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DRR-Pathways: Incentives for Mitigation & Adaptation Investments

Funded by Canadian Safety and Security Program
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Project Scoping Report

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SAGE ON EARTH CONSULTING
SUSTAINABLE AND INNOVATIVE SOLUTIONS

Prepared by:

Sahar Safaie, Sage on Earth Consulting Ltd.

Reviewed by:

Murray Journeay, NRCan

Mike Ellerbeck, NRCan

Kathryn Forge, Steering Committee Chair, EMBC



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1. Introduction

1.1 Overview

‘DRR-Pathways’ project contributes to building disaster resilience in BC and in Canada by enhancing understanding of systemic risk, evidence-based disaster risk management (DRM), and delivering socio-economic value of investing in mitigation and adaptation measures in advance of major earthquake and flood events.

The goal is to increase our collective understanding of the recovery process following a disaster event to inform the evaluation of planning and policy alternatives that are currently under consideration at various levels of government in BC. These include catastrophic earthquake and flood management plans under development by Emergency Management British Columbia (EMBC) and the Fraser Basin Council (FBC); and disaster resilience strategies under development by the Integrated Partnership for Regional Emergency Planning (IPREM), the City of Vancouver and North Shore Emergency Management.

The project includes components focusing on engagement, risk communication, data management platform, and capacity building which will enable connecting practitioners and academia, sharing data and outputs of the project across Canada.

‘DRR-Pathways’ project started in January 2019 and is schedule to end in June 2021. It is led by the Geological Survey of Canada-Natural Resources Canada and funded by the Canadian Safety & Security Program (CSSP) which is co-chaired by Defence Research and Development Canada (DRDC) and Public Safety Canada.

The project consists of fourteen components that contribute to the following three objectives:

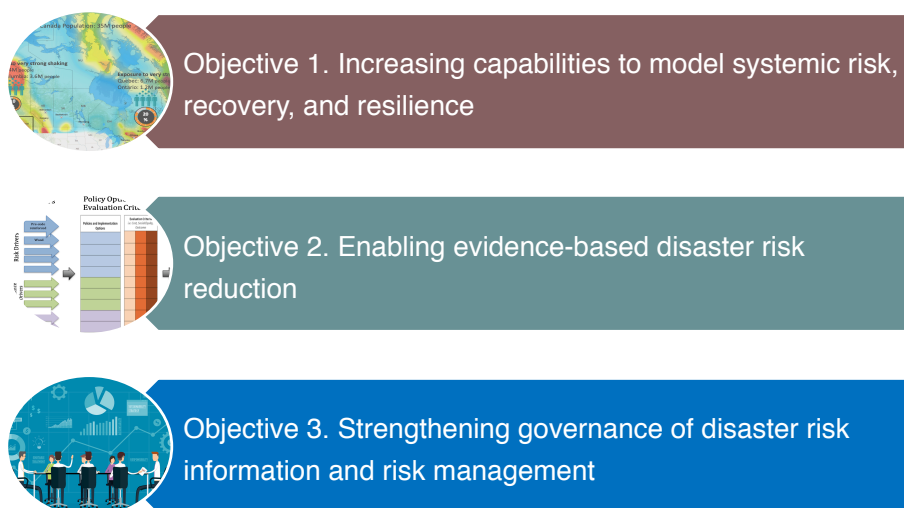


Figure 1: Three objectives of the DRR Pathways project

The key elements in understanding systemic risk and post-disaster recovery process that will be assessed in the DRR Pathways project are outlined in figure 2.

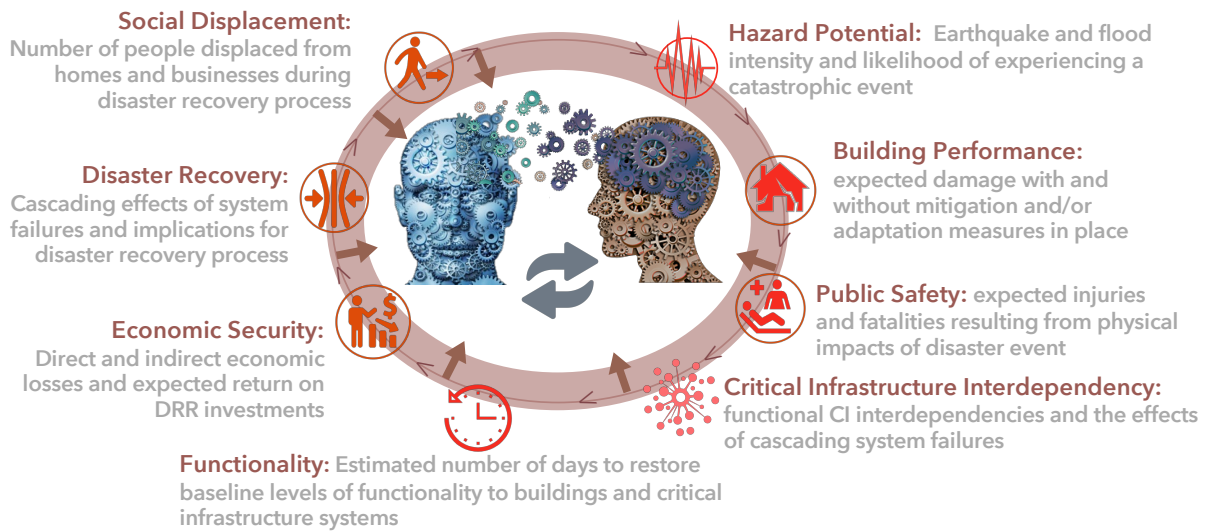


Figure 2: Increasing capabilities to model and understand systemic risk, recovery, and resilience

Partners

There are ten signatory partner institutions from academia and government:

- Emergency Management BC (EMBC)
- City of Vancouver (CoV)
- DRDC's Center for Security Science
- North Shore Emergency Management (NSEM)
- Fraser Basin Council (FBC)
- University of British Columbia (UBC) School of Community and Regional Planning (SCARP) and Civil Engineering Department
- University of Victoria (UVIC)
- Global Earthquake Model (GEM)
- Earthquake Engineering Research Institute (EERI)
- Institute for Catastrophic Loss Reduction (ICLR)

