MAPPING METHODOLOGY

Introduction/context

Not yet any national mapping standards

Provincial/municipal maps:

- Have variable coverage
- Are often outdated
- Are provided in inconsistent formats

Downtown Calgary floods, June 21st, 2013
(Flickr user Wilson Hui - Attribution License 2.0)

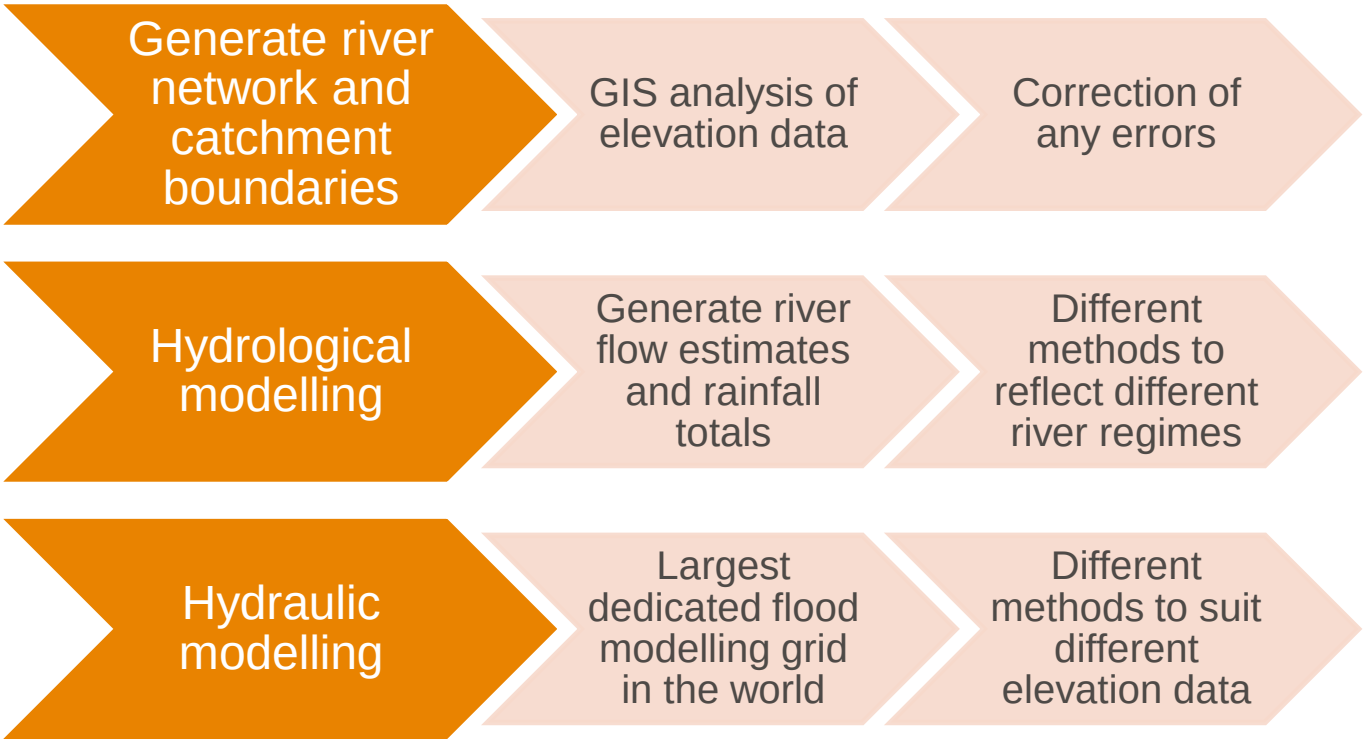
Ambitious project – mapping for every single river, plus pluvial flooding

Considering data availability, what could we achieve?

Mapping approach

Traditional engineering approaches to flood mapping, but with a hi-tech twist!

