Remaining Priority Science Gaps to Advance Coastal Blue Carbon

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Restore America’s Estuaries and
The Coastal Society
Coastal Summit

National Harbor
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Ecosystems in focus for climate change mitigation

Forest

Mangroves

Tidal Marshes

Peatland

Seagrass
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
Estimating Global “Blue Carbon” Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems

Linwood Pendleton, Daniel C. Donato, Brian C. Murray, Stephen Crooks, W. Aaron Jenkins, Samantha Sifleet, Christopher Craft, James W. Fourqurean, J. Boone Kauffman, Núria Marbà, Patrick Menge, Emily Pidgeon, Dorothee Herr, David Gordon, Alexis Baldera

Table 1. Estimates of carbon released by land-use change in coastal ecosystems globally and associated economic impact.

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th>Global extent (Mha)</th>
<th>Current conversion rate (% yr⁻¹)</th>
<th>Near-surface carbon susceptible (top meter sediment+biomass, Mg CO₂ ha⁻¹)</th>
<th>Carbon emissions (Pg CO₂ yr⁻¹)</th>
<th>Economic cost (Billion US$ yr⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tidal Marsh</td>
<td>2.2–40 (5.1)</td>
<td>1.0–2.0 (1.5)</td>
<td>237–949 (593)</td>
<td>0.02–0.24 (0.06)</td>
<td>0.64–9.7 (2.6)</td>
</tr>
<tr>
<td>Mangroves</td>
<td>13.8–15.2 (14.5)</td>
<td>0.7–3.0 (1.9)</td>
<td>373–1492 (933)</td>
<td>0.09–0.45 (0.24)</td>
<td>3.6–18.5 (9.8)</td>
</tr>
<tr>
<td>Seagrass</td>
<td>17.7–60 (30)</td>
<td>0.4–2.6 (1.5)</td>
<td>131–522 (326)</td>
<td>0.05–0.33 (0.15)</td>
<td>1.9–13.7 (6.1)</td>
</tr>
<tr>
<td>Total</td>
<td>33.7–115.2 (48.9)</td>
<td></td>
<td></td>
<td>0.15–1.02 (0.45)</td>
<td>6.1–41.9 (18.5)</td>
</tr>
</tbody>
</table>

Compare to national emissions from all sources

Poland

Japan
Blue Carbon Interventions

- Policy adjustment
- Management actions
- Carbon finance projects
Blue Carbon: The Game Plan

• United Nations Framework Convention on Climate Change
  – Brief national climate change negotiators
  – Identify policy opportunities
  – Engage IPCC and SBSTA
  – Multi-national demonstration projects

• National Governments
  – Establish programs and science research
  – Recognize wetlands in national accounting
  – Agency awareness, action, funding

• Local Demonstration and Activities
  – Landscape level accounting
  – Establish carbon market opportunities
  – Look for synergistic conservation benefits
  – Demonstration projects and public awareness
Recent Activity

• IUCN and UNEP Reports on Blue Carbon (2009)
• Climate Action Reserve - Tidal Wetlands Offsets Issues Paper (2009)
• RAE Blue Ribbon Panel and Action Plan  US focused 2010
• International Blue Carbon Initiative (2011-onwards)
  • Science Working Group
  • Policy Working Group
• Reports (2011)
  • World Bank, IUCN, ESA PWA – Global estimates and policy implications
  • Duke University – Economic Potential
  • Climate Focus – international Policy
  • Blue Carbon Policy WG – Policy Frameworks.
• IPCC Wetlands Supplement for National GHG Accounting (2011-2013)
• Voluntary Carbon Standards
  • Recognizes wetlands activities
  • Methodology for Tidal Wetlands and Seagrass Restoration in review
  • Conservation Methodology in Development
• Working Groups
  • US Federal Agency Blue Carbon Group
  • World Bank Blue Carbon Working Group
  • National groups / programs – Indonesia, Australia, Abu Dhabi, Costa Rica, Brazil, CEC Oregon, Washington (?)
• Engagement with UNFCCC – regular technical briefings and reports (e.g. SBSTA workshop).
• Demo projects & Technical Capacity – GEF Blue Forest, NASA, National.
Methodological Guidance for Coastal Wetlands in the
2013 SUPPLEMENT TO THE 2006 IPCC GUIDELINES FOR
NATIONAL GREENHOUSE GAS INVENTORIES: WETLANDS
2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands

1. Introduction
2. Cross cutting guidance on organic soils
3. Rewetting and restoration of organic soils
4. Coastal wetlands
5. Other freshwater wetlands
6. Constructed wetlands
7. Good practice and implications for reporting

Adopted by IPCC Oct 2013, Published Feb 2014
http://www.ipcc-nggip.iges.or.jp/
Chapter 4: Coastal Wetlands

This chapter updates guidance contained in the 2006 IPCC Guidelines to:

- Provide default data for estimation of C stock changes in mangroves living biomass and dead wood pools for coastal wetlands at Tier 1

This chapter gives new:

- Guidance for CO₂ emissions and removals from organic and mineral soils for the management activities of extraction (including construction of aquaculture and salt production), drainage and rewetting and revegetation
- Default data for the estimation of anthropogenic CO₂ emissions and removals for soil in mangrove, tidal marsh and seagrass meadows.
- Guidance for N₂O emissions during aquaculture use.
- Guidance for CH₄ emissions for rewetting and revegetation of mangroves and tidal marshes.
Connecting Blue Carbon to Carbon Markets

Wetlands Restoration and Conservation (WRC)
Adopted into Standard Oct 4, 2012
http://v-c-s.org/wetlands_restoration_conservation

Other Categories:
• Afforestation, Reforestation, Revegetation (ARR)
• Agricultural Land Management (ALM)
• Improved Forest Management IFM)
• Reduced Emissions from Deforestation and Degradation (REDD)
VCS GHG Accounting Methodology for Coastal Wetlands and Seagrass Restoration

Example Project Activities Likely to be Covered by

- Rewetting of drained wetlands (dike breach, managed wetlands)
- Subsidence reversal (managed reed beds soil building)
- Restoring sediment supply
- Lowering of water levels on impounded wetlands
- Raising soil surfaces with dredged material
- Restoring salinity conditions
- Improving water quality
- Revegetation (marsh / forest)
- Combinations of the above

Methodology in review
Expected early 2015!
National Level Opportunities

1. Establish a national blue carbon working group to inform science and planning activities
2. Support additional research and analysis of GHG benefits of estuary wetland management
3. Assess blue carbon emissions and removals across landscape
4. Assist reporting on GHGs (new IPCC guidelines)
5. Integrate climate mitigation, adaptation, and restoration actions in local land-use plans
6. Enact blue carbon demonstration projects
7. Integrate blue carbon into regulatory and policy frameworks
8. Scale up public and private investment in estuary wetland restoration and protection
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
Priority Blue Carbon Activities

• Data collection
• Develop methodologies for monitoring emissions, emissions reductions and removals
• Assessing specific drivers leading to loss of coastal and marine ecosystems
• Development of reference emissions levels for one or more type of blue carbon
• Demonstration projects and policy analysis & development
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
Guidance on Blue Carbon Interventions

• Combined experience from carbon project, community engagement and wetlands restoration.

• To be released at COP 19 Lima, Peru.
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

3-5 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)
- SSC: 150 mg/L (high)
- SSC: 50 mg/L (low)

Modeled with Marsh98
Large-scale Emissions, or not?

Wetland loss: 100 km$^2$/yr

If top 50 cm erodes then 27.5 Tg CO$_2$

Released into circulation

But what is its fate???

Coastal Louisiana has lost an average of 34 square miles of land, primarily marsh, per year for the last 50 years. From 1932 to 2000, coastal Louisiana lost 1,909 square miles of land, roughly an area the size of Delaware. If nothing more is done to stop this land loss, Louisiana could potentially lose approximately 700 additional square miles of land, or an area about equal to the size of the greater Washington D.C.-Baltimore area, in the next 50 years.

Data Sources:
- 1932-1950 Land Change Analysis
- U.S. Army Corps of Engineers, New Orleans
- 1950-1990 Land Change Analysis
- U.S. Geological Survey
- Louisiana Coastal Zone Research Center
- Lafayette, LA

Prepared by:
- U.S. Department of the Interior
- U.S. Geological Survey
- Louisiana Coastal Zone Research Center
- Lafayette, LA

Map ID: USGS N002-005-10-0001
Map Date: December 6, 2004

For more information about the land loss analysis or to see an animated time series of wetland change, visit [www.LaCoast.gov/LandLoss](http://www.LaCoast.gov/LandLoss)
Stock based calculations (1992-2011)
- NLCD data through NOAA’s C-CAP
- Linked with SSURGO 1m soil data

Revised data at 6 sentinel sites for:
- Validation of mapped carbon fluxes
- Biomass and aqueous algorithms
- “Price of Precision” for attributes
- Hydrology, elevation, biomass
- MEM-CH4 – predicting methane from salinity class, inundation,
Blue Carbon: Emissions, Economics and Policy

http://estuaries.org/climate-change.html
Priority Readiness Activities

• Data collection
• Develop methodologies for monitoring emissions, emissions reductions and removals
• Assessing specific drivers leading to loss of coastal and marine ecosystems
• Development of reference emissions levels for one or more type of blue carbon
• Demonstration projects and pilot policy measures
Opportunities

• Build on growing recognition of the importance of coastal and marine ecosystems in climate change mitigation and adaptation.

• Connect with developing policy frameworks such as REDD and development of Nationally appropriate Mitigation Actions (NAMAs).

• Connect to funding for Climate Readiness Activities
Challenges

Science
• Lack of quantification (particularly in degraded ecosystems)
• Fate of remobilized carbon
• Coastal scale GHG budgets

Policy
• Complexity of coastal ecosystems
• Demonstration of application
• Ownership – property rights
• Information overload