The project steering committee consists of these ten signatory members and Sage on Earth Consulting, which is the lead contractor for the project. As project implementation advances, many other key entities are joining as associate members. At time of writing this report (early June 2019), the following entities have expressed interested in joining as associate members:

- Integrated Partnership for Regional Emergency Planning (IPREM)
- Metro Vancouver
- Financial Institutions Commission (FICOM)
- Building Codes and Standards Branch (BSSB)
- Ministry of Municipal Affairs and Housing

- Public Safety Canada- BC office ¹
- Climate Adaptation Secretariat at Ministry of Environment and Climate Change Strategy
- Health Emergency Management BC (EMBC)

Budget

Table 1. Project Budget

CSSP Funds	In-kind Co-investment*	Cash Co-investment**
\$1,499,460	\$1,254,215	\$1,590,112

*All Chartered Partners

**NRCan, FBC, CoV

1.2 The purpose of this document

This document is the project scoping report and is meant to provide all partners with information on the scope of all project components, how they serve the project objectives, connections to other components and specific DRR policies in BC as well as the overview of the project implementation approach and project management structure.

The project scope outlined in this document is based on the identified gaps and common interests from various resilient actors in BC and lower mainland. This document refines the original concepts and design outlined in the project charter based on conversations held with project partners and many other actors in BC from January to May 2019.

Few components remain open to be designed in different stages of the project implementation based on stakeholders needs.

1.3 Alignment with the Sendai Framework

The Sendai Framework for Disaster Risk Reduction 2015 – 2030 reinforces the shift from only focusing on emergency management to managing risk in a holistic manner with the vision of building long term resilience in the society. Specifically, the Sendai Framework calls for strong political leadership, commitment, and involvement of all stakeholders at all levels from local to national and international to pursue the goal of “preventing new and reducing existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience”.

The Sendai Framework calls for legislation, policies and practices for disaster risk management distinguished as three categories of action:

- Preventing creation of new disaster risk through disaster risk management activities which focus on addressing disaster risks that may develop in future if disaster risk

¹ Close interaction with Public Safety Canada at federal level has been identified as a key partnership to establish too.

reduction policies are not put in place, including measures to ensure new investments in development account for disaster risk considerations and are risk-sensitive;

- Reducing existing disaster risk through disaster risk management activities which are meant to remove or reduce disaster risks which are already present, and which need to be managed and reduced now through structural or non-structural measures such as retrofitting of critical infrastructure or immunization programmes, or the relocation of exposed population or assets;
- Managing residual risk through emergency management including disaster preparedness, response, recovery and build back better activities, but also a mix of different financing instruments, such as national contingency funds, contingent credit, insurance and reinsurance and social safety nets as well as building the environmental, health, social and economic resilience of individuals and societies in the face of anticipated residual risk.

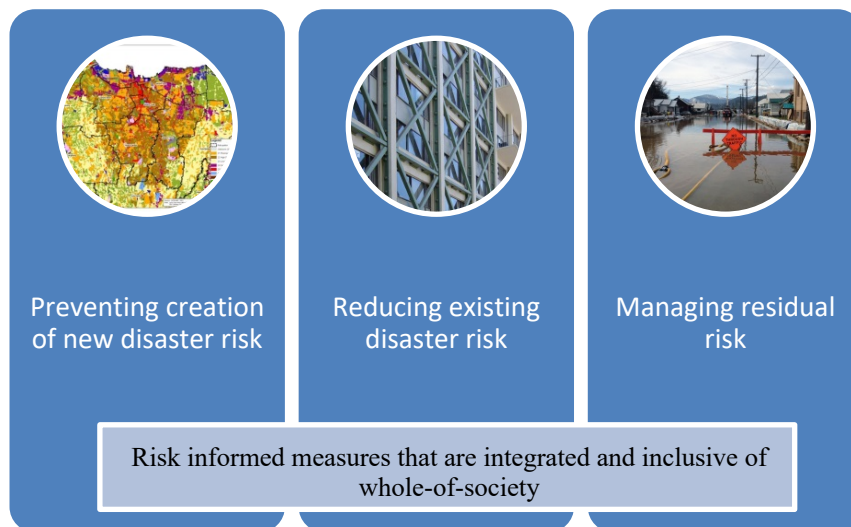


Figure 3: Aligned with the Sendai framework, three categories of DRM measures covered

The DRR Pathways project is aligned with the Sendai Framework through the following connections.

Sendai Targets:

Targets A to D², which are focused on disaster impacts and their respective indicators, are used in DRR Pathways project for scoping risk analysis, communicating risk results, and establishing risk tolerance and recovery thresholds.

² Target (a): Substantially reduce global disaster mortality

Target (b): Substantially reduce the number of people affected

Target (c): Reduce direct disaster economic loss

Target (d): Substantially reduce disaster damage to critical infrastructure and disruption of basic services

Target (e): Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;

Target (f): Substantially enhance international cooperation to developing countries

Sendai Guiding Principles:

The project core team and partners are committed to integrate the following guiding principles of the Sendai Framework into various components of the DRR Pathways project:

- All of society engagement and partnership
- Disaster risk reduction requires a multi-hazard approach and inclusive risk-informed decision-making based on the open exchange and dissemination of disaggregated data
- Special attention to the most vulnerable people
- Coordination and collaboration across sectors
- Sharing roles and responsibilities between federal, provincial and local governments
- Coherence with sustainable development, growth and climate change
- Understanding local characteristics of disaster risk for determination of measures
- Addressing underlying drivers of risk with risk informed public and private investments

Sendai Priorities for Action:

Priority 1: Understanding Disaster Risk

DRR Pathways project objective 1 directly contributes to the Sendai first priority for action through the following activities:

- Increase capabilities to model systemic risk and disaster recovery
- Integrate quantitative risk assessment and critical infrastructure interdependency models to analyze the root causes of vulnerability (stressors)
- the probable physical impacts and cascading consequences of high-impact disaster events (shocks), and
- the levels of risk reduction that can be achieved through proactive investments in mitigation and/or adaptation.

Priority 2: DRR Governance

DRR Pathways project objective 3 directly contributes to the Sendai second priority for action through the following activities:

- Strengthen risk governance through knowledge exchange and community engagement
- Develop risk communication strategies and mechanisms of community engagement that promote more effective modes of interaction between researchers, practitioners and decision makers to ensure that project outputs are relevant, fit for the intended use, and provide the necessary incentives for DRR investment decisions.