Extensive validation and correction at all stages



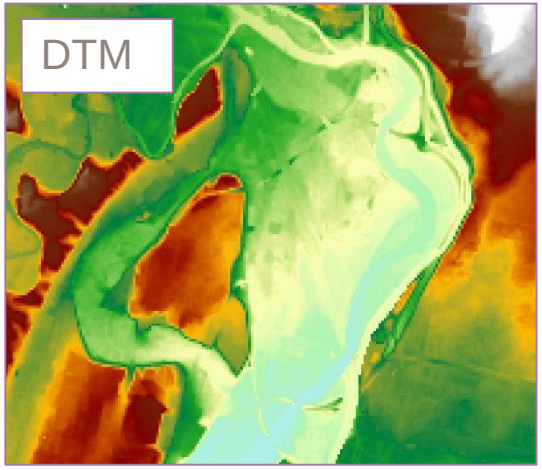
Elevation data

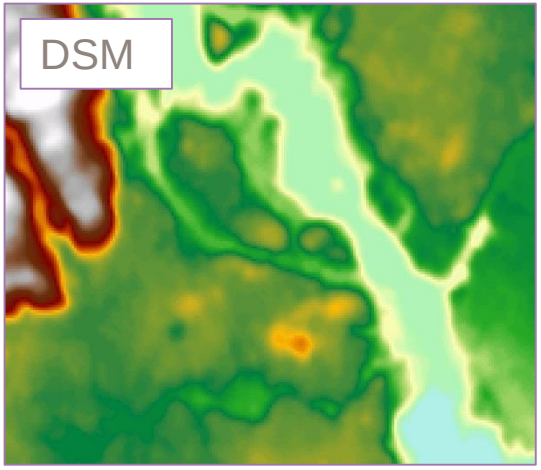
Digital Surface Model (DSM)

- represents the earth's surface as detected by radar
- includes features such as tree canopies and tall buildings

Digital Terrain Model (DTM)

- representation of the true 'bare-earth' ground level





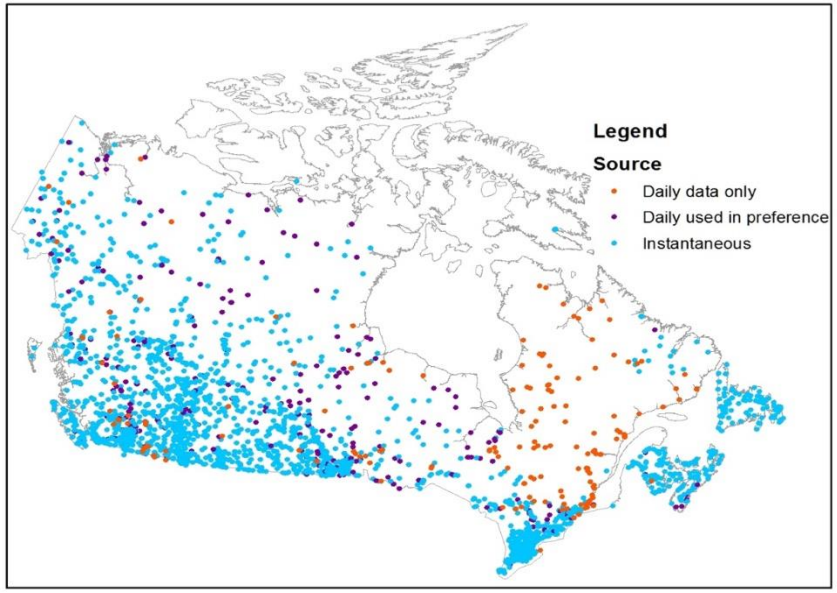
34% of national population mapped on bare-earth terrain data

Hydrology introduction

Purpose: methods to calculate river flows and rainfall totals for any ungauged location in the country

