



# The MSC's Collaborative Monitoring Initiative & Risk Based Approach to Hydrometric Network Design

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Prairie Provinces Water Board Workshop

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Network Design & National Partnership Development

Meteorological Service of Canada

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# Outline

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- Collaborative Monitoring Initiative
- Hydrometric Network Design – Risk Based Approach

# Collaborative Monitoring Initiative

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- Vision/Overview
- Memorandum of Understanding
- National Governance

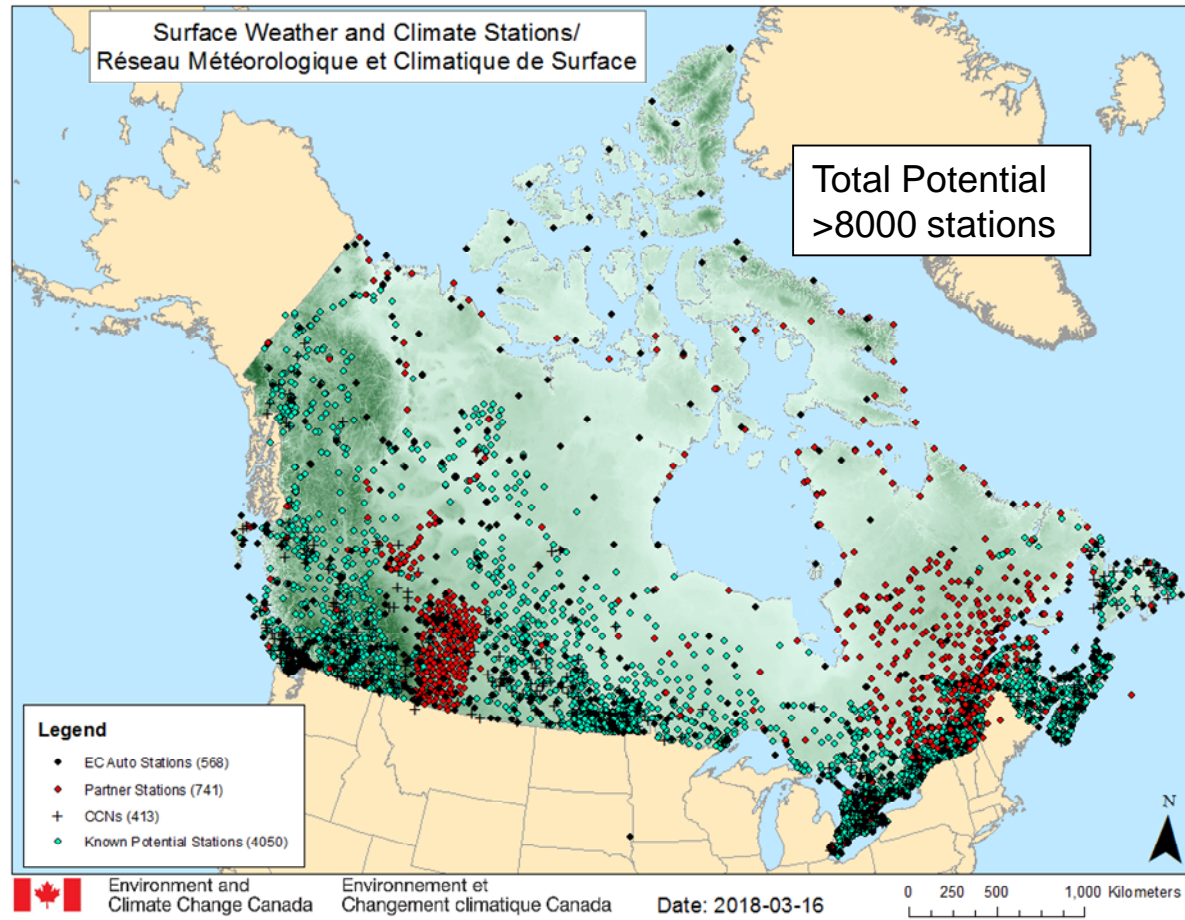
# Vision for ECCCC/MSC Collaborative Monitoring

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Over the next 5-10 years ECCCC will respond to the federal government priority of strengthening our national capacity to:

*Monitor weather, water and climate change through increased collaboration with Provinces and Territories, Federal Departments as well as other network operators/data owners (e.g. Academia, Regional/Municipal Governments, Private Sector)*

# An initial inventory of stations indicates a high potential...



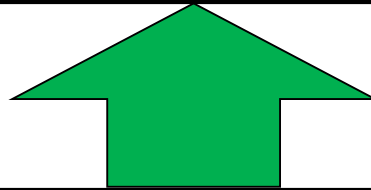
...to significantly improve the accessibility of surface weather and climate data through collaboration

# Collaborative Monitoring Initiative has evolved...



## **Potential for Integrated Network Planning & Joint Operations: *More Potential to Realize Vision***

- Potential optimization of collective monitoring investments
  - Reduce redundancies, improve coverage (i.e. address gaps), etc.
- Potential operational collaboration
  - Infrastructure, Instrumentation, Maintenance, Data-Management, QA, etc.



## **Initial focus on Data Exchange (Network of Networks)**

- Enhance the access, quality and interoperability of hydro-meteorological data in Canada for the benefits of all users
  - Free & Open Data Exchange
  - Data of Known Quality (metadata)
  - Proper Data Attribution
  - Voluntary Participation (best-effort)
  - Respect for IP rights

# Planning and working together will benefit Canadians...



## Supporting Government Priorities & Policy Activities

*Improved access to weather/climate data and products will support...*

- Inter-jurisdiction responsibilities associated with public safety
  - Emergency management operations
  - Public health alerting
  - Food security (i.e. agriculture)
  - Wildfire management & operations
- Improved evidenced based decision-making
  - Climate Change planning, adaptation, research
  - Water management (including flood & drought prediction)
  - Environmental assessments
  - Sustainable economic development

## Operational Benefits

- More effective monitoring networks
  - Ability to identify monitoring gaps, and redundancies
  - Identify opportunities for cost-sharing and facilitate operations in the north (e.g. land access, real estate)
- Win-win for partners. More rapid advancements in use of innovation and technologies
  - Leveraging ECCC/MSC high performance computer and modeling capacity to create real-time data products (weather and water data layers), integrating additional data sources (earth observations from satellites)
  - Co-development of Network Management tools (Qa)
  - Assessment and installation of new field technologies

