



# Integrated Modelling for Prediction and Management of Change in Canada's Major River Basins (IMPC)

First Annual General Meeting  
Saman Razavi, July 18-19, 2018



Integrated Modelling  
Program for Canada  

---

Global Water Futures



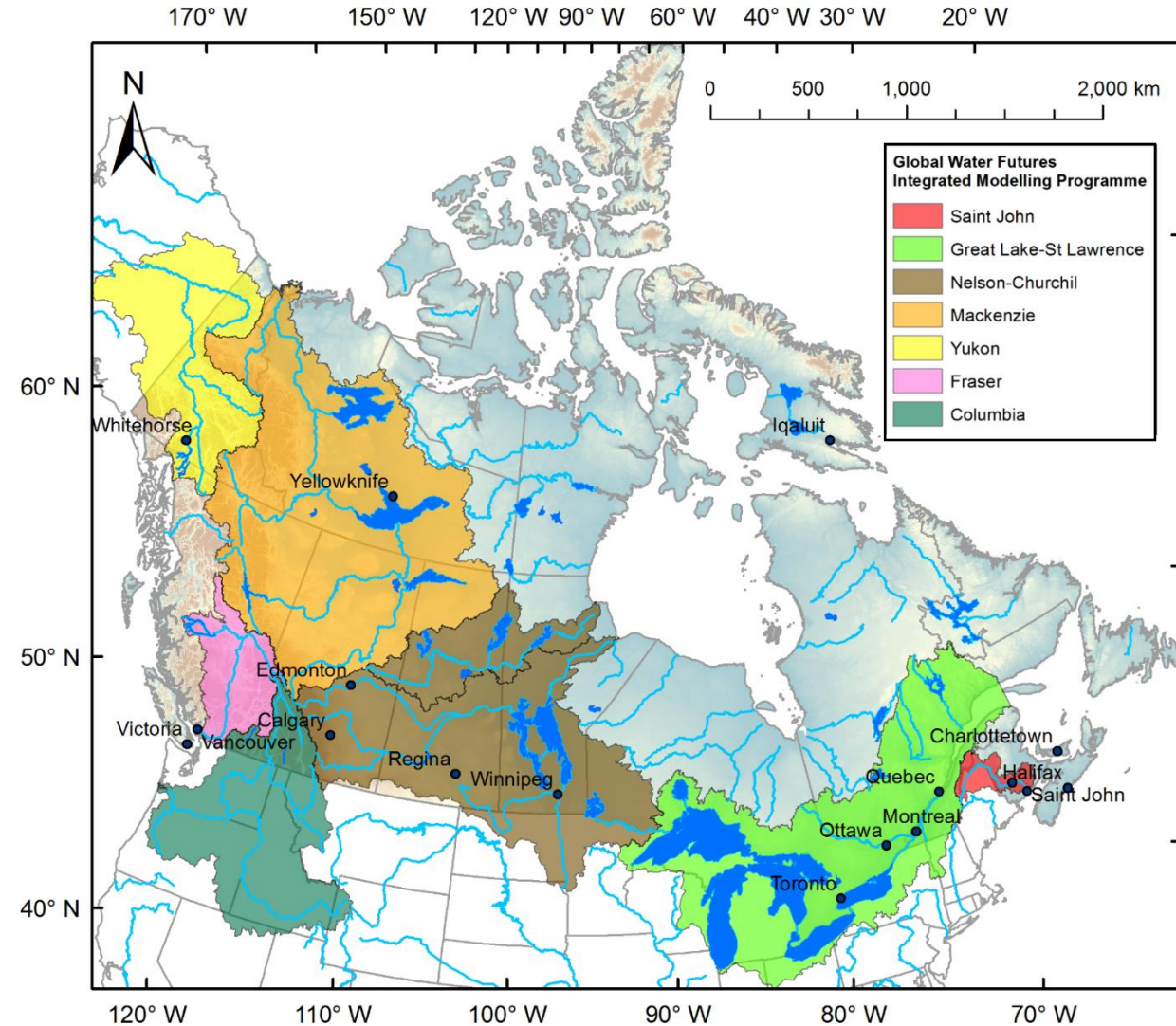
# Overarching Challenges

- (I) **Failure to link important features** of climate, hydrology, water quality, ecosystem, and water management systems. Important positive and negative feedback loops, tipping points, and dynamical behaviour of these human-natural systems are not included in current modelling schemes.
- (II) **Fragmentation** in operations, management, and governance of Canadian water resources systems leads to piecemeal science, policy, and modelling. Our research transcends artificial boundaries (international, provincial, and local) and provides information at scales appropriate for decision-making.
