



**esa**  
Ecosystem Services  
Assessment

# 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



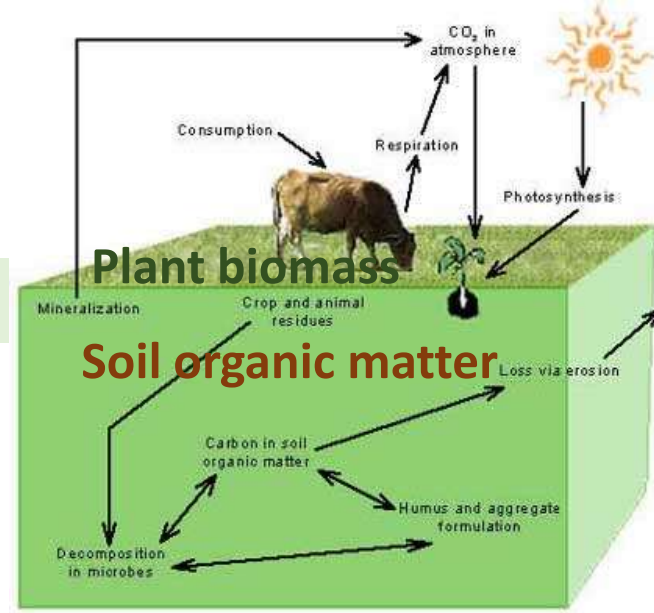
# Grassland Carbon Assessment project



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

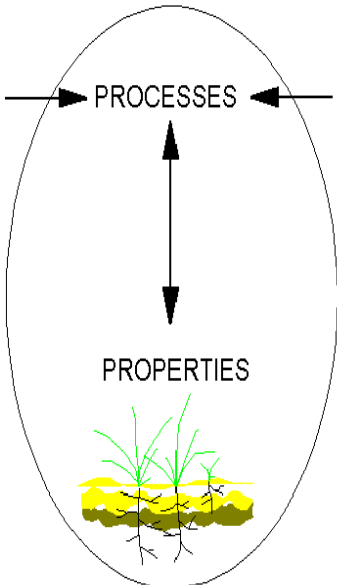
Establish a regional grassland carbon dynamics model

The ecosystem carbon model **CENTURY** (process-based)



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

DRIVING VARIABLES → PROCESSES ← MANAGEMENT



- Fire regime
- Land management history (grazing regime)

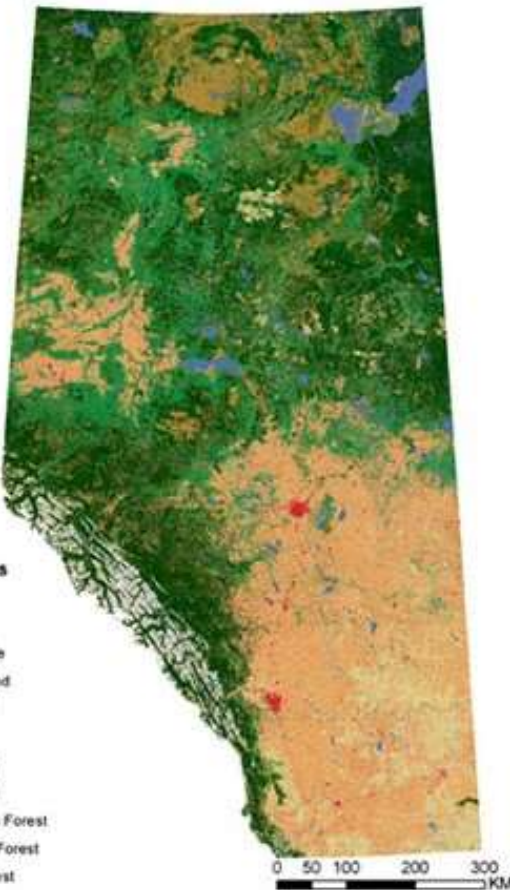
(NREL 2009; Parton et al. 1988)

