# Overview of Flood Forecasting Procedures Developed in the FloodNet Strategic Network

Donald Burn, University of Waterloo

Paulin Coulibaly, McMaster University

OUTLINE

❑ FloodNet overview

❑ Survey of Flood Forecasting Centres

❑ Overview of CAFFEWS (Canadian Adaptive Flood Forecasting and Early Warning System)

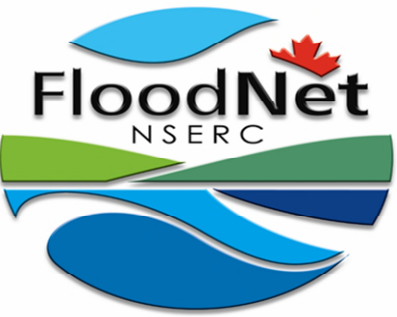 ❑ Preliminary test results

❑ Evaluation of forecasting system

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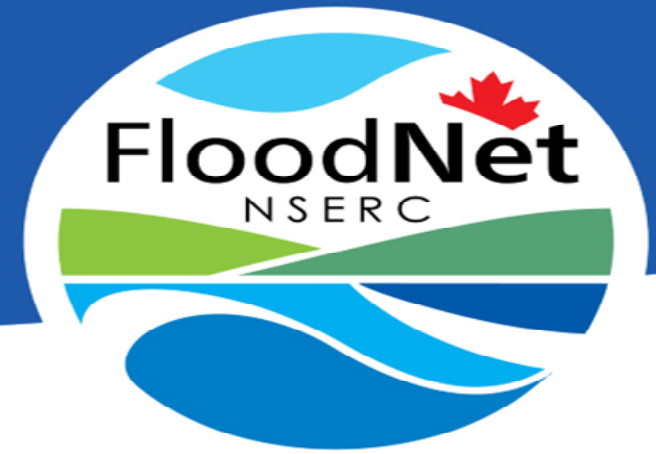
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A vehicle for a
concerted nation-wide effort to enhance
flood forecasting and management capacity
in Canada

Funded in June 2014
Operational in January 2015
Term: 2014-2020

FloodNet Multidisciplinary Team
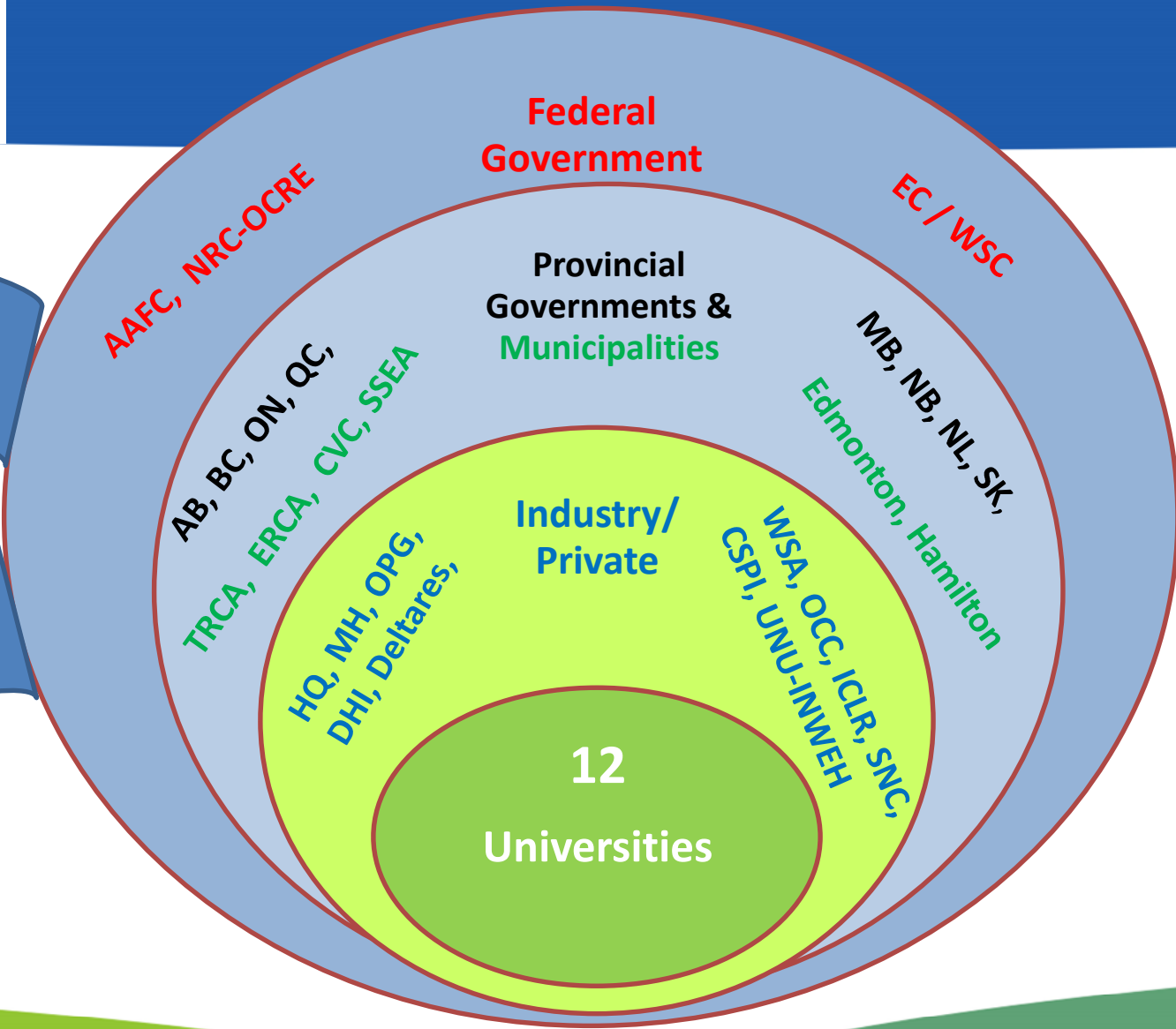
25 academic investigators
> 30 scientists/engineers

