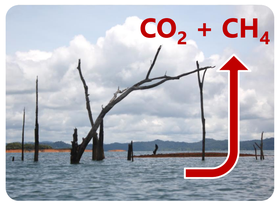
The carbon footprint of a tropical reservoir: role and regulation of downstream emissions

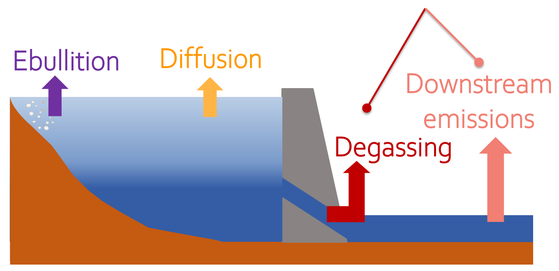
Cynthia Soued (cynthia.soued@gmail.com) and **Yves Prairie**
Département des sciences biologiques, Université du Québec à Montréal

The context

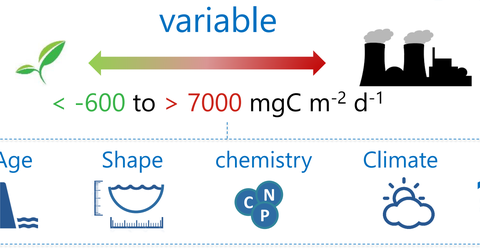


- +58 000 large reservoirs
- 0.8 – 2.6 $PgCO_2eq.yr^{-1}$
- Uncertain global estimates
  - ➢ Sampling biases

Often overlooked



Reservoirs GHG emissions are highly variable



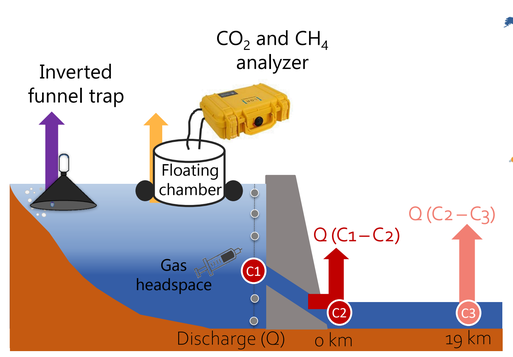
The goals

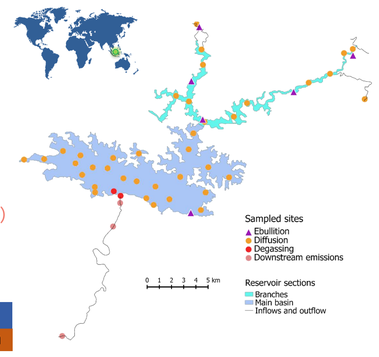
1. Quantify the comprehensive C footprint of a tropical reservoir
2. Compare measured vs modeled data
3. Model deep GHG dynamics sustaining emissions below the dam

The methods

Batang Ai reservoir

- Age = 35 years
- Reservoir = 68.4 km^2
- Catchment = 1149 km^2 (mostly forested)
- Max depth ~72m
- Mean depth ~28m
- **Permanent thermocline ~10 m**

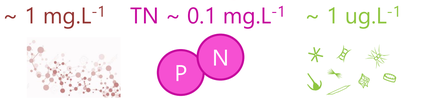




Sampling campaigns

Oligotrophic clear reservoir

DOC ~ 1 $mg.L^{-1}$ | TP ~ 6 $\mu g.L^{-1}$ TN ~ 0.1 $mg.L^{-1}$ | Chl a ~ 1 $ug.L^{-1}$

