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The impact of different flooding periods on the dynamics of pore water concentrations of As, Cr, Mo and V in a contaminated floodplain soil – results of a lysimeter study

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Trace elements and arsenic (As) were transported with water during inundation in floodplain ecosystems, where they settled down and accumulated predominantly in depressions and low-lying terraces. Highly variable hydrological conditions in floodplains can affect the dynamics of pollutants. The impact of different flooding/drying periods on the temporal dynamics of pore water concentrations of As, Cr, Mo and V as a function of soil EH/pH changes and dynamics of DOC, Fe, Mn and SO42- was studied in a contaminated floodplain soil collected at the Elbe River (Germany). A specific groundwater lysimeter technique with two separate small lysimeter vessels served as replicates was used for this study. The groundwater level inside the lysimeters was controlled to simulate long term and short term flooding/drying. The long term (LT) flooding scenario consists of 94 days of flooding followed by similar drying term. The short term (ST) flooding/drying scenario comprises 21 days and was six times repeated. The entire experimental period (LT_ST) was about 450 days.
Flooding of the soil caused a significant decrease of EH and pH. Concentrations of soluble As, Cr, Fe, Mn, Mo and DOC were higher under reducing conditions than under oxidizing conditions in LT. However, As and Cr tended to be mobilized under oxidizing conditions during ST, which might be due to slow kinetics of the redox reaction of As and Cr. Dynamics of Mo were more affected by changes of EH/pH as compared to As, Cr and V and governed mainly by Fe-Mn chemistry. Concentrations of V in ST were higher than in LT and were controlled particularly by pH and chemistry of Fe. The interactions between the elements and carriers studied were stronger during long flood-dry-cycles than during short cycles, which confirmed our hypothesis. We conclude that the dynamics of As, Cr, Mo and V are determined by the length of time soils are exposed to flooding, because drivers of element mobility need a certain time to provoke reactions in soils under changing conditions.