

Hazus supports table-top earthquake response exercises, Canada

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Exercises

Metro Vancouver, British
Columbia

MAG12

October 2012

Earthquake, Magnitude 7.3

Charlevoix, Quebec

La Grande Secousse de

Charlevoix,

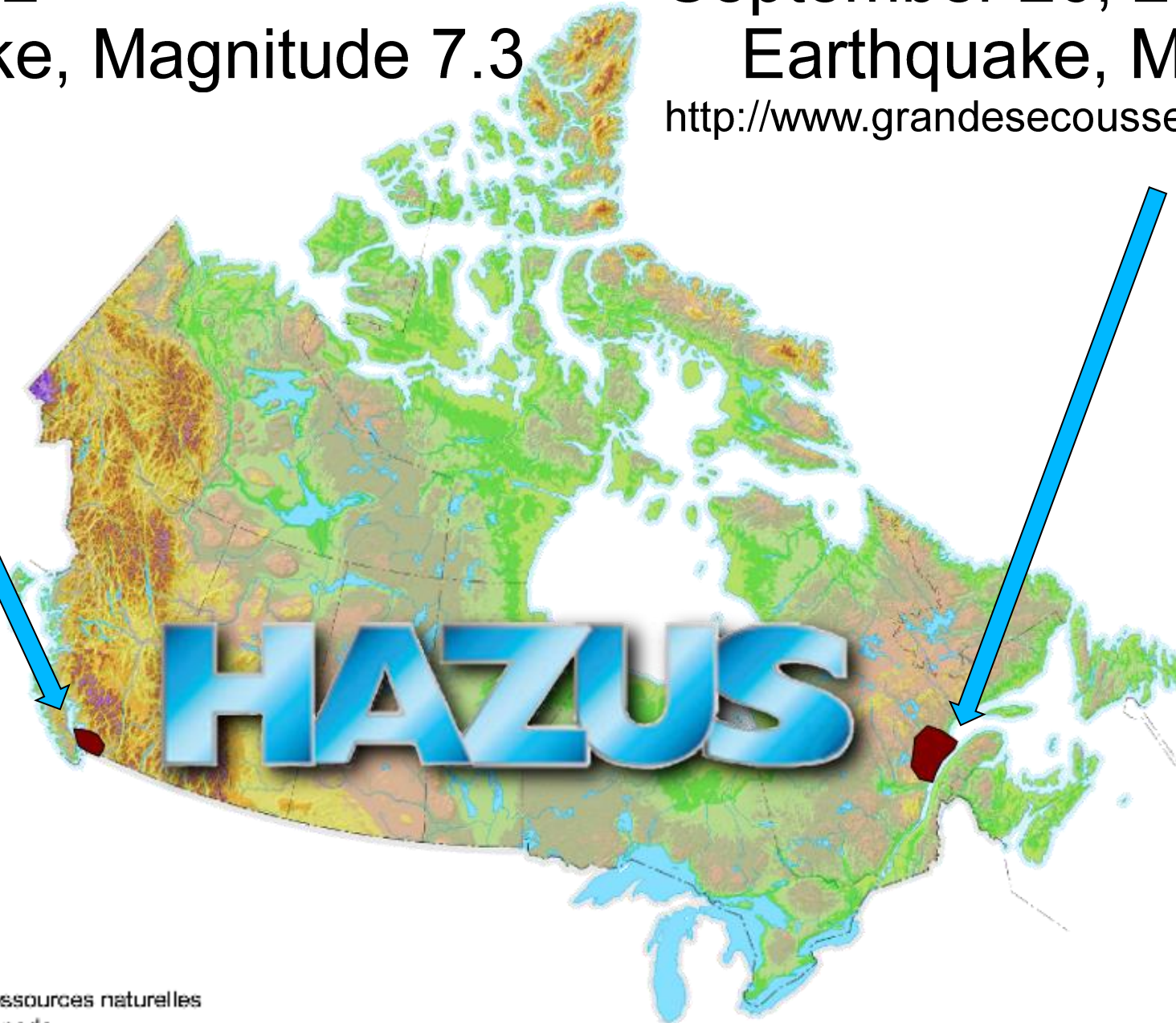
September 26, 2013

Earthquake, Magnitude 6.5

<http://www.grandesecousse.org/charlevoix>

National, Provincial
and Municipal
governments and
the Heavy Urban
Search and
Response team
testing earthquake
response capability

National, Provincial
and Municipal
governments
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Positive consequences of using Hazus disaster scenarios for Canadian emergency response simulations:

-  *Better appreciation of earthquake scenario consequences (areal and scope)*
-  *Triggers conversations about simulation needs (what and why)*
-  *Prompts rigour in disaster scenario development*



Learning from use of Hazus disaster scenarios for Canadian emergency response simulations:

 *Too much of a good thing too quickly?* 

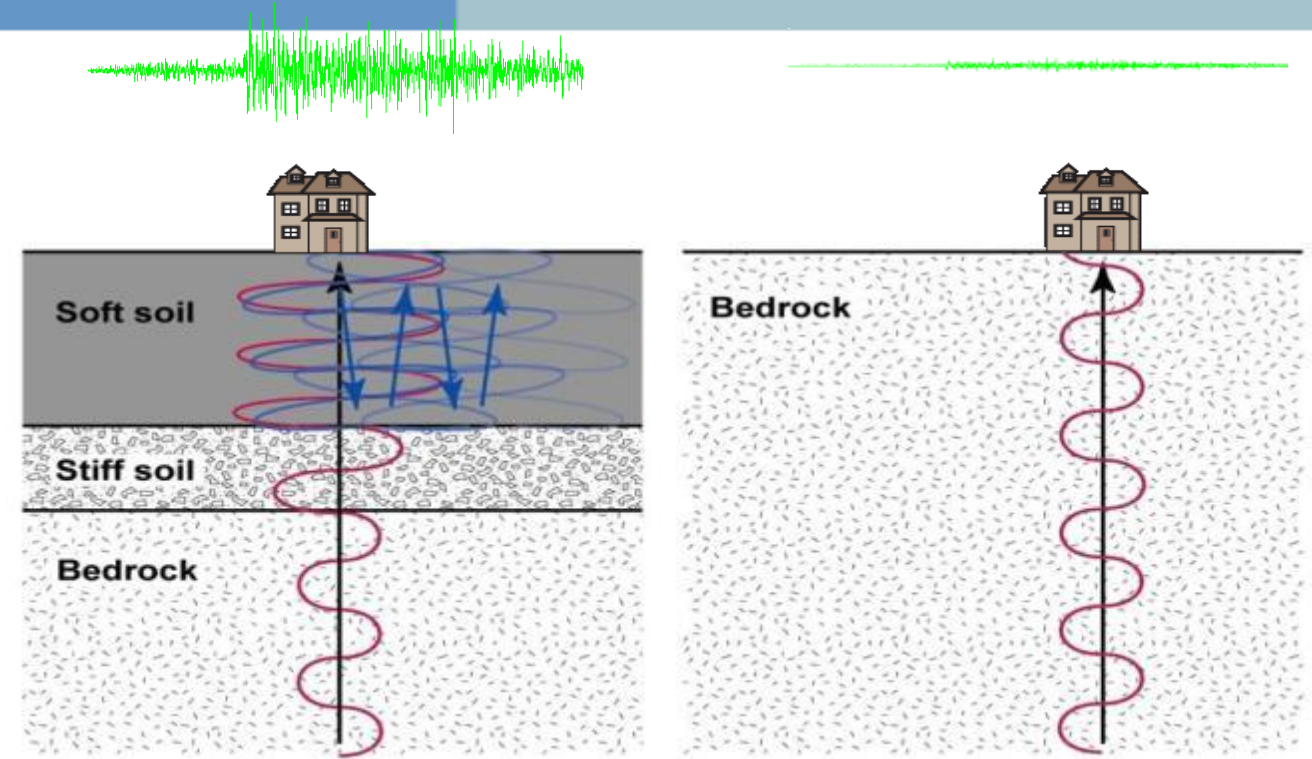
 *Creates issues with response focus*

 *Diverts attention to scenario credibility*

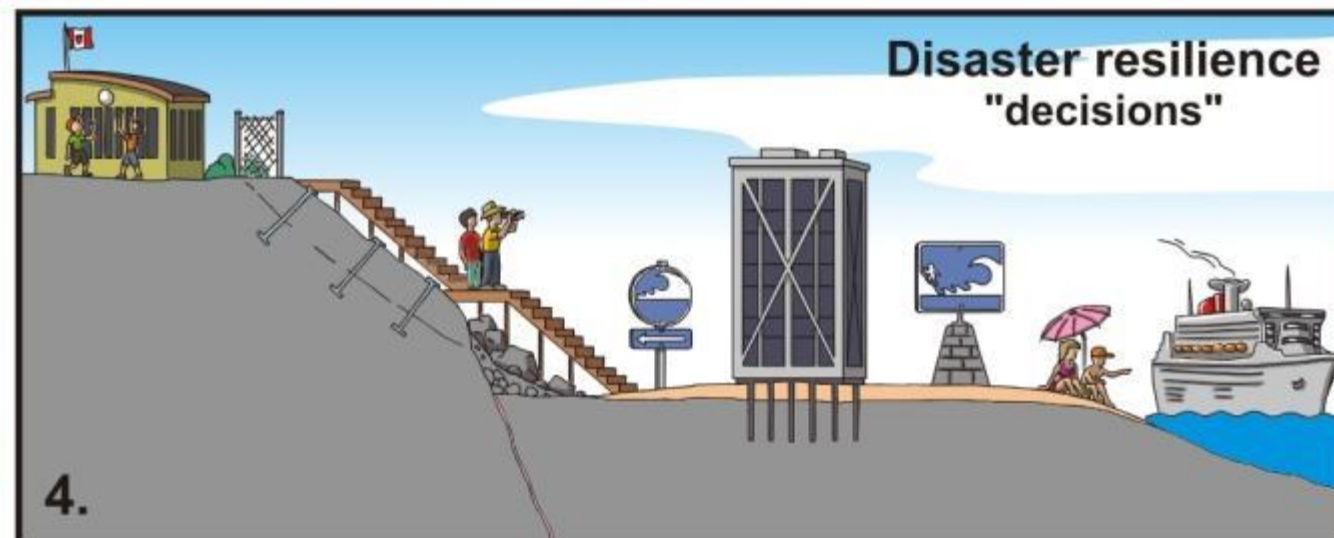
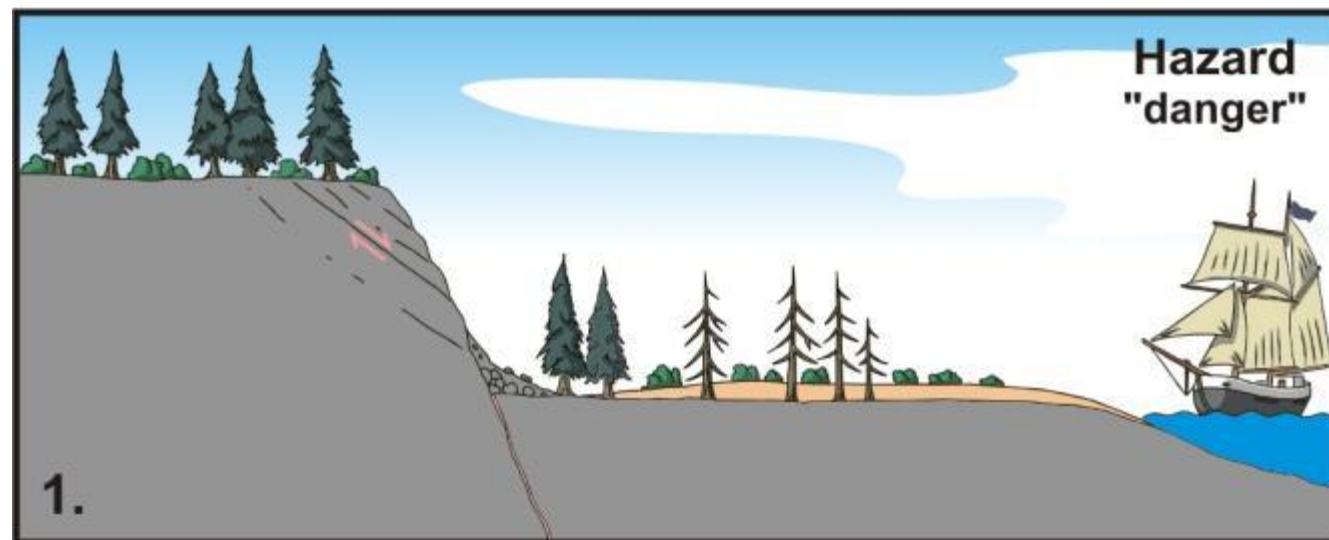
 *Coming to terms with “Risk”*