Priority 3: Investing in DRR

DRR Pathways project objective 2 directly contributes to the Sendai third priority for action through the following activities:

- Enable an evidence-based approach to disaster resilience planning
- Utilize analytic and deliberative methods of integrated assessment to support the evaluation of disaster risk reduction strategies based on user-driven planning scenarios

Target (g): Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments

and context-specific target indicators that measure both expected financial return (RoI) and the broader societal co-benefits of investing in mitigation and adaptation measures.

Priority 4: Preparedness for response and to “Build Back Better” in recovery, rehabilitation and reconstruction

Significant number of the DRR Pathways project partners and users of its outputs are emergency managers at municipal, provincial, and federal levels, including entities/individuals working on disaster recovery strategies and plans.

Roles of Stakeholders:

The DRR Pathways project is seeking to engage and serve a wider range of stakeholders aligned with the Sendai’s All of Society approach. The following key stakeholder groups are directly engaged or benefit from the DRR Pathways project:

- Academia, science and technology institutions
- Businesses, professional associations and private sector financial institutions
- Local, provincial, First Nations, and federal governments
- General Public


The project will indirectly serve the civil Society working with women, children, elderly, indigenous, and migrants through data and analysis on socio-economic vulnerability and community resilience that informs targeted mitigation options for these vulnerable groups.

The project team has the intent to engage with the media in an effective way to utilize the agency of this important stakeholder group in raising awareness and educate the society on disaster risk and resilient building.

1.4 Project Objectives

The three project objectives provide clear direction for the design and implementation of project tasks and clearly state how the project contributes to building resilience in BC.

1. **Increase capabilities to model systemic risk and disaster recovery:** Integrate quantitative risk assessment and critical infrastructure interdependency models to analyze the root causes of vulnerability (stressors), the probable physical impacts and cascading consequences of high-impact disaster events (shocks), and levels of risk reduction that can be achieved through proactive investments in mitigation and/or adaptation.
2. **Enable an evidence-based approach to disaster resilience planning:** Utilize analytic and deliberative methods of integrated assessment to support the evaluation of disaster risk reduction strategies based on user-driven planning scenarios and context-specific target indicators that measure both expected financial return (RoI) and the broader societal co-benefits of investing in mitigation and adaptation measures.
3. **Strengthen risk governance through knowledge exchange and community engagement:** Develop risk communication strategies and mechanisms of community engagement that promote more effective modes of interaction between researchers, practitioners and decision



makers to ensure that project outputs are relevant, fit for the intended use, and provide the necessary incentives for DRR investment decisions.

1.5 DRR Pathways Guiding Principles

The following guiding principles were adopted for the project by the steering committee on February 15, 2019:

Public good: We work to serve the public good from research to practice, from knowledge to action, with our efforts ultimately motivated by the welfare of the public

Credible: Co-develop a shared understanding of risk and a base of evidence that will both inform and empower risk reduction and disaster recovery planning decisions on the ground in southwest British Columbia

Collaborative: We work with partners across sectors, geographies and disciplines to generate and exchange knowledge that helps inform and support implementation of the Sendai Framework in a Canadian context

Open and transparent: Our methods, tools and outputs are transparent and made accessible to the public through open data, open science and open platform protocols

1.6 Core Concepts and Strategic Approaches

Keeping a Sharp Focus on the Objective: Building Disaster Resilience

The shocks and stresses from disaster and climate risk is a threat to social and economic wellbeing of people in the short term and can set back the gains from years of investments in development and achievement of long-term goals. The objective of disaster risk management and building resilience is to ensure the society, as the whole system, would bounce back from the shock and get back on the same track of socio-economic growth in a timely manner (resilience is the ability of a system to recover back to its past level of function or even higher level in a timely and efficient manner³).

DRR Pathways project has set building disaster resilience in BC and in Canada as the focus for design and implementation of all project components.

BC Provincial Platform for Disaster Risk Reduction (DRR)

The need for a systemic and formal set up to coordinate, strategize, and guide integration of risk information into EM and DRR policy, investments, and operations in BC has been identified by the community at the past two Understanding Risk conferences (see section 2.3).

³ From “Resilience: the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management“, United Nations General Assembly Report on indicators and terminology relating to disaster risk reduction, 2016

“DRR governance and risk assessments tend to lack the necessary links and this fragmentation increases the price tag of each new risk assessment, keeps risk assessments within the scientific community and isolated from policy processes, and impedes the use of risk information in policy design, capability development and for shaping investments.”⁴ A provincial platform for DRR, would ensure risk information is relevant in context and format, robust in scientific methodologies but also flexible in the approach to effectively meet the DRR user needs within the limitation of available resources. In a nutshell, the BC provincial platform for DRR would have the following design⁵:

- Is hosted or co-hosted by provincial entities that have a DRR mandate,
- Has a small secretariat to manage the day to day work
- Has a coordination mechanism that is inclusive and multi-sectoral
- Has data management strategies and tools
- Has risk communication strategy and an effective risk profiler
- Has technical committees that provide guidance and advice on methodologies for risk analysis and linkage with ongoing policy development
- Has a sustainability plan for financial resources and operations

Support for a DRR provincial platform would allow expert entities to conduct risk assessments and produce risk information within the DRR governance system instead of in isolation, behind closed doors of research facilities.

DRR Pathways project is dedicated to pave the way for creating a BC provincial platform for DRR through each of the project components and the opportunities for convening the key actors to talk, think, and take action towards creating such a platform.

Risk, Resilience and Recovery Indicators

The hazard and risk assessments provide a significant amount of information about the overall impact of a disaster, probabilities and uncertainties, and characteristics of each component of disaster risk⁶. A set of indicators can be used as a metric to measure different types of impact and can be grouped into risk, resilience and recovery indicators. Below are few examples:

- Risk indicator: # of people injured, # of health facilities damaged
- Resilience Indicator: Income level of people displaced by a disaster, % of people with property insurance covering >80% of building replacement cost
- Recovery Indicator: Duration of time for getting back to certain service level

The main value of indicators is in communication of risk assessment results to various disaster risk management users.

