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Nitrous oxide and methane emission in an artificial wetland treating polluted runoff from an agricultural catchment

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An artificial wetland built in 2010 to reduce water pollution in a drained agricultural watershed showed real potential for pesticide and nitrate removal. The 1.2 ha off-shore wetland with a depth of from 0.1 to 1 m intercepts drainage water from a 450 ha watershed located near the village of Rampillon (03°03'37.3" E, 48°32'16.7" N, 70 km south-east of Paris, France). A sluice gate installed at the inlet makes it possible to close the wetland during the winter months (December – March), when no pesticides are applied and rainfall events are more frequent. The flow entering the wetland fluctuates from 0 to 120 L/s. The wetland is partially covered by Carex spp., Phragmites australis, Juncus conglomeratus, Typha latifolia and philamentous algae. Since 2011, an automatic water quality monitoring system measures water discharge, temperature, dissolved O_2, conductivity pH, NO_3- and DOC in both inlet and outlet. In May 2014, an automatic weather station and Campbell Irgason system for the measurement of CO_2 and H_2O fluxes were installed in the middle of the wetland.
In May and November 2014 one-week high frequency measurement campaigns were conducted to study N2O and CH4 fluxes using 6 manually operated opaque floating static chambers and 12 floating automatic dynamic chambers. The latter were operated via multiplexer and had an incubation time of 5 minutes, whereas the gas flow was continuously measured using the Aerodyne TILDAS quantum cascade laser system. During the campaign, the reduction of NO_3- concentration was measured in nine reactor pipes. Also, water samples were collected for N2O and N2 isotope analysis, and sediments were collected for potential N2 emission measurements.
In May, the hydraulic retention time (HRT) was 30 days, and the average NO_3- concentration decreased from 24 in the inflow to 0 mg/L in the outflow. Methane flux was relatively high (average 1446, variation 0.2-113990 μg CH4-C m-2 h-1), while about 2/3 was emitted via ebullition. Nitrous oxide flux was low (average 1.1, variation from -25 to 63 μg N2O-N m-2 h-1) and showed consumption during the daytime. Similarly to CH4, most of the N2O emission originated from ebullition. The potential N2 flux from sediments was high (990-1920 μg N m-2 h-1). In November, with HRT at about 3 days, the average NO_3- concentration decreased from 45 to 20 mg/L. Methane flux was 2-3 times lower and N2O emission about 2 times higher than in May. This is related to the lower water temperature (20°C in May and 10°C in November) and shorter HRT in November. However, in situ pipe reactors showed a 90% NO_3- removal potential in both periods.
Offshore artificial wetlands can efficiently remove NO_3- without significant N2O emission, although CH4 flux can be high during the first 5 years after establishment.