Issue No. 12 May 2016

Putting waste to work

A CENTRE FOR INTEGRATED BIOWASTE RESEARCH PUBLICATION

INSIDE THIS ISSUE

Biosolids business case for coal mined pasture 2

Emerging organic contaminants 3

Social and cultural group update 4

Effects of long-term greywater disposal on soil 4

Update from the soil science team 5

Antimicrobial ability of Myrtaceae plant species on pathogens in soil 6

New Zealand Land Treatment Collective conference 7

Letter to the editor 8

Establishment of an expert advisory panel 8

Publications list 8

Centre for Integrated Biowaste Research

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UPDATE FROM THE PROGRAMME MANAGER

Welcome to the Autumn edition of the CIBR newsletter.

In March, a large contingent from CIBR attended the Land Treatment Collective (LTC) conference in Gisborne – turn to page 7 to read about highlights from the conference. Congratulations to Jamie Ataria and the Social/Cultural science team for winning the "Best Overall Paper' award at the conference for their presentation on "Tapu to Noa – Māori cultural views on biowastes management: a focus on biosolids". This presentation and accompanying report is a summation of many years of work with communities around New Zealand. It is intended to guide non-Māori towards knowing how to ask the right questions in their conversations and engagement with local hapū and Iwi regarding biowaste and biosolids issues. The Tapu to Noa report is available on the CIBR website (www.cibr.org.nz).

Also launched at the LTC conference is the joint CIBR/LEI Community Engagement Framework for Biowastes. CIBR researchers have developed, implemented and evaluated a number of community engagement methods over the years while Lowe Environmental Impact (LEI) bring practical experience and processes required to satisfy regulatory and environmental requirements. Together, their collective experience has developed this Community Engagement Framework for the management of biowastes that provides a pathway to meet the requirements of the Resource Management Act, Local Government Act and the Treaty of Waitangi. This document can also be found on the CIBR website or email Sarah at the below email address for a copy; we hope that you find both useful.

Congratulations to both Staci Boyte and Morkel Zaayman from ESR who won the student scholarships to attend the LTC and especially to Morkel who also won the "Best Young Professional Paper" award at the conference – well done!

In the last few months CIBR scientists have published over 11 papers in peer reviewed journals – a full list of the publications can be found on page 8. These can usually be accessed from the journal but you can also contact Sarah for a copy of a paper that you are interested in. This is the best way to access the newest science that we are undertaking.

This is the 12th newsletter we have produced since CIBR was launched in 2010 – we'd really like to hear from you as to whether you find the information interesting and if it is presented in a useful way. Is there anything you want to hear about? Please let us know – you can contact the newsletter editor Sarah Quaife at Sarah.Quaife@esr.cri.nz.

Jacqui Horswell

UNDERPINNING A HOLISTIC BIOSOLIDS BUSINESS CASE FOR COAL-MINED PASTURE

Robyn Simcock and Jo Cavanagh

Biosolids are rich in organic carbon and nutrients. Plant growth on mined land is often restricted by limited soil organic carbon and nutrients. Hence biosolids have been used internationally to create topsoil for mine reclamation for decades, both solely and blended with industrial by-products such as wood fibre or coal ash. In 2007, Solid Energy investigated using biosolids to rehabilitate ash subsoils at Rotowaro coal mine near Huntly in the Waikato. At the time it was one of NZ's largest earthmoving operations and had a deficit of topsoil for rehabilitation. After extracting coal, backfilled areas were (and are) rehabilitated to pasture or pine plantations. At the time, the business case for spreading biosolids only considered the direct value of biosolids, being the 'gate fee' for disposal. Any benefits from enhancement of rehabilitation outcomes were not included in the business case.

In summer 2007/08 a biosolids 'gradient' trial was installed by Dr Paul Weber. Aged Hamilton biosolids were thoroughly mixed into the surface 300 mm of six, 20 by 20 m plots at rates of 0, 50, 100, 200 or 400 dry T/ha to determine the optimum application rate. This optimum rate was measured by soil contaminant concentrations and leached nitrogen concentrations under pasture. An additional plot of 425 T/ha of 'fresh' North Shore biosolids was added in summer 2008/9. In 2015 we resampled the gradient trial plots to assess the medium-term effects of these one-off biowaste applications. We repeated the initial Solid Energy measurements of soil contaminants and added soil and plant measures to provide information on rehabilitation benefits that could be useful in a business case. These included biomass, foliar nutrient concentrations, plant diversity, and typical soil physical and chemical quality parameters. In addition, contaminant induced effects were examined by assessing microbial and enzyme activity and the response of earthworms exposed to the collected soil; these results will be reported in the next newsletter.

