Drivers of dissolved CO_2 and CH_4 dynamics in artificial drains of a coastal floodplain following a flood

JACKIE R. WEBB[1,2*], ISAAC R. SANTOS[1,2], DOUGLAS R. TAIT[1,2], JAMES SIPPO[1,2], BEN MACDONALD[3], BARBARA[4] ROBSON, DAMIEN T. MAHER[1,]

[1]School of Environment, Science, & Engineering, Southern Cross University, NSW, Australia (*correspondence: j.webb.20@student.scu.edu.au)
[2]National Marine Science Centre, Coffs Harbour, Southern Cross University, NSW, Australia
[3]CSIRO Agriculture, Canberra, ACT 2601, Australia
[4]CSIRO Land and Water, Canberra, ACT 2601, Australia

Many coastal floodplains have been artificially drained for agriculture, altering hydrological connectivity and the delivery of groundwater-derived solutes including CO_2 and CH_4 to surface waters. Here, we investigated the drivers of CO_2 and CH_4 within the artificial drains of a coastal floodplain under sugarcane plantation, and quantify the relative contribution of groundwater to CO_2 and CH_4 fluxes over a flood. High temporal resolution, in situ observations of dissolved CO_2 and CH_4, stable isotope ($\delta^{13}C$-CH_4), and a natural groundwater tracer radon allowed us to quantify CO_2, CH_4 and groundwater dynamics during the rapid recession of a flood over five days. Extreme super-saturation of CO_2 (25,480%) was driven largely by mass groundwater input into the drains, facilitated by the creation of a large hydraulic head between the surface water and groundwater. Groundwater input sustained the CO_2 flux by delivering high carbonate alkalinity groundwater to acidic surface water, consequently transforming all groundwater-derived DIC to CO_2. In contrast to CO_2, groundwater was not a major driver of CH_4 fluxes. Instead, the flood appeared to indirectly enhance CH_4 fluxes through the delivery of organic matter substrates to the drain sediments. This resulted in large diurnal oscillations in CH_4 concentrations (101,690%) driven by production and oxidation at the sediment-water interface. Our findings demonstrate how separate processes can drive the CO_2 and CH_4 response to a flood event in a drained coastal floodplain, and the key role groundwater has in post flood CO_2 fluxes.

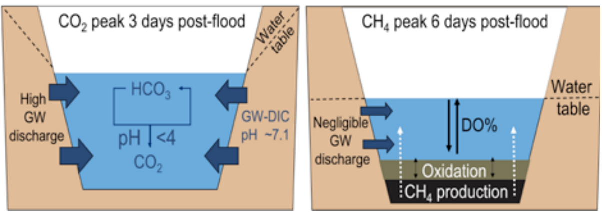

Figure 1: Summary of the major drivers of peak CO_2 and CH_4 fluxes in artificial drains post-flood event.