



# Prairie Provinces Water Futures

John Pomeroy  
Director, Global Water Futures Programme



UNIVERSITY OF SASKATCHEWAN

Global Water Futures

[GWF.USASK.CA](http://GWF.USASK.CA)



# Global Water Futures: Solutions to Water Threats in an Era of Global Change

GWF aims:

- a) to place **Canada as a global leader in water science for cold regions,**
- b) to **address the strategic needs of the Canadian economy** in adapting to change and managing the risks of uncertain water futures and extreme events.





**CANADA RANKS IN THE TOP 10 GLOBALLY**  
FOR ANNUAL RENEWABLE RESOURCES PER CAPITA

**DESPITE THIS, CANADA IS NOT A WATER SECURE COUNTRY**



### ECONOMY + WATER



THE CANADIAN ECONOMY RELIES ON

- Mining
- Oil and Gas
- Agriculture Production
- Tourism
- Transportation

ALL SECTORS RELY ON WATER AVAILABILITY

Recent events such as **FLOOD, DROUGHT, AND FIRE**

are affecting water availability and quality which influences the environment, public health and the Canadian economy

these events have been estimated to cost

**\$28 BILLION**

from 2000-2017



### WATER AVAILABILITY

85% of Canada lives in the south, while 60% of rivers flow north



Water availability is disproportionately spread over Canada's geography and unique ecosystems

Water stress is being compounded by large-scale urbanization and population growth



### CLIMATE CHANGE



CANADA IS WARMING

**2X** THE GLOBAL AVERAGE



SHIFTING CANADA'S COLD-DOMINATED HYDROLOGICAL CYCLE

changing regime of snow-melt and rain driven streams

### THREATENING TO

DECREASE

- AGRICULTURE PRODUCTION
- HYDROPOWER GENERATION



INCREASE

- FLOOD
- DROUGHT





# Global Water Futures - Mission

- **Improve disaster warning** – develop:
  - scientific knowledge, monitoring and modelling technologies,
  - national forecasting capacity to predict the risk and severity of extreme events
- **Predict water futures** –
  - use Big Data to make informed decisions,
  - Develop better models to assess change in human/natural land and water systems
- **Inform adaptation to change and risk management** – to reduce the risk of water threats, design adaptive strategies, and enhance economic opportunities, propose
  - governance mechanisms,
  - management strategies,
  - policy tools



# GWF Today

Awarded  
**\$ 77.84 M**

over 7 years  
 **2016 - 2023**

from  
 **CANADA FIRST**  
RESEARCH EXCELLENCE FUND  
 **APOGÉE CANADA**  
FONDS D'EXCELLENCE EN RECHERCHE

 supports

## 4 Global Programs

  
research for global sustainability

  
World Climate Research Programme



 **WORLD METEOROLOGICAL ORGANIZATION**

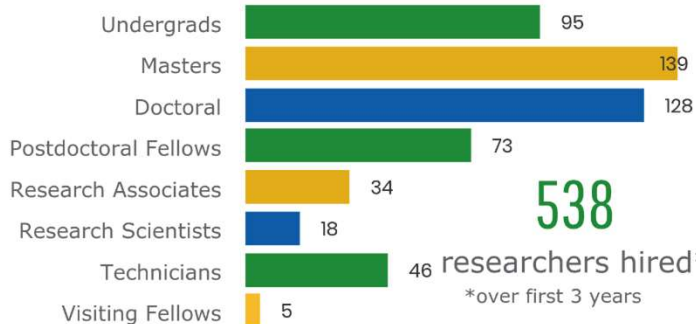
 **39 projects**  
funded across Canada



**15**  
universities



**157**  
faculty investigators



**\$259 M** in GWF project & core team funding



**\$104.8 M**  
In-kind



**\$154.5 M**  
Cash



**356**  
partners

# Designing Solutions for Water Users



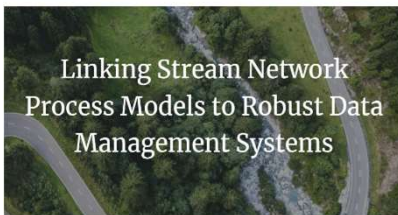
- 12 user-question led projects with 117 faculty investigators training 278 researchers in 15 universities and working with 327 partners



# Transformative Water Science



- 21 transformative science projects with 94 faculty investigators training 100 researchers in 10 universities, and working with 82 partners.



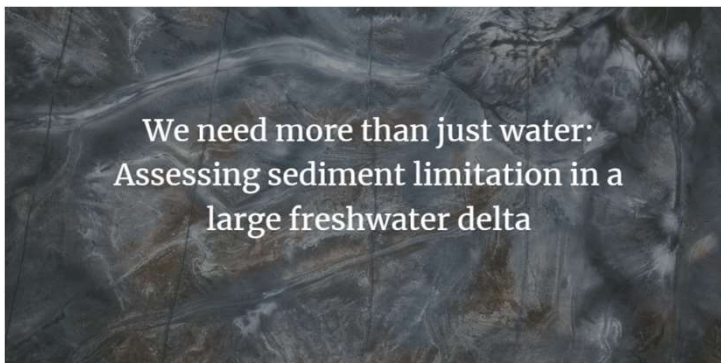
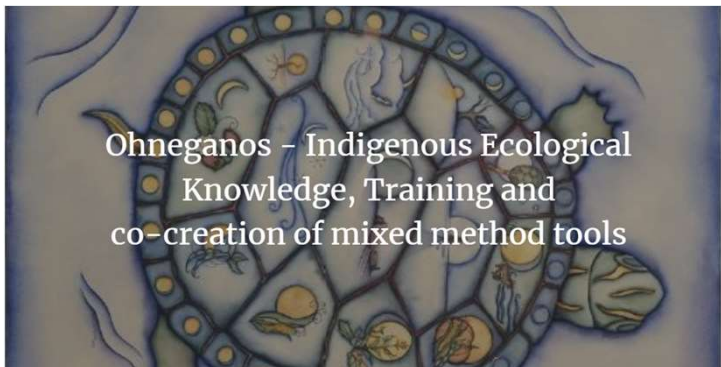
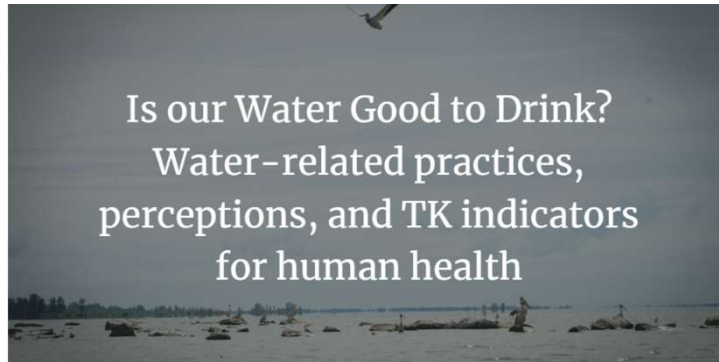
# Indigenous Community Water Research



UNIVERSITY OF SASKATCHEWAN  
Global Water Futures  
GWF.USASK.CA



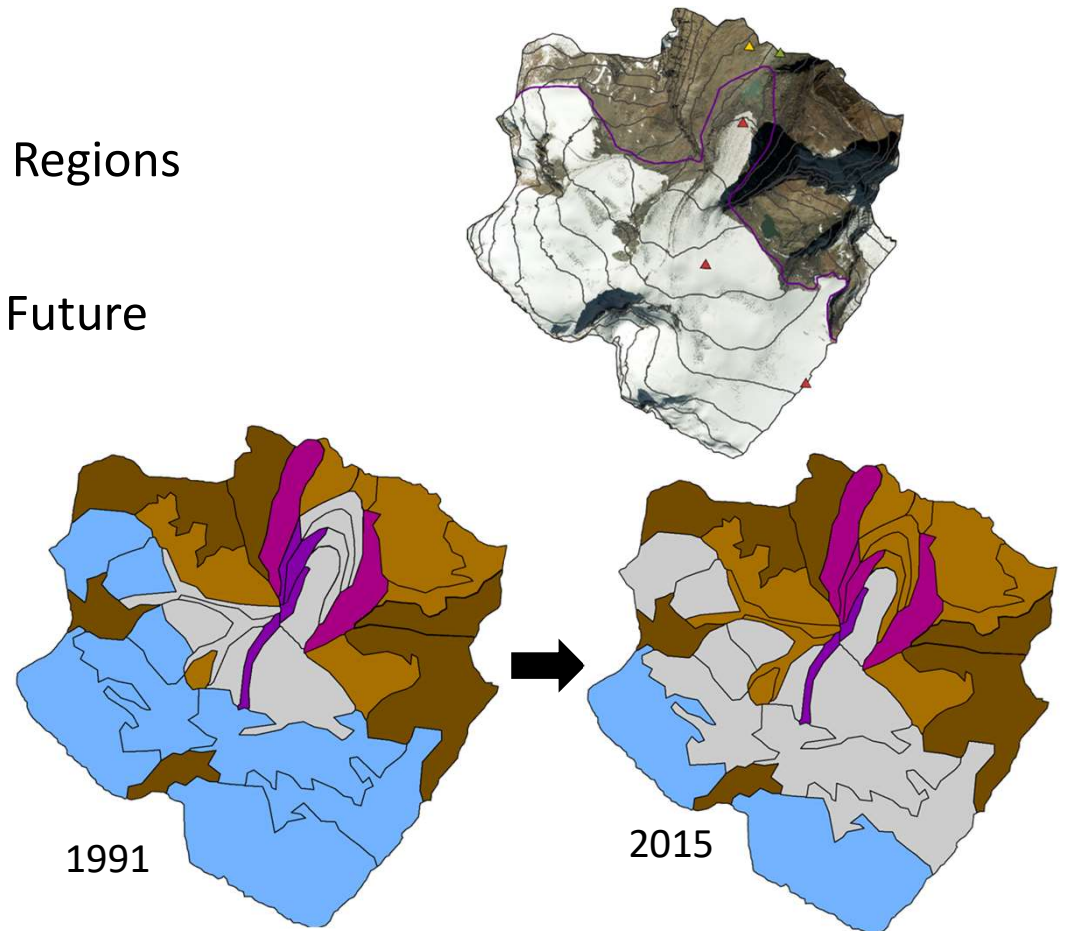
- 6 co-led projects with 69 faculty and Indigenous community investigators training 36 researchers in 11 universities and 14 Indigenous communities,