We found:

- The conventionally fertilised 'control' treatment was nutrient deficient, and had low pasture biomass 7 years following rehabilitation.
- Moderate rates of Hamilton biosolids dramatically increased pasture biomass (from <5 T/ha to >10 T/ha) and height (from ~11 cm to >50 cm) over the conventional treatment. This was attributed primarily to more favourable soil fertility, particularly available P rates (Olsen P > 80 mg/kg) and organic matter (N). The highest rate of addition also reduced plant stress by increasing the volume of plant available moisture held in the soil.
- The high rate of North Shore biosolids supressed soil pH and increased extractable aluminium levels to levels at which legumes would be inhibited (they were not present)
- Metal concentrations showed a strong dose-related gradient. North Shore biosolids had elevated Cu and Zn compared to Hamilton biosolids. Application rates at 200 dry T/ha North Shore provide less than half the resource consent ceiling values (i.e. 50% safety factor)

Rehabilitated pasture on ash subsoils at Rotowaro benefitted markedly from a one-off, relatively high application of incorporated biosolids. At 200 dry T/ha Hamilton biosolids overcame all soil nutrient limitations. Typical surface agronomic rates would have been 30 to 50 dry T/ha. The levels of organic matter, nitrogen, and plant-available phosphate means no additional fertilisers need be applied under current management to these plots. Increased pasture biomass and height means rates over 100 dry T/ha increased resistance to surface erosion and weed invasion over 7 years.

Left: Rehabilitated soil profile of unamended ash subsoils: control plot (2016). Above: Biosolids gradient trial plots: control and high-rate (c 2010).

Treatment	pH (2:5 Water)	Organic C (%)	Total N (%)	C/N ratio	Olsen P (mg/kg)	Bray 2 P (mg/kg)	CEC (cmol(+)/kg)	Base Saturation (%)	KCl- extract. Al (cmol(+)/kg)
1) 425 T/ha North Shore	4.52	7.77	0.74	10	552	1257	27	31	1.9
2) Control: fertiliser only	5.72	3.67	0.22	16	5	8	14	60	<0.2
3) 50 T /ha Hamilton	6.11	3.86	0.29	13	39	61	18	68	<0.2
4) 100 T/ha Hamilton	5.93	3.93	0.29	13	84	164	17	62	<0.2
5) 200 T/ha Hamilton	5.83	5.33	0.38	14	206	611	22	57	<0.2
6) 400 T/ha Hamilton	5.84	5.23	0.40	13	203	704	21	55	<0.2
	slightly acid	high	high	high	very high	very high	high	high	high
	mod acid	medium	medium	medium	med to high	med to high	medium	medium	medium
	strongly acid	low	low	low	low	low	low	low	low
		very low	very low		very low	very low	very low	very low	very low

Measuring pasture height in the 400 T/ha North Shore plot, spring 2015.

A BIOANALYTICAL APPROACH TO IDENTIFYING EMERGING ORGANIC CONTAMINANTS OF CONCERN IN NEW ZEALAND BIOSOLIDS.

Jo Cavanagh, Grant Northcott, Louis Tremblay, Gerty Gielen

One of the road blocks preventing further beneficial reuse of biosolids is the uncertainty surrounding the potential fate and effect of organic compounds and in particular the "emerging organic contaminants". Emerging organic contaminants (EOCs) include pharmaceutical and personal care products, many other industrial chemicals, plasticisers, steroid hormones, and agricultural pesticides. Most research to date on the toxicological effects associated with EOCs in wastewater treatment systems has focused on effects arising from the discharge of treated effluent into aquatic systems. In comparison limited research has been completed on determining the potential toxicological effects of EOCs arising from exposure to biosolids, and/or the effects arising from land-application of biosolids, especially through direct toxicity testing. Previous research undertaken within CIBR assessed the biological response of organic contaminants in biosolids from 10 New Zealand wastewater treatment plants. This research demonstrated that the mixture of EOCs present in biosolids was able to produce estrogenic, anti-androgenic, thyroid disruption, and oxidative stress responses (see issue no.9 and Cavanagh *et al* 2013).

We also used these same bioassays to investigate the effects of specific individual EOCs including plasticisers - bisphenol-A and Bis(2-ethylhexyl) phthalate, technical nonylphenol, the polycyclic musk galaxolide, the anti-microbial compound triclosan, and the pharmaceutical carbamazepine. We have used this data to produce an "effect profile" for these contaminants and obtained an indication of the concentration at which different biological effects are activated. While our preliminary experiments have produced valuable information on the toxicological profile of NZ biosolids, measuring the biological response associated with a whole extract doesn't help us to identify the primary contaminants responsible for the toxicological properties of NZ biosolids.