Essentials of Earthquake Risk



Coming to terms with risk



More consequences of using Hazus disaster scenarios for Canadian emergency response simulations:

 *Peer review requirements for a Hazus earthquake disaster scenario?*

 *Liability evaluation*

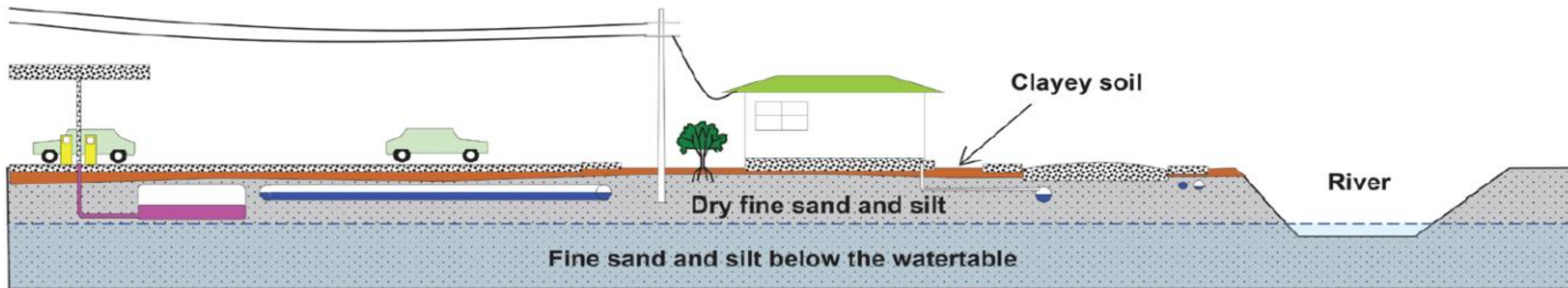


Liquefaction Hazards

Liquefaction and its Effects

Before the Earthquake

Areas of flat, low lying land with groundwater only a few metres below the surface, can support buildings and roads, buried pipes, cables and tanks under normal conditions.



During and after the Earthquake

During the earthquake fine sand, silt and water moves up under pressure through cracks and other weak areas to erupt onto the ground surface. Near rivers the pressure is relieved to the side as the ground moves sideways into the river channels.

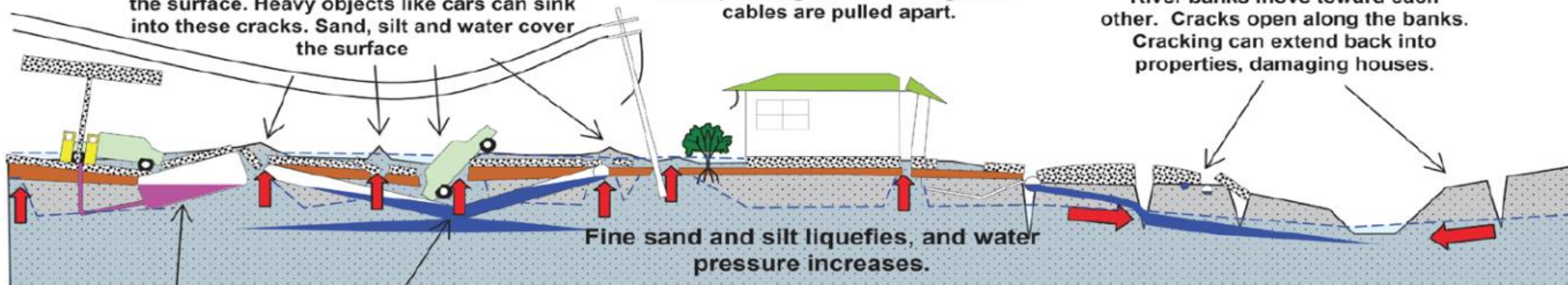
Sand Boils (Sand Volcanoes)

Sand, silt and water erupts upward under pressure through cracks and flows out onto the surface. Heavy objects like cars can sink into these cracks. Sand, silt and water cover the surface

Power poles are pulled over by their wires as they can't be supported in the liquefied ground. Underground cables are pulled apart.

Lateral Spreading

River banks move toward each other. Cracks open along the banks. Cracking can extend back into properties, damaging houses.



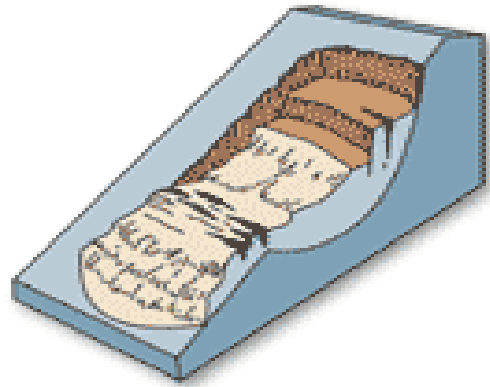
Tanks, pipes and manholes float up in the liquefied ground and break through the surface. Pipes break, water and sewage leaks into the ground.

Source: Institute of Professional Engineers of New Zealand (2012): Christchurch Earthquake - an overview.

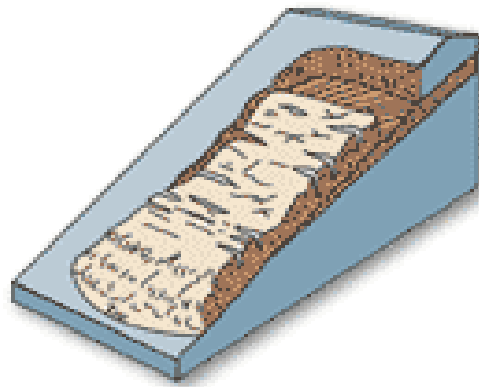
Liquefaction Hazards



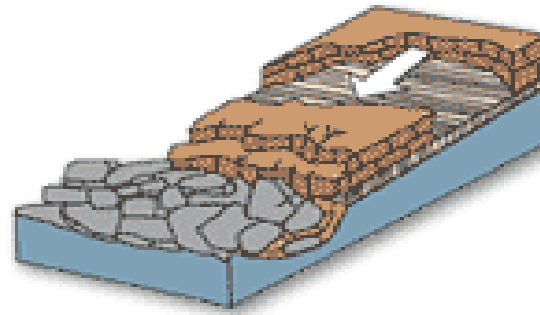
Seismic Landslide Hazards



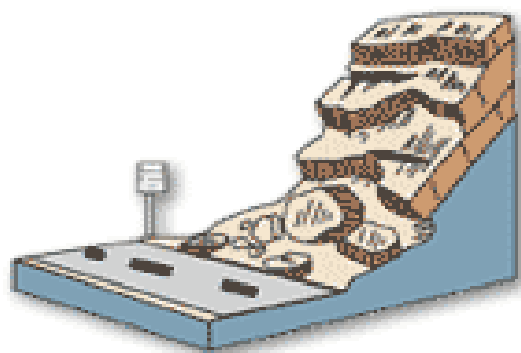
Rotational landslide



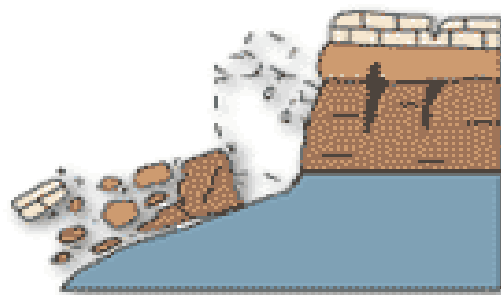
Translational landslide



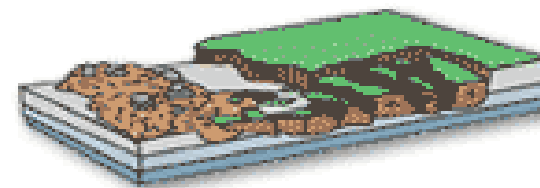
Block slide



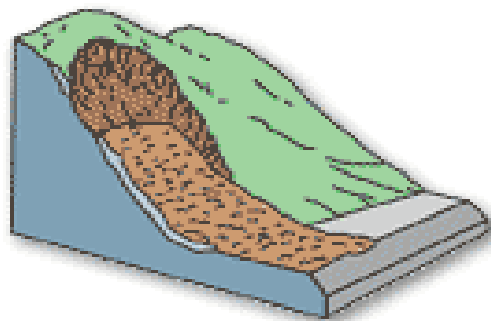
Rockfall



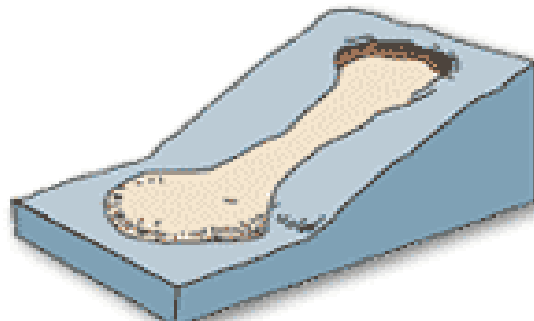
Topple



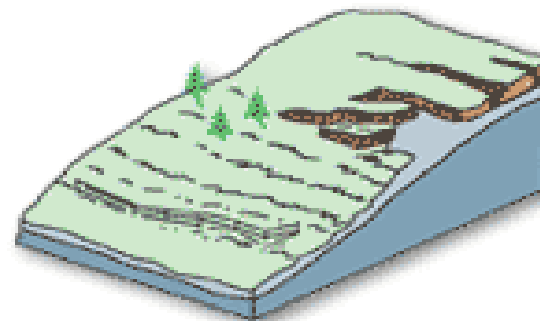
Lateral slide



Debris avalanche or flow



Earth flow



Creep





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Charlevoix, Quebec Earthquake scenario

