



esa
Ecosystem Services
Assessment

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

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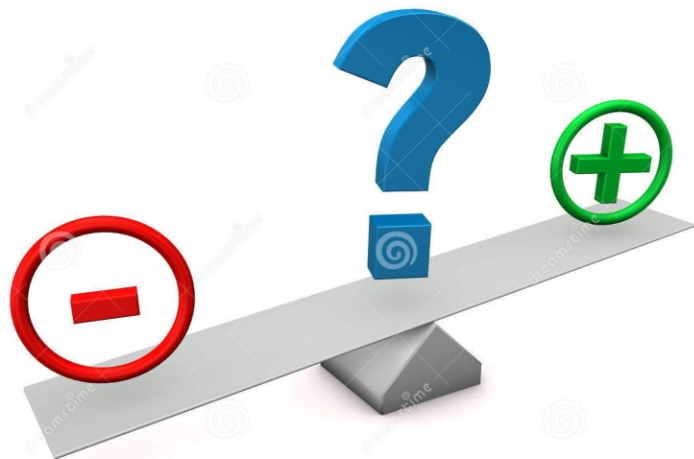
Grassland carbon storage assessment



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

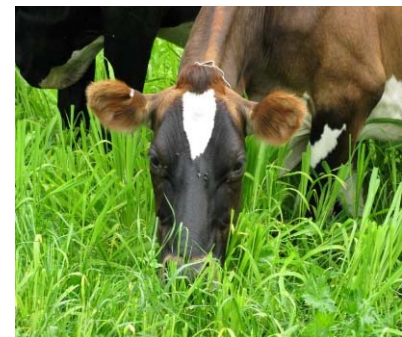


Part of a province-wide initiative : *Ecosystem Services Research and Innovation Roadmap*

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)

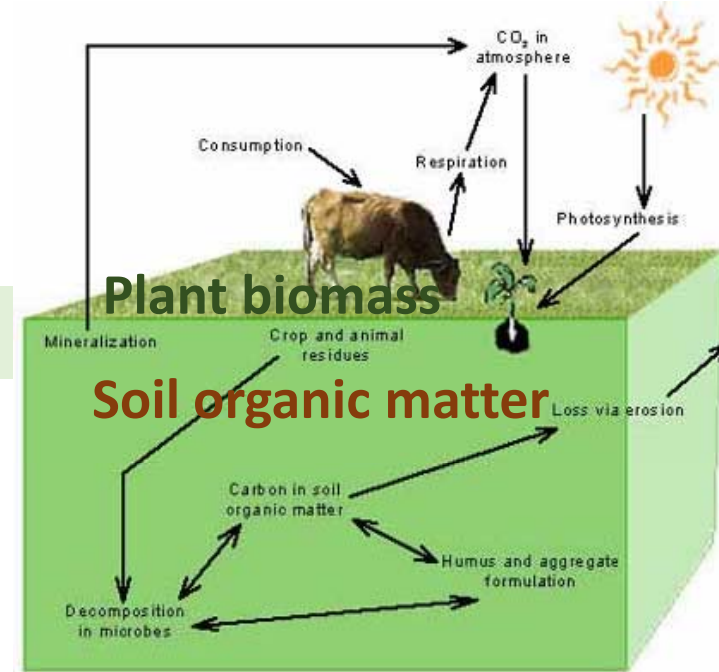
- Monthly climate data (rainfall, temperature)
- Soil properties (texture, depth, bulk density, drainage class and pH)

DRIVING
VARIABLES

PROCESSES

MANAGEMENT

PROPERTIES



- Fire regime
- Land management history (grazing regime)