No published Canada-wide methods for estimating these

However, high quality data plentiful



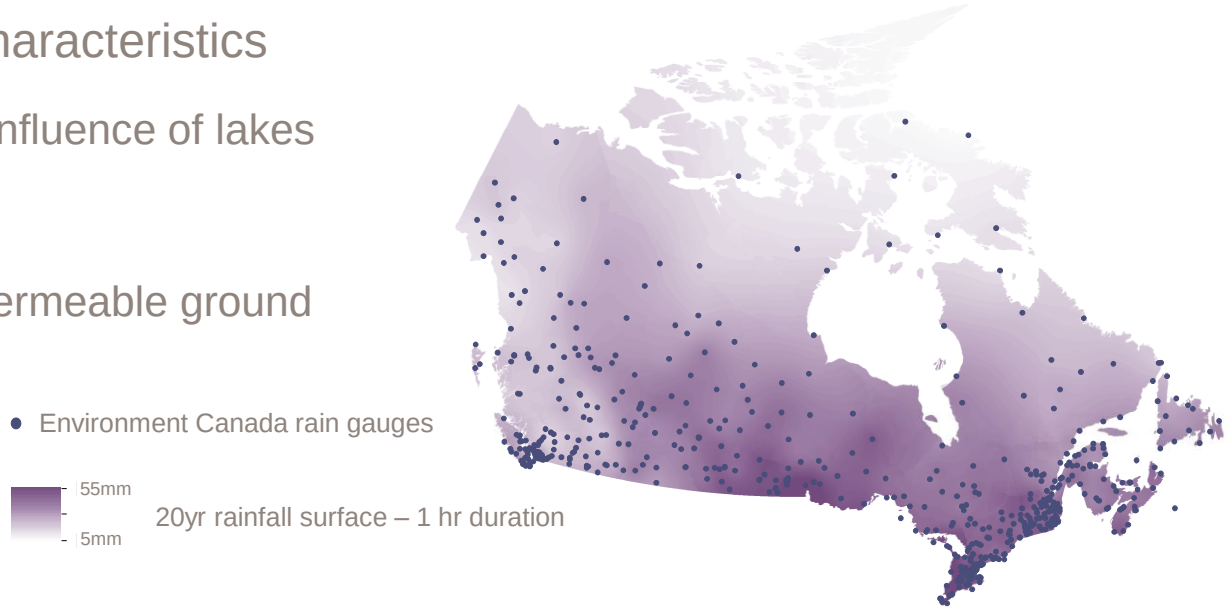
Hydrology overview

Input data

- Water Survey of Canada - HYDAT database of 1,664 river gauge records
- Environment Canada – IDF curves and snow depth records at 565 gauges
- Ecological Framework of Canada – ecozones to calculate losses e.g. from urban drainage

Represents local characteristics

- Significant influence of lakes
- Snow-melt
- Frozen impermeable ground



Design rainfall estimation

Rainfall hyetographs for every catchment across Canada

Intensity-duration-frequency (IDF) statistics at 565 gauges used to calculate rain depth per return period

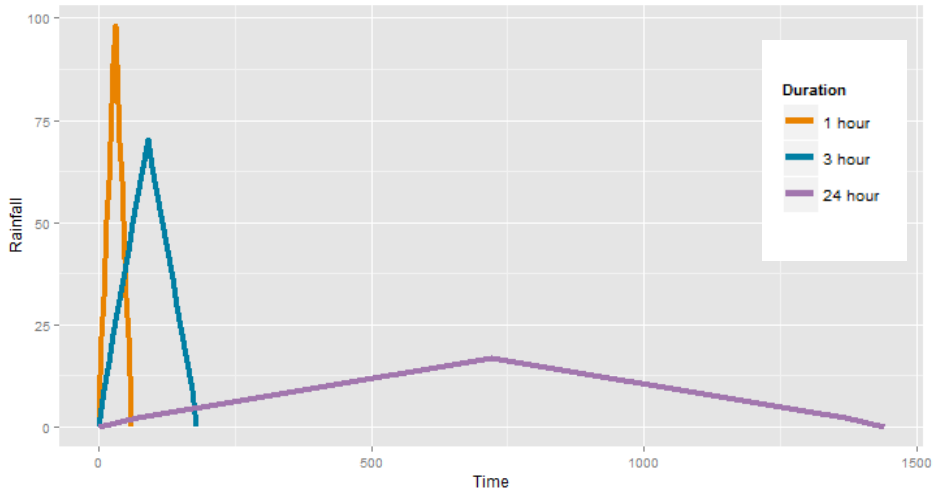
Three storm durations for each return period, to capture critical storm duration in different topographies