...and will help support making the case for re-investment in weather and climate networks stronger

# Collaborative Monitoring **Memorandums of Understanding** are designed to be flexible...

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Revised MoU focuses on collaboration rather than solely data exchange:

- Generic core focuses on broader collaboration between ADMs
- Annexes designed to cover details, signed at the Director or DG levels:
  - Terms of Reference for a National Governance body
  - Letter of Collaboration
  - **Collaboration on Data Exchange**
  - **Collaboration on Integrated Network planning:**
    - Monitoring redundancies;
    - Monitoring gaps;
    - Tailored Needs Index for P/Ts.
  - Joint Network Operations Agreement:
    - Stations of interest;
    - Cost-sharing principles;
    - Etc.

...to accommodate various partnership models under one agreement while maintaining consistency



# 2017/2018: Collaborative Monitoring Initial approach was focused on data sharing...

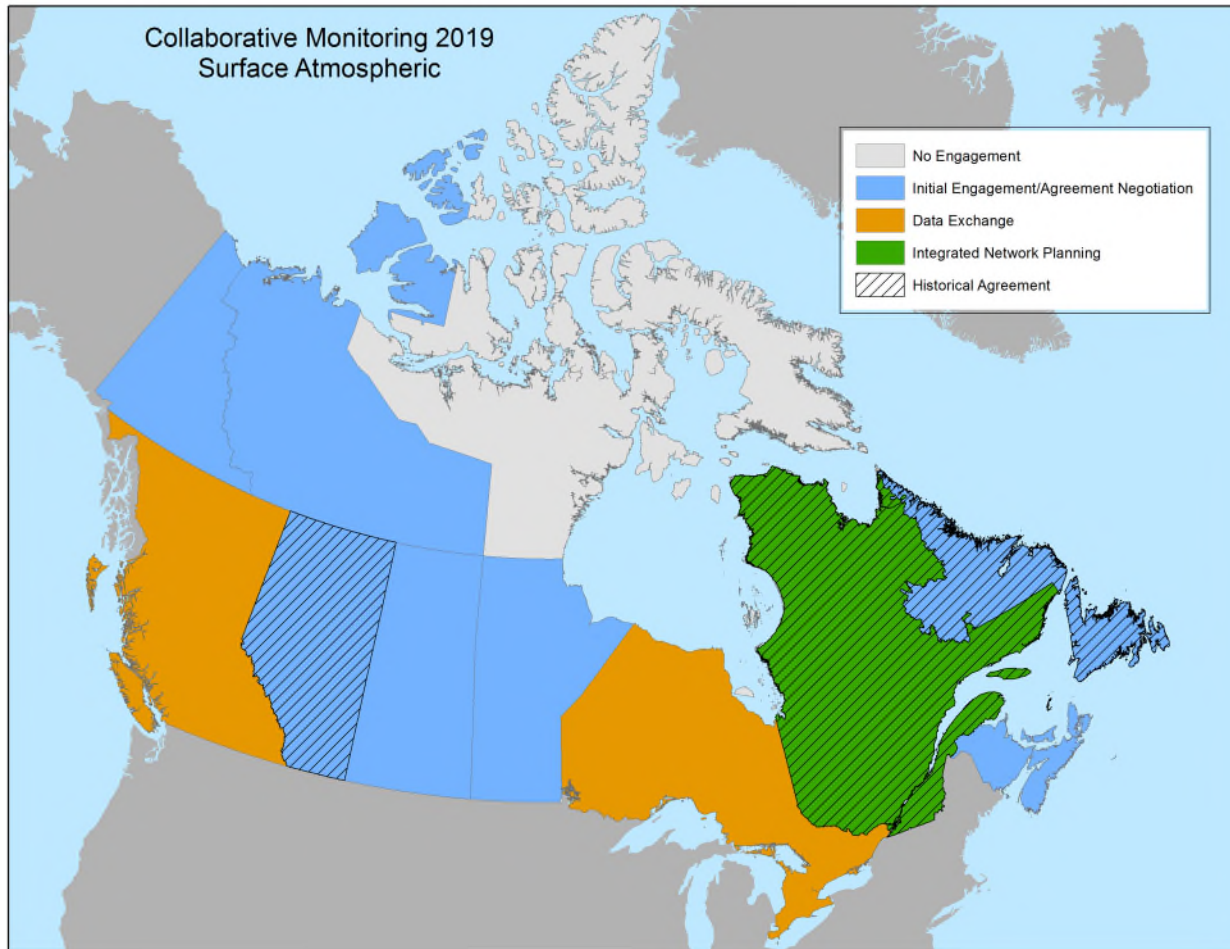
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...with a few pilots that took time to review and finalize

# Today: Collaborative Monitoring MoU now adjusted to be more generalized...

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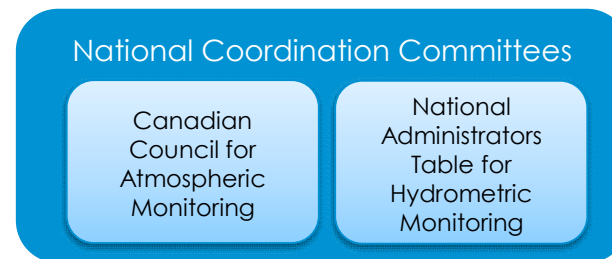


...to facilitate initial signature and buy-on at the executive level

# Collaborative Monitoring governance proposes national integration...

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- National committee to focus on **atmospheric** monitoring that will complement the NAT for Hydrometric
  - **Canadian Council for Atmospheric Monitoring**
- Improve communication amongst stakeholders, share standards and best practices, and explore potential cross-regional collaborations
- Have **representative(s) from each Province & Territory** participating on this committee to:
  - Discuss/compare weather & climate monitoring data and services requirements
  - Share, review and discuss monitoring transformation plans/progress
  - Provide updates on key projects, innovation and challenges
  - Discuss opportunities to improve collaboration (data collection, data management, dissemination, etc.)