# Native grassland

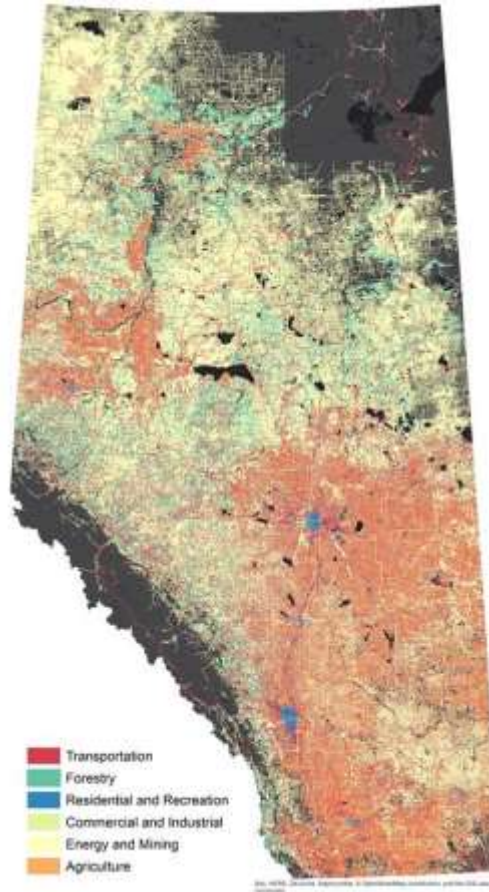


*Where are the native grasslands located?*

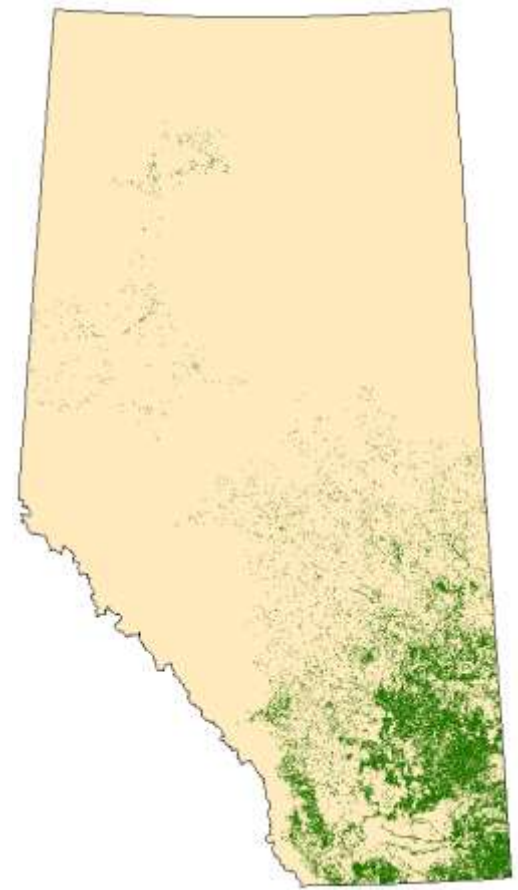
ABMI's Wall to Wall  
Land Cover map



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



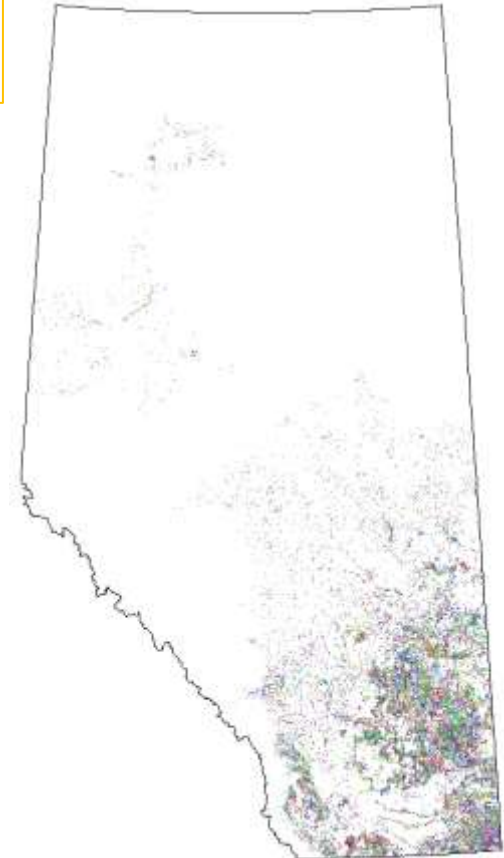
Native grassland soil database



25,093 **soil polygons** (1491  
soil types)

CENTURY model run for  
each polygon (representing  
soil, climatic, vegetation and land  
management)

Native grassland  
soil map



# 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**



Combined SCA name	Original SCA code(s)	Agroclimatic zone	AGRASID	
			Soil types	Soil polygons
Brown Soil of Dry Mixedgrass	1	3A	75	4688
Dark Brown Soil of Mixedgrass	2,3	2AH, 2H	77	2012
Dark Brown Soil of Northern Fescue	4	2AH	39	2736
Thin Black soil of Foothills Fescue	5,6	2AH, 3H	49	1521
Thin Black soil of Central Parkland	7,9	2H, 3H	39	1753
Thin Black Soil of Foothills Parkland	8,13	4H	66	1929
Thin Black-Dark Gray Soil of Parkland	10	2H, 3H	84	3268
Dark Gray-Black Soil of Dry Mixedwood	12,18	2H, 3H	106	2151
Dark Gray-Gray Soil of Mixedwood	17,20,21, 22	4H (5H)	123	1495

