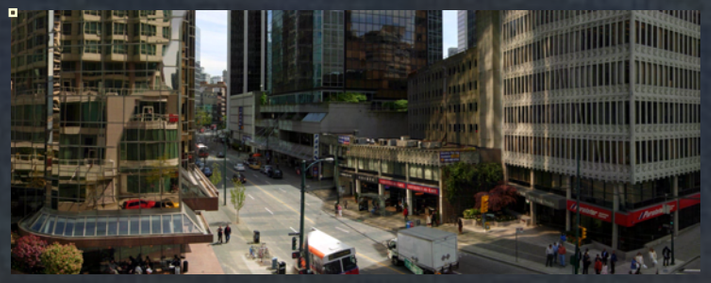
Motivating Questions for a National Earthquake Risk Model

What is the likelihood of experiencing a catastrophic earthquake in the next 50 yrs?



What are the underlying factors driving increasing disaster risk trends in Canada?

What are the likely impacts and consequences of a catastrophic earthquake?

What are the financial incentives and co-benefits of investing in disaster risk reduction?

How can knowledge about earthquake risk be used to inform disaster resilience planning?

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an Open Geoscience Web Portal for Disaster Resilience Planning in Canada

I. Intended Audience(s)

Domain Experts Responsible for the underlying base of knowledge used to inform all aspects of disaster resilience planning. Scientists and engineers provide authoritative information used to assess objective measures of risk (hazard, exposure, vulnerability, impacts & consequences). Community leaders provide information and knowledge used to determine values & preferences and to assess risk tolerance thresholds

Emergency Managers: Planner, operations manager and/or staff member of an emergency management agency whose primary role is to develop strategic and operational plans that will protect people and critical assets in the event of an unexpected disaster. Collectively, they are responsible for all aspects of prevention/mitigation, preparedness, response and recovery for disaster risks of concern under the Emergency Management Act of Canada.

Community Planners: Local and/or regional planner responsible developing strategies and public policy recommendations that incorporate principles of disaster resilience into sustainable community development in ways that meet legislative requirements for development that is ‘safe for the use intended’ and that balance competing demands for economic vitality, social justice, quality of life, and environmental integrity for current and future generations.

Insurance/Financial Sector: Analyst, planner and/or broker responsible for the development and implementation of financial instruments that are effective in transferring risks that cannot be effectively managed by individuals, businesses or government agencies; and who have agency to develop incentives that promote risk reduction through proactive investments in mitigation/adaptation measures.

Individuals: Resident and/or employee who is likely to bear the primary impacts & consequences of a disaster event and who has agency to influence mitigation/ adaptation decisions that increase their capabilities to withstand and recover

Businesses: Owner and/or manager of a business who is responsible for assessing potential risks to corporate assets and who has agency to invest in mitigation/ adaptation measures that increase the financial security of their business and the safety of its employees

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Design Elements

I. Intended Audience(s)

II. Neighbourhood Setting: Characteristics of the built environment and land use patterns that set the stage for understanding risk at the local and regional scale.

III. Determinants of Risk: Intersecting dimensions of natural hazard, hazard susceptibility, physical exposure and vulnerability that determine evolving patterns of landscape risk at a given neighbourhood or region over time.

IV. Risk Metrics: A standardized framework of indicators that measure the expected impacts and consequences of disaster events in terms of building performance, public safety, economic security, lifeline services and recovery time.

V. Risk Reduction Pathways: Planning scenarios that help make evident risk reduction potential through proactive investments in mitigation/adaptation and how to balance trade-offs between diverse and often competing policy goals and objectives.

