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Titel
Soil Contamination due to Arsenic-Enriched Irrigation Water – Impact of Irrigation Practices

Abstract
Increasing irrigation with arsenic (As) contaminated groundwater represents a growing problem in the densely populated delta and floodplain regions of SE Asia. The overarching aim of this study was to evaluate retention and mobility of As in soils in dependence of the irrigation practice. Irrigation of calcareous agricultural soils was simulated in a green-house experiment, in which artificial anoxic groundwater enriched in dissolved AsIII (10 mg/L) was applied regularly. We compared the following three different irrigation scenarios: permanently flooded, promoting reducing conditions (R); alternating flood irrigation, characterized by frequent changes in water saturation (RO); and sprinkler irrigation, maintaining permanently oxic conditions (O). Several wet chemical extraction procedures were carried out to characterize soil As storage pools at the end of the experiment. Pore water analysis reflected strongly reducing redox conditions (up to 42.9 mg/L dissolved Fe) for the R treatment, while less reducing conditions developed in the RO scenario (Fe max. 0.14 mg/L). Furthermore, As concentrations in pore water increased steadily to 1.34 (R) and 0.39 mg/L (O), respectively, with 20% (R) and 80% (RO) being present in the oxidized form AsV. The addition of As by irrigation water resulted in surprisingly similar depth distributions being independent of the irrigation treatment. Highest As contents (R: 52.2, RO: 49.6 and O: 43.9 mg/kg) occurred within the top 0-2 cm and decreased rapidly to values close the initial content (11.5 mg/kg) below 4 cm depth. This reflects a generally high sorption capacity of the soil for As. Even reductive dissolution of Fe-phases and the accompanying loss of sorption sites (R treatment) did not affect the As sorption behavior in general. However, pore water As concentrations and sequential extraction results point at a higher As mobility in case of the R treatment. This can be explained by the higher proportion of AsIII in the pore water, which is more mobile than AsV at the prevailing conditions. In sum, the three irrigation practices did not result in differences regarding the vertical distribution of As, but permanent flooding clearly increased the mobility of As as compared to the other treatments. The comparison of different wet chemical extraction procedures further emphasizes that protocol and sample treatment should be selected with caution, especially when redox conditions in the soil vary.