# 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

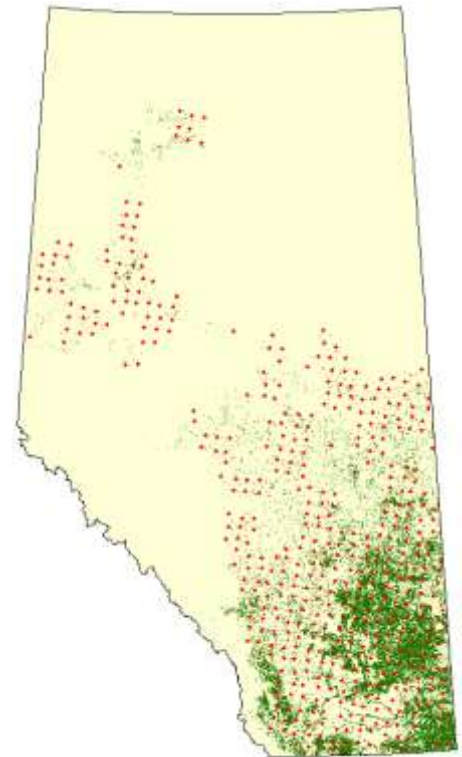
**1656** sites (20 km apart),  
350 sites/year

Around **400** grassland monitoring sites

ABMI carbon data for grassland regions



Combined SCA name	ABMI sites
Brown Soil of Dry Mixedgrass	110
Dark Brown Soil of Mixedgrass	38
Dark Brown Soil of Northern Fescue	53
Thin Black soil of Foothills Fescue	29
Thin Black soil of Central Parkland	24
Thin Black Soil of Foothills Parkland	30
Thin Black-Dark Gray Soil of Parkland	35
Dark Gray-Black Soil of Dry Mixedwood	47
Dark Gray-Gray Soil of Mixedwood	37



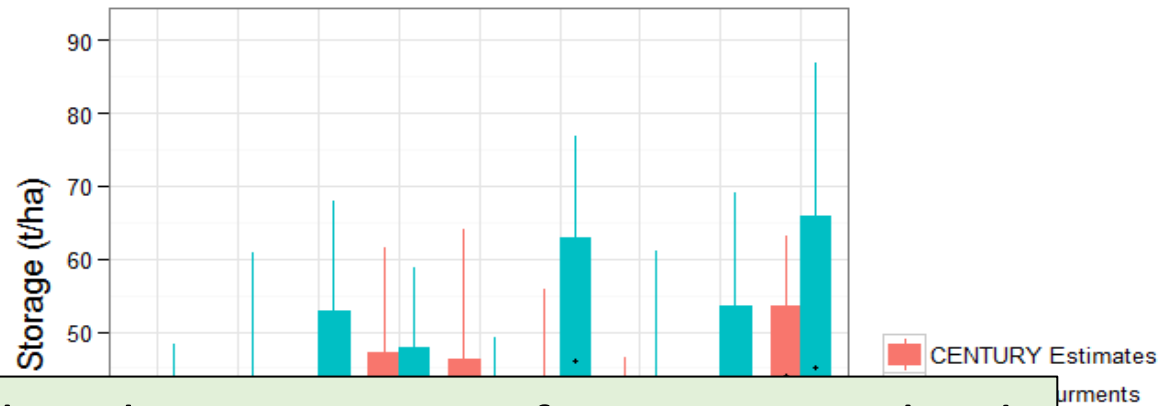


# Establish a regional grassland carbon dynamics model



## What are the challenges?

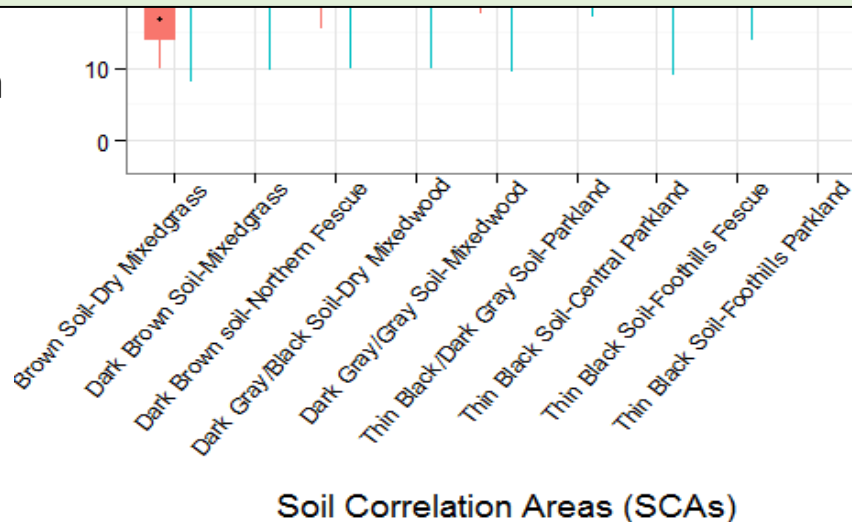
- limitations of currently available **data** and **scientific knowledge**
- Model parameterization, calibration and validation