# Mountain Water Futures Project Science Highlights

- New process modules for the Cold Regions Hydrological Model (CRHM)
- Glacier Change, Land Use Change, Future Climates



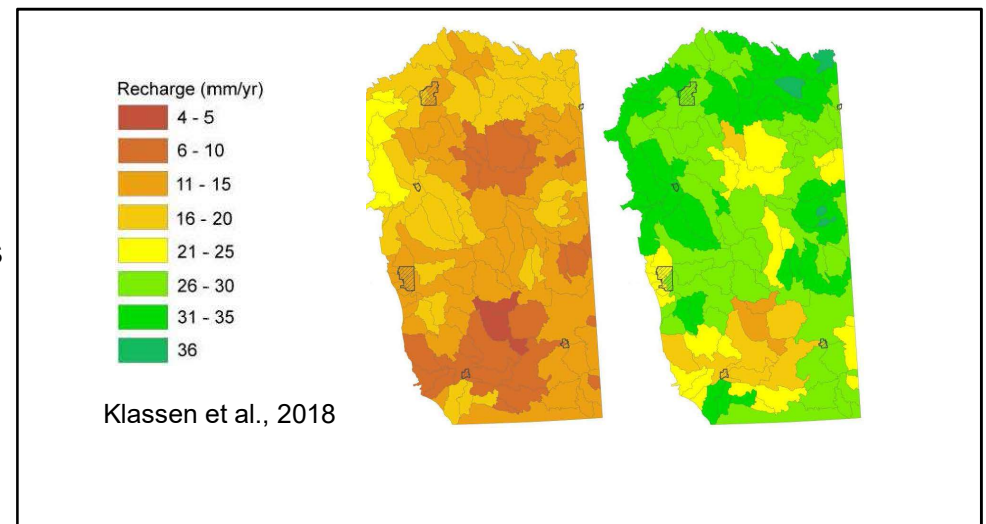
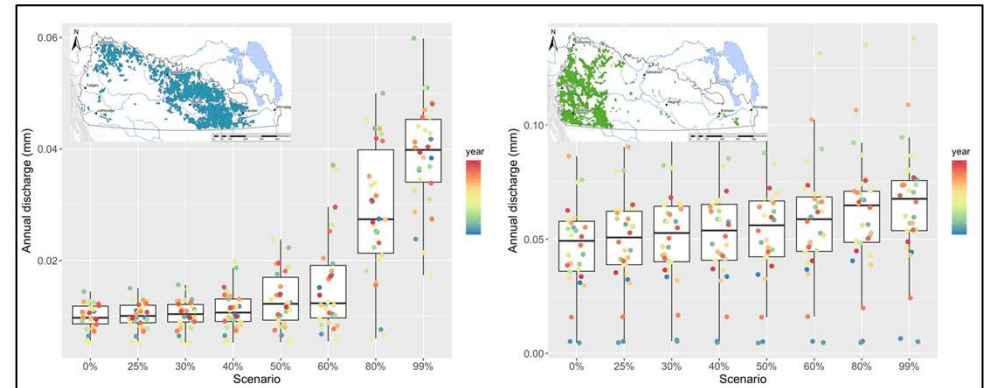
Courtesy J. Pomeroy

Peyto Glacier, Alberta



# Prairie Water Project Science Highlights

- Found that hydrological response to wetland loss differs among Prairie watershed types.
- Assembled maps on groundwater vulnerability, oil spills, and water production and use by the oil industry in Saskatchewan.
- Mapped groundwater recharge rates in Alberta
- Conducted four wetland surveys (n > 150), which represent the first extensive sampling of biogeochemical and pesticide conditions in the region.
- Developed a model to estimate which wetlands are most at risk of being removed by land owners based solely on private costs.
- Evaluated the interactive effects of climate and land cover/use on wetland biodiversity.

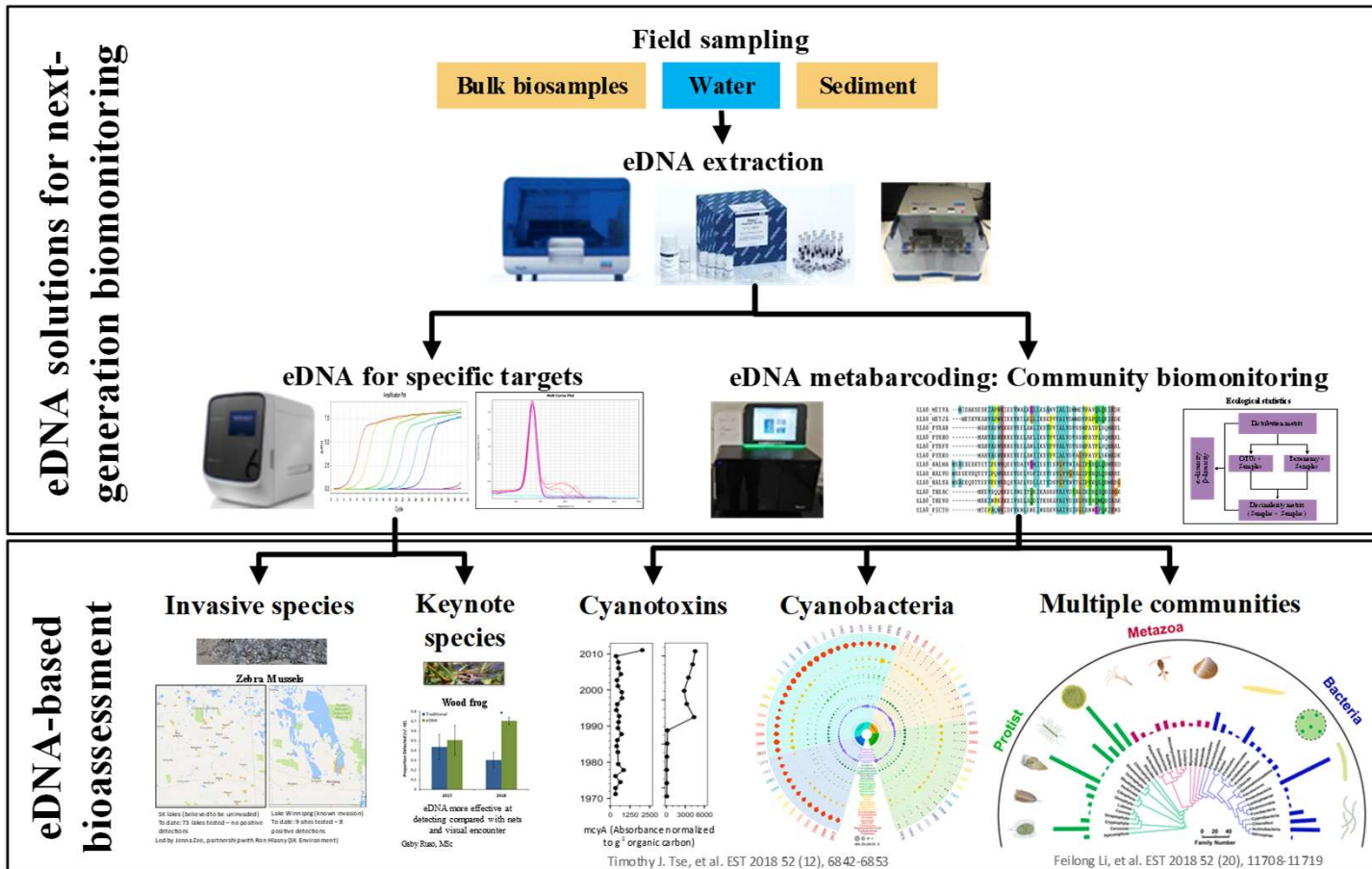


# Formbloom Project Science Highlights

- Climate & precipitation linked to harmful algae bloom changes
  - Extreme event led to early onset bloom
- Can predict algae bloom onset 4-7 days in advance
- Novel seasonal patterns of diverse cyanotoxins
  - Toxin diversity greater than anticipated
  - Reason for major concern
- Predict timing of bloom pre-conditions
- *Test science-based bloom mitigation options*



