Coupled Climate Change and Soil Arsenic Alters Future Greenhouse Gas Emissions from Flooded Rice Paddies

ALANDRA M. LOPEZ[1], E. MARIE MUEHE[1], AND SCOTT FENDORF[1]

[1]Department of Earth System Science, Stanford University, Stanford, CA-94305, USA

Rice paddies are a major contributor to global greenhouse gas (GHG) emissions. Methane (CH_4) and nitrous oxide (N_2O) are potent GHGs that constitute the bulk of total global warming potential (GWP) from rice production today. A changing climate also increases the demand of groundwater for irrigation, which in many areas of Asia result in increased arsenic (As) within paddy soils. With pressure intensifying to meet food demands for a growing global population, it is crucial that we understand how **(1)** climate change and **(2)** the presence of soil contaminants will alter microbial-mediated paddy GHG emissions. This study investigated how soil As contamination and climate change factors (temperature, CO_2) combine to transform microbial GHG emissions and C dynamics in Bangladeshi paddy soils. We performed laboratory incubations of flooded paddy soils, amended with and without As, exposed to today's climate (33˚C, 415 ppmv CO_2) and the postulated IPCC worst-case scenario for the year 2100 (38˚C, 850 ppmv CO_2) in major rice-growing regions. Additional incubations were used to determine the decoupled effects of elevated temperature (38˚C) and CO_2 (850 ppmv) with and without high As. Overall, we find that the seasonal GWP for flooded rice paddies will intensify under future climates, and elevated soil As can either exacerbate or reverse climate effects. During the growing season, dissolved As affects paddy soil microbiome in two ways: **(1)** As reduces GHG emissions by exhibiting toxicity effects, and/or **(2)** shifts emissions of each GHG based on preferred chemical and metabolic pathways. For instance, under high temperature and future climates, As-contaminated paddy soils exhibit higher GWPs due to a rapid N_2O release immediately following the initial flooding event. We suggest that chemical denitrification is the driver. Additionally, increased CH_4 emissions in As-contaminated paddy soils may be due to microbial-mediated detoxification strategies (e.g., As methylation). Our findings illustrate that agricultural GHG emissions depend on soil contaminants, and global climate models must be refined to reflect these soil interactions.