⁴ From “Understanding Risk System (URS): An essential foundation for implementing the Sendai Framework“, Safaie. S., Alfonso Santamaria. N., Houdijk, R., Onur. T., 2018

⁵ From “Understanding Risk System (URS): An essential foundation for implementing the Sendai Framework“, Safaie. S., Alfonso Santamaria. N., Houdijk, R., Onur. T., 2018

⁶ Disaster risk components are: Hazard, Exposure (assets), Vulnerability, Capacity, from UNISDR National Disaster Risk Assessment guideline, 2017)

Understanding Risk Drivers Guides Risk Management Action

The information that risk and recovery indicators provide is similar to the disease symptoms in a medical patient. Assessing the symptoms such as high temperature, nausea or headache are the first steps before diagnosing the causes and then suggesting the treatments. Understanding drivers or causes of risk and poor recoverability are critical to ensure risk reduction actions and policies are targeted and effective for reducing risk. Risk drivers can influence hazards, exposure, vulnerability and capacity and an analytical evaluation can identify a wide range of drivers and chain of causes and consequences.

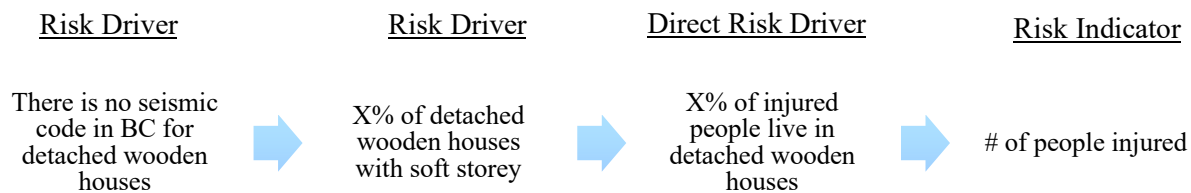


Figure 4: An example of a risk indicator and few relevant risk drivers

The Nexus of Information and Action: Risk Tolerance and Recovery Thresholds

Understanding the outputs of risk assessments and using the risk information in policy and planning is a common challenge for DRR and emergency management (EM) practitioners and policy makers. While application of hazard and risk information in some actions and policies such as land use planning and insurance portfolio management is more straightforward, using risk information in some other applications such as the process of designing DRR strategies, asset management, and community development is less understood.

Risk assessments can produce information that shows the expected level of risk and timelines of the recovery process. In addition to helping decision makers understand the baseline risk and recoverability levels, risk and recovery indicators can help them think about the targets for resilience building and establish quantitative or qualitative goals framed as *risk tolerance and recovery threshold* to guide policy design and investment decision making in order to get from baseline risk and recoverability levels to the target levels.

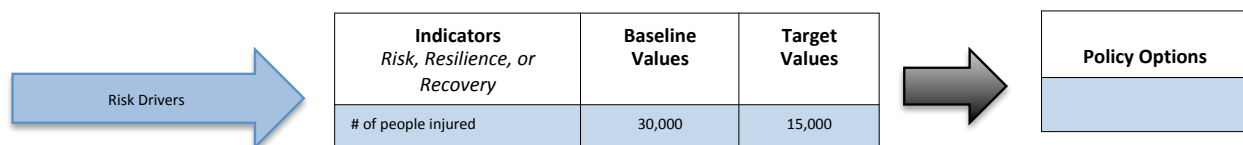


Figure 5: A simple overview of Risk Tolerance and Recovery Thresholds Framework

2. Scope of Project Components

Aligned with the three objectives of the project, the project components can be categorized under three groups:

- i. Risk, recovery, and resilience information
- ii. Methods for evidence-based DRR
- iii. Strengthening risk governance:

In this section the components are listed under each of the three categories with brief description, scope as defined by June 2019, team members, expected outputs and delivery time.

The original titles of the project tasks, short description, and timeline as presented in the project Charter can be found in Annex I.

2.1 Risk, Recovery, and Resilience Information

Components in this category enable modeling systemic risk and disaster recovery. The outputs of these components are quantitative or semi-quantitative datasets and information on disaster risk, recovery, and resilience of various assets and systems at different levels. Below are the short description of all project components under this category.

Buildings and critical infrastructure exposure dataset

Team: Spatial Vision Group (SVG)

Description: Upgrading the existing (from 2017) exposure database of the critical infrastructure (CI) assets (10 sectors) by identifying and collecting additional datasets to cover the data gaps including transformation of BC assessment data for use in risk modeling. The aim is to use open access datasets to the extent possible, but to meet the CI interdependency modelling requirements, the team is considering collecting closed datasets with data sharing limitation provisions.

The scope includes:

- (i) Based on Pathways project goal and scope and through discussion with relevant partners, prioritize the data gaps in 2017 CI dataset to be completed in this project.
- (ii) Transform BC Assessment Data (e.g., NAICS codes, construction types).
- (iii) SVG to assess gaps in NRCan taxonomy to inform compilation of additional information/attributes required for using the CI data in risk models using OpenQuake.

The expected output is an upgraded dataset of critical infrastructure and buildings, including businesses in Fraser Valley Regional District, Greater Vancouver Regional District, and District Municipality of Squamish

Timeline: To be completed by September 2019

Developing Building and CI fragility/vulnerability functions

Team: UBC-Earthquake Engineering Department with inputs from GEM

Description: Developing baseline and retrofitted building fragility/vulnerability functions for representative building archetypes and Critical Infrastructure (CI)

Timeline: January to September 2019 (baseline) and December 2020 (retrofitted)

Earthquake risk assessment of baseline and risk reduction scenario

Team: GSC-NRCan, City of Vancouver, UBC, GEM

Description: Using the OpenQuake platform to model catastrophic earthquake risk for baseline and proposed seismic mitigation planning scenarios at local and regional scales: Scope of the work include

Timeline: January 2019-June 2020

Flood hazard and risk modelling

Team: Fraser Basin Council

Description: Use available loss estimation models to analyze expected impacts and consequences for selected flood and sea-level rise scenarios. Scope of work includes:

- Assets: buildings, people, environmental assets, and critical Infrastructure
- Social vulnerability
- Developing BC specific flood building damage functions

Timeline: May 2019-March 2020 (pending funding approval)

Analyzing risk dynamics

Team: UBC SCARP

Description: To analyse risk levels from the historical levels (1971-2006) to the baseline (2016) and anticipated future (2050) conditions of growth and development in selected study regions.

