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How well do soils filter Escherichia coli applied in animal wastes

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While human excreta are treated generally in centralized facilities, dung and urine from grazing animals are deposited directly onto land. Animal wastes applied to land provide a valuable source of nutrients for plants and microbial growth and functioning. However, animal wastes also contain microbial pathogens. Therefore, it is important that soils act as an effective barrier between applied waste and the surface or ground waters that ultimately receive the waste. Using large diameter (500 mm diameter $\times$ 700 mm high) undisturbed replicate soil cores (lysimeters) irrigated with animal waste (dairy shed effluent), we have shown soils vary in their ability to filter Escherichia coli. In strongly structured soil E. coli readily move through most soils by bypass flow. This type of flow is characterised by the presence of high numbers of E. coli in the leachate collected at the base of the core soon after surface application of the dairy shed effluent. Under bypass flow, E. coli are excluded from smaller pores by their size and or aggregation, move preferentially through larger soil pores and structural cracks in the soil where transport velocities are rapid. However, in soils without a strong soil structure, E. coli are transported through the soil predominantly by matrix flow, thus allowing better filtration and retention of the E. coli by the soil.

In soils where >80% of the soil aggregates are retained on a 10-mm aperture sieve, bypass flow of E. coli is dominant. Whereas in soils where <20% of the soil aggregates are retained on a 10-mm aperture sieve, matrix flow of E. coli is dominant. Typically, clayey soils have high microbial bypass flow and surface-applied microbes are rapidly transmitted to depth. In contrast, microbes appear to be retained in soils developed in air-fall volcanic material. This and other information on soil properties available directly or from accessory soil properties of the New Zealand Soil Classification have allowed us to make a country-wide map showing the potential for microbial movement through soil. Soil properties used include drainage class, presence of pans, argillic horizons, soil structure, and the nature of the parent material. In New Zealand, the microbial bypass flow potential of soils has already been incorporated into local body regulations governing the application of dairy effluent. In future, the spatial soil microbial movement data will be combined with hydrological models to model catchment scale movement of E. coli.

As there is evidence for the growth of E. coli within the soil, a new area of our research will be to use genotyping and cluster analysis of E. coli to determine whether the surface-applied E. coli are the same as the E. coli collected at the base of the lysimeter after passing through the 700 mm of undisturbed soil.