# Next Generation Solutions Project Science Highlights

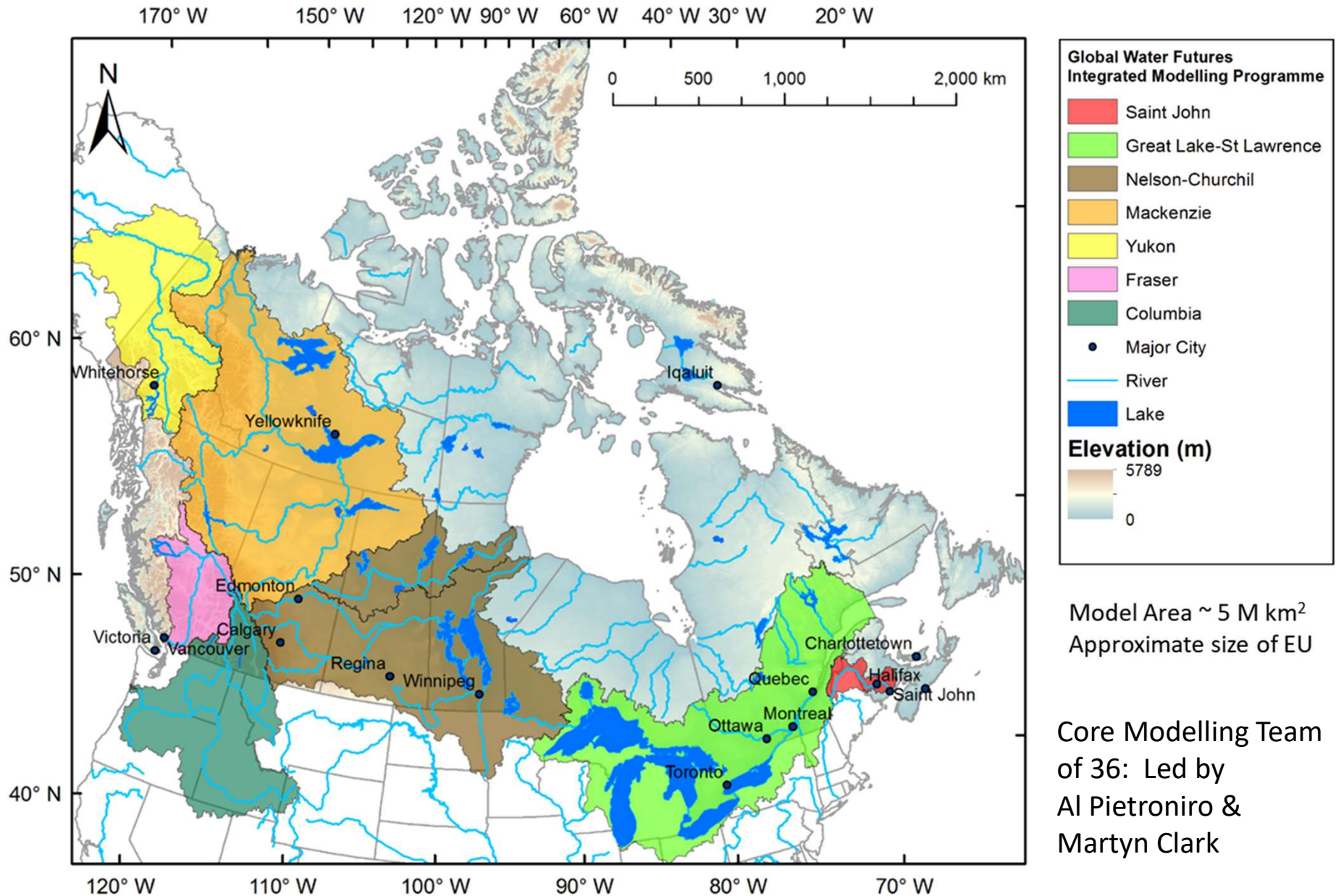


## Fish metabarcoding North Saskatchewan River

	Fish	eDNA	Netting	Consistency
Global equivalency ~ 85%				
Minnow and Shiners Sp.				
Salmon and trouts Sp.				
Sucker sp.				
Brook Stickleback				
Goldeye				
Johnny Darter				
Logperch				
Mooneye				
Northern pike				
River Shiner				
Sauger				
Shorthead redhorse				
Walleye				
White sucker				
Yellow perch				

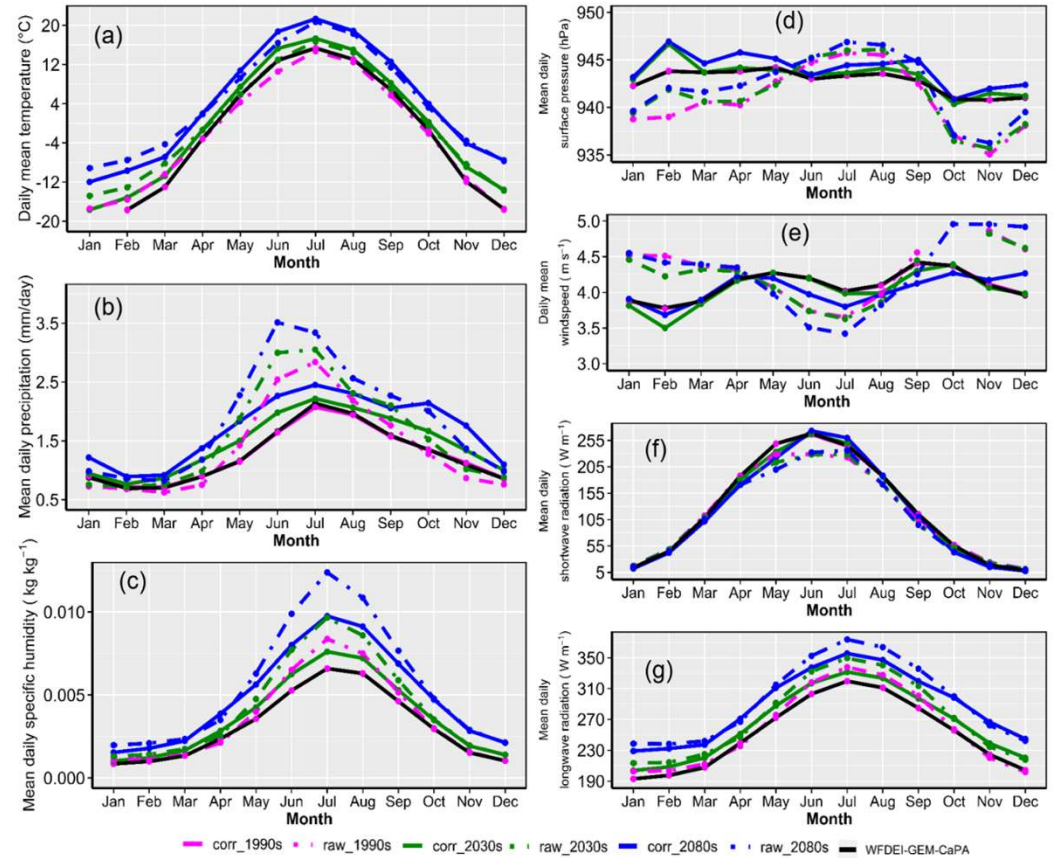
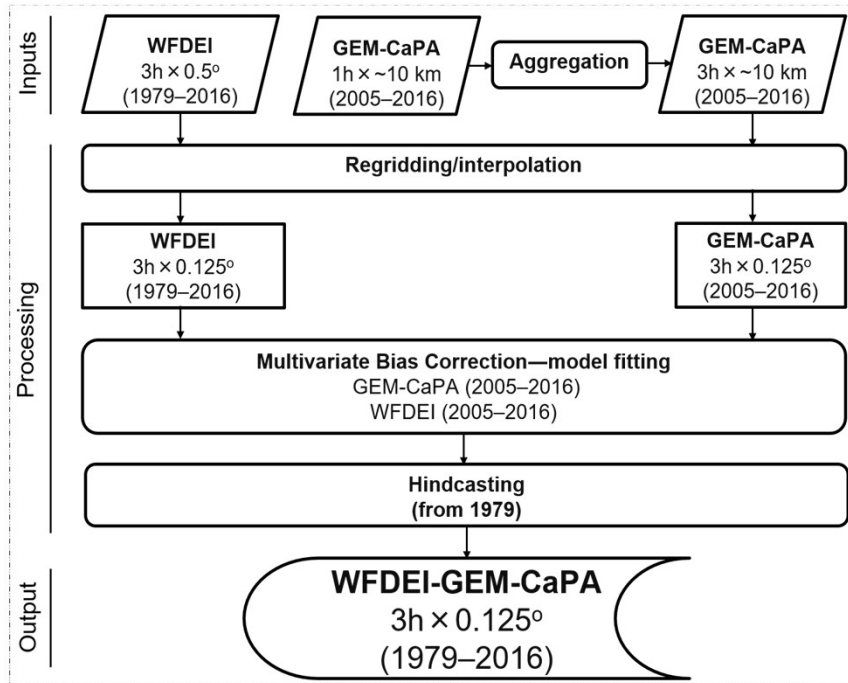