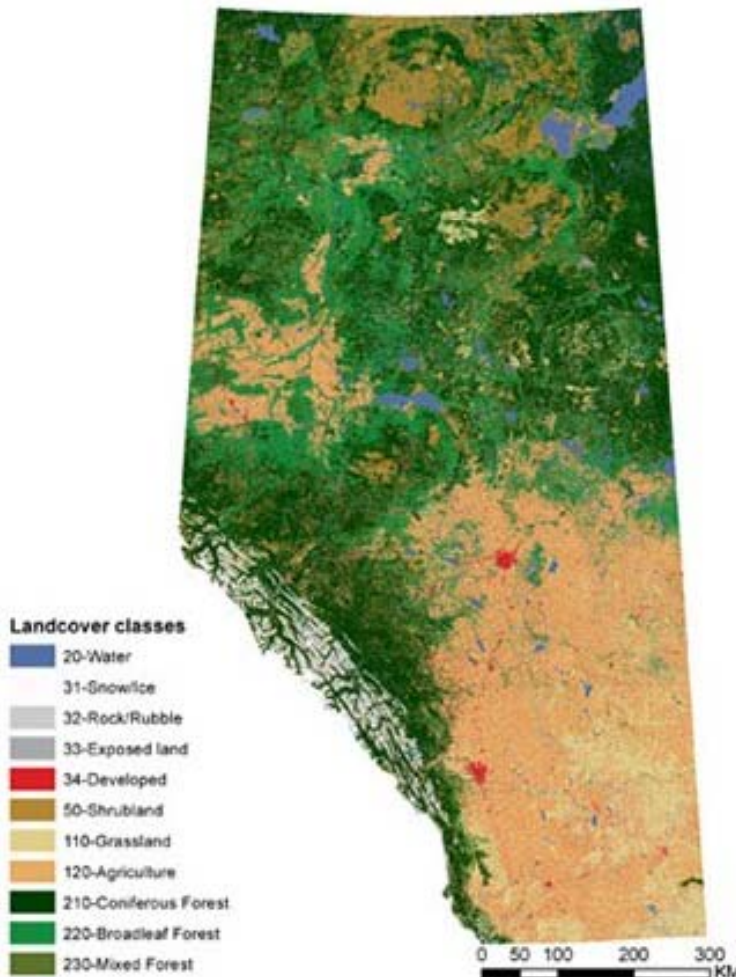
(NREL 2009; Parton et al. 1988)

Native grassland

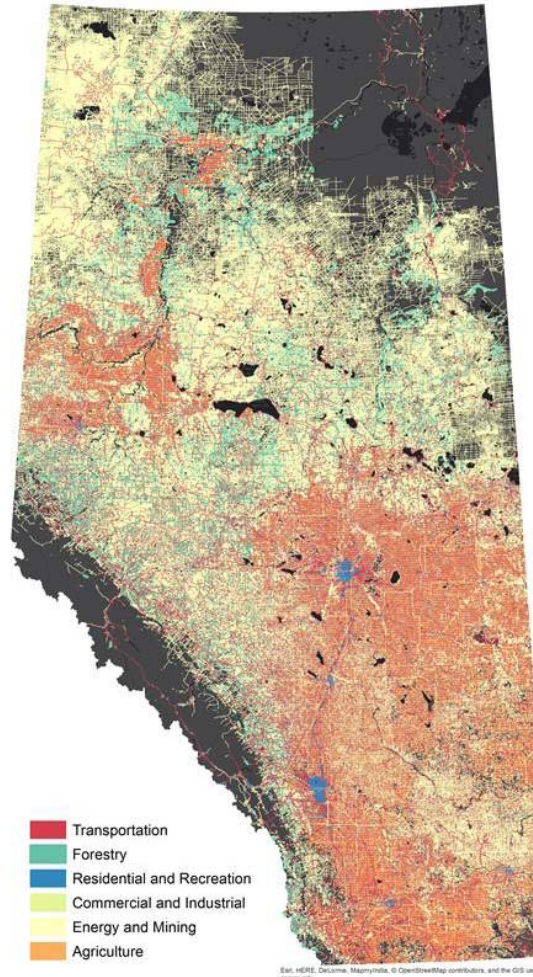


Where are the native grasslands located?