Provides baseline estimates of current grassland carbon storage and associated uncertainty

## Other available data:

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



It's Our Nature *to Know*

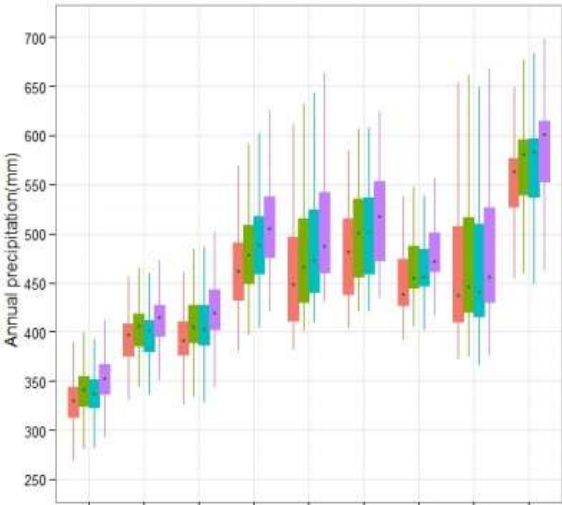
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# Climate projections for native grassland

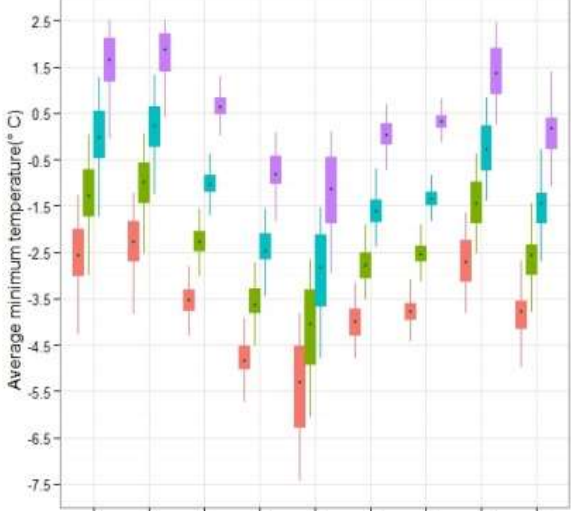


Ensemble of 23 CMIP3 global climate models (A2 emission scenario) available through ClimateWNA (Wang et al. 2012)

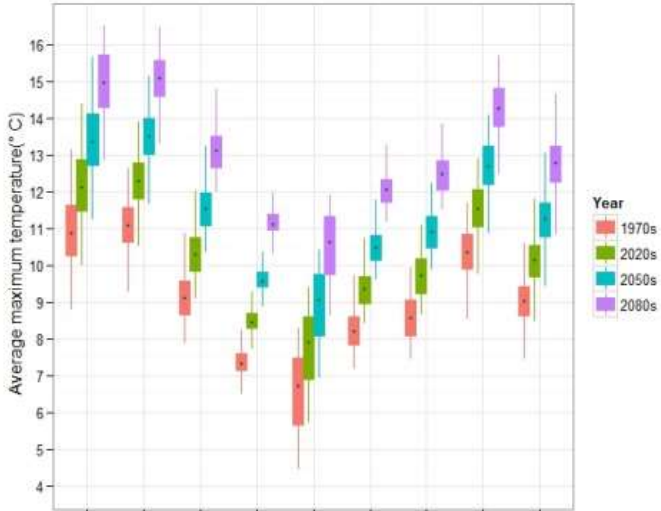
Annual precipitation



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



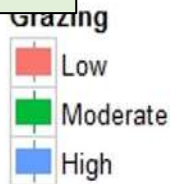
## What are the applications?

- Impacts of future land management practices
- Impacts of future climate change adaptation strategies
- Cost-benefit of potential adaptation strategies

Relative change in aboveground biomass carbon (%)



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

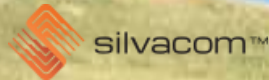


# Thank you



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