...first meeting held Oct. 25<sup>th</sup>, first F2F meeting planned for early 2020...trying to align with NAT to identify potential common interests



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# INTEGRATION OF INFORMATION THEORY IN RISK-BASED NETWORK DESIGN



Canada 

# Risk

“ECCC has not located its monitoring stations based on an assessment of risks to water quality and quantity. As a result, it may not be focusing its monitoring efforts on the activities and substances that pose the greatest risk.” [1]

[1] Report to the Commissioner of the Environment and Sustainable Development to the House of Commons. Chapter 2 – Monitoring Water Resources. Fall, 2010. Office of the Auditor General of Canada.

**Interpretation:** risk is a result of NOT having adequate hydrometric information, where it is needed, to fulfill responsibilities.

**Application:**  $R = C \times L$

$R = \{ \textit{consequence} \text{ of not having enough information} \}$

x

$\{ \textit{likelihood} \text{ of not having enough information} \}$

# FRAMEWORK FOR WATER MONITORING RISK

## (HYDROMETRIC RISK)

- Likelihood

- Likelihood the network fails to characterize the hydrology of Canada at a location
- Due to uncertainty/lack of data at the location

- Consequence

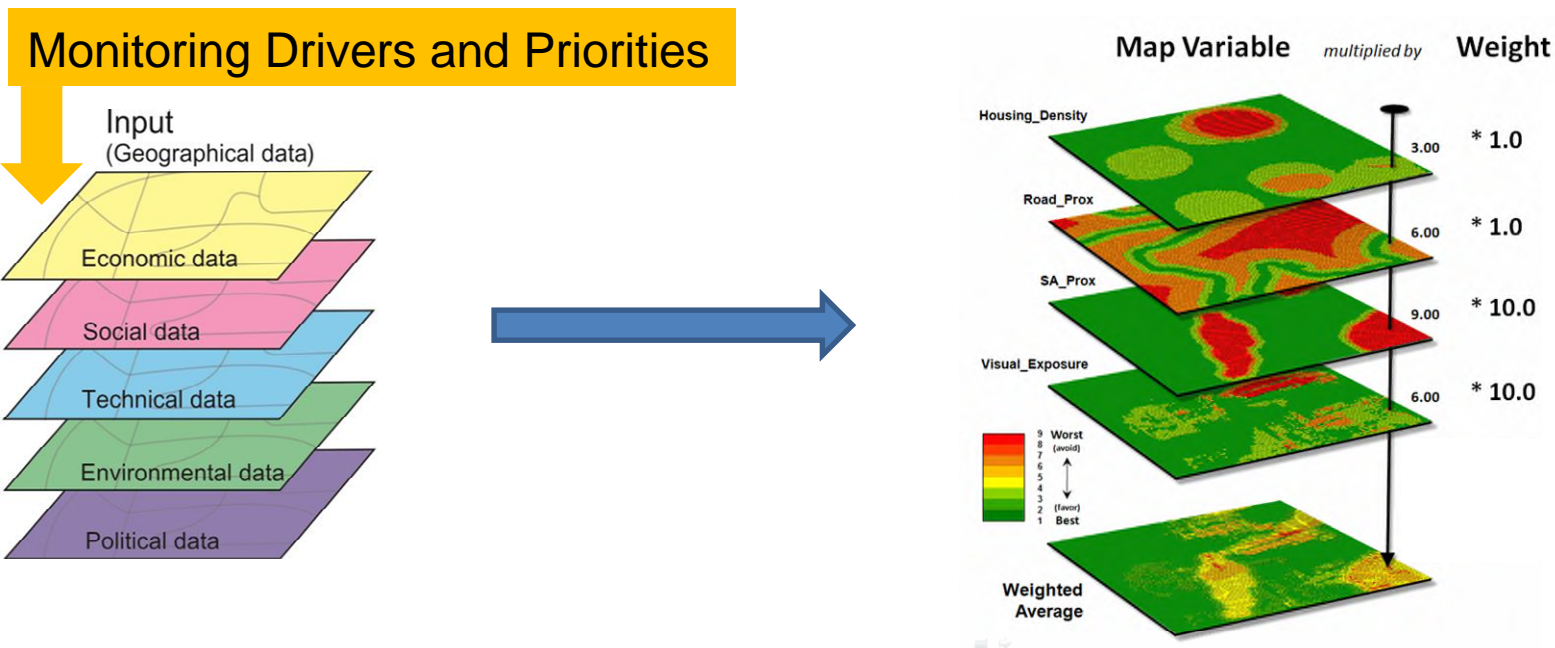
- Consequence of making water resource decisions with inadequate data for a location

RISK SPACE		Likelihood of having Uncertain Data		
		Unlikely	Somewhat Likely	Very Likely
Consequence of Uncertain Data	Mild	Well-gauged basin with nil developments		
	Moderate		Species at risk in glacial basin with short record	
	Severe			Remote community with depending on river for transport

# Consequences of Uncertain Data

Monitoring Drivers and Priorities → “The Needs Index”

- Adaptable geospatial multi-criteria analysis
- Proxy data sets are used to represent monitoring drivers and the consequences of having uncertain data

