

# INTEGRATED ENVIRONMENTAL, SOCIAL, CULTURAL AND ECONOMIC BIOSOLIDS RESEARCH IN NEW ZEALAND

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## ABSTRACT

Biosolids (treated or stabilised sewage sludge) are a product of human excreta and a vehicle for numerous contaminants (heavy metals, human pathogens, pharmaceutical and personal care products). They make up about a third of organic wastes and are generally landfilled in New Zealand. While the presence of micro-contaminants including emerging contaminants presents challenges, biosolids are carbon-rich and can contain high concentrations of valuable plant nutrients which offer opportunities for reuse.

A Foundation for Research, Science and Technology research programme under the partnership of three Crown Research Institutes (CRIs): ESR, Scion and Landcare Research, in collaboration with other CRIs, universities and iwi, is addressing the hypothesis that uncertainty about knowledge gaps is a key barrier to biosolids land application.

The research will be centred on two case studies where the programme will work in partnership with small communities and councils and will have a strong Māori component. Social and cultural components will be integrated with community focused biophysical research in a process aimed at developing better management guidelines. The research will explore how biosolids nutrients can add value to amended soils without compromising cultural, social, environmental and, economic values. The research aims to help overcome immediate barriers preventing beneficial use of biosolids.

## KEYWORDS

**Biosolids reuse, nutrients, contaminants, social, cultural, environmental and economic research, uncertainty, case studies.**

## 1 INTRODUCTION

Organic wastes comprise more than 50% of the total wastes going to landfill in New Zealand. Biosolids (treated or stabilised sewage sludge) are a product of human excreta and contain numerous micro-contaminants (e.g., heavy metals, human pathogens, pharmaceutical and personal care products (PPCPs)) and make up about a third of the organic wastes. While these micro-contaminants are a potential risk, the waste material also offers opportunities for reuse. Biosolids are carbon-rich and contain high concentrations of valuable nutrients, such as nitrogen and phosphorus, which can assist in increasing plant growth rates and thereby bolstering soil carbon reserves. In contrast, the landfilling of biosolids results in the sequestration of those valuable nutrients, producing potentially environmentally toxic leachates and methane production.

Biosolids research in New Zealand dates back to 1995 when ESR began an investigation of the effects on soil and groundwater quality from the application of high rates of undigested sewage sludge onto low fertility coastal dune sand soils under Foundation for Research, Science and Technology (FRST) funded research. While ESR in collaboration with Lincoln University focused on the contaminant heavy metals in soil following biosolids applications on coastal sands, pasture and under radiata pine (*Pinus radiata*) plantation forest (e.g., Speir et al.,

2003; Speir et al., 2007; McLaren et al., 2006) considerable work has proceeded over the past 10 years on bacterial pathogens: their fate and survival in soil and their potential to contaminate food crops (e.g., Horswell et al., 2007).

Research on biosolids by Scion began at a similar time in collaboration with councils, the forest industry, other Crown Research Institutes (CRIs) and universities, dating back at least to 1997. The FRST funded research included determining the fate and mobility of municipal biosolids applied to plantation forest land in the Canterbury region with a focus on identifying temporal variability of constituent concentrations and nutrient availability. Additional research developed management systems for land application of biosolids, determined how wetlands below land treatment sites facilitated nitrate removal, and identified how tree species and stocking rates affected nutrient uptake and productivity of effluent-irrigated forests. From 2003 – 2009, Scion led a second multi-disciplined FRST funded research programme again with collaborators from other CRIs, universities, local councils, forest industry and iwi. This programme had a sustainability approach with environmental, social and cultural research components. The major research elements included the effects of land application of biosolids to radiata pine plantations (e.g., Wang et al. 2004; 2006); aquatic and terrestrial ecotoxicology of biosolids (e.g., Landman, et al., 2008; Taylor, et al., 2009); endocrine disrupting chemicals (EDCs) presence in the environment and the efficacy of current treatment technologies to remove those contaminants (e.g., Leusch et al., 2006a,b); risk assessment of pulp and paper biosolids and waste (e.g., van den Heuvel et al., 2006; Bandelj et al., 2006; Hoeger et al., 2006); fate and effects of pharmaceuticals from wastes (Gielen et al., 2009); and social and cultural engagement in biosolids management (Goven and Langer, 2005; 2009; Langer, et al., 2008). The land application to forest plantations research culminated in the development of end-user best management practices, which is providing a useful tool for the local governments and other end-users to make informed decisions to manage biosolids sustainably (Magesan, et al., 2010).