- (III) Current practice assumes stationarity, the idea that the past empirical record is a basis for understanding the present and future conditions. We now know that **stationarity is dead** and that our environmental systems are in the throes of unprecedented climate and environment change.



# Overarching Objective

*“This program aims to develop a pan-Canadian **integrated modelling platform** to diagnose, simulate, and predict interactions amongst natural and human-driven water-resource components of the changing Earth and environmental systems, and to deliver **robust decision making tools and solutions** for uncertain future water resources, considering the range of stakeholder needs in Canada’s major river basins.”*



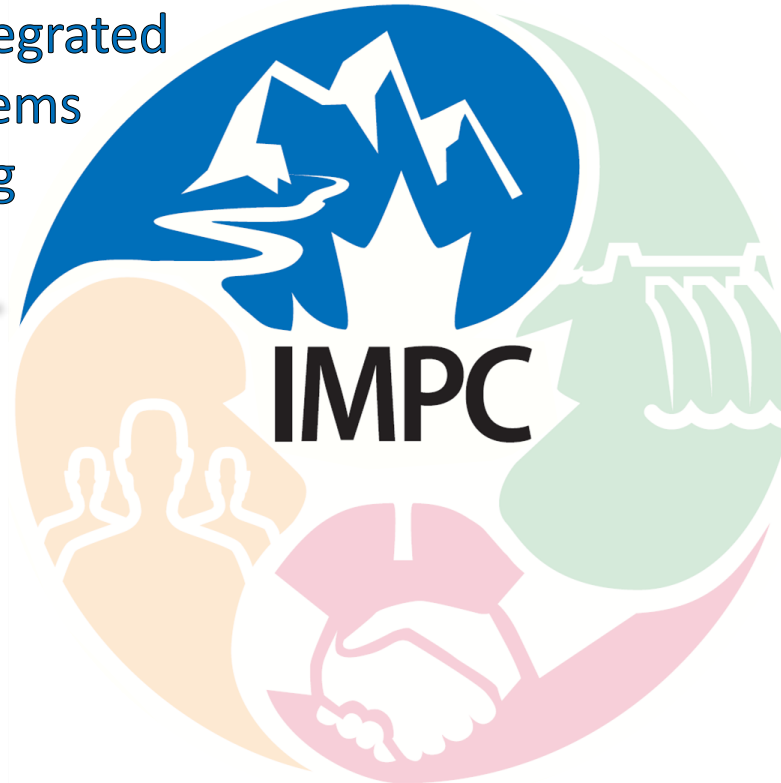
# Research Themes



**Integrated Modelling  
Program for Canada**  
Global Water Futures

**A1:** Atmospheric Modelling  
**A2:** Hydrologic Modelling  
**A3:** Water Quality Modelling  
**A4:** River Ice Modelling  
**A5:** Model Intercomparison  
**A6:** Floodplain Mapping  
**A7:** Uncertainty Characterization