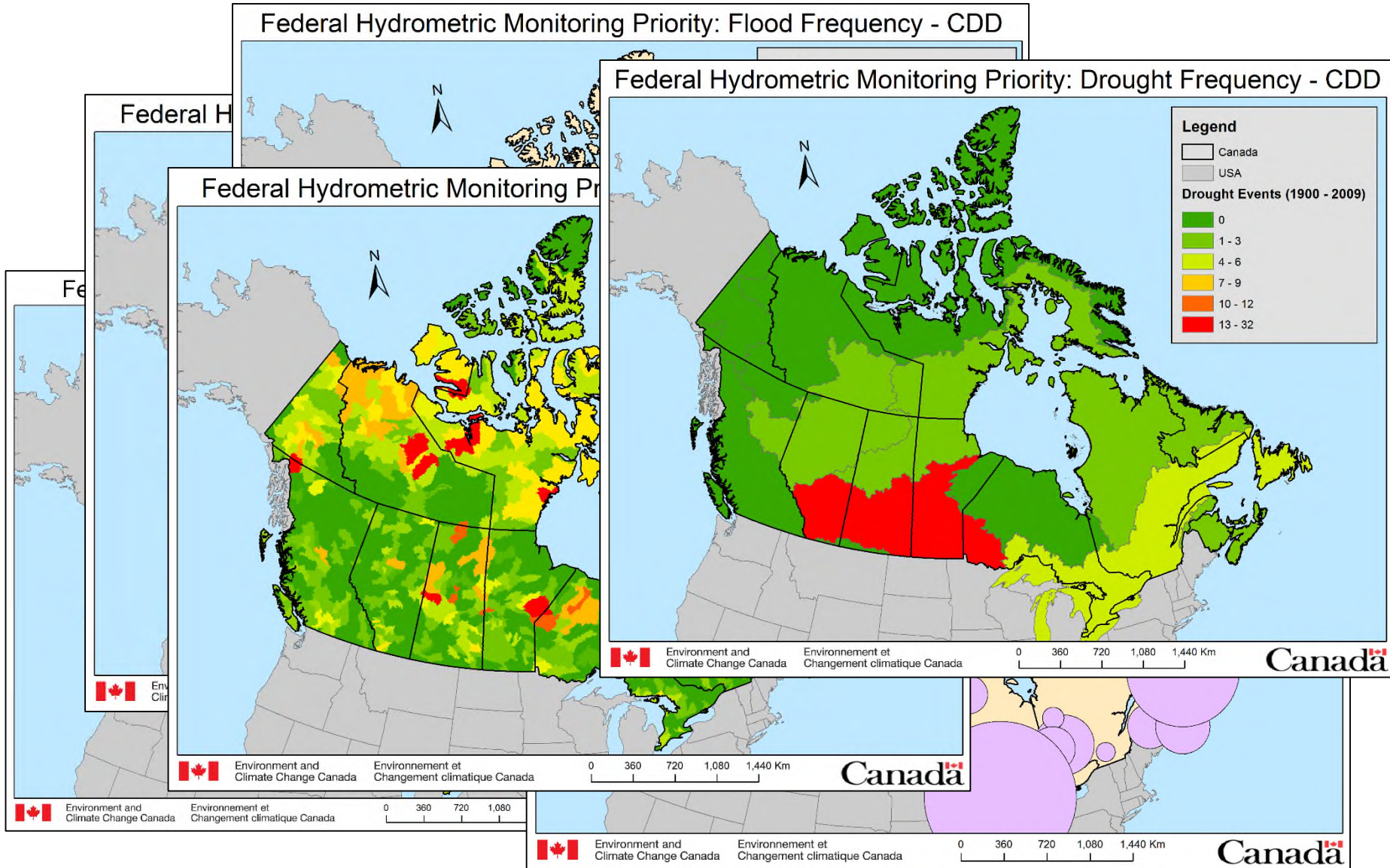


# STATION USE CATEGORIES

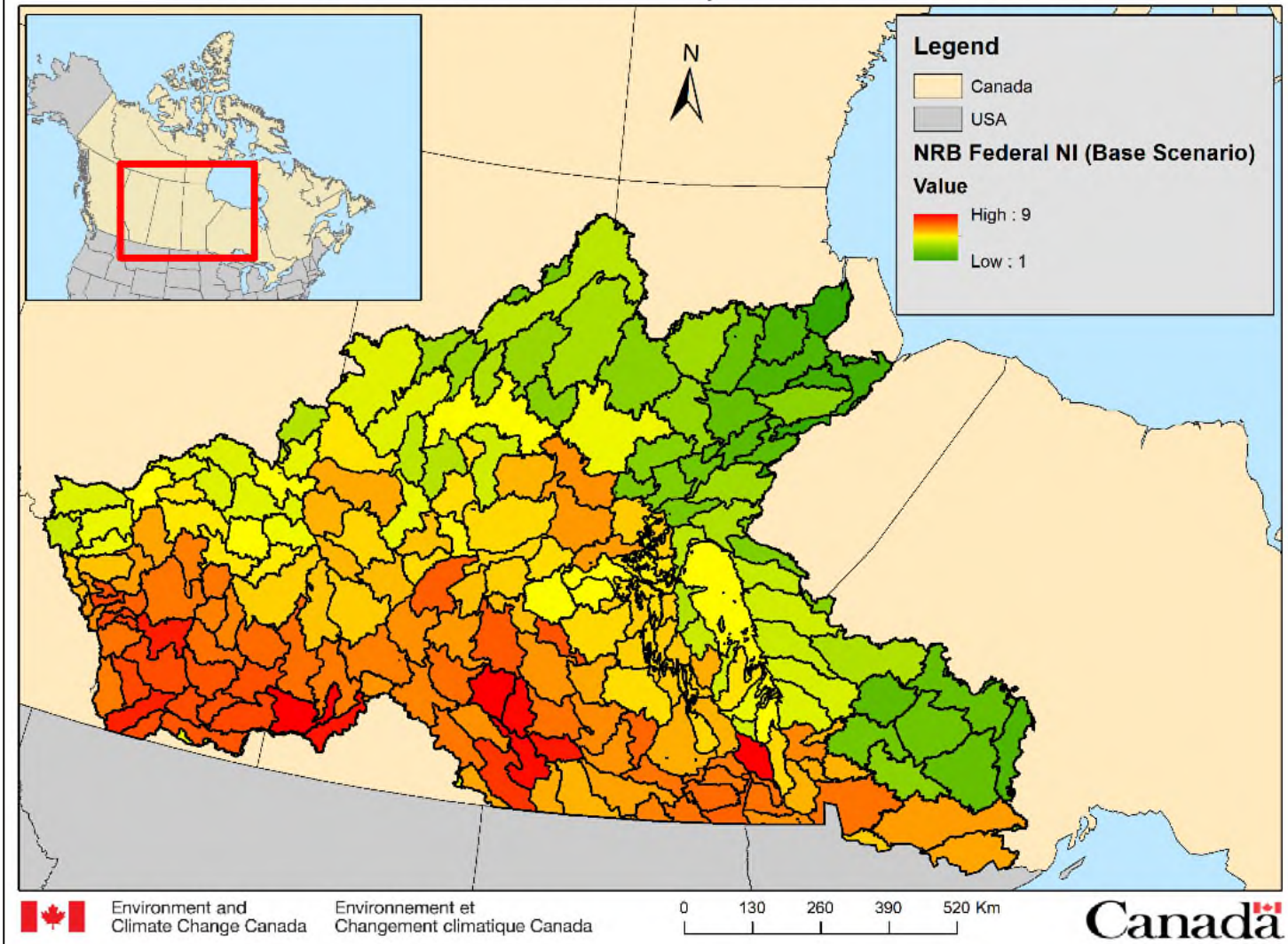
1. Baseline monitoring
  2. Science
  3. Environmental flows
  4. Public safety
  - 5. Water control structure operation**
  - 6. Inter-jurisdictional transfers**
  - 7. Transportation and infrastructure operation**
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# Data Layers for the Hydro Needs Index



