25 April 2017

Precision Infrastructure for Climate Change mitigation and adaptation on the agricultural landscape

Hank Venema AIC 2017 Winnipeg

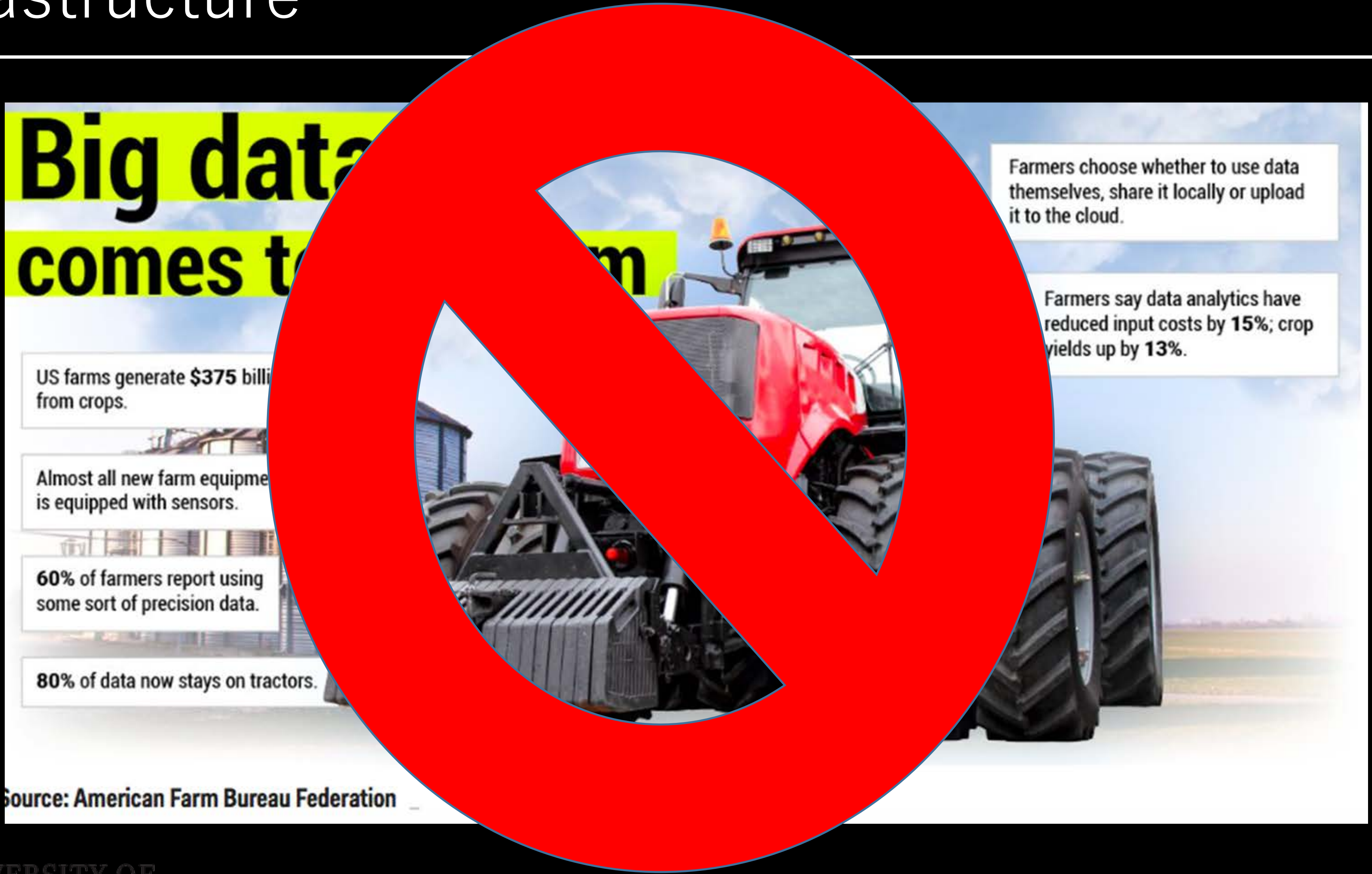
Prairie Climate Centre
From Risk to Resilience

The University of Winnipeg

IISD
International Institute for Sustainable Development

Precision Agriculture versus Precision Infrastructure

Prairie Climate Centre



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International Institute for Sustainable Development

Precision Infrastructure

Designing Advanced and Resilient Infrastructure: Big Spatial Data “CyberGIS”

GeoJournal (2016) 81:965–968
DOI 10.1007/s10708-016-9740-0

CrossMark

CyberGIS and spatial data science

Shaowen Wang

INTERNATIONAL JOURNAL OF GEOGRAPHICAL INFORMATION SCIENCE, 2016
VOL. 30, NO. 3, 427–431
http://dx.doi.org/10.1080/13658816.2015.1112906

Taylor & Francis
Taylor & Francis Group

EDITORIAL

Cyberinfrastructure, GIS, and spatial optimization: opportunities and challenges

INTERNATIONAL JOURNAL OF URBAN SCIENCES, 2016
http://dx.doi.org/10.1080/12265934.2016.1233075

Routledge
Taylor & Francis Group

Complexity in future cities: the rise of networked infrastructure

Sybil Derrible

Complex and Sustainable Urban Networks (CSUN) Laboratory, University of Illinois at Chicago, Chicago, IL, USA

Journal of Cleaner Production 117 (2016) 73–88

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

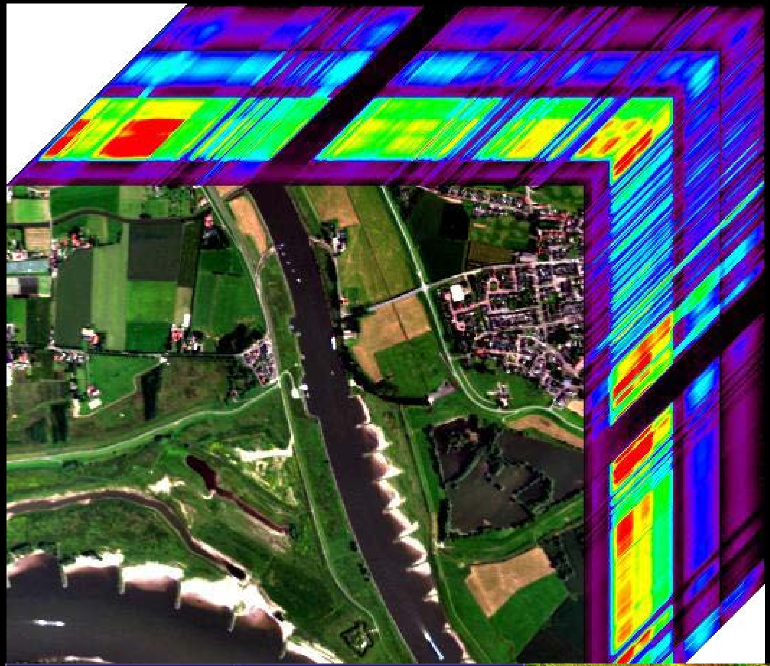
ELSEVIER

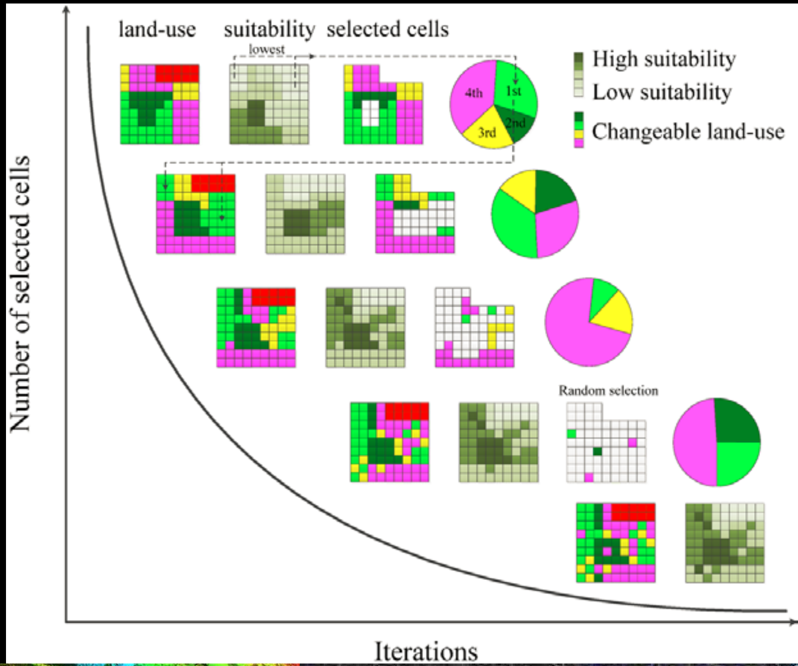
The energy-water agriculture nexus: the past, present and future of holistic resource management via remote sensing technologies

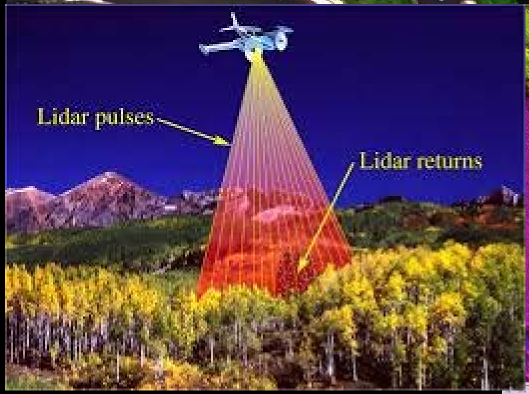
CrossMark

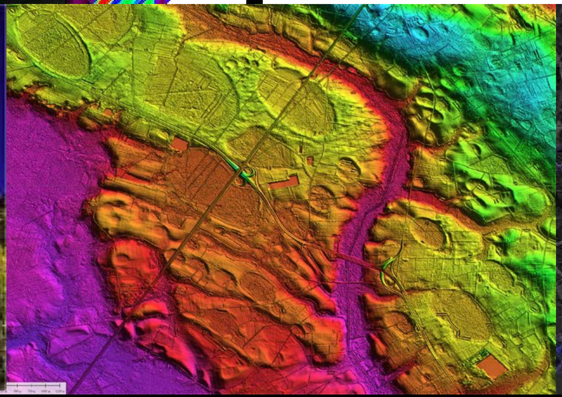
Kelly T. Sanders*, Sami F. Masri

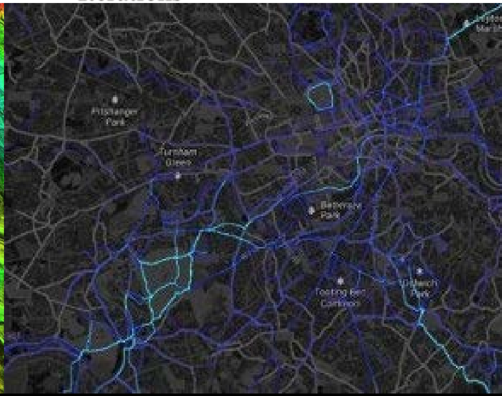
Sonny Astani Department of Civil and Environmental Engineering, University of Southern California, 3620 S. Vermont Avenue, Los Angeles, CA 90089-2531, USA





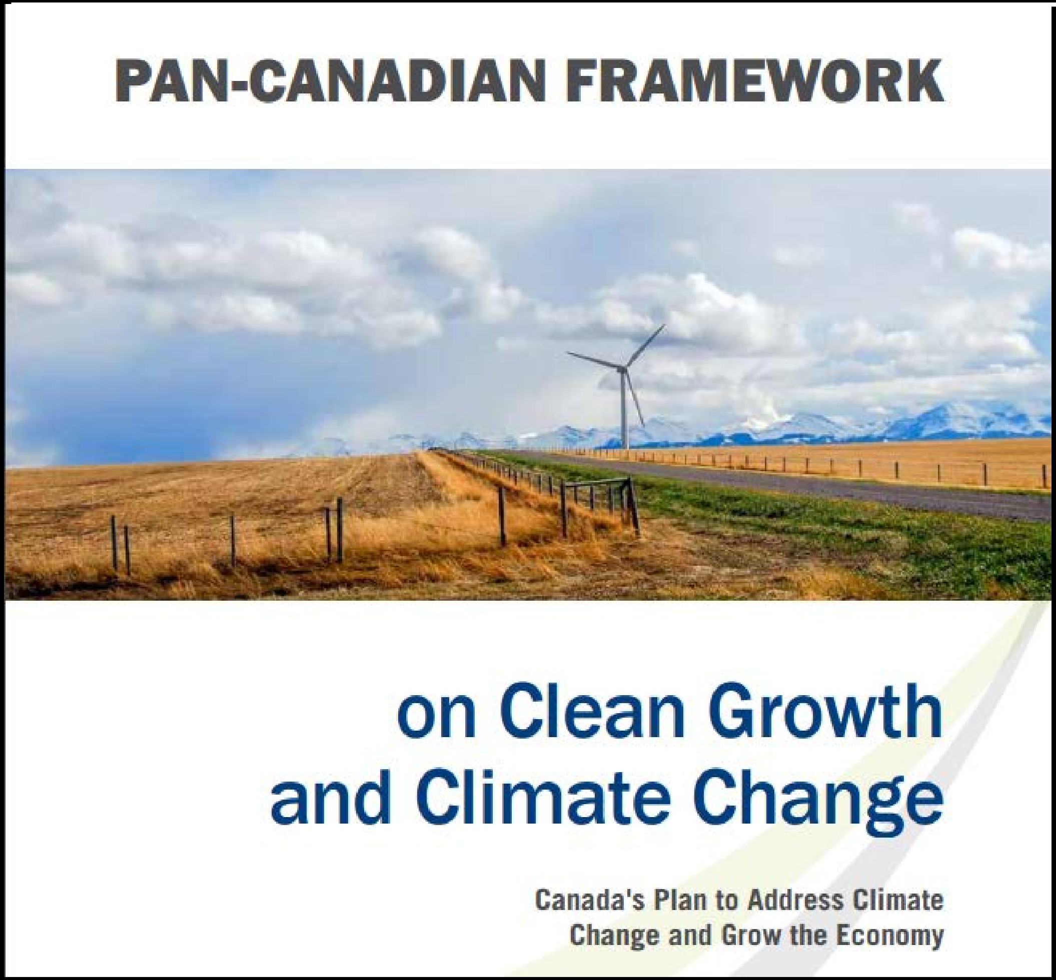






Motivation

Prairie Climate Centre



Text analysis:
"resilience" 33x,
"resilient" 16x,
"agriculture" 18x
"water" 6x, and
"infrastructure"
83x!

