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Climatic conditions impact As and Cd mobility differently in flooded paddy soils

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Arsenic (As) and cadmium (Cd) contamination in rice paddy soil are prevailing due to human activities including the application of agrochemicals and wastewater irrigation. Due to their inherently different geochemistry, As transitions to the porewater becoming more mobile under flooded water management while Cd binds to sulfidic minerals becoming more immobile. We currently have little understanding to which extent future climatic conditions imprint on native and elevated Cd and As mobilities in paddies, and whether they influence each other when being present in elevated concentrations together.

In order to close this gap in knowledge, we performed an incubation experiment with flooded paddy soils exposed to two different climatic conditions. The soil either contained the native metal(loid) content or elevated As and Cd realistic for contamination scenarios (+15 mg/kg As, +0.7 mg/kg Cd, or combined with +15 mg/kg As and +0.7 mg/kg Cd). Future climatic conditions were set relative to today's climatic conditions (ambient CO_2 and room temperature) with 850 ppm atmospheric CO_2 and +4°C air temperature.

Adsorbed As approximated with 0.01 M $CaCl_2$ extraction and outer-mineral associated As approximated with 0.1 M HCl extraction increased under flooded soil conditions over the incubation period, whereas 0.01 M $CaCl_2$-extractable Cd decreased and 0.1 M HCl-extractable Cd remained stable, supporting prior knowledge on the contrasting geochemical behaviour of these two contaminants under flooded conditions. Future climatic conditions enhanced the increase of $CaCl_2$ –extractable As but not 0.1 M HCl-extractable As when present as a single contaminant, indicating that climatic conditions influenced As dynamics on the surface of minerals but were not able to exert deeper into mineral phases. $CaCl_2$- and HCl-extractable Cd were not affected by climatic conditions when present as a single contaminant, indicating resilience to climatic change. In the presence of combined As and Cd, the enhancement of the increase of $CaCl_2$-extractable As by future climatic conditions was eliminated suggesting a toxicity of Cd to As-cycling related microbes which offset the stimulation by future climatic conditions.

Respirational output and other microbial dynamics data will be discussed relative to climatic impacts on either of these two contaminants and their combination.

Our findings show a link between climatic conditions and metal(loid) contaminant mobility under flooding conditions. The results of combined elevated As and Cd indicate a more realistic situation which is potentially overlooked in previous studies.