Diverse Expertise

Hydrologists
Climatologists
Meteorologists
Biologists
Statisticians
Environmental scientists
Social scientists
Engineers
Managers

38 partners public/private

89 HQP

Federal Government

AAFC, NRC-OCRE

EC / WSC

Provincial Governments & Municipalities

AB, BC, ON, QC, TRCA, ERCA, CVC, SSEA

MB, NB, NL, SK, Edmonton, Hamilton

Industry/ Private

HQ, MH, OPG, DHI, Deltares,

WSA, OCC, ICLR, SNC, CSPI, UNU-INWEH

12 Universities

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FloodNet Objectives

❑ **Advance Knowledge on Flood Regimes (Past and Future) and Provide Guidelines for Infrastructure Design**

❑ **Advance Knowledge on Flood Forecasting Systems and Enhance Flood Forecasting in Canada**

❑ **Assess Impacts of Floods on People, Society, and Environment**

FloodNet Survey of Hydrologic Forecast Centres (2016-2017)

Objective

Review flood forecasting systems currently implemented by Canadian Provinces, identify limitations/challenges to inform development of adequate solutions
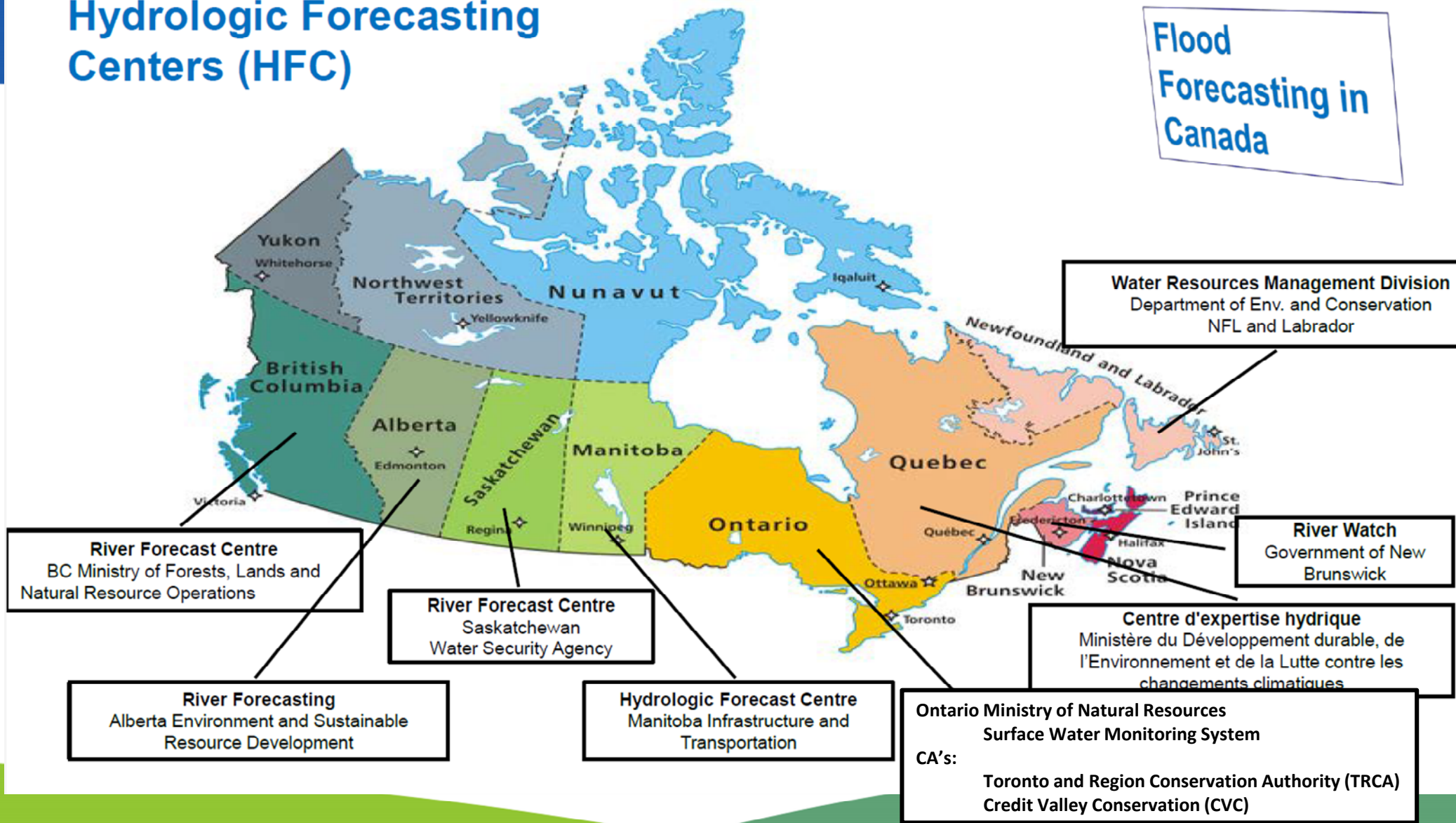
Survey Focus Points

– **Methods** (hydrologic models, data processing tools,…)

– **Data and sources** (collection, storage, management)

– **Challenges** (physical, techniques, data, gaps…)

– **Communication** (internal/external)

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FloodNet Partners

Hydrologic Forecasting Centers (HFC)

Flood Forecasting in Canada

Water Resources Management Division
Department of Env. and Conservation
NFL and Labrador

