Terrestrial Wetlands – Chapter 13
2nd State of Carbon Cycle Report

Wetlands:
- Hydrophytic vegetation
- Hydric soil
- Saturated soils near surface during growing season

C Stocks: \( f(\text{wetland type, climate, vegetation hydrogeomorphic setting}) \)
Organic Soil vs Mineral Soil Wetlands: Definition

Organic Soils:
- Peatlands (Bogs and Fens)
- Soil Order Histosols
- >18% Organic C in the Upper 40 cm

Mineral Soils:
- Don’t Meet the Definition of Organic Soils but still Hydric
- Prairie Potholes, Marshes, Black Ash Wetlands
- In Many of the Soil Orders – Wet End
- <18% Organic C in the Upper 40 cm
Wetland Functions

- Carbon Sink
- Hydrology/Water Quality
- Habitat
Wetland Functions

- Carbon Sink
  - Peatlands = 3% of terrestrial area, 30% of soil C
  - Numerous studies indicate that wetlands continue to be sinks for C
  - Some studies and models indicate that wetlands are/will soon become sources of C

Starting to Change?

Production

Decomposition
Wetland Functions
Wetland Functions

- Habitat
  - Animals and Endangered Plants
Terrestrial Wetlands Chapter Scope

- Geography
  - Alaska
  - Canada
  - Conterminous U.S.
  - Mexico
  - Puerto Rico (Hawaii not reported)

- Wetlands
  - Included
    - Terrestrial freshwater wetlands
  - Not included
    - Tidal, marine wetlands → Chap. 15
    - Tidal, freshwater wetlands → Chap. 15
    - Open water bodies (lakes, streams) → Chap. 14
    - Arctic wetlands → Chap. 11
    - Converted wetlands → Chap. 5

(from Commission on Environmental Cooperation, based on Lehner and Döll 2004)
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Approach

• Carbon Stocks
  • **Soil type** – mineral soils, organic soils (i.e. peat)  
    **Vegetation type** – forested, non-forested

• Assessment
  • Wetland inventory – incorporate new assessments of wetland area (Mexico, Canada, Alaska)
  • Carbon stocks – incorporate C stock inventory (soils, vegetation) where feasible
  • Update C Stock and emission factors utilizing IPCC and literature
### Basis for the Assessment

<table>
<thead>
<tr>
<th>Area</th>
<th>Data Sources</th>
<th>Spatial Data Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>Peatland inventory</td>
<td>Vector (1:7.5 million)</td>
</tr>
<tr>
<td></td>
<td>Soil Landscape of Canada</td>
<td>Vector (1:1 million)</td>
</tr>
<tr>
<td>Mexico</td>
<td>Wetland inventory</td>
<td>Vector (1:250,000)</td>
</tr>
<tr>
<td></td>
<td>North America Land Cover data</td>
<td>Raster (250mx250m)</td>
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<tr>
<td>United States</td>
<td>gSSURGO (soil)</td>
<td>Raster (10mx10m)</td>
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<td></td>
<td>National Wetland Inventory (NWI)</td>
<td>Vector (1:12,000)</td>
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<td></td>
<td>FIA Forest Biomass</td>
<td>Raster (250mx250m)</td>
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<tr>
<td></td>
<td>State boundary</td>
<td>Vector (1:50,000)</td>
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<tr>
<td>Alaska</td>
<td>Vegetated Wetlands of Alaska (Clewey et al. 2015)</td>
<td>Raster (50 x 50 m)</td>
</tr>
<tr>
<td></td>
<td>STATSGO2</td>
<td>Vector (1:1 million)</td>
</tr>
</tbody>
</table>
North America contains ~37% of global wetland area (2.2 x 10^6 km^2). Non-forested wetlands comprise ~44% of the area, mostly in Canada & Alaska. Organic soils comprise ~58% of the area. Wetland restoration & creation are major factors off-setting losses.
Peatlands contain 80% of the C stock

57% of the C stock occurs in forested wetlands
### Terrestrial Wetland Net C Flux

<table>
<thead>
<tr>
<th>Region</th>
<th>Peat-NonForest</th>
<th>Peat-Forest</th>
<th>Mineral-NonForest</th>
<th>Mineral-Forest</th>
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<tbody>
<tr>
<td>Canada</td>
<td>51%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONUS</td>
<td>29%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alaska</td>
<td>14%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>&lt;1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>6%</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

- Mineral soils account for 51% of the net sequestration
- 53% of the sequestration in forested wetlands
Terrestrial Wetland Net CH$_4$ Flux

Mineral soils account for 56% of the emissions.

