

### Project 4-3: Modeling based integrated assessment of flood impacts- Part II

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## **Theme 4-3 Objectives**

- 1. Investigate and predict the hydrologic connectivity in a watershed under high flow conditions
- 2. Build a suitable systems modelling approach to simulate a flood and its spatial extent in a watershed and its effect on the various watershed components (e.g., agricultural lands, lakes and wetlands, rural development, and water supply)
- 3. Simulate the effect of extreme rainfall on urban drainage infrastructure and storm water detention facilities



## Hybrid Modelling Approach



## Lake Systems Model



• STELLA 10.1 by isee systems



## **Model Complexity**



#### **Single Reservoir Model**

- All lakes represented by a single equivalent reservoir
- Simple and easy to handle
- Loose total picture



#### **Multiple Reservoir Model**

- Every lake is represented separately
  - Complex and interactive operation rules
  - Captures complete picture

## **Multiple Reservoir SD Model Results**



## **Sensitivity Analysis**



## Hybrid Modelling Top-down Approach

• (Step-1) Develop a well calibrated MESH model for QRB to estimate outflows from the tributaries

Multi-site Optimization-Maximize,  $Z = \sum_{i=1}^{n} NS$ , where  $\infty < Z < 10$ [total number of tributaries =10]

Minimize,  $Z = \sum_{i=1}^{n} |bias|$  , where  $0 < Z < \infty$ 

• (Step-2) Feed outflows of tributaries to the SD model and Optimize to predict streamflow at Welby



## MESH model for QRB (Step-1)



4-GRU (83 params to calibrate)

20-GRU (340 params to calibrate)



#### Hybrid Optimization Methodology (Step-2)



## **MESH QRB Preliminary Results**



## Hybrid Modelling Bottom-up Approach

 (Step-1) Generate naturalized flow at Welby using the SD model and observed outflows from the tributaries.

 (Step-2) Optimize MESH model using naturalized flow at Welby.



## Naturalized Flow @ Welby (Step-1)



### MESH QRB Preliminary Results (Step-2)



#### 4-GRU

Maximize NS





Stream flow [m3/s]

Tributaries	Calib.	Valid.
Moose Jaw	0.53	0.39
Kronau Marsh	0.29	-2.4
Ridge	0.25	-0.21
Lewis	-1.1	-0.36
Lanigan	-1.7	-0.93
Saline	-2.3	-7
Jumping Deer	-28	-16
Pheasant	-0.49	0.35
Ekapo	0.58	0.15
Cutarm	0.24	0.21





- Reservoir SD model is developed for lake system and it is performing well for streamflow prediction at Welby.
- Hybridization with hydrological model is proposed and tested.
- Results indicate performance of the hybrid model can be improved by focusing on improving hydrological MESH model.



## **Future work**

- Improve hybrid model by fixing the hydrological MESH model for QRB.
- Using the information on extreme events for future scenarios (obtained from Theme-1) and assess impact on flood in QRB.
- Compare and analyze the flood impact with the Canadian adaptive flood forecasting and early warning system (CAFFEWS) outcome (obtained from Theme-3).



# Thank you

