Lateral Carbon and Nitrogen Exchanges from a Mangrove Tidal Creek  
A Multi-Stable Isotope Approach

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Context

- Litterfall
- NPP
- CO₂ efflux
- Tidal export
- Burial
Processes

DIC, DOC, Dissolved nutrients export

CO2 efflux

Export of Particulate and Dissolved Material

Alongi 2014
1. What is the contribution of Porewater Discharge for C and N?

2. Can we constrain the magnitude and processes of carbon exchanges in a mangrove tidal creek?

3. Do Mangroves Assimilate or Release Nitrate?

[Outwelling vs. Biofiltration]
Study Site – Can Gio Mangrove

Eastern Side of Mekong Delta (South Vietnam)

Can Gio UNESCO Biosphere Mangrove Reserve

Surface area: 35,000 ha
Dominant specie: Rhizophora A.
Study Site – Tidal Creek

24h time series
1. Dry Season Neap Tide
2. Dry Season Spring Tide
3. Wet Season Neap Tide
4. Dry Season Spring Tide

- Porewater
## Data collection – 24h time series

### Continuous *in situ* measurements

1. Air Temperature
2. Rainfall
3. Wind speed
4. Wind direction
5. Water Temperature
6. pH
7. Salinity
8. Dissolved Oxygen
9. $^{222}$Rn
10. pCO$_2$
11. CO$_2$ efflux$_{(\text{water/atm})}$
12. Surface and bottom water collection (n=13 X 4)
Data collection – Porewater

**in situ measurements**

1. Water Temperature
2. pH
3. Salinity
4. $^{222}$Rn

4. Porewater collection (n=50)

**Triplicated sampling**

![Images of data collection tools and samples]
## Data Analysis

<table>
<thead>
<tr>
<th>Concentrations</th>
<th>Stable Isotopes</th>
<th>Radioactive isotopes</th>
</tr>
</thead>
<tbody>
<tr>
<td>POC</td>
<td>DOC</td>
<td>DIC</td>
</tr>
<tr>
<td><strong>Carbon</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PN</td>
<td>NH₄⁺</td>
<td>NO₃⁻</td>
</tr>
<tr>
<td><strong>Nitrogen</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH, Salinity, Dissolved Oxygen, Temp&lt;sub&gt;Water&lt;/sub&gt;</td>
<td></td>
<td></td>
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<tr>
<td><strong>Environmental Variables</strong></td>
<td></td>
<td></td>
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- Significance of each element
- Origins and processes of transformation
- Proxy for determining subsurface discharge
# Data Analysis

## Concentrations
- POC
- DOC
- DIC
- pCO₂
- CO₂
- efflux

## Stable Isotopes
- δ¹³C<sub>POC</sub>
- δ¹³C<sub>DIC</sub>
- δ¹³C<sub>DOC</sub>

## Radioactive isotopes
- ²²²Rn

## Carbon
- CO₂
- pCO₂

## Nitrogen
- PN
- NH₄⁺
- NO₃⁻
- N0₂⁻

## Environmental Variables
- pH
- Salinity
- Dissolved Oxygen
- Temp
- Water

---

**High definition Multi criteria Biogeochemical analysis**

**Significance of each element**

**Origins and processes of transformation**

**Proxy for determining subsurface discharge**
Results - Carbon

Water Depth (m)