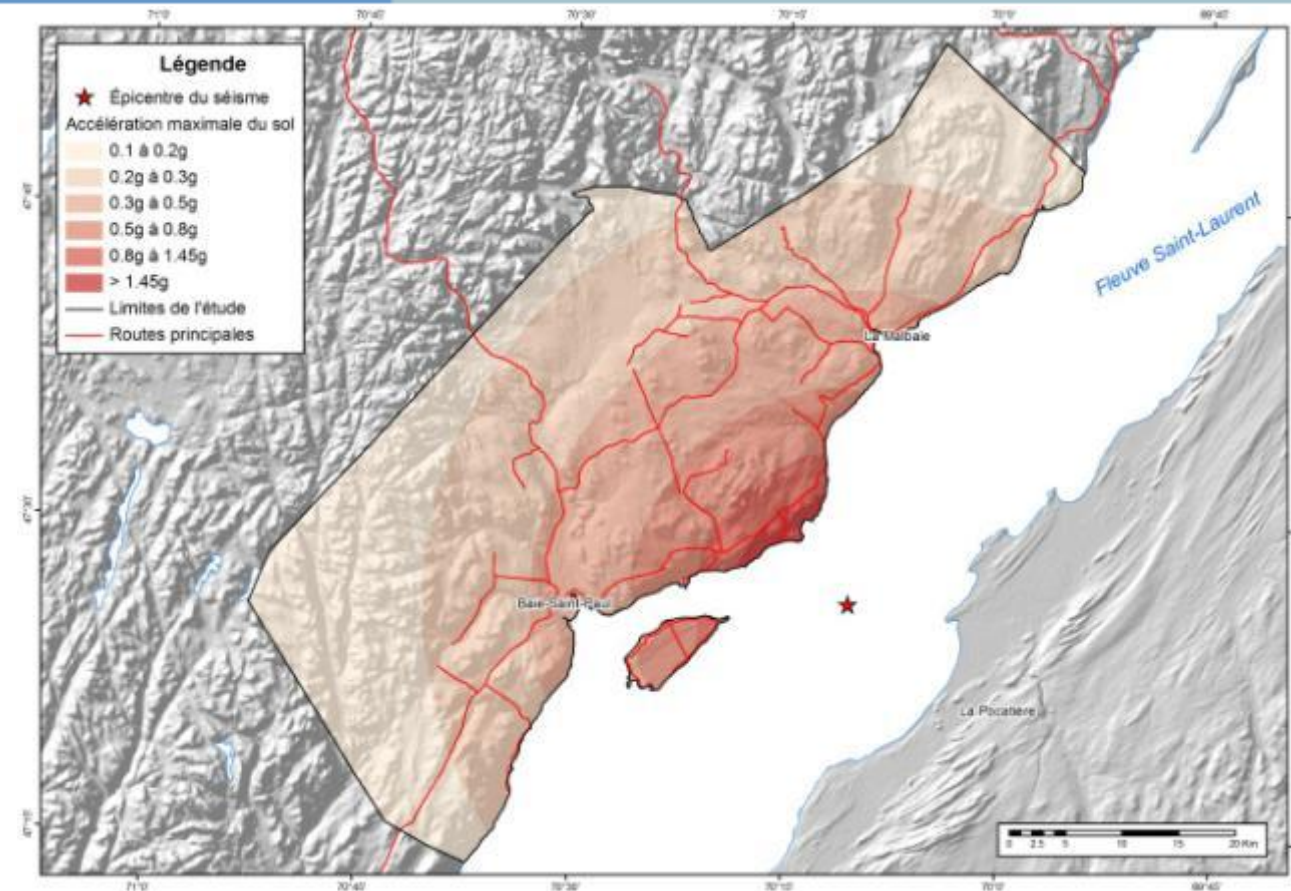
Magnitude 6.5 at 10:26 hrs, 47.438 north and -70.175 west under the St Lawrence River at 10km depth, 13 seconds of worst shaking (worst credible case wanted). Numerous aftershocks of magnitude 5 or less.

Conditions: day time temperature: 14C, night time 3C.

Sun rise 6:34, sets 18:31. Rains for week following event.

Sponsor: Public Security Quebec

Participants: Public Safety Canada, Public Security Quebec and Local governments



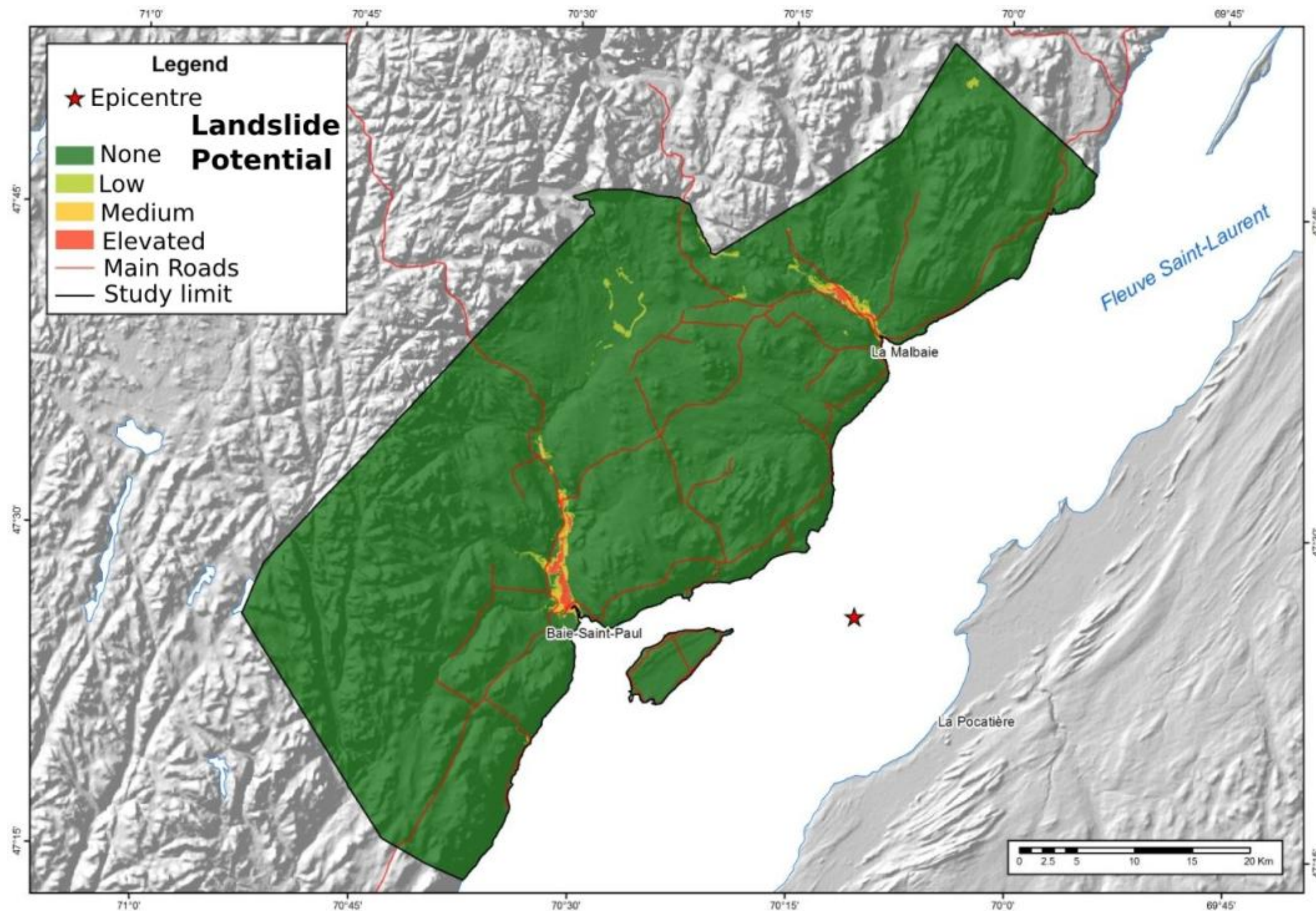
Historically most seismically active of eastern Canada.

5 largest recorded events

- 1663 (M7.0);
- 1791 (M6.0);
- 1860 (M6.0);
- 1870 (M6.5); and
- 1925 (M6.2 ± 0.3)

NRCan

Landslide Potential



Charlevoix, Quebec:: Exposed assets

2046km², densest areas of Charlevoix and Charlevoix east. Data from Census 2006.

Residential structures

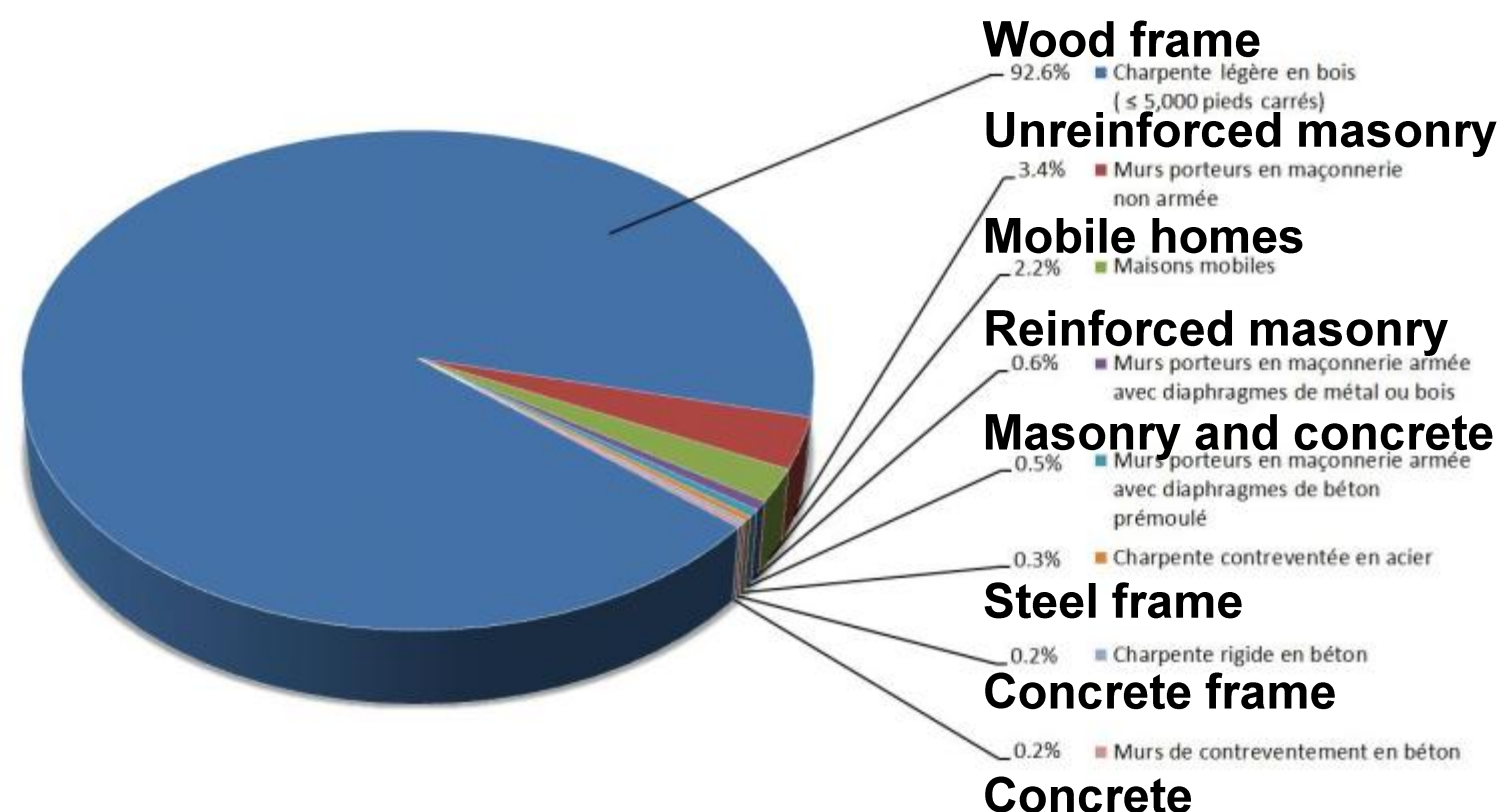
9,000

Essential Facilities

17 schools,
2 police stations,
9 health centres, and
13 fire stations.