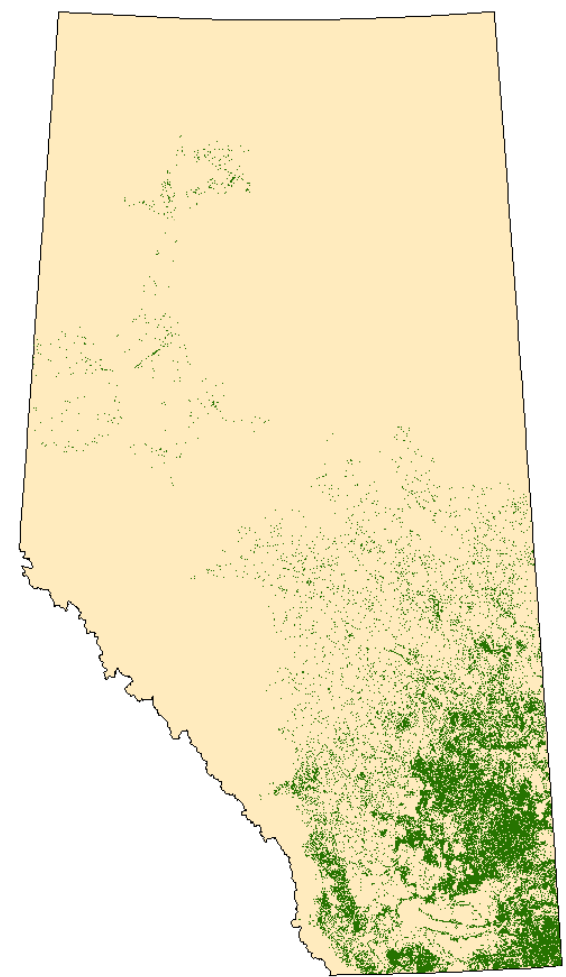
ABMI's Wall to Wall
Land Cover map



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



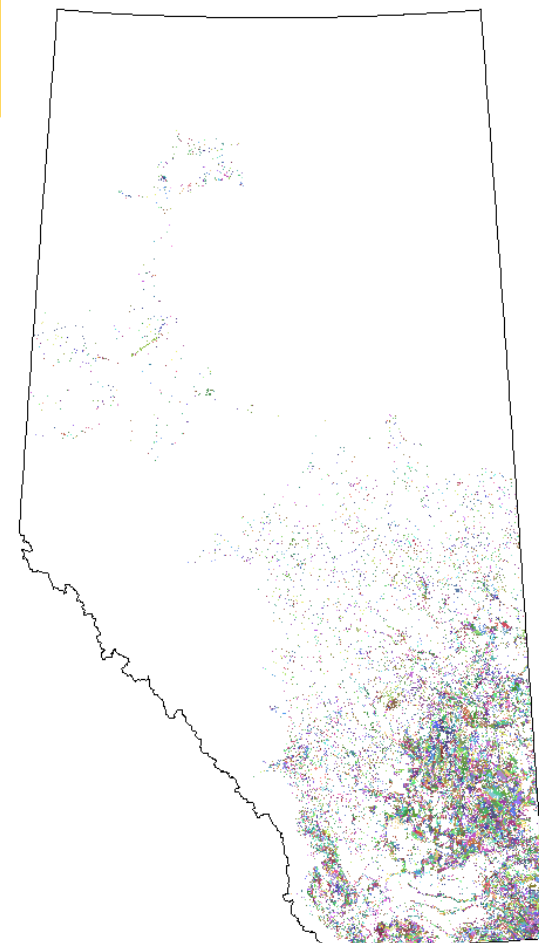
Native grassland soil database



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

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

Native grassland
soil map