# Nelson River Basin Federal Hydrometric Needs Index



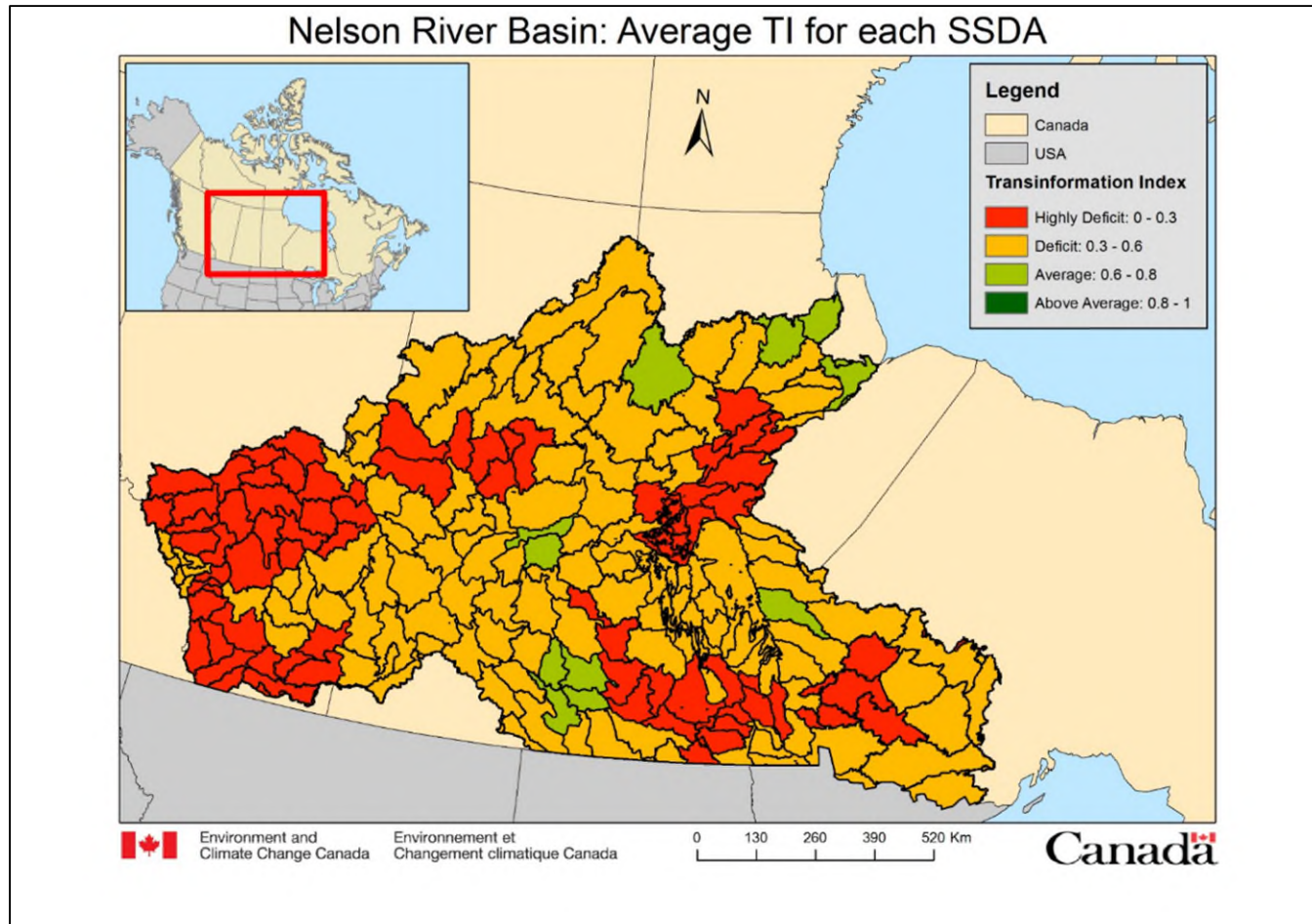
*Magnitude of consequences of uncertain data*

# Likelihood

*(of inadequate hydrologic data)*

- Entropy-based methods provide an estimate of hydrological knowledge transfer (Coulibaly et al.)
  - evaluate the information transfer from node-to-node within a watershed network
- Transinformation (TI) = index of hydrological knowledge transfer
  - “High” TI = high knowledge transfer = good characterization
  - “Low” TI = low knowledge transfer = poor characterization
- We can use TI to assess the likelihood that our networks characterize the hydrology of Canada

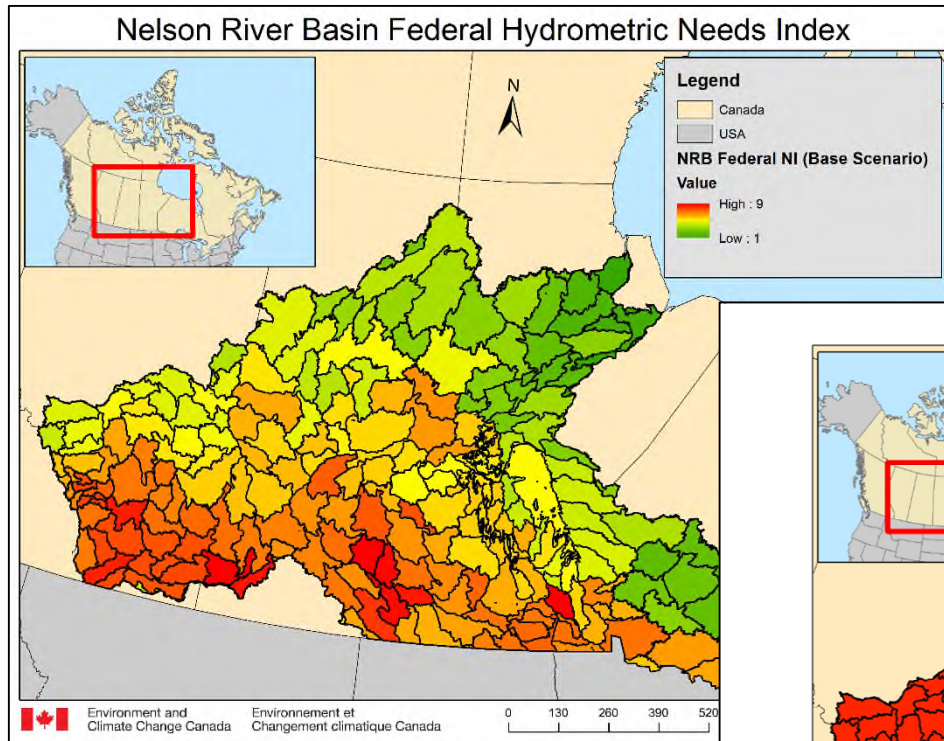
# Trans-information Map



Coulibaly et al. 2019

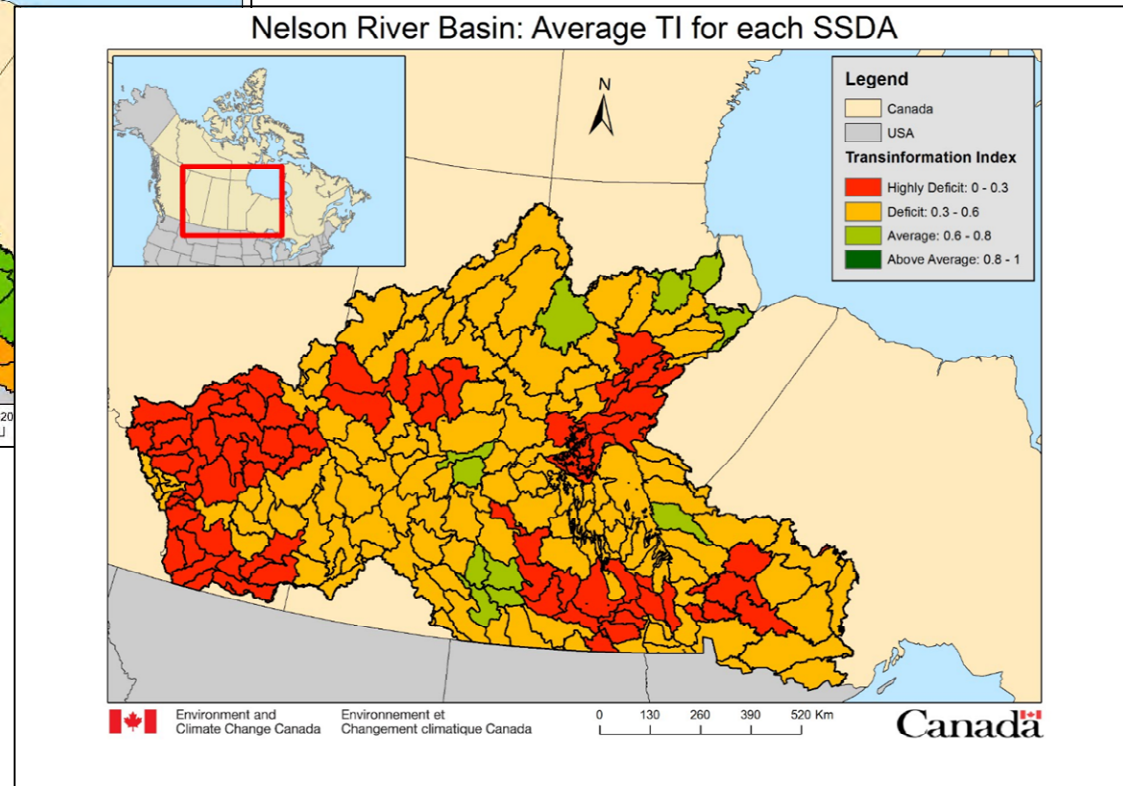
*Likelihood of uncertain data*

# Monitoring Risk: $C \times L$



Needs Index:

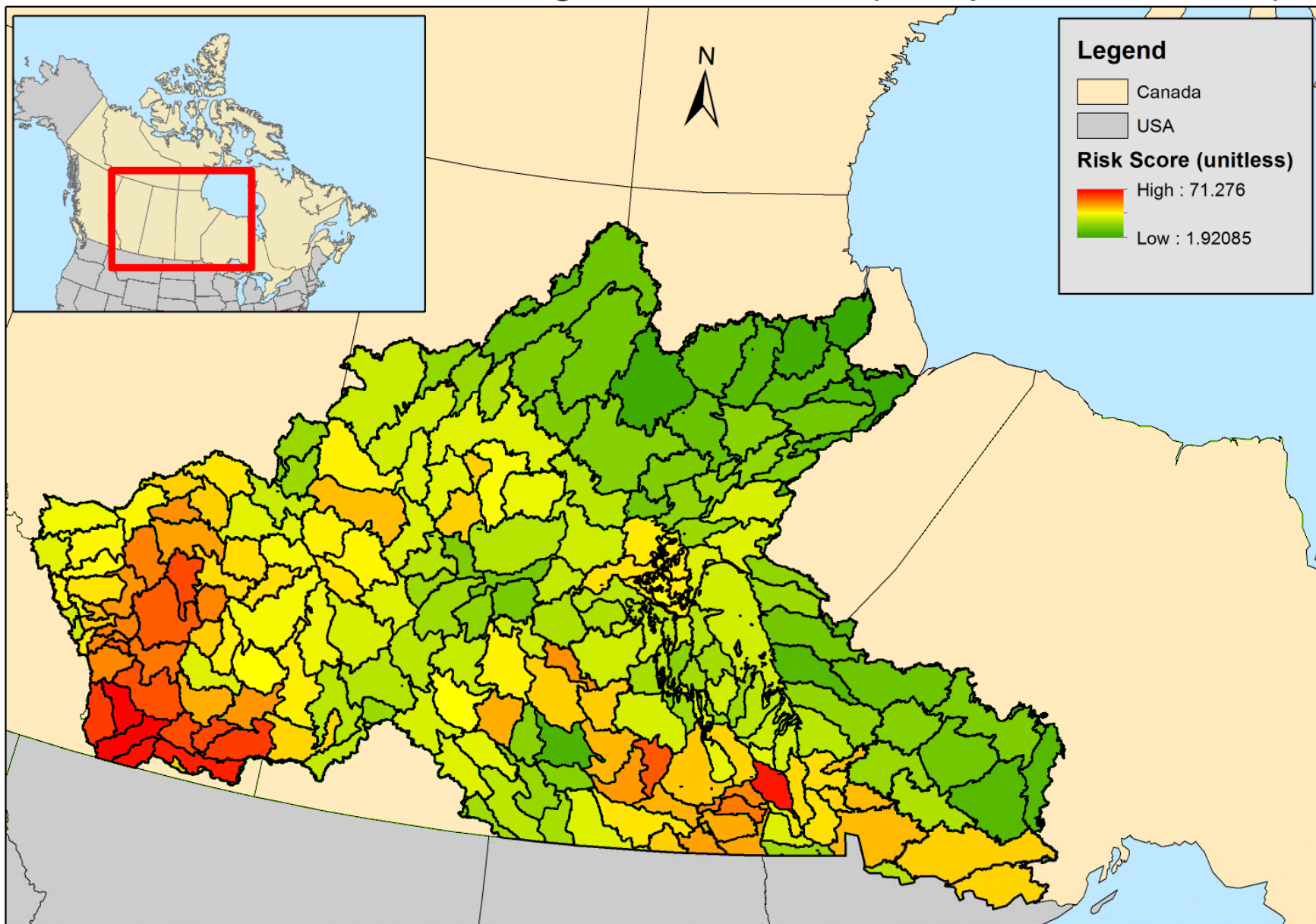
→ Spatial gradient of consequences



Trans-information:

→ Spatial gradient of unique info

# Nelson River Basin: Average TI x Base NI (Interpolated Version)



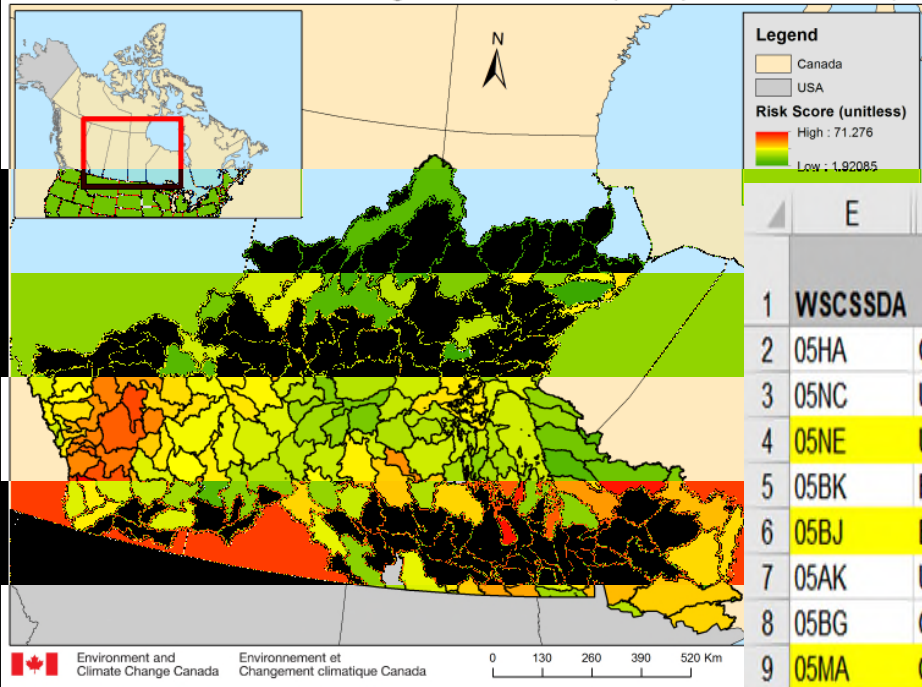
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0 130 260 390 520 Km

Canada

## Nelson River Basin: Average TI x Base NI (Interpolated Version)



	E	H	M	N	O
	WCSSDA		Needs Index of SSDA	TI x NI	EnDemo Score (%)
1	WCSSDA	WCSSDA_EN			
2	05HA	Crane Lake - Non-contributing	8.47	76.20	1.31
3	05NC	Upper Moose Mountain	8.26	74.38	4.30
4	05NE	Upper Pipestone	8.11	72.98	61.81
5	05BK	Fish (Alta.)	7.52	67.66	1.29
6	05BJ	Elbow	7.49	67.37	44.86
7	05AK	Upper South Saskatchewan - Lower	7.31	65.82	3.73
8	05BG	Ghost	7.27	65.39	0.00
9	05MA	Quill Lakes - Non-contributing	7.25	65.28	27.22
10	05AD	Central Oldman - Belly	7.98	64.77	14.29
11	05OJ	Lower Red	8.52	64.62	49.59
12	05AF	Pakowki Lake - Non-contributing	7.30	64.41	0.36
13	05AB	Central Oldman - Willow	7.48	63.73	3.85
14	05OF	Morris	7.01	63.12	41.30
15	05AE	St. Mary	7.41	62.56	28.81
16	05JH	Last Mountain	6.91	62.19	33.52
17	05OE	Rat and Tourond	6.90	62.07	36.25
18	05OH	Seine	6.86	61.77	0.00
19	05PD	Lake of the Woods	6.85	61.68	13.70