Adjusted to account for snowmelt & frozen ground

Interpolated to create continuous rainfall surfaces

Hyetograph generation using US Soil Conservation Service method

Percentage runoff varies with land use



Snowmelt & frozen ground

Rain on snow can lead to significant flooding

Losses reduced by:

- Priming of depressions (snow-filled)
- Frozen ground
- Lack of vegetation

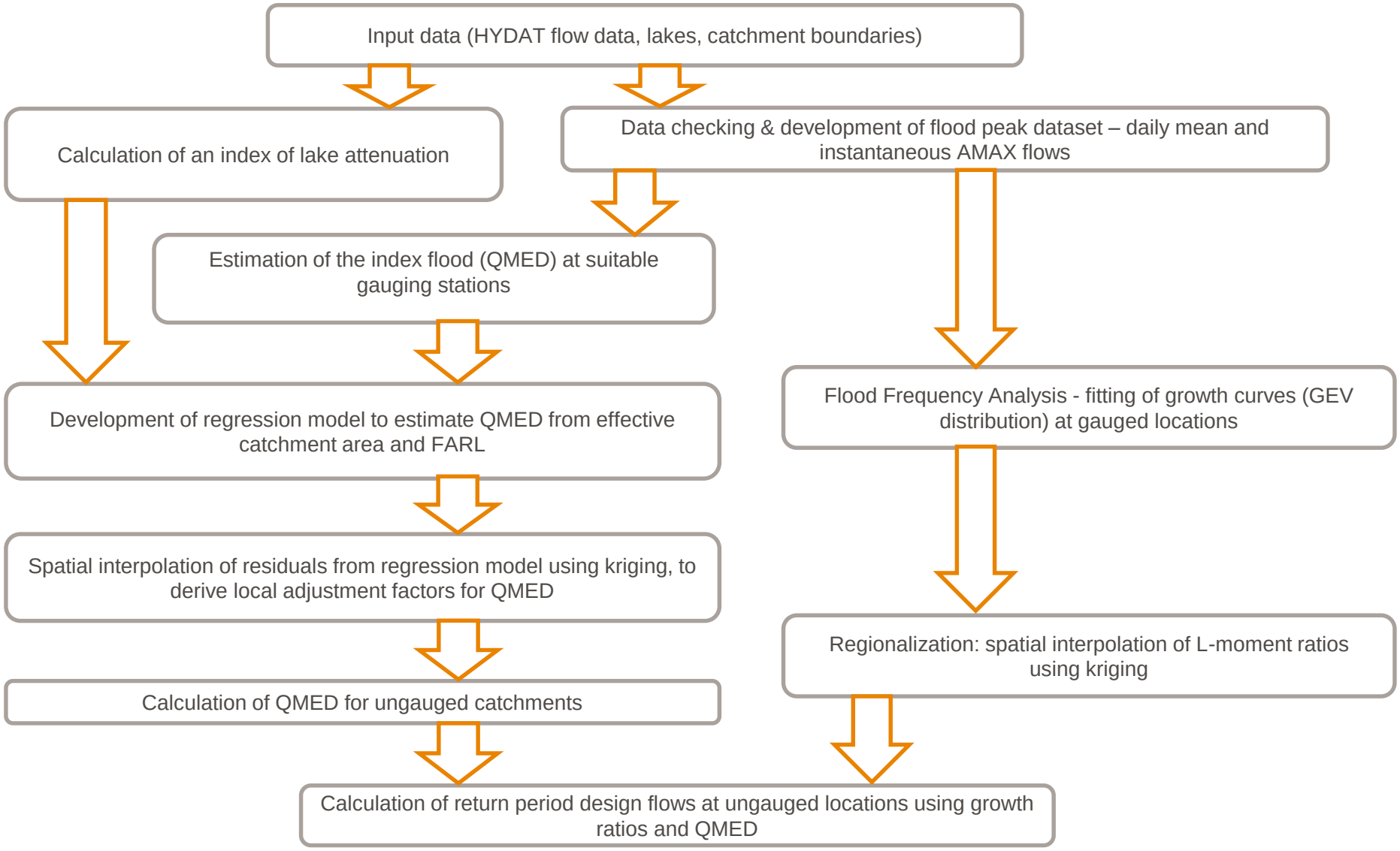
Stirling Flood, 25th Jan 2010 (Flickr user Robert Taylor. Attribution License 2.0)