Timeline: March –December 2019

Analyse Critical interdependencies

Team: UVIC and DRDC

Description: Using the National Critical Infrastructure Model (NCIM) to analyze functional CI interdependencies and the effects of cascading system failures. Model outputs are used to identify and prioritize strategic risk reduction opportunities and help inform the development of DRR planning scenarios by project partners.

Integrating quantitative risk and NCIM functional model outputs to analyze cascading effects of system failures on disaster recovery with and without DRR measures in place. Modeling of disaster recovery profiles to be carried out using the Graph Model for Operational Resilience (GMOR).

Timeline: January 2019- June 2021

Assess community resilience

Team: UBC-SCARP department

Description: Assessing community resilience through a blend of:

- i) top-down geostatistical methods that use demographic variables to measure local variations in social and economic vulnerability
- ii) bottom-up survey-based methods that use local knowledge to measure context-specific capacities for disaster response and recovery.

Timeline: March 2019-June 2021

Components in this category enable evidence-based approaches to disaster resilience planning or in other words approaches that enable using various risk information in design and decision making for risk reduction policies and programs

The outputs of most of the components under risk, resilience, and recovery information category will include datasets. Table 2 outlines the resolution of various datasets at different geographical coverage level.

Table 2. Resolution of output datasets at different levels (geographical coverage level)

	British Columbia	Fraser Valley RD+ Greater Vancouver RD+ District Municipality of Squamish	Metro Vancouver	City of Vancouver	North Shore
Building and CI Exposure Model	Past work covered all BC	Buildings: Parcel, CI (best possible level of detail)	Buildings: Parcel, CI: DA	Buildings: Parcel, CI: DA	Buildings: Parcel, CI: DA
Earthquake risk (impact on people and buildings)	Dissemination area (DA) Level	DA	DA	DA, Dissemination Block (DB), Parcel (Buildings)	DA
Socio-economic Vulnerability (NRCan-UBC model)	DA	DA	DA	DA	DA
Community Resilience and Recovery Indicators (bottom up approach)	-	-	-	Neighborhood Level	-
FBC Flood hazard and risk	-	Buildings: Parcel, CI: DA	Buildings: Parcel, CI: DA	Buildings: Parcel, CI: DA	Buildings: Parcel, CI: DA
Critical Infrastructure interdependency and recovery model	-	-	Metro Vancouver Area	A subset of modeling conducted for Metro	A subset of modeling conducted for Metro
Historical trends in risk levels (1974-2006)	-	-		CoV area	-
Risk and risk reduction options in growth projection scenarios (2016-2050)	-	-	Metro Vancouver area	CoV area	-
Indirect economic impact	-	-	Metro Vancouver area	-	-

2.2 Methods for Evidence-based DRR

Components in this category enable evidence-based approaches to disaster resilience planning or in other words approaches that enable using various risk information in design and decision making for risk reduction policies and programs. Below are the short description of all project components under this category.

City of Vancouver seismic risk tolerance and recovery threshold framework

As described in section 1.6 on core concepts and approaches, risk tolerance and recovery threshold framework is a nexus between communicating the risk information to policy makers who need to use risk-based policy goals and define actions. The policy partner for this project is the resilient Vancouver team at the City of Vancouver and the project support CoV team to use the outputs of the seismic risk modeling and socio-economic vulnerability assessment to define risk tolerance and recovery thresholds, evaluate and prioritize DRR actions, and choose the best combination of actions to reduce Vancouver seismic risk.

This project contributes to the DRR Pathways project objectives of enabling an evidence-based approach to disaster resilience planning through working closely with the City of Vancouver. The project also contributes to the objective of strengthening risk governance in BC and Canada through knowledge exchange and capacity buildings by developing a practitioner's guideline to share information on the risk tolerance framework design, process, and lessons learned with a wider set of DRR practitioners across BC and Canada.

The project team consists of the City of Vancouver, GSC-NRCan, UBC- SCARP, Sage on Earth Consulting, and Compass Resource Management.

The timeline for this work is April-November 2019

Profiles of Risk Information Users

Understanding users goals, needs and processes for accessing and using risk information is fundamental requirement for user-centered design of any risk assessment, development of risk data management strategy and tools, and design of any risk communication tool.

This work is part of the risk governance and risk communication component of the DRR Pathways project and has the following goals:

- Identify and document the user goals, needs, processes, obstacles and incentives in *accessing* and *using* disaster risk information in policy design, investments planning, and operations.
- Define most appropriate modality and format of data and information sharing

The main categories of users will be included:

- Scientific, engineering, and technical users
- Emergency management
- Development planners, urban and community planners, asset managers, critical infrastructure development planners
- Risk financing and insurance providers
- General public

Financial Security for Earthquake Economic Impact

Financial Institutions Commission (FICOM) is interested in using the results of earthquake risk modeling in lower mainland to conduct an evaluation of current financial risk management capacities and gaps for a threshold event of PML (probable maximum loss) of 500 years return period among various risk holders:

- Private home owners with and without seismic insurance
- Private insurance and reinsurance companies
- Banks providing mortgages
- Provincial government
- Federal government

2.3 Strengthening governance of disaster risk information and risk management

Disaster risk reduction is all-encompassing and requires multi-sectoral and multi-stakeholder actions. The Sendai Framework recommends using “... integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience”. To manage disaster and climate risk, a strong governance system is needed. A governance system consists of legislations and policies, institutions with clear roles and responsibility, capacities and resources, coordination mechanisms as well as monitoring and accountability arrangements across all sectors, actors and levels.

Strengthening a risk governance system is a significant task that requires commitment and contribution from all stakeholders through a coordinated effort. One of the objectives of the DRR Pathways Project is to contribute to strengthening risk governance through knowledge exchange and community engagement. Below is the set of projects or initiatives to be conducted as part of the DRR Pathways project implementation. These projects were either already defined as part of the project proposal and the charter or have been identified based on the dialogue and inputs from various partners during the scoping phase.