Transportation (replacement cost = \$4 billion)

770 kilometres of road
55 bridges
2 tunnels
> 80 kilometres of railway and
9 railway bridges

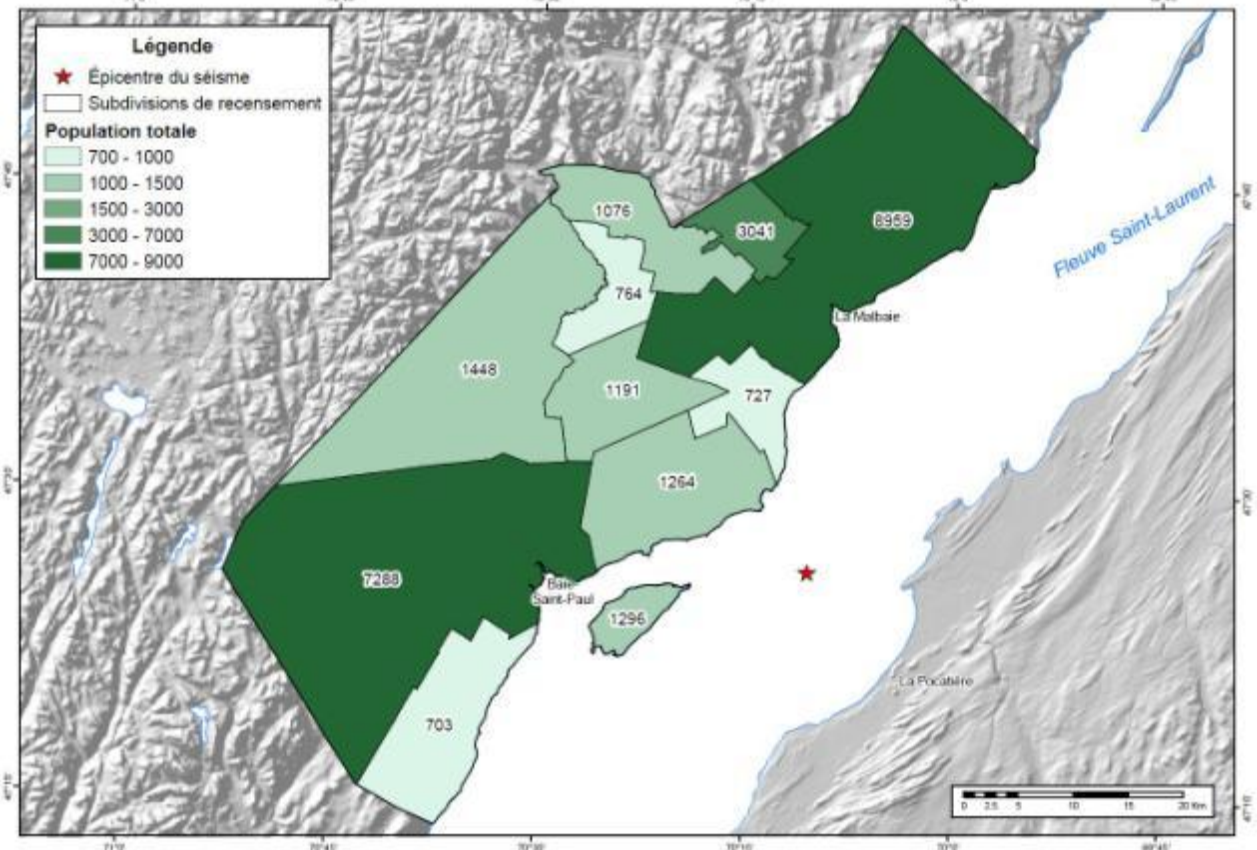


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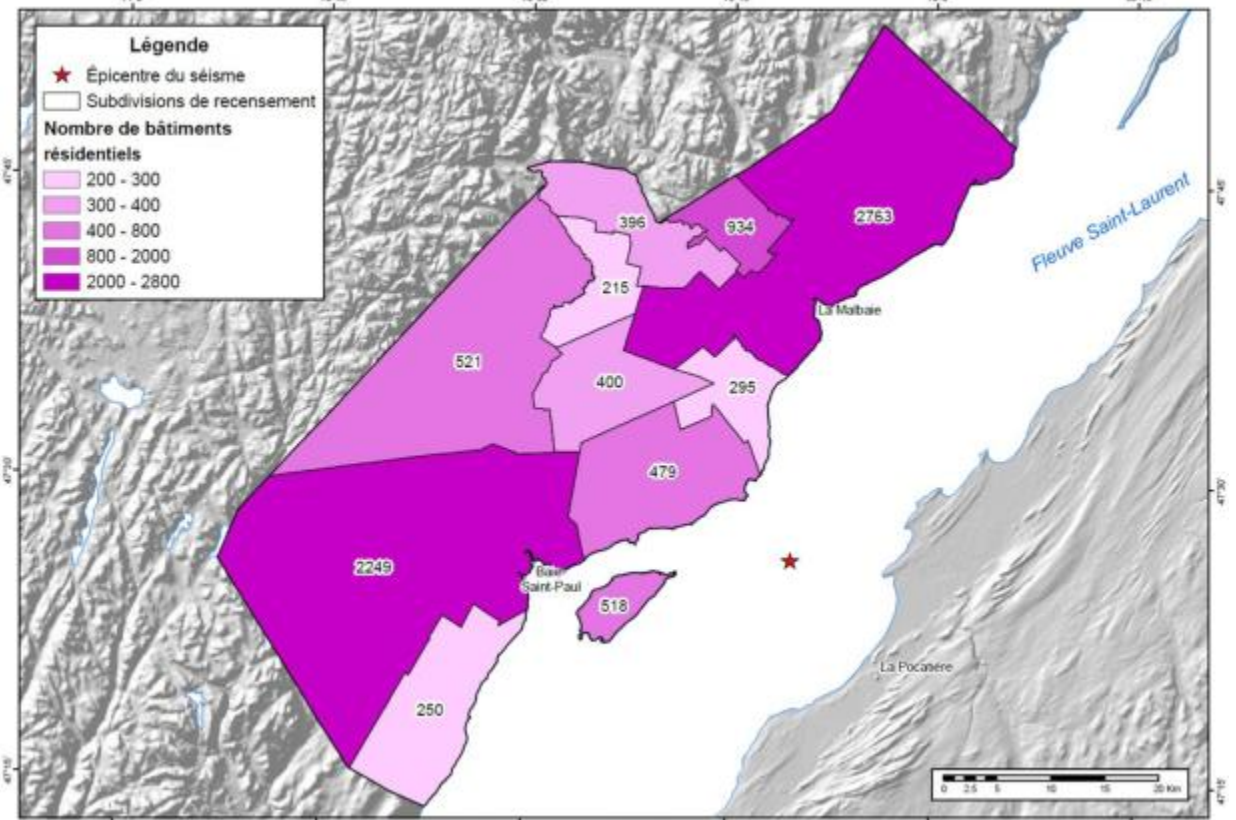
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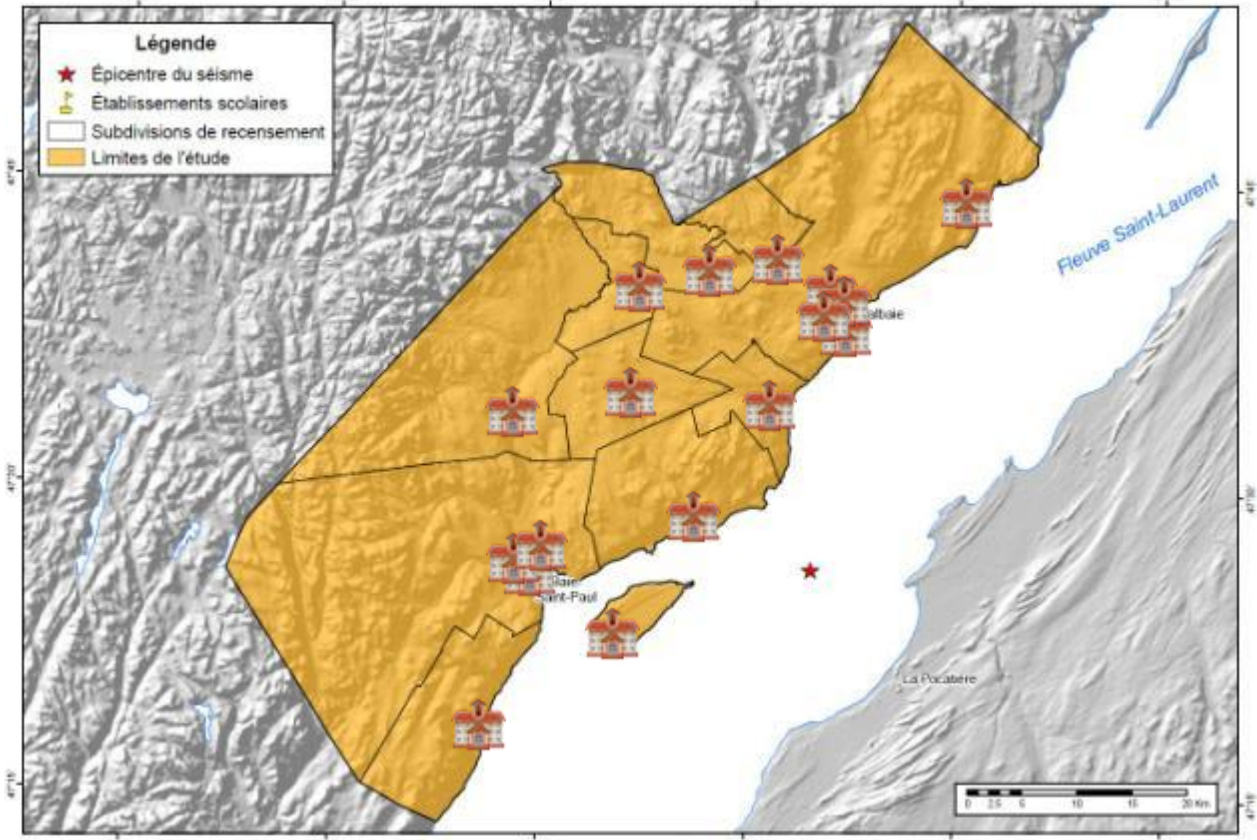
Census Subdivisions