River Forecast Centre
BC Ministry of Forests, Lands and
Natural Resource Operations

River Watch
Government of New
Brunswick

River Forecast Centre
Saskatchewan
Water Security Agency

River Forecasting
Alberta Environment and Sustainable
Resource Development

Hydrologic Forecast Centre
Manitoba Infrastructure and
Transportation

Centre d'expertise hydrique
Ministère du Développement durable, de
l'Environnement et de la Lutte contre les
changements climatiques

Ontario Ministry of Natural Resources
         Surface Water Monitoring System
CA's:
         Toronto and Region Conservation Authority (TRCA)
         Credit Valley Conservation (CVC)

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Identified Needs of HFC - General

- Access to more accurate precipitation/snowfall estimation and forecasts

- Up-to-date soil moisture products for use in forecasting

- Improved modelling tools; Modelling of more watersheds

- Tools and approaches for ensemble forecasting

- Support tools to more effectively communicate results of forecasts, risk, and uncertainty

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Identified Needs of HFC – General...

- Tools that would make it easier to develop, implement and run continuous models

- Data management systems

- More seamless integration of the steps involved in the production of forecasts

- Better online reporting tools

- "Standards of Practice" in the flood forecast community

- More staff

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Summary of Key Challenges Reported

- DATA

  - Uncertainty in the weather (precipitation) forecasts

  - Availability, access and cost of data

  - Determining antecedent soil moisture

  - Estimating snow-water equivalent

  - Unknown accuracy of streamflow forecast at upstream locations in neighbouring Provinces or US states

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Summary of Key Challenges Reported

- **Hydrologic and hydraulic modelling**
  - Selection of the appropriate modelling system
  - Consideration of regulated flow in hydrologic modelling
  - Need an automated and integrated real-time forecast system
  - Hydrology of the Prairie region, characterized by a high percentage of non-contributing areas due to potholes
  - Presence of urban and rural areas in the same watershed

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Summary of Key Challenges Reported

- **Effective communication between different FFCs**

- **Staffing**
  - Limited number in some of the FFCs
  - Losing hydrologic modelling/forecasting knowledge due to frequent staffs transfer

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OBJECTIVES OF CAFFEWS

1. Adapt to different regions of Canada
   - ➢ Hydrologic model selection & multi-model configuration

2. Enhanced flood forecasting
   - ➢ Data assimilation

3. Forecast uncertainty estimation
   - ➢ Bayesian forecasting system
   - ➢ Ensemble forecasting

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CAFFEWS: Canadian Adaptive Flood Forecasting and Early Warning System
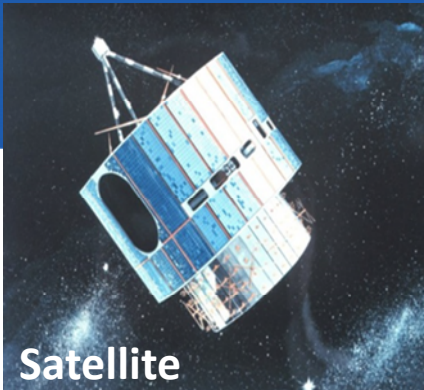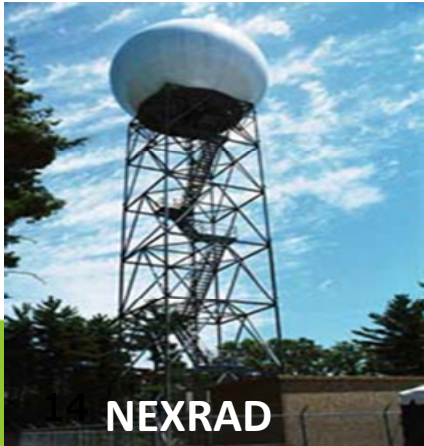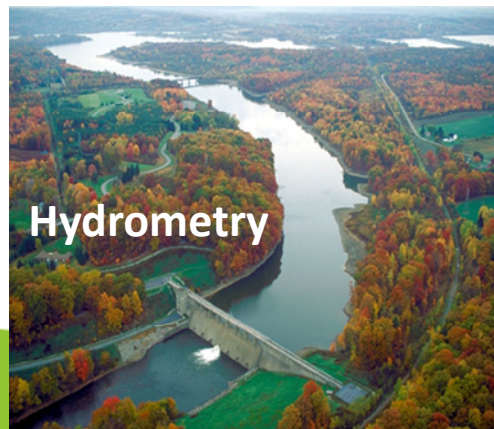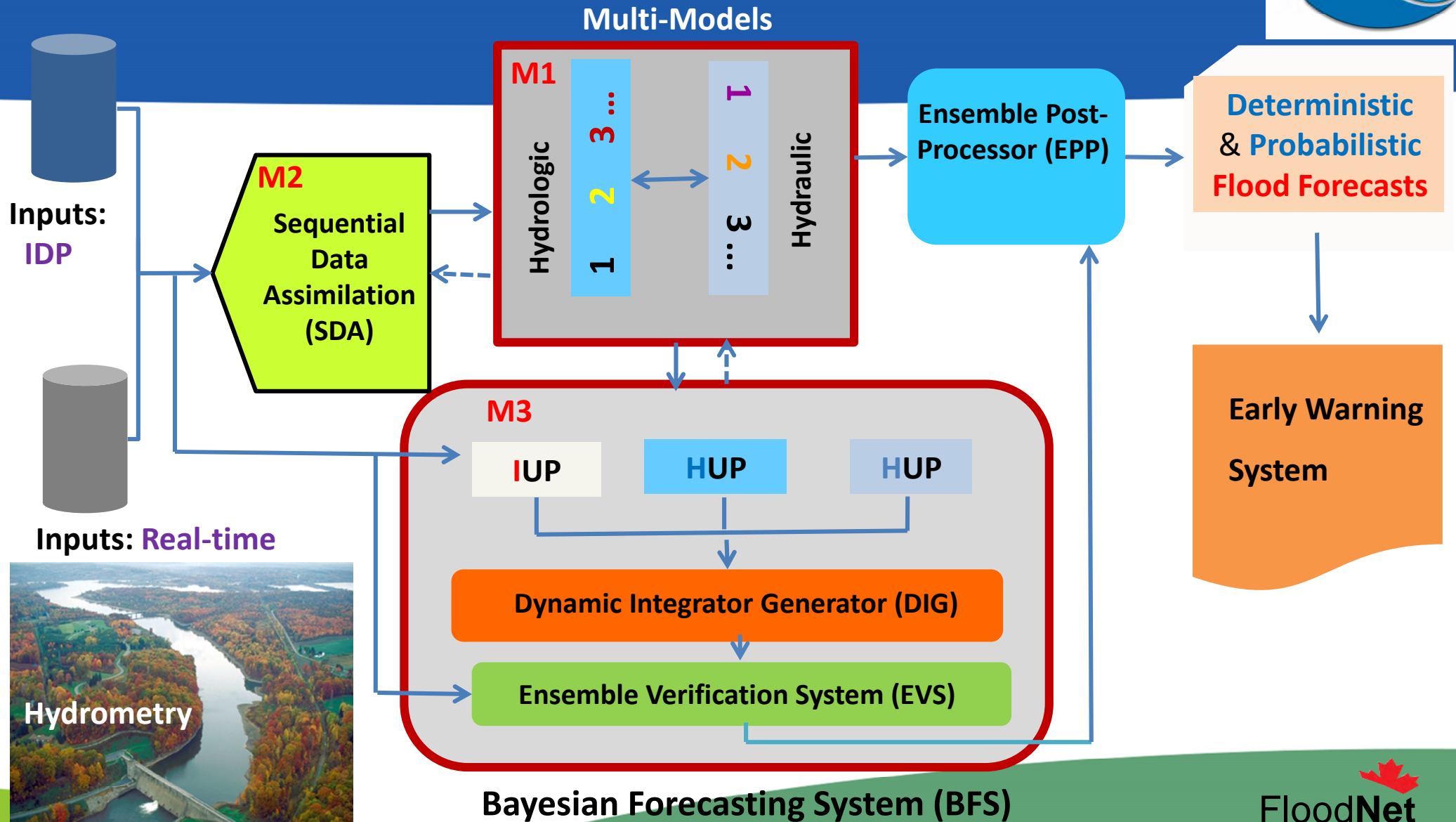
CAFFEWS Development