DRR Planning Support Hub: A Platform for Data Management, Web Mapping (Risk Profiler), and Knowledge Exchange

The objective for designing and establishing spatial data management infrastructure and a web mapping service is to strengthen mechanisms of engagement between researchers and practitioners and provide access to distributed risk assessment information to facilitate knowledge exchange, project collaboration and science-policy integration across BC and beyond.

The platform will serve a wide range of stakeholders/users with different features. Some users are mostly interested in the data, some would use interactive maps more, and others can benefit from a digested set of information and instructions for action. Below are the key groups, categorized based of the differences in their needs for data type and format and information based on use and modality of operations:

- Scientific, engineering, and technical users
- Emergency management
- Development, urban, and community planners including CI developers and asset managers
- Financial and insurance sector
- General public

Design and development of the data management and web mapping platform consists of three major components:

- i. Spatial data infrastructure for sharing and managing geospatial data between the outputs of the pathways project and the existing data sharing mechanisms in BC such as GeoBC or partner specific geospatial data platforms. Spatial data infrastructure (SDI) is the framework of geospatial data, metadata and technology standards, policies, tools, user processes, security, and maintenance processes to allow use of available data in an efficient and flexible way among stakeholders both on data production side and users side. The work on this component has started by Minerva Intelligence Inc. developing a report with recommendations on the platform architecture and modes of operation.
- ii. Web mapping or risk profiler, which would have a user-centered design to make the risk information understandable for all users, specially the general public and the small-medium sized enterprises (SME). This component of the platform would allow users to produce maps with desired data features and get answer to simple queries about the content of the map.
- iii. Knowledge sharing component, which would host digital and for-print media solutions that strengthen stakeholder engagement, promote a shared understanding of risk and identify the incentives for individuals, businesses, and public/private sector organizations to invest in disaster risk reduction opportunities.

An important step for designing the web mapping and knowledge sharing components is the research on user cases mentioned in the previous section.

The DRR Planning Support Hub is a deliverable of the Project Task 3 and Task 12. (See Table 4 in Annex I).

A Common Set of Risk, Resilience and Recovery Indicators for BC

The objective here is to have one comprehensive set of indicators for use by all actors across BC to better facilitate data and information exchange and bring harmony to the research and policy making processes. Using the Sendai Framework indicators as a basis, enhancing and expanding them based on inputs from technical experts and policy practitioners in BC.

The same indicators could be used for:

- Measuring post-disaster damage and losses for the purpose of monitoring and reporting
- Communicating results from risk assessments with various disaster risk management users
- Evaluating risk levels and acceptable risk tolerance and recovery thresholds as part of goal setting exercise. This can be an effective approach to connect risk information production to policy objectives

- Facilitating data compatibility, data sharing, and comparing results from different risk assessments

The indicators will be one of the products under the “Resilience by Design Series” as part of the Task 12 Risk Communication and Engagement.

Mapping of BC Critical Infrastructure Governance System Through Disaster Resilience Lens

Understanding the current setup of decision-making processes, policies and legislations, communications and collaboration mechanisms among critical infrastructure (CI) providers in the context of disaster resilience is a critical step for any resilience building strategy that includes CI interdependencies. Based on the feedback from many of the policy and academic partners, it has become apparent that a mapping of a BC critical infrastructure (CI) disaster risk governance system can be very useful for many of the policy partners who are embarking on developing policies to improve CI resilience at municipal and provincial level.

The report will be one of the products under the “Resilience by Design Series” as part of the Task 12. Risk Communication and Engagement of the DRR Pathways project.

Engagement and Dialogue for Resilience

An objective of this program is to build a stronger community of practice around risk management and resilient building in BC and elevate the knowledge and capacity of this community through knowledge sharing, engagement, and dialogue on various topics.

The following are the list of different initiatives:

- Project Website to post major documents, events calendar, etc.: The website will be managed by NRCan and Sage Consulting
- Monthly in-person and webcast seminar on various topics related to project scope or partners’ activities
- Monthly Blog discussions by various experts/practitioners hosted on DRR Pathways project. Ideally the blogs topics and discussion would be related to the same topic as the seminar in that month but discussing the challenges and opportunities in BC context.

Below is the list of possible seminar topics in 2019:

- Vancouver Resilient City Strategy
- CI interdependency modelling (UVIC/DRDC)
- CoV Seismic Mitigation Strategy
- Risk financing and insurance strategies (California Earthquake Authority)
- Learning from flood risk management in Manchester
- Recovery Planning Guideline

Understanding Risk BC Conference

Two Understanding Risk⁷ conferences in 2017 and 2018 (UR Vancouver and URBC) were very successful in bringing together a wide range of practitioners and researchers in the field of emergency management and disaster risk management in BC and ignite discussion on current practice, gaps and ideas for enhancing the practice of EM and DRR for building a more resilient future in BC. At 2017 UR Vancouver event, the need for a more organized mechanism to integrate risk assessments into policy and investment planning was identified and titled BC DRR Hub or BC Provincial Platform for DRR.

DRR Pathways project will contribute to design, co-finance, and implement possibly two more UR conferences until 2021. The next one will be held in the late fall of 2019 and will be designed as a “working conference” focused on the concept of BC Provincial Platform for DRR. As part of the organization process, technical working groups will be created to work on designing each component of the DRR Platform in advance of the conference, present and discuss their proposal at the conference, and prepare the recommended design (Terms of Reference) for that component after the conference. The proceedings of the conference will be a document that includes a TOR for each component of the BC Provincial Platform for DRR.

3. Connections with Partner Policies

Bridging the gap between production of quantitative risk information and application of it in disaster risk reduction policies, investments and operations is one of the guiding principles of the DRR Pathways project. There are ongoing efforts by the project team to identify the policies that can benefit from the DRR Pathways project and define the relevant connection points. The table below lists some policies or activities of project partners which can benefit from the outputs of the DRR Pathways project.

Table 3. List of the partners’ policies that can benefit from DRR Pathways project

EMBC
Emergency Program Act modernization
Disaster Mitigation Program
Integrated provincial disaster recovery
City of Vancouver
Resilient Vancouver Strategy & City Wide Plan
Seismic policy for buildings and infrastructure
Engaging the public and policy makers in risk communication and dialogue
NSEM
North Shore Resilience Strategy (Sendai and 10 Essentials)
Operational Readiness initiative (EM)

⁷ UR is a global community of experts and practitioners with interest in the field of disaster risk identification, specifically risk assessment and risk communication. At international level, Understanding Risk conferences are hosted by Global Facility for DRR at the World Bank. See Understandrisk.org.

