Province-wide assessment of grassland carbon storage: challenges, opportunities and potential applications

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Grassland carbon storage assessment

Several studies have assessed grassland carbon storage under different management regimes and climate conditions.

Potential impacts of management practices and future climatic changes

Adaptive land management practices

Lack of a province-wide dynamics tool for consistent assessment of grassland carbon storage
Ecosystem Services Assessment project

Part of a province-wide initiative: *Ecosystem Services Research and Innovation Roadmap*

Ecosystem Services

- Soil carbon storage
- Forage production
- Water purification
- Pollination
- Biodiversity
- Timber production

- Develop an *integrated set* of spatially-explicit ecosystem service *models*
- Support a better accounting of the *provision and value* of multiple services
- Assess potential *future changes* in ecosystem service provision
Grassland Carbon Assessment project

Assess the current and future status of organic carbon storage across Alberta’s native grasslands

Establish a regional grassland carbon dynamics model

The ecosystem carbon model CENTURY (process-based)

- Monthly climate data (rainfall, temperature)
- Soil properties (texture, depth, bulk density, drainage class and pH)

- Fire regime
- Land management history (grazing regime)

(NREL 2009; Parton et al. 1988)
Native grassland

Where are the native grasslands located?

ABMI’s Wall to Wall Land Cover map

ABMI’s Human Footprint map

Alberta’s Native Grassland map
Native grassland soil database

What is the appropriate spatial unit?

Agricultural Region soil map

The Agricultural Region of Alberta Soil Inventory Database AGRASID 3.0

Native grassland soil database

25,093 soil polygons (1491 soil types)

CENTURY model run for each polygon (representing soil, climatic, vegetation and land management)
Grassland Soil Correlation Areas (SCAs)

What are the significant regions?

SCAs: generally agree with natural **ecoregion** boundaries, correlate strongly with **soil zone** lines, with further subdivisions reflecting recognized **agroclimatic zones**

<table>
<thead>
<tr>
<th>Combined SCA name</th>
<th>Original SCA code(s)</th>
<th>Agroclimatic zone</th>
<th>AGRASID</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Soil types</td>
</tr>
<tr>
<td>Brown Soil of Dry Mixedgrass</td>
<td>1</td>
<td>3A</td>
<td>75</td>
</tr>
<tr>
<td>Dark Brown Soil of Mixedgrass</td>
<td>2,3</td>
<td>2AH, 2H</td>
<td>77</td>
</tr>
<tr>
<td>Dark Brown Soil of Northern Fescue</td>
<td>4</td>
<td>2AH</td>
<td>39</td>
</tr>
<tr>
<td>Thin Black soil of Foothills Fescue</td>
<td>5,6</td>
<td>2AH, 3H</td>
<td>49</td>
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<tr>
<td>Thin Black soil of Central Parkland</td>
<td>7,9</td>
<td>2H, 3H</td>
<td>39</td>
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<tr>
<td>Thin Black Soil of Foothills Parkland</td>
<td>8,13</td>
<td>4H</td>
<td>66</td>
</tr>
<tr>
<td>Thin Black-Dark Gray Soil of Parkland</td>
<td>10</td>
<td>2H, 3H</td>
<td>84</td>
</tr>
<tr>
<td>Dark Gray-Black Soil of Dry Mixedwood</td>
<td>12,18</td>
<td>2H, 3H</td>
<td>106</td>
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<tr>
<td>Dark Gray-Gray Soil of Mixedwood</td>
<td>17,20,21, 22</td>
<td>4H (5H)</td>
<td>123</td>
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</table>
ABMI soil organic carbon monitoring program

What are the available soil carbon data?

**Geo-referenced** organic carbon measurement in the top (0-5 cm) mineral soil layer

1656 sites (20 km apart), 350 sites/year

Around **400** grassland monitoring sites

### ABMI carbon data for grassland regions

<table>
<thead>
<tr>
<th>Combined SCA name</th>
<th>ABMI sites</th>
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<tbody>
<tr>
<td>Brown Soil of Dry Mixedgrass</td>
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<td>Dark Brown Soil of Mixedgrass</td>
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<td>Thin Black soil of Foothills Fescue</td>
<td>29</td>
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<tr>
<td>Thin Black soil of Central Parkland</td>
<td>24</td>
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<tr>
<td>Thin Black Soil of Foothills Parkland</td>
<td>30</td>
</tr>
<tr>
<td>Thin Black-Dark Gray Soil of Parkland</td>
<td>35</td>
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<tr>
<td>Dark Gray-Black Soil of Dry Mixedwood</td>
<td>47</td>
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<tr>
<td>Dark Gray-Gray Soil of Mixedwood</td>
<td>37</td>
</tr>
</tbody>
</table>
Establish a regional grassland carbon dynamics model

What are the challenges?

- limitations of currently available data and scientific knowledge
- Model parameterization, calibration and validation

Other available data:

- AESRD long-term biomass data
- Remotely sensed data (MODIS NDVI vegetation product)
- Rangeland Research Institute biomass and carbon data

Provides baseline estimates of current grassland carbon storage and associated uncertainty
Climate projections for native grassland

Ensemble of 23 CMIP3 global climate models (A2 emission scenario) available through ClimateWNA (Wang et al. 2012)

- Annual precipitation
- Minimum temperature
- Maximum temperature

Soil Correlation Areas (SCAs)

Projected changes in precipitation is smaller than the changes in temperatures
Predicting changes in grassland carbon storage

What are the applications?

- Impacts of future land management practices
- Impacts of future climate change adaptation strategies
- Cost-benefit of potential adaptation strategies
- A baseline to assess whether management practices and adaptation strategies will lead to resilience of socio-ecological systems in Alberta’s rangeland
Conclusion and future directions

Alberta needs a regional grassland carbon model

Science

- Knowledge review on grassland carbon storage and grassland carbon assessment
- A provincial database on grassland carbon storage and grassland management history

Policy and management

- Guideline for land management practices and climate change adaptation strategies
Thank you

Collaborators

Supported by

http://ecosystemservices.abmi.ca/