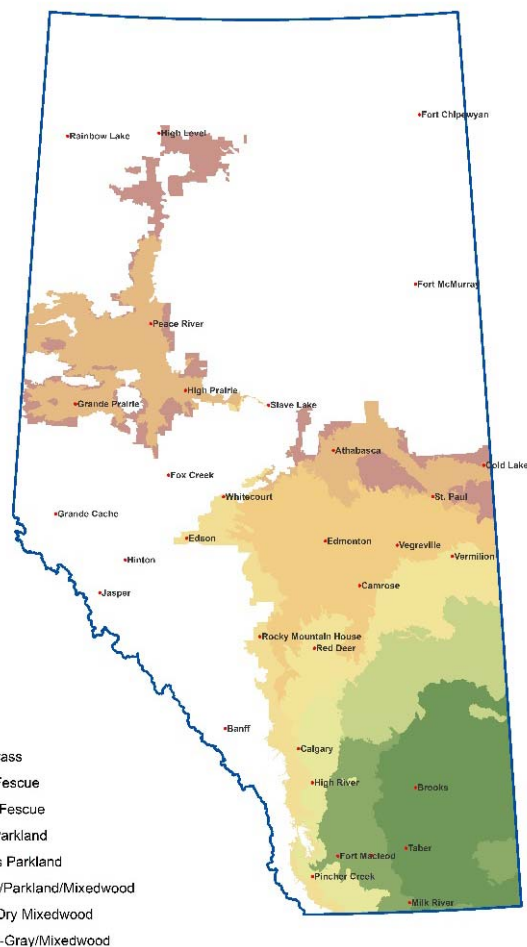


Grassland Soil Correlation Areas (SCAs)



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



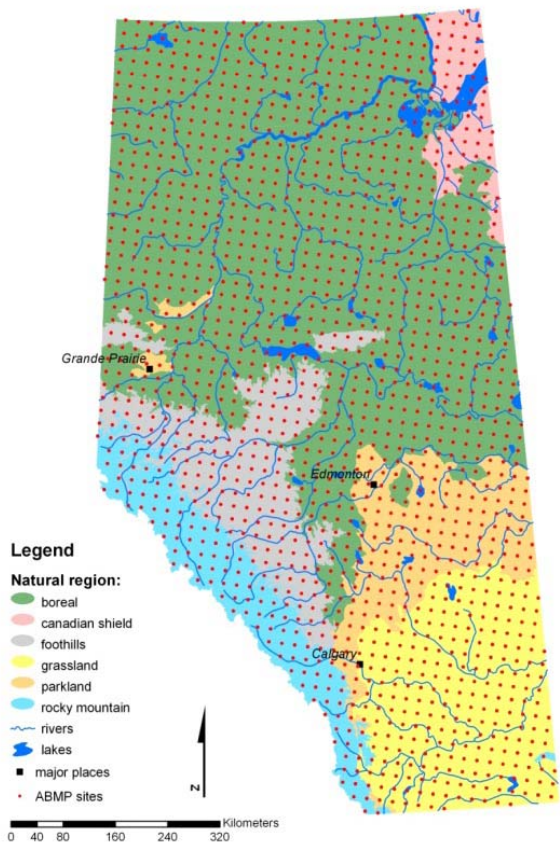
What are the available soil carbon data?

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

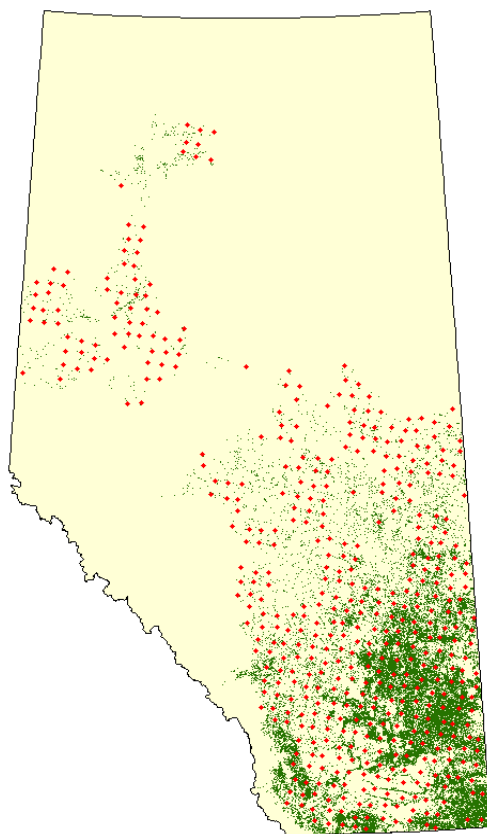
1656 sites (20 km apart),
350 sites/year