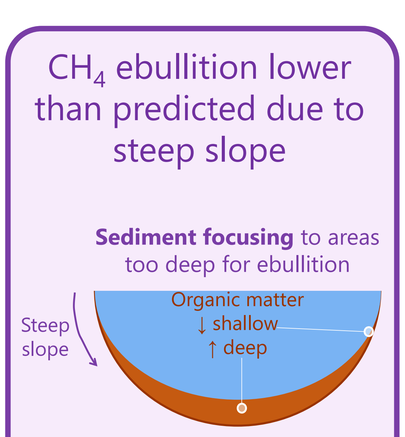


The results

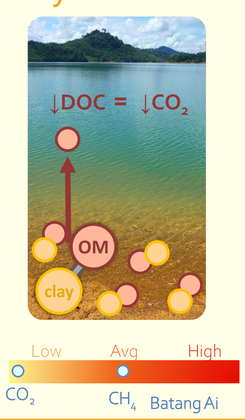
Reservoir C footprint

CH_4 ebullition lower than predicted due to steep slope

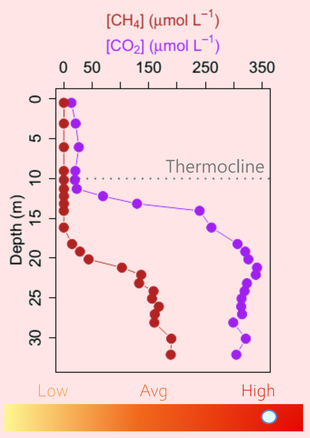
Sediment focusing to areas too deep for ebullition