**THEME A:**  
**Integrated  
Earth Systems  
Modelling**



# Research Themes

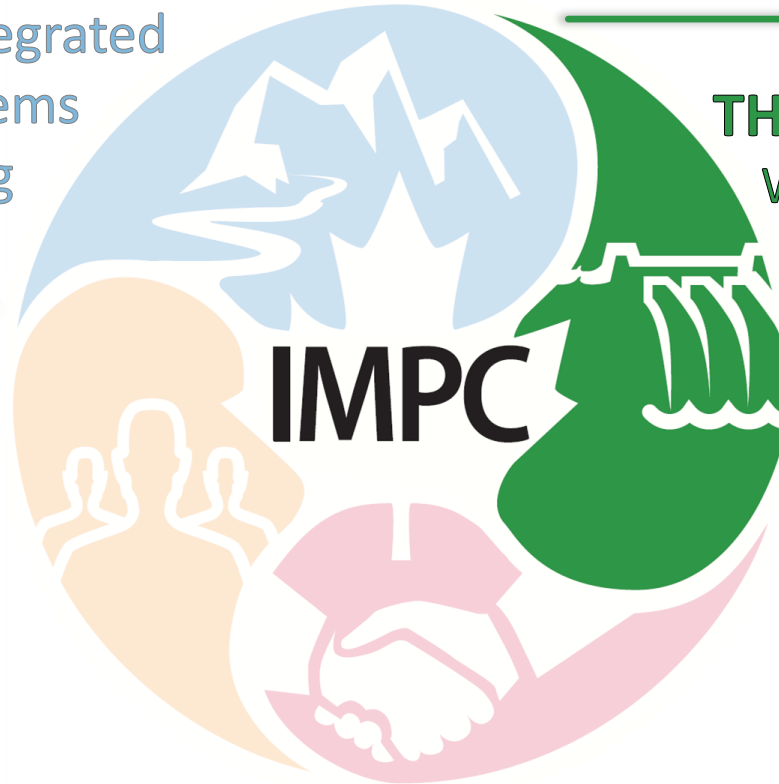


Integrated Modelling  
Program for Canada

Global Water Futures

**A1:** Atmospheric Modelling  
**A2:** Hydrologic Modelling  
**A3:** Water Quality Modelling  
**A4:** River Ice Modelling  
**A5:** Model Intercomparison  
**A6:** Floodplain Mapping  
**A7:** Uncertainty Characterization

**THEME A:**  
Integrated  
Earth Systems  
Modelling



**THEME B:**  
Water Management  
Modelling, Coupling  
Human-driven and  
Natural Systems

**B1:** Basin-wide Water  
Resource Modelling  
**B2:** Environmental Demands  
**B3:** Hydro-economic Modelling

# Research Themes



**Integrated Modelling  
Program for Canada**

Global Water Futures

**A1:** Atmospheric Modelling  
**A2:** Hydrologic Modelling  
**A3:** Water Quality Modelling  
**A4:** River Ice Modelling  
**A5:** Model Intercomparison  
**A6:** Floodplain Mapping  
**A7:** Uncertainty Characterization

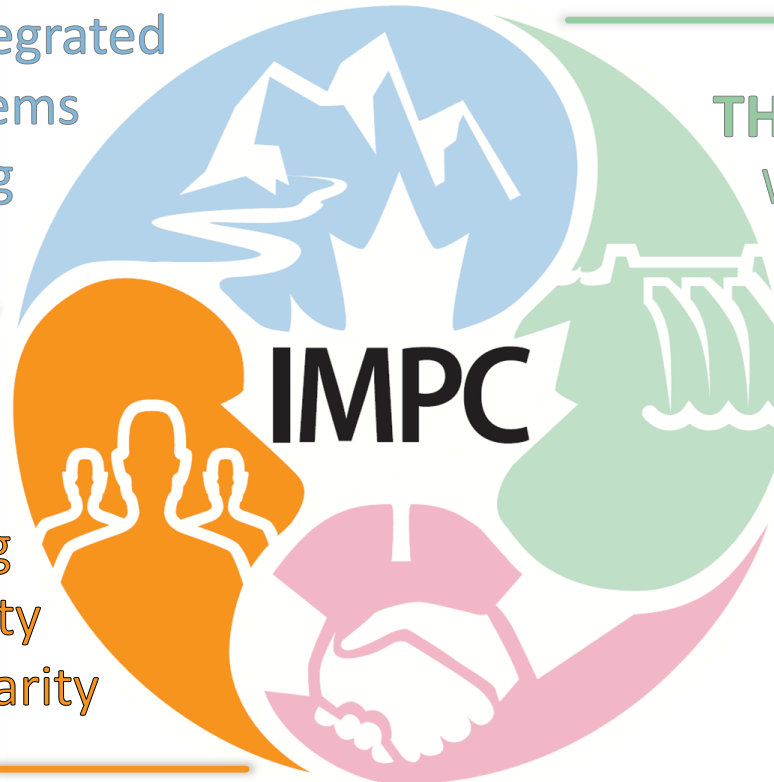
**THEME A:**  
Integrated  
Earth Systems  
Modelling

