Geophysical Research Abstracts, Vol. 9, 02872, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02872

Persistent organic pollutants in the unsaturated soil domain under transient flow conditions

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Most Persistent Organic Pollutants (POPs) are subject to strong sorption in the subsurface, which not only decreases a compounds' bioavailability but also increases its residence time in the soil. Typical field scenarios exhibit a contamination source term in the upper soil profile as a result of a point source pollution incident or diffuse pollution like deposition by air or water. Assessing the contaminants' further fate requires modeling of various processes active in the subsurface, such as advective-dispersive transport, sorption and degradation.

When modeling the mobility of POPs in soil, commonly steady state flow fields and linear equilibrium sorption behavior is assumed, to keep mathematics simple. Research in the last decades, however, found many organic pollutants' sorption properties to be highly nonlinear and limited by mass transfer. The steady state flow field assumption is another simplification, which is often valid in laboratory experiments, but depending on the climatic environment, precipitation variability and soil hydraulic properties this is not true for actual field sites. Especially when kinetic sorption behavior and transient flow fields in the unsaturated zone come together, simplified models often are unable to predict the true contaminant fate, even more so when biodegradation can be expected, or when process parameters vary over depth in layered profiles.

Therefore the need arises to classify sites or conceptual models into environments under which simplifications like equilibrium sorption or steady state flow may be safely assumed, or where those simplifications significantly increase our model uncertainty or even lead to wrong predictions.

This talk shows model calculations for contaminant movement in the unsaturated soil zone and compares results with different mass transfer rates under transient and steady state flow fields.