The organic chemicals in biosolids occur as a complex mixture of literally thousands of chemicals which makes it extremely challenging to identify each and every one of them and determine their respective biological response. New approaches have been developed to compliment the identification and quantitation of chemicals by combining instrument analyses with bioanalytical techniques that take advantage of specific properties of groups of chemicals to produce specific biological responses.

This approach, referred to as Effects-Directed-Analysis (EDA) or Toxicity Identification and Evaluation (TIE), is based on a combination of fractionation procedures, bioanalytical testing, and subsequent identification and quantification of individual chemicals or classes of chemicals.

EDA reduces the complexity of the biosolid extracts to less complex mixtures for bioassay testing. The EDA procedure involves the separation of a whole sample extract into

Sample extracts undergoing fractionation.

different fractions containing chemicals of similar physico-chemical properties. These fractions are tested using different bioassays to establish which fractions produce a significant biological response and warrant further analyses including chemical analysis.

In this current study, we are utilising this approach to provide greater insight into the chemicals producing specific biological responses in New Zealand biosolids.

A biosolid sample was extracted by accelerated solvent extraction and the extracted organic chemicals recovered and concentrated using solid-phase extraction (SPE). The concentrated biosolid extract solution was fractionated into four separate fractions of increasing polarity using normal phase adsorption chromatography. The procedure broadly separates sample extracts into a non-polar fraction containing organic contaminants such as PAHs, alkanes, PCBs, organochlorine pesticides and phthalates; another containing more polar chemicals such as alkylphenols and alkylphosphate flame retardants; a higher polar fraction containing steroid hormones and bisphenol-A; and a final highly polar acidic fraction containing chemicals such as the pharmaceutical chemicals salicylic acid, diclofenac, and ibuprofen.

These extracts will then be tested using a suite of bioassays to determine the biological response of each fraction. This will highlight fractionations for further analysis and provide some initial indications of the groups of contaminants potentially causing the effect. A suite of in vitro assays covering nine toxicological endpoints will be used. These endpoints include binding to the oestrogen (ER), androgen (AR) and aryl hydrocarbon receptors (AhR) using cell-based bioassays; binding to a thyroid hormone transport protein; redox activity; and profiling microbial substrate utilisation using Biolog Ecoplates to assess potential effects on microbial populations. The fractions will also be tested in the zebrafish fish embryo toxicity (FET) test. The FET will provide an indication of general toxicity on the sensitive early life stages. It represents an in vivo endpoint to complement the in vitro endpoints.

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Cavanagh, J, Tremblay L, Northcott G, Trought K, Mitchell C. 2013. The biological response associated with biosolids. In: the proceedings for NZ Land Treatment Collective Annual Conference 2013. Water – what is it worth? Blenheim, 10-12th April.

TAPU TO NOA – MĀORI CULTURAL VIEWS ON BIOWASTES MANAGEMENT: A FOCUS ON BIOSOLIDS

Alan Leckie, Jamie Ataria, Lisa Langer, Jinny Baker and Joanna Goven

Jamie Ataria in collaboration with the Social and Cultural team was awarded "Best Overall Paper" at this year's LTC conference.

Tēnā koutou mai i Te Tairawhiti, Tūranganui-a-Kiwa – te uranga mai o te rā

Greetings from Gisborne – the place that receives the first rays of the sun.

The community engagement session of this year's LTC was kicked-off with an insightful and informative presentation on the concepts of "from Tapu to Noa" given by CIBR's Jamie Ataria. This presentation was so well received by attendees that Jamie, in collaboration with the CIBR social and cultural team was awarded "Best Overall Paper."

Tapu and noa are key Māori concepts that influence and inform Māori cultural practice. Although difficult to define, a simplistic description of tapu is forbidden or restricted, whereas noa is free from restriction. Māori consider that biosolids are very tapu as they are a bodily waste product. Traditionally the management of human waste was very prescriptive and processes were used to protect human and environmental health and ensure desired spiritual outcomes. Ensuring that waste streams were not mixed, employing designated disposal areas and allowing sufficient time for appropriate biodegradation are examples of traditional practices employed. The transitional nature of tapu and noa have implications for the management of biosolids today – especially in examples where the criteria of adequate separation/knowledge of biosolids composition and appropriate treatment processes are met.

RECENT CIBR PUBLICATION: EFFECTS OF LONG-TERM GREYWATER DISPOSAL ON SOIL: A CASE STUDY.

Siggins A, Burton V, Ross C, Lowe H, Horswell J.

