Understanding Resilience and its Applicability to the UBC Building Context

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Sustainability Scholar Disclaimer

This report was produced as part of the UBC Sustainability Scholars Program, a partnership between the University of British Columbia and various local governments and organizations in support of providing graduate students with opportunities to do applied research on projects that advance sustainability across the region.

This project was conducted under the mentorship of UBC Sustainability Initiative staff. The opinions and recommendations in this report and any errors are those of the author and do not necessarily reflect the views of UBC Sustainability Initiative or the University of British Columbia.

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Executive Summary

UBC has achieved numerous milestones in creating a vibrant and healthy campus and community through sustainability, wellbeing and community integration strategies. Numerous UBC policies and guidelines, such as the UBC Green Building Action Plan (UBC GBAP), support the development and growth of the UBC Vancouver campus. Resilience has been a topic identified in the UBC GBAP as a characteristic of almost every aspect to consider for new and existing buildings, and include as a key priority action in the category of Climate Adaptation. For this reason, this study explores the concept of resilience and how it can be applied and catered to the context of UBC.

The project aims to develop an understanding of resilience initiatives of organizations across the world, review the recently developed RELi rating system for resilient design and construction, and identify the key opportunities to build resilience at the UBC Vancouver campus. This study has the potential to inform campus-wide resilience initiatives, actions and strategies, and in particular, the implementation and achievement of resiliency in the built environment through the UBC GBAP.

The research is divided into six parts, starting with an understanding of resilience at a broad scale and narrowing down to the UBC context. The research is approached first by studying the meaning of resilience, and principles and strategies adopted by organizations worldwide. The following parts of the report summarizes the resilience plans and initiatives at the Canadian federal, provincial and municipal (city) level, as well as the UBC Vancouver campus. The next part consists of a review of the RELi standard, a resilience-based building rating system, and understanding its applicability alongside the LEED rating system. The concluding part identifies the gaps, challenges, opportunities and recommendations towards strengthening resilience at the UBC campus.

This study includes the review of the resilience actions that UBC has taken, mainly through four departments and three frameworks, including a Climate Adaptation component in the UBC Green Building Action Plan, Mental Health + Resilience in the UBC Wellbeing Strategy Framework, Seismic Resilience Plan in the Seismic Mitigation Plan, and Risk management services.

The final part identifies key topics of discussion and opportunities aimed at informing resilience initiatives through UBC policy, specifically the UBC GBAP. The highlighted points are adopting a multifaceted lens towards resilience, including the introduction of a central oversight on resilience actions; setting up of a holistic resilience framework for the UBC Vancouver campus; collaborations with the City of Vancouver and BC Housing for additional support and resource availability; conduct a study of UBC stressors and shocks; review of UBC technical guidelines and standards to identify existing actions and requirements that contribute towards achieving resilience; and public participation and awareness of resilience actions at UBC. The identified topics hope to inform the implementation of the GBAP resilience components, the creation of a

holistic strategy to achieve resilience for the UBC Vancouver campus, and instigate further research to create a resilient and vibrant UBC campus and community.

Introduction

Urban centers across the globe have been facing significant pressures to provide safety and security to the citizens due to hazards and risks from climate change, increased density of urban population, growing need of transportation and infrastructure, and resource depletion. Rapidly changing urban settings have directly or indirectly impacted the health and lifestyle of the people, leading to inhabitable and stressful living environments.

Within the context of climate change risks and accumulating pressures on the community, UBC aims at creating a safe and vibrant environment for the students, faculty and staff. A leading institute in achieving sustainability and wellbeing across the campus through research, teaching, learning, partnerships, operations and infrastructure, UBC is committed to making its campus and the community healthy, resilient and adaptable.

Since 1990, UBC has been developing plans, policies and initiatives to guide sustainