USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Field Assessment Of Groundwater Quality Beneath Cracking Soil With Surface-Applied Hog Manure.

Focus Categories: AG, GW, NPP.

Keywords: Agriculture, Animal Waste, Contaminant Transport, Groundwater Quality, Hydrology, Infiltration, Mathematical Models, Soil Physics, Surface-Groundwater Relationships, Unsaturated Flow, Water Quality Modeling.

Duration: March 1, 1999 to February 28, 2001 (24 months).

Federal funds requested: 30,979 30,979 0 Total Direct Indirect

Non-Federal funds pledged: 62,674 33,833 28,841 Total Direct Indirect

Principal investigator: Dr. Robert Horton, Iowa State University

Congressional district: Iowa 3rd

Statement of critical regional or state water problems

The hog industry in the Midwest has a large impact on regional economies. It may have a large impact on surface and ground water quality as well. Hog manure is often spread over agricultural fields as a source of nutrients for crops (Hoag and Roka, 1995). Surface-applied manure is a potential source of nitrate in surface and ground water, which is usually used for drinking water in the region (Simpson, 1991). High nitrate concentration (>10 mg L-1) in drinking water is hazardous to human health . Intensive studies to reduce manure impact on both surface and ground water have been conducted (Mikkelsen and Gilliam, 1995). Especially vegetative filter strips were found to be effective in improving surface and ground water quality.

However, solute (manure) transport in cracking soils has had little attention. The cracking soils occupy large areas in Iowa and substantial part of the region. Water containing manure can flow preferentially along openings of cracks. Crack formation and widths of openings are functions of soil water content (Noborio et al., 1998). Ewing et al. (1998) reported that depths of cracks of an Iowa cracking soil reached 0.5 to 0.7m below the surface and connected to wormholes so that surface cracks acted as collectors or funnels for wormholes which might carry contaminated surface water to groundwater. With field measurements Lin et al. (1998) found that locations with 1 to 5mm-wide cracks had two to three times higher infiltration rates than locations without cracks in cracking soil. After cracks appear to be closed with hydration, they still contribute to flow (Drumm and Wilson, 1997). Widths of cracks reached as wide as >30mm in the field while they could be >0.1m in extreme cases (Lin et al., 1998). Water can flow at rates as high as 0.5 m s-1

through 30mm-wide surface cracks, several orders of magnitude larger than in clay. Thus, a risk of drinking water contamination due to surface-applied hog manure in regions with cracking soils might be much higher than anticipated as illustrated in Fig. 1. To evaluate a present status of groundwater quality and develop future strategies of hog manure application to reduce degradation of groundwater quality, detailed studies of preferential transport through dynamically changing cracks need to be conducted.

Statement of results or benefits

This study includes both field experiment and a numerical model of hog manure transport in cracking soil. The field study will provide data on hog manure mobility and threat to groundwater quality of a particular location and time period. The model will be used to study numerically other soil and climate conditions. This project will provide answers to the question of how important cracks are in transporting hog manure to groundwater.

Nature, scope, and objectives of the research

This work will investigate impacts of surface-applied hog manure transported through dynamically changing soil cracks on groundwater quality by field measuring and modeling techniques. Objectives are:

1) To obtain field measured data of water, manure, and crack dynamics in cracking soil; and

2) To apply a numerical model (the GLEAMS-CF model described by Morari and Knisel, 1997) to simulate water flow and manure transport through dynamically changing soil cracks, and to evaluate the model's performances by comparing field measured data.