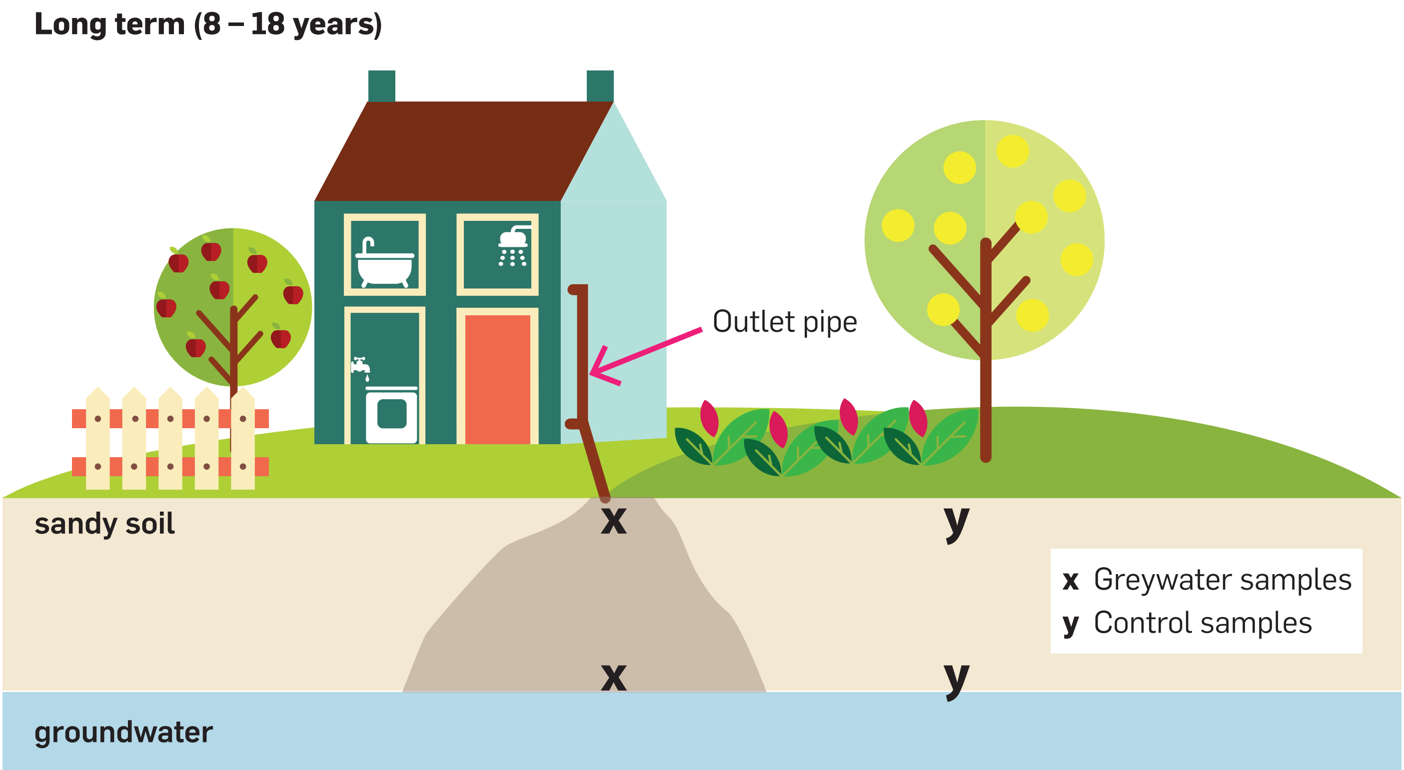
ABSTRACT

This study investigated the environmental health risks to soil and potential risks to groundwater associated with long term (8-18years) greywater disposal practices. Land application of greywater is likely to have environmental impacts, which may be positive or negative.

Greywater can contain plant macronutrients that may benefit plant growth. Conversely, high levels of surfactants, oils, grease, sodium and potentially pathogenic organisms may negatively impact environmental and human health. In this study, land disposal of untreated greywater was practiced at five coastal domestic properties.

At each property, soil samples were collected at two depths from areas used for greywater disposal and from control areas that were not exposed to greywater. Soils were analysed for chemical and biological responses to greywater exposure. Generally, greywater irrigated soils had higher pH, Olsen P, base saturation, and increased soil microbial activity (as measured by biomass carbon, basal respiration and dehydrogenase activity). A pH of >9 was recorded for some greywater treated soil samples. *Escherichia coli (E. coli)* were detected at up to 103MPN/g in the greywater exposed surface soils at some sites.