# GWF Prediction Strategy





# Bias-corrected CanRCM4

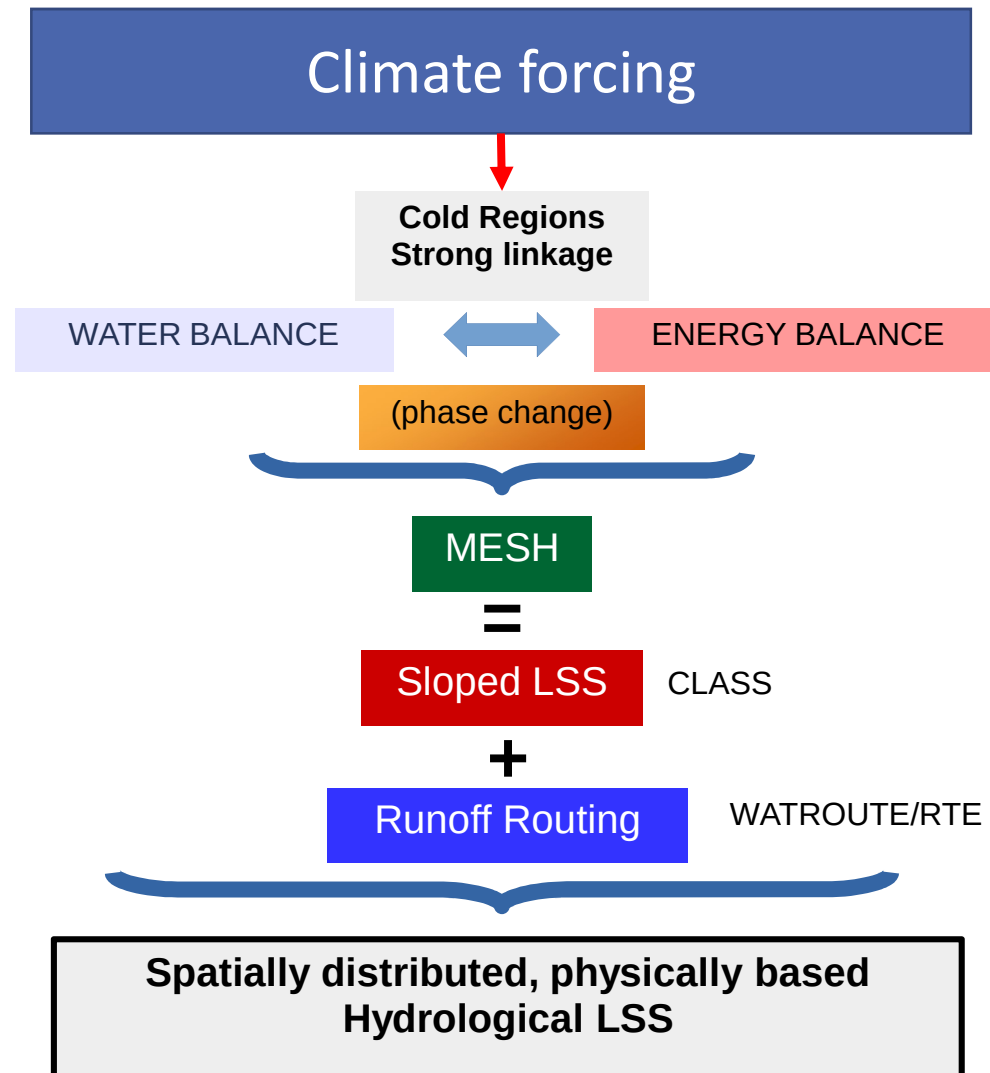


Example from MRB of “raw” and corrected CanRCM4 surface meteorology for RCP8.5 and historical periods

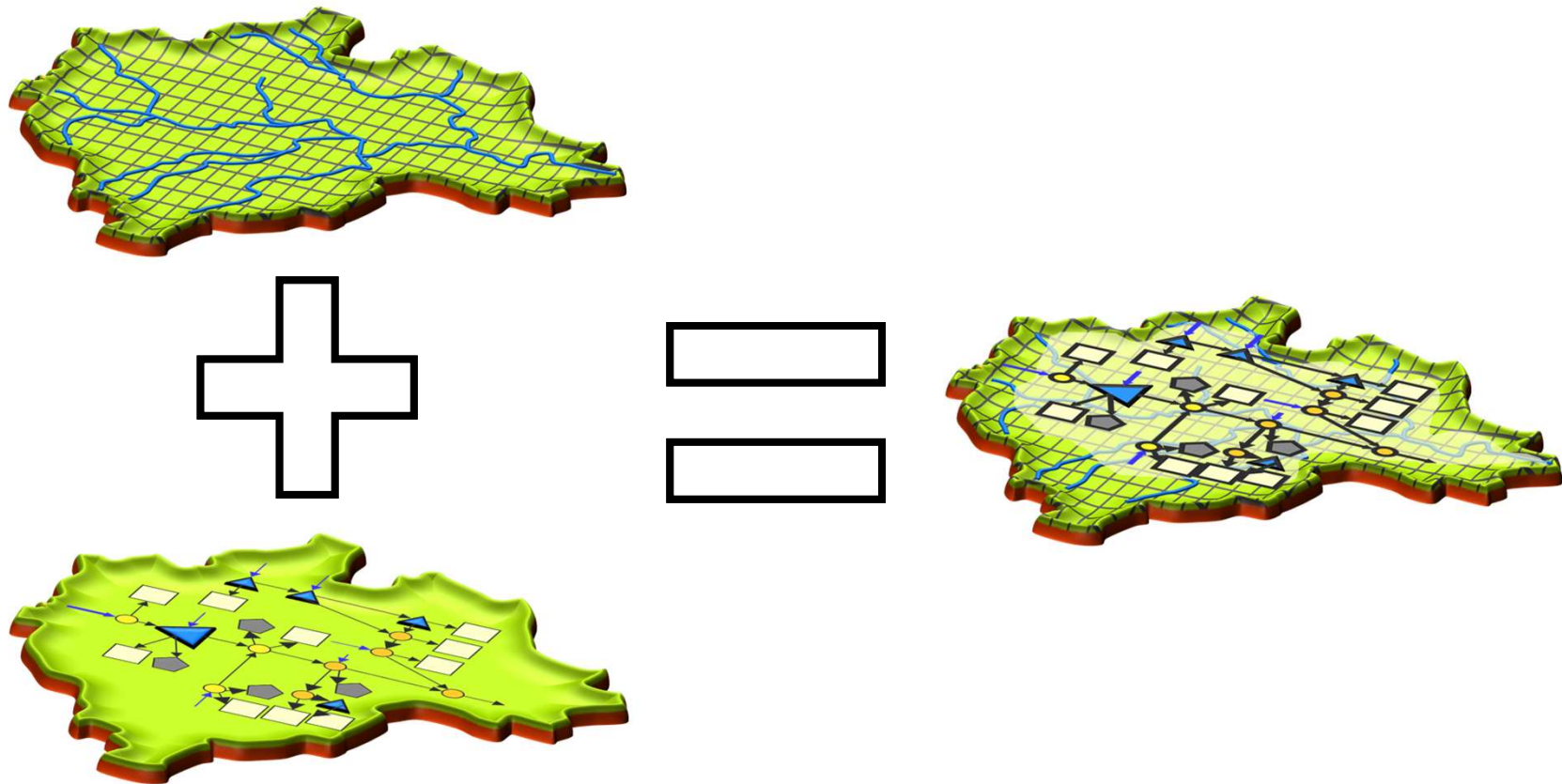


# MESH Modelling Framework

- CLASS LSS coupled to hydrological routing
- Represents glaciers, soil/permafrost, snowpacks, vegetation, water bodies
- Mountain MESH includes slope/aspect and elevation
- Prairie routing includes variable contributing area due to pond/sloughs



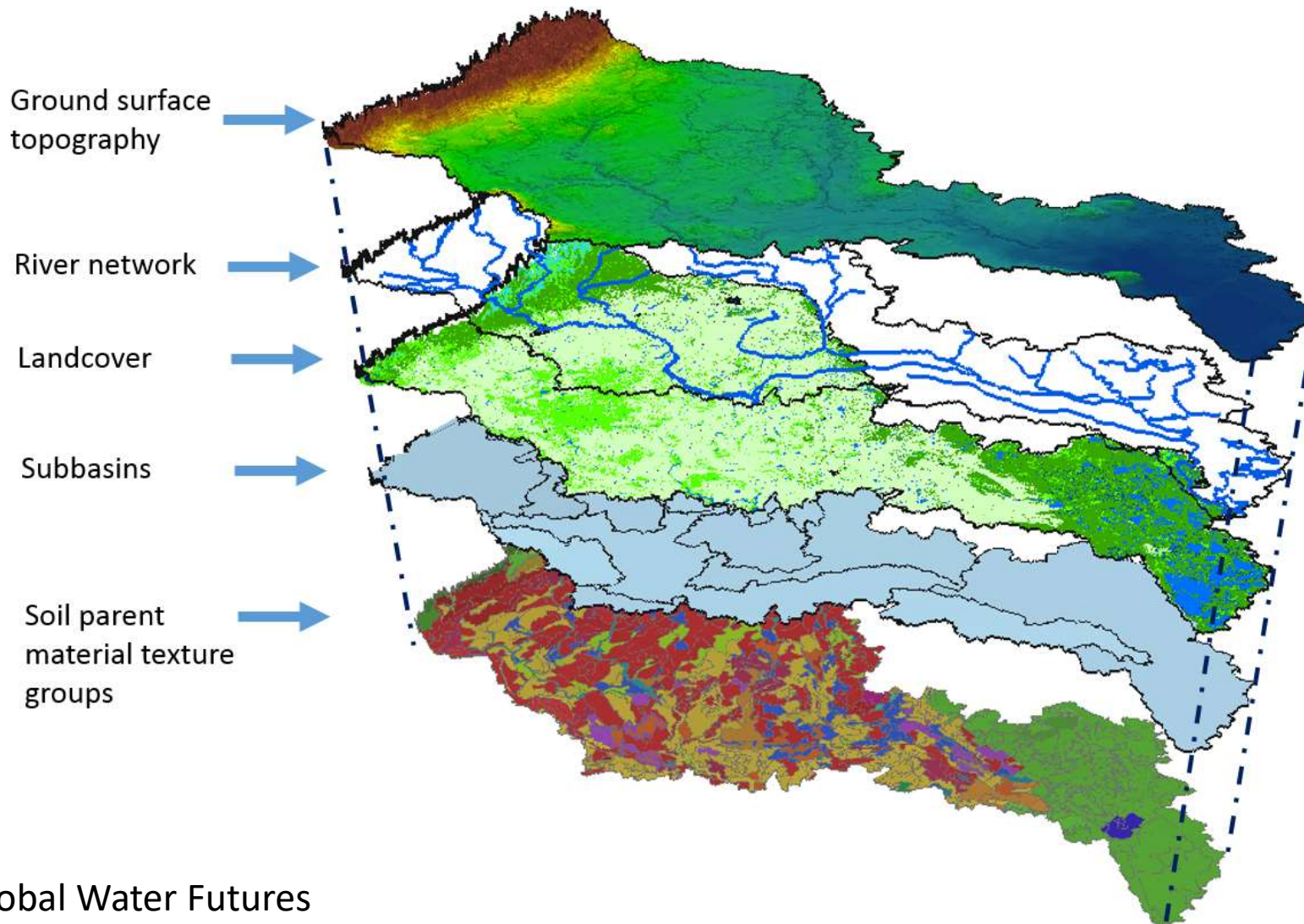
# Coupling Climate Change, Hydrology and Water Management