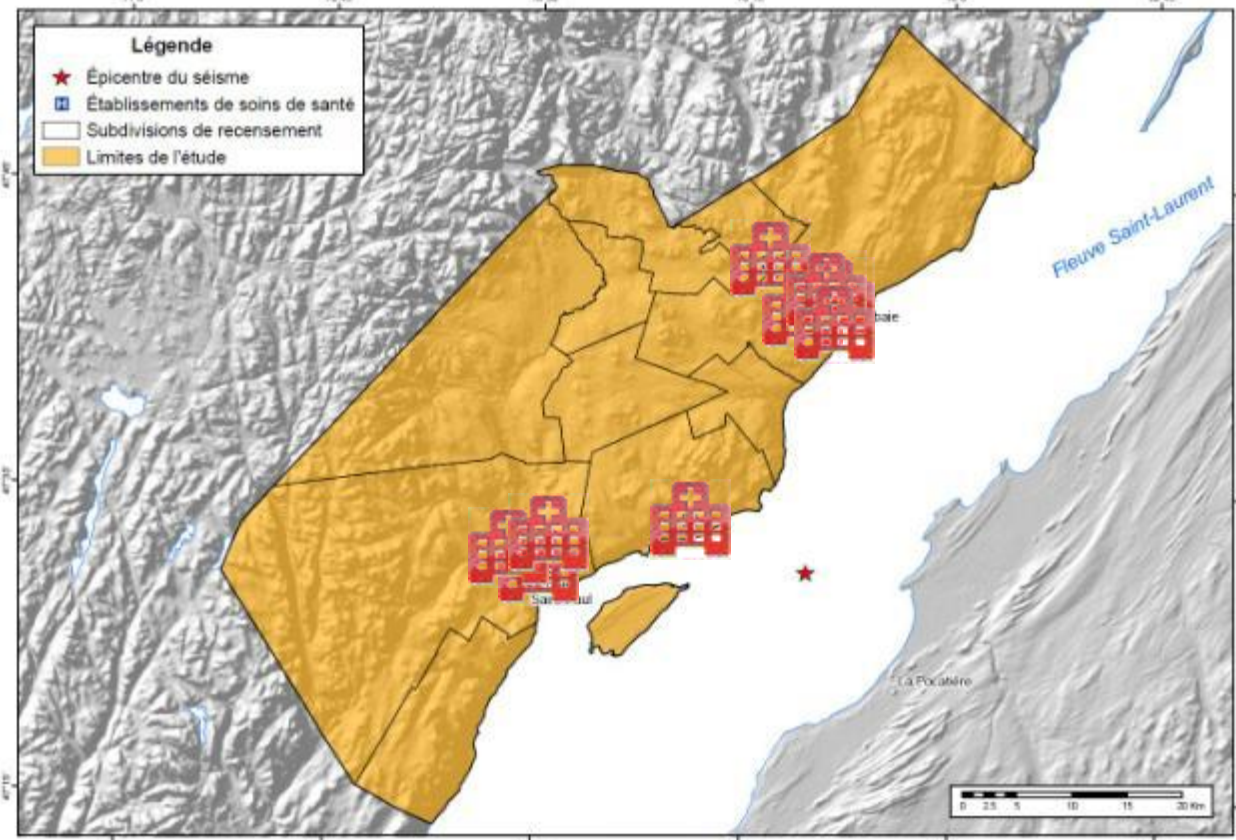
Numbers of buildings



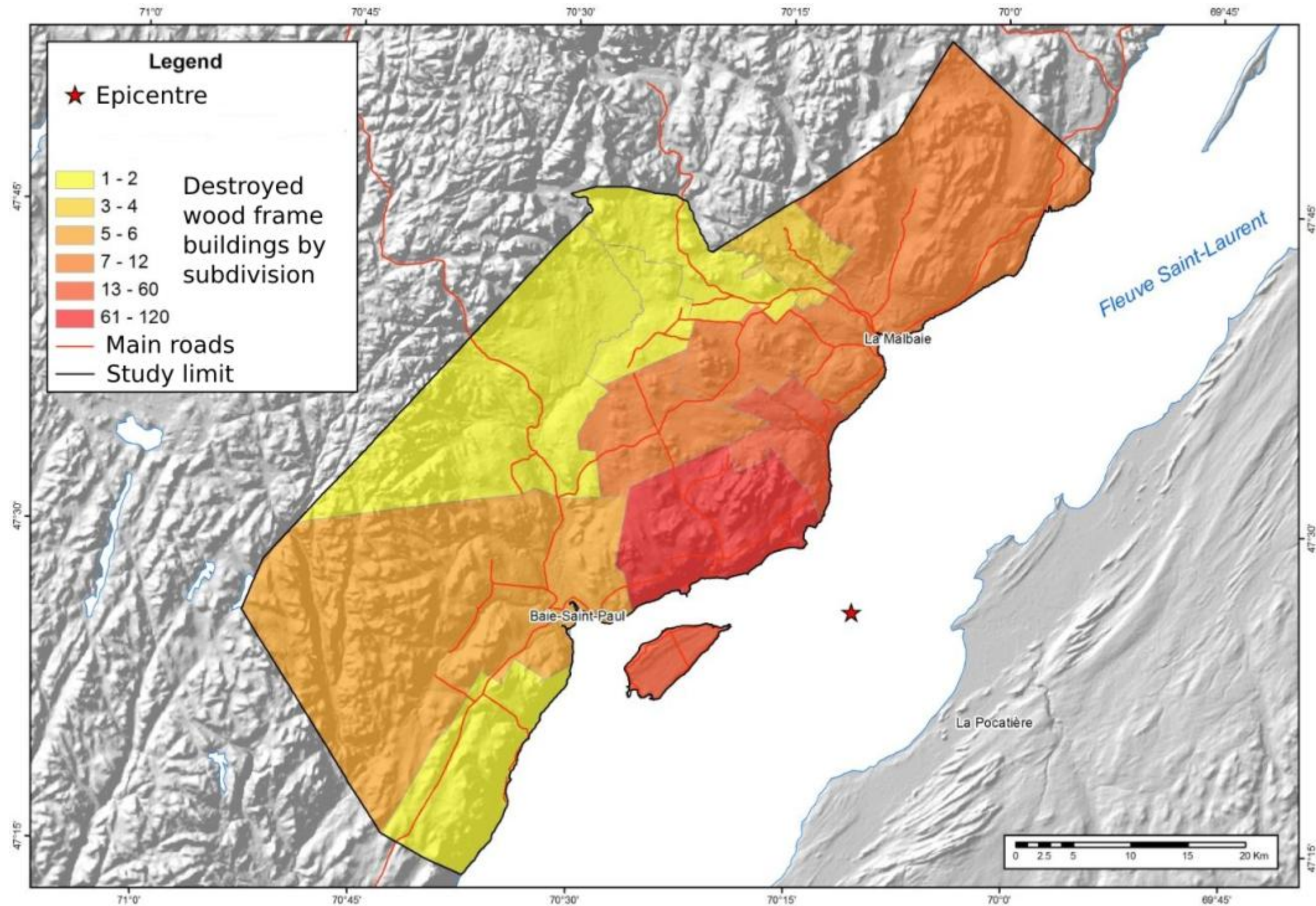
Schools



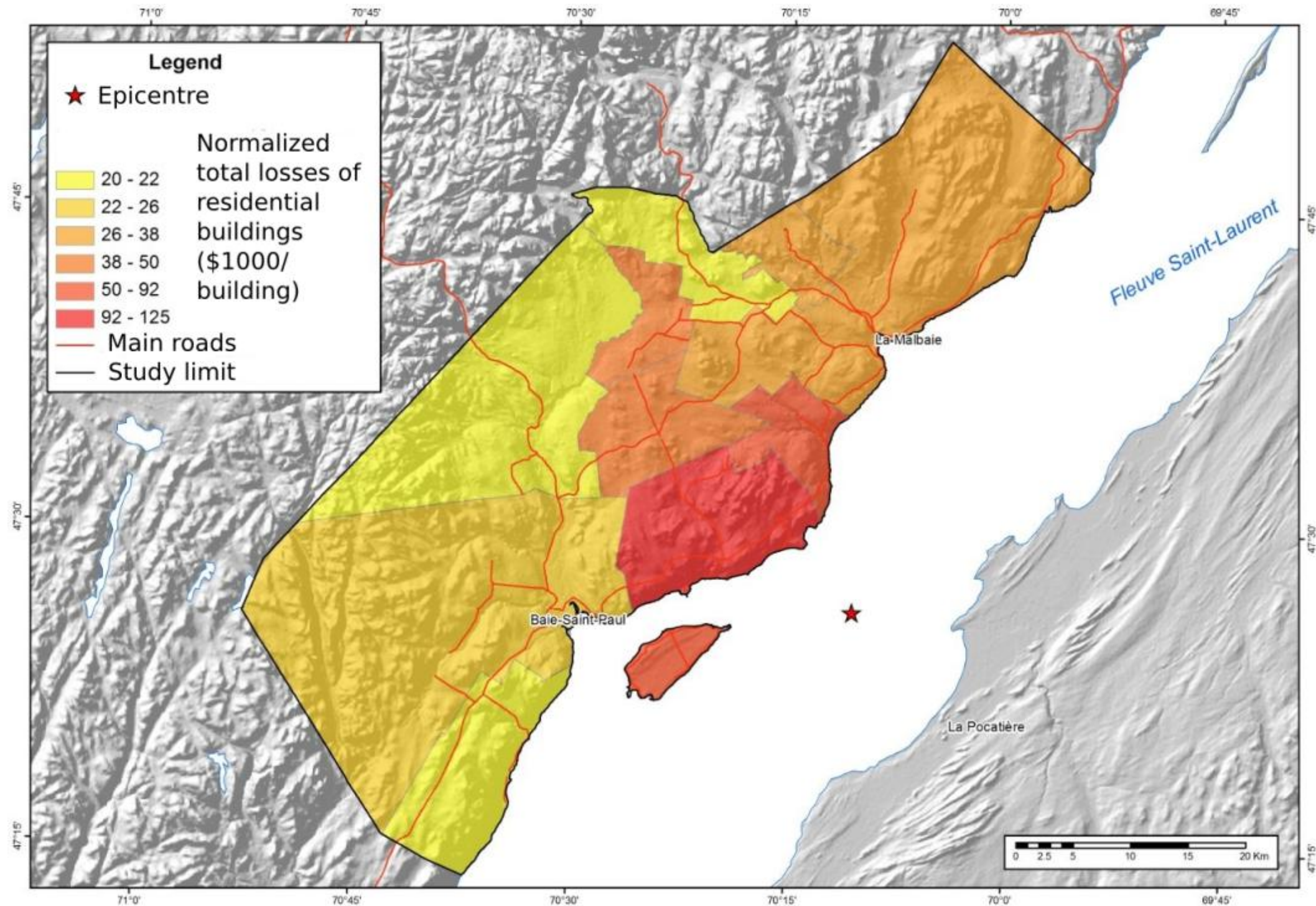
Health centres



Wood Frame Buildings Destroyed



Residence Building Losses: Normalized



A satellite map of the Metro Vancouver region in British Columbia, Canada. The map shows the Fraser River and its delta flowing into the Burrard Inlet and the larger Salish Sea. The urban areas of Vancouver, Burnaby, and Richmond are visible, along with surrounding green spaces and mountains. The text "Metro Vancouver" is overlaid in white on the right side of the map.