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Different target audiences require different communication strategies

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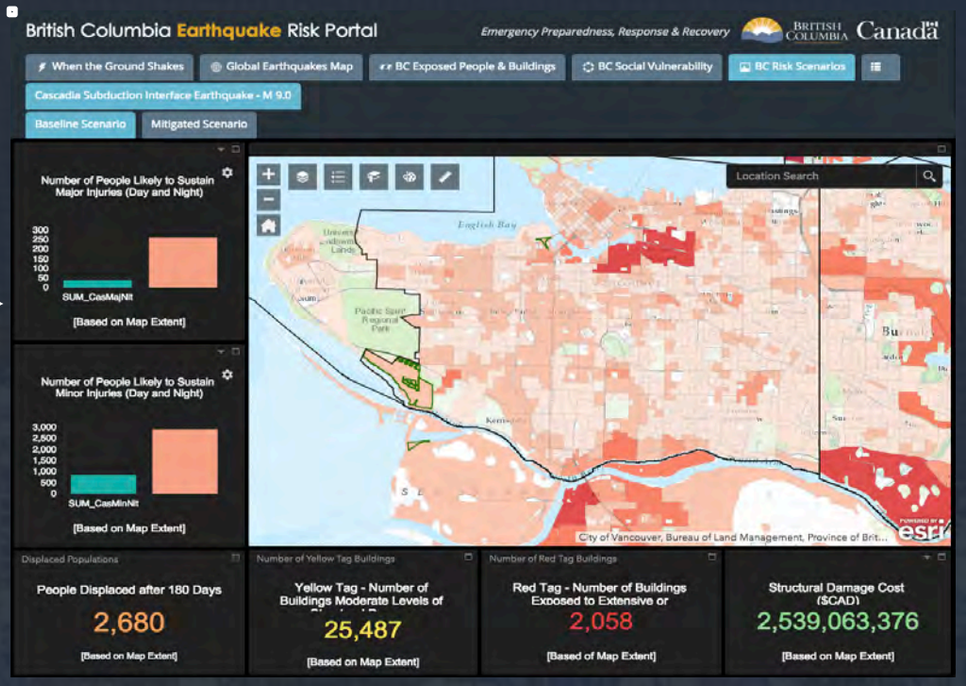
Engineer/ Analyst

Financial Sector

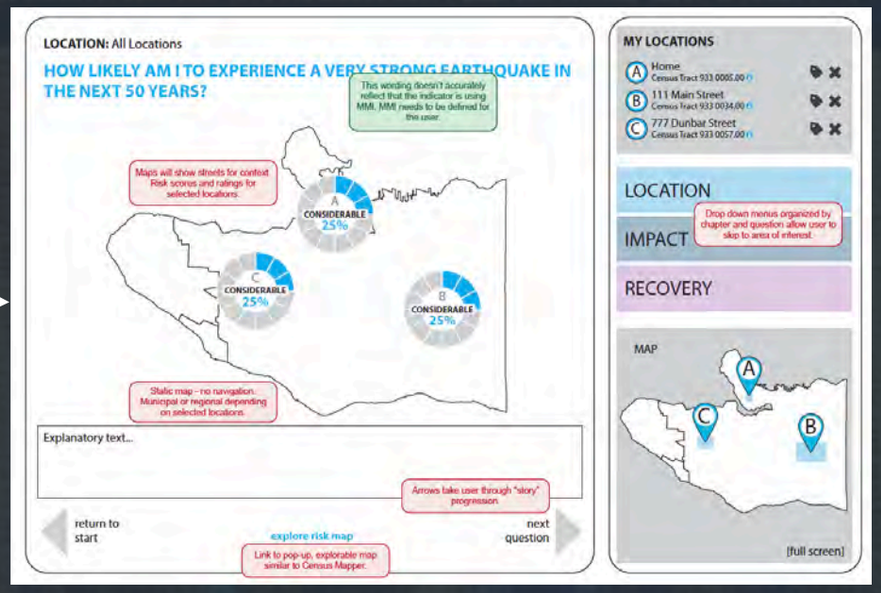
Community Planner

EMBC Earthquake RiskPortal



Emergency Manager

CoV RiskProfiler



Individual/ Business

Risk Profile indicators help bridge the gap between understanding risk and taking action

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Seismic Hazard(s)