Driven by dynamically downscaled atmospheric models  
Driving water quality and hydroeconomics models  
Forming a Decision Support System suite of Integrated Models



# MESH Modelling of the Saskatchewan River Basin

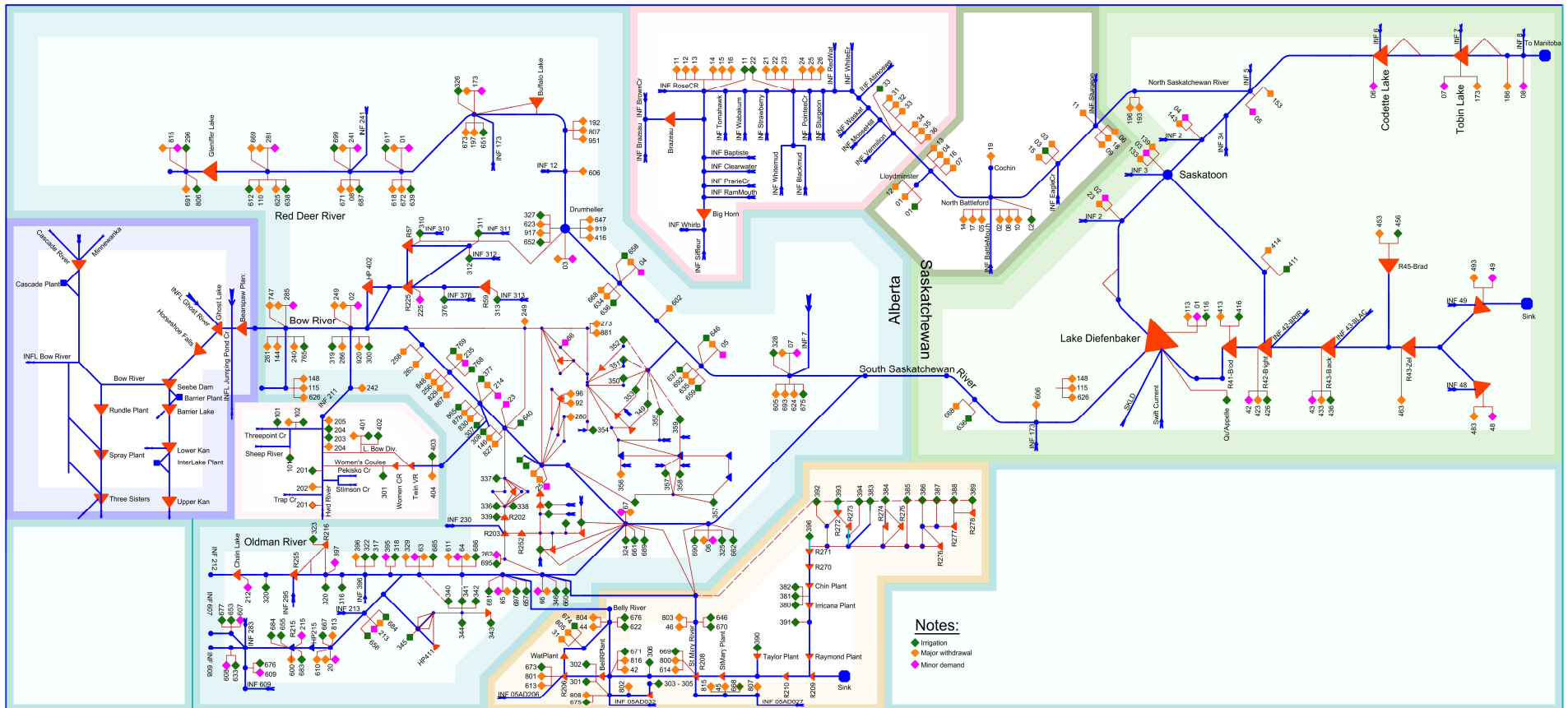


Global Water Futures

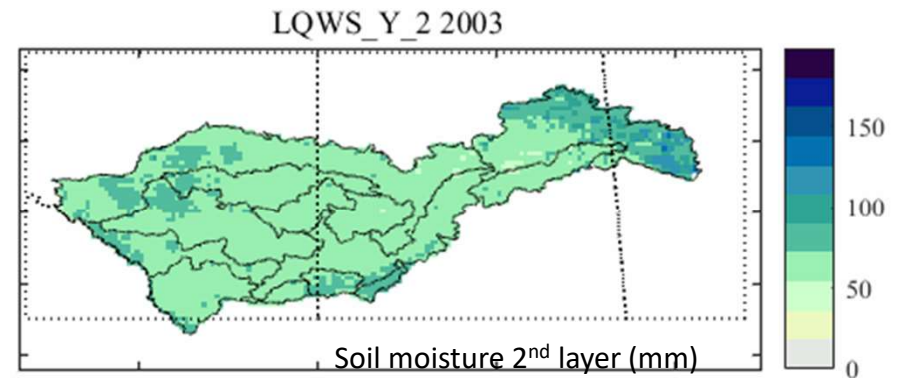
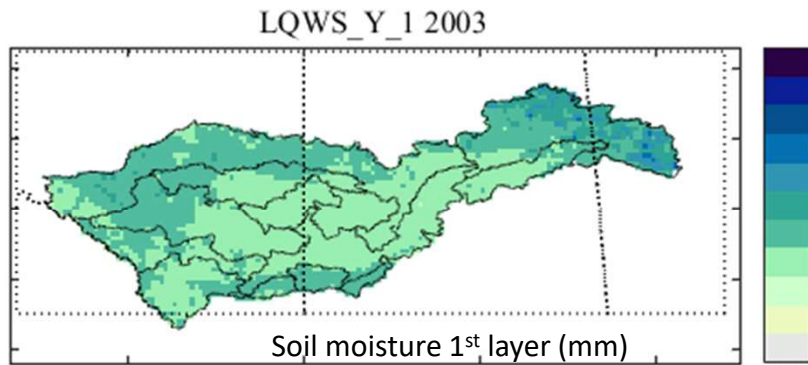
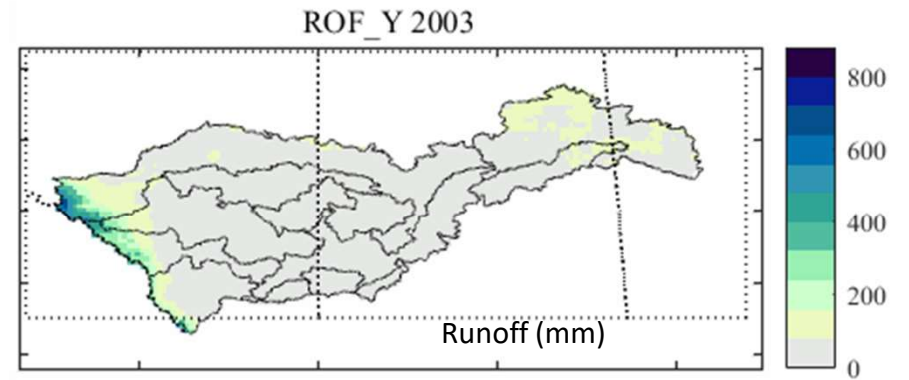
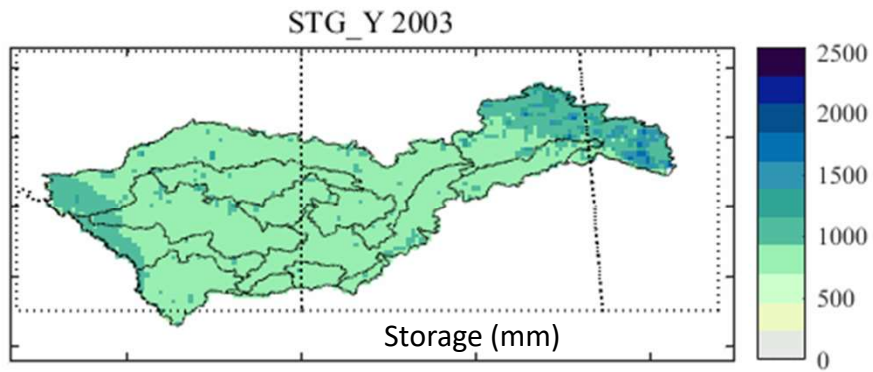
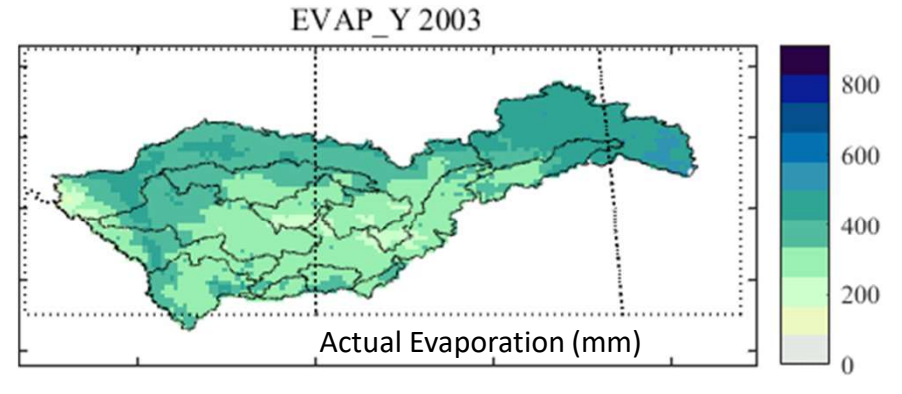
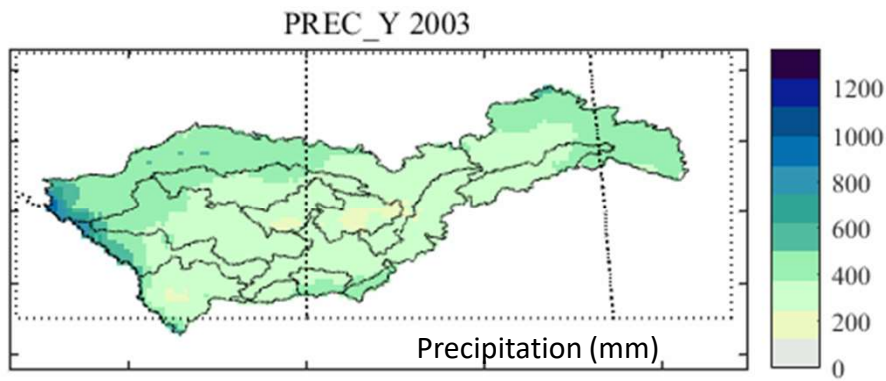
GWFI Integrated Modelling Project for Canada – Saman Razavi,

