Assessment of greenhouse gas emissions in a tropical Brazilian reservoir

Speaker: Guilherme S. D. Andrade
Global Energy Demand

• It has been increasing since 1700s – Industrial revolution

Source: IEO, 2013
The world has to generate more energy to attend the increasing demand

That is where countries such as China and Brazil appear!

Source: IEO, 2013
Importance of hydropower

Source: IEO, 2013

Approx. 20%
<table>
<thead>
<tr>
<th>Soil</th>
<th>Water</th>
<th>Atmosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flooding;</td>
<td>Water quality</td>
<td>GHG</td>
</tr>
<tr>
<td>Accommodation</td>
<td>Hydrology</td>
<td></td>
</tr>
</tbody>
</table>

Energy production vs. Environmental impacts
Is hydropower carbon free?

Source: Demarty and Bastien, 2011
Volta Grande reservoir
Methods

• Thin Boundary Layer (TBL)

• \[ \text{Fluxo} = K_x \times (C_{\text{water}} - C_{\text{sat}}) \]

• \[ K_x = K_{600} \times (Sc/600)^{-x} \]

• \[ Sc \ (CO_2) = 1911,1 - 118,11t + 3,4527t^2 - 0,04132t^3 \]

• \[ Sc \ (CH_4) = 1897,8 - 14,28t + 3,4527t^2 - 0,03906t^3 \]

• \[ K_{600} = 2,07 + (0,215 \times (1,22 \times U)^{1,7}) \]

Source: UNESCO/IHA, 2010
Considerations...

• It was considered only diffusive fluxes;

• Although different methods were employed worldwide, all of them are presented on the UNESCO/IHA guidelines
Results and Discussion

<table>
<thead>
<tr>
<th></th>
<th>CO₂ flux (mmol.m⁻².d⁻¹)</th>
<th>CH₄ flux (µmol.m⁻².d⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volta Grande</td>
<td>2.2 – 58.3</td>
<td>90.3 – 649.5</td>
</tr>
<tr>
<td>Tropical</td>
<td>3.8 – 192.5</td>
<td>436.4 – 8,104.7</td>
</tr>
<tr>
<td>Global</td>
<td>-23.6 – 192.5</td>
<td>2.4 – 8114</td>
</tr>
</tbody>
</table>
CO$_2$ spatial variation

CO$_2$ Flux (mmol.m$^{-2}$.d$^{-1}$)
CH$_4$ spatial variation

Related to the longitudinal zonation

CH$_4$ Flux (µmol.m$^{-2}$.d$^{-1}$)
Overall comparison...

There is a wide variation within tropical systems!

Sources: ABRIL et al., 2005; Chanudet et al., 2011; Demarty et al. 2011; Demarty et al. 2009; dos Santos et al., 2006; Huttunem 2002; Kemenes et al., 2011; Li & Zang, 2013; Roland et al., 2010; Soumis et al. 2004; Tremblay et al. 2005; Wang et al., 2011; Zhao et al., 2013.
Examining the tropical region...

Volta Grande Atlantic Forest Savanna Scrub Savanna Rain Forest

GHG fluxes (kgCO$_2$eq. km$^{-2}$. d$^{-1}$)

Volta Grande Atlantic Forest Savanna Scrub Savanna Rain Forest

and Volta Grande is **not** the one with the lowest emissions!!

Sources: ABRIL et al., 2005; dos Santos et al., 2006; Kemenes et al. 2011; Roland et al., 2010
What could explain this pattern?

- Organic matter;
- Age;
- Type of reservoir;
- Watershed;
- Weather conditions;

Affect anaerobic / aerobic oxidation

GHG production and emission
Concluding

• Extrapolation can lead to an overestimation!

• Our data are underestimating the fluxes and the atmospheric impacts!

• Few *in situ* measurements!

• Amazonian reservoirs have the highest impact level!
Thank you!!

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m:

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Undergraduates

Arthur Paixão
Karoline Costa

Sponsors:
Volta Grande Tropical Non-Amazonian Subtropical Temperate

CO₂ fluxes (mmol.m⁻².d⁻¹)
Volta Grande Tropical Non-amazonian Tropical Amazonian Subtropical Temperate

CH$_4$ fluxes (µmol.m$^{-2}$.d$^{-1}$)
Additional information

$R^2 = 0.6067$