The sustainability approach of the Scion programme led to a considerable focus on social and cultural research on biosolids management. Social research within this programme was closely aligned with Māori focused research to maximize outcomes for all communities. The cultural research initially concentrated on Māori partnerships for evaluating sustainability, with a detailed study of traditional and contemporary Māori views and values (Pauling & Ataria, 2010). The social and cultural research centred on community engagement to enable sustainable solutions for a major urban centre and a peri-urban/peri-rural community by studying a framework, thereby enabling better waste management decision-making. Scenario Workshops to design future strategies for biosolids management for Christchurch City found that the approach had an enormous potential for addressing local and regional issues (Goven and Langer, 2005; 2009) and was found to be well-regarded by the community. The peri-urban/peri-rural community dialogue culminating in a community hui, led the Christchurch City Council to agreeing to rectify some outstanding issues of community concern, thereby bringing positive social impact for the community (Langer, et al., 2008).

Principal scientists involved in the ESR and Scion led New Zealand Public Good Science Fund biosolids research programmes joined forces to present a combined programme to FRST. FRST has agreed to fund a new joint programme to provide research to the address the hypothesis that uncertainty is a key barrier to land application of biosolids for four years from October 2009. The sustainability focus has been extended by including an economic component to the environmental, social and cultural research. The new programme is under the partnership of three CRIs: ESR, Scion, and Landcare Research, and in collaboration with colleagues from other CRIs, universities and iwi.

## **2 INTEGRATED ENVIRONMENTAL, SOCIAL, CULTURAL AND ECONOMIC RESEARCH**

The new joint integrated research programme will have a social science focus, and will integrate the social components with community focused biophysical, cultural and economic research to provide better management tools and guidelines for a range of contaminants, including research that will explore how biosolids nutrients can add value to soils without compromising economic and aesthetic values. The research aims to help overcome immediate barriers preventing the beneficial reuse of biosolids and result in a reduced quantity of biosolids going to landfill.

The behaviour of nutrients and established and emerging contaminants (organic, inorganic and biological) present in the expanding range of differently treated biosolids will be predicted, and integrated with social, cultural and economic risk criteria to support the development of viable management practices that optimise beneficial biosolids reuse. Research will determine which new and emerging contaminants are of most concern; their comparative cost of management; how combinations of contaminants interact with soil biota and alter biological indices of soil health and fertility; what environmental, regulatory, social and cultural drivers limit land application; and how the costs and benefits of biosolids application can best be measured and used in a risk assessment framework.

## **2.1 THE INTEGRATED CASE STUDY APPROACH**

The research will be centred on two case studies in Kaikōura and Taupo where the research team will work in partnership with small communities, district and regional councils in relationships with strong and vibrant Māori authorities, and a commitment to sustainably managing municipal biosolids. The two research sites aim to provide 'real time, real issue' settings that fully integrate the biophysical and social/cultural research streams.

One case study is focused on the South Island coastal town, Kaikōura. The Kaikōura District Council is the first local authority in the world, and the second community in the world, to achieve Green Globe certification in recognition of its commitment to protecting the environment and working towards sustainability for their community, visitors and future generations. In addition, it was one of the first councils in New Zealand to adopt a 'zero waste' policy. Here, researchers will explore the reuse of biosolids with Māori, local government and extend this dialogue and engagement with the wider community. This will occur in the context of implementing the 'zero waste' strategy and Green Globe certification as the environment and clean green image underpin the success of the town's thriving Māori owned and operated tourism industry that services about one million visitors every year. Sewage sludge has been dredged from the town's sewage settling ponds following about 25 years of use. Approximately 1500 tonnes of sewage sludge/biosolids has been left to weather in a pile at the Kaikōura District Council waste treatment plant and the council is keen to engage with the community to explore beneficial reuse options.