- Model identification and adaptation for selected watersheds
- Integration of DA and BFS
- Configure forecast/hindcast simulation and warning system
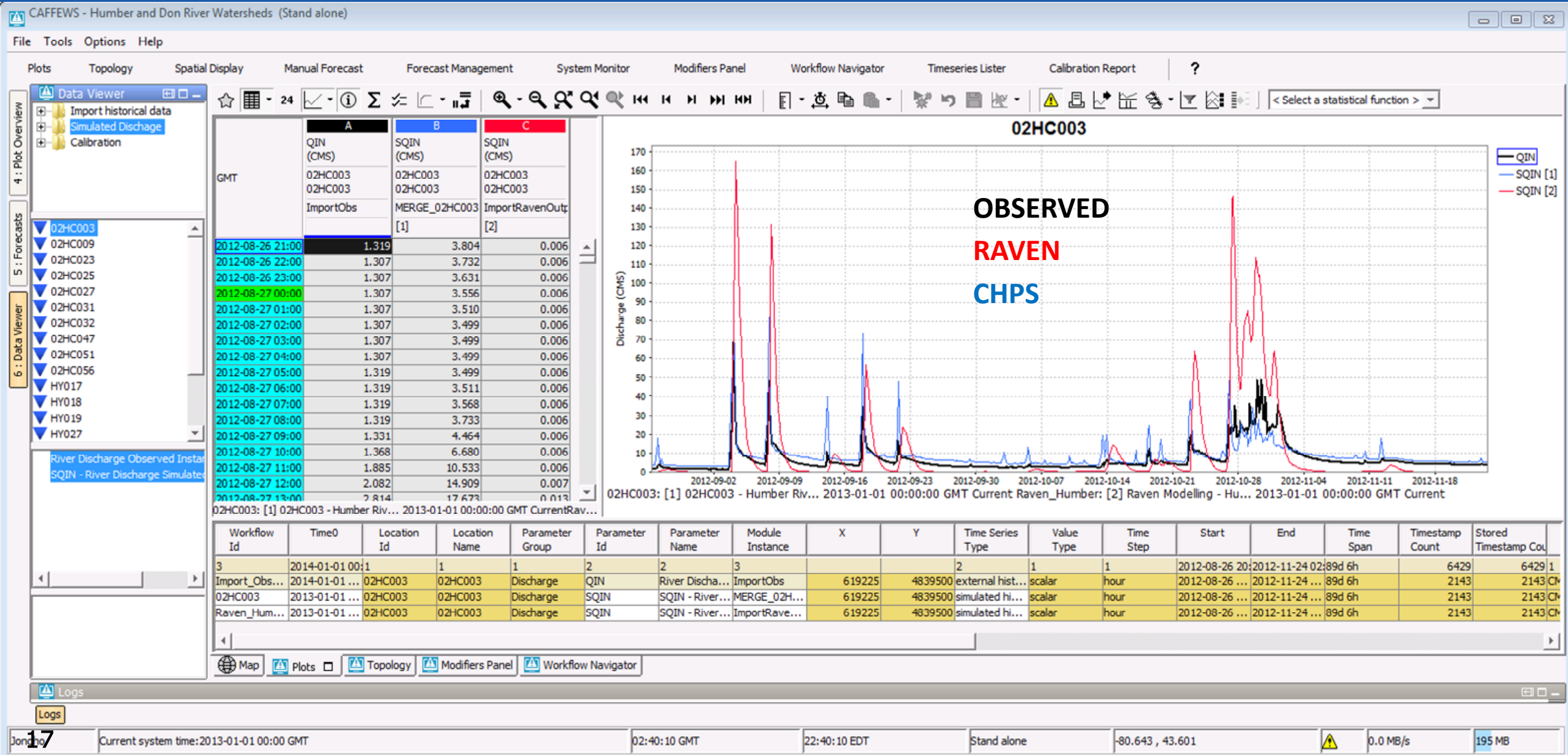
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Test Basins/Study Areas

