Drying and rewetting periods trigger high pulses of greenhouse gases in mesocosms from Tres Rios permanently-flooded constructed treatment wetland

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Introduction

- The concept of wastewater treatment by wetland ecosystems developed from the fact that wetlands include both aerobic and anaerobic environments, which in combination enhances N removal through several biogeochemical processes.
- However, permanently-flooded constructed wetlands may generate appropriate conditions for the production and emission of greenhouse gases such as methane (CH_4) and nitrous oxide (N_2O).
- We aimed to investigate the effect of different hydrological regimes on CH_4 and N_2O fluxes in wetland soil core mesocosms from a permanently-flooded constructed wetland (Fig 1).

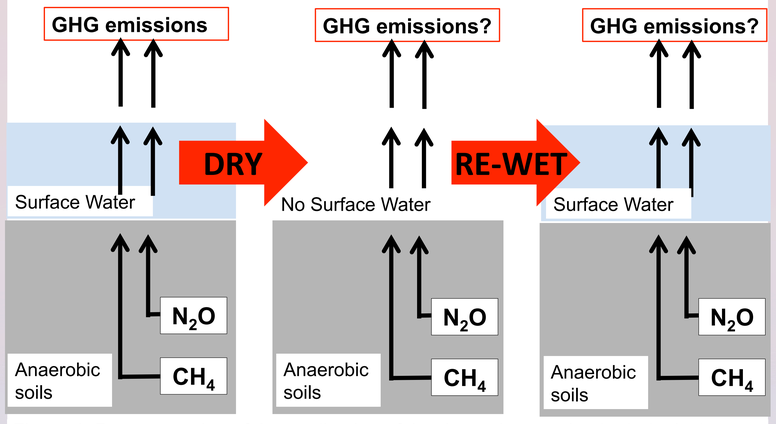
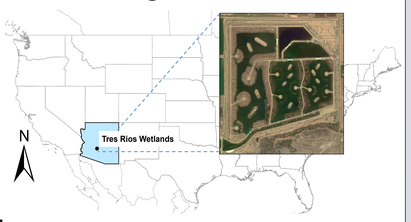


Figure 1. Representation of the application of the dry and re-wetting hydrological regimes to permanently-flooded wetland soils and the GHG emissions we investigated.

Materials, Methods and Experimental Design



- Soil cores were collected from the permanently-flooded Tres Rios Constructed Wetland, located approx. 20 km east of Phoenix, AZ.
- Soils consist of clay loam and sandy loam soils.
- From June 19 – July 17, 2015, we constructed an experiment inside a greenhouse that included 24 mesocosms. These were exposed to a control and 3 flooding regimes: 2, 7, and 14 day-dry periods before re-wetting again (Fig. 2).
- During the first week, gas fluxes were analyzed, using a Gasmet DX4040 FTIR gas analyzer (data not shown). Afterwards, we extracted air samples from mesocosms and sampled 3 times in a 20 min period (samples analyzed using a Varian CP-3800 GC.).
- Fluxes were calculated using HMR package in R which allows for linear and non-linear regression analysis (Pedersen 2013).

Figure 2. Experimental set up inside the greenhouse of the 24 wetland mesocosms.

