Predicting Climate Change Impacts on Wetland Boundaries in the Eastern U.S.

by

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Introduction

Wetlands are protected by state and federal laws that prevent them from being filled in or drained. Land can be used for agriculture or real estate development up to the edge of the wetland boundary. This study developed techniques for determining how wetland boundaries would shift as a result of climate change. Such information should be of interest to land planners as well as land owners.

Objectives

1. Estimate how predicted changes to rainfall and temperature through 2070 will affect the location of the wetland hydrology “line” (wetland boundary) in the Eastern U.S.
2. Estimate amounts of land area that may be affected if changes to the wetland hydrology line occur.

Sites

The wetlands were “wet flats” that were not affected by rivers or sea level. Precipitation was the only water source, and evapotranspiration was the only way water was lost. These can be thought of as “Soup Bowls” in the landscape. The same kind of wetland was evaluated at four sites: Miami FL, Greenville NC, Easton MD, and Portland Maine.

Methods Overview

A Four-Step Approach was used to acquire data for the study.

1. Calibrate DRAINMOD model to predict water table levels from rainfall and temperature.
2. Identify climate change model that best predicts rainfall for sites.
3. Input current and future temperature and rainfall data from climate model into hydrologic model to compute water table levels.
4. Estimate amounts of land area affected.

Climate Model Used

Three global change models were evaluated for use by comparing predicted and measured precipitation using data from Greenville NC. The Hadley model performed best (Hadcm3_a1b) and was the only model used across all sites. The models tested and r² values are shown below for the relationship between measured and predicted precipitation for the period 1951-2011.

<table>
<thead>
<tr>
<th>Climate Model</th>
<th>Decadal Data By Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hadley: UKMO-HadCM3</td>
<td>0.71</td>
</tr>
<tr>
<td>USDC/ NOAA/ GFDL-CM2.0</td>
<td>0.53</td>
</tr>
<tr>
<td>Canadian Centre for Climate Modeling &amp; Analysis CGCM3.1</td>
<td>0.46</td>
</tr>
<tr>
<td>ALL</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Elevation Changes

A hypothetical wetland is shown on the right. The climate model was used in DRAINMOD and the latter adjusted so that it simulated water table levels at a point where wetland hydrology was met during the period 1983-2012.

We assumed that the differences in depths shown on the left could be used to estimate the elevation change in the wetland line from 1983-2012 (current condition) to 2041-2070 (future condition).

Modeling Results

Summary of results across sites. Sizes of changes in precipitation, evapotranspiration (Et), temperature, and wetland boundary elevation increased from south to north as a result of climate change. Temperature changes were predicted to be much larger than changes in rainfall. Hadley models from each site were used for the modeling.

Changes From “1983-2012” to “2041-2070” in: % Inches

<table>
<thead>
<tr>
<th>Sites</th>
<th>Precip.</th>
<th>Et</th>
<th>Temperature</th>
<th>Elevation of Hydrology Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Maine</td>
<td>5</td>
<td>32</td>
<td>12</td>
<td>-10</td>
</tr>
<tr>
<td>Easton MD</td>
<td>8</td>
<td>18</td>
<td>8</td>
<td>-4</td>
</tr>
<tr>
<td>Greenville NC</td>
<td>-1</td>
<td>9</td>
<td>6</td>
<td>-7</td>
</tr>
<tr>
<td>Miami FL</td>
<td>-6</td>
<td>5</td>
<td>5</td>
<td>-2</td>
</tr>
</tbody>
</table>

Conclusions

• Global climate change will tend to cause freshwater wetlands to shrink in size along the eastern U.S.
• Changes through 2070 will be relatively small, being least in the South and increasing northward.
• In NC, we estimated that the reduction of wetland area will be <2%.
• Impacts of these changes on current land uses near wetlands will probably be small.