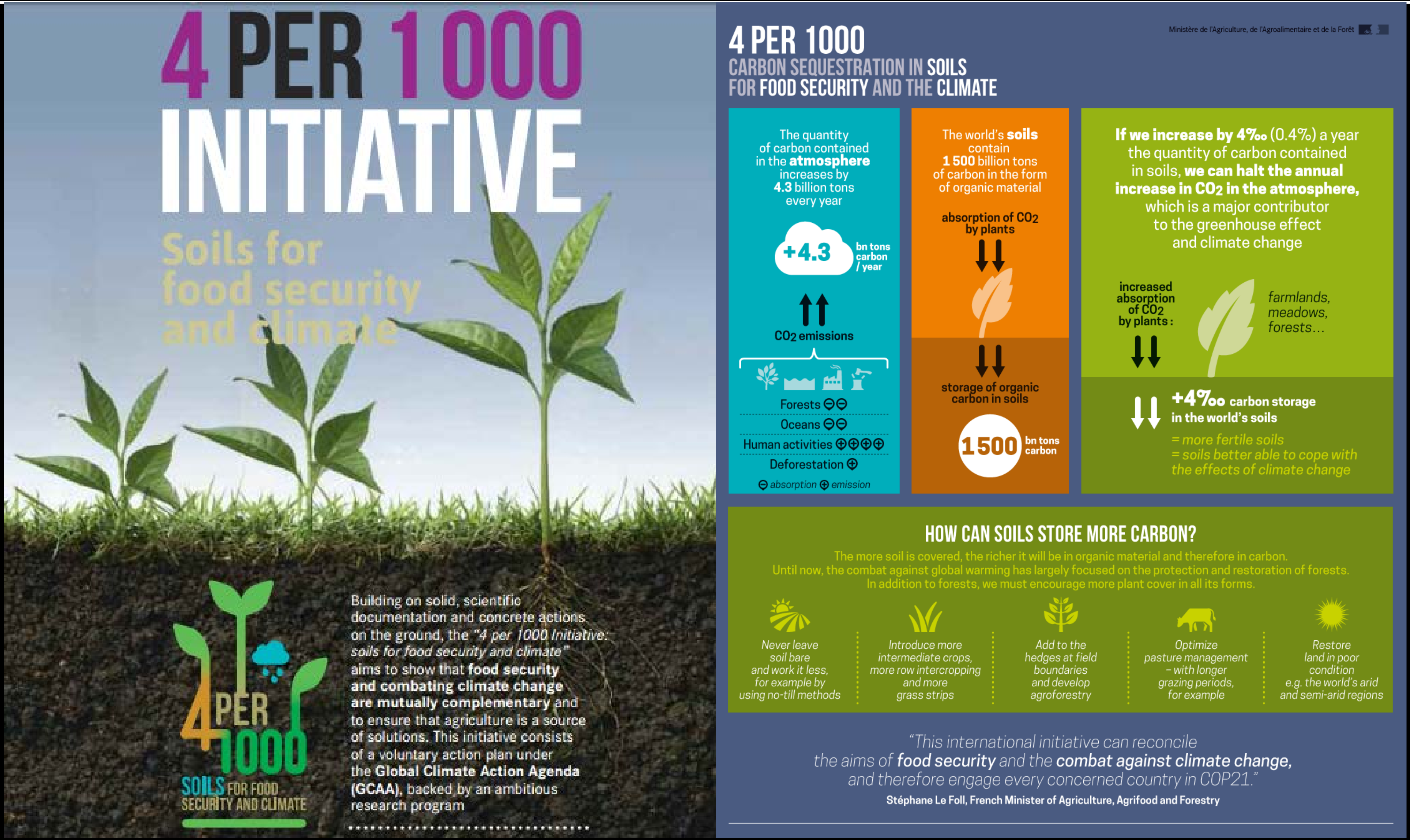
from foreword:

It means more resilient infrastructure and ecosystems that can better withstand climatic changes. It means land use and conservation measures that sequester carbon and foster adaptation to climate change. It means new jobs for Canadians…will allow us to become a leader in the global clean growth economy and will also help bring down the cost of low-emission technologies.

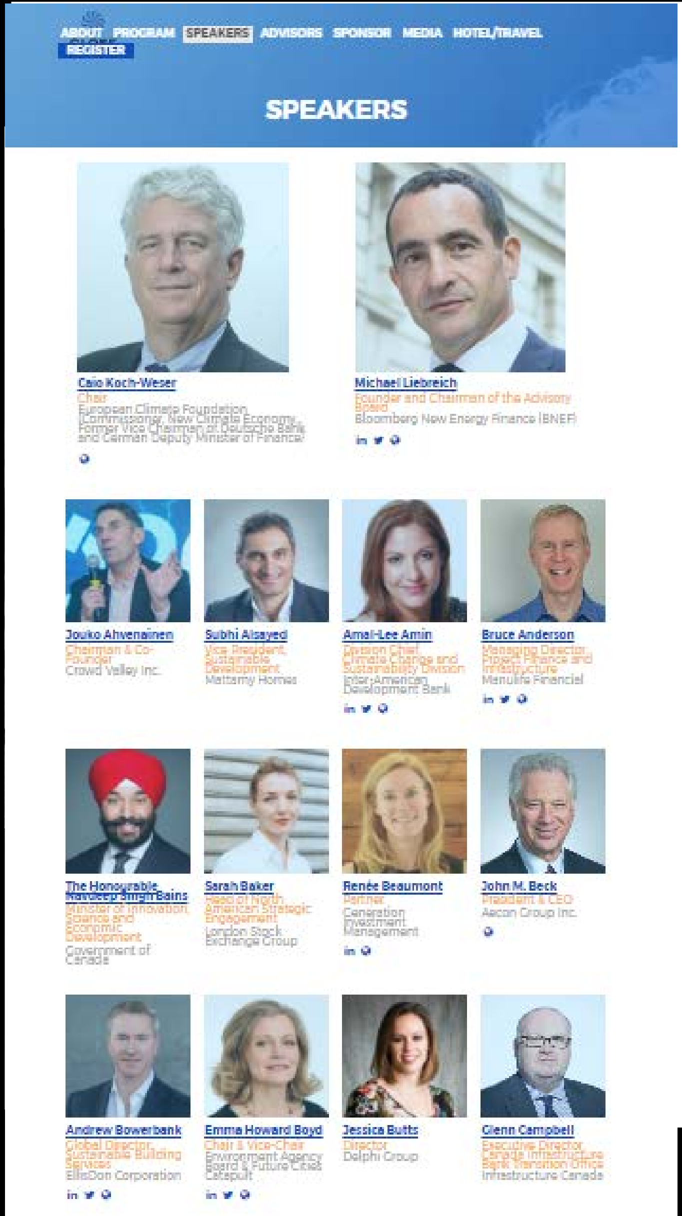
The University of Winnipeg

IISD International Institute for Sustainable Development

Global Motivation: Agriculture as crucial climate solution space

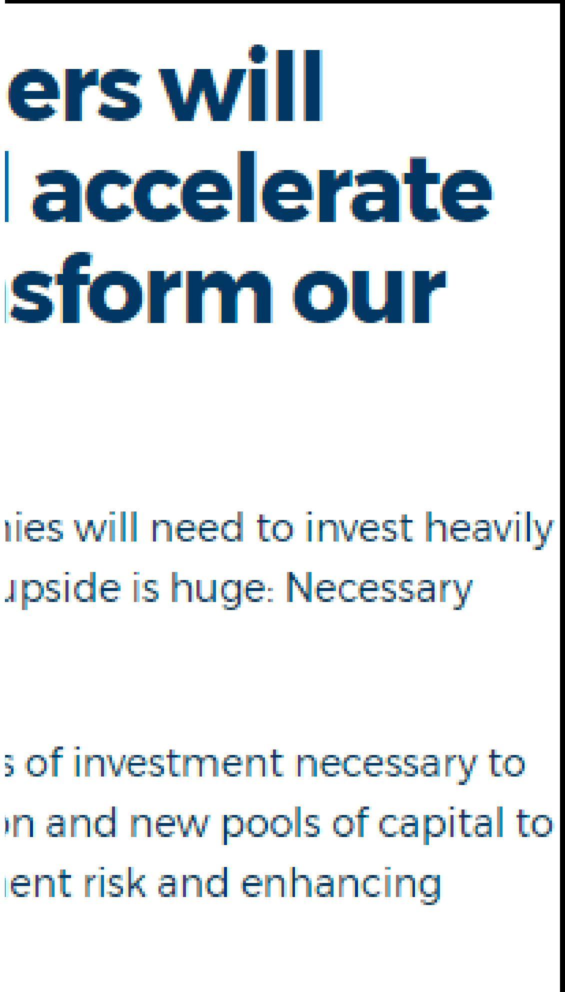


Global Motivation
“need to invest heavily in resilient infrastructure”



<u>2017 Federal Budget - Green infrastructure Highlights</u>

- **$2.8 billion directly on new green infrastructure** *over the next 11 years. Much more money for green infrastructure projects will be made available indirectly.*
- **The federal government will transfer $9.2 billion over 11 years to the provinces for green infrastructure and a**
- **further $20.1 billion over 11 years for public transit infrastructure.**
- *The new* **Canada Infrastructure Bank will invest at least $35 billion of federal money over 11 years, of which $5 billion is allocated to green infrastructure** *and an additional $5 billion is allocated specifically to public transit infrastructure.*



Hypothesis:

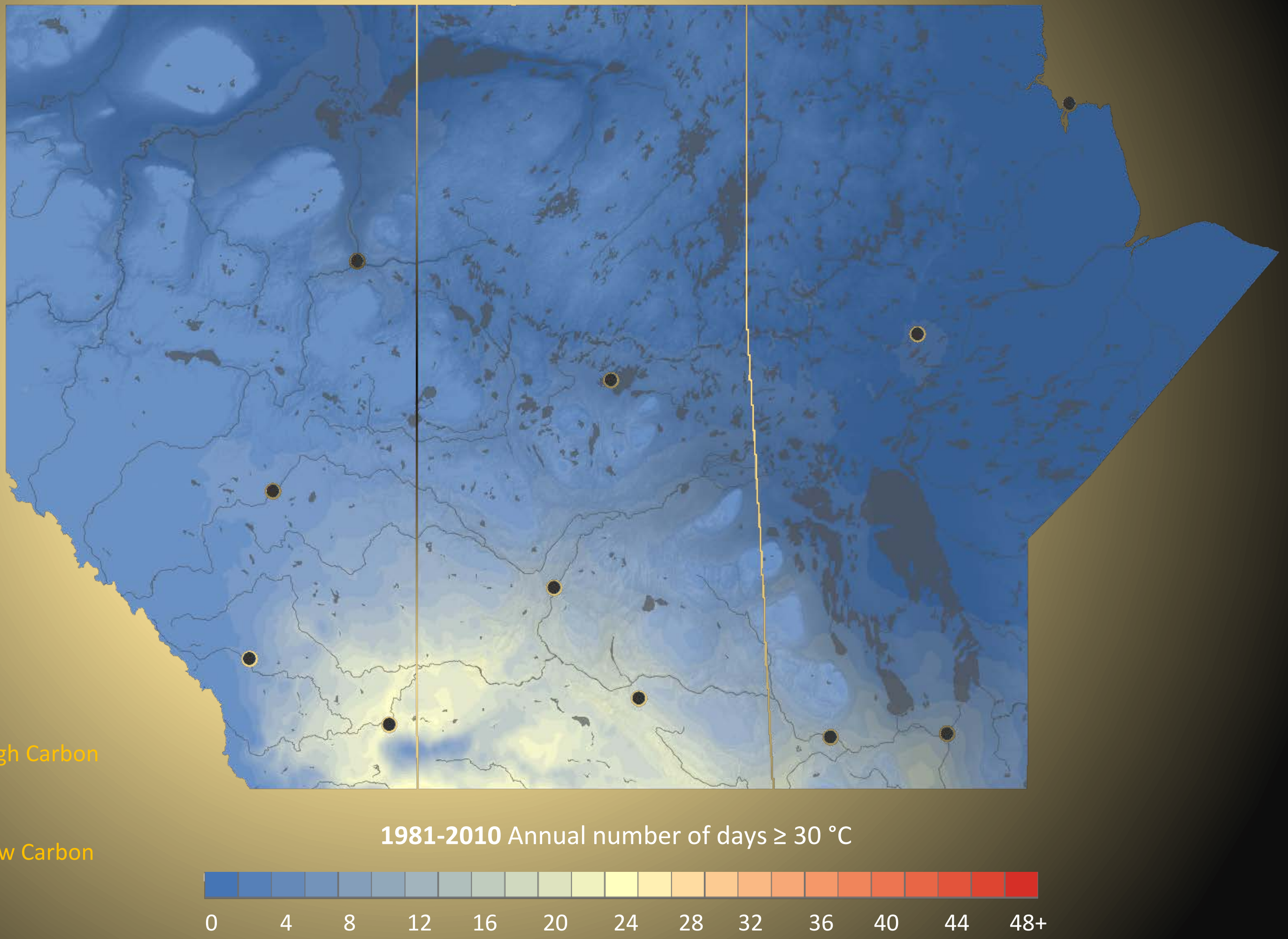
Agriculture is not at the table on Green Infrastructure – dangerous omission as agriculture lies at the heart of a large class of climate solutions

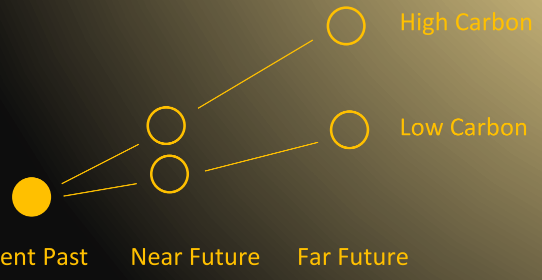
Regional Context: Highlights from www.climateatlas.ca

Shifting Extremes

Change in the Number of Very Hot Days

Prairie Climate Centre





Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.