Terminal Restriction Fragment Length Polymorphism (TRFLP) analysis revealed that greywater affected the soil microbial community structure, which may have implications for soil health and fertility. Overall, this study shows that the long-term application of greywater at the investigated sites had a moderate impact on the soil environment. This may have been due to the sandy soils and high rainfall that would flush the soil. Increases in microbial biomass and dehydrogenase activity indicate that greywater application may be beneficial for plant growth. However, high levels of *E. coli* in some soils may be a risk to human health and sub-surface irrigation should be the recommended application method.



UPDATE FROM THE SOIL SCIENCE TEAM – REPEATED BIOSOLIDS APPLICATION INCREASED BASAL AREA AND RING WIDTH OF RADIATA PINE PLANTATION AT RABBIT ISLAND – X-RAY DENSITOMETRY ANALYSIS RESULTS

By Jianming Xue and Russell McKinley

Figure 1. Wood core samples collected from radiata pine stands of biosolids research trial at Rabbit Island in Nelson (left) and the cut core samples for X-ray densitometry analysis (right).

The CIBR soil science team has been conducting research on the environmental, ecological and economic impacts of long-term application of biosolids to a radiata pine plantation at Rabbit Island. The research aims to develop guidance for sustainable land application of biosolids for the Nelson community, and provides indicative research findings for land application of biosolids throughout New Zealand. This newsletter reports our recent findings of X-ray densitometry analysis, focusing on the improvement of basal area and ring width growth of radiata pine stands by biosolids application at Rabbit Island.

Beneficial use of biosolids as a supplemental fertiliser and soil amendment is one of the most common options for biosolids management. In New Zealand, application of biosoilds on forest land is preferred because it can reduce the risk of contaminants entering the human food chain and it can also increase tree growth and subsequent economic returns.

Treated biosolids from the Nelson Regional Sewage Treatment Plant have been applied to a 1000-ha radiata pine forest plantation at Rabbit Island near Nelson City since 1996. A research trial was established on the site in 1997 to investigate the long-term effects of biosolids application on soil and groundwater quality, tree nutrition and growth. Biosolids have been applied to the trial site every three years (1997, 2000, 2003, 2006, 2009 and 2012) at three application rates: 0 (Control), 300 (Standard) and 600 kg N/ha (High). Tree nutrition status and growth are monitored annually, groundwater quality quarterly and soil properties every three years to determine both the risks and benefits as well as sustainable application rates.

The latest wood core samples were collected for X-ray densitometry analysis from this biosolids research trial in May 2016 (Figure 1). Here we update our recent findings on the impact of repeated biosolids application on the basal area and ring width growth of radiata pine stands at Rabbit Island. Basal area is the area of a given section of land that is occupied by the cross-section of tree trunks and stems at the base. This is usually a measurement taken at the diameter, at breast height (1.4m up the trunk from ground height), and includes the complete diameter of every tree, including the bark. Measurements are usually made for a plot and this is then scaled up for 1 hectare of land for comparison purposes to examine a forest's productivity and growth rate. Tree diameter is an indicator of tree radial growth, which is increased annually (i.e. annual ring growth). For example, under normal growth conditions, a 25 year old tree will have 25 annual rings, which is measured as ring width.

The cumulative basal area showed a considerable difference between biosolids-applied trees and the control trees irrespective of stocking rates since 1998. In 2015, the standard and high biosolids treatments increased the cumulative basal area by 12.5% and 30.9% when compared to the control at the stocking rate of 300 stems/ha (Figure 2 left), by 4.6% and 42.7% at the stocking rate of 450 stems/ha (Figure 2 right), and by 0.2% and 19.2% at the stocking rate of 600 stems/ha (Figure 3 left).

The ring width showed significant difference between biosolids applied trees and the control trees irrespective of stocking rates. Overall, the standard and high biosolids treatments increased the ring width from 1997 to 2005 and approached to similar values afterwards at the stocking rate of 300 stems/ha (Figure 3 right). At both stocking rates of 450 (Figure 4 left) and 600 stems/ha (Figure 4 right), the standard and high biosolids treatments largely increased the ring width from 1997 to 2005 but reduced it slightly afterwards.

The X-ray densitometry analysis results confirmed that repeated biosolids application significantly altered radial growth pattern of radiata pine and improved the overall radial growth (increased diameter) although there was inter-annual variation.