ABMI carbon data for
grassland regions

Around **400** grassland
monitoring sites



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



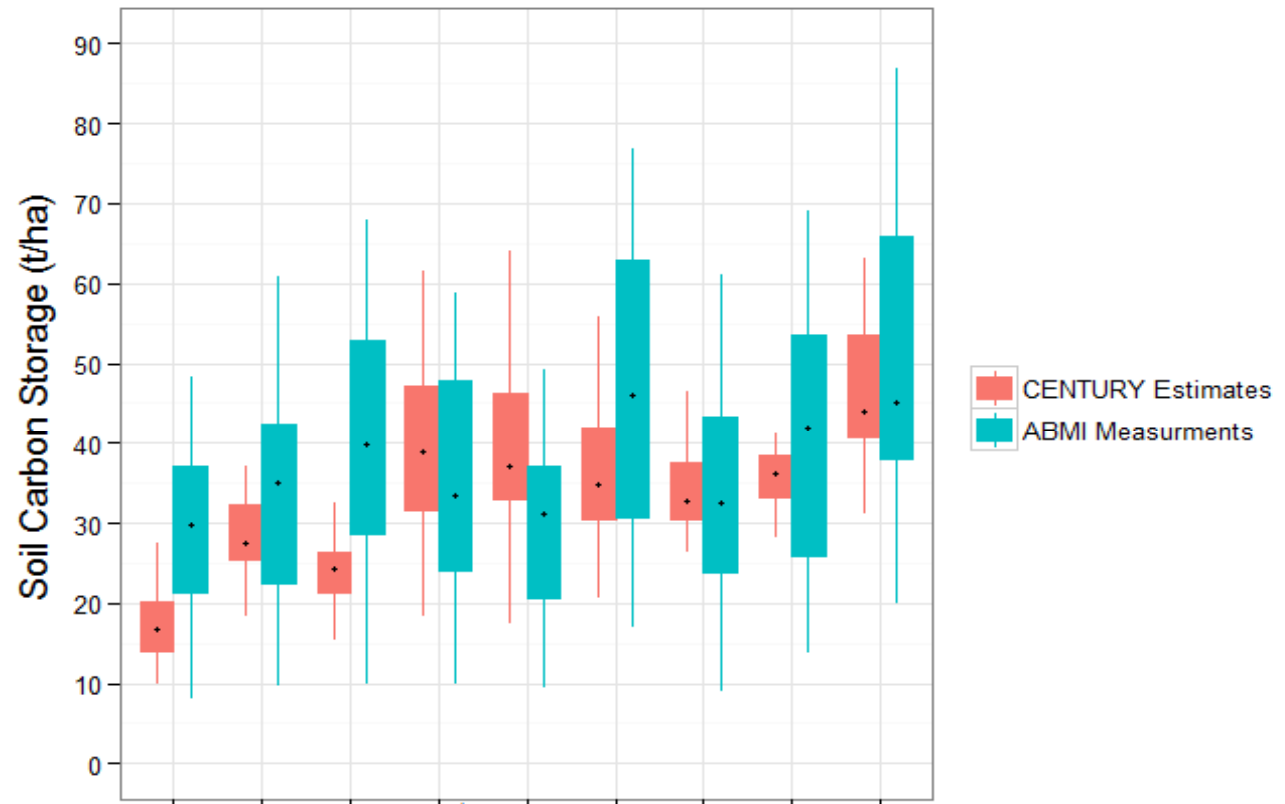
What are the challenges?