### Benefits:

- social/economic considerations
- Information theory considerations
- Risk-based approach
- **Flexible**
- **Guide for further investigation**

### Limitations:

- capacity

# Thank-you!

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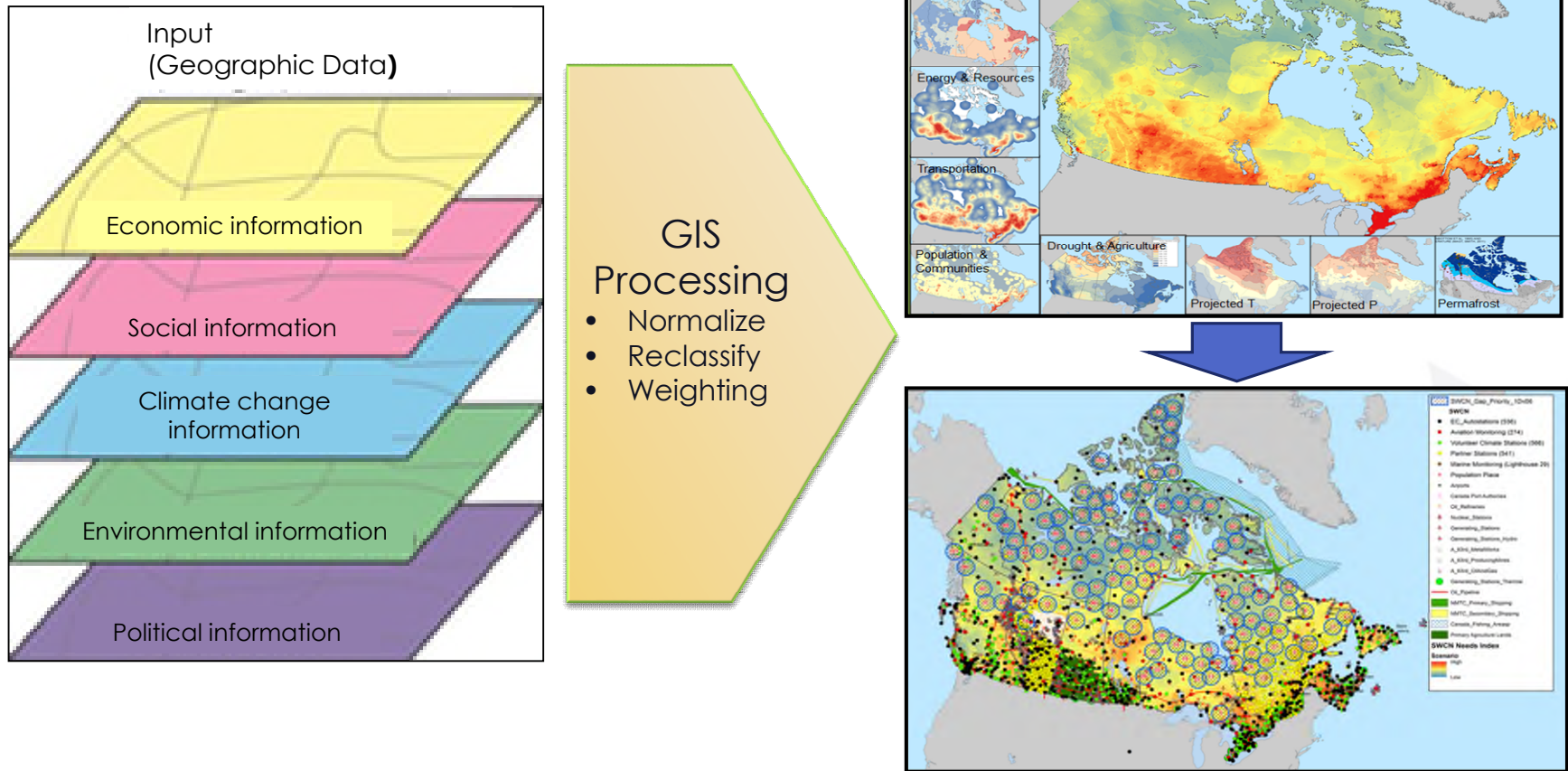
Dave Hutchinson and Jeanette Fooks (ECCC – NHS)



Questions?

# Annex Slides

# Network planning tool integrates scientific and socio-economic monitoring drivers to prioritize data gaps...



...to optimize networks in an agreed upon, participatory process

# Monitoring & Data Services Coordination

## Potential Governance - Monitoring Coordination Committee

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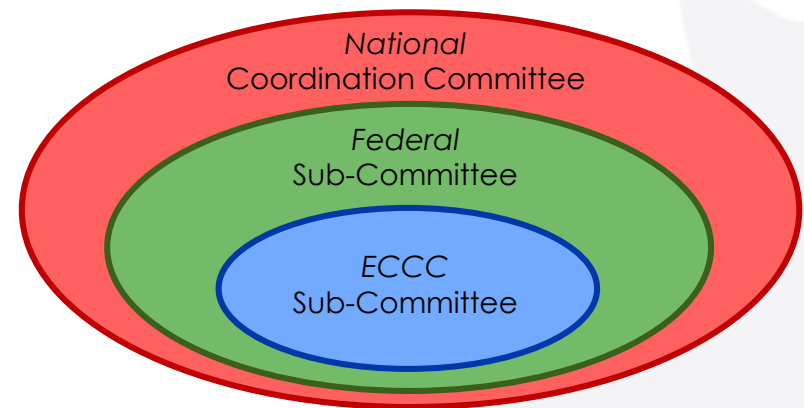
### Overview:

The intent is to put in place monitoring coordination committees at all 3 levels of government to:

- Leverage the investments of all Canadian institutions involved in, and dependent on, weather, water & climate monitoring, to provide an effective, efficient, sustainable, national framework for monitoring.
- Optimize the delivery of weather, water & and climate data and information across Canada in support of regional, provincial, territorial and national service delivery, policy development and emergency management preparedness and response.

Committees discussions and activities will focus on 4 key themes (and linkages between):

1. Requirements & Dependencies
2. Partnership and Collaboration
3. Standards & Best Practices
4. Network Evolution



# Collaborative Monitoring ECCC Data Flow Diagram