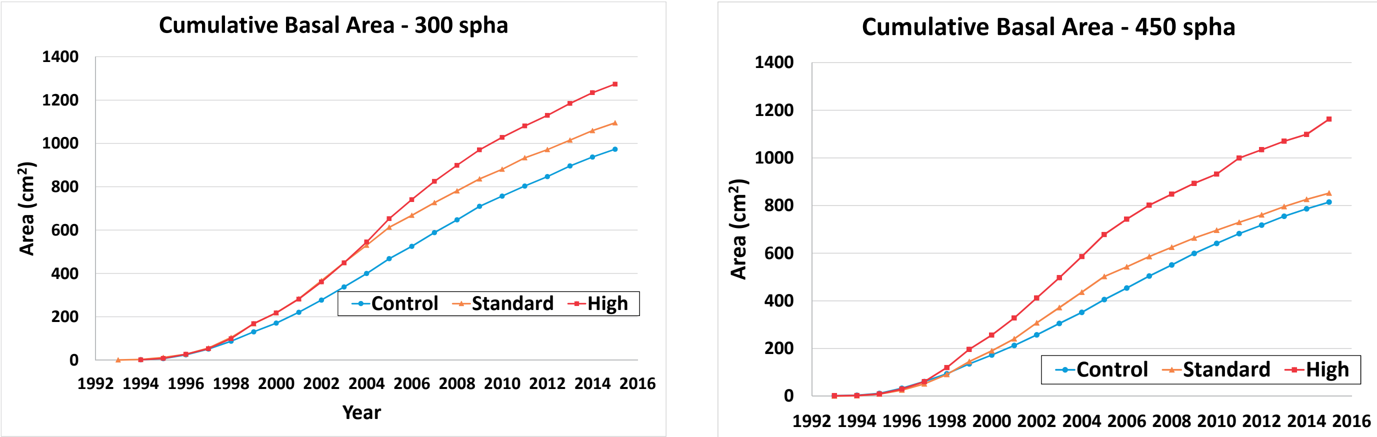


Figure 2. Effect of repeated biosolids application on the cumulative basal area at 300 stems/ha (left) and 450 stems/ha (right).

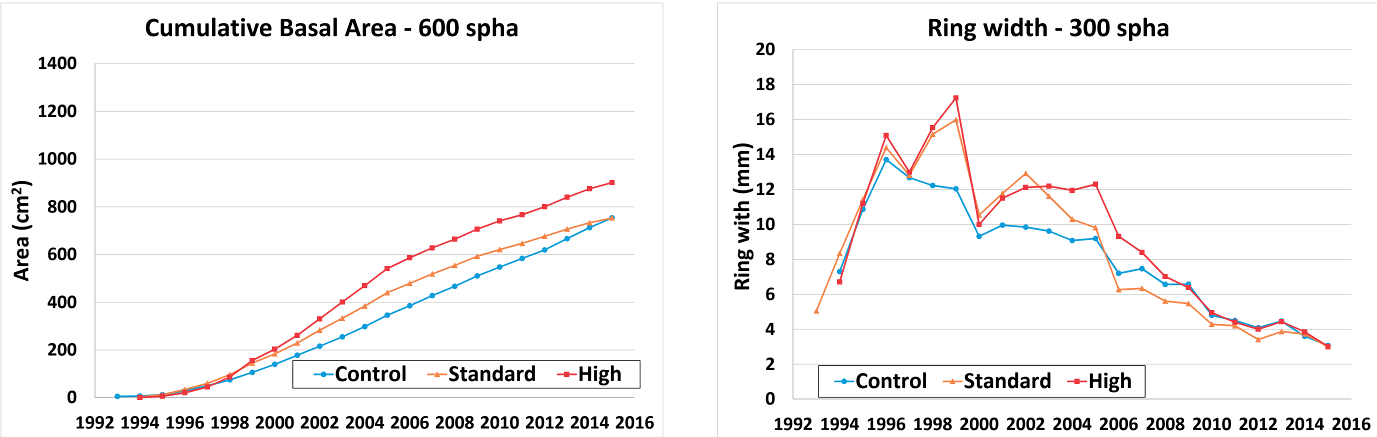


Figure 3. Figure 3. Effect of repeated biosolids application on the cumulative basal area at 600 stems/ha (left) and ring width at 300 stems/ha (right).

