Methane emissions and carbon balance in Mediterranean wetlands and rice fields: Ebro Delta case study

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The Ebro Delta is one of the most important wetland complexes in the Mediterranean with 65% of its area covered by rice fields.

Rice fields are crucial for preserving biodiversity of the surrounding natural wetlands and the local economy.

Paddy rice fields, considered as semi-natural wetlands, also play crucial role in C budget:

- Paddy rice cultivation represents 47% of anthropogenic CH$_4$ emissions.
- After harvest, straw is incorporated into the soil: soil accretion, carbon sequestration.
- Rice fields as sources or sink of C? Agronomic practices to modulate C budget.
Two studies on CH4 and C accretion in natural wetlands and rice fields in the Ebro Delta


• Quantify carbon accretion and CH4 emission rates from coastal wetlands in the Ebro Delta → the balance between C sequestration and CH4 emissions
• Determine how salinity affects CH4 emission rates


• Estimation of CH4 emission and seasonal pattern
• Determination of the major drivers of CH4 emissions
• Guidelines for mitigation practices in rice fields
• Soil accretion and C sequestration in rice fields

http://www.lifeebroadmiclim.eu/
**STUDY 1.- The Effect of Landscape Position on CH4 Emissions in Wetlands in the Ebro Delta**

**Type of wetlands**

<table>
<thead>
<tr>
<th>Marsh Type</th>
<th>Sedimentary Environment</th>
<th>Study Sites</th>
<th>Dominant Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh water Marshes</td>
<td>Impounded</td>
<td>Ullals</td>
<td>Phragmites australis</td>
</tr>
<tr>
<td>Brackish Marshes</td>
<td>Coastal Lagoon</td>
<td>Encanyissada W</td>
<td>Phragmites australis</td>
</tr>
<tr>
<td></td>
<td>Riverine Mouth</td>
<td>Garxal W</td>
<td>Spartina versicolor, Paspalum spp.</td>
</tr>
<tr>
<td>Salt Marshes</td>
<td>Coastal Lagoon</td>
<td>Tancada</td>
<td>Sarcocornia fruticosa</td>
</tr>
<tr>
<td></td>
<td>Bay</td>
<td>Alfacs</td>
<td>Sarcocornia fruticosa</td>
</tr>
</tbody>
</table>
The effect of salinity on carbon accretion and CH$_4$ emission rates

Balance between C accretion and CH$_4$ emission rates across wetland types. Freshwater wetland showed highest sink capacity.

Carbon accretion and CH$_4$ emissions were negatively related to salinity.
Soil accretion in natural wetlands and rice fields in Ebro Delta

Rice accretion rates comparable to salt and brackish marshes

Data from: Ibáñez et al 2010; Callaway et al., 2013
Material and Methods (2015-2016)

• Monthly sampling in 22 commercial fields in Ebre Delta
  ➔ Rice fields are flooded from May to September (harvest) and left to progressively dry out over post-harvest period
  ➔ After harvest, straw is incorporated

• Data collection:
  o CH₄: non-steady closed chambers
  o Physicochemical: Soil temperature Eh, pH, conductivity
  o Agronomic traits
Gas sampling and analyses methodology
Temporal pattern of CH$_4$ emissions

70% of CH$_4$ emitted during post-harvest

<table>
<thead>
<tr>
<th>Season</th>
<th>2015 (mg C-CH$_4$ m$^{-2}$ ha$^{-1}$)</th>
<th>2016 (mg C-CH$_4$ m$^{-2}$ ha$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growing season</td>
<td>2.71 ± 0.25</td>
<td>3.15 ± 0.61</td>
</tr>
<tr>
<td>Post-harvest</td>
<td>9.71 ± 1.60</td>
<td>10.1 ± 2.14</td>
</tr>
<tr>
<td>Annual</td>
<td>5.20 ± 0.62</td>
<td>6.12 ± 1.01</td>
</tr>
</tbody>
</table>
Correlation among all the variables

Rice growing season

Martínez-Eixarch et al., in review
Correlation among all the variables

Martínez-Eixarch et al., in review
Straw incorporation
### Generalized Linear Model (GLMz)

<table>
<thead>
<tr>
<th>model parameter</th>
<th>RICE GROWING SEASON</th>
<th>POST-HARVEST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=20</td>
<td>N=26</td>
</tr>
<tr>
<td></td>
<td>SP</td>
<td>β</td>
</tr>
<tr>
<td>(Intercept)</td>
<td>1.000</td>
<td>3.670</td>
</tr>
<tr>
<td>Soil Redox</td>
<td>1.000</td>
<td>-3.798</td>
</tr>
<tr>
<td>Soil Temperature</td>
<td>0.288</td>
<td>0.208</td>
</tr>
<tr>
<td>Soil pH</td>
<td>0.335</td>
<td>-0.766</td>
</tr>
<tr>
<td>Soil conductivity</td>
<td>0.379</td>
<td>-0.214</td>
</tr>
<tr>
<td>Plant cover</td>
<td>0.956</td>
<td>0.050</td>
</tr>
<tr>
<td>Water level</td>
<td>1.000</td>
<td>3.884</td>
</tr>
<tr>
<td>Air temperature</td>
<td>0.225</td>
<td>0.000</td>
</tr>
</tbody>
</table>

- ... 1 month prior to CH4 sampling
- ... 2 months prior to CH4 sampling
- ... 3 months prior to CH4 sampling

Martínez-Eixarch et al., in review
Wetlands in Ebro delta are a sink of carbon

Soil salinity is negatively related to CH4 emissions and to soil accretion

Rice fields emit more CH4 than natural wetlands

Rice fields in Ebro Delta emitted more than 70% of the total annual emissions during post-harvest, after straw incorporation >> need of more studies on straw management strategies.

Main drivers of CH4 emissions in rice fields differ in the growing and post-harvest seasons:

Growing season: water level, soil redox, plant cover and temperature

Post-harvest season: straw incorporation, water level and soil temperature

Soil accretion in rice fields in Ebro Delta is comparable to salt and brackish wetlands
Thank you!