AN EMERGING TOOL TO ASSESS PEAT LOSS AND MARSH VULNERABILITY IN THE FLORIDA EVERGLADES

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Peat collapse causes rapid declines in soil surface elevation and a net loss in organic carbon.

• Marsh $\rightarrow$ Open water

Loss of coastal marshes has the potential to hinder inland transgression of mangrove forests with sea level rise and saltwater intrusion.

While our mechanistic understanding of peat collapse in coastal marshes has grown strong, we still lack an integrated method to evaluate occurrence, extent, and severity of collapse at the landscape scale.

Translating experimentally determined relationships to the landscape!
Q: What sawgrass-dominated areas across the coastal landscape are indicated as vulnerable to peat collapse, based on our understanding of the drivers of collapse?

OBJ: Develop a product that visualizes areas indicated to be most vulnerable to peat collapse.

- Indicators
  - Using components of an ecosystem that are selected in order to characterize the system and the process of interest.

- Ecological Vulnerability
  - “The potential to which an ecosystem is likely to experience harm due to exposure to a hazard, either a perturbation or a stress/stressor, where the potential is determined by characteristics of the ecosystem that span multiple levels of organization.”
    - Soils, vegetation, environmental parameters (hydrology, disturbance, etc.).

- Experimentally determined Drivers
  1. Driver: Saltwater intrusion
     Mechanism: Threshold ~10-15 ppt where sawgrass productivity declines and initiates peat collapse.
  2. Driver: Drought/length of drawdown
     Mechanism: Soil exposure 5-6 months or more increases mineralization and CO₂ loss, increasing elevation loss.

- Product
  - GIS-based map that portrays vulnerability based on a set of standardized indicators, aggregated into a single value (index), that takes into account the relative influence of each indicator on peat collapse.
CMVI indexes coastal marshes using a classic rank classification system:

\[ \text{CMVI} = \sum (X_i \times X_w) \]

**Method**

- **Standardize a set of indicators** to a common numeric scale.
- **Weight** each indicators based on it’s relative influence to peat collapse.
  - Weights equal one (1) between all indicators and selected to emphasize the drivers of peat collapse.
- **Aggregate indicators** to single value (index).

**Indicators, ranks, and weights, for the CMVI.**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Class</th>
<th>Rank</th>
<th>Weight</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation Type</td>
<td>Communities dominated or co-dominated by <em>Cladium jamaicense</em></td>
<td>1</td>
<td>0.2</td>
<td>Everglades National Park Service (Ruiz et al. 2017)</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Depth (m)</td>
<td>250-400</td>
<td>6</td>
<td>0.1</td>
<td>EPA; USGS; unpublished, Troxler lab data; literature</td>
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<tr>
<td></td>
<td>150-250</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>90-150</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>60-90</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30-60</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 - 30</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groundwater Salinity (top 2 m; ppt)</td>
<td>20 +</td>
<td>5</td>
<td>0.4</td>
<td>E. Swain; USGS BISECT Model</td>
</tr>
<tr>
<td></td>
<td>15 - 20</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 - 15</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 - 10</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 - 5</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of dry-down (days)</td>
<td>180-365</td>
<td>5</td>
<td>0.3</td>
<td>E. Swain; USGS BISECT Model</td>
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<tr>
<td></td>
<td>150-180</td>
<td>4</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>120-150</td>
<td>3</td>
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<td>90-120</td>
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<tr>
<td></td>
<td>0-90</td>
<td>1</td>
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</tr>
</tbody>
</table>
INDICATORS

Top-left:
Vegetation Community
(Source: NPS, Ruiz et al. 2017)

Top-right:
Soil Depth (cm)
(Source: Various).

Bottom-left:
Median Groundwater salinity to max depth of 2m
(Source: USGS).

Bottom-right:
# Days Dry
(Source: USGS)

* All inputs at 50 x 50 m spatial scale
CMVI OUTPUT

CMVI, 2000

CMVI, 2003

CMVI, hectares

<table>
<thead>
<tr>
<th>Rank</th>
<th>2000</th>
<th>2003</th>
<th>Change</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>16,333</td>
<td>16,659</td>
<td>326</td>
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<tr>
<td>2</td>
<td>7,464</td>
<td>7,477</td>
<td>-13</td>
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<tr>
<td>3</td>
<td>3,793</td>
<td>3,454</td>
<td>-339</td>
</tr>
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</table>
CMVI uses a ranked classification system that visualizes and indexes sawgrass dominated/co-dominated marshes vulnerable to peat collapse, based on mechanistically determined relationships.

- Increase number of inputs → Soil type
- Move away from classic rank-classification approach towards a more mechanistic approach → decision-tree
- Develop composite index that takes into account multiple years to arrive at an overall composite index value that can be used to select field sites.
Can we probabilistically model the occurrence of peat soil at coarse scales (50x50m) based on soil depth and hydrology?

**Goal?**
- Feed into broader Coastal & Greater Everglades Landscape Vulnerability Analysis and serve as input to CMVI
- Be available to the broader research community

**Limitations**
- Soil is heterogeneous in reality.
- Mismatch of spatial scale between response and predictors.
- Can only focus on individual community types due to inability to capture biotic forces within model.

**Modeling Approach**
- Predict probability of soil along a gradient of organic content.
  - Mineral: <40%
  - Intermediate 40-70%
  - Organic: <70%
- Preliminary analysis using logistic regression
IDENTIFY A FIELD APPROACH THAT CAN BE USED TO INDICATE IF PEAT COLLAPSE IS OCCURRING AND ITS SEVERITY.
THANKS! QUESTIONS?