**B1:** Basin-wide Water  
Resource Modelling  
**B2:** Environmental Demands  
**B3:** Hydro-economic Modelling

**THEME B:**  
Water Management  
Modelling, Coupling  
Human-driven and  
Natural Systems

**THEME C:**  
Decision Making  
under Uncertainty  
and Non-stationarity

**C1:** Future Scenario Generation  
**C2:** Optimization and Multi-  
Criteria Decision Analysis



# Research Themes



**Integrated Modelling  
Program for Canada**  
Global Water Futures

**A1:** Atmospheric Modelling  
**A2:** Hydrologic Modelling  
**A3:** Water Quality Modelling  
**A4:** River Ice Modelling  
**A5:** Model Intercomparison  
**A6:** Floodplain Mapping  
**A7:** Uncertainty Characterization

**THEME A:**  
Integrated  
Earth Systems  
Modelling

**B1:** Basin-wide Water  
Resource Modelling  
**B2:** Environmental Demands  
**B3:** Hydro-economic Modelling

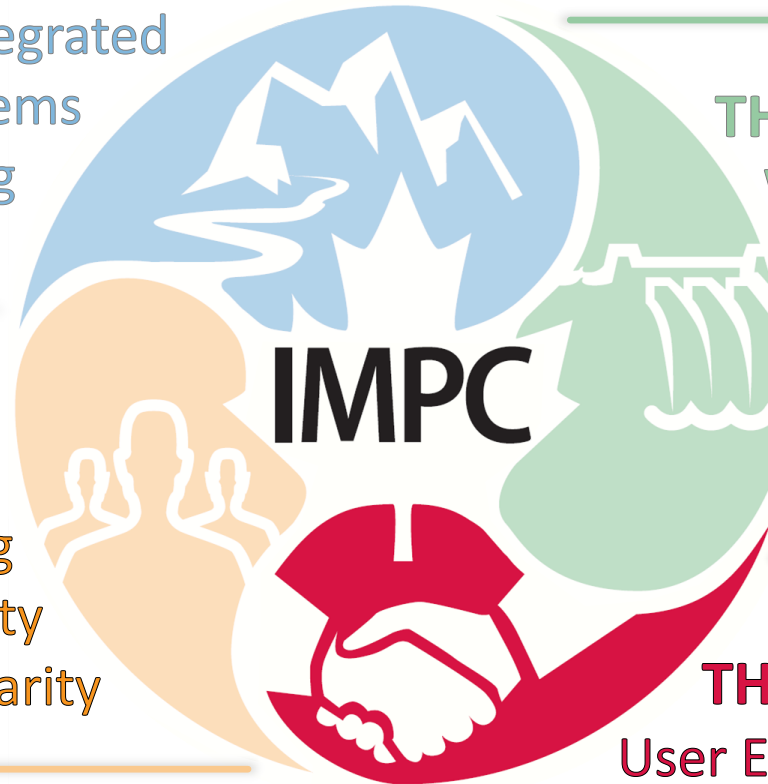
**THEME B:**  
Water Management  
Modelling, Coupling  
Human-driven and  
Natural Systems

**THEME C:**  
Decision Making  
under Uncertainty  
and Non-stationarity

**C1:** Future Scenario Generation  
**C2:** Optimization and Multi-  
Criteria Decision Analysis

**THEME D:**  
User Engagement  
and Knowledge Mobilization

**D1:** Outreach and  
User Engagement  
**D2:** Decision Support Systems



# Research Themes



**Integrated Modelling  
Program for Canada**  
Global Water Futures

**A1:** Atmospheric Modelling  
**A2:** Hydrologic Modelling  
**A3:** Water Quality Modelling  
**A4:** River Ice Modelling  
**A5:** Model Intercomparison  
**A6:** Floodplain Mapping  
**A7:** Uncertainty Characterization