Metro Vancouver



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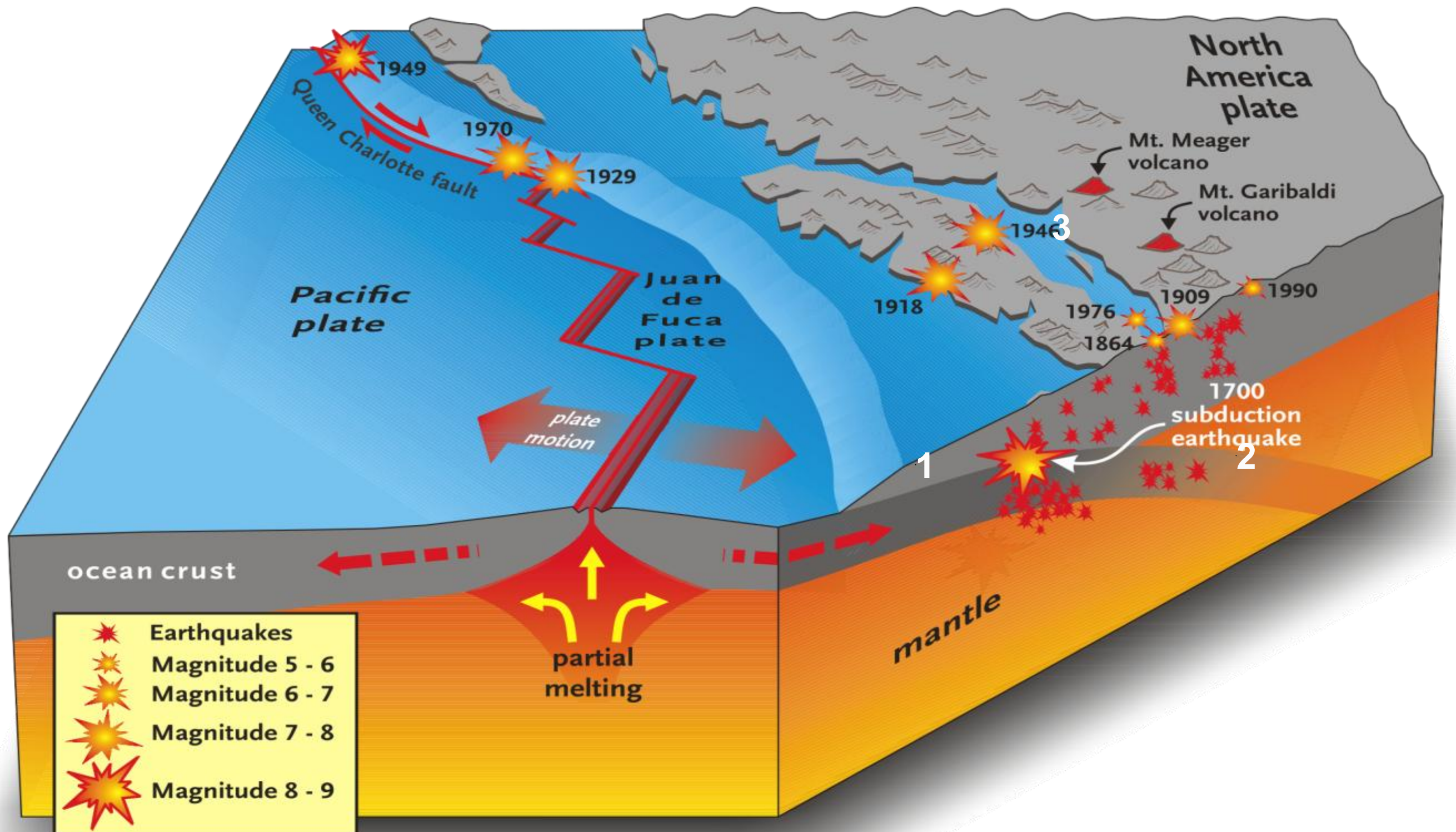
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Georgia Strait Scenario (M7.3)

Earthquake	Mean Loss Ratios	Source
Christchurch 2011	12 % (preliminary. 1 Insurance Company)	A.S. Munich Re 2013
Northridge 1994	2% - 3%	A.S. Munich Re 2013
Mexico 1985, zone C	6.2%-15%	A.S., Earthquake Spectra, 1989
Chile 2010	2.5% - 7%	A.S. Munich Re 2013
DNV Puget Sound	2.7%	GSC-HAZUS, 2013
DNV Georgia Strait	8%	GSC-HAZUS, 2013

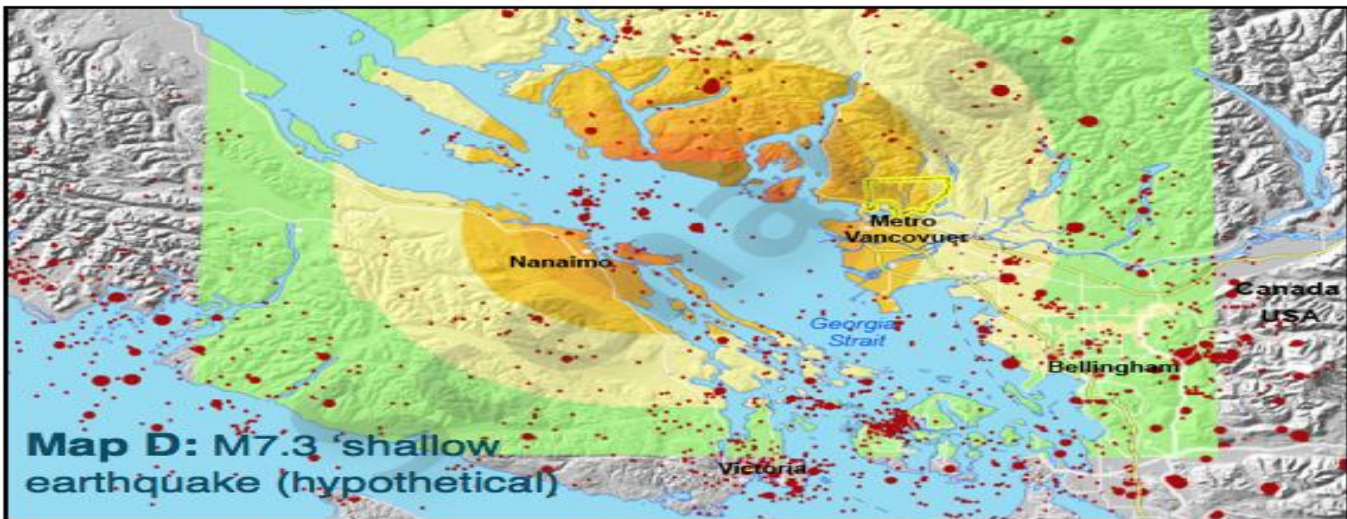
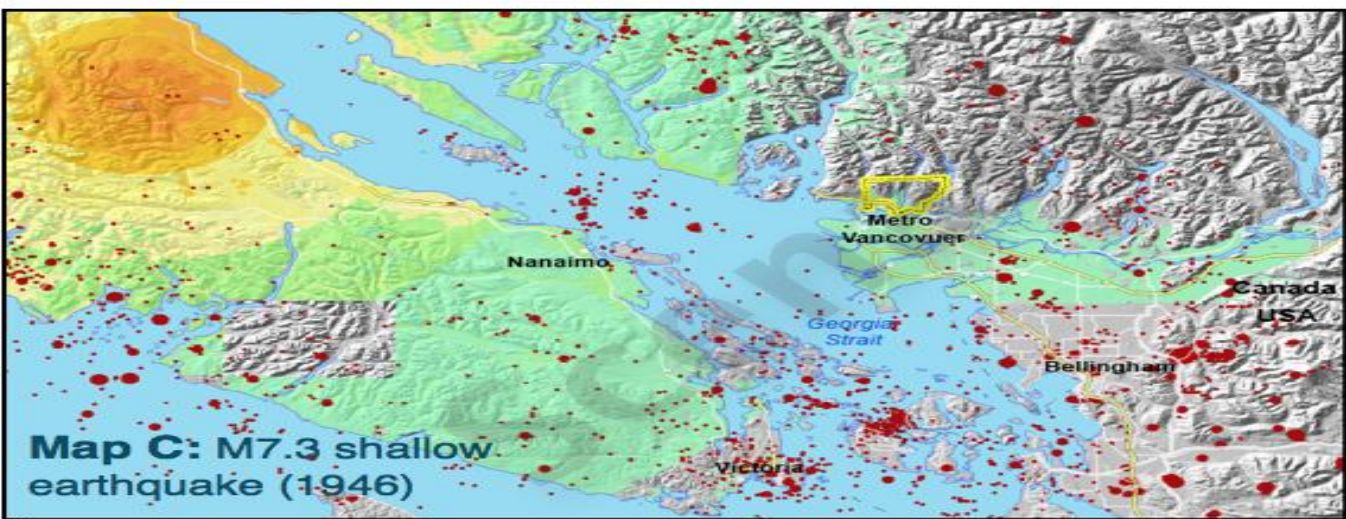
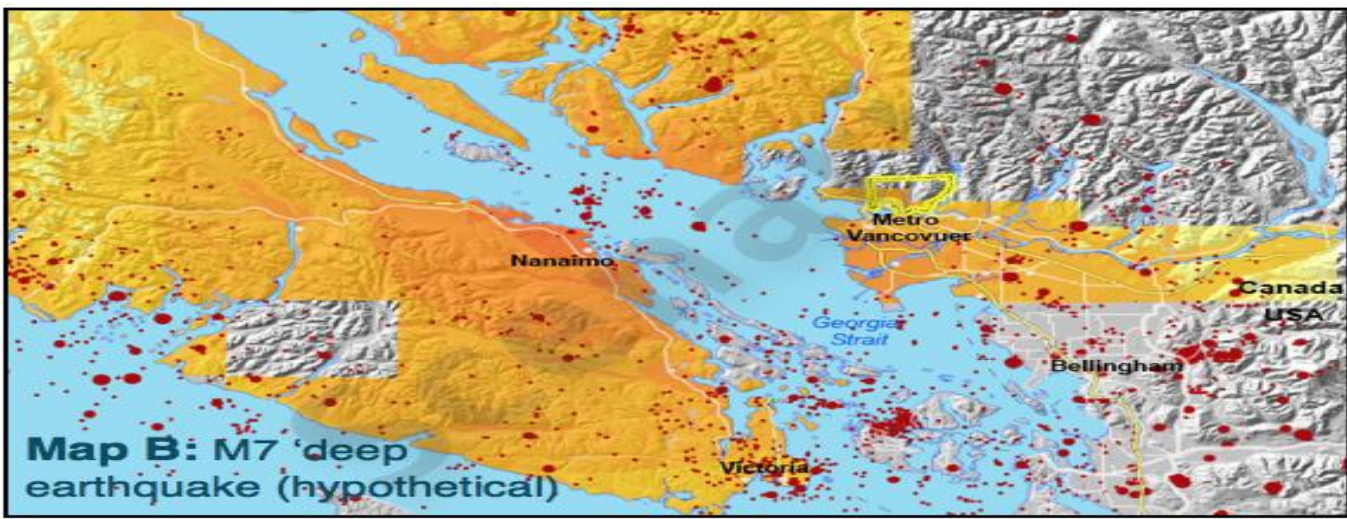
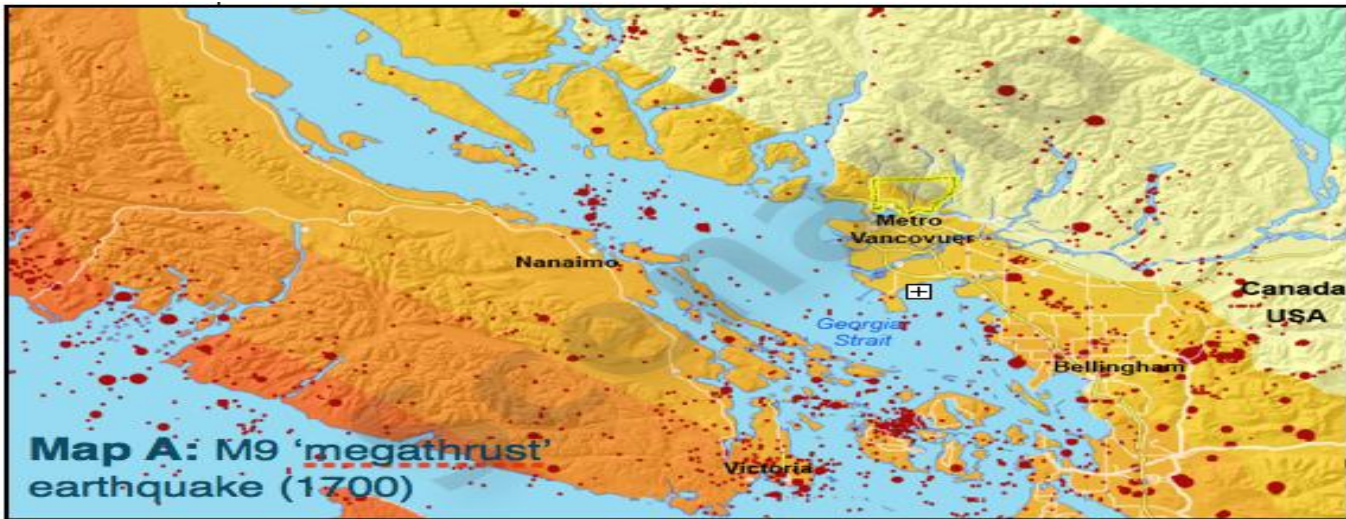


