FIGURE 1: A field-plot scale study examined the surface runoff of contaminants following the land application of three types of biosolids from the same WWTP.

Application of wastewater treatment plant sludge to land

TEAGASC researchers have been collaborating in a study on the production of sewage sludge from wastewater treatment and its impact on agricultural land in Ireland.

The development of wastewater treatment facilities in Ireland has meant that more wastewater is subject to high levels of treatment. While this is good for the environment, it also means that more sewage sludge – an organic by-product of wastewater treatment – is produced. The production of sewage sludge has increased over the years, and in 2015 more than 58,000 tonnes were produced in the Republic of Ireland. The treatment and disposal of sewage sludge presents a major challenge in wastewater treatment, and although there are many disposal and reuse pathways, in Ireland up to 80% is currently reused on agricultural land. This is done in accordance with current guidance documents and legislation, but there remains concern over the presence of metals, nutrients, pathogens, pharmaceutical and personal care products (PPCPs), and other endocrine-disrupting and synthetic compounds in sewage sludge, which may cause environmental and human health problems. An EPA-funded research project, comprising researchers from NUI Galway, Teagasc and UCD, set out to examine all aspects of sewage sludge production and application to agricultural land.

Aims

The aims of this research were:

1. To quantify the range of concentrations of metals, and of two of the most abundant PPCPs in the world, the antimicrobials triclosan (TCS) and triclocarban (TCC), in treated sewage sludge ('biosolids') from a range of wastewater treatment plants (WWTPs) in the Republic of Ireland.
2. To undertake a field-scale experiment to assess losses of nitrogen (N), phosphorus (P), metals, TCS and TCC, and microbial matter following successive rainfall events on grassland onto which biosolids had been applied, and to compare the results with another commonly spread organic fertiliser, dairy cattle slurry.
3. To measure the uptake of metals by ryegrass for a period of time after the application of biosolids.
4. To conduct a risk assessment of potential hazards of human health concern based on the experimental data.

To read the published EPA report visit: http://www.epa.ie/researchandeducation/research/researchpublications/researchreports/research200.html.

Results

The concentrations of metals in the biosolids in 16 WWTPs examined ranged from 11mg/kg (cadmium) to 1,273mg/kg (zinc), and were within the EU regulatory limits (Healy *et al.*, 2016a). Amounts of two potentially hazardous metals, antimony and tin, for which no legislation currently exists, were much higher than their baseline concentrations in soils, meaning that potentially large amounts of these elements may be applied to the soil without regulation. The antimicrobials, TCS and TCC, neither of which are governed by existing legislation, were present in low quantities, and were well below the concentrations reported elsewhere. Working with colleagues in the Galway-Mayo Institute of Technology, the researchers found that small plastic particles, with particle sizes less than 5mm, called microplastics, were present in the biosolids from all the WWTPs examined (Mahon *et al.*, 2016). As these are potential vectors for the transfer of contaminants, their presence in biosolids is concerning.

Runoff study

A field-plot scale study examined the surface runoff of contaminants following the land application of three types of biosolids (anaerobically digested, lime stabilised, and thermally dried). The biosolids all originated from the same WWTP and, to facilitate comparison to another type of organic waste, were applied at the same rate as dairy cattle slurry to the plots (**Figure 1**). All plots were then subject to numerous simulated rainfall events, during which water flowing over the soil surface ('runoff') was collected and analysed for a range of water quality parameters.

This study found that nutrient concentration in runoff following land application of dairy cattle slurry was far greater than the concentrations arising from the application of biosolids (Peyton *et al.*, 2016). Furthermore, the metals and microbial matter present in the runoff from the biosolids-amended plots were, in general, of the same order as the dairy cattle slurry plots. Therefore, in these respects, the application of biosolids to land did not pose a greater risk than dairy cattle slurry. Furthermore, there was no significant difference in metal bioaccumulation of the ryegrass between plots that received biosolids and those that did not, over the study duration (Healy *et al.*, 2016b).

Exposure assessment models, which considered human exposure to metals and *E. coli* through surface water abstracted for drinking, indicated that the risk of illness was negligible for healthy individuals (Clarke *et al.*, 2016, 2017).

Conclusion

The overall conclusion from this study is that although, in general, land-applied biosolids pose no greater threat to water quality than dairy cattle slurry, and cattle exclusion times from biosolids-amended fields may be overly strict (within the context of current exclusion criteria), a matter of concern is that unlegislated metals, PPCPs and microplastics, found to be present in biosolids originating from a selection of WWTPs examined in this study, may be inadvertently applied to land. With multiple applications over several years, these may build up in the soil and enter the food chain, raising concerns over the continued application of biosolids to land in Ireland.

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