Shifting Extremes

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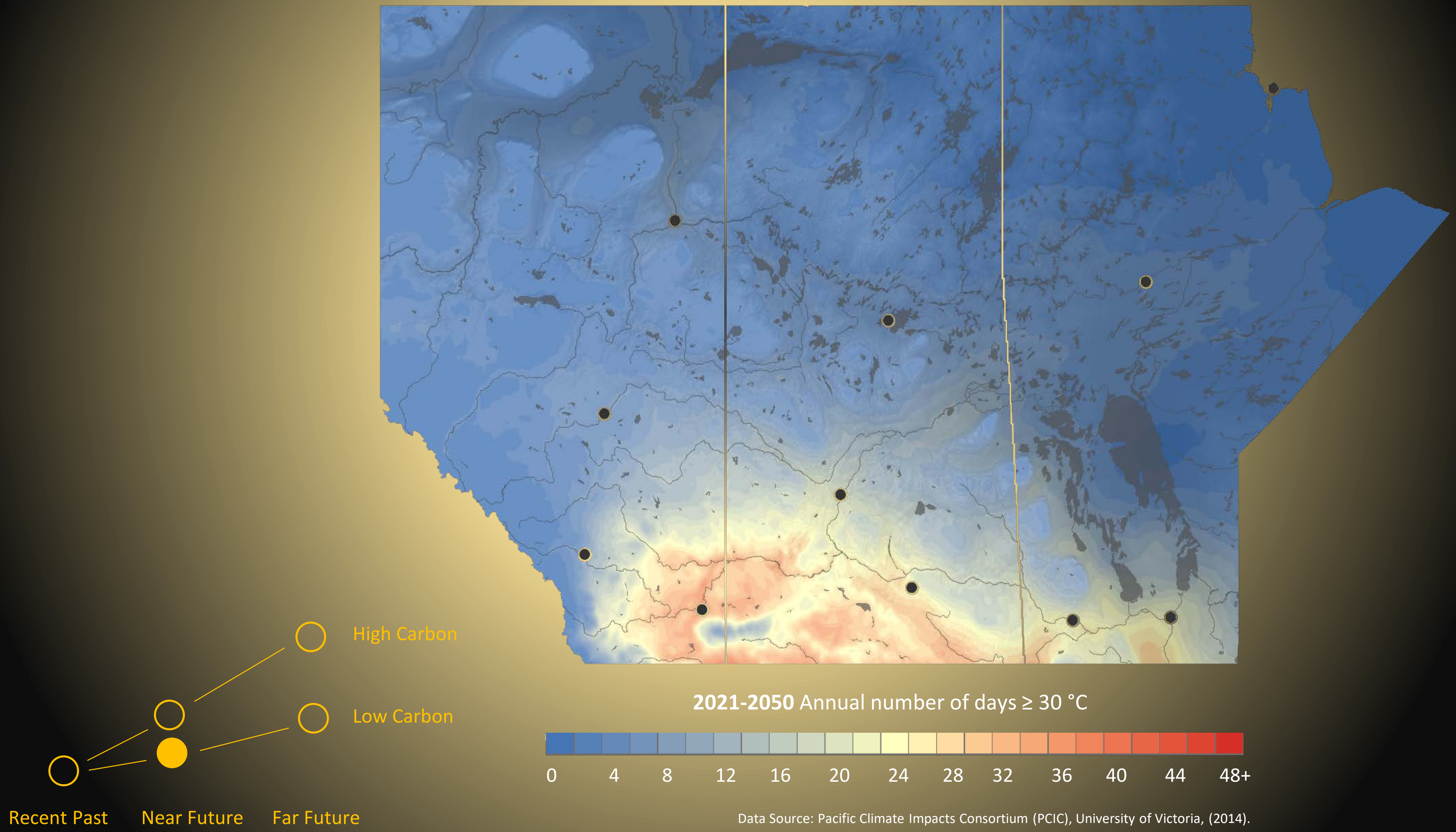
Prairie Climate Centre



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Shifting Extremes

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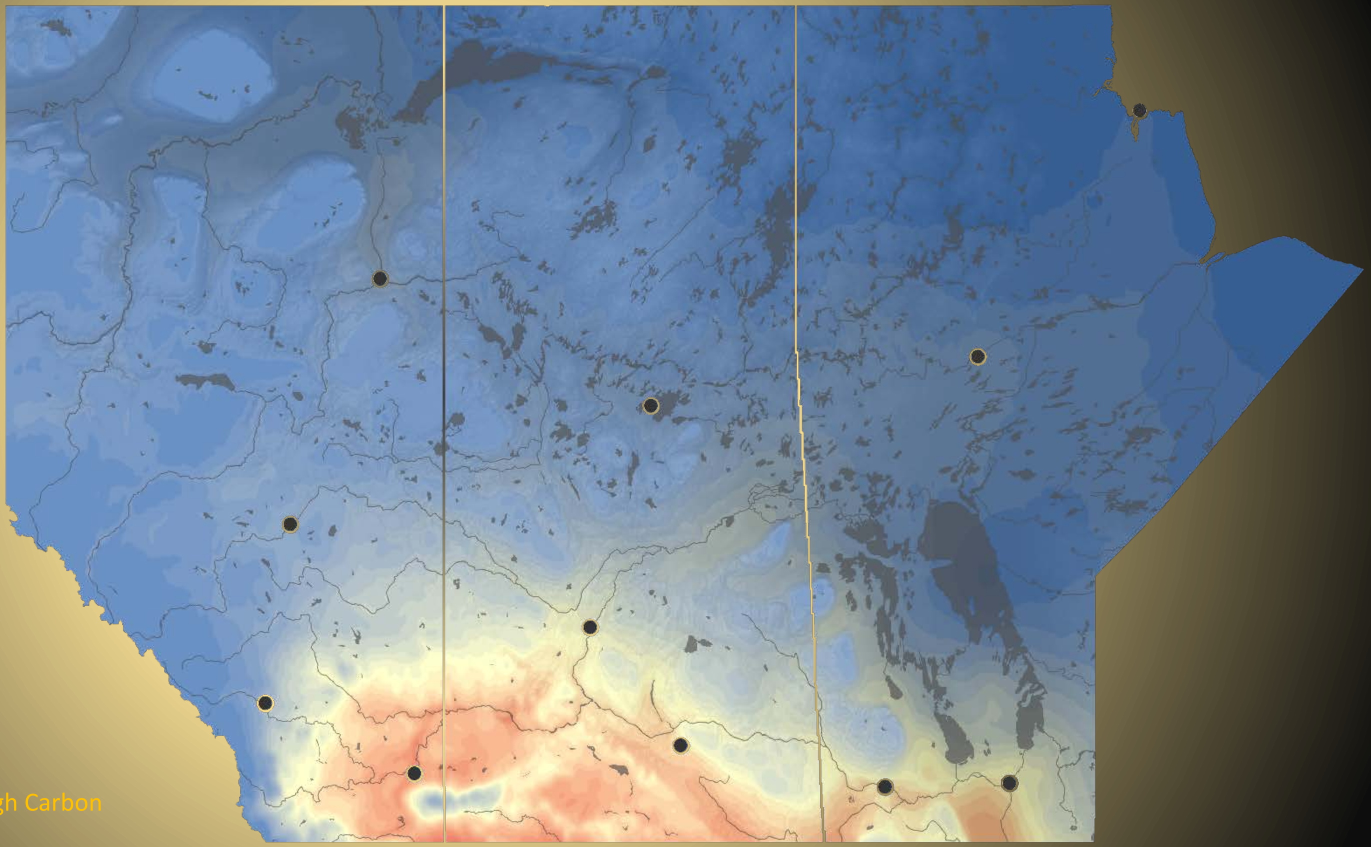

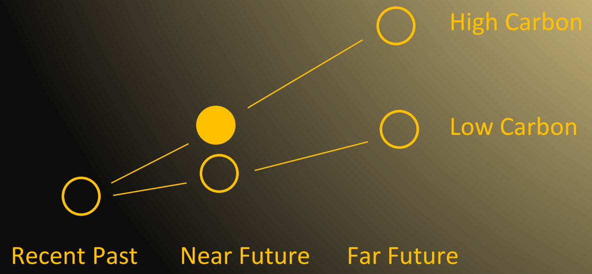

2021-2050 Annual number of days ≥ 30 °C

0 4 8 12 16 20 24 28 32 36 40 44 48+

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.

Shifting Extremes

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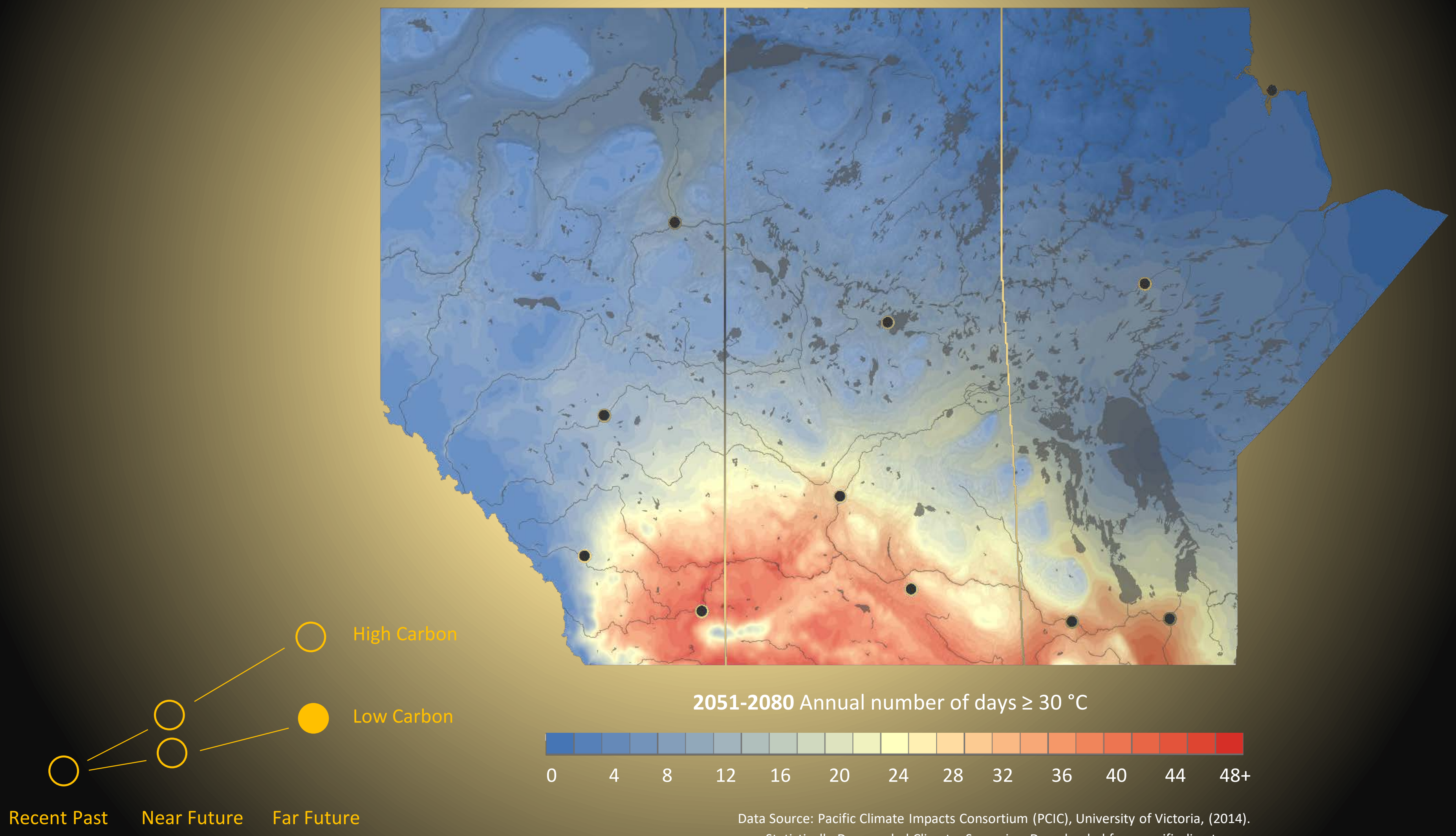

