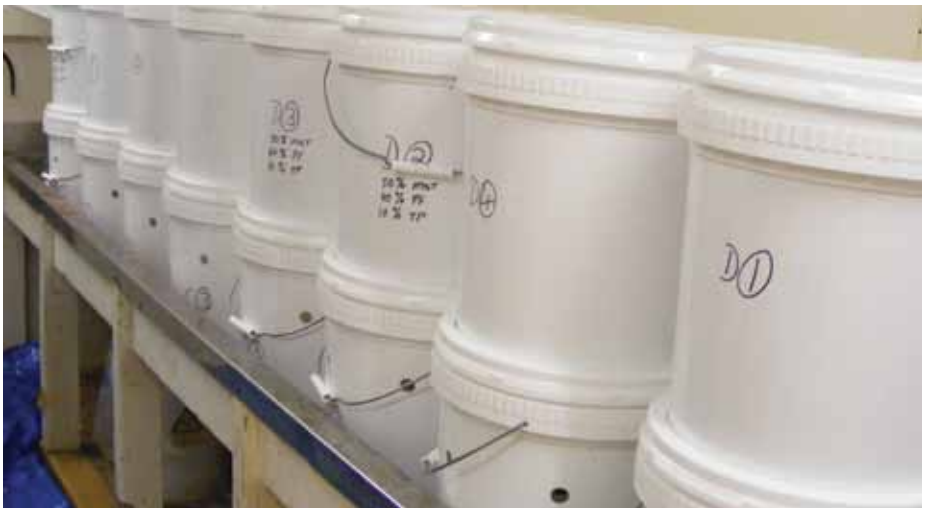
Units under construction.

A sub-sample of mixed compost to be distributed for initial analyses.



Douglas Graham maintaining the sanitation station where we cleaned our boots before exiting the premises.

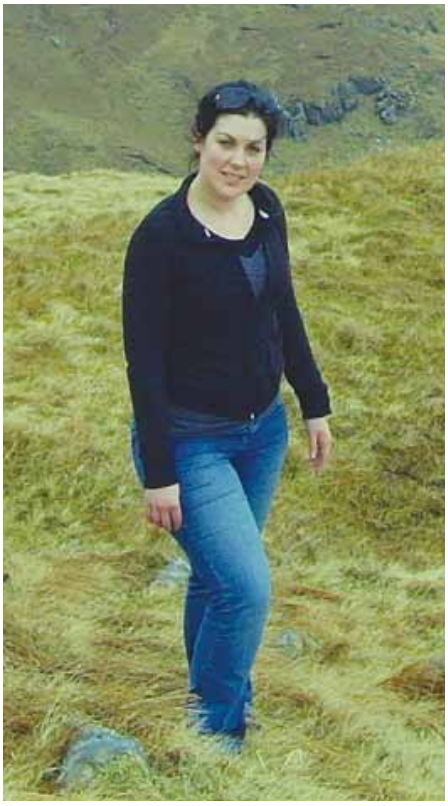
The ESR team – Andrew, Jacqui and Jen – compiling the treatments. Good protective gear and hygiene practices are vital when working with sludge in enclosed areas.



The final set up comprised of 16 vermi-composting containers. The bucket on top contains the worms and the compost mix in aerated conditions, whilst the bucket below contains a funnel and glass bottle that is designed to collect worm leachate for analysis.

Staff changes:

This quarter we welcome a new team member – Dr Alma Siggins.



Alma recently moved to New Zealand from Ireland, to take up a postdoctoral research position in the Water group at KSC. She completed her Ph.D. in environmental microbiology at the National University of Ireland, Galway in December 2010. Her previous research included the use of molecular ecology tools to investigate changes in the microbial communities supporting anaerobic digestion and microbial fuel cell technologies. At ESR, Alma will be employing molecular ecology techniques to monitor soil microbial communities associated with the land application of biowastes. In particular, she will be focusing on organisms associated with key biogeochemical cycles and soil fertility.

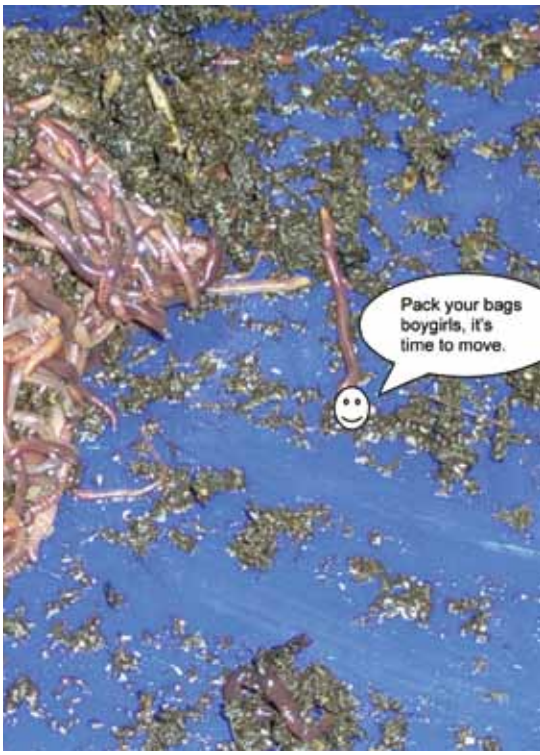
ESR Post Graduate Scholar

Dharini Paramschivam is undertaking a PhD at Lincoln University under the supervision of Brett Robinson, she is co-supervised by Jacqui Horswell and is the recipient of an ESR Post Graduate Scholarship, her project is described below.

When biosolids are added to soil, they can significantly improve fertility due to their high organic matter content and high concentrations of essential macro & micro nutrients. One of the aims of this programme is to use biosolids to rebuild degraded soil, such as occurs after logging operations. However, the rate of biosolids addition required to rebuild degraded soil can result in excessive nitrate leaching, which can reduce groundwater quality and lead to eutrophication of lakes and rivers. Biochar, namely charcoal that is incorporated into soil, is a potential solution. Biochar is made by the pyrolysis of waste organic material at temperatures <700 °C. Preliminary experiments at Lincoln University (LU) have shown that under certain conditions, biochar reduces the nitrate leaching from pasture amended with biosolids by over 50%. I aim to elucidate the mechanisms by which biochar reduces nitrate leaching with a view to determining the optimal types and rates of biochar addition to biosolids-amended soil. In collaboration with Marta Camps at Massey University, I have prepared four different biochars using pine waste. I have discovered that the inhibition of nitrate leaching is not due to simple absorption of nitrogen in the soil. Some other property of the biochar is interfering with the nitrogen cycle in soil. My next step is to investigate the complex interactions in soils amended with both biosolids and biochar.

Up and coming events

- The New Zealand Land Treatment Collective (NZLTC) annual conference will be held in Tuaranga North from March 28th – 30th 2012. This year the conference theme is "Emerging contaminants - unlocking the secrets of everyday chemicals and their fate in the environment". Grant Northcott has been invited to be a keynote speaker and Louis Tremblay will run a workshop. Other members of the programme team will also give presentations, thus the NZLTC continues to be an important conduit for the programme to transfer research results and engage with stakeholders and end-users.
- The third Biowastes hui will be held with representative members of the Kaikōura community on Sunday 4th March 2012 at the Takahanga marae, Kaikōura. Biowastes programme scientists will present findings from their research on Kaikōura biosolids to the broader community to allow the community to formulate a recommendation for the Kaikōura District Council on the future reuse of the stockpiled biosolids.



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