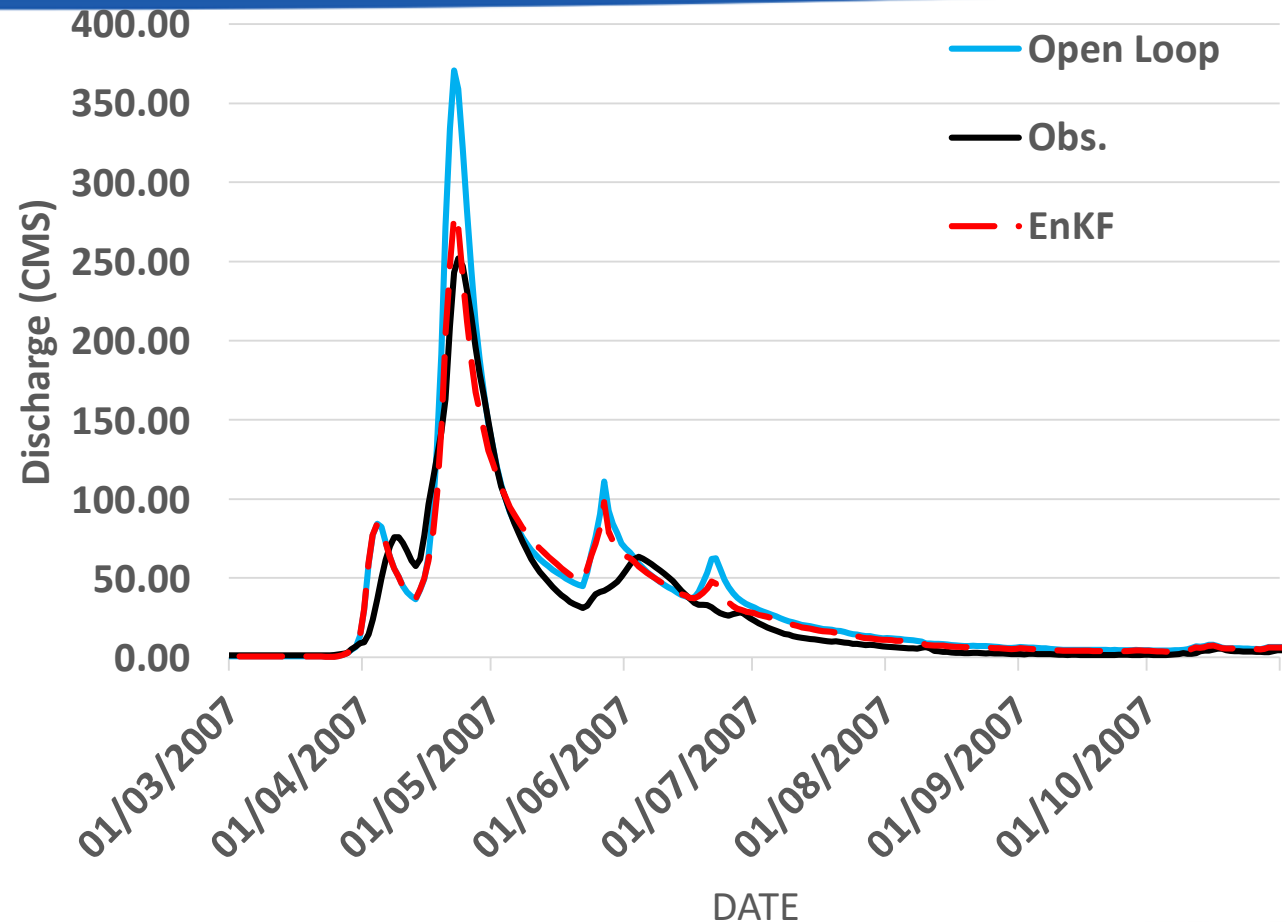Upper Assiniboine River at Shellmouth, Manitoba
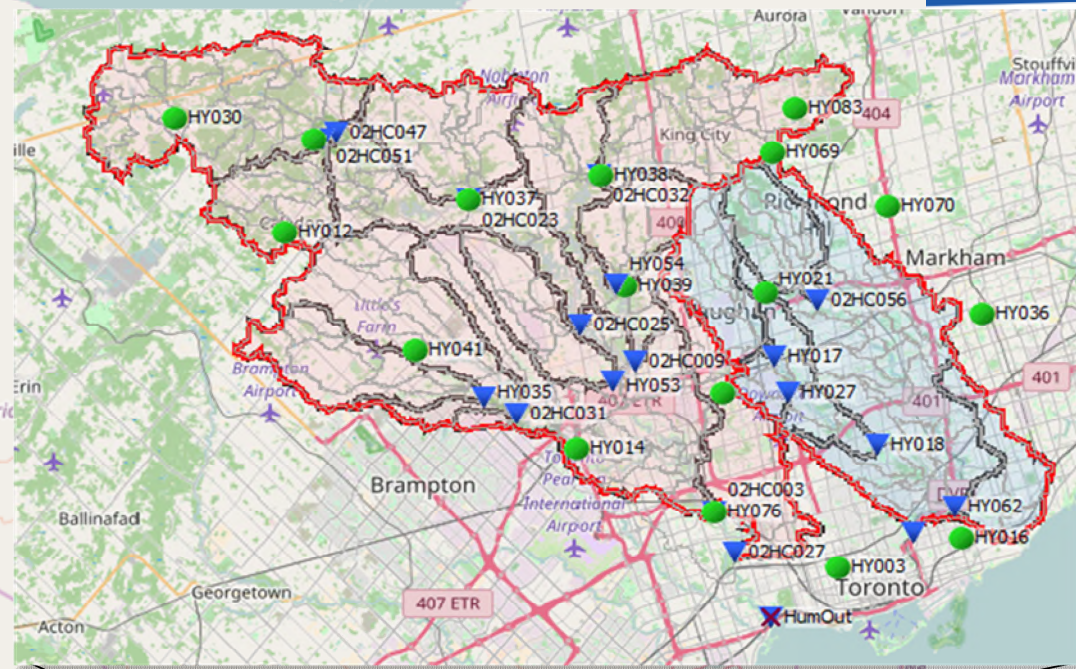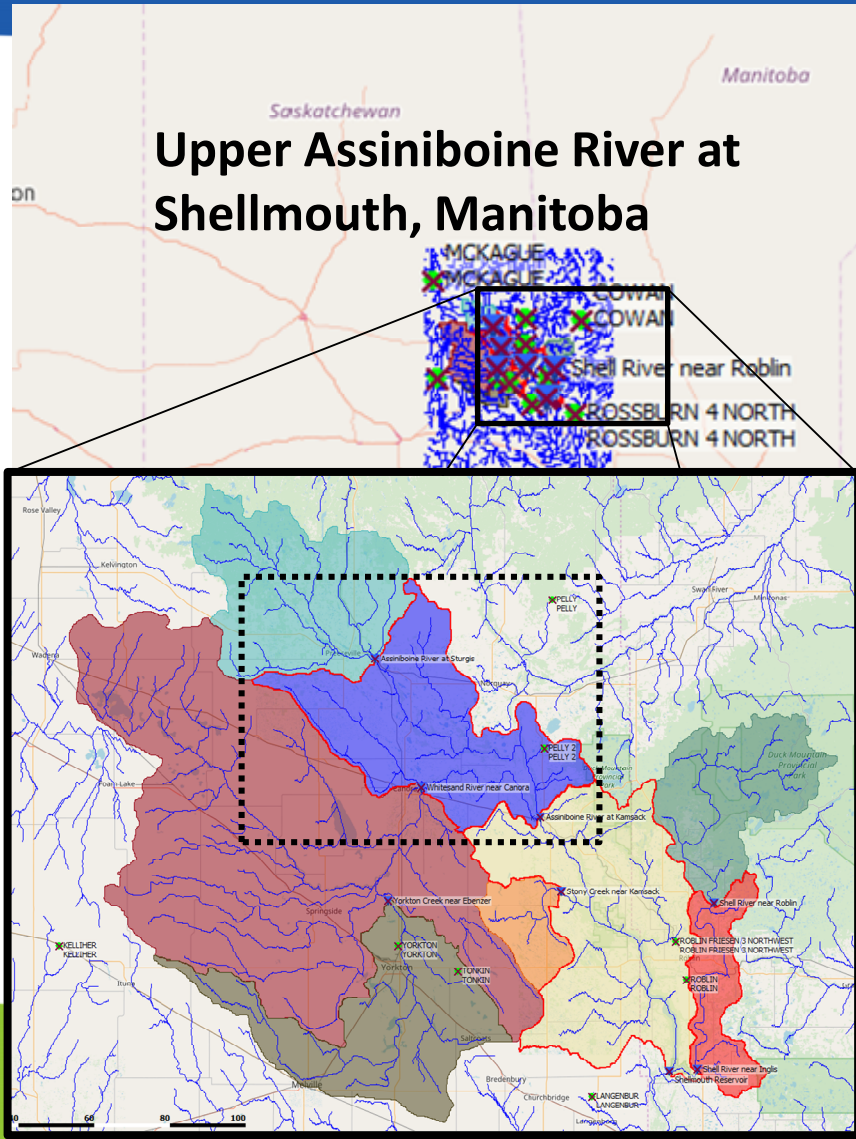
Don & Humber, Ontario