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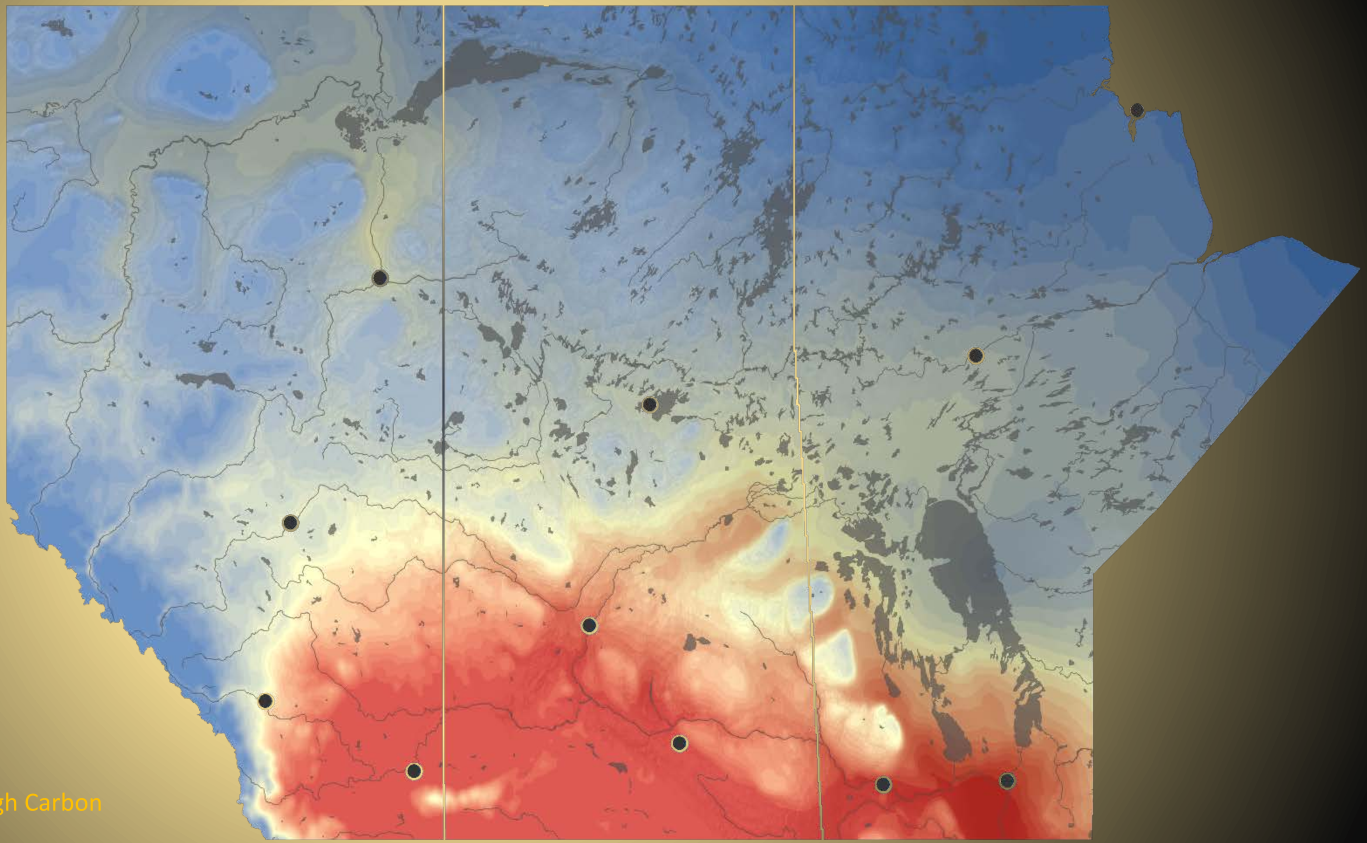
Shifting Extremes

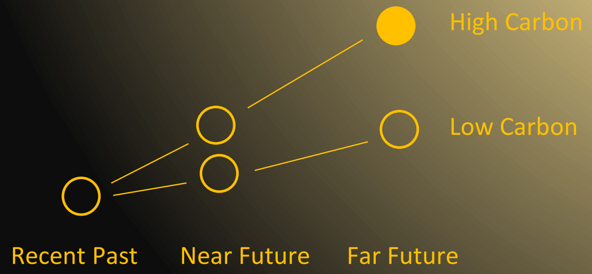
Change in the Number of Very Hot Days

Prairie Climate Centre



2051-2080 Annual number of days ≥ 30 °C

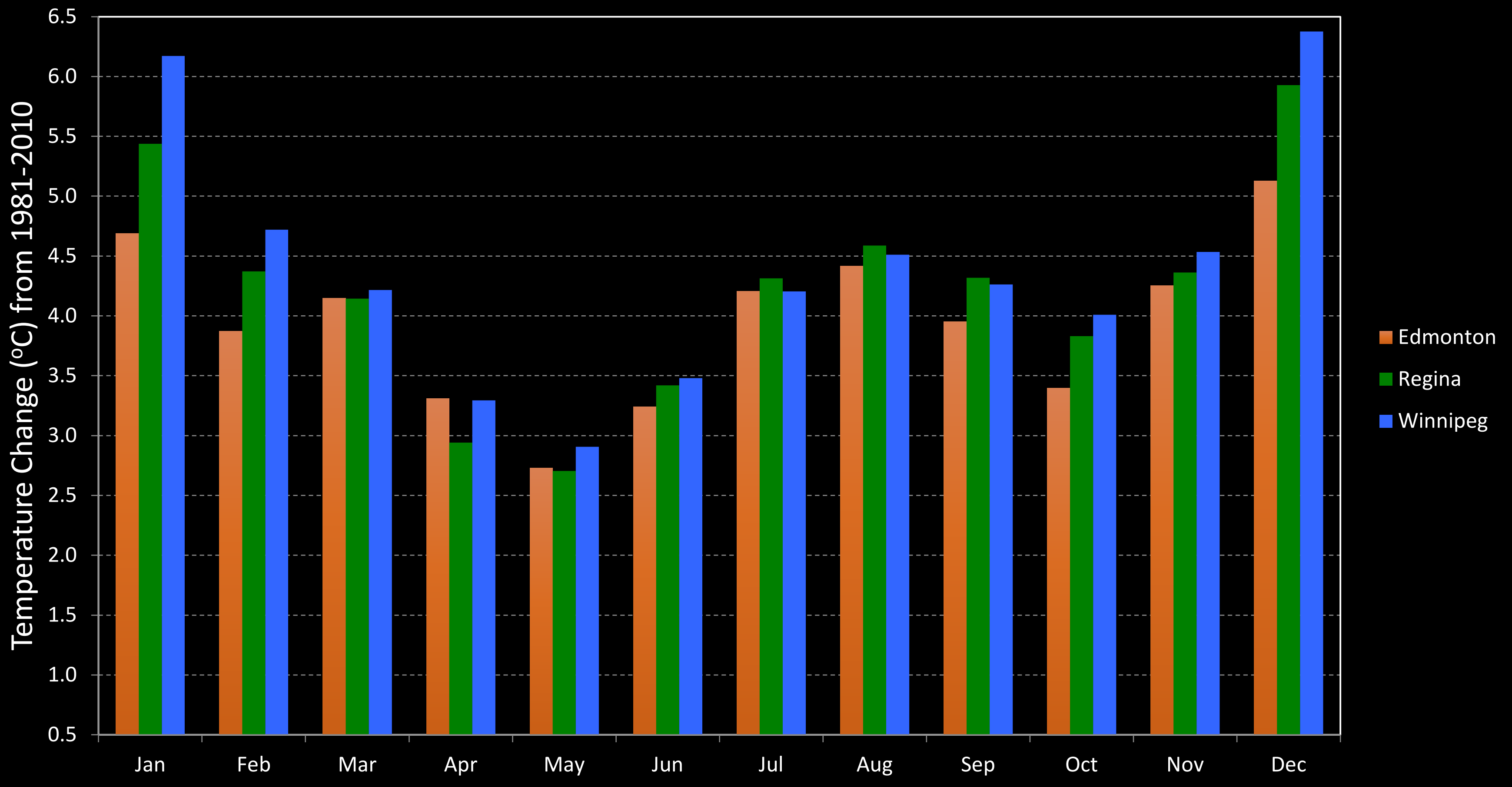
0 4 8 12 16 20 24 28 32 36 40 44 48+



Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014).
Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.

2051-2080 ΔT: RCP8.5

Prairie Climate Centre

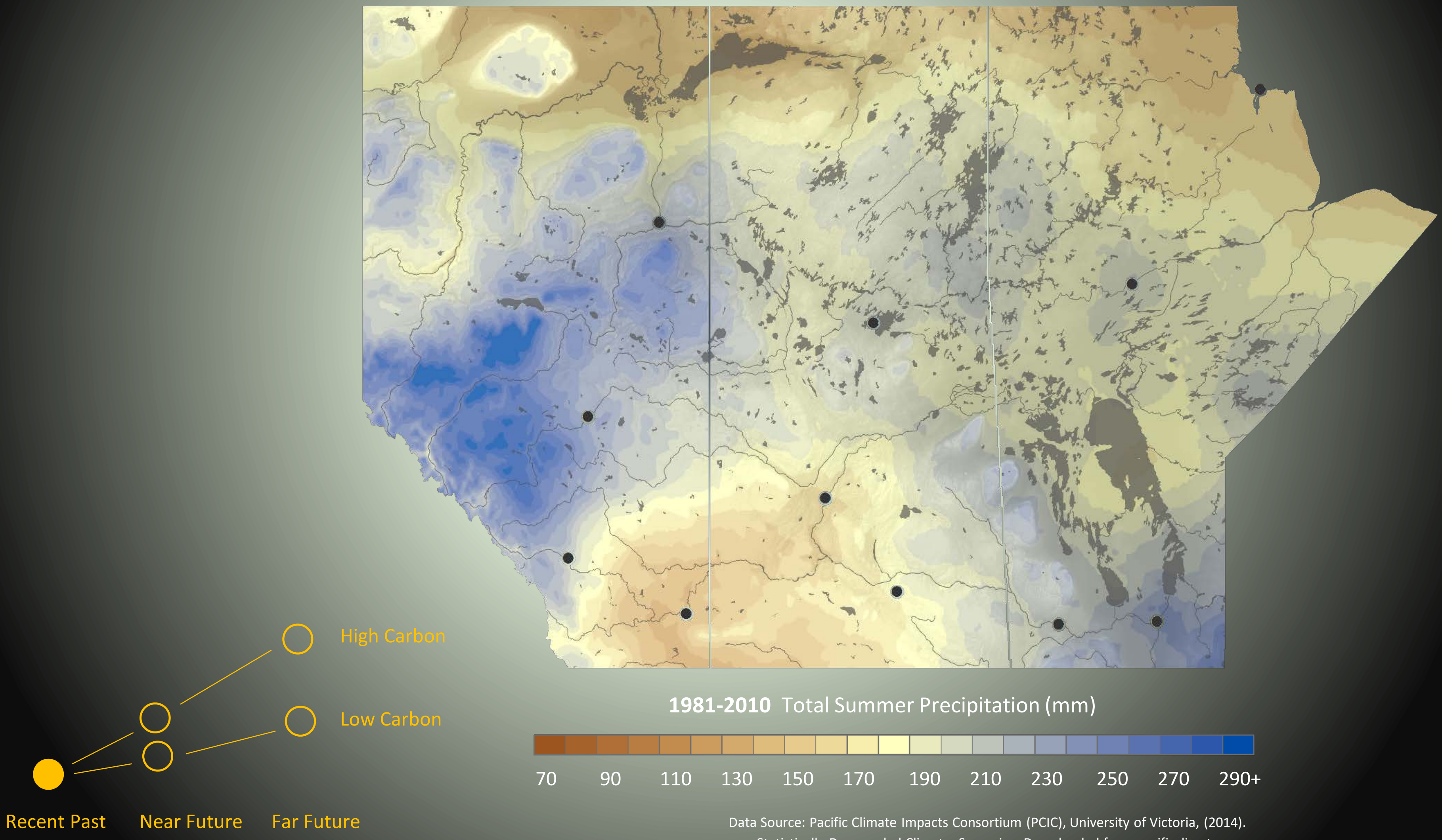


Summer Precipitation

Prairie Precipitation

Projected Changes in Total Summer Precipitation

Prairie Climate Centre



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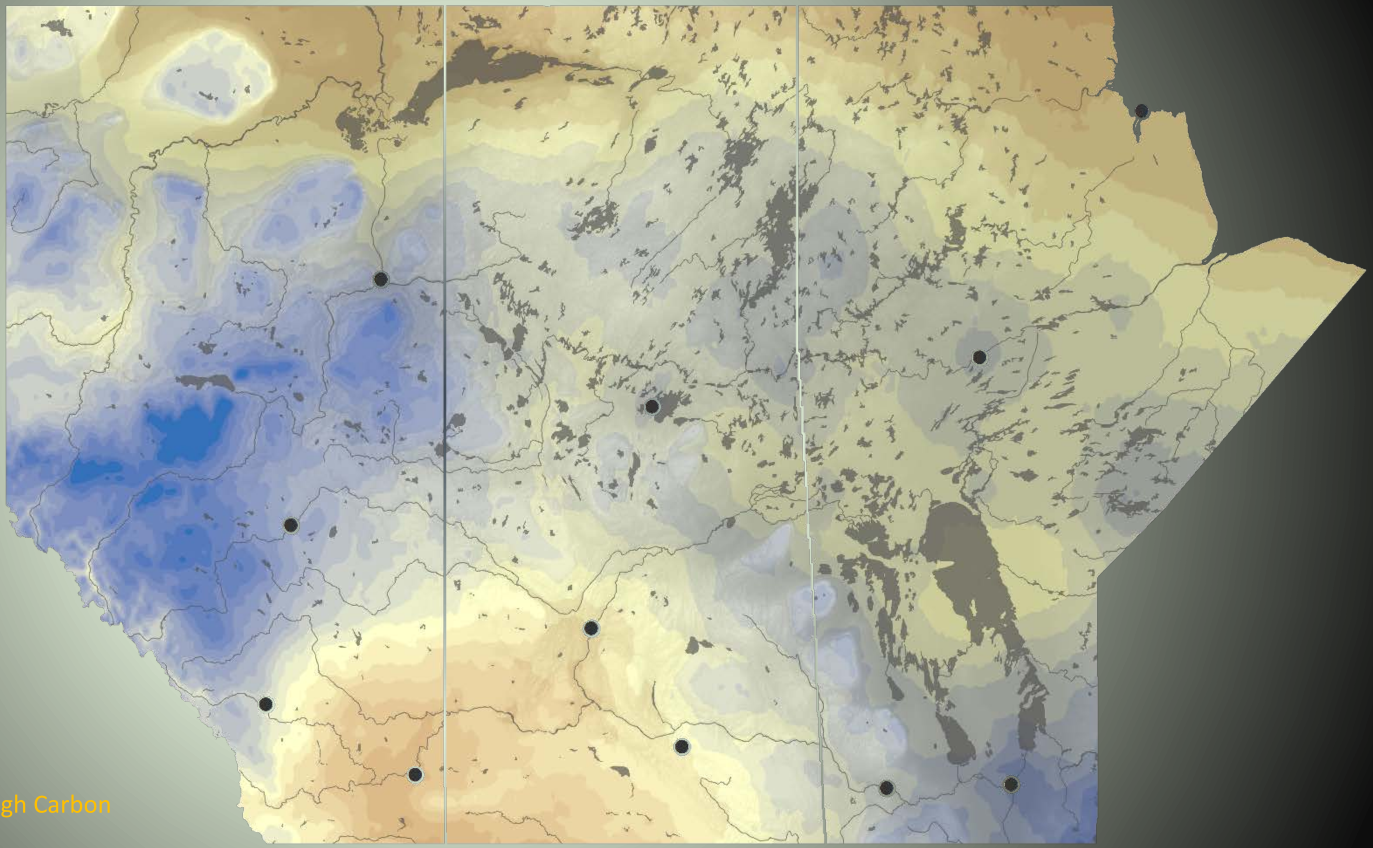

High Carbon

Low Carbon

Recent Past Near Future Far Future

2021-2050 Total Summer Precipitation (mm)

70 90 110 130 150 170 190 210 230 250 270 290+

Data Source: Pacific Climate Impacts Consortium (PCIC), University of Victoria, (2014). Statistically Downscaled Climate Scenarios. Downloaded from pacificclimate.org.

Prairie Precipitation

Projected Changes in Total Summer Precipitation

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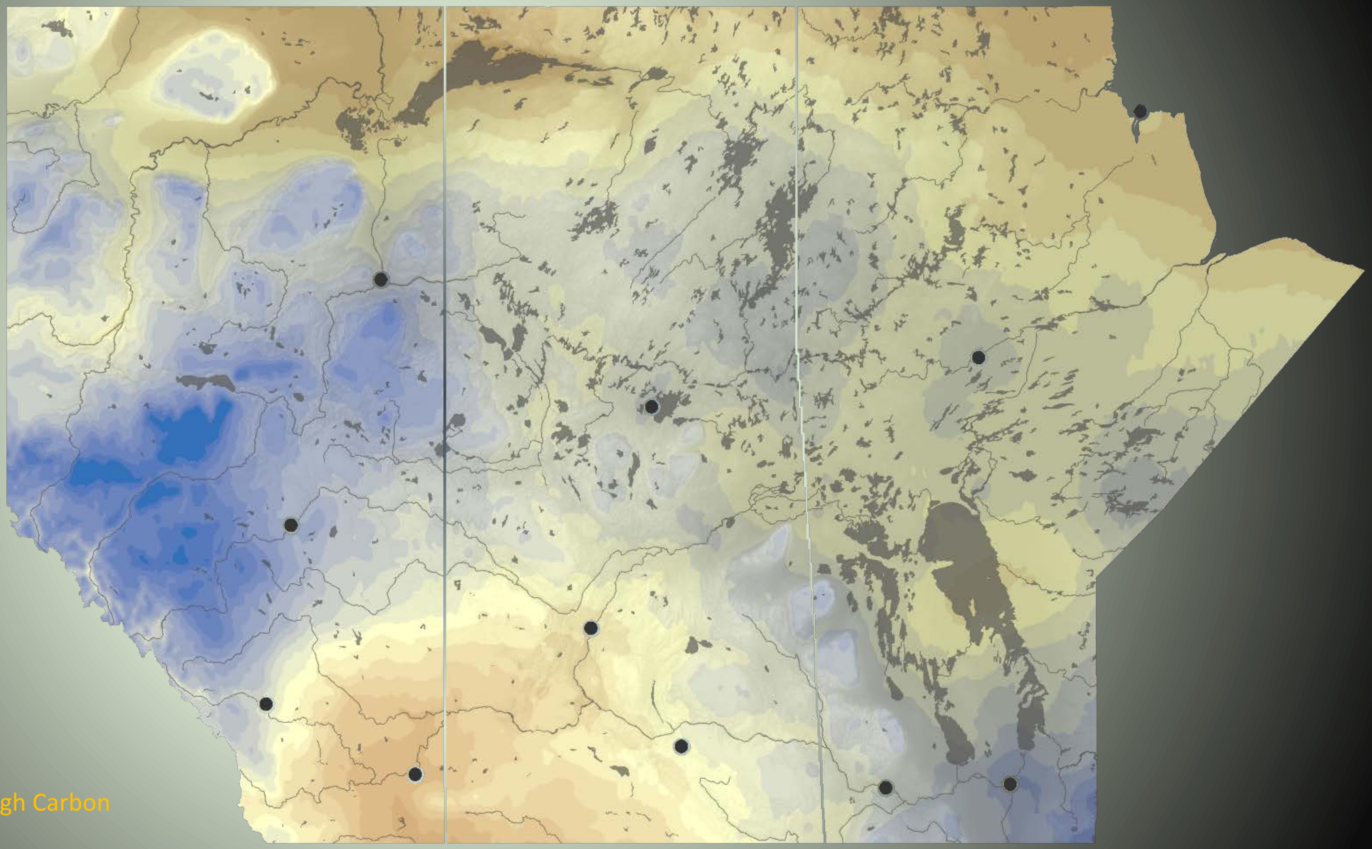

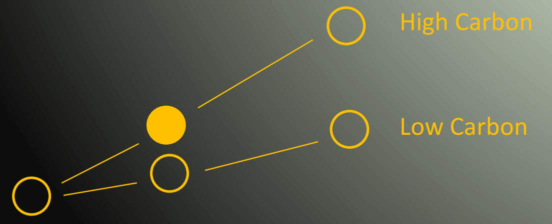

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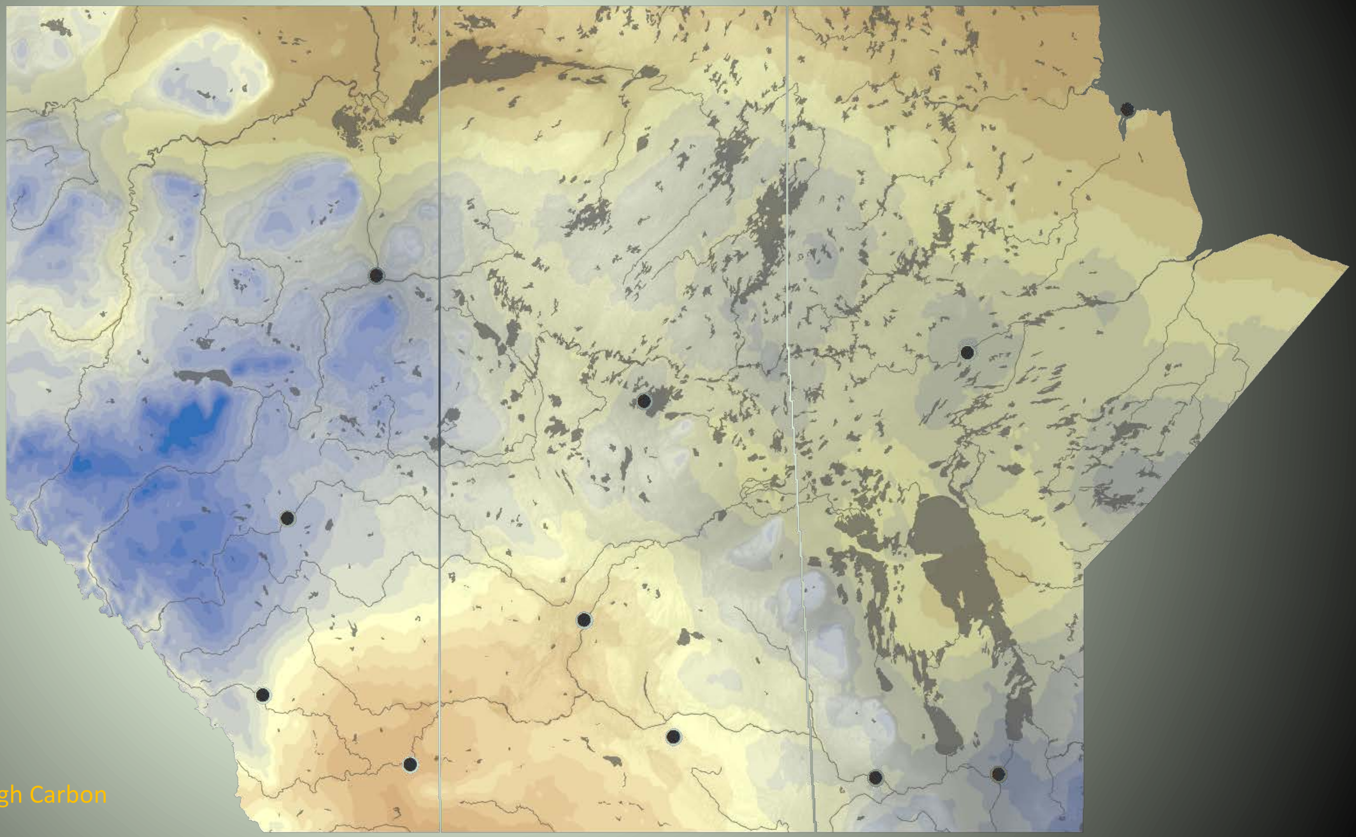

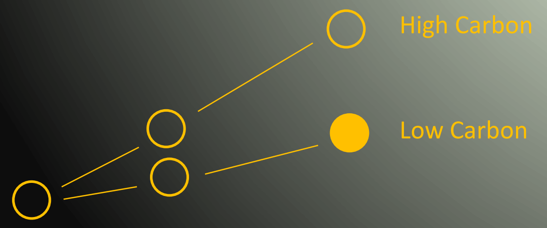

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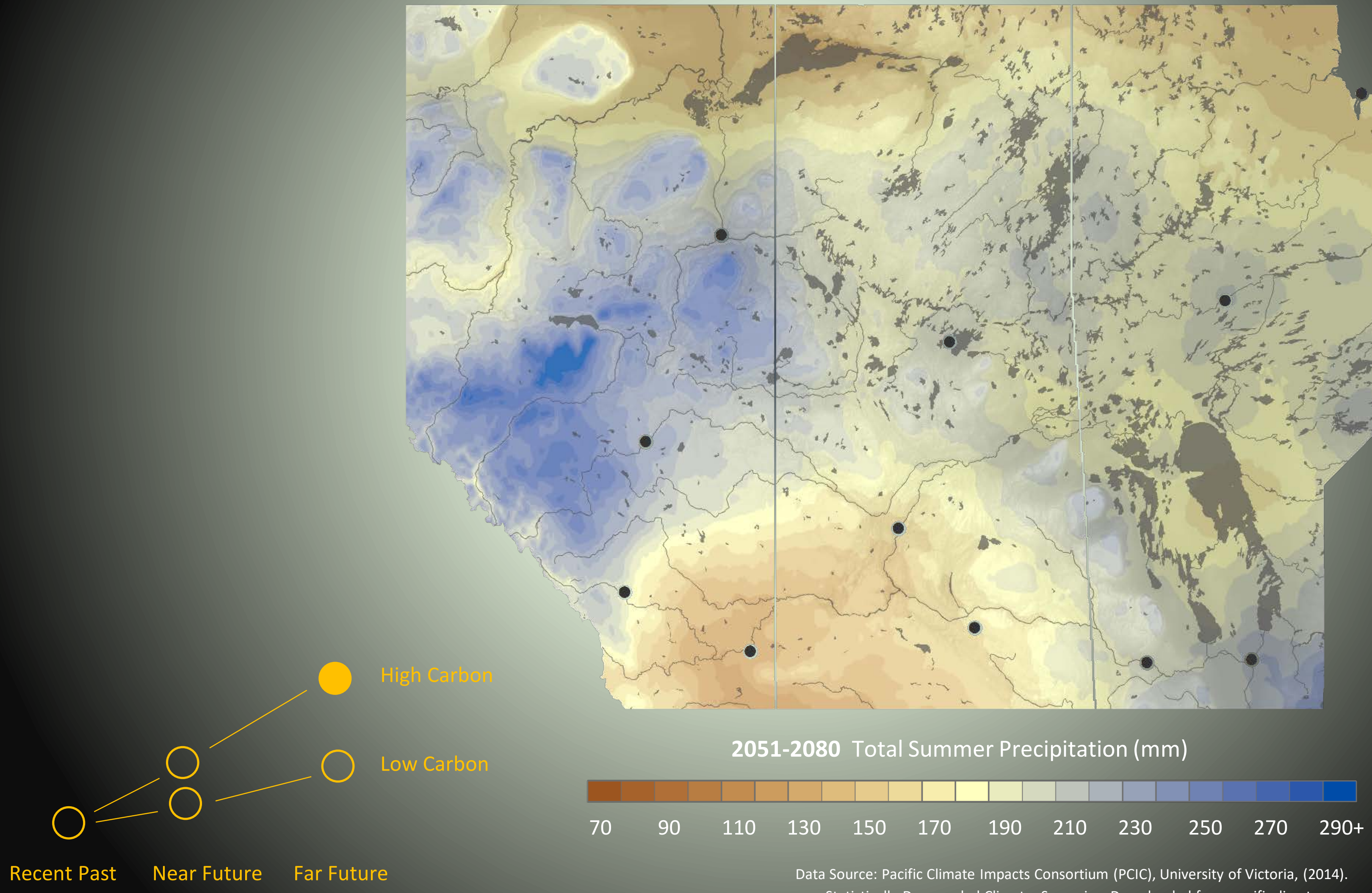