GWFI Core Modelling – Al Pietroniro

# SRB as an Integrated Hydrological – Water Resources System

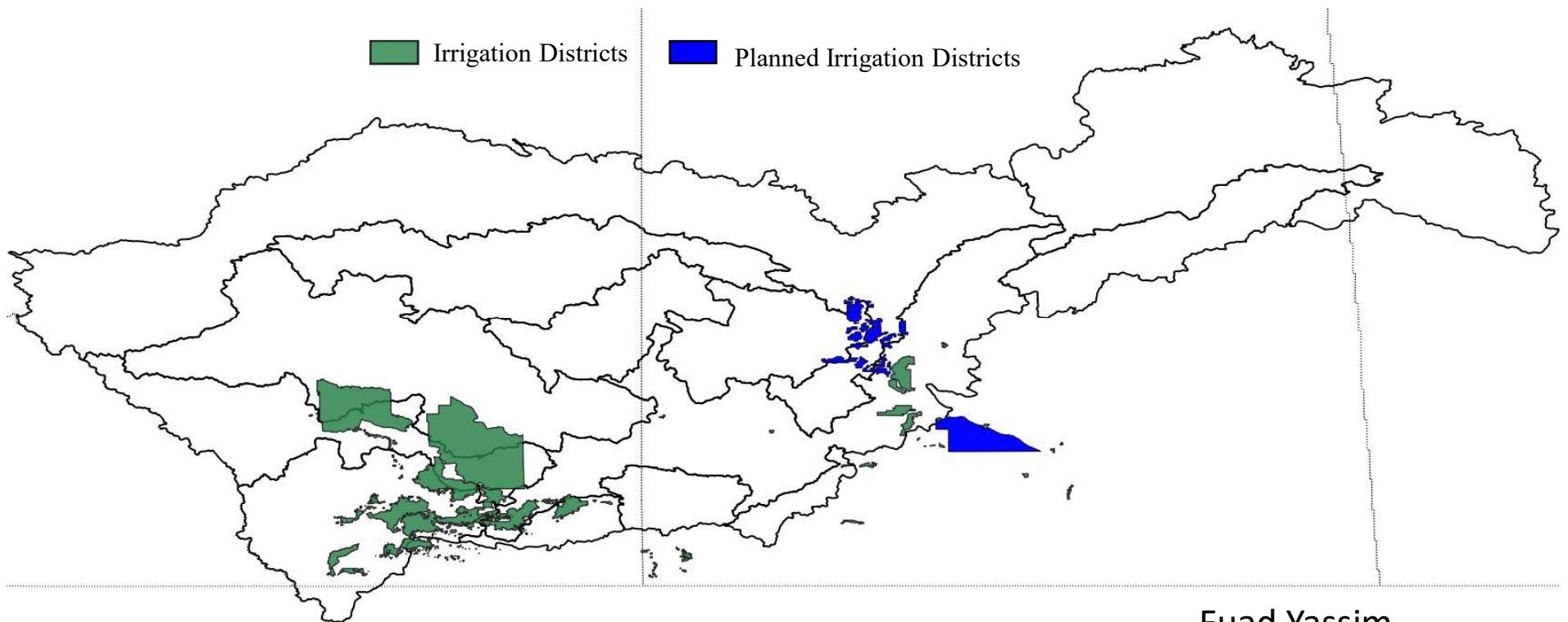


# GWF MESH Model Outputs for SRB



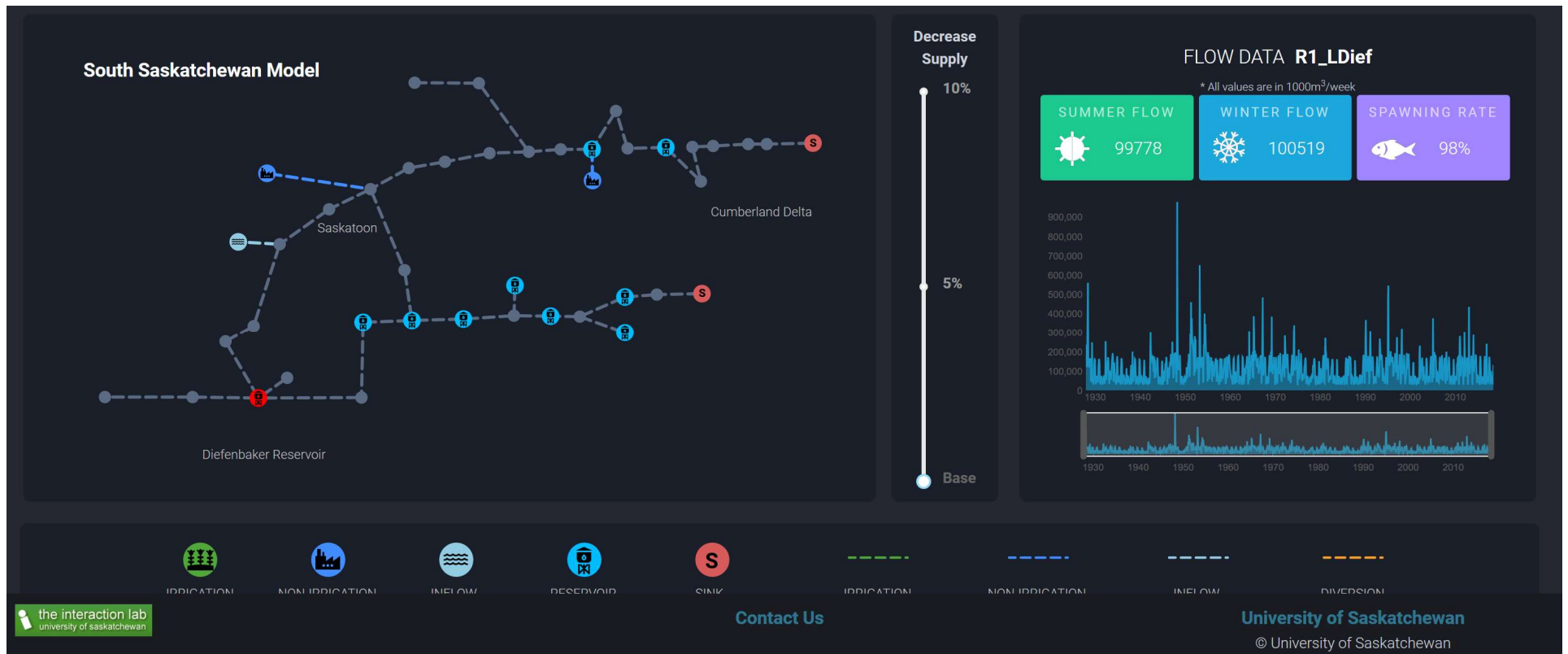
# MESH Future Scenarios- Irrigation Expansion

- Saskatchewan:- Qu'Appelle and west side projects will potentially add 500,000 acres of irrigation area.
- Alberta:- irrigation districts will expand by approximately 12% (200,000 acres) by 2025.



