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A hydrobiological mechanism controlling the synergistic effects of unsaturated flow and soil organic matter on transport and degradation of EOCs in soils

XIJUAN CHEN[1] AND JIE ZHUANG[2]

[1]Institute of Applied Ecology, Chinese Academy of Sciences
[2]The University of Tennessee

Presenting Author: chenxj@iae.ac.cn

Irrigation with reclaimed water and sludge application introduces emerging organic contaminants (EOCs) into soils, causing soil health and food safety concerns. Hydrology is a key factor influencing transport and microbial degradation of EOCs, but the impact depends on the properties of the soil and the EOCs. A key knowledge gap is how soil characteristics determine the degradation and transport of EOCs. In this study, biotic and abiotic column experiments were performed to investigate the degradation and transport of EOCs in soils with different soil organic matter (SOM) content under saturated and unsaturated flow conditions.

The results demonstrate that a small desaturation (e.g., 20%) of pore water could greatly increase the retention and degradation of biodegradable, non-dissociated, or negatively charged EOCs, such as bisphenol-A and ibuprofen, depending on SOM content. However, the desaturation had no effect on the degradation and transport of these compounds when microbial activity was inhibited and/or SOM was depleted from the soils. Comparison of SOM-differing soils indicated that the desaturation effect was larger in soils with higher SOM content. Dominant processes include air water interface (AWI) -enhanced attachment of microorganisms and SOM-facilitated adsorption of EOCs at soilwater interface (SWI), where SOM existed and biodegradation happened. This study provides an important implication that AWI and SWI might have a nonlinear relationship in promoting the adsorption and reducing the mobility of EOCs under unsaturated flow conditions.