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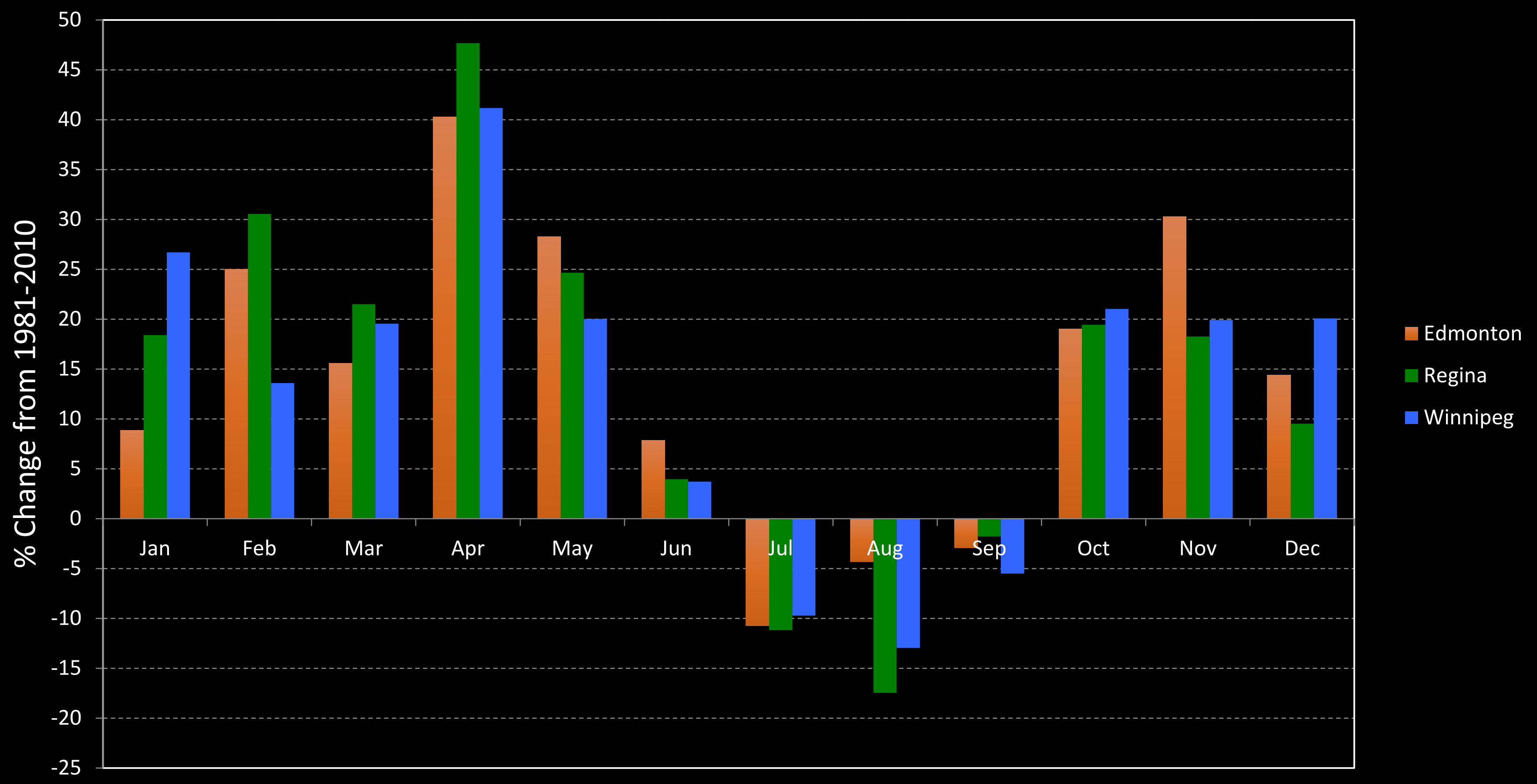
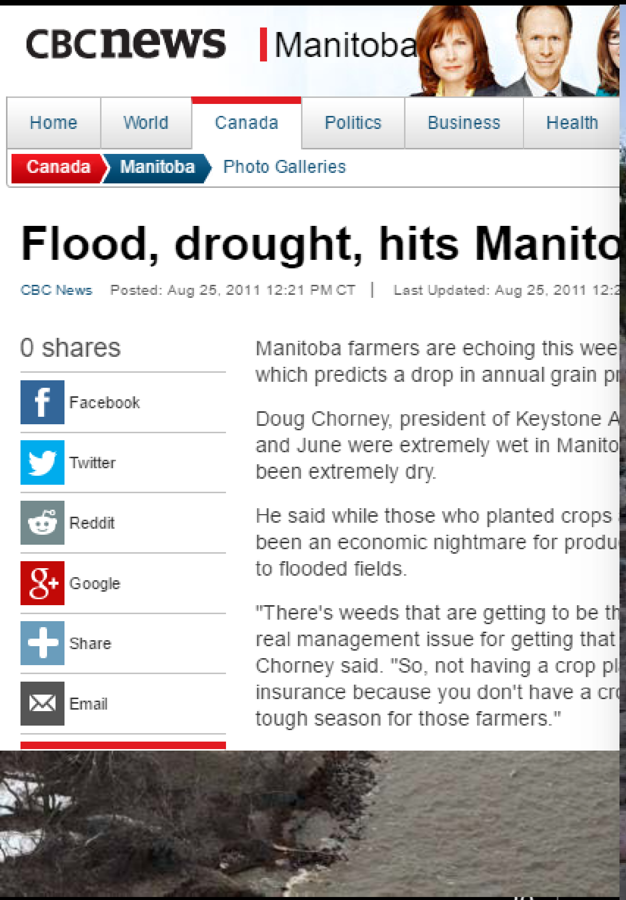
2051-2080 ΔPPT: RCP8.5