Volume of water from snowmelt on successive days calculated from snow depth gauges

Snowmelt amounts combined with rainfall totals to generate winter runoff at each gauge

Considered alongside summer rainfall totals – worst case taken forward

Peak flow estimation for main rivers



Adapted from Faulkner, D., Warren, S. and Burn, D (2015) – Design floods for all of Canada. Accepted by Canadian Journal of Water Resources

Hydrology summary

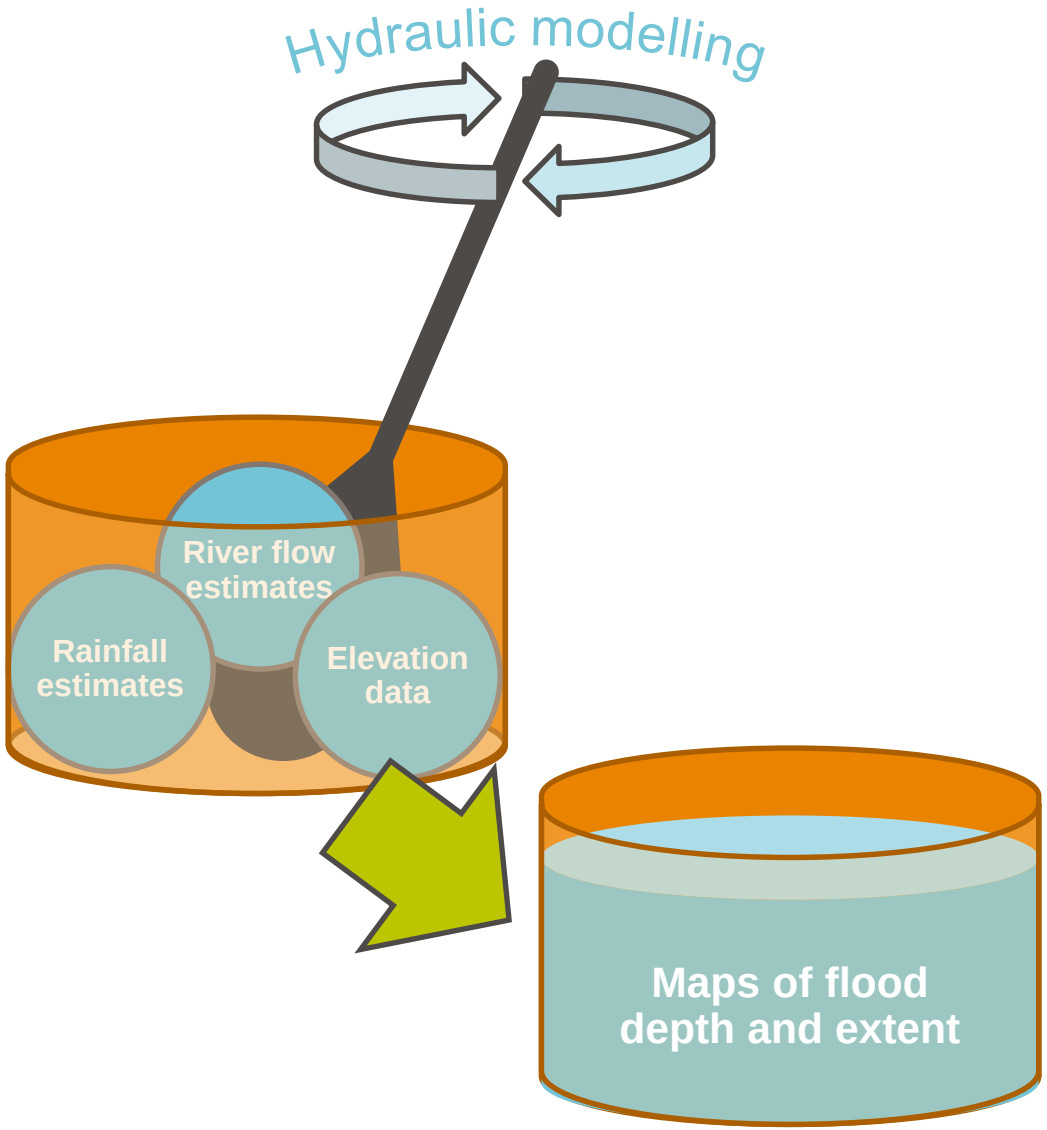
We developed methods that enabled us to:

- Calculate rainfall amounts for all catchments in Canada
- Calculate river flows for 24,000 locations along the national river network
- Account for the impacts of snowmelt
- Represent different land uses and ground conditions

Whitemud Park, Edmonton, 23rd June 2013. Flickr user Kurt Bauschardt. Attribution License 2.0

These form some of the inputs into our hydraulic models…

Hydraulic modelling



RFlow®

- Extremely fast
- Credible outputs
- Used in largely unpopulated areas

JFlow®

- Fast
- Specifically designed for large-scale hazard mapping
- Developed since 2002
- Benchmarked by UK government

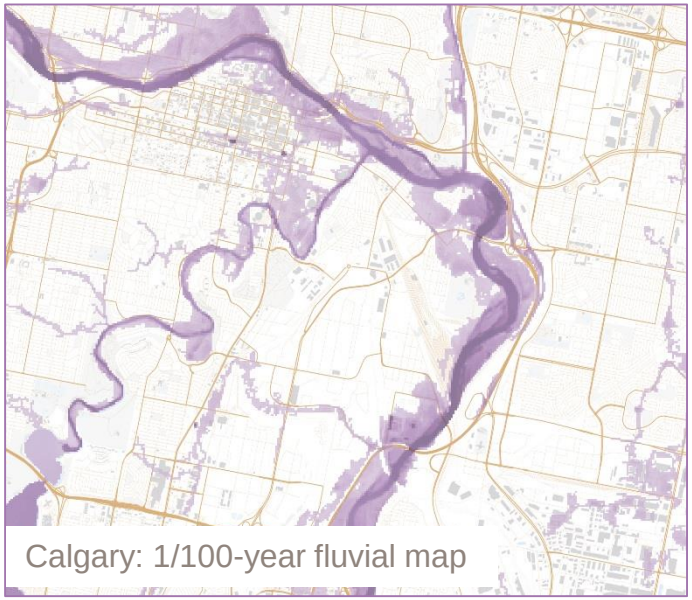
What's the result?