**THEME A:**  
Integrated  
Earth Systems  
Modelling

**B1:** Basin-wide Water  
Resource Modelling  
**B2:** Environmental Demands  
**B3:** Hydro-economic Modelling

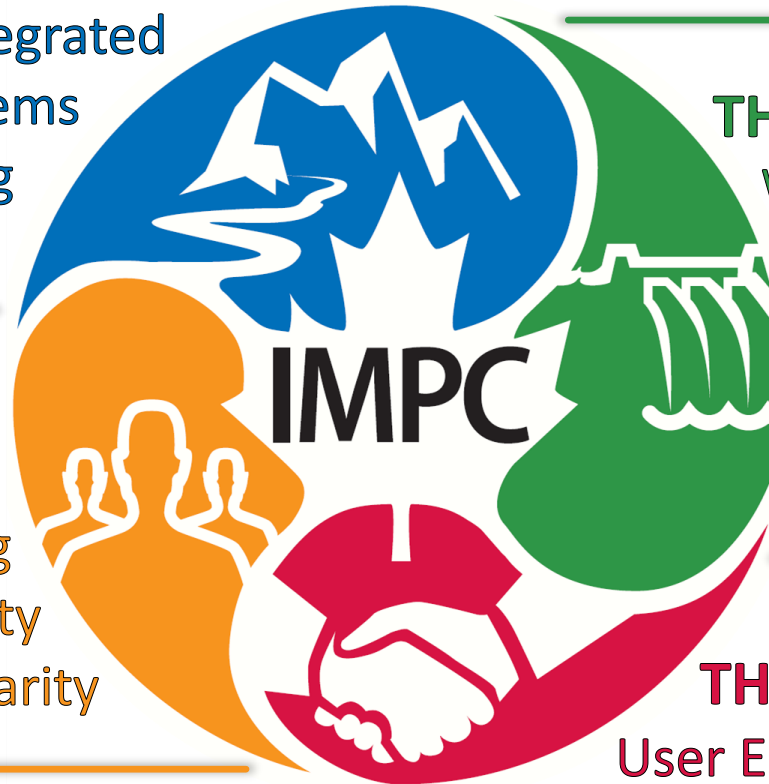
**THEME B:**  
Water Management  
Modelling, Coupling  
Human-driven and  
Natural Systems

**THEME C:**  
Decision Making  
under Uncertainty  
and Non-stationarity

**C1:** Future Scenario Generation  
**C2:** Optimization and Multi-  
Criteria Decision Analysis

**THEME D:**  
User Engagement  
and Knowledge Mobilization

**D1:** Outreach and  
User Engagement  
**D2:** Decision Support Systems



# Lead Investigators



Integrated Modelling  
Program for Canada

Global Water Futures



**Dr. Saman Razavi**  
Primary Investigator  
University of Saskatchewan



**Dr. Karl-Erich  
Lindenschmidt**  
University of Saskatchewan



**Dr. John Pomeroy**  
Canadian  
Research Chair



**Dr. Amin Elsehorgaby**  
University of  
Saskatchewan



**Dr. Patricia Gober**  
University of  
Saskatchewan



**Dr. Tricia Stadnyk**  
University of  
Manitoba



**Dr. Tim Jardine**  
University of  
Saskatchewan



**Dr. Yanping Li**  
University of  
Saskatchewan



**Dr. Al Pietroniro**  
Environment Canada



**Dr. Brian Tolson**  
University of Waterloo



**Dr. Paulin Coulibaly**  
McMaster's University



**Dr. Howard Wheeler**  
University of  
Saskatchewan



**Dr. Carl Gutwin**  
University of  
Saskatchewan



**Dr. Graham Strickert**  
University of  
Saskatchewan



**Dr. Roy Brouwer**  
University of Waterloo

# Knowledge Mobilization Oversight Committee (KMOC)



Integrated Modelling  
Program for Canada  
Global Water Futures



**Dr. Amin Haghnegahdar**  
Program Manager  
University of Saskatchewan



**Stephanie Merrill**  
Knowledge Mobilization Specialist  
University of Saskatchewan



**Hayley Carlson**  
User Engagement Specialist  
University of Saskatchewan



**Mike Renouf**  
Executive Director  
Prairie Provinces Water Board



**Bob Halliday**  
Board Chair  
Partners for the Saskatchewan River Basin



**Wayne Jenkinson**  
Senior Engineering Advisor  
International Joint Commission

# Partnership Wheel



Integrated Modelling  
Program for Canada  
Global Water Futures



## 21 Current Partners

- 3 Federal Agencies
- 4 Provincial Governments
- 5 International Organizations
- 2 Transboundary Agencies
- 2 Municipalities
- 3 Indigenous Communities
- 1 Industry
- 1 NGO

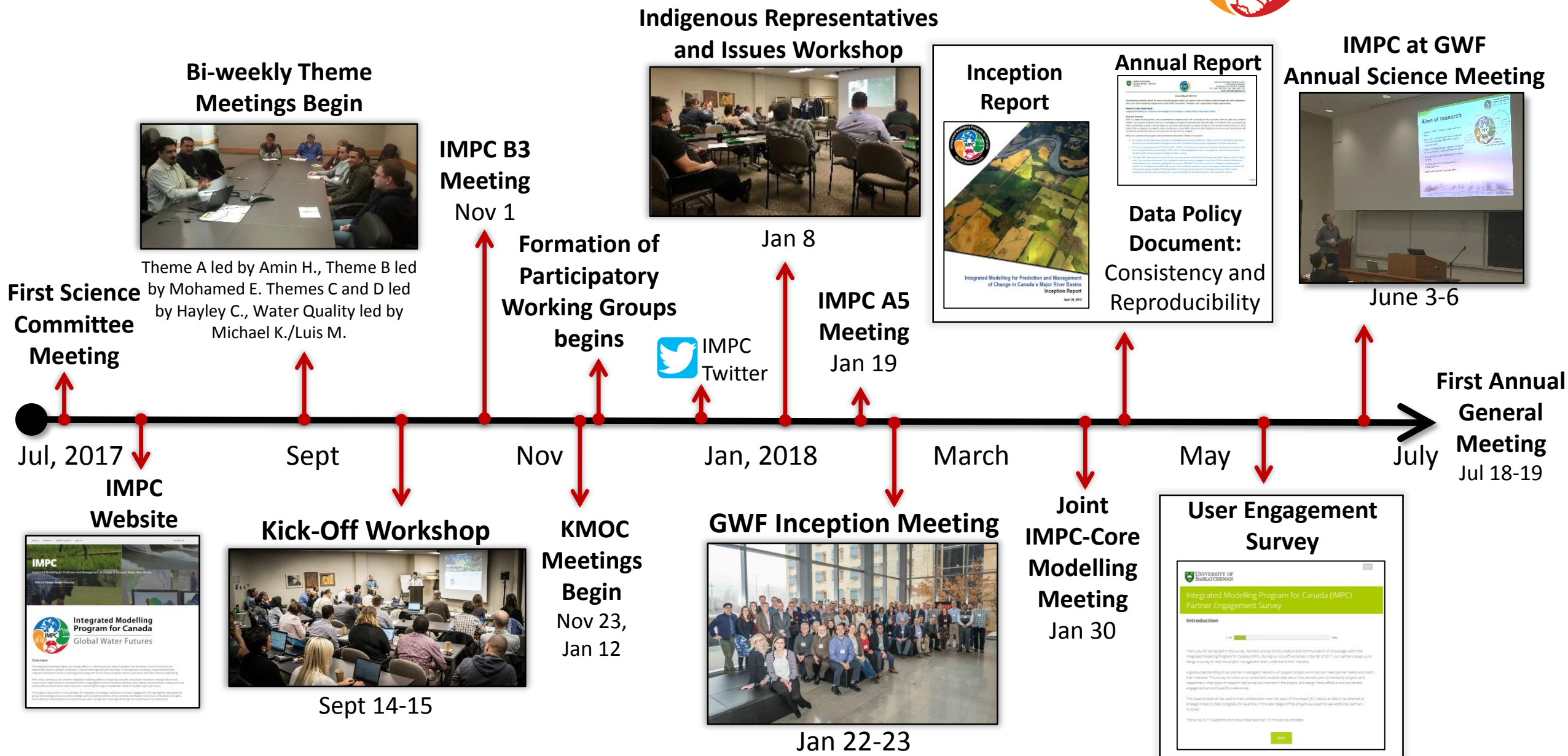
We're working with our KMOC to fill the wheel!

