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Overland transport of manure-borne pathogen indicator organisms: observations and modeling

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Significant amounts of pathogenic microorganisms are released with the land-applied or deposited animal waste and are subsequently transported with runoff. The objective of this presentation is to summarize several experimental datasets that elucidate mechanisms of this transport and the magnitude of uncertainty in transport parameters of pathogen indicator organisms.

Pathogen concentrations may first grow rather than decrease in deposited animal waste. In experiments with bovine fecal samples, *E. coli* concentrations showed up to 1.5 order of magnitude increase both in the field and in laboratory during the first week and subsequently decreased. .The die-off was faster in the field than in the laboratory at similar temperatures. The proportion of potentially pathogenic *E. coli* in total released *E. coli* did not change during the first month.

Release rates may be organism-specific for the same animal waste. We observed significant differences in release of *E. coli* and enterococci from bovine manure. A change from first-order release kinetics to zero-order kinetics after 1 h of rainfall simulation was observed.

Manure particulates released along with pathogens may substantially inhibit the association of pathogens with soil particles. We observed the negligible association of *E. coli* with wet soil aggregates in presence of manure suspensions, whereas the bacteria association with dry soil aggregates remained substantial even in presence of manure suspensions.

The temporal stability of particle size distributions was observed in runoff and soil leachate from bovine manure slurry after 15 min of the runoff initiation. Particles had the median diameter of 3.8 μm, and 90% of particle diameters were between 0.6 and 17.8 μm.

Fecal coliforms from the manure slurry partition between solid and liquid phases of the overland flow. Seasonal variations of the partitioning coefficients between 10 ml g^{-1} and 50 ml g^{-1} were observed in experiments with the bovine manure slurries.

E. coli concentrations in field applied manure were typically lognormally distributed with four orders of magnitude difference between concentrations at the 10% and 90% probability levels.

Modeling overland *E. coli* movement as the convective-dispersive transport with the first order reversible retention kinetic term and the infiltration-proportional surface straining rate was generally successful for field plot experiments. The differences in attachment and detachment rates could not be efficiently evaluated from the runoff experiment data. The surface straining rates were negligible at grassed plots and reached maximum at bare plots. The flow-surface partitioning coefficients were relatively stable and varied between 75 and 100 ml g^{-1}, whereas the surface attachment rate constants exhibited the high variability with the 95% tolerance interval between 0.1 h^{-1} and 10 h^{-1}.

Simulations showed that relatively long high-intensity rainfalls, low infiltration, and concentrated flow between vegetation clumps can promote the overland transport of pathogens. The high uncertainty in parameters of the overland transport of manure-borne pathogens indicates the need in probabilistic characterization of this transport with site-specific soil and weather properties.