National flood hazard maps for 7 return periods at 30m resolution

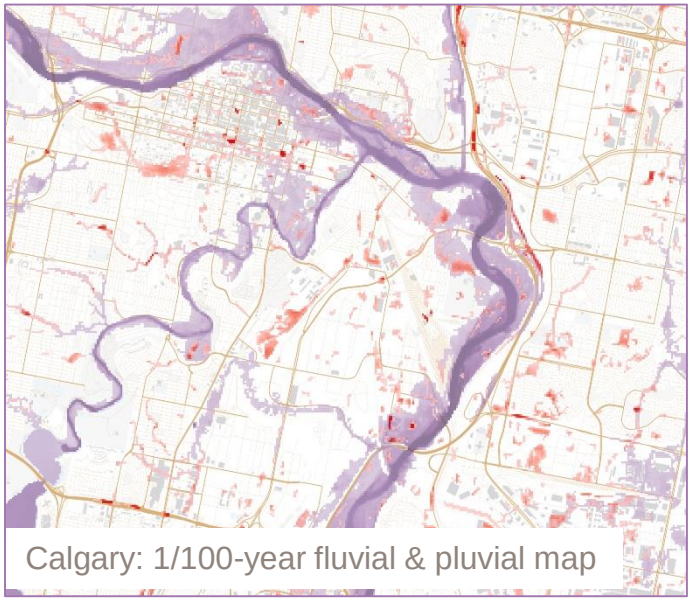
> 5 million km of river mapped

Pluvial flooding for every location

Full 2D hydrodynamic simulations for three storm durations, for each return period, on a 30m grid!