- ***Probabilistic:*** Ground motion models developed by the GSC as part of the 2015 National seismic hazard assessment (PGA, PGV, Sa, MMI). Outptus are used to inform seismic safety guidelines established as part of the National Building Code of Canada (NBCC).
- ***Deterministic:*** Scenario-based ground motion models for a representative portfolio of subduction interface, subduction intraslab and shallow crustal earthquake events in western Canada. Outputs are used to help build a shared understanding of cause-effect relationships
- ***Liquefaction & Landslide Hazards:*** Regional hazard susceptibility maps based on available surface and subsurface geological information

Exposure

- ***Buildings:*** Neighborhood-level aggregate building portfolio describing physical characteristics of the built environment in terms of: i) land use typology (commercial, mixed, residential, industrial, etc.), ii) construction type (36 Hazus structural classes; W1, C1L, URML, etc.,), iii) seismic design level (Pre-Code, Low-Code, Moderate Code, High-Code), and iv) estimated capital assets (structural, non-structural, contents).
- ***People:*** Estimated number of building occupants (day, night, and transit) - based on Census data reported at the block level (neighborhood).

Vulnerability

- ***Physical:*** Updated fragility and vulnerability models developed by GEM for ~128 representative North American building taxonomies (structural & non-structural components). The GEM models address known deficiencies in existing versions of Hazus and are likely to be revised by researchers at the UBC-EERF to better reflect characteristics of Canadian building stock.
- ***Socio-economic***: A hierarchical SoVI model comprising 7 distinct community typologies that describe the capacity of neighborhoods to respond and recover from disaster events based on general demographics (age, family structure, mobility, etc.,), economic vitality (financial security, employment, income, etc.,), community health profile (illness, disease, medical care, etc.,) and access to emergency services.

Building Performance

- ***Damage State:*** Probability of exceeding threshold damage states (slight, moderate, extensive & complete) for a given seismic hazard.
- ***Recovery Profile:*** Estimated number of days to restore building functionality based on damage state and available capacities.

Public Safety

- ***Injuries & Fatalities:*** Probability of exceeding threshold levels of injury (L1-minor, L2-major, L3-life threatening and L4-fatality) for a given seismic hazard.
- ***Social Disruption:*** Estimated number of people likely to be displaced from homes & businesses in the days, weeks and months following a catastrophic earthquake.

Economic Security

- ***Capital Losses:*** Direct economic losses sustained as a result of earthquake damage (Probable Maximum Loss & Average Annual Loss)
- ***Risk Reduction:*** Capacity to reduce earthquake impacts & consequences through proactive investments in seismic retrofit to vulnerable buildings
- ***Return on Investment:*** Benefit/Cost ratio and expected rate of return on mitigation investments over a specified planning horizon.

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Approach and methods of risk communication are tailored to needs of specific audience groups