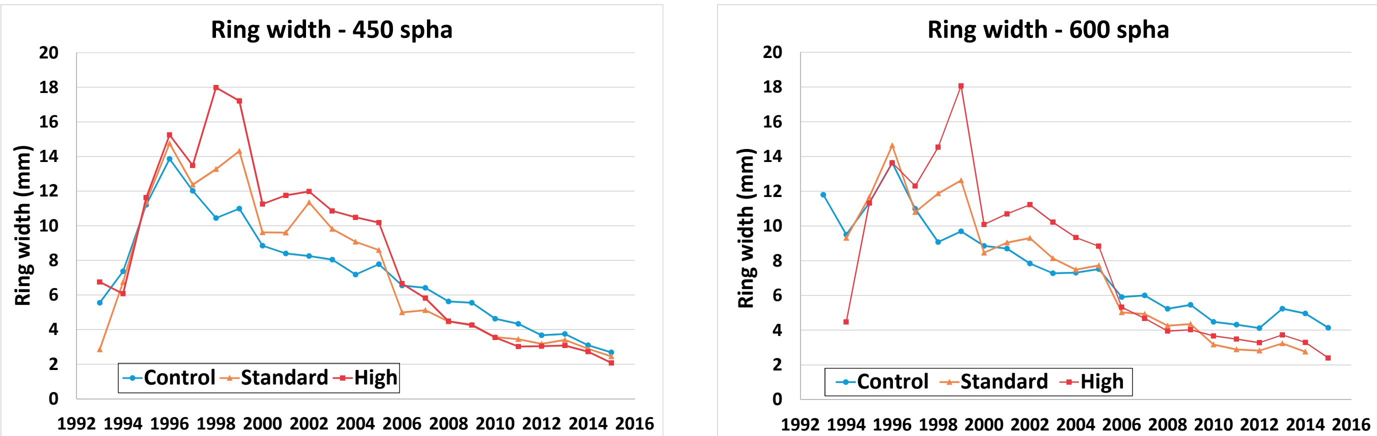


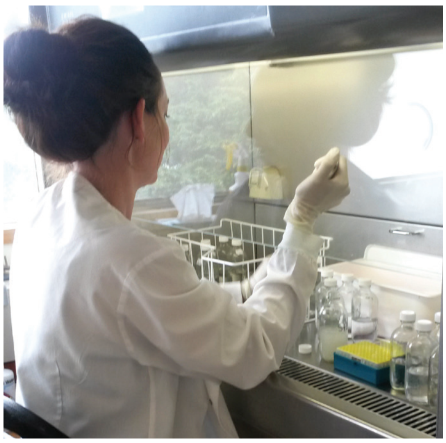
Figure 4. Effect of repeated biosolids application on the ring width at 450 stems/ha (left) and ring width at 600 stems/ha (right).

RECENT CIBR PUBLICATION: THE POTENTIAL IN-SITU ANTIMICROBIAL ABILITY OF MYRTACEAE PLANT SPECIES ON PATHOGENS IN SOIL

J.A. Prosser, R.R. Woods, J. Horswell, B.H. Robinson

ABSTRACT

Concerns that land application of organic waste may introduce microbial contaminants into the environment could be mitigated by growing plants with antiseptic properties in waste-amended soil. We investigated the potential for two myrtaceous plants, mānuka (*Leptospermum scoparium*) and kānuka (*Kunzea robusta*) with antiseptic properties to reduce numbers of the pathogen indicator *Escherichia coli* in soil. Pots containing perennial ryegrass (*Lolium perenne*), mānuka and kānuka, were spiked with *Escherichia coli* and a rainfall event was simulated. Decimal reduction times (DRT) showed *E. coli* numbers were reduced under kānuka and mānuka compared to a pasture control (8, 5 and 93 days respectively). Potentially, these myrtaceous species could mitigate the threat of microbial contamination of soil, while producing valuable biomass for fuel, essential oils or honey.



Scientist Jen Prosser innoculating pathogens in soil.

NEW ZEALAND LAND TREATMENT COLLECTIVE CONFERENCE

Alma Siggins

CIBR representatives at the 2016 LTC conference held in Gisborne, March 16th–18th.

CIBR was extremely well represented at the recent New Zealand Land Treatment Collective (NZLTC) conference in Gisborne, from March 15th to 18th, with fifteen members in attendance. Gisborne District Council kindly hosted this year's event, and played a very active role in proceedings. The week kicked off with a one day workshop "Achieving excellence with onsite wastewater", following up on the 2012 Hamilton workshop. It was a highly interactive day, with lots of interest and energy from attendees.

Mayor Meng Foon kindly opened the conference itself on Wednesday morning, and delegates heard 31 presentations under the theme "Community Engagement and Land Treatment". Our CIBR research was presented and discussed at a very high standard. Jinny Baker and Tina Ngata's talks on sustainable behaviour change asked LTC attendees to consider different approaches on how to achieve behavioural change when looking at conventional western philosophies compared to mātauranga Māori. We all possess sustainable behavioural values and are all part of our environment. However, we are also part of society's problems and issues. There are barriers to being sustainable but valuing the future means we also have to value intangible concepts that are yet to arrive. The question asked by Jinny and Tina is "what does a behaviour change look like?" Does this start with changing our personal practices?

