Fire following earthquake in the Lower Mainland of British Columbia

Summary Presentation
13 November 2020

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Keith Porter, P.E.
Outline

• Introduction
• Lower Mainland seismic hazard / scenarios
• Analysis of fire following earthquake
  • Exposure
  • Firefighting resources
  • Water supply
• Results
• Opportunities for mitigation
• Conclusion
• Discussion
Acknowledgments

This report builds on a large body of data and work by others. We gratefully thank:

- People and governments of the City of Vancouver, other municipalities and the Province of British Columbia for their graciousness, open data policies and hospitality.

- **City of Vancouver**: Vancouver Fire Rescue Services, particularly Deputy Chief Rob Renning and Assistant Chiefs Rick Cheung and Ray Bryan; Mr. Micah Hilt, City of Vancouver Lead Seismic Policy Planner

- **Burnaby FD**: Chief Joe Robertson

- **Metro Vancouver**: Mike Searle, Greg Smith and their colleagues.

- **Surrey Water Department**: Mr. K.K. Li and Mr. A.

- **Dr. Zachary Bullock** (Caltech, formerly Univ. of Colorado, Boulder)

- **Natural Resources Canada** (NRCan), particularly Dr. Murray Journeay

- **The Institute for Catastrophic Loss Reduction** (ICLR), especially Paul Kovacs, Glenn McGillivray, Tracy Waddington, Sophie Guilbault
Institute for Catastrophic Loss Reduction

- World-class centre for disaster research and communication.
- Established by property and casualty (P&C) insurance industry
- Independent, not-for-profit research institute
- Affiliated with Western University.

**Board of Directors**

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</tbody>
</table>

**SPA Risk**
• Independent consultancy
• Focus: natural hazards risk management

Retained by ICLR to analyze Lower Mainland fire following earthquake risk:
“Lower Mainland”: the study region
Scenario Earthquakes

<table>
<thead>
<tr>
<th>ID</th>
<th>Moment Magnitude</th>
<th>Fault</th>
<th>Tectonic Environment</th>
<th>Faulting Mechanism</th>
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<tbody>
<tr>
<td>EQ1</td>
<td>9.0</td>
<td>Cascadia Subduction Zone (CSZ)</td>
<td>Subduction</td>
<td>Interface</td>
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<tr>
<td>EQ2</td>
<td>6.8</td>
<td>Juan de Fuca Slab (JDF)</td>
<td>Subduction</td>
<td>Inslab</td>
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<td>EQ3</td>
<td>7.3</td>
<td>Leech River – Devil’s Mountain (LRDm)</td>
<td>Shallow Crustal</td>
<td>Strike Slip</td>
</tr>
<tr>
<td>EQ4</td>
<td>7.3</td>
<td>Georgia Strait (GS)</td>
<td>Shallow Crustal</td>
<td>Strike Slip</td>
</tr>
<tr>
<td>EQ5</td>
<td>6.5</td>
<td>New Westminster</td>
<td>Shallow Crustal</td>
<td>Strike Slip</td>
</tr>
</tbody>
</table>
Soil stiffness

$V_{s30}$

(Source: NRCan)
Median Peak Ground Acceleration (g)
EQ4 Mw 7.3 Georgia Strait (GS) shallow crustal event
So, 100 realizations of the ground motions are actually used in our analyses.
Permanent ground displacement / Liquefaction

Balboa Boulevard, 1994 Northridge earthquake
Areas of Moderate, High and Very High liquefaction susceptibility

Source: (Journeay 2020)
EXPOSURE

ICLR Lower Mainland FFE  SPA Risk

Total Floor Area per grid cell, sq. ft
<1000
1000 - 10000

SPA Risk
Overhead electrical distribution in CBD – unnecessary source of ignition
Reports will be delayed:

- 911 centers will be overwhelmed
- FDs do not have their own helicopters, and TV helicopter news reporting will be a valuable resource for a few major incidents, but not most.
- Quickly gaining an accurate complete situational awareness is still a challenge.
- FD-dedicated UAVs can help
<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>Fire Halls</th>
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</thead>
<tbody>
<tr>
<td>Village of Anmore</td>
<td>1</td>
</tr>
<tr>
<td>City of Burnaby</td>
<td>7</td>
</tr>
<tr>
<td>Bowen Island Municipality</td>
<td>1</td>
</tr>
<tr>
<td>City of Coquitlam</td>
<td>4</td>
</tr>
<tr>
<td>City of Coquitlam</td>
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</tr>
<tr>
<td>Electoral Area A</td>
<td>0</td>
</tr>
<tr>
<td>Township of Langley</td>
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</tr>
<tr>
<td>City of Langley</td>
<td>1</td>
</tr>
<tr>
<td>Village of Lions Bay</td>
<td>1</td>
</tr>
<tr>
<td>City of Maple Ridge</td>
<td>4</td>
</tr>
<tr>
<td>City of New Westminster</td>
<td>3</td>
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<tr>
<td>City of North Vancouver</td>
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<tr>
<td>District of North Vancouver</td>
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<td>City of Pitt Meadows</td>
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<tr>
<td>City of Port Coquitlam</td>
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<tr>
<td>City of Port Moody</td>
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<td>City of Richmond</td>
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<td>City of Surrey</td>
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<td>Tsawwassen First Nation</td>
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<td>City of Vancouver</td>
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<td>City of White Rock</td>
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<tr>
<td>District of West Vancouver</td>
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**Lower Mainland Fire Halls**
Water Supply

Alternative Water Supply Factor
Water Supply Factor
EQ 4 Mw 7.3 Georgia Strait (GS)
shallow crustal event
EQ1 Mw 9 Cascadia Subduction Zone event

Table:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Mean Ignitions</th>
<th>Mean no. Large Fires</th>
<th>Mean Losses CS$ billions</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQ1 Mw 9.0 CSZ</td>
<td>16</td>
<td>0.6</td>
<td>0.16 ($ billions)</td>
</tr>
</tbody>
</table>

Histogram:

EQ1 Mean Ignitions, 1000 trials

Map:

SPA Risk
### EQ2 Mw 6.8 Juan de Fuca slab (JDF) in-slab event

<table>
<thead>
<tr>
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<th>EQ2 Mw 6.8 JDF</th>
</tr>
</thead>
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<tr>
<td>Mean Ignitions</td>
<td>16</td>
<td>106</td>
</tr>
<tr>
<td>Mean no. Large Fires</td>
<td>0.6</td>
<td>31</td>
</tr>
<tr>
<td>Mean Losses C$ billions</td>
<td>$ 0.16</td>
<td>$7.4</td>
</tr>
</tbody>
</table>

**Graph**:
- Mean Ignitions distribution
- Mean no. Large Fires distribution
- Mean Losses C$ billions distribution

**Maps**:
- PGA distribution
- Ignition distribution
- Loss distribution

**Notes**:
- SPA Risk
- Building resilient communities
- Bâtir des communautés résilientes
EQ4 Mw 7.3 Georgia Strait (GS) shallow crustal event

<table>
<thead>
<tr>
<th>Scenario</th>
<th>EQ1 Mw 9.0 CSZ</th>
<th>EQ2 Mw 6.8 JDF</th>
<th>EQ3 Mw 7.3 LRDM</th>
<th>EQ4 Mw 7.3 GS</th>
</tr>
</thead>
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<tr>
<td>Mean Ignitions</td>
<td>16</td>
<td>106</td>
<td>4</td>
<td>216</td>
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<tr>
<td>Mean no. Large Fires</td>
<td>0.6</td>
<td>31</td>
<td>0.02</td>
<td>47</td>
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<tr>
<td>Mean Losses C$ billions</td>
<td>$0.16</td>
<td>$7.4</td>
<td>$0.01</td>
<td>$10.7</td>
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SPA Risk
### EQ5 Mw 6.5 New Westminster (NWM) shallow crustal event

<table>
<thead>
<tr>
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<th>EQ1 Mw 9.0 CSZ</th>
<th>EQ2 Mw 6.8 JDF</th>
<th>EQ3 Mw 7.3 LRDM</th>
<th>EQ4 Mw 7.3 GS</th>
<th>EQ5 Mw 6.5 NWM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Ignitions</td>
<td>16</td>
<td>106</td>
<td>4</td>
<td>216</td>
<td>93</td>
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<tr>
<td>Mean no. Large Fires</td>
<td>0.6</td>
<td>31</td>
<td>0.02</td>
<td>47</td>
<td>29</td>
</tr>
<tr>
<td>Mean Losses C$ billions</td>
<td>$ 0.16</td>
<td>$7.4</td>
<td>$ 0.01</td>
<td>$ 10.7</td>
<td>$ 7.2</td>
</tr>
</tbody>
</table>
Summary Results

<table>
<thead>
<tr>
<th>Scenario</th>
<th>EQ1 Mw 9.0 CSZ</th>
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<th>EQ3 Mw 7.3 LRDM</th>
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Insurance aspect
- Almost entirely insured.
- Consensus: Swiss Re (2017): potential for financial contagion
- Being addressed by industry and government
What can we do?

These recommendations have already been presented in briefings to the:

- Fire Service
- Water sector
- Building code community
- Energy sector
Fire Hall Vulnerability

Figure 78: Fire station collapse, 1933 Long Beach (CA) earthquake. Note fire headquarters building dates from 1932.

Largely addressed.
Water supply for firefighting

- Metro Van (water wholesaler)
- Vancouver CBD / DFPS
- Vancouver Fire & Rescue
- Other water dists, fire depts
Firefighting Water Capacity

• **Lower Mainland is almost surrounded by water**
• *and so was San Francisco in 1906*

• **Recommendation:**
  • A *regional Portable Water Supply System be developed*
  • *Compatible equipment, fittings, procedures*
  • **Regular inter-departmental exercises**
An automatic secondary on-site water supply shall be provided for high-rise buildings … [useable capacity of 30 minutes ~ 15,000 gallons].


No similar provision in City of Vancouver or BC Building By-laws
Secondary water supply – 15,000 gallons (60 m³)
Energy industry

• Was not assessed (in this study)
• Nevertheless, major energy facilities are typically damaged in earthquakes, including by fire, and exacerbate the FFE risk

• We recommend:
  (1) review seismic vulnerability of major energy facilities;
  (2) review ability to control and isolate gas transmission and distribution networks to the event of a major earthquake.
  (3) Consider seismic gas shutoff device in all gas meters
Suspension and restoration of gas supply after large earthquakes

Tokyo Gas’s response and support

A major tremor was detected and the gas supply to homes was automatically shut off.

Wide area

When an earthquake measuring intensity 5* or greater on the Japanese seismic intensity scale (JMA) was detected in an area, the gas supply was automatically shut off by the safety device in intelligent gas meters. This ensured the safety of an estimated 3 million homes.

Areas where an intense tremor was observed

The city gas supply was suspended as a safety precaution when an earthquake measuring intensity 6 (upper)** was observed in the Hitachi region and two other areas in Ibaraki prefecture, as well as one area in Yokohama in Kanagawa prefecture.

* Gas supply resumed by late at night on March 11 in all areas other than the Hitachi region.

When an earthquake occurs, the earthquake disaster prevention system “SUPREME” is immediately activated.

Immediately after the Great East Japan Earthquake occurred, Tokyo Gas's earthquake disaster prevention system “SUPREME” was activated. It assessed whether it was appropriate to suspend the gas supply and helped restore gas supply quickly.

Restoration work will commence if damage has been sustained. If there is no damage, the supply will be resumed promptly.
Consider seismic gas shutoff device in all gas meters
It's time to upgrade our natural gas meters

Intelligent gas meter recovery

If a gas leak or an earthquake measuring intensity 5 or greater on the Japanese seismic intensity scale (JMA) is detected, or if a gas device was accidentally left on or there is a high flow of gas, the gas meter automatically shuts off the gas supply. The customer can restore the gas supply by following a simple recovery operation procedure.

* Refer to the instruction manual provided with the meter for further details.

1. Turn off all gas devices. Do not forget to turn off outside devices. (Meter gas tap is left open)
2. Remove the reset button cap. (There are also types without caps)
3. Press the reset button all the way in, and then slowly release it. (When the red lamp lights up, it starts to flash)
4. Do not use the gas and wait approximately 3 minutes. (Gas meter checks the safety during this time)

When it stops flashing, the gas can be used if it does not stop flashing, start over from step 1.

(Contact Tokyo Gas if the procedure does not reset the gas)

Scan the QR code or use the following URL to view the Tokyo Gas website in English.

[Toyo Gas website]
http://www.tokyo-gas.co.jp/index_e.html

Institute for Catastrophic Loss Reduction
Building resilient communities
Conclusion

• Lower Mainland region is a major economic and cultural centre of Canada.
• Highest earthquake risk of a major Canadian city
• Scenario earthquakes break water distribution pipes & ignite many fires
• For those scenario events, median losses up to $10 billion
• Fire loss is largely insured, will significantly impact Canadian insurers.
• This risk need not be tolerated and can be significantly reduced.
• Key recommendations:
  • Develop a regional Portable Water Supply System
  • Provide secondary water supply for high-rise buildings
  • Energy facilities’ seismic vulnerability should be assessed.
• Water, Fire and Building officials have been briefed on these findings
• Insurance companies are also aware - ICLR Insurance Advisory Committee has been briefed and the report today is going to ICLR’s 120 member insurers.
• Insurance industry enthusiastically supports these recommendations and believes that implementation would significantly reduce the risk of fire damage after a major earthquake.
• Canada’s Insurance companies look forward to supporting efforts to implement fire reduction actions.
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Thank you

Questions?

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