CAFFEWS Results @ Humber River Outlet
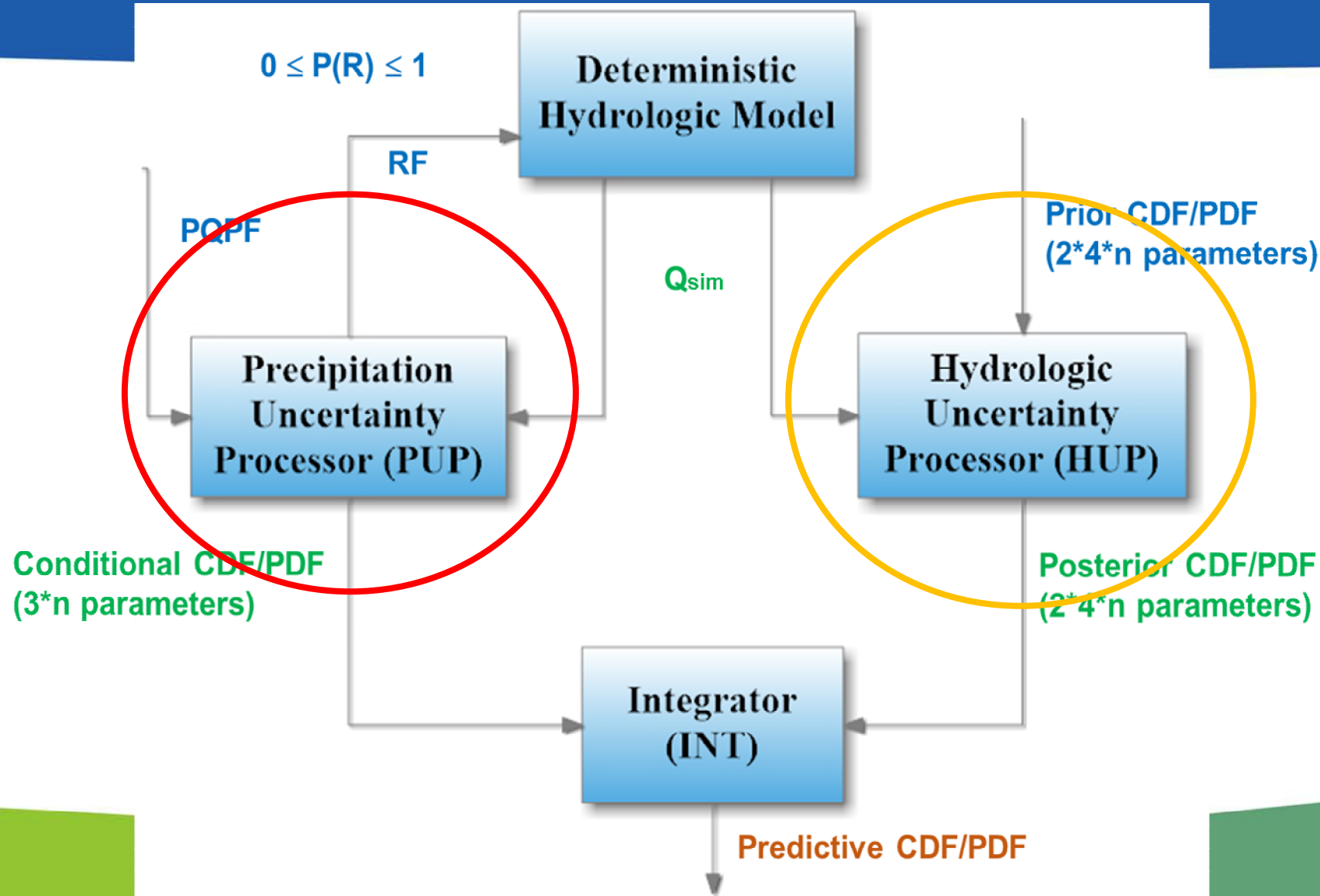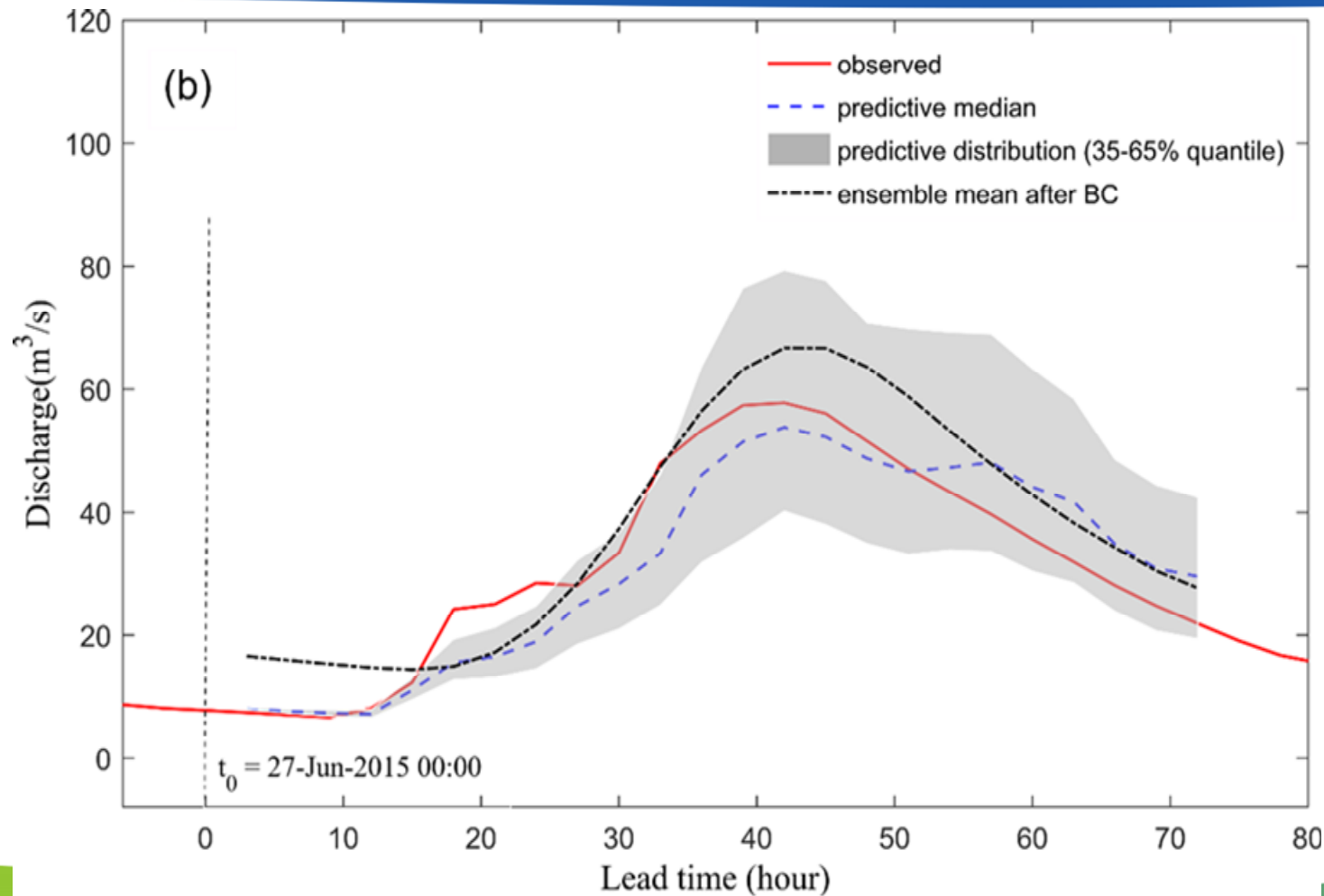
Results: Assiniboine River at Kamsack