# Progress To Date



Integrated Modelling  
Program for Canada

Global Water Futures



# The Meeting Agenda



Integrated Modelling Program for Canada (IMPC) First Annual Meeting  
July 18-19th, 2018  
National Hydrology Research Centre  
11 Innovation Boulevard, Saskatoon, SK

## Objective:

This is the first annual IMPC meeting for the IMPC team to present, evaluate, and discuss their progress in the first year of the research program. This will be done in collaboration with the GWF core modelling team. Strategies for user-engagement and knowledge mobilization will also be discussed in this meeting. Investigators, HQPs, the GWF core modelling team, collaborators, and representatives of various local, provincial, and national stakeholders/users are all invited to attend this meeting.

Day 1: Wednesday, July 18 <sup>th</sup> , 2018		
8:00-8:30	Registration and Refreshments	
	Opening, Chair: Razavi	
8:30-8:45	Welcome, IMPC overview, meeting agenda	Razavi
8:45-9:00	Global Water Futures: Year one progress	Pomeroy
9:00-9:10	Remarks from the Strategic Advisor to GWF	Wheater
9:10-10:00	Water management challenges, scenarios and decision-support (C1) (Presentation and Interactive Session)	Gober
10:00-10:20	Coffee Break	
	Themes B-D, Chair: Stadnyk	
10:20-10:35	Water resources modelling (B1)	Razavi
10:35-10:50	Water resources modelling - Manitoba (Nelson-Churchill)	Asadzadeh
10:50-11:05	Hydro-economic modelling (B3)	Brouwer
11:05-11:20	Cultural and environmental flows, and user engagement (D1)	Strickert
11:20-11:35	Advanced visualization tools (D2)	Gutwin
11:35-12:00	Discussion	Stadnyk (Moderator)
12:00-13:00	Lunch Break	
	Management & Knowledge Mobilization, Chair: Brouwer	
13:00-13:15	Project management	Haghnegahdar
13:15-13:30	User engagement and knowledge mobilization	Carlson
13:30-13:40	Report from knowledge mobilization committee (KMOC)	Renouf/Halliday
13:40-13:45	Café discussion table explanation and break-out	Carlson and Haghnegahdar
13:45-15:40	Café discussions for Theme B-D (see instructions on page 4.)	All
15:40-16:10	Coffee Break	
16:10-16:40	Report back from Café tables – Starting from Table 1	Table Leaders
16:40-	Closing Remarks, Day 1	Razavi
17:30	Dinner @ Luis'	



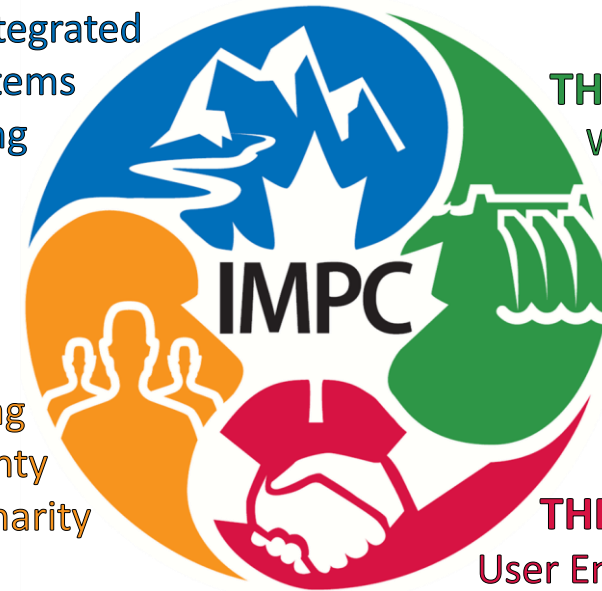
Pietroniro, Pomeroy
Clark
Pietroniro
Li
Pomeroy
Lindenschmidt
Pomeroy (moderator)
Tolson
Stadnyk
Vionnet
Princz/Pietroniro
Gharari/Razavi
Elshorbagy
Razavi
Pietroniro (moderator)
HQPs
Fahlman, Luo, Gupta, Pietroniro, Elshorbagy
Wheater (moderator)
Razavi

