Natural Channel Vulnerabilities to Climate Change
Spencer Creek Watershed
Natural Channel Design Conference 2016
Project Partners
Study Overview
Purpose

- Recent increase in damage caused by extreme weather
- Analyze effects of future climate conditions.
- Model watershed-specific potential impacts
Approach

• Develop 100 years of potential future climate data

• Use hydrologic and hydraulic models and predictive datasets to assess
  – Environmental vulnerabilities
  – Infrastructure vulnerabilities
Study Area

- Spencer Creek watershed located in the City of Hamilton
- Tributary to Lake Ontario
- Discharges into the Hamilton Harbour
Spencer Creek Watershed

- Drainage area: 230 km$^2$
- Headwaters rural
- Lower reaches urban
- Natural areas include:
  - Dundas Valley Forest
  - Fletcher Creek Swamp
  - Beverly Swamp
  - Christie Lake Reservoir
Study Application – Geomorphology

• Watershed model to predict the impacts of climate change
• Estimate future sediment loading
• Evaluate geomorphic impacts of future climate
Climate Model Forecast
Climate Trends

- Higher temperatures, greater annual precipitation, larger precipitation events
- Increase frequency of high flow events

<table>
<thead>
<tr>
<th></th>
<th>Future Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Annual Temperature</td>
<td>↑</td>
</tr>
<tr>
<td>Days Above 35°C</td>
<td>↑</td>
</tr>
<tr>
<td>Days Below -15°C</td>
<td>↓</td>
</tr>
<tr>
<td>Annual Precipitation</td>
<td>↑</td>
</tr>
<tr>
<td>Days with &gt; 20 mm</td>
<td>↑</td>
</tr>
</tbody>
</table>
Fluvial-Geomorphologic Impacts
Sediment Analysis

• Continuous turbidity monitoring
  – Coincides with flow gauge location
• Developed TSS-Flow Rating Curve

Turbidity → TSS → Rating Curve
Sediment Loading

- Future climate scenario predicts a 40% increase in future TSS loading
  - Increased variable
Critical Flow Exceedance

- Return periods for critical flows are reduced future scenarios
- Larger storms more frequent in near and far future

<table>
<thead>
<tr>
<th>Reference Flow</th>
<th>Predicted Return Frequency (Years)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Description</td>
</tr>
<tr>
<td>D_{50} Critical Flow</td>
<td>16.9*</td>
</tr>
<tr>
<td>D_{84} Critical Flow</td>
<td>44.6*</td>
</tr>
</tbody>
</table>

* From Lower Spence Creek Subwatershed Study
Baseflow Impacts

- Lower baseflow
- Baseflow occurs more often
- Potential impacts on rates of aggradation
Higher Flows Lead to...

- Erosion Vulnerability
  - Increased risk of erosion damages to infrastructure
- Infrastructure impacts
  - Crossings may need to be larger
- Erosion thresholds exceeded more frequently
- Greater sediment loading in watercourses
Physical Effects

Combined with higher peak flows and lower baseflow, altered sediment transport regimes could change the way our rivers form and adjust.
Potential Downstream Impacts

• Water quality in receiving channels and water bodies
  – Turbidity
  – Organic Loading
  – Sediment Loading
  – Increased Dredging
  – Infrastructure
Climate Change Impacts to Infrastructure

• Increased Erosion
• Increased Flood Risk
• Operational changes at Christie Dam
Environmental Vulnerability

- Change in vegetation
- Change in habitat
  - Increase in invasive species
- Drying wetlands
  - Further stress to S.A.R.
- Fish in warm turbid water
Ongoing Monitoring and Adaptation
Ongoing Monitoring

- Enhance monitoring programs
- Identify hydrologic and environmental changes as they occur
Mitigation and Adaptation

- Mitigation (reducing greenhouse gases)
- Climate change (including variability)
- Impacts and Environmental Adaptation
- Responses and Investments
- Planned Adaptation