Geophysical Research Abstracts,
Vol. 11, EGU2009-11396, 2009
EGU General Assembly 2009

Forced gradient infiltration experiments: effect on the release processes of mobile particles and organic contaminants

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Mobile colloidal and suspended matter is likely to affect themobility of polycyclic aromatic hydrocarbons (PAHs) in the unsaturatedsoil zone at contaminated sites.

We studied the release of mobile (organic) particles (MOPs), which include among others dissolved and colloidal organic matter in response to forced sprinkling infiltration and multiple flow interrupts using undisturbed zero-tensionlysimeters. The aim was to assess the effect of these MOPs on the exportof PAHs and other contaminants in floodplain soils. Seepage water samples were analyzed for dissolvedand colloidal organic carbon (DOC), PAH, suspended particles, pH, electrical conductivity, turbidity,zeta potential and surface tension in the fraction smaller 0.7μm. In additional selected PAH were analysed in the size fraction > 0.7 μm. Bromide was used as a conservative tracer to determine the flow regime.

First arrival of bromide was detected 3.8 hours after start of irrigation. The concentration gradually increased and reached a level of C/C_0=0.1 just before the flow interrupt (FI). After flow was resumed, effluent bromide concentration was equal to the concentration before the FI. Ongoing irrigation caused a breakthrough wave, which continuously increased until the bromide concentration reached $\sim$100% of the input concentration.

A high-intensity rain event of 4 L m $^{-2}$ h^{-1} upon summer-dried lysimeters results in a release of particles in a the size of 250-400 nm. In addition it seems that with the initial exported seepage water surface-active agents are released which is indicated by the decrease of the surface to 60 mN m^{-1} (Pure water: 72mN m^{-1}). The turbidity values range from 8-14 FAU. The concentration of DOC is about 30-40 mg L^{-1} in the initial effluent fractions and equilibrates to 15 mg L^{-1} with ongoing percolation. The PAHs in the fraction < 0.7 μm amount to 0.02 μg L^{-1}, and 0.05 μg L^{-1} in the fraction > 0.7 μm.

After establishing steady state flow conditions, first arrival of bromide was detected after 6 hours of irrigation. If uniform flow at water-saturated conditions were assumed, first arrival of bromide would be expected not earlier than 16 hours (approx. 0.3 pv) after start of irrigation. The much earlier arrival points to the fact, that transport along preferential flow paths controls part of the bromide transport. Round 30% of the total infiltrated solution remains in the lysimeter and might comprise $\sim$ 70% of the water holding capacity of the micro- and mesopores (equivalent pore diameter < 0.2 μm and 200- 0.3 μm, resp.). Flow and transport in response to the simulated heavy rain event seem to be controlled by the macropores. This in turn affects the release of PAHs, in particular those associated with particles.

Singular events, like the studied heavy rain events, drying/rewetting or freezing/thawing cycles seem to be the most prominent trigger of PAH mobilization and transport in surface soil horizon not only at floodplain sites.