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Assessment of methane (CH4) dynamics in a sub-tropical hydroelectric reservoir: Nam Theun 2, Lao PDR

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In the 90's, hydroelectric reservoirs have been identified as significant CH_4 contributors to the atmosphere, especially in tropics. It has been shown than the degradation of organic matter from the flooded soil and vegetation and from the watershed leads to the production of CH_4. Part of the CH_4 which is not consumed by aerobic CH_4 oxidation is emitted to the atmosphere by different pathways i.e. diffusion from the water surface or the surrounding soils, ebullition and by emissions downstream of the dam. Since then, most of the debate regarding emissions of this potent greenhouse gas resulting from the anthropogenic flooding of large land surfaces is based on results from hydroelectric reservoirs flooding primary forest in South America. We present here the first detailed study on the CH_4 dynamics in a subtropical reservoir located in Southeastern Asia.

The Nam Theun 2 Reservoir (NT2) located in Lao PDR was flooded in 2008. At high water stage, it floods 450 km^2 of tropical forests, wetlands and rice paddies whereas the area of the water body is only 80 km^2 during the dry season. Based on fortnightly water sampling, laboratory and field works, we studied the CH_4 dynamics (production and oxidation) and atmospheric emissions from NT2 with a description of the temporal and spatial variation.

Vertical profiles of CH_4 concentration were measured in the water column. Methane concentration varied at the spatial and temporal scale. Results show that surface CH_4 concentration ranged from 0.09 μmol L^{-1} to 2.09 μmol L^{-1} with bottom concentration of methane ranged from 51 μmol L^{-1} to 693 μmol L^{-1}, concentrations being higher during the dry season than during the wet season. Soils were sampled from the drawdown area and reservoir's surrounding. They have been incubated in the laboratory to determine the kinetics of potential GHG production in anaerobic conditions. CH_4 production rates range from 0.003 to 8389 nmol $h^{-1}g_{soil}^{-1}$ depending on the soil types. In the laboratory, kinetics of potential aerobic CH_4 oxidation have been determined for a varied range of methane concentrations (water sampled from epilimlion water column, oxycline and water from the downstream rivers). Methane oxidation rates ranged from 0.011 to 27.16 μmol.$L^{-1}day^{-1}$. Relationships between CH_4 concentrations and oxidation rates show different kinetics at the oxicline, in the epilimnion and in the river downstream of the dam but are not dependant on the season. The diffusive fluxes of CH_4 measured by floating chambers are in the order of 1.2$\pm$1.35 mmol $m^{-2}day^{-1}$ with very high spatial and temporal variations. Bubbling fluxes were measured with funnels and found to highly depend on the water depth (decreasing with water depth). Mean values of bubbling CH_4 fluxes were 2.5$\pm$2.7 mmol $m^{-2}day^{-1}$(EGU2011-6175). Methane fluxes measured from drawdown area of NT2 reservoir were well correlated with soil moisture and varied from -0.4 to 124 mmol m^{-2} day $^{-1}$ with an average value of 8.8$\pm$23.3(39) mmol m^{-2} day $^{-1}$.

Total CH_4 emissions from the NT2 are at least two times lower than reported emissions from hydroelectric reservoirs from South America at the same "age". The final goal of the project is to integrate the empirical relationships for processes into a coupled physical biogeochemical model which would be useful to predict impact on the CH_4 emissions from existing and new dam projects.

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