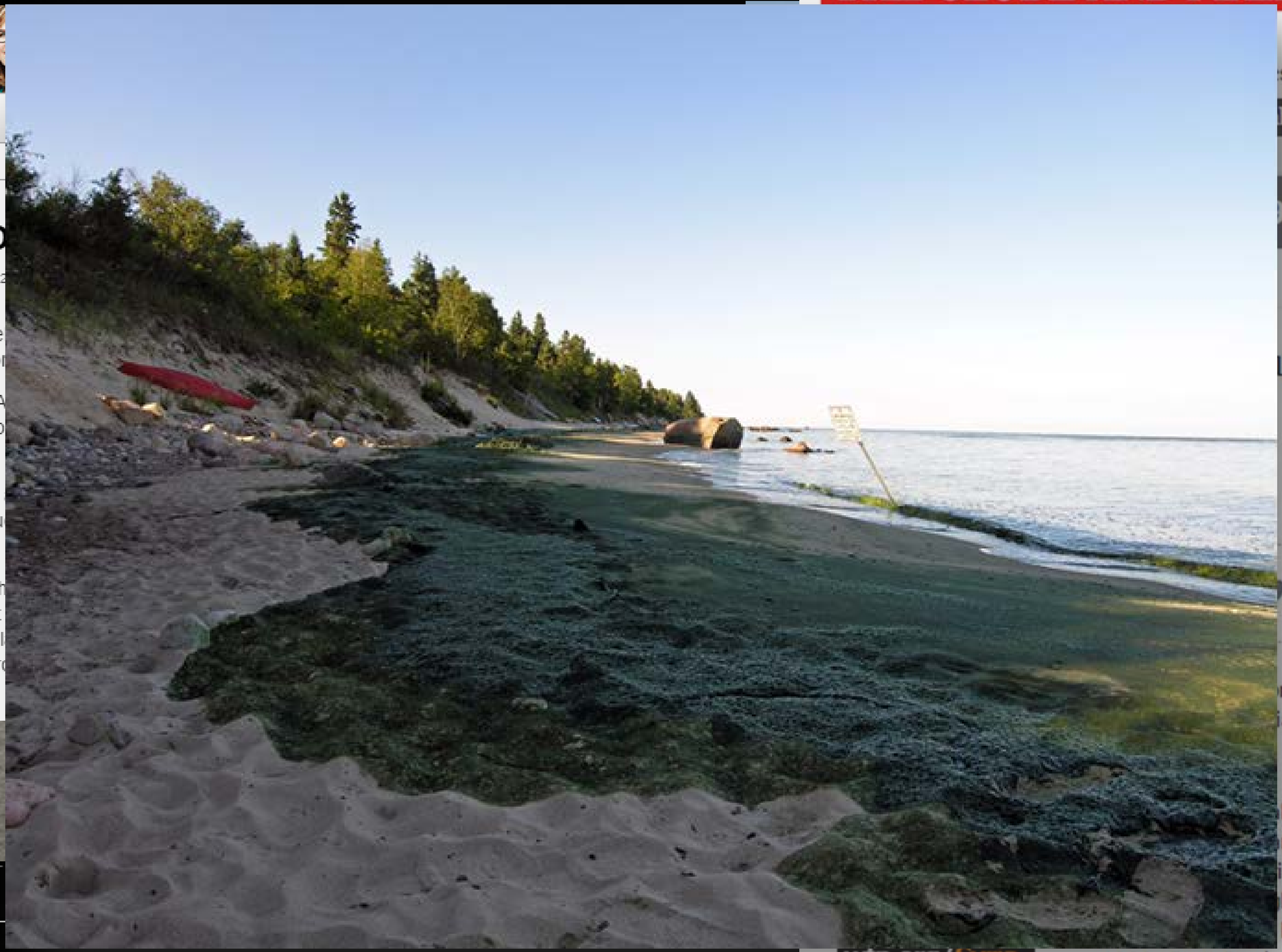
Prairie Climate Centre

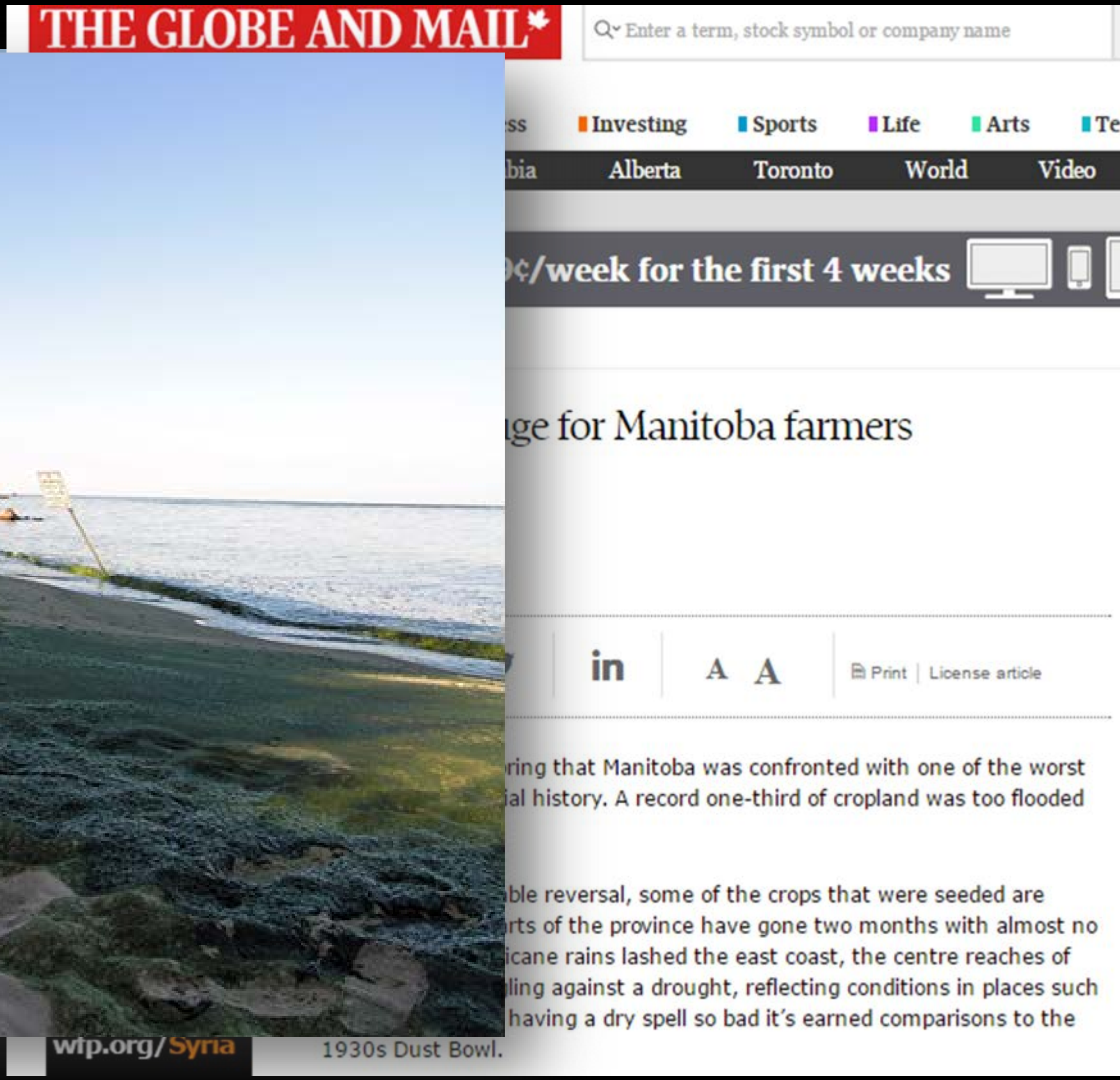


Agricultural Water Management: Lessons from 2011

Prairie Climate Centre



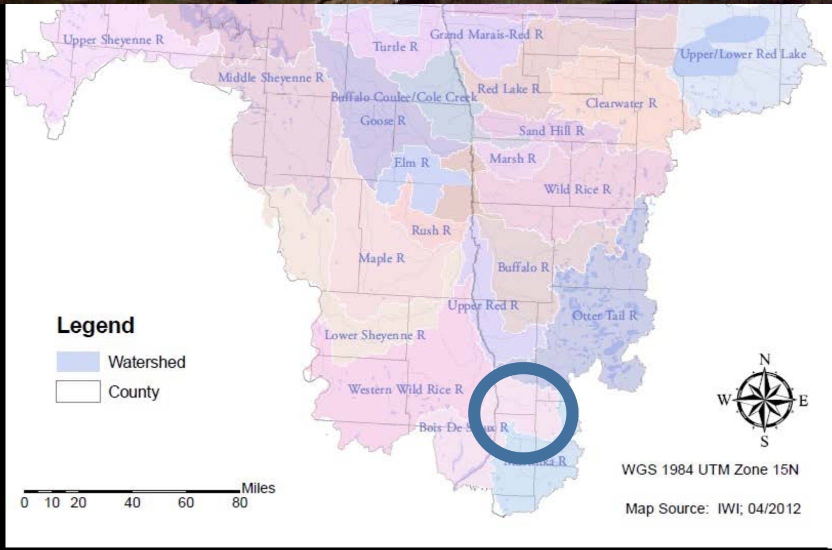




The solution: US example

North Ottawa project http://www.bdswd.com/

Prairie Climate Centre



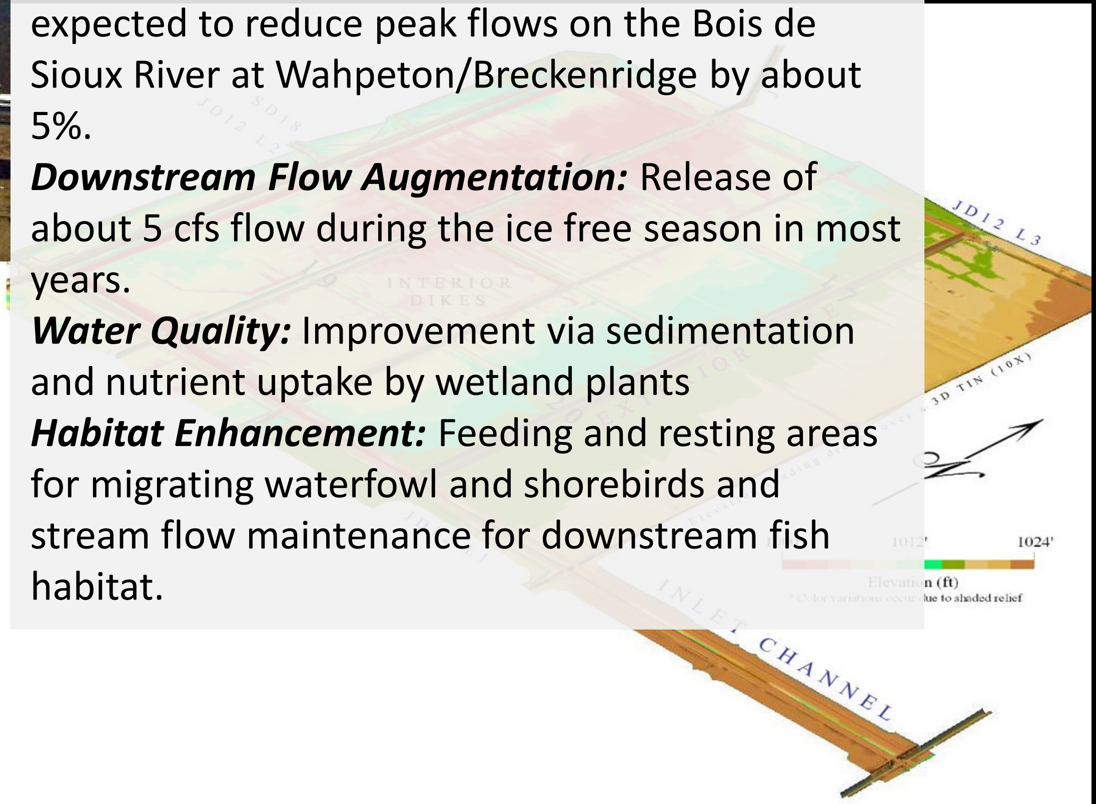
Project Benefits:

Flood Damage Reduction (Primary objective): Provides 16,000 acre feet of gate-controlled storage which is equivalent to 75% of the estimated 100 year spring runoff. This is expected to reduce peak flows on the Bois de Sioux River at Wahpeton/Breckenridge by about 5%.

Downstream Flow Augmentation: Release of about 5 cfs flow during the ice free season in most years.

Water Quality: Improvement via sedimentation and nutrient uptake by wetland plants

Habitat Enhancement: Feeding and resting areas for migrating waterfowl and shorebirds and stream flow maintenance for downstream fish habitat.



The solution: MB example

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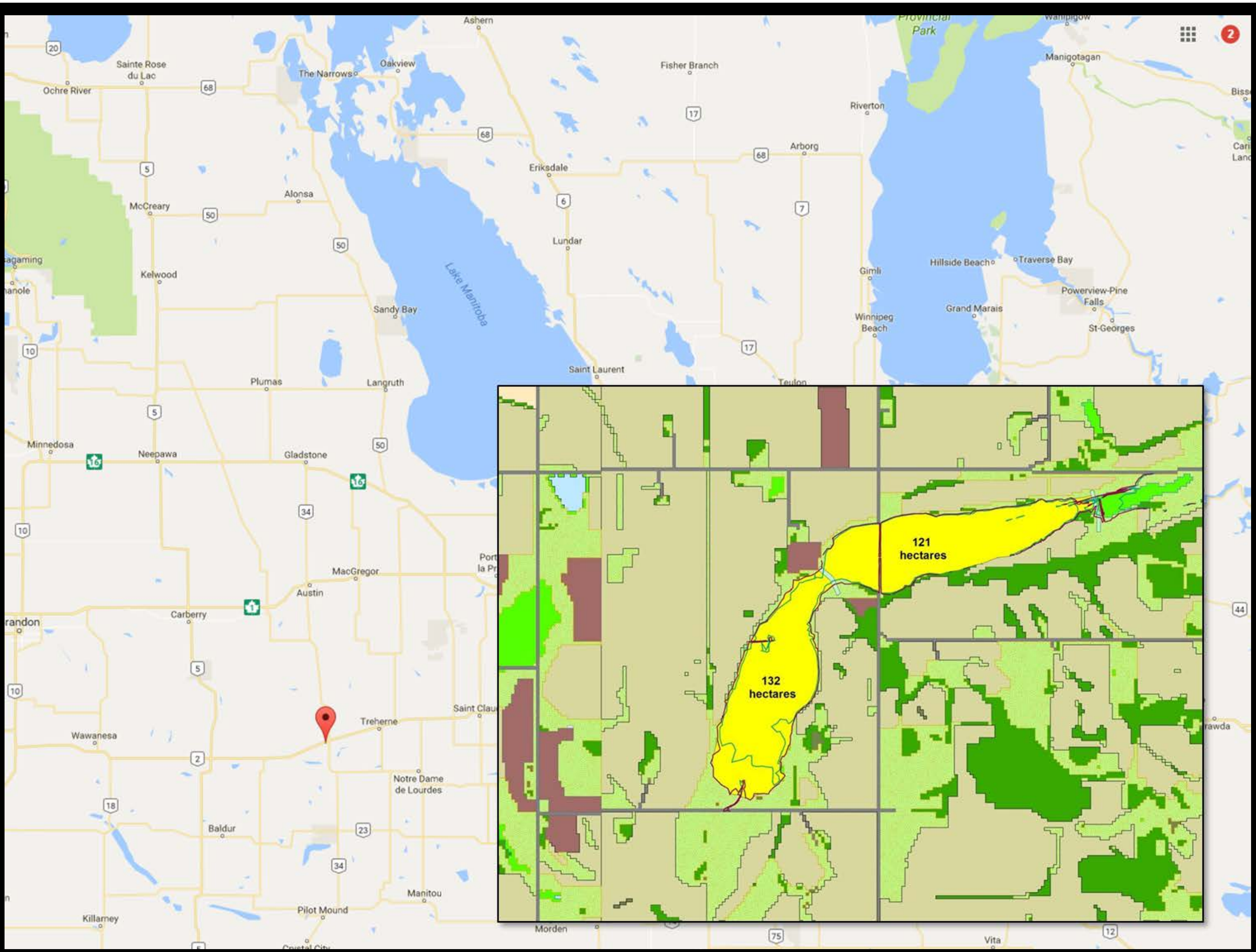
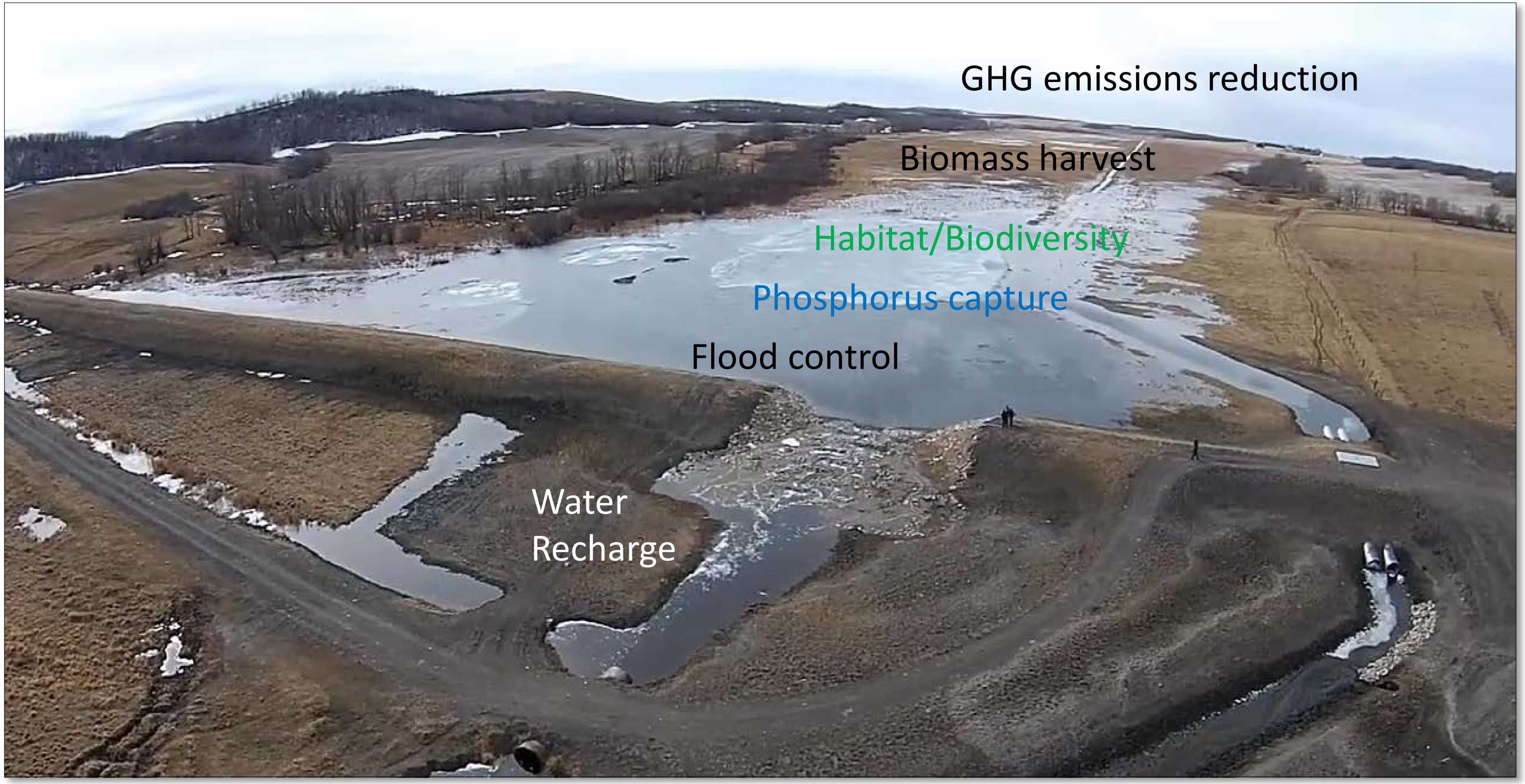


Stacked Benefits of Surface Water Retention:

Not just for flood management

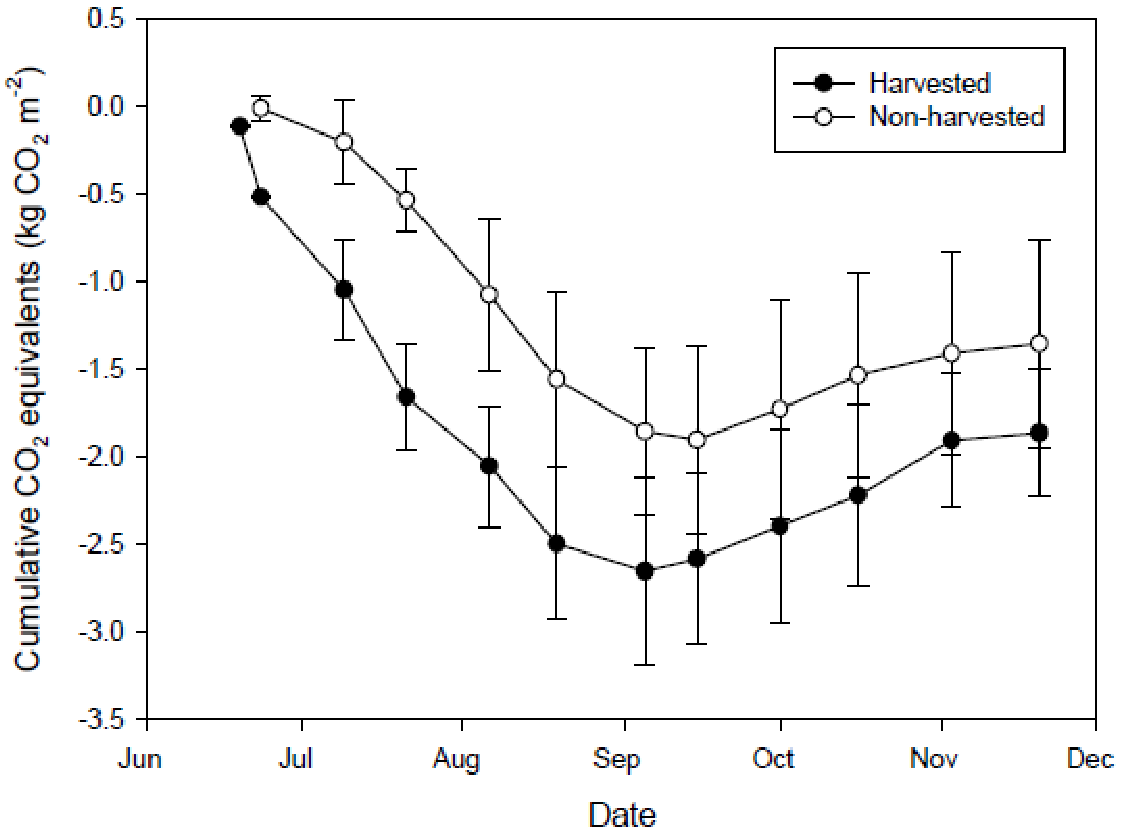


Pelly's Lake water retention site - near Holland, Manitoba

Pelly’s Lake Fall 2015 Cattail Harvesting

Dries up in the fall (September) - suitable conditions for harvesting with conventional agricultural equipment