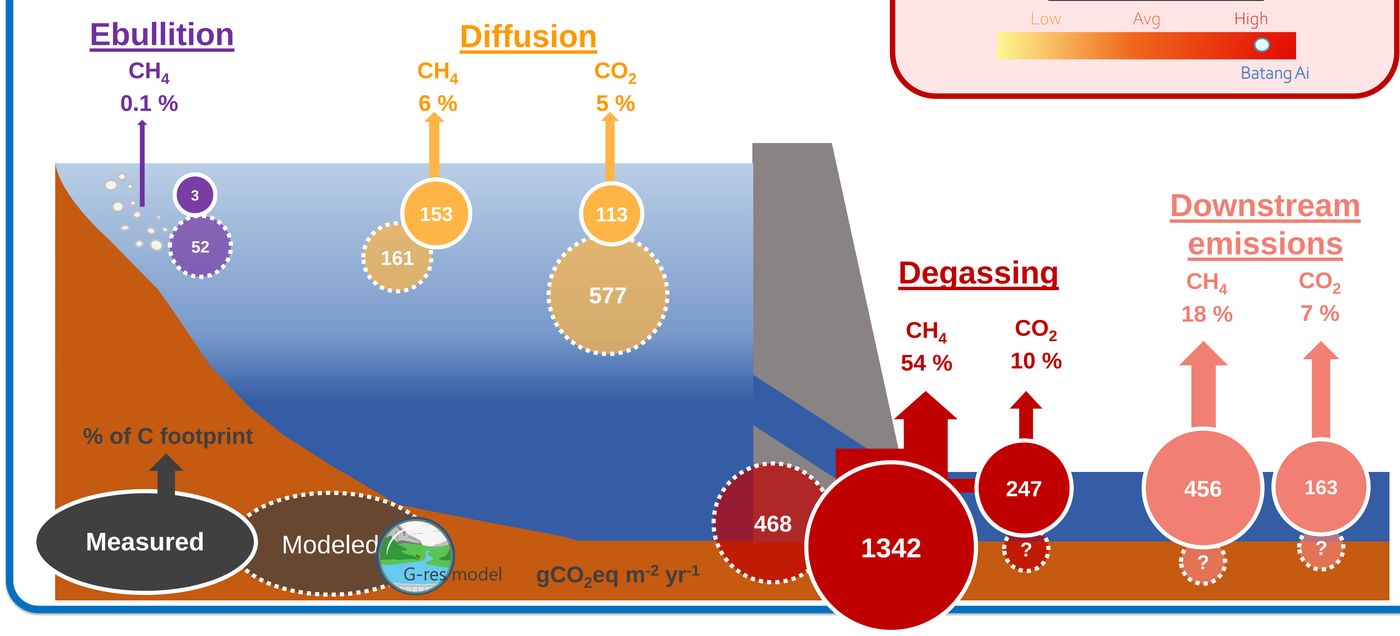


CO_2 diffusion lower than predicted due to clay-rich soils



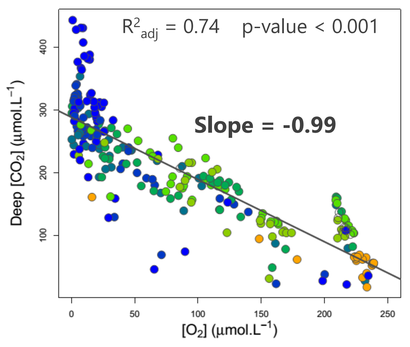
Large underestimation of below dam emissions due to gas accumulation under the permanent stratification



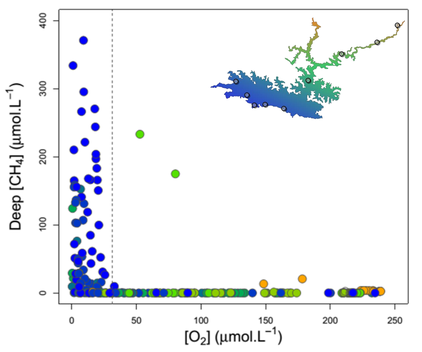


Deep GHG dynamics

Gradual CO_2 accumulation along the flow via respiration.

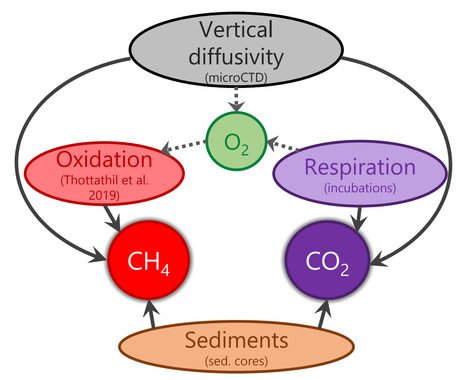


CH_4 Accumulation only under an O_2 threshold (main basin).

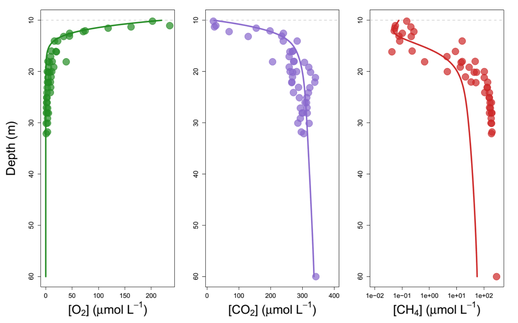


Model structure

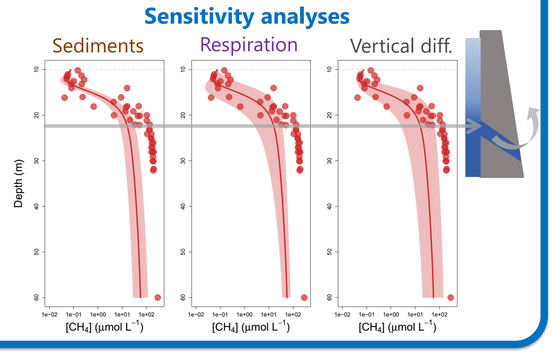
System of coupled 2nd order partial differential equations



Modeled vs measured data



Sensitivity analyses



CH_4 concentration in discharged waters is highly influenced by changes in vertical diffusivity and in respiration (via its effect on O_2).

The conclusions

1. 89 % of Batang Ai C footprint is due to GHG emissions below the dam, an often overlooked pathway.
2. Improving reservoir emissions model: better account for slope, soil properties, and deep GHG dynamics.
3. Deep [CO_2] and [CH_4] are tightly linked to [O_2], and its drivers (vertical diffusivity and respiration)

Acknowledgments

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