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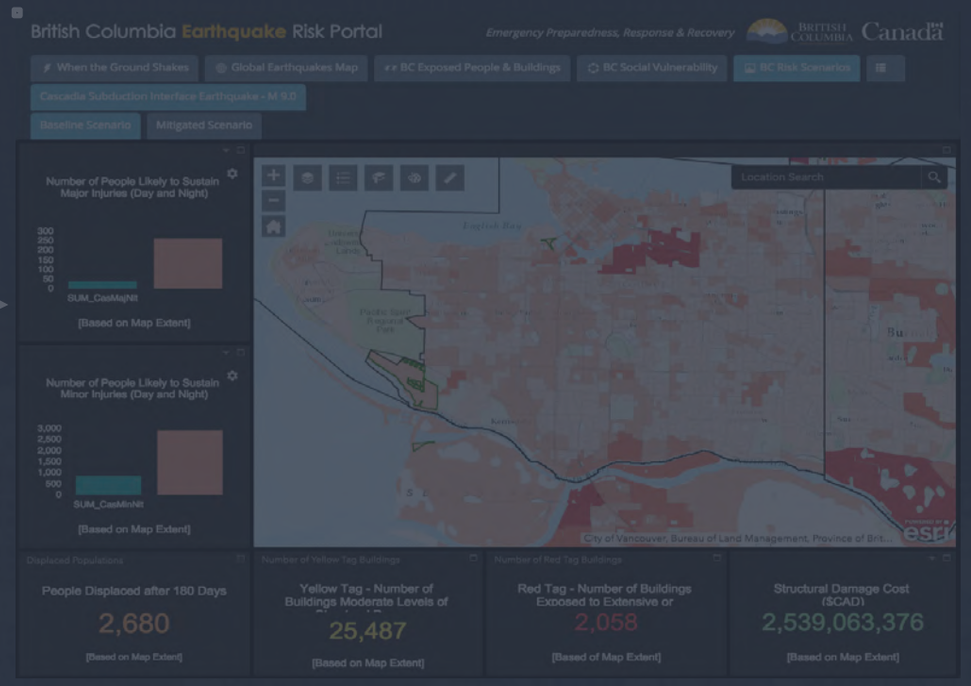
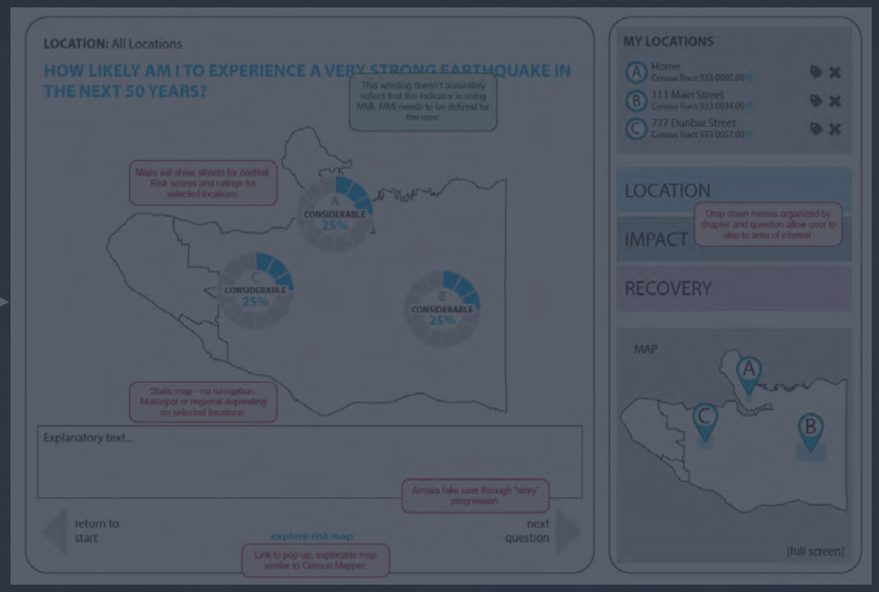
EMBC Earthquake RiskPortal