- Timeframe:
  - 2007-01-01 to 2007-12-31

- Open loop NSE: 0.62

- EnKF NSE: 0.90
  - 24 ensemble members
  - state and parameter estimating

- Shows improved peak flow

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Using Bayesian Forecasting System (BFS)

CAFFEWS: Bayesian Forecasting

Using **GEPS-BC with HUP** improve predictive performance compared to GEPS-BC (business as usual)

Evaluation of forecasting system

- Comparison of CAFFEWS with operational forecasting system
  - Watersheds of various sizes and conditions

- Streamflow forecasting and warning performance

- Probabilistic and non-probabilistic metrics

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Forecasting skill for streamflow

- Single output (median)
- Accuracy
  - Nash-Sutcliffe, Mean absolute deviation, Bias
- Testing for significant differences
  - Wilcoxon signed-rank test
  - Permutation test

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Forecasting skill for warnings

- Exceeding important Flood stages

- Basic metrics

$$BIAS = \frac{(A+B)}{(A+C)}, \quad ACC = \frac{(A+C)}{n}$$

- Unbalanced design
  - Hit rate : H=*A/(A+C)*
  - *Precision: P=A/(A+B)*

|		Observation		
Forecast	Yes	No	
Yes	A	B	A+B
No	C	D	C+D
	A+C	B+D	n

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Status

- Current progress
  - Collecting data
  - Working with partners

- Future work
  - Setting up CAFFEWS
  - Perform comparative analysis

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McMaster University
McGill University
Trent University
UNU-INWEH
Université de Moncton
Université Laval
University of Alberta
University of Guelph
University of Manitoba
University of New Brunswick
University of Saskatchewan
University of Waterloo
Western University

IISD-ELA, LWCB
Institute for Catastrophic Loss
Reduction
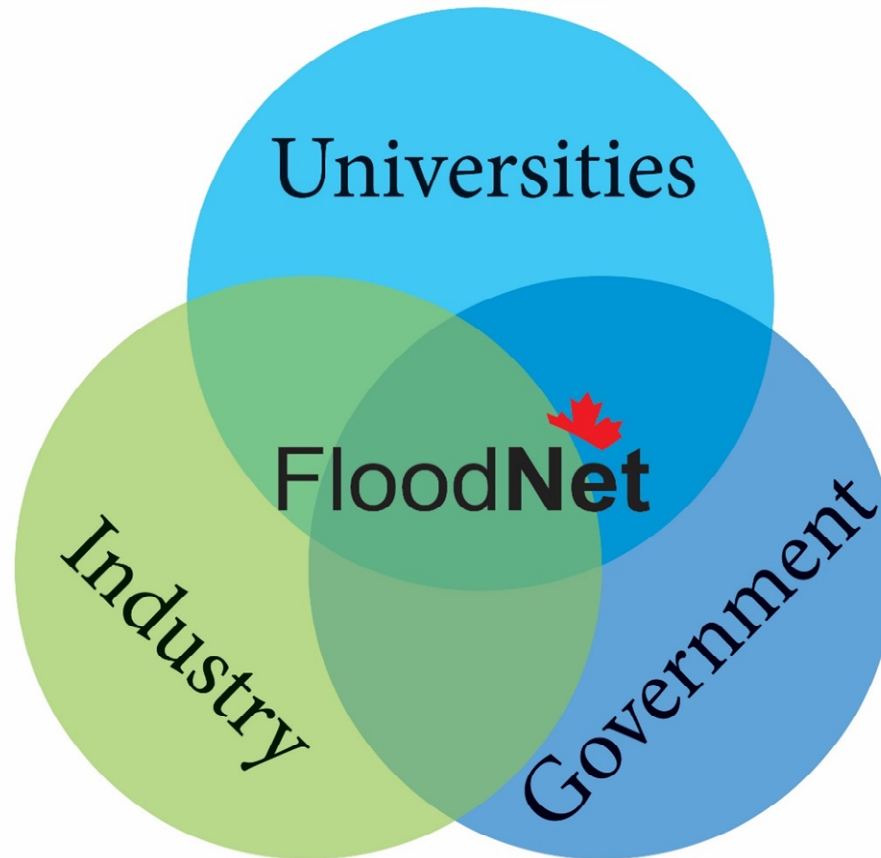
FloodNet Team

Government of Canada (EC, NRC, AAFC)
Government's of Ontario, Alberta, B.C.,
Manitoba, Quebec, Newfoundland and
Labrador, Saskatchewan,
Cities of Edmonton, Toronto, Hamilton,
Mississauga, Essex Region, Calgary

Deltares USA
Aeroscribe Consulting
Corrugated Steel Pipe Institute
DHI Canada
Hydro-Quebec
Manitoba Hydro
Ontario Power Generation
SNC Lavalin
Ouranos, OCCC

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