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

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*
Alberta Biodiversity Monitoring Institute



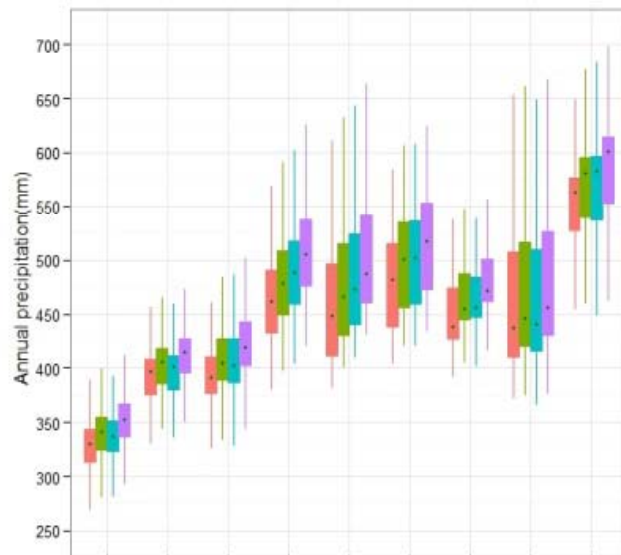
Provides baseline estimates of current grassland carbon storage and associated uncertainty

Climate projections for native grassland

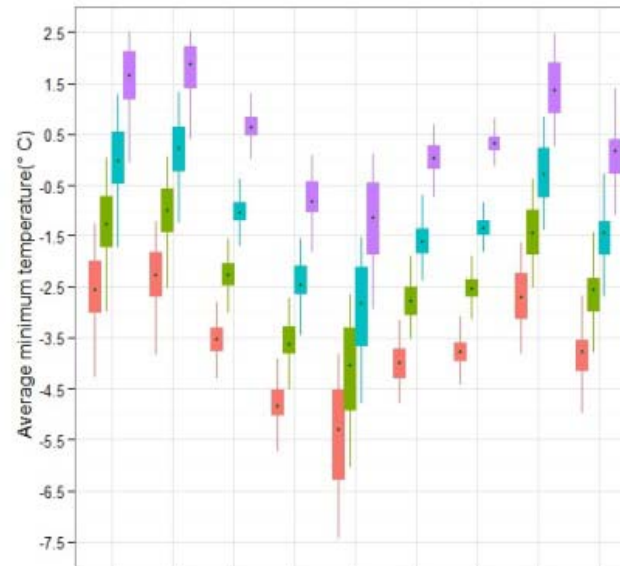


Ensemble of 23 CMIP3 global climate models (A2 emission scenario) available through ClimateWNA
(Wang et al. 2012)

