Annual balances of CO_2 and CH4 from drained agricultural peatlands and restored wetlands in the Sacramento-San Joaquin Delta, California

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Worldwide, drainage of organic soils for agricultural and forestry purposes has resulted in significant soil subsidence, and some of the fastest rates and largest magnitudes of carbon loss attributable to land-use change. The Sacramento-San Joaquin Delta (referred to hereafter as the Delta) in California was drained over a century ago for agriculture and human settlement and has since experienced subsidence rates that are amongst the highest observed in the world. It is well recognized that drained agriculture in the Delta is unsustainable in the long-term, and thus to help reverse subsidence and capture carbon there is a growing interest in converting drained agricultural land-use types to flooded conditions (e.g. restored wetlands and rice agriculture). However, flooding may increase the emission of methane (CH4) as well as the loss of water via evaporation. I used multiple years of simultaneous eddy covariance measurements at conventional drained agricultural sites (a pasture and a corn field) and flooded land-use types (a rice paddy and two restored wetlands) to assess the impact of drained to flooded land-use change on CO_2, CH4, and evaporation fluxes in the Delta.

I found that the drained sites were net greenhouse gas (GHG) sources, releasing between 134-350 g-C m-2 yr-1 as CO_2 and up to 10 g-C m-2 yr-1 as CH4. Conversely, the restored wetlands were net sinks of atmospheric CO_2, sequestering up to 450 g-C m-2 yr-1. However, they were also large sources of CH4, with emissions ranging from 40 to 57 g-C m-2 yr-1. In terms of the full annual GHG budget (assuming that 1 g-CH4 equals 25 g-CO_2 with respect to the greenhouse effect over a time horizon of 100 years), the restored wetlands could be either GHG sources or sinks. Annual net CO_2 exchange at the rice paddy ranged from -283 g-C m-2 to 95 g-C m-2 depending on management practices, and the site was always a moderate source of CH4. The flooded land-use types evaporated 45-200% more water than the pasture or corn sites. Therefore, from a subsidence perspective, restored wetlands and rice appear to provide a benefit for Delta sustainability as they are predominantly large carbon sinks. However, flooding also has secondary effects on the GHG budget through increased CH4 emissions and higher rates of evaporation.