Reducing human health risks from animal agriculture: Comparative analysis of the transmission of multiple zoonotic pathogens in mixed-use agricultural systems

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Justification:
The prevalence of some waterborne pathogens has prompted water districts, food safety agencies, and regulatory agencies to include animal agriculture and wastewater treatment plants in their list of possible adulterating water sources during outbreak investigations. This has renewed public interest, and highlighted the need to better understand transmission dynamics along potential transport pathways from fecal pathogen sources to humans via drinking and irrigation water supplies. While there has been considerable research on transport of microorganisms at small scales, such as in flow cells and packed columns of sediment, the transport dynamics of zoonotic pathogens at the field, farm, and catchment scale are still poorly understood.

Objectives:
This study is designed to understand similarities and differences in the occurrence, fate, and transport of key zoonotic pathogens and several indicator organisms in soil water, groundwater, and surface water at the field- and catchment-scale; and to provide a conceptual framework for the quantitative assessment of pathogen transport in the surface water – groundwater continuum. We evaluate the environmental transmission of *Cryptosporidium*, *Campylobacter*, *E. coli* O157:H7, and *Salmonella*, as well as the indicator organisms *Enterococcus* spp. and *Bacteroidales* in animal production areas and in cropping systems irrigated with waters containing animal or human waste. This project begins to evaluate whether our current understanding of lab-scale processes can be scaled to the field- and catchment-scale. With multidisciplinary expertise in microbiology, veterinary medicine, and hydrology, the project team combines the strength of empirical work at various scales in agricultural systems with the need to understand transport processes based on first scientific principles.

Progress to date:
Over the past 15 months, we have completed three field sampling campaigns of a dairy groundwater monitoring network. The network encompasses eight dairies in two distinctly different hydrogeologic regions of the San Joaquin Valley, California. Monitoring wells are constructed to collect groundwater immediately below the water table, representing recent groundwater recharge (from 0 – 2 years). Source areas of the monitoring wells include dairy wastewater lagoons, animal holding areas (corrals), forage fields irrigated with diluted liquid manure, and non-treated agricultural lands. Preliminary results show widespread occurrence of indicator organisms, while no confirmed detections were made in shallow groundwater of *Campylobacter*, *Salmonella* or *E. coli H7:O157*.

Impacts:
The knowledge gained will be critical to better assess and delineate the potential impacts of cattle grazing, confined animal agriculture (dairy), and municipal effluent application in cropping systems on surface water and groundwater quality.