The field trip on the last day took the delegates to the Gisborne Wastewater Treatment Plant. Here they received a tour of the treatment facility, including the full scale biological trickling filter. The tour also included the ESR sludge drying experiment, and the NIWA algal ponds, which was a great opportunity to see first-hand the experiments that had been described during the conference.

Overall, the conference was a great success for both the NZLTC and the CIBR teams, and we would like to thank all CIBR delegates who made such a huge effort to present their research.

A closer look at one of the "sludge drying wetland" experimental lysimters, presented at the LTC conference.

LTC delegates viewing the constructed wetlands presented during the conference.

LETTER TO THE EDITOR

Attention: Editor of the Centre for Integrated Biowaste Research (CIBR): Putting Waste to Work newsletter

From: Environmental Choice, General Manager

At the end of 2015, the Environmental Choice New Zealand team met with the Centre for Integrated Biowaste Research (CIBR). Our team was really impressed with the work of the CIBR. We were interested to learn that New Zealand produces nearly 700,000 tonnes of biowaste each year, waste comprised predominantly of organic matter (that's approximately 2,000 747s).

As supporters of e-waste management (see our recent article on the future of e-waste in New Zealand http://www.villainesse.com/think/are-you-e-waste-litterbug) we encourage CIBR's work in the biowaste space.

When sending e-waste to landfill, toxic substances can leach into soil, pollute waterways, upset ecosystems and have the potential to affect our health. This is why it is important to find ways to manage e-waste disposal and to reuse e-waste materials. Similarly, we recognise it is important to ensure biosolids are properly handled and treated and, when possible, productively reused in agriculture and compost.

There are some excellent organisations working to identify innovative solutions to our varied environmental challenges.

At Environmental Choice our team develops the specifications for various categories of products and services. New Zealand businesses that gain the Environmental Choice ecolabel can confidently communicate to their consumers that they have taken into consideration the lifecycle impacts of their product and services as part of the assessment required for their certification. Essentially, the work has been done for them.

At Environmental Choice, we value the research methodologies and science-based approach used by CIBR as we depend on the research to develop our specifications. CIBR's multidisciplinary collaboration between 10 New Zealand research institutes, universities, and research partners means the research is robust and backed by a depth and breadth of knowledge. The science-based approach means our team can confidently rely on the CIBR's research to inform our specifications. Essentially the work's been done for us. Thank you for the work that you do.

Kind regards,

Francesca Lipscombe
General Manager, Environmental Choice New Zealand

ESTABLISHMENT OF AN EXPERT ADVISORY PANEL ON EMERGING ORGANIC CONTAMINANTS

The CIBR team has been involved in coordinating a range of activities to raise the profile of Emerging Organic Contaminants (EOCs) to discuss options to manage concerns raised by Māori and the wider community. Those included the 2013 Wellington end-users workshop "Emerging Contaminants – Securing the Future" and, the November 2014 EPA Tikanga and Technology wānanga on emerging chemical contaminants in Porirua. It was agreed by the participants that there was a need for the formation of a group that is resilient to changes over time and can provide a source of advice on EOC issues. We have finally established an independent Advisory Panel on EOC that will be chaired by our own Jacqui Horswell (ESR). With great assistance from Graham Sevicke-Jones (Director, Science & Information, Environment Southland) we were very fortunate to secure a membership of environmental experts from Regional Councils (Tim Davie (ECan), Claire Conwell (Greater Wellington), Anna Madarasz-Smith (Hawke's Bay), Matthew Taylor (Waikato) and Marcus Cameron (Auckland Council)), Ministry for the Environment (Alice Bradley), Environmental Protection Authority (David Weller, HSNO team), Department of Conservation (Dave West), Ministry for Primary Industries (Andrew Pearson), and the EPA Ngā Kaihautū Tikanga Taiao (Tipene Wilson, chair). We are having discussions to include someone from Ecostore to represent industry. The cross-sectorial membership of the panel reflects the vertical integration of managers, planners, policy makers at the local and national levels. This will provide exceptional opportunities to engage the key people that can promote changes from national policy that will subsequently influence pollutant monitoring plans at the regional level. We are planning a first meeting around the Wellington WasteMINZ conference in October. The plan is for the panel to meet yearly and review summary results of EOC research and provide strategic oversight and guidance to ensure the research outcomes are relevant to end-users.

Louis Tremblay

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If you would like further information on the programme or have any questions, please see our website www.cibr.esr.cri.nz or contact a member of the Science Leadership Team:

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