CoV RiskProfiler



Engineer/ Analyst

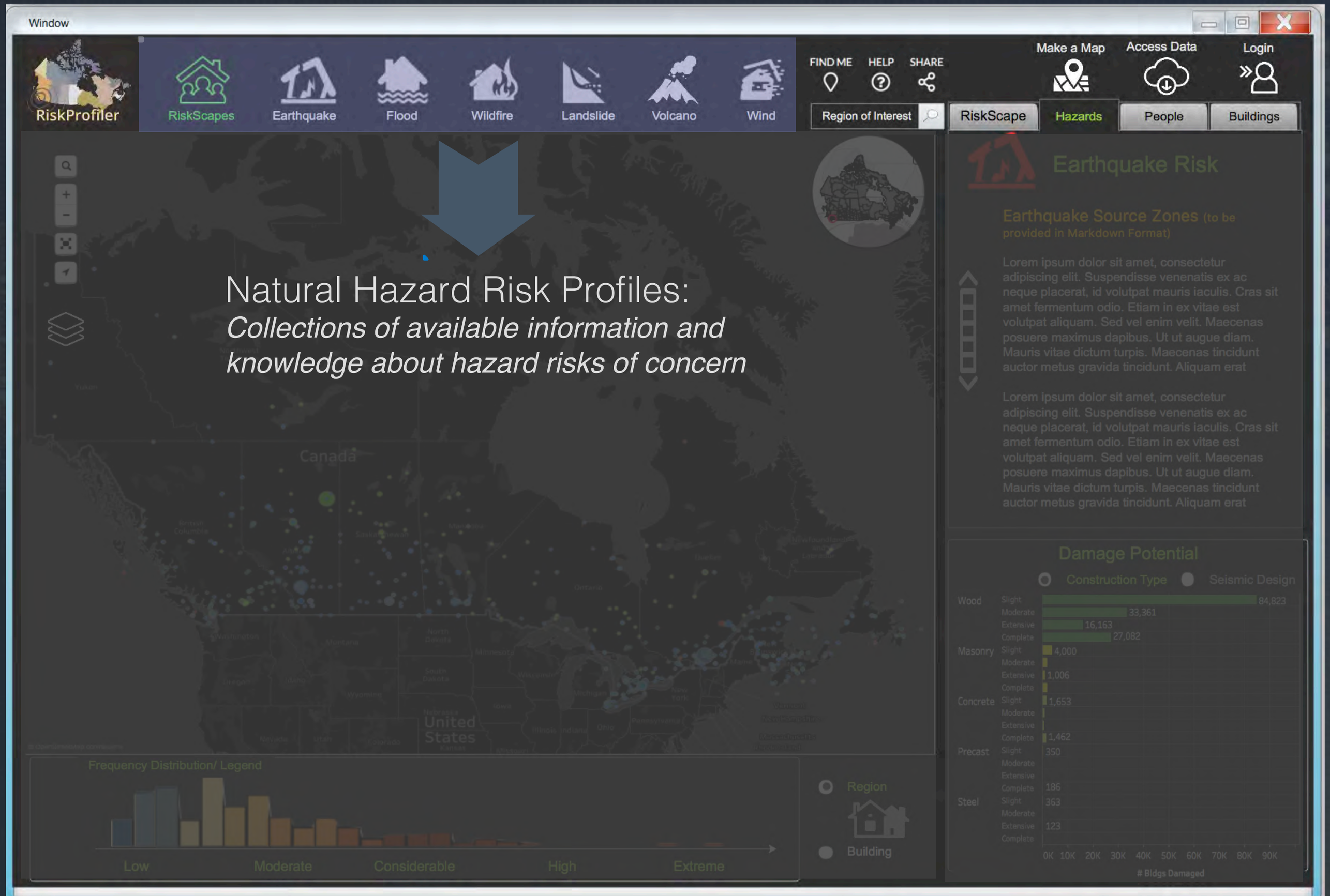
Financial Sector

Community Planner

Emergency Manager

Individual/ Business

RiskProfiler - Wireframe Design



RiskProfiler - Wireframe Design

RiskProfiler - Wireframe Design

RiskProfiler - Wireframe Design

Window

RiskProfiler | RiskScapes | Earthquake | Flood | Wildfire | Landslide | Volcano | Wind | FIND ME | HELP | SHARE | Make a Map | Access Data | Login

Region of Interest

RiskScape | Hazards | People | Buildings

Earthquake Risk

Earthquake Source Zones (to be provided in Markdown Format)

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Risk Profile StoryLines:

Plain language narratives that convey essential knowledge and understanding about disaster risk, and that help make evident opportunities for risk reduction

Canada | United States

Frequency Distribution/ Legend

Low | Moderate | Considerable | High | Extreme

Region | Building

Damage Potential

Construction Type | Seismic Design

Wood	Slight	84,823
	Moderate	33,361
	Extensive	16,163
	Complete	27,082
Masonry	Slight	4,000
	Moderate	
	Extensive	1,006
	Complete	
Concrete	Slight	1,653
	Moderate	
	Extensive	
	Complete	1,462
Precast	Slight	350
	Moderate	
	Extensive	
	Complete	186
Steel	Slight	363
	Moderate	
	Extensive	123
	Complete	

0K 10K 20K 30K 40K 50K 60K 70K 80K 90K

Bldgs Damaged

RiskProfiler - Wireframe Design

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Earthquake Risk

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Visual Analytics:

Interactive charts and infographics that summarize key dimensions of risk for a region of interest. Can be used to disaggregate risk outputs to explore factors that are driving patterns of vulnerability

Region

Building