Results

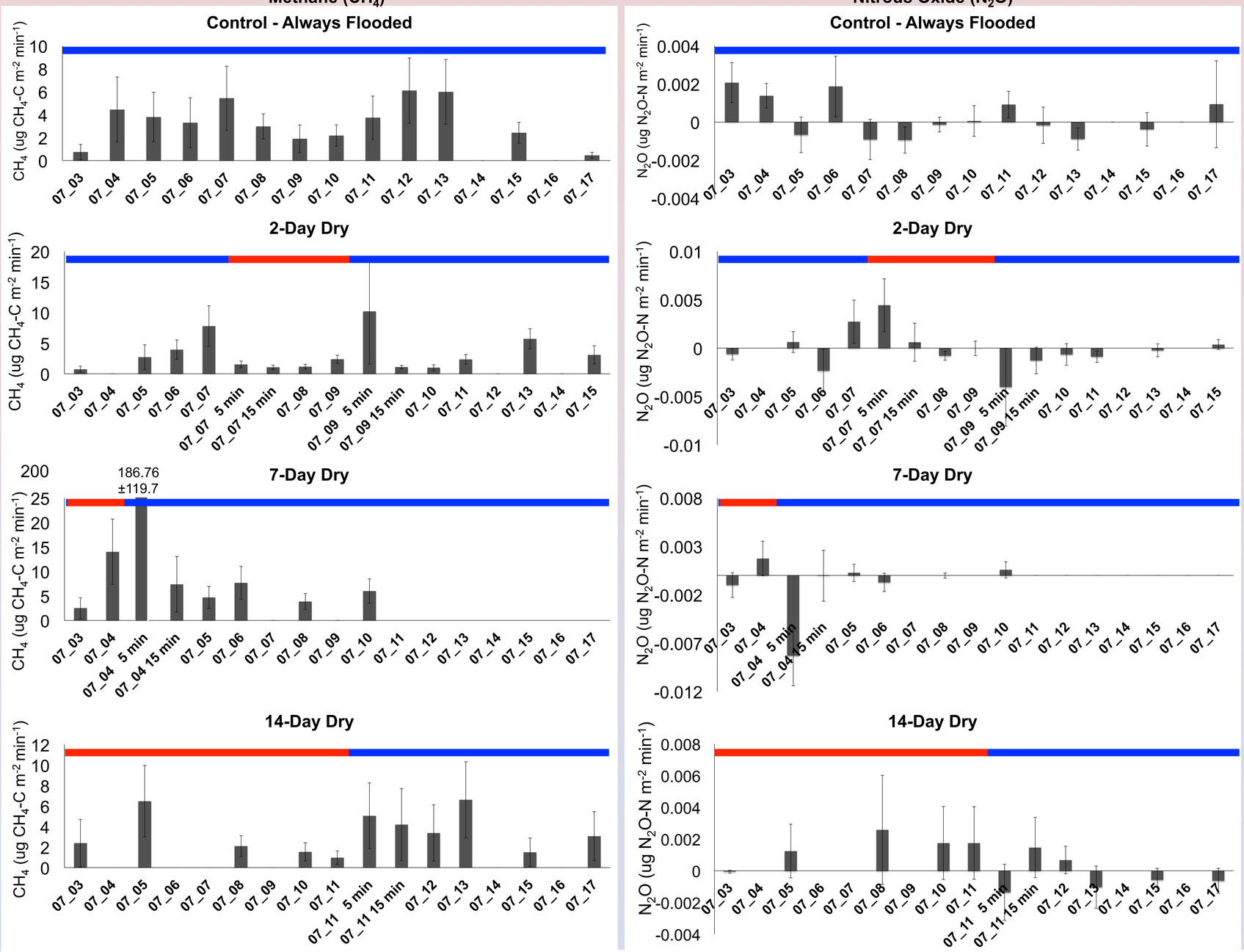


Figure 3. Data summary of CH_4 and N_2O fluxes from July 13 -17, 2015 during experiment. Important to note that cores were collected on June 19, left flooded 8 days, and began dry days on June 27. Dry days and wet days are depicted as red and blue respectively above flux data.

Preliminary Data Summary (Fig. 3)

- CH_4 fluxes were always positive in control and all treatment mesocosms, however, N_2O fluxes were more variable in all mesocosms.
- CH_4 fluxes were consistently higher during the wet days of all treatments. Additionally, compared to the fluxes in the dry periods, CH_4 fluxes were much higher in the first 20 minutes immediately after the rewetting events.
- Preliminary observations reveal that mostly all N_2O fluxes were positive during the dry periods. However, N_2O fluxes shift to negative fluxes in all treatments immediately after the rewetting event.
- Water chemistry data (NO_3, NO_2, NH_4) as well as soil properties will be integrated to this data in a forthcoming analysis.

Conclusions

- Our results emphasize the need to develop new and more feasible methods to better resolve the role of hydrologic regimes in the in the biogeochemical cycling of methane (CH_4) and nitrous oxide (N_2O) fluxes as an important component of closing the gap in the greenhouse gas fluxes from constructed wetland ecosystems.
- Due to the increased development of CW worldwide, it is important not just to study their effectiveness in purifying water but also the design and management decisions that control GHG fluxes.

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