Flood Risk under Climate Scenarios

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Introduction

- Climate change is already affecting mortgage portfolios of banks due to exposure to climate events such as flooding and the impact is likely to continue increasing in the future
- Practical challenge for flood risk modeling and assessment under climate change scenarios: drastic sensitivity of the output to the choice of climate and hydraulic models rather than to climate change scenarios
  - Ex.: 6 climate models $\times$ 4 hydrological models $\times$ climate scenarios $\Rightarrow$ either no damage or a lot of damage predicted irrespective of the climate change scenario
- One of the key reasons for this sensitivity is the global nature of the models used
- Hence, the need for bottom-up local flood modeling

Geographic scope

- We began by focusing on BC
- Fraser river is not the main concern for the region under climate change
  - peak flows are snow melt driven and hence unlikely to be affected by climate change due to reduction in snow cover
  - weather events (precipitation) have only minor impact due to large watershed area
  - Maintenance of aging dikes is a concern

- We currently consider modeling for Squamish watershed
  - peak flows are rain-dominated and in addition to rising sea water level the region is most vulnerable to climate change
  - a simpler physical set-up relative to Fraser river
  - a fast growing urban region

Game Plan

1. Simulate extreme precipitation event
2. Run hydraulic model to obtain maximum flood-depth map
3. Quantify expected damage costs from the maximum flood depths for each point on the map

Repeat this for several independently simulated weather events to quantify uncertainty

Simulation of extreme precipitation under climate change scenarios

Methods for simulating precipitation:

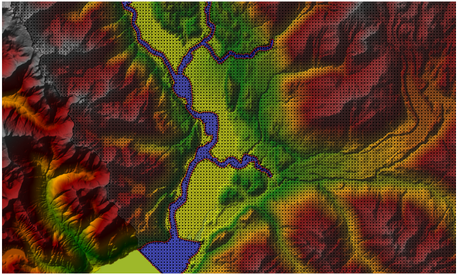
- Direct dynamical approaches
  - Such as in Hirsch et al. 2019, Yang et al. 2021,
- Downscaling of global climate models (GCMs) or regional climate models (RCMs)
  - Such as in Solman et al. 2021, Farnham et al. 2017
- Stochastic methods
  - Such as in Chen and Brissette 2014, Palacios-Rodriguez et al. 2020

As for climate change...

- IDFCC (Intensity Duration Frequency Curves under Climate Change) is a project associated with Western University Canada
- Provides intensity duration frequency curves for different climate scenarios which describe rain intensity for different rain intensity return periods

Hydraulic model

- Define a grid over the extent of the watershed
- Water level and flux for each cell is computed
- "Rain on grid" used to model rainfall
- A coastal water level boundary condition can be used



Next steps

- Implement the hydraulic model
  - Coastal boundary conditions.
  - Physical parameters e.g. land surface friction
  - Initial conditions
- Choose a precipitation model
  - Understand geographic heterogeneity
  - Understand changes under climate change
  - Simulate extreme precipitation events
- Run ensemble of hydraulic simulations with different extreme rainfall events
- Translate results into expected property damage costs