Seismic Source Zones— Southwest British Columbia



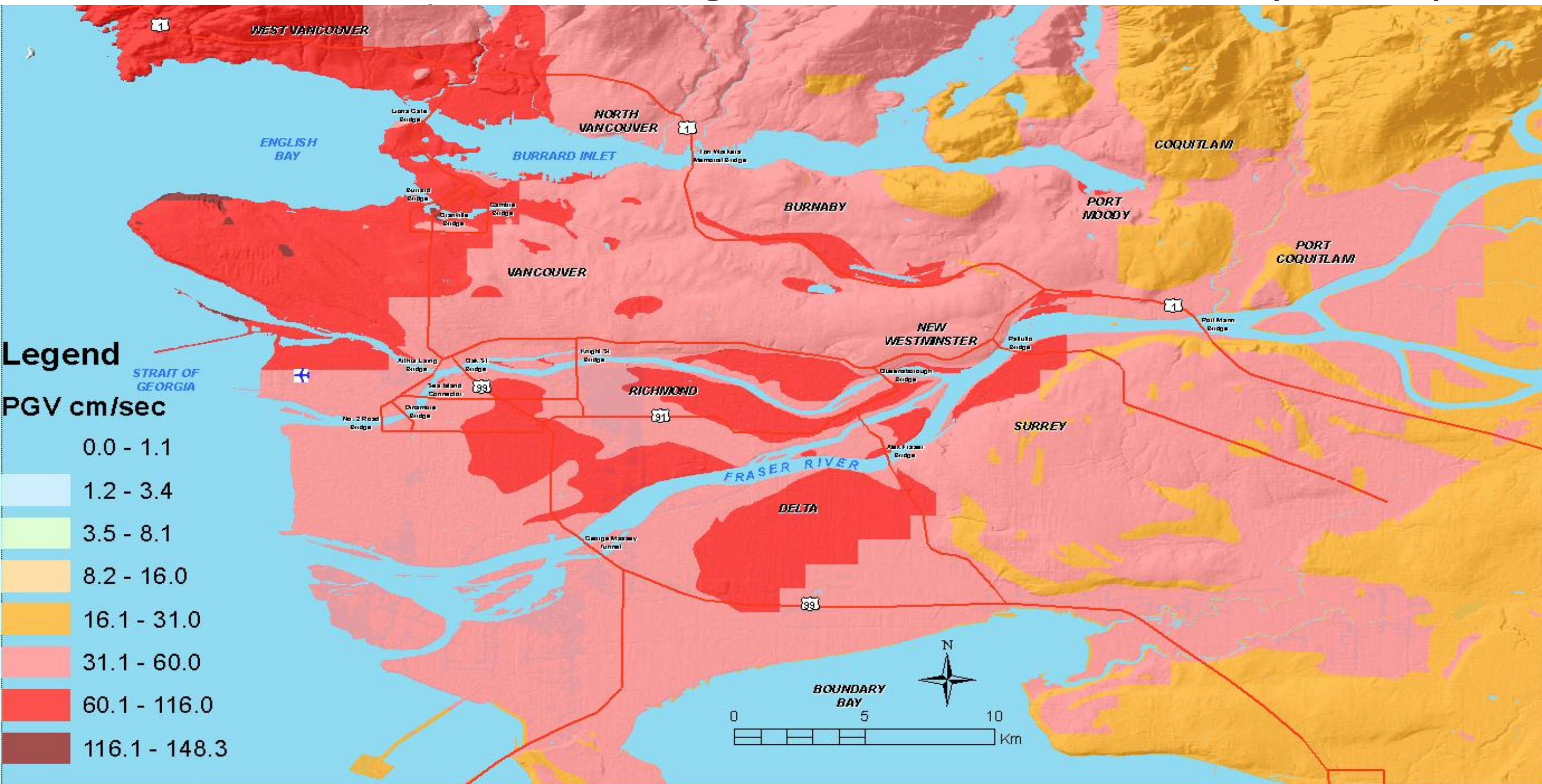
Ground Motions for Earthquake Event Scenarios

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	None	None	None	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
PEAK ACCELERATION (%g)	< 0.17	0.17 - 1.4	1.4 - 3.9	3.9 - 9.2	9.2 - 18	18 - 34	34 - 65	65 - 124	> 124
PEAK VELOCITY (cm/s)	< 0.1	0.1 - 1.1	1.1 - 3.4	3.4 - 8.1	8.1 - 16	16 - 31	31 - 60	60 - 116	> 116
MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	None	None	None	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
PEAK ACCELERATION (%g)	.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VELOCITY (cm/s)	.02	0.1	1.4	4.7	9.6	20	41	86	>178
MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Ground Motions – Georgia Strait Scenario (M7.3)



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	None	None	None	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
PEAK ACCELERATION (%g)	< 0.17	0.17 - 1.4	1.4 - 3.9	3.9 - 9.2	9.2 - 18	18 - 34	34 - 65	65 - 124	> 124
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MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

HAZUS estimates ~ **130,000** buildings will have moderate damage: over **27%** of the of buildings in the region.

8,100 buildings damaged beyond repair.

Building-related losses are ~**\$20-25 B dollars**; 21% of the estimated losses are business interruption.

Largest loss is residential occupancies: > **68%** of the total.

Damage Potential

Building Safety

Damage Potential - *Georgia Strait Scenario*



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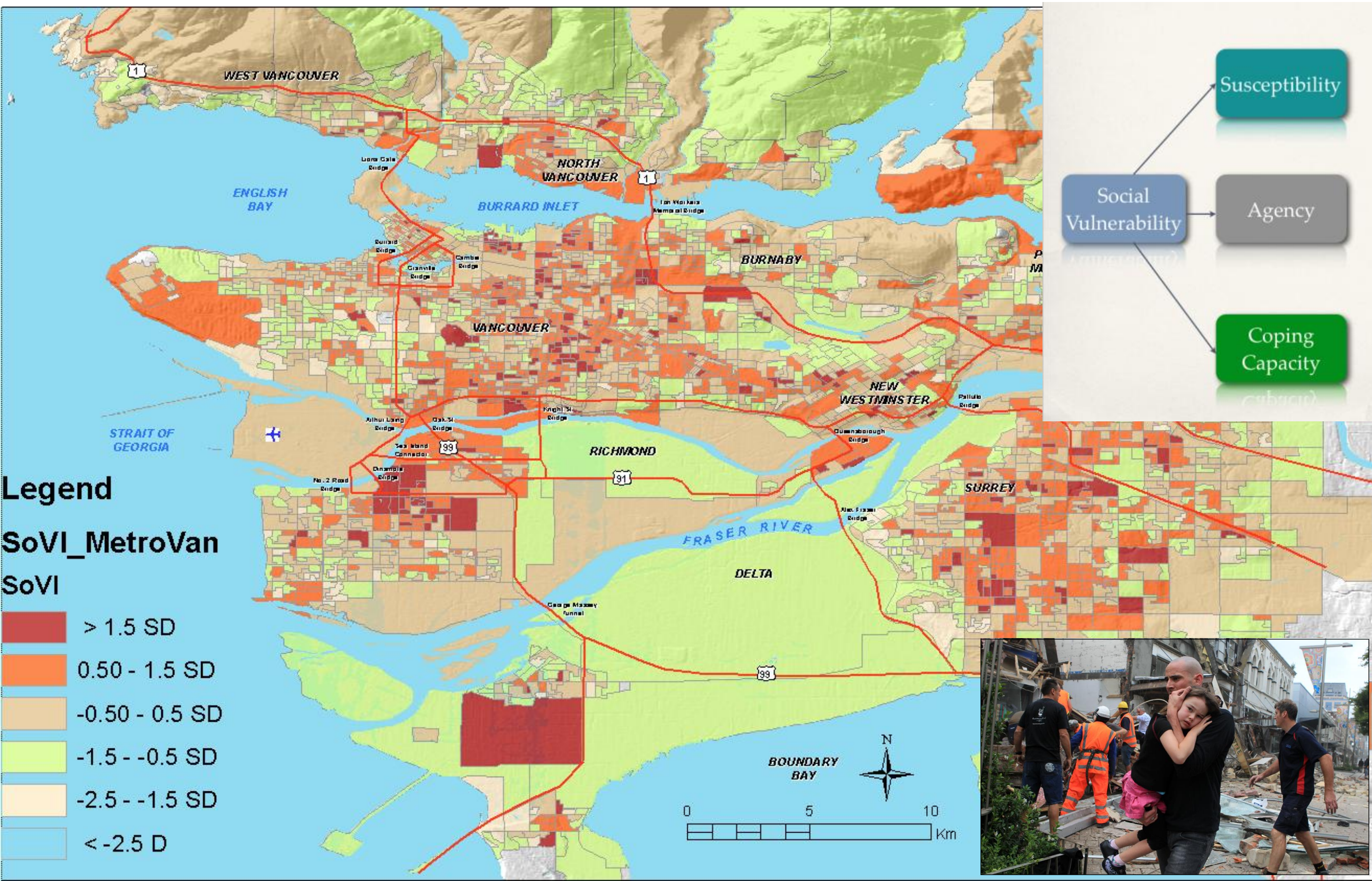
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Public Safety