A second case study will explore possible constraints and opportunities for the reuse of biosolids by district councils and Māori land entities in the Taupo/Rotorua areas. Incorporations such as Tuaropaki Trust are aware that cultural values and market perceptions associated with land application of biosolids may impact across its various business ventures (farming and horticulture). As well, several communities around Lake Taupo, such as Waitahanui with about 900 permanent residents and an ageing septic tank system, are in need of sewage infrastructure investment, of which waste management and nutrient recovery through a vermi-composting system may be an acceptable and practical option. The Taupo case study provides an opportunity to study the different cultural concerns and aspects of risk, uncertainty and impact relating to different biowaste treatment methods and risk management frameworks.

Both case studies aim to: a) identify conditions that might support a land application decision, b) further develop our knowledge on the social, cultural, economic and environmental barriers to land application, and c) better understand how stakeholder communities negotiate risk and uncertainty in complex decision-making. In particular, we aim to better understand how a reuse decision is considered and debated by mana whenua, Māori operators, local government and their wider community, and how complex trade-offs might be overcome. A cross-case study design will facilitate shared learning and support a transferable process for integrated land management planning for biosolids reuse.

A three-phase approach is planned for the case study fieldwork. Phase one is a scoping and framing exercise to understand the current situation using a stakeholder analysis. The second phase is to explore uncertainty and co-design further interventions. The third phase is improved risk management planning followed by an evaluation of the process and outcomes.

### 2.1.1 COMMUNITY HUI

Annual hui, alternating between case study sites, will bring all the researchers with a significant component in the research programme together with iwi partners to plan the research, report research results and bring the broader community into the decision-making process to determine the future biosolids management options.

As the first step in the integrated case study approach a very successful project planning hui was held at Takahanga marae, Kaikōura in October 2009 (see Photographs 1 & 2). This strengthened the excellent relationships with local community who were highly supportive of where the research could explore beneficial reuse with the wider community.



*Photograph 1: Senior research team with Kaikōura mayor and CEO Kaikōura District Council, Takahanga marae, Kaikōura, October 2009.*



*Photograph 2: Partners and research team at Takahanga marae, Kaikōura, October 2009.*

The next hui is planned for Taupo in October 2010. It is intended that the research team will focus on building and sharing learning between the biophysical science and the social sciences at the hui. A key focus will be to compare the two case studies and share local knowledge and experiences in biosolids based management and possible ventures between Taupo and Kaikōura. An aim of this hui is to generate viable scenarios for Kaikōura and Taupo and to identify further key areas of uncertainty that can be explored and addressed through the full research programme.

The depth of knowledge and experience with beneficial reuse in the Taupo region will allow the social science team to further explore and document key barriers and uncertainties, including end-user and market dependencies, changing costs, cultural impacts and risk communication dilemmas. The knowledge and experience in Taupo could be a good resource to support Kaikōura to reflect and develop options for suitable reuse options in their area.

### **3 CONCLUSIONS**

The new multi-agency integrated environmental, social, cultural and economic research will benefit New Zealand by addressing knowledge gaps around benefits and risks of biosolids. It will generate further information needed for local authorities and communities to make informed decisions about beneficial management options, including land application, for biosolids. In addition, it will provide a portfolio of effects-based evidence to support or reject the current stance on biosolids application to land; address community, and particularly Māori, concerns about biosolids being added to soil; identify the risks to food products grown in soils enhanced with biosolids; and provide evidence for cost effective alternatives to landfilling that include long-term social and environmental benefits of applying biosolids to land.

These outcomes from the case studies will result in an increase in resource recovery, potential revenue returns from adding value to a former waste product, longer landfill life, lower environmental footprints, improved soils for primary production, social and cultural understanding of reuse solutions, lower compliance costs, improved regional soil and water quality, and increased carbon reserves.

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