Eutrophication increases methane emission to the atmosphere in tropical lagoons: insights from two Ivory Coast sites

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1) Introduction

Eutrophication is a worldwide environmental problem and a definitive solution is far from being achieved, despite the large number of studies documenting its causes. In small aquatic ecosystems, excessive growth of macrophytes is a well known undesirable consequence of eutrophication (Aloo et al., 2013). Lagoons are shallow environments that typically present a broad colonization by aquatic macrophytes. When these plants die and sink to the bottom, they produce the carbon necessary for the production of methane (CH_4). Here, we reported the CH_4 data obtained during six campaigns in two small lagoons of Ivory Coast (Ono, Kodjoboué) that are contrasted with respect to the degree of eutrophication and the corresponding coverage of macrophytes (e.g. Echinochloa pyramidalis, Eichhornia crassipes, Hydrilla verticillata). These lagoons behave as freshwater lakes due to limited marine inputs.

2) Material and methods

Samples were carried out with a 1.5L Niskin bottle in subsurface waters at a depth of 30 cm in the Ono and Kodjoboué lagoons at three different sites (Figure 1). Water was sampled in serum bottles of 40 mL taking care to avoid formation of bubbles, poisoned with $HgCl_2$ and sealed. The Concentrations of CH_4 were determined by gas chromatography (for more details see Koné et al., 2010).

3) Results & discussion

The CH_4 distribution in the surface waters of the two lagoons (Fig. 1) showed a large spatial and temporal variability because CH_4 concentrations in the lagoons are the result of the balance between transports with water masses, outgassing to the atmosphere, and production and oxidation in waters and sediments of these systems. For the all sampling period, the concentrations ranged from 80 to 74,604 nmol L^{-1} with the highest values observed in the Ono lagoon that is densely covered by aquatic macrophytes suggesting that CH_4 production was regulated by input of the autochthonous organic matter (OM) via macrophyte detritus. The degradation of this OM reduces the concentrations of oxygen in the water column especially in the Ono lagoon (data not shown). During the high dry season (March) where the growth of most of the plants is limited, the concentrations of CH_4 were low in the two lagoons (Figures 1) due to a limited organic matter inputs and/or an increase of CH_4 oxidation in the water column. Moreover, the higher CH_4 concentrations in the Ono lagoon were found at site 1 close to the emergent macrophyte: *Echinochloa pyramidalis* that is characterized by a high productivity rate, especially in shallow environments, and may constitute the main source of organic matter to these ecosystems. Overall, the CH_4 concentrations found in the Kodjoboué and Ono lagoons were largely above the ones previously reported in five lagoons of Ivory Coast (Koné et al., 2010) ranging from 34 to 1004 nmol L^{-1}. These results suggest that small lagoons covered by macrophytes could be a significant source of CH_4 toward the atmosphere.

4) Conclusion

Our data showed a large spatial and temporal variability of CH_4 within and between the Ono and Kodjoboué lagoons. The CH_4 concentrations were particularly high in the Ono lagoon that is 80% covered by macrophytes. We concluded that CH_4 production in these lagoons was controlled by the autochthonous organic matter inputs via macrophyte detritus.

4) References

Aloo et al. (2013). A review of the impacts of invasive aquatic weeds on the biodiversity of some tropical water bodies with special reference to Lake Victoria (Kenya). Biodiversity Journal, 4 (4), 471-482
Koné et al. (2010). Seasonal variability of methane in the rivers and lagoons of Ivory Coast (West Africa). Biogeochemistry, 100, 21–37.

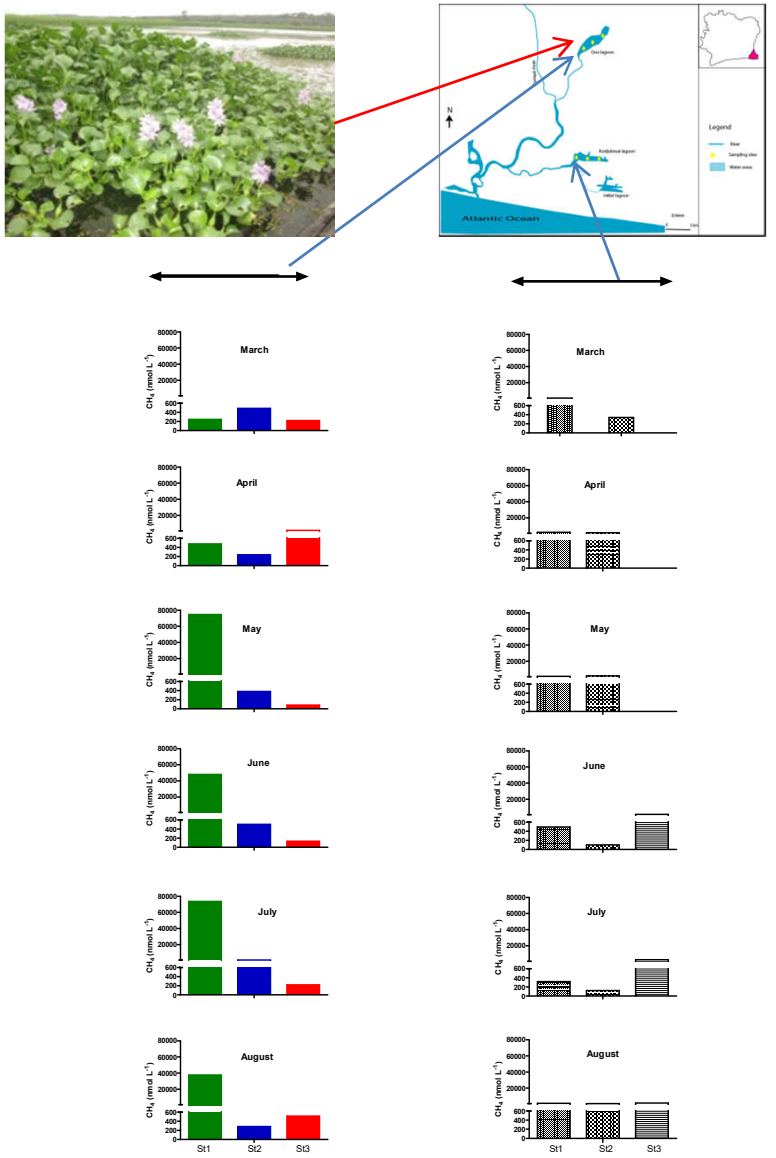

Figure 1: Spatial and temporal CH_4 (nmol L-1) concentrations in Ono and Kodjoboué lagoons.

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