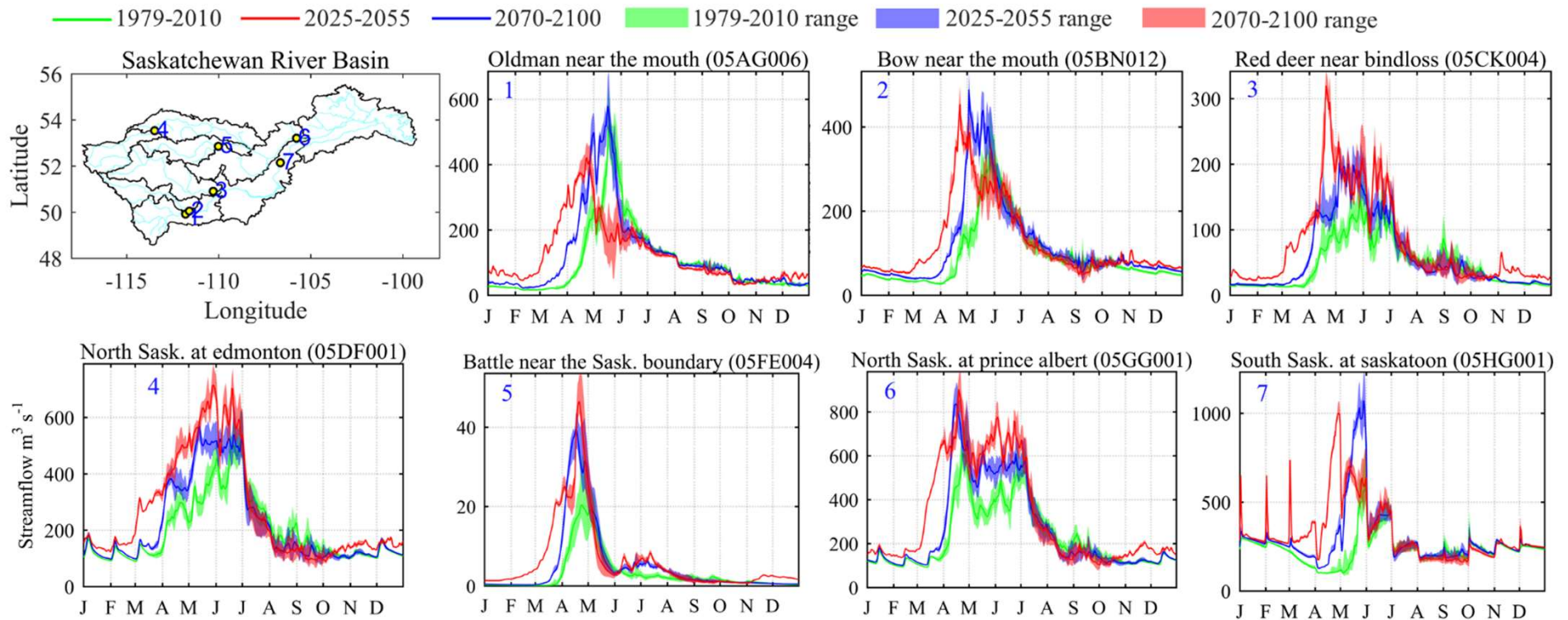
Fuad Yassim

# GWF Decision Support Tool and Visualisation



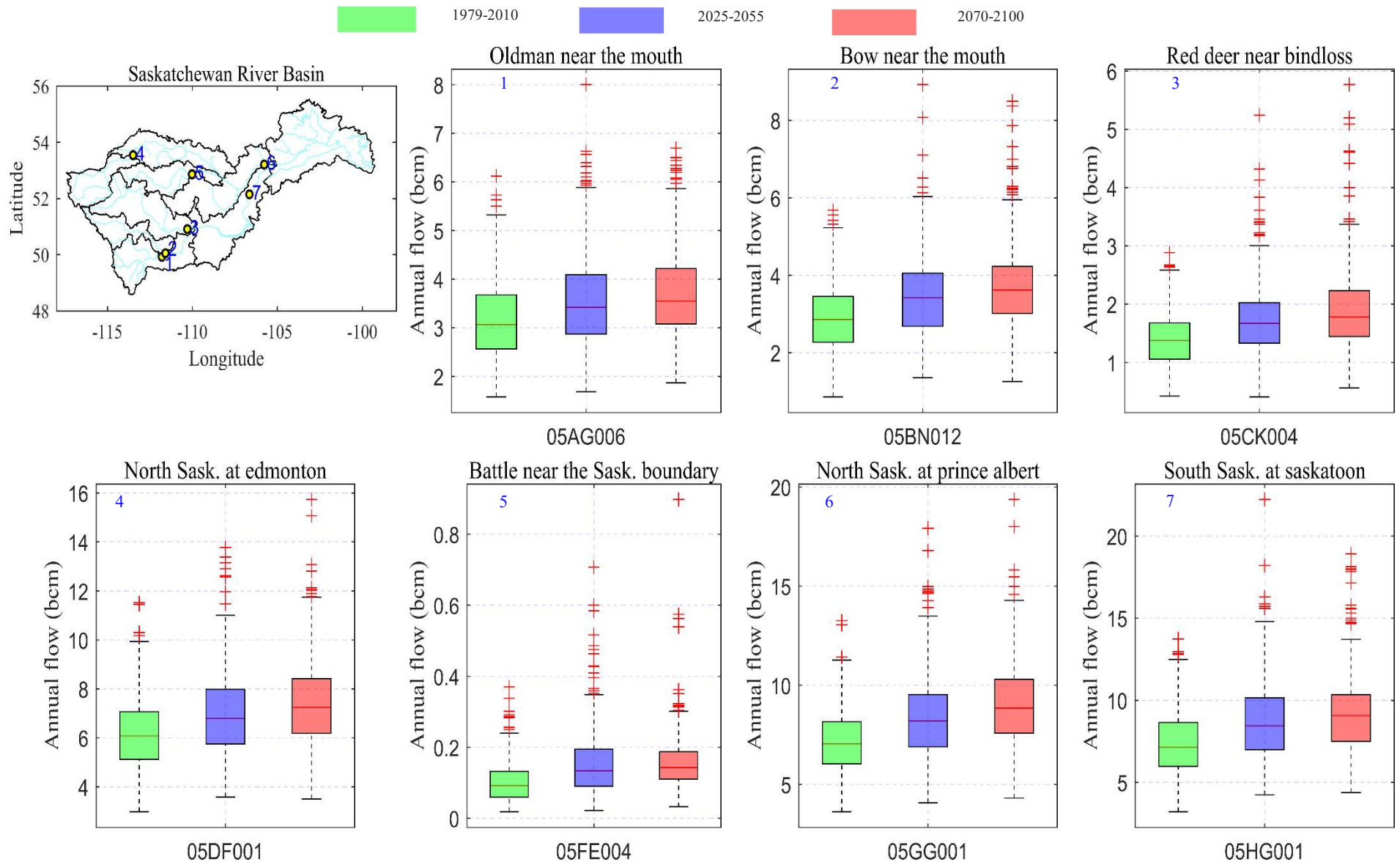
Carl Gutwin

# SRB Streamflows under Climate Change with Current Water Management Rules



MESH hydrological model with water management driven by WATCH-GEM-CaPA bias-corrected CanRCM4. Glacier and irrigation area, land use, reservoir operations held constant.

# SRB Mean annual flow volume variability over 30 years and 15 RCM forcings



# Climate change impact on mean annual flow volume

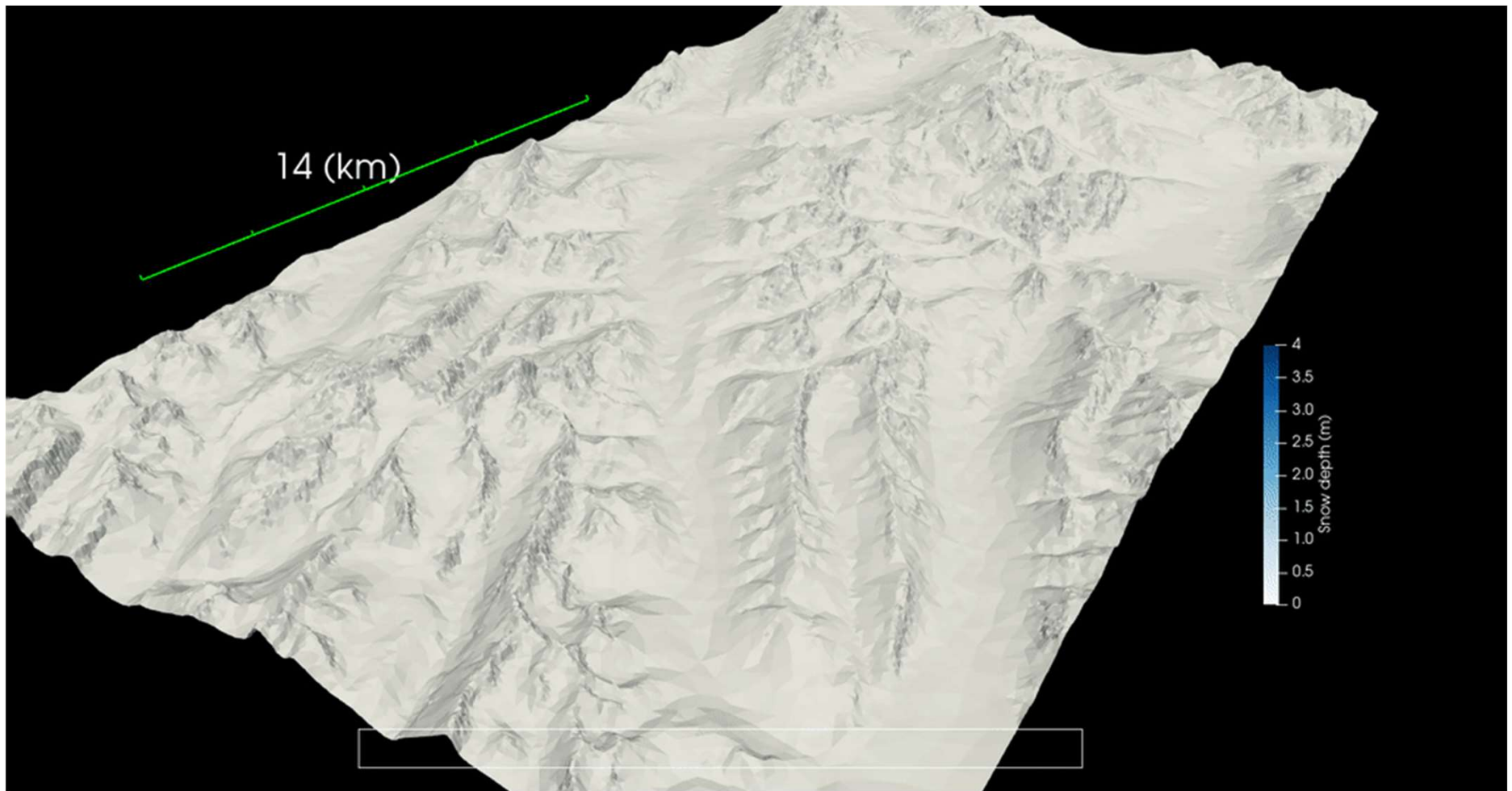
Streamflow Station	Area (km <sup>2</sup> )	Mean annual flow (BCM) (Billion Cubic Meters)			Percentage Change (%) Relative to 1980 – 2010	
		1980 - 2010	2025 - 2055	2070 - 2100	2025 - 2055	2070 - 2100
Oldman River near the Mouth	27,532	3.144	3.490	3.610	11	15
Bow River near the Mouth	25,278	2.883	3.374	3.673	17	27
Red Deer River near Bindloss	47,849	1.373	1.671	1.862	22	36
North Saskatchewan river at Edmonton	28,096	6.147	6.883	7.284	12	19
Battle River near the Saskatchewan Boundary	25,064	0.0980	0.1475	0.149	51	52
North Saskatchewan River at Prince Albert	131,000	7.108	8.252	8.926	16	26
South Saskatchewan River at Saskatoon	141,000	7.322	8.545	9.171	17	25