**THEME A:**  
Integrated  
Earth Systems  
Modelling

**THEME B:**  
Water Management  
Modelling, Coupling  
Human-driven and  
Natural Systems

**THEME C:**  
Decision Making  
under Uncertainty  
and Non-stationarity

**THEME D:**  
User Engagement  
and Knowledge Mobilization



## Agenda Highlights:

- A bottom-up approach
- Interactive components
  - Café Discussions
  - Discussion Panel
- Science speed-dating (HQP)





Integrated Modelling  
Program for Canada  
Global Water Futures

# Exciting Two Days Ahead!



# THEME A: Integrated Earth Systems Modelling

## A1: Atmospheric Modelling

High resolution atmospheric modelling to represent scenarios of change and land-atmosphere feedbacks

## A2: Hydrologic Modelling

Improving hydrologic process representations for cold regions to better simulate snow and glacier and accommodate hyper-resolution modelling

## A3: Water Quality Modelling

Integrating land-surface and in-stream water quality processes into hydrologic modelling

## A4: River Ice Modelling

Integrating river ice processes into hydrological modelling for operation and flood forecasting

## A5: Model Intercomparison

Hydrologic model inter-comparison and multi-model analysis for improved prediction

## A6: Floodplain Mapping

Improving floodplain mapping in flood sensitive areas

## A7: Characterization and Communication of uncertainty



# THEME B: Water Management Modelling and Coupling Human-driven and Natural Systems

## B1: Basin-Wide Water Resources Modelling

Developing a water resources model to simulate different operational policies of existing and future water infrastructure

## B2: Environmental Demands

Developing a performance model for aquatic ecosystems based on hydro-ecologic metrics and environmental demands

## B3: Hydro-economic Modelling

Developing an integrated hydro-economic model to assess the direct and indirect impacts of policy decisions based on socio-economic water valuation studies



# THEME C: Decision Making under Uncertainty and Non-stationarity

## C1: Future scenario generation

Future scenario generation for river-basin scale changes in climate, land surface, and water resources

## C2: Optimization and Multi-Criteria Decision Analysis

Optimization and multi-criteria decision analysis to optimize policy and decision scenarios and evaluate trade-offs between different competing objectives



# THEME D: User Engagement, Knowledge Mobilization, and Decision Support Systems

## D1: Outreach and user engagement

Outreach and user engagement to inform model development and output design, inclusion of user community representative on modelling team, and iterative, two-way sharing of information between scientists and users

## D2: Decision support systems

Developing decision support systems with advanced visualization tools and expert systems built on research in Themes A-C and linked to the programme data inventories



# IMPC Kick-off Workshop

September 14-15th, 2017 National Hydrology Research Centre, Saskatoon



Integrated Modelling  
Program for Canada  
Global Water Futures

The aim of the workshop was to plan for large-scale modelling activities for forecasting, prediction, and water resources management and decision support over the next three years, until August 2020.

More than 70 people from academic, regulatory, and industrial sectors attended the workshop in-person or online to present and discuss their objectives, plans, and perspectives for IMPC. These included:

- Environment and Climate Change Canada,
- Agriculture and Agri-Food Canada,
- Prairie Provinces Water Board,
- Saskatchewan Water Security Agency,
- Alberta Environment and Parks,
- City of Calgary,
- Manitoba Infrastructure and Transportation,
- Manitoba Hydro,
- Yukon Department of Environment, and
- EPCOR Water.