Nonforested wetlands account for 55% of the emissions.

Canada: 57%
CONUS: 21%
Alaska: 18%
Puerto Rico: <1%
Mexico: 4%
Wetland Carbon Stocks & Fluxes in North American

Peatland

- CO₂: -216 to 70
- CH₄: 17 to 50
- CO₂: -255 to 64
- CH₄: 23 to 43

Mineral Soil Wetland

- CO₂: -245 to -14
- CH₄: 14 to 40

Water Table

- CO₂: -251 to -16
- CH₄: 1 to 33

Peat

- CO₂: 23,800 to 90,300
- CH₄: 61,400 to 104,400

Units: Tg C

DOC export

16
## Ecosystem Fluxes

<table>
<thead>
<tr>
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<th>Tg C yr(^{-1})</th>
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<tbody>
<tr>
<td>Net sequestration</td>
<td>-126.4</td>
</tr>
<tr>
<td>CH(_4) emissions</td>
<td>44.8</td>
</tr>
<tr>
<td>DOC leaching</td>
<td>16.3</td>
</tr>
<tr>
<td><strong>Balance</strong></td>
<td><strong>-65.3</strong></td>
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</tbody>
</table>
Key Findings

• Wetland Area
  • Comprise ~ 37% of the global wetland area (2.2 x 10^6 km^2)
  • The rate of wetland loss is much lower than historical rates
    • 53% of wetland area lost from 1870-1980 (>85% in Midwest, 95% in CA)
    • ~0.06% of the wetland area from 2004 to 2009
    • restoration and creation nearly offset losses of natural wetlands
  • Considerable uncertainty about the functional equivalence of disturbed, created, and restored wetlands as compared to undisturbed wetlands
  • 2016 study by EPA assessed national (US) wetland health and found 48% of wetlands were in good condition, 20% in fair condition and 32% in poor condition
  • Wetlands tend to be disturbed on the edges or perimeter which then affects the water and nutrient balance of the entire ecosystem
Key Findings, Cont’d

- C stocks in Terrestrial Wetlands
  - Contain ~36% of the global wetland C stock (161 Pg)
  - Peatlands contain ~58% of the total area & ~ 80% of the carbon
  - Forest comprise ~55% of the area
Key Findings, Cont’d

• C Fluxes from Terrestrial Wetlands
  • CO$_2$ sink (~126 Tg C yr$^{-1}$)
  • CH$_4$ source (~45 Tg C-CH$_4$ yr$^{-1}$)
  • DOC source (~16 Tg C yr$^{-1}$)
  • Overall net sink (~65 Tg C yr$^{-1}$)
  • Considerable uncertainty about the effects of disturbance regimes on carbon stocks and greenhouse gas (GHG) fluxes
Key Findings cont’d

• Studies and monitoring systems are needed that compare C pools, rates of C accumulation, and GHG fluxes across disturbance gradients, including restored and created wetlands.

• Produce data that are needed for model applications. Really need to be able to better model wetland C cycles for application in Global Circulation Models.
Major Differences with SOCCR 1

- SOCCR 1 Wetlands Chapter included all wetlands.
- 320,000 km$^2$ more freshwater wetlands
  - Wetland area of Alaska 50% less (permafrost in Arctic chapter);
  - 619,000 km$^2$ more in Canada
- Net sequestration 4X greater;
- CH$_4$ emissions 6X greater.
A Special Thanks to: Nancy Cavallaro and Gyami Shrestha for leading the project; And to: Ray Najjar and Zhiliang Zhu for their work in overseeing the wetland & water chapters.

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