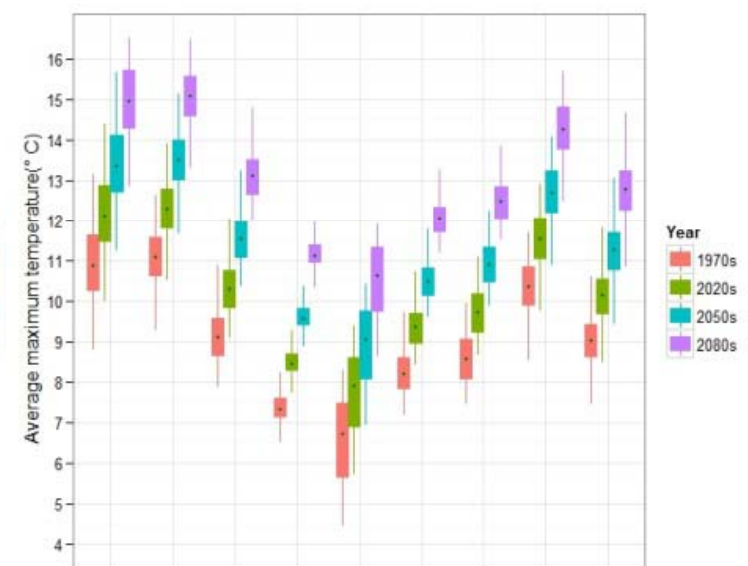
Annual precipitation



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

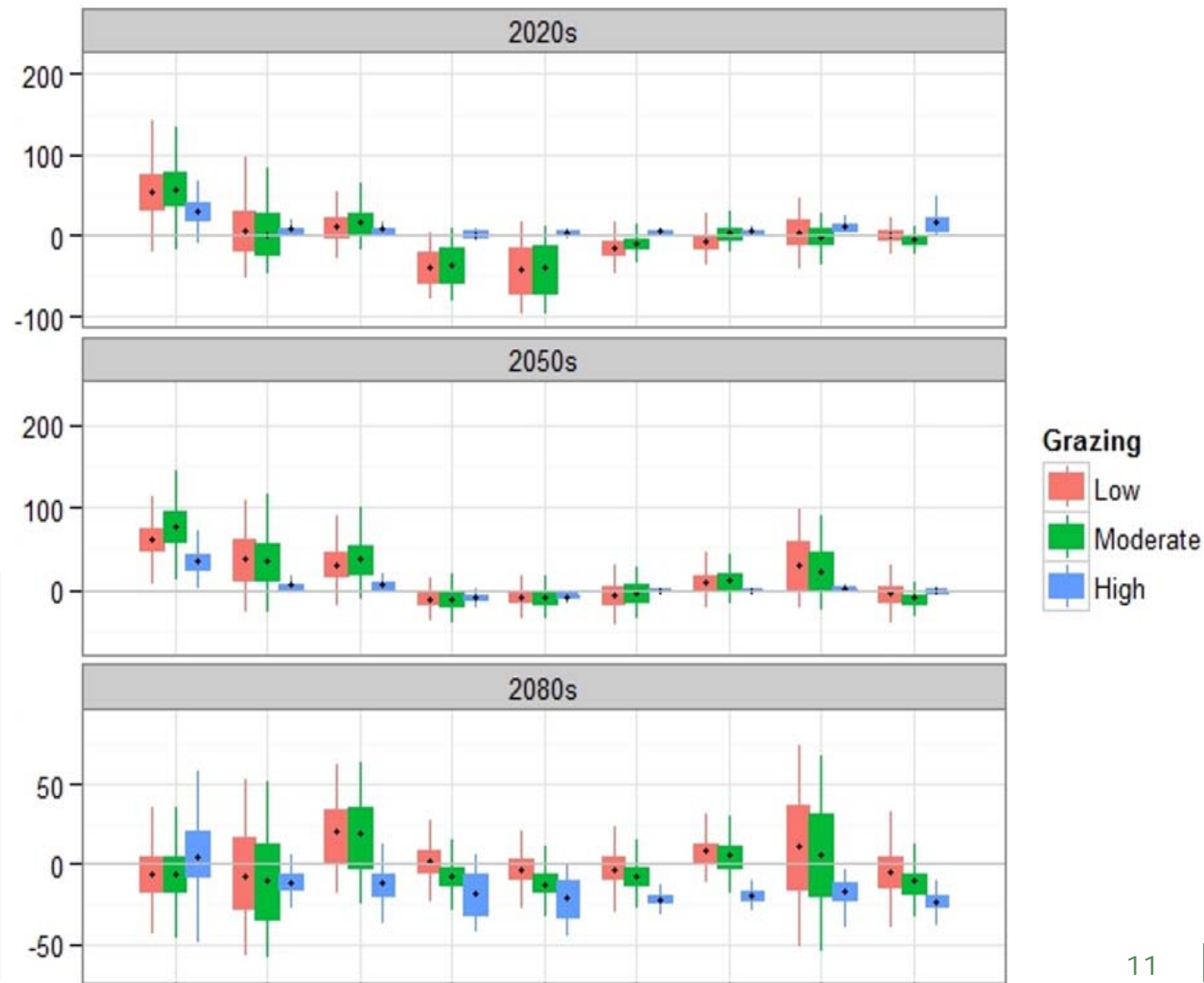


What are the applications?

- Impacts of future land management practices and climate change scenarios
- Impacts of alternative 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

Relative change in aboveground biomass carbon (%)



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



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Thank you



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