Radioactive Isotopes
Carbon concentrations
Carbon Stable Isotopes
3

Results - Carbon

Radioactive Isotopes

Carbon concentrations

Carbon Stable Isotopes
Results - Carbon

Highest values at low tide
Results - Carbon

Highest values at low tide

Lowest values at low tide
## Two Sources Mixing Model

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<tr>
<th>Source 1: Mangrove (Porewater)</th>
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<th>Source 2: Estuary (High Tide)</th>
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<tr>
<td>$^{222}\text{Rn (Bq.m}^{-3}\text{)}$</td>
<td></td>
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<td>$\text{DIC (}\mu\text{M)}$</td>
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<tr>
<td>$\delta^{13}\text{C}_{\text{POC}}$ (‰)</td>
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<td>222Rn (Bq.m⁻³)</td>
<td>$1214_{±658}$</td>
<td>$265.68_{±193}$</td>
</tr>
<tr>
<td>DIC (µM)</td>
<td>$4124_{±2302}$</td>
<td>$2164_{±492}$</td>
</tr>
<tr>
<td>DOC (µM)</td>
<td>$249.4_{±197}$</td>
<td>$159.9_{±15}$</td>
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<tr>
<td>δ¹³C_{POC} (‰)</td>
<td>$-27.91_{±0.92}$</td>
<td>$-26.93_{±0.64}$</td>
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\[
Porewater \ contribution = \frac{C_n[δ_n] - C_{estuary}[δ_{estuary}]}{C_{porewater}[δ_{porewater}] - C_{estuary}[δ_{estuary}]}\]

| DIC (µM)                      | $4124_{±2302}$ | $2164_{±492}$ | $1880_{±88}$ |
| δ¹³C_{dic} (‰)               | $-19.29_{±2.42}$ | $-12.78_{±2.57}$ | $-9.19_{±1.1}$ |
## Two Sources Mixing Model

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<td>$22%_{\pm 2.4%}$</td>
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<td>DIC (µM)</td>
<td>$4124_{\pm 2302}$</td>
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<tr>
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<td>$14%_{\pm 1.8%}$</td>
<td>$86%_{\pm 1.8%}$</td>
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<td>DOC (µM)</td>
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<td>$159.9_{\pm 15}$</td>
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<td>$26%_{\pm 4.7%}$</td>
<td>$74%_{\pm 4.7%}$</td>
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Porewater contribution = \( \frac{C_n[\delta_n] - C_{\text{estuary}}[\delta_{\text{estuary}}]}{C_{\text{porewater}}[\delta_{\text{porewater}}] - C_{\text{estuary}}[\delta_{\text{estuary}}]} \)

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Discussion - Carbon

- Clear **tidal influence** with **highest concentrations at low tide**

- Release of **mangrove porewater at low tide** ($^{222}$Rn)

- Results refined previous study on (sub)tropical **mangroves** (Bouillon 2008, Maher 2013)

- Mangrove tidal creeks are **emitting sources of carbon** towards the coastal ocean and the atmosphere
Results - Nitrate

Ho Chi Minh City

Upstream (River) n=13

Tidal Creek n=26

Downstream (Estuary) n=13
Results - Nitrate

δ15N-N03

δ18O-N03

NO3 (μmol L−1)

NO3 (μmolN L−1)
Results - Nitrate

- Lowest concentrations from mangrove at low tide
- Highest concentrations from river at high tide

\[ \delta^{15}N_{NO_3} \]
\[ \delta^{18}O_{NO_3} \]

- NO\(_3\) (\(\mu\)mol.L\(^{-1}\))

- Surface water at high tide
- Surface water at low tide

- Mangrove (Porewater)
- Estuary (Downstream)
- River (Upstream)
• Nitrate originating from mangroves is of lower concentrations (<15μM)

• Highest nitrate concentrations at high tide (>15μM), coming from external (anthropogenic) source(s)

• Mangroves receive more nitrate from external sources (anthropogenic) than they release it
Concluding Remarks

- Clear influence of the tide variation on biogeochemical lateral processes
- Significant output from mangrove porewater seepage
- Mangrove tidal creeks act as:
  - emitting source of carbon towards the coastal ocean and the atmosphere
  - transiting area for natural and anthropogenic nitrate
cảm ơn các bạn

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Future perspectives

- Describing the CO$_2$ efflux in the tidal creek
- Describing the N cycle within its different forms and isotopes
- Describing the porewater properties regarding the vegetation stands
- Applying the same research design to a smaller and more impacted Mangrove Estuary (Ranong Province, Thailand)
4 References


