Effects of Intermittent Draining of Rice Fields on Biogeochemical Redox Processes and Arsenic Mobility

SCOTT C. MAGUFFIN[1], JAI ROHILA[2], ANNA MCCLUNG[2], AND MATTHEW C. REID[1]

[1]Civil and Environmental Engineering, Cornell University, Ithaca, NY USA (correspondence: maguffin@cornell.edu; mcr239@cornell.edu)
[2]Dale Bumpers National Rice Research Center, USDA ARS, Stuttgart, AR, USA

Rice consumption can be a significant pathway for human exposure to arsenic (As) particularly where groundwater used for irrigation has elevated As concentrations. Intermittent draining of rice paddy soils has been shown to reduce grain As accumulation relative to traditional cultivation practices in continuously flooded fields. There have been few detailed biogeochemical characterizations of the soil solution under intermittent irrigation regimes, however, so process-level knowledge required to optimize intermittent irrigation schemes to mitigate As bioavailability and uptake is limited.

We present results from field experiments investigating the effects of intermittent and continuous flooding on the evolution of biogeochemical redox processes in Arkansas silt loam rice paddy soils and their impact on As dynamics. Intermittent draining delayed the onset of reductive dissolution of iron (Fe) and manganese (Mn) oxide minerals and significantly reduced overall Fe and Mn oxide mineral dissolution, leading to lower As concentrations in pore water and plant biomass. We used silicon as a tracer and determined that reductions in Mn, Fe, and As concentrations after a drainage event were not explained by dilution due to reflooding. Arsenic speciation analysis was used to explore As methylation-demethylation dynamics under different irrigation regimes and to link As speciation in rice grains to microbial As transformations in soil.