Geophysical Research Abstracts
Vol. 20, EGU2018-16799, 2018
EGU General Assembly 2018

The transformation of organic matter in on-site wastewater effluent percolating through soil as determined using fluorometric methods

Donata Dubber, Jan Knappe, Celia Somlai, and Laurence Gill
Trinity College Dublin, Civil, Structural and Environmental Engineering, Ireland (dubberd@tcd.ie)

The key attenuation / biogeochemical recycling processes with respect to the discharge of on-site effluent into soil are fundamentally regulated by the microbial biomat that forms at the infiltrative surface. This research has focused on the transformation of the organics in the effluent as they pass through the biomat, infiltrating into the unsaturated zone beneath, in order to allow further insights into linked contaminant attenuation and transformation processes, particularly in relation to nitrogen removal and virus transport.
Field research has been carried out on two full-scale Domestic Wastewater Treatment Systems with percolation areas in moderate permeability subsoils in Ireland. Half of the percolation area at each site was receiving primary effluent (PE) from a septic tank while the other half was receiving secondary treated effluent (SE) from a small packaged treatment plant. Respective samples of PE and SE as well as soil moisture samples of percolating PE and SE at 10 cm beneath the biomat from the different trenches have been collected across different times of the year. These have been analysed using Excitation-Emission Fluorescence Spectroscopy to determine differences in the nature of organic matter and transformations.
The fluorometric analysis has been used to determine Humification Index (HI) and presence/absence of Fluorescent Whitening Compounds (FWCs). The Excitation-Emission-Matrices (λex = 230-455 nm, λem = 290-700 nm) followed by PARAFAC analysis has then been used in order to identify and quantify contributions from underlying signals from fluorescent organic compounds. From the PARAFAC analysis a 6-component model was obtained whereby individual model components could be assigned to Fulvic acids (FA), Humic acids (HA), FWCs and protein-like (tyrosine- and tryptophane-like) compounds. The results demonstrate that contributions from proteins were significantly higher in primary effluent (50%) than in secondary effluent (29%). With aerated secondary treatment the ratio between tyrosine- and tryptophane-like compounds also decreased. As the effluent percolates through the soil beneath the trenches a reduction in contributions from proteins and FWCs was observed and the contribution of HA increased. This is also reflected in an increase of the HI. Finally, samples of soil moisture from outside of the effluent plume were characterised by high HI and high HA and FA contributions with a similar organic composition to Suwannee river sediment, commonly used as the reference for natural organic matter.
Finally, a multi-virus injection experiment was conducted on both sites using a selection of bacteriophages and compared between percolation trenches receiving PE and SE. Three phages (MS2, φX174 and PRD1) were used and the comparative phage attenuation and transport rates beneath the different trenches have been compared and correlated against the respective dissolved organic matter compositions en route through the biomat and into the unsaturated subsoil beneath.