Common Operating Platform (Lightship)
Fraser Basin Council
Lower Mainland Flood Management Strategy
Modelling and Mapping of Fraser River and Coastal Flood Scenarios
Education and Awareness-Raising with Decision Makers, Stakeholders and the Public
Integrated Partnership for Regional Emergency Management in Metro Vancouver (IPREM)
Regional Strategy for Recovery Planning
ICLR- Planning related research
Pre-Disaster Recovery Planning for the Fraser River
Metro Vancouver
Regional Growth Strategy
BC Financial Institutions Commission
Understanding financial implications of a major earthquake disaster

4. Project Management and Oversight

Project Management Structure

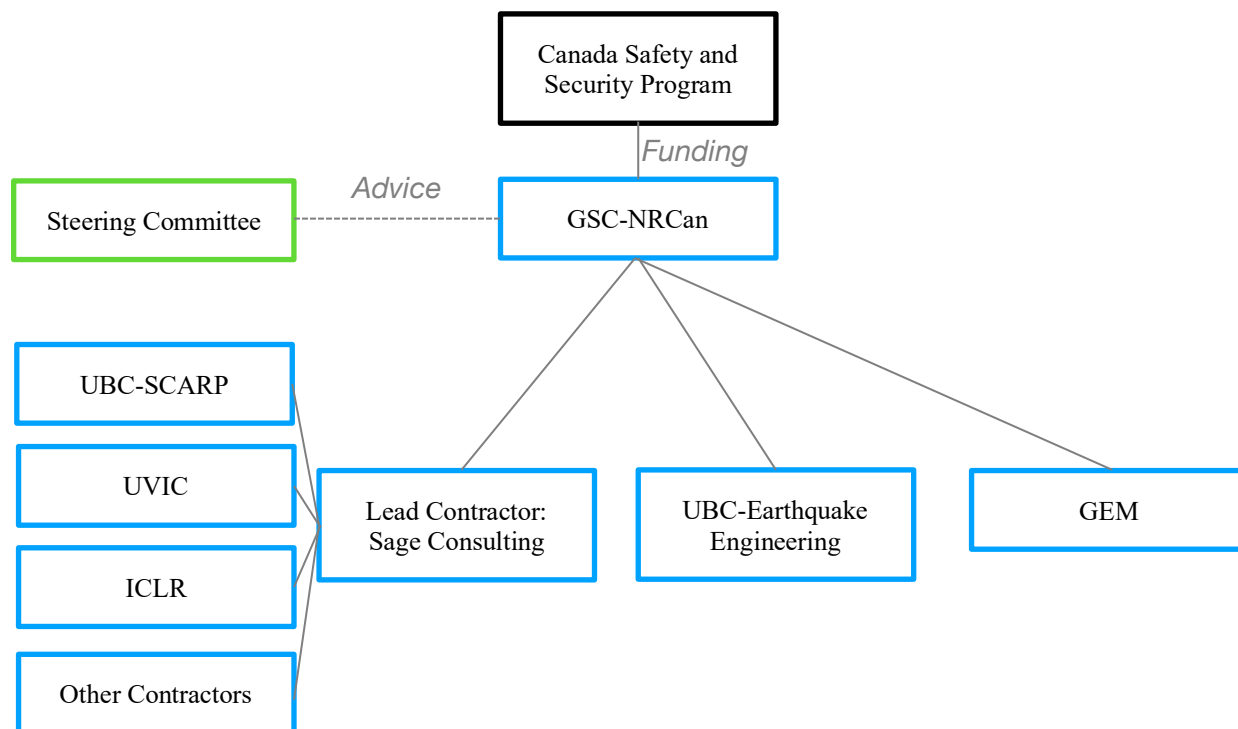



Figure 6: DRR Pathways project management structure

Steering Committee

The DRR Pathways Project shall be governed by a Steering Committee. Steering Committee members are the chartered partners including the lead contractor. These members have voting



power and during Steering Committee meetings, decisions will be made by majority vote of the Partners except on issues that affect the Project Charter, in which case DRDC and/or NRCan will make the final decision. In the instance of a tie, the Chair will cast the deciding vote. Other policy institutions, which will have active engagement with the project, can join the Steering Committee as associate members.

The terms of reference was endorsed at the inception meeting on February 15, 2019 and Ms. Kathryn Forge was selected as the Steering Committee Chair. Steering Committee will meet twice per year. In 2019, the committee will meet twice in addition to the inception meeting.

Internal Communication

In addition to the communication initiatives that are designed for engaging with the wider disaster risk management community, project specific information will be communicated through the following:

- Steering committee meetings (2 times per year)
- Bi-lateral or small group meetings to facilitate implementation
- Quarterly Newsletters
- Emails by project core team or leads of various components as needed

Annex I Overview of Project Tasks

The table below provides an overview of all project tasks, deliverables and timelines per project charter document.

Table 4: Project tasks and deliverables as outlined in the project charter document