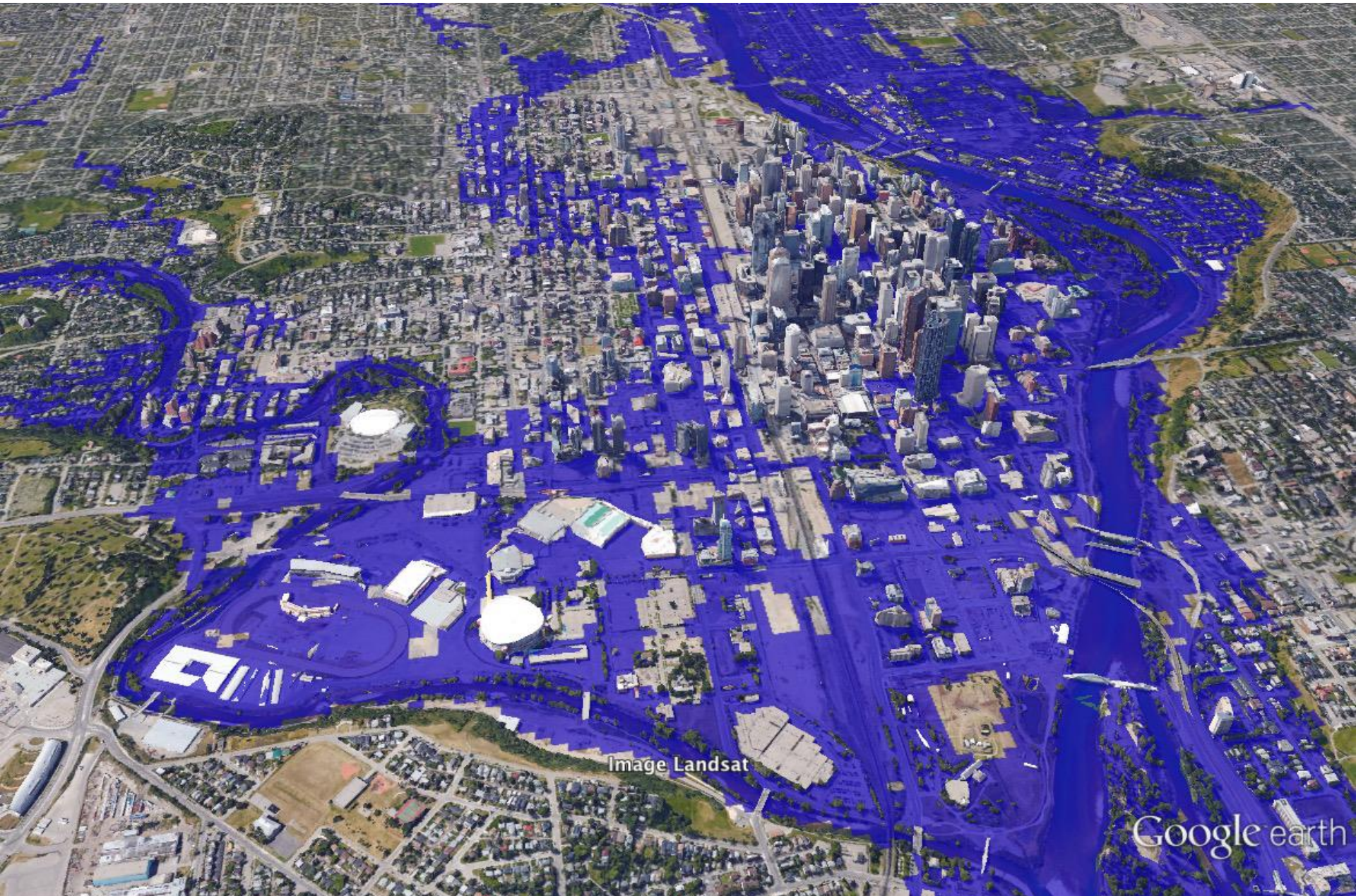


Calgary: 1/100-year fluvial map



Calgary: 1/100-year fluvial & pluvial map

River Flood - Calgary



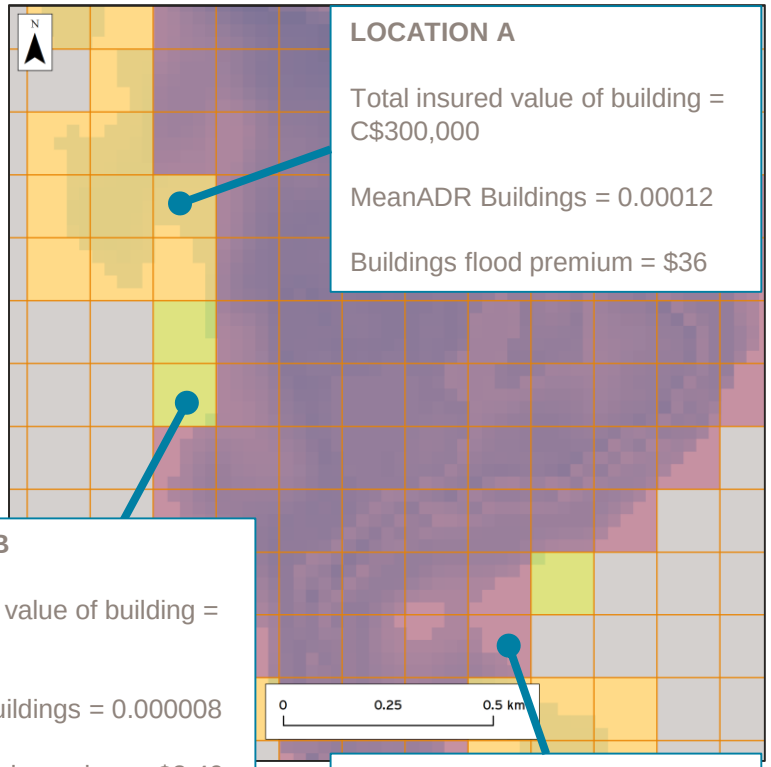
Application of flood hazard maps

Insurance metrics

- Underwriting/risk scores
- Pricing tools
- Eg Annual Damage Ratios

Probabilistic models

Flood warning & forecasting systems



LOCATION A

Total insured value of building = C$300,000

MeanADR Buildings = 0.00012

Buildings flood premium = $36

LOCATION B

Total insured value of building = C$300,000

MeanADR Buildings = 0.000008

Buildings flood premium = $2.40

LOCATION C

Total insured value of building = C$300,000

MeanADR Buildings = 0.00266

Buildings flood premium = $798

What's next?

Understanding of flood risk across Canada is better than ever – but more to do!

- Local hydrology & hydraulic studies

To do more, we need more:

- Flood defence data
- High quality terrain data – LIDAR
- Investment

Thank you!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226
Muskoka Rd. 3
Old North Rd.
1 km
Flickr user Ryan McGilchrist. Taken April 21st 2013. Highway 11. Attribution License 2.0

Thank you!

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Q&A