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Arsenic contamination of the Ogosta River floodplain and its environmental impacts

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The floodplain soils along the Ogosta River, northwestern Bulgaria, are heavily contaminated with hazardous metals and metalloids as the result of historic mining activities and a tailings dam failure in 1964. Arsenic (As) is the main contaminant with concentrations locally exceeding 10'000 mg As per kg soil. This extreme pollution poses a risk to ecosystem and human health as large areas of the floodplain are used as pasture and cropland. Knowledge of arsenic uptake by plants other than commodity crops is sparse, in particular for floodplains. Floodplain soils are subject to flood events, e.g., during snow melt in spring or after heavy rainfall. Water-saturation can trigger reductive dissolution of iron mineral phases having a high capacity for As retention. The contaminated floodplain soils may therefore act as a major source of dissolved As during floodings.

In a detailed study along a transect across the Ogosta River floodplain close to the reservoir nearby the city of Montana, we investigated the As levels in soils and in the plant species Trifolium repens and Holcus lanatus. The strong contamination gradient observed in soil was clearly reflected in the shoots of both herbaceous species. Soil-to-shoot transfer factors were found to be fairly low, with values mostly below 0.07 (As-shoot/As-soil).

Flooding-induced solubilization of As from soils was studied by laboratory experiments simulating prolonged flood events in microcosms. We identified the reductive dissolution of As-bearing Fe oxyhydroxides as the major mode of As solubilization. High manganese contents in soils were found to limit this process. The results further showed that As solubilization was strongly controlled by temperature and the availability of nutrients, most likely organic carbon, indicating that As solubilization is largely driven by microbial activity.