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Event-driven dynamics of the total mobile inventory in soils - Results from a comparative multi-year lysimeter study

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A diverse size- and matter spectrum of inorganic, organo-mineral and organic substances, and dissolved, colloidal, but also larger particulate matter, including microbiota, is mobile in soil and potentially involved in matter interchange between surface and subsurface ecosystems. Specifically including the widely neglected particulate fractions, conditions and field-scale factors controlling the long-term seasonal and episodic dynamics of the "total mobile inventory" (Lehmann et al., 2021), in undisturbed soil and its translocation through the subsurface of the Critical Zone is almost unknown. To overcome this knowledge gap, we established long-term soil monitoring plots in the Hainich Critical Zone Exploratory (HCZE; NW-Thuringia, central Germany). Soil seepage from 22 tension-controlled lysimeters in topsoil and subsoil, covering different land use (forest, pasture, cropland) in the topographic recharge area of the HCZE, was collected and analyzed by a variety of analytical methods (physico-/chemical and spectroscopic) on a regular (biweekly) and event-scale cycle. Atmospheric forcing was found to be the major factor triggering the translocation of the mobile inventory, mainly causing considerable seasonality in the solute signature (e.g., sulphate) and seepage pH. However, episodic high-flow (infiltration) events rather than seasonality caused mobilization of significant amounts of particulates, for instance, after snow melts or rainstorms. Noteworthy, particulate organic carbon translocated during the winter-season infiltration events, accounted for up to 80% of annual fluxes. On average, 21% of the total OC of the seepage was particulate (>0.45 µm). Our study provides field-scale evidence for the importance of the mobile inventory fraction >0.45 µm for soil elemental dynamics and budgets. We, thus, suggest involving suspended fractions in environmental monitoring programs, although requiring adapted sampling procedures.

References:

Lehmann, K., Lehmann, R., & Totsche, K. U. (2021). Event-driven dynamics of the total mobile inventory in undisturbed soil account for significant fluxes of particulate organic carbon. Science of The Total Environment, 143774.