Impact of climate change on the dynamics of arsenic in paddy soils

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Globally, rice is the staple food, with more than 50% of the global population consuming rice daily. Unfortunately rice productivity is postulated to decrease drastically due to climate change. Rice productivity models for the year 2100 are based on higher annual temperatures and doubled atmospheric CO_2 concentrations; they do not, however, account for the presence of toxic elements, such as arsenic, in paddy soils that are abundant in many of the World's largest rice producing regions. However, arsenic is being enriched in Asian paddy soils via irrigation with arsenic-bearing ground water, while other toxic elements are being added through fertilizer, mine wastes, and coal burning. Within the soil, arsenic moves between the soil solution and the solid phase as a consequence of the prevailing biogeochemical conditions. The mobile fraction of arsenic is easily taken up by rice plants and enriched in the grain, thereby not just reducing rice productivity but also grain quality.

We investigated how the two main parameters of climate change, namely a postulated increase of temperature by 5°C and doubled concentrations of atmospheric CO_2 in the year 2100, affect the mobility of arsenic in paddy soils. We show that under the environmental conditions of 2100, arsenic is 1) more volatilized to the atmosphere, and 2) mobilized in the pore water. To further understand the underlying biogeochemical differences between today's and 2100's dynamics of arsenic in paddy soils, we supportingly quantified differences in solid and porewater iron, manganese, sulfur, and organic carbon, as well as changes in greenhouse gas emissions and soil microbial community abundance and activity.

The data presented here allows to more precisely predict the dynamics of arsenic in paddy soils in the future. It further lays the groundwork for investigating how much and what type of arsenic will be taken up by rice and accumulated in the grain – allowing more accurate predictions of future rice grain production and quality.