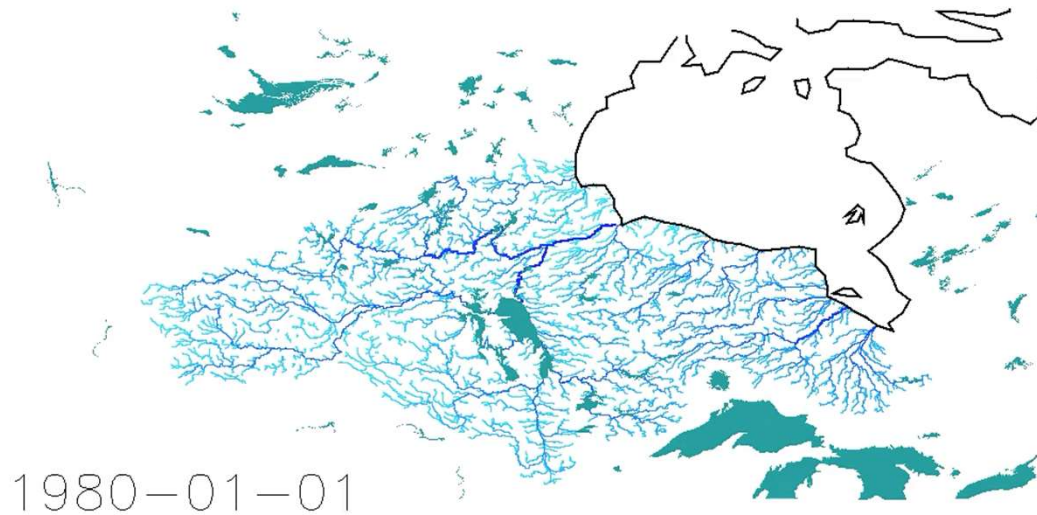
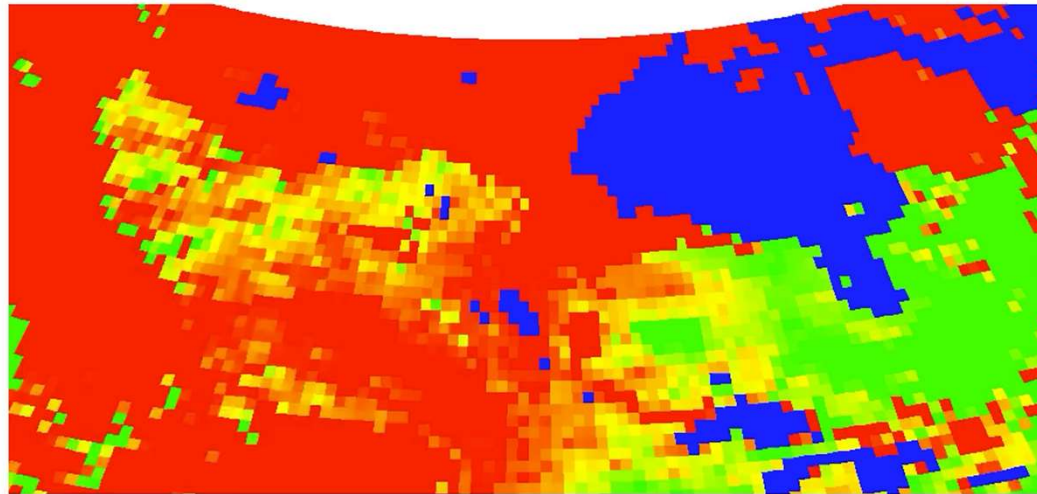


# Canadian Hydrological Model - Snow Forecast

[www.snowcast.ca](http://www.snowcast.ca)



# Next Generation Hydrological Forecasting and Prediction





# GWF National and Policy Initiatives

- Engagement with ECCC
  - Co-hosted 1<sup>st</sup> National Flood Forecasting Workshop, Vancouver Feb 2019
  - Joint national water prediction strategy
- MOU with NRCan
  - Co-hosted Water Science Summit, Ottawa, November 2018
- Sustainable Development Goals with UN University Institute for Water, Environment and Health (Hamilton) – UN Water Decade
- Water Security for Canadians
  - Strategic Briefing and Discussion, Ottawa, April 2019



# The Sustainable Development Goals Water Report



UNIVERSITY OF SASKATCHEWAN  
Global Water Futures  
GWF.USASK.CA



- Water in the World
- Water in Canada
- Challenges for Achieving Water-related SDGs
- Rising to the Challenge
- Foundations for a Path forward





## OPPORTUNITIES TOWARDS ACHIEVING SDG 6

EVIDENCE AS  
FOUNDATION 



COMMUNITY-LED  
ACTIVITIES AND INTERVENTIONS

INCORPORATE  
AND INTEGRATE 



PUBLIC  
DISCOURSE

BONDING  
TRADITIONAL  
KNOWLEDGE  
& WESTERN SCIENCE



IMPROVING  
THE SCIENCE

LEADING BY  
EXAMPLE 



CO-CREATED  
RESEARCH

END-USER  
DECISION TOOLS 

RECOGNIZING  
THE URGENCY 



COMMITTING  
TO CAPACITY

# How to Reach the Sustainable Development Goals for Water in Canada?



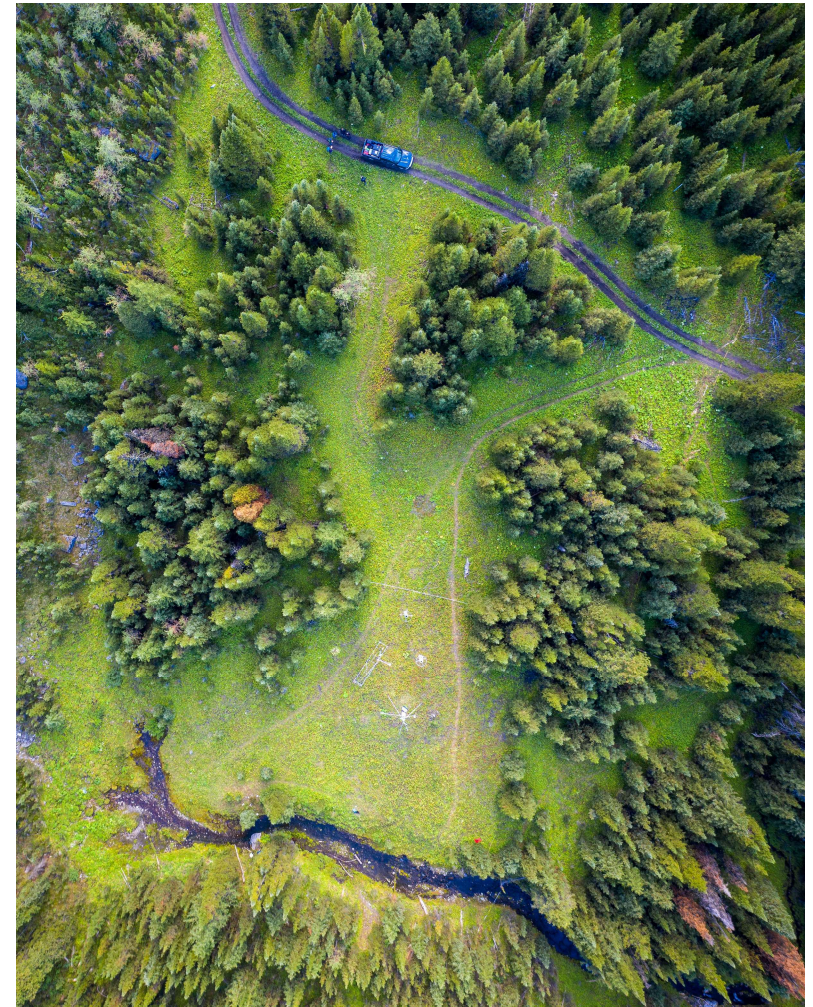
UNIVERSITY OF SASKATCHEWAN

Global Water Futures

GWF.USASK.CA



- Create a national water agency to provide water information and predictions, support integrated river basin management, transboundary agreements and reconciliation
- Commit to water sustainability as individuals, communities, institutions & governments
- Create, support & share strategic research
- Find room for co-created Indigenous leadership on water



[www.gwf.usask.ca/SDGREPORT](http://www.gwf.usask.ca/SDGREPORT)



## By 2023, GWF will contribute to

- *Improved scientific foundations* for solving water problems.
- National *water forecasting and prediction* system
- *Predictions of water futures* around the world
- *Water solutions* for food security, energy security, infrastructure, economic development, safe communities, ecosystem conservation, governance.
- *Decolonialization* of Indigenous water management in Canada.
- *Water, peace and security* around the world
- Revitalized *water strategy for Canada*
- Making Canada known as the *water solutions country*.



# Global Water Futures 3rd Annual Open Science Meeting

- GWF will hold its next Open Science meeting in Waterloo, ON, Canada
- 11–13 May, 2020
- Hosted jointly by the University of Waterloo and Wilfrid Laurier University
- We welcome everyone involved with GWF and anyone wishing to make connections to the program to attend and participate.
- We expect 600–700 attendees over the 3-day event







## **Global Water Futures**

National Hydrology Research Centre

11 Innovation Boulevard

Saskatoon, SK S7N 3H5 Canada

Tel: (306) 966-2021; Fax: (306) 966-1193

Email: [gwf.project@usask.ca](mailto:gwf.project@usask.ca)

Website: [www.globalwaterfutures.ca](http://www.globalwaterfutures.ca)