The Rapidly Evolving Science of Coastal Blue Carbon: What’s Known and What Do We Want to Know

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Blue Carbon, Green Opportunities

Society of Wetlands Scientists / INTECOL
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Ecosystems in focus for climate change mitigation

Forest

Mangroves

Tidal Marshes

Peatland

Seagrass
Blue Carbon: Emissions, Economics and Policy

http://estuaries.org/climate-change.html
Coastal ecosystems: long-term carbon sequestration and storage
Distribution of carbon in coastal ecosystems

Data summarized in Crooks et al., 2011; Murray et al., 2011, Donato et al., 2011
### Rates of Wetland Loss

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th>Global Extent (km²)</th>
<th>Annual Rate Of Loss (%)</th>
<th>Total Stock (top meter) Pg C</th>
<th>Reference (stock estimates)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tidal Marsh</td>
<td>400,000?</td>
<td>1 - 2</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Mangrove</td>
<td>160,000</td>
<td>1 - 2</td>
<td>14.7 - 73.0</td>
<td>Donato et al 2011</td>
</tr>
<tr>
<td>Seagrass</td>
<td>300-600,000?</td>
<td>1 - 2</td>
<td>15.4 - 30.8</td>
<td>Fourquarean et al. 2012</td>
</tr>
</tbody>
</table>

Estimate of global emissions 0.15 – 1.0 Pg CO₂ / yr (Pentleton et al. in press)
Progressive change of our coastlines

405 km of levees
870 km² of drained wetlands

C deposition >99% decrease
Release of historic carbon
Andrews et al., 2000, 2006

The Humber Estuary
Extensive diked wetlands
Post industrial estuary
Agricultural run-off
Long-term release of carbon from organic soils

Sacramento - San Joaquin Delta
Emissions from One Drained Wetland: Sacramento-San Joaquin Delta

Area under agriculture: 180,000 ha

Rate of subsidence (in): 1 inch

5 million tCO$_2$/yr released from Delta

1 GtCO$_2$ release in c.150 years
4000 years of carbon emitted
Equiv. carbon held in 25% of California’s forests

Accommodation space: 3 billion m$^3$
CO₂ Emissions from drained coastal wetlands (million tons)
# Emissions from drained wetlands organic soils

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th>Modification</th>
<th>CO2 efflux t/ ha/a</th>
<th>Method</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mangrove (Belize)</td>
<td>Cleared</td>
<td>29</td>
<td>CO2 efflux</td>
<td>Lovelock et al. 2011</td>
</tr>
<tr>
<td>Mangrove (Honduras)</td>
<td>Forest damaged by hurricane</td>
<td>15</td>
<td>Inferred from peat collapse</td>
<td>Cahoon et al. 2003</td>
</tr>
<tr>
<td>Mangrove (Australia)</td>
<td>Drained for agriculture</td>
<td>32</td>
<td>Peat collapse and CO2 efflux</td>
<td>Couwenburg et al. 2010</td>
</tr>
<tr>
<td>FWT marsh (California)</td>
<td>Drained for agriculture</td>
<td>6-40</td>
<td>Peat collapse and CO2 efflux</td>
<td>Rojstaczer &amp; Deverel 1993; Deverel &amp; Leighton 2010; Hatala et al. 2011</td>
</tr>
<tr>
<td>FWT marsh (Po Delta)</td>
<td>Drained for agriculture</td>
<td>92 ± 55</td>
<td>Peat collapse and CO2 efflux</td>
<td>Camporese et al. 2008; Zanello et al. 2011</td>
</tr>
</tbody>
</table>
What about remaining wetlands?
Low Marsh Response to SLR for Ranging Sediment Availability

SLR Scenario: NRC-III
Organic sedimentation rate: 1.0 mm/yr

SSC:
- 300 mg/L (very high)
- 150 mg/L (high)
- 50 mg/L (low)

Modeled with Marsh98
Large-scale Emissions, or not?

Wetland loss: 100 km² /yr

If top 50 cm erodes then 27.5TgCO₂
Released into circulation

But what is its fate???
Information needs - quantification

- CO$_2$, CH$_4$ and N$_2$O fluxes in wetlands across salinity gradients and under ranging conditions of nitrogen loading.

- GHG fluxes for undisturbed, converted and restoring wetlands

- Wetland carbon stocks - better global coverage

- Fate of C & N released from eroding wetlands

- Contribution of DOC to global warming
Information needs - models

- GHG emissions / reductions with landscape change – wetland migration, conversion.

- Process-based models to understand science of C&N cycling (e.g. DNDC)

- Simplified monitoring approaches / indicators

- Default factors of emissions and removals with activities.
Information needs - mapping

- Intact and degraded salt marsh and seagrasses

- Subclasses of coastal wetlands (can we connect to cover to geomorphology and below ground processes?)

- Drained wetlands, soil classification (C%)
Information needs - technology

- Near surface atmospheric GHG monitoring
- High resolution surface elevation mapping
- Less costly monitoring equipment
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