Reduction in GHG emissions



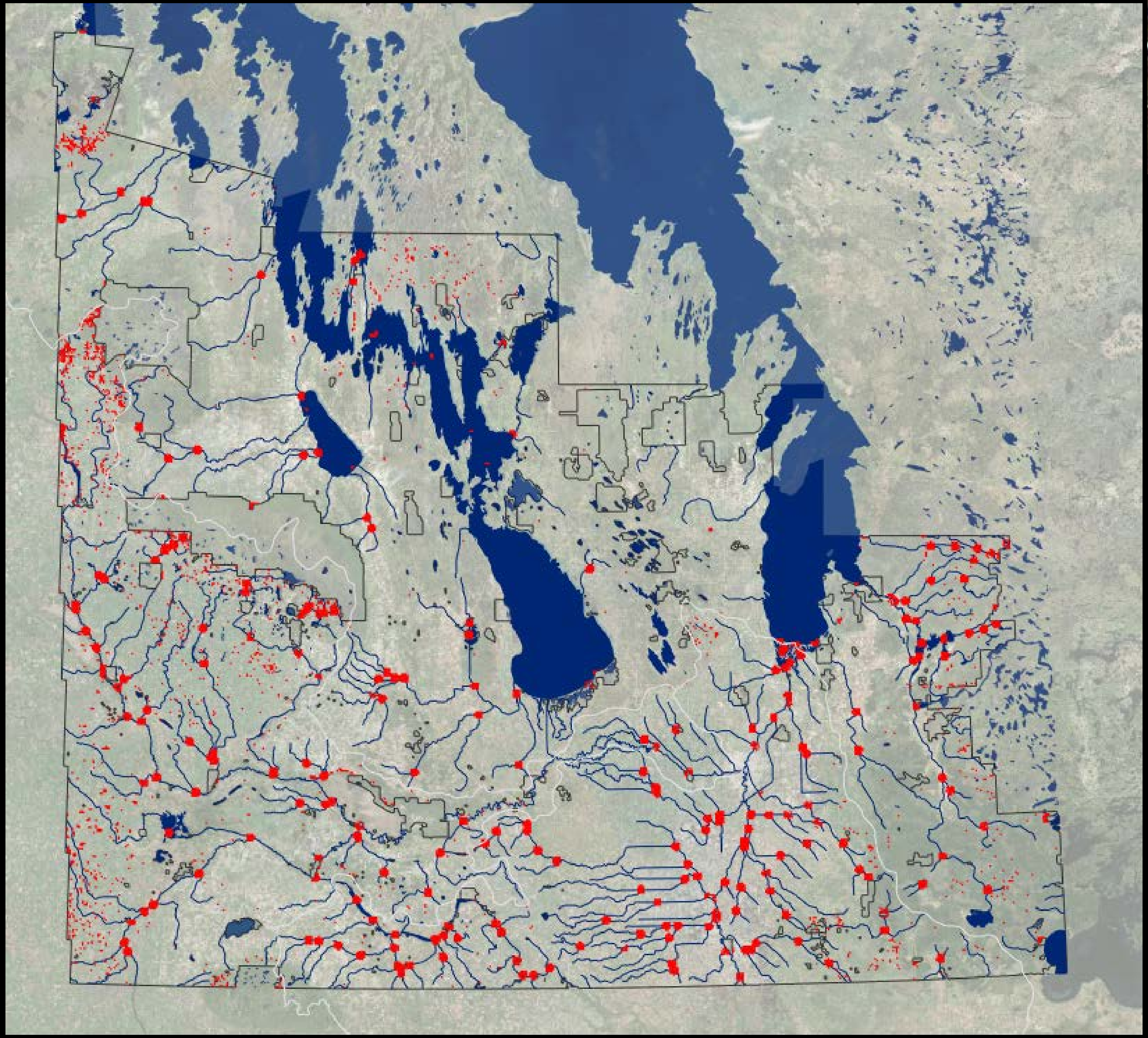
Cumulative greenhouse gas flux (CO2 + CH4 + N20, expressed as CO2 equivalents; mean +/- SE) for harvested and non-harvested cattail plots in the Pelly's Lake retention area

The big picture

Prairie Climate Centre

- Boutique projects are necessary but insufficient
- Finance, Treasury, Feds can not deal with the granularity of high-performance adaptation projects
- Structural adaptation means aggregation and bundling for green bond issues.
- High performance computational platform for benefit aggregation, economic performance, visualization (and institutional gap analysis)

Aggregation and Systems Desi
Re-mosaicking the landscape



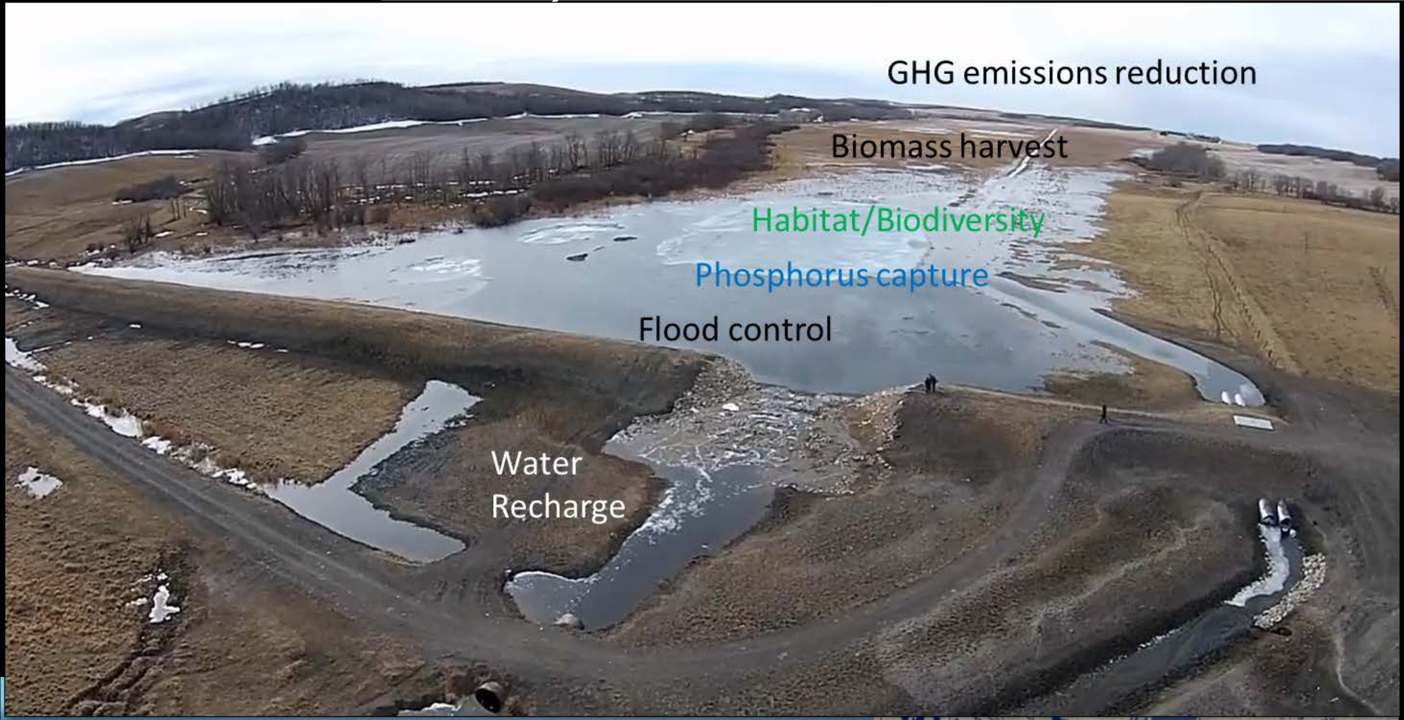
Key parameters:

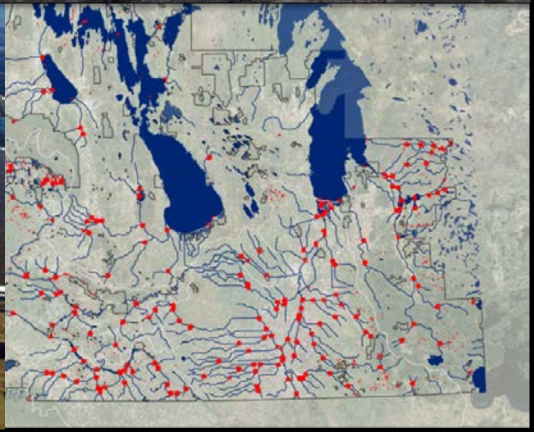
- *Retention area*
  = 4750 km2
  = 1840 sections
  = 3.4% of ag land base

- *Storage Volume @ 1m depth*
  = 4.75 Gm3
  = 3.85 M ac-ft
  = 80.6% of 2011 flood

- *Biomass / Phosphorus @ 8t/ha*
  = 3.8 Mt biomass
  = 3.8 kt phosphorus
  (100% of Lk Winnipeg policy target)

Aggregating Costs and Benefits
(direct monetization and engineering substitution costs)





Cost
@ $1000/acre-foot + $400/acre + 50% contingency
= $6.3 Billion

Co-Benefit Stack
Irrigation @ 10% of storage @ $500 acre-ft
= $192 Million/year
Biomass Production @ $30/t
= $114 M/year
GHG emissions reduction
Fuel Switch @ $30/t CO2e
= $114 M/year
Sequestration @ $30/t CO2e @ 10t/ha
= $142 M/year
Water Quality @ $50/kg P
= $190 Million/year
Flood Risk Reduction [omitted]
Drought Resiliency [omitted]
Habitat [omitted]

Co-Benefit Stack Total *= $753 M/year*

Motivation – the $64 trillion dollar question (actually $90T)

nature climate change

PERSPECTIVE

PUBLISHED ONLINE: 14 NOVEMBER 2016 | DOI: 10.1038/NCLIMATE3142

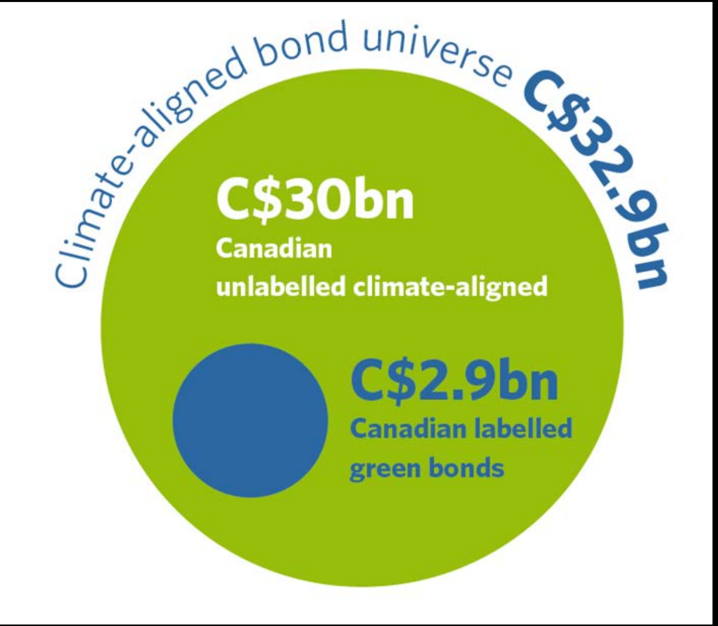
Nested barriers to low-carbon infrastructure investment

Ilmi Granoff[1,2]*, J. Ryan Hogarth[1,3]* and Alan Miller[1]

Low-carbon, 'green' economic growth is necessary to simultaneously improve human welfare and avoid the worst impacts of climate change and environmental degradation. Infrastructure choices underpin both the growth and the carbon intensity of the economy. This Perspective explores the barriers to investing in low-carbon infrastructure and some of the policy levers available to overcome them. The barriers to decarbonizing infrastructure 'nest' within a set of barriers to infrastructure development more generally that cause spending on infrastructure—low-carbon or not—to fall more than 70% short of optimal levels. Developing countries face additional barriers such as currency and political risks that increase the investment gap. Low-carbon alternatives face further barriers, such as commercialization risk and financial and public institutions designed for different investment needs. While the broader barriers to infrastructure investment are discussed in other streams of literature, they are often disregarded in literature on renewable energy diffusion or climate finance, which tends to focus narrowly on the project costs of low- versus high-carbon options. We discuss how to overcome the barriers specific to low-carbon infrastructure within the context of the broader infrastructure gap.

Climate Bonds INITIATIVE

Climate Bond Certified



Recent climate-aligned bonds in Canada

DATE	ISSUER	SIZE	THEME	LABEL
October 2015	Dufferin Wind Power	C$200m	Energy	Unlabelled project bond
December 2015	EDC	US$300m	Multi-sector	Green Bond
January 2016	Ontario	C$750m	Multi-sector	Green Bond
February 2016	CoPower	C$300,000	Energy	Green Bond
February 2016	Canadian National Railway	US$500m	Transport	Unlabelled corporate bond
March 2016	Hydro Quebec	C$16.9m	Energy	Unlabelled corporate bond

The enablers

Prairie Climate Centre

- (technical) LiDAR for proper geospatial and hydrodynamic modelling
- (technical) Hydro-climatic modelling (ECCC-MESH model)
- (technical) High performance computational platform for benefit aggregation, economic performance, watershed visualization
- (policy) hard commitment to climate leadership/green economy/cleantech and green value chain development
- (policy) institutional flexibility on carbon/water quality/biodiversity offsetting
- (policy) investment aggregation/leveraging: green infrastructure/P3
- (policy) institutional and governance innovation

The Prize: Deep Innovation

Prairie Climate Centre

- Deep Driver for Economic Development and Growth
- Climate Resilience
- International Leadership in Precision Infrastructure design, implementation and management
- A new class of cyberinfrastructure technology crucial to climate resilience, water and food security:
  - Biorefining
  - Biomaterials
  - Systems Design and Logistics
  - Geospatial Analytics
  - Smart Hydrology and Hydraulics
  - Ecosystem Modeling and Visualization
  - Low-impact Agricultural Harvesting