Task #	Description	Deliverable(s)	Performed By	Start Date	End Date
1	Risk Appraisal: Establish overall context and focus for risk assessment process	<ul style="list-style-type: none"> • Project Roadmap - an internal guidance document that identifies: <ul style="list-style-type: none"> ○ specific disaster risks of concern ○ policy goals and existing mechanisms of risk governance ○ scope of DRR planning scenarios ○ communication/outreach strategy 	LC, with input from project partners	01/2019	03/2019
2	Exposure Model: compile and synthesize available information on built environment that is required for earthquake and flood risk modelling	<ul style="list-style-type: none"> • GIS map layers & attribute tables - secured through data sharing agreements or acquired from public domain and/or commercial sources, including: <ul style="list-style-type: none"> ○ construction type & cost tables ○ building & CI assets of concern 	LC, with input from project partners	01/2019	03/2019
3	DRR Planning Support Hub: strengthen mechanisms of engagement between researchers and practitioners and provide access to distributed risk assessment information to facilitate knowledge exchange, project collaboration and science-policy integration	<ul style="list-style-type: none"> • Risk Information Portal - web-mapping application for managing distributed access to data: <ul style="list-style-type: none"> ○ spatial data infrastructure ○ OGC compliant web services • Community Engagement Platform- design of mechanisms that promote deliberative dialog & collaboration <ul style="list-style-type: none"> ○ interactive workshops, planning charrette and community forum ○ web-based platform to support knowledge exchange, project collaboration and a shared understanding of systemic risk 	LC, with input from GSC	01/2019 02/2019	12/2020 12/2020
4	Risk Dynamics Model: Analyze land use change and identify underlying risk drivers (stressors)	<ul style="list-style-type: none"> • GIS map layers & attribute tables - <ul style="list-style-type: none"> ○ baseline conditions (historic-present) ○ regional growth and development scenarios (present - 2040) 	UBC-1, with input from GSC	04/2019	12/2019
5	Functional CI Interdependencies: Extend Critical Infrastructure Model (NCIM) developed for NSEM pilot study to represent system functions at regional scale	<ul style="list-style-type: none"> • Phase I model output files-for baseline conditions <ul style="list-style-type: none"> ○ interdependencies between CI system components ○ cascading consequences and estimated recovery time • Phase II model output files-for ‘What-if’ planning scenarios 	DRDC-CSS, with input from UVic	04/2019 04/2019	09/2019 03/2020

		<ul style="list-style-type: none"> ○ cascading consequences and estimated recovery time with mitigation/adaptation measures 			
6	DRR Planning Charrette: design and co-develop stakeholder engagement process to define DRR planning scenarios	<ul style="list-style-type: none"> ● DRR Planning Scenarios -used to identify risk reduction opportunities in the context of: <ul style="list-style-type: none"> ○ CoV Resilient Cities Initiative ○ NSEM Disaster Resilience Plan ○ MV Regional Growth Plan ○ FBC Flood Management Plan ○ EMBC earthquake mitigation, response & and recovery plans 	LC, with input from project partners	07/2019	03/2020
7	Fragility/Vulnerability Functions: develop analytic functions used in seismic risk analysis to correlate hazard intensity with expected building damage and related consequences	<ul style="list-style-type: none"> ● Expected Baseline Performance - analytic functions for assessing <ul style="list-style-type: none"> ○ structural fragility (damage) ○ vulnerability (loss) ● Expected Retrofit Performance - analytic functions for assessing <ul style="list-style-type: none"> ○ structural fragility (damage) ○ vulnerability (loss) 	UBC-2, with input from GEM	01/2019 04/2019	09/2019 12/2020
8	Earthquake Risk Modeling: Use the OpenQuake to analyze catastrophic earthquake risk for baseline and proposed seismic mitigation planning scenarios at local and regional scales.	<ul style="list-style-type: none"> ● Phase I model output files - for baseline conditions <ul style="list-style-type: none"> ○ damage and loss estimates ○ risk metrics (performance indicators) ● Phase II model output files - for selected DRR mitigation scenarios <ul style="list-style-type: none"> ○ damage and loss estimates ○ risk metrics (performance indicators) 	GSC, with input from GEM	01/2019 09/2019	09/2020 06/2021
9	Flood Risk Modeling: Use available loss estimation models to analyze expected impacts and consequences for selected flood and sea-level rise scenarios, including both baseline conditions and selected mitigation strategies	<ul style="list-style-type: none"> ● Phase I model output files - for baseline conditions <ul style="list-style-type: none"> ○ damage and loss estimates ○ risk metrics (performance indicators) ● Phase II model output files - for seismic retrofit scenarios <ul style="list-style-type: none"> ○ damage and loss estimates ○ risk metrics (performance indicators) 	FBC, with input from CoV	01/2019 06/2019	06/2019 03/2021
10	Community Resilience Indicators and Analysis: assess capabilities for disaster response and recovery	<ul style="list-style-type: none"> ● GIS layers and attribute tables - <ul style="list-style-type: none"> ○ phase 1: indicator-based vulnerability ratings ○ phase 2: indicators of community resilience 	UBC-1, with input from CoV	01/2019 01/2020	12/2019 06/2021
11	Disaster Recovery Profiles: Use Graph Model for Operational Resilience (GMOR) to analyze cascading effects of system failures on disaster recovery with and without DRR measures in place	<ul style="list-style-type: none"> ● Phase I model output files - for baseline conditions <ul style="list-style-type: none"> ○ operational interdependencies ○ system recovery profile ● Phase II model output files - for selected DRR mitigation scenarios <ul style="list-style-type: none"> ○ operational interdependencies 	UVic, with input from DRDC-CSS	06/2019 04/2020	06/2020 06/2021

		<ul style="list-style-type: none"> ○ system recovery profile ○ risk metrics (performance indicators) 			
12	<p>Risk Communication and Engagement: Design and develop user-centred print and digital media solutions that strengthen stakeholder engagement, promote a shared understanding of risk and identify the incentives to invest in disaster risk reduction opportunities.</p>	<ul style="list-style-type: none"> • RiskProfiler.ca - web mapping applications that provide open access to multi-hazard risk information using: <ul style="list-style-type: none"> ○ interactive story maps ○ visual analytics • Disaster Resilience by Design- mixed media and engagement solutions that encourage a place-based exploration of disaster resilience on the ground: <ul style="list-style-type: none"> ○ Brochure(s) ○ Blog series ○ Ride for Resilience 	LC, with input from project partners	01/2019 04/2019	06/2021 06/2021
13	<p>Disaster Resilience Forum: Stakeholder engagement workshop(s) and conference forum to solicit input on proposed DRR strategies and ongoing sustainability of planning support hub</p>	<ul style="list-style-type: none"> • Project Report - <ul style="list-style-type: none"> ○ Summary of outputs and findings from DRR-Pathways project ○ Recommendations for future work 	LC, with input from project partners	04/2020	06/2021
14	<p>Capacity Development: share knowledge and project findings on an ongoing basis throughout the project cycle</p>	<ul style="list-style-type: none"> • Knowledge Exchange Outputs: <ul style="list-style-type: none"> ○ final project report ○ conferences ○ digital media productions ○ training workshops ○ refereed journal publications 	LC, with input from project partners	04/2019	06/2021