Intrinsic Social Vulnerability

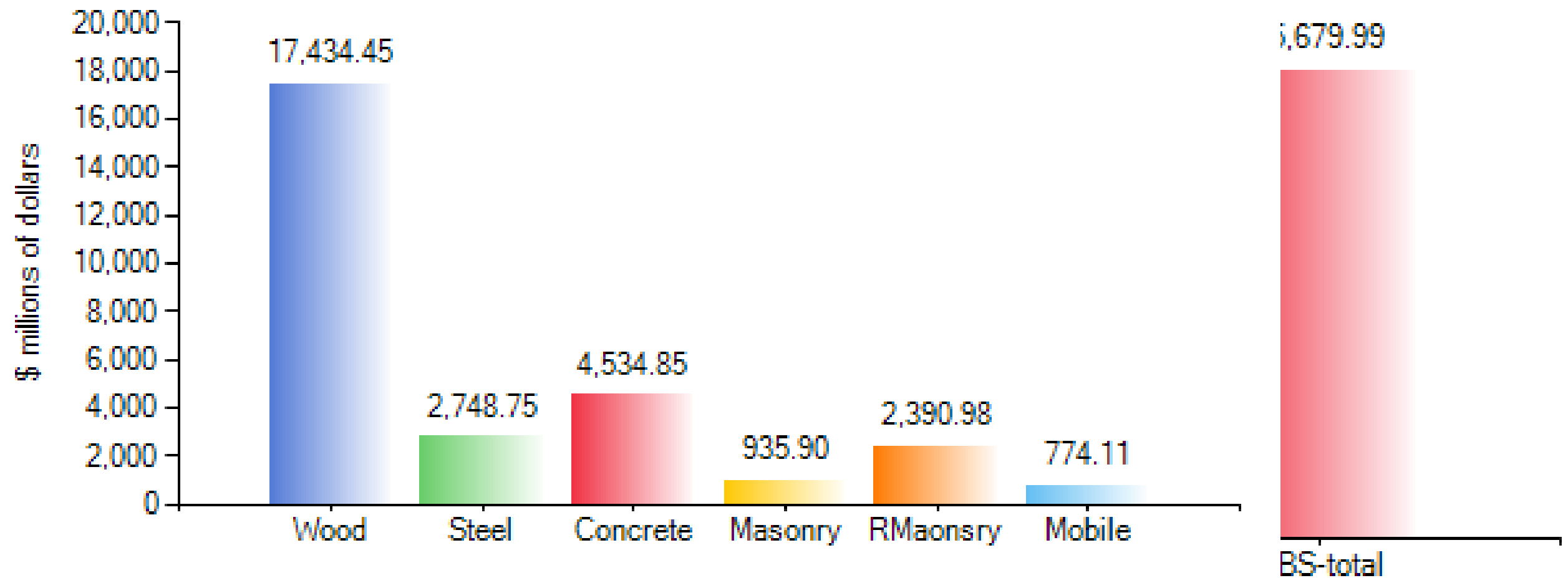
Injuries Requiring Medical Attention

Vulnerable Populations- MetroVan



Earthquake Losses - Building Type-CT

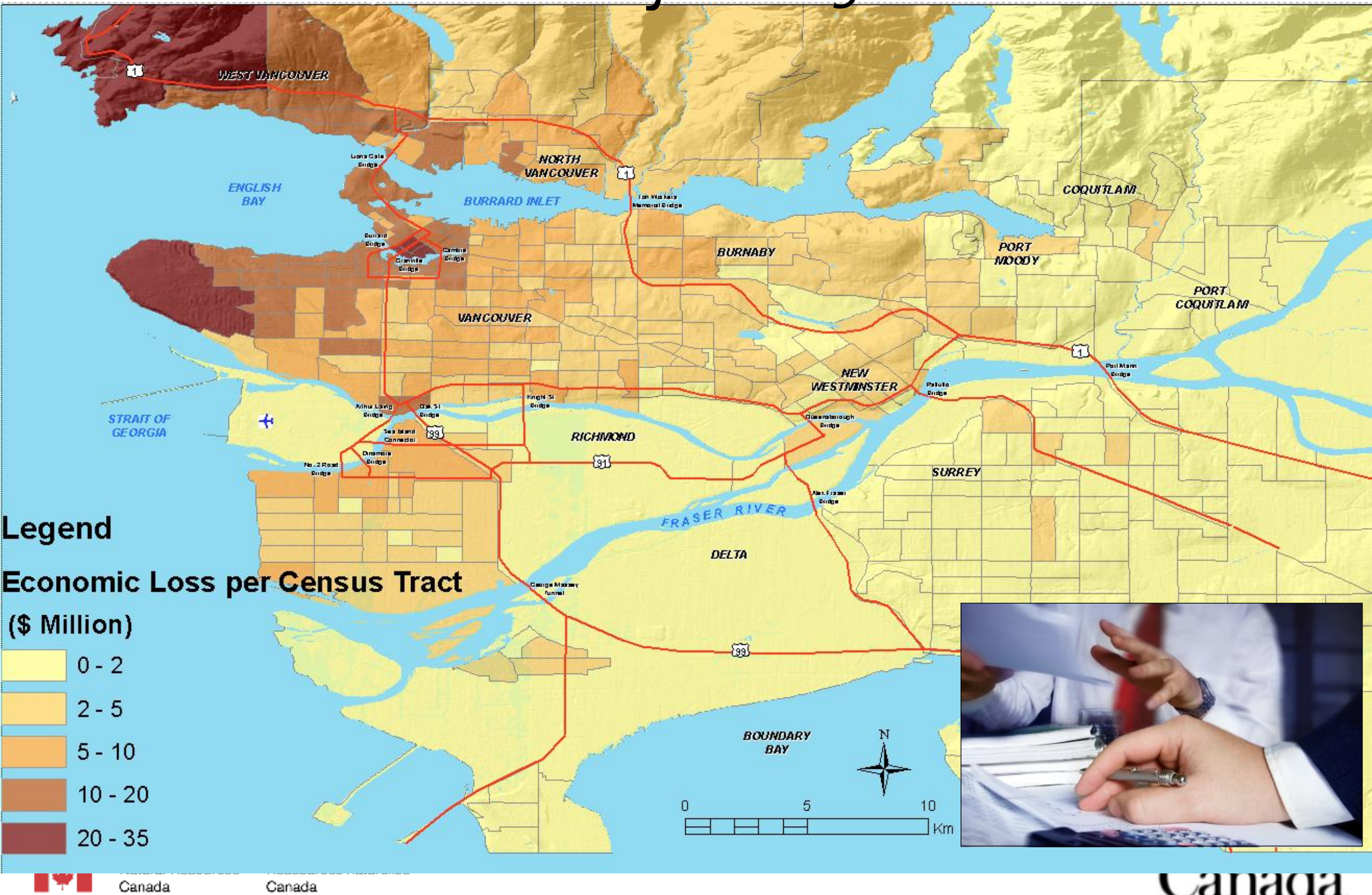
Capital stock losses by building type



Socioeconomic Security

Direct Economic Losses

Socioeconomic Security- *Georgia Strait Scenario*



Hazus estimates > **9 million tons** of debris will be generated.

Brick/Wood comprise 26% and the rest is **Reinforced Concrete/Steel**.

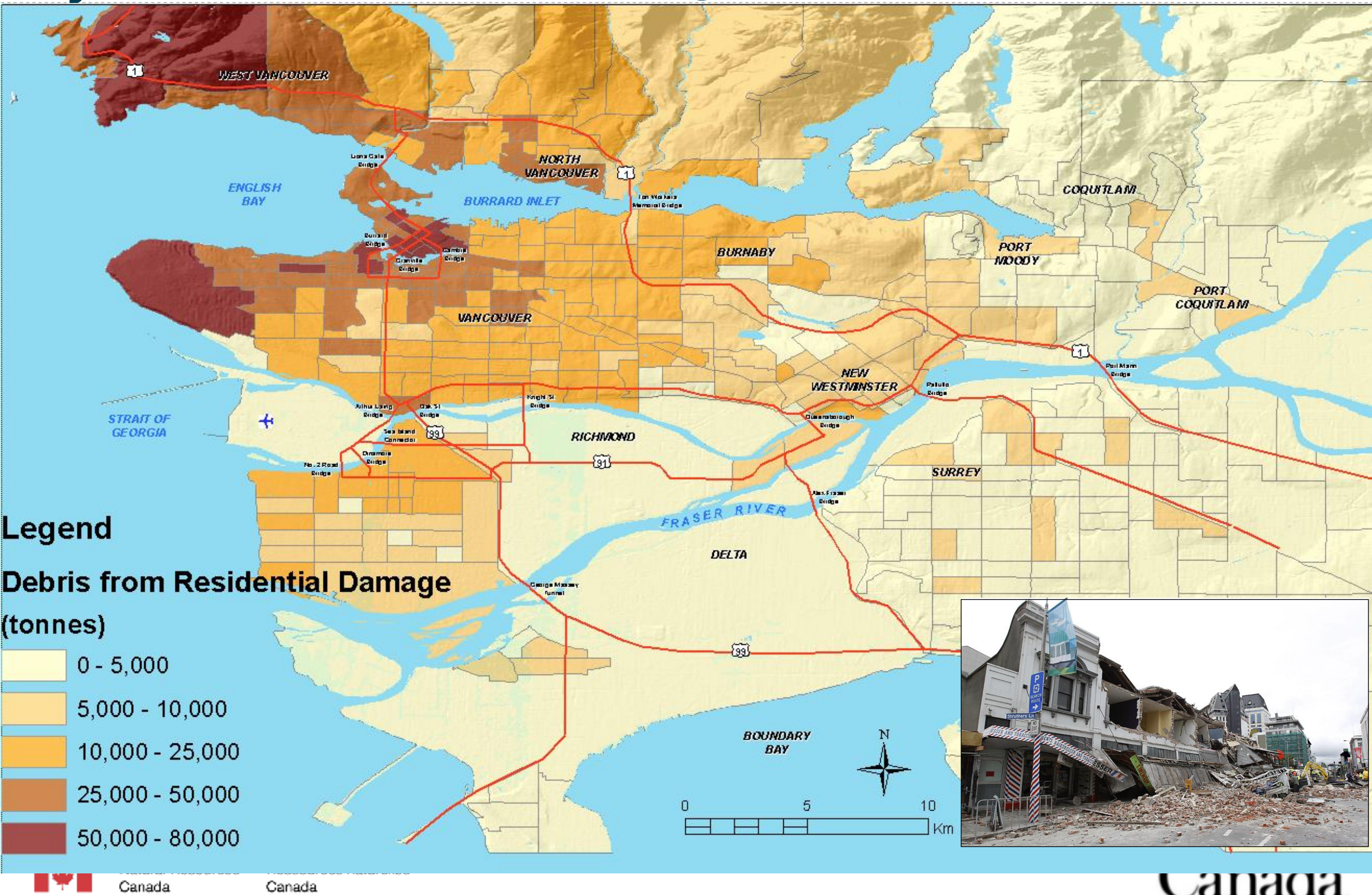
That is **~375,000 truckloads (@25 tons/truck)** to remove the debris generated by the earthquake.

System Resilience

Disaster Debris

Lifeline Systems (Water & Power)

System Resilience- *Georgia Strait Scenario*



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Hazus disaster scenarios for:



Preparedness & Response:
Operational plans that increase capabilities to withstand and respond to unexpected disasters.

Recovery & Reconstruction
Foresight to rebuild communities in ways that restore socioeconomic vitality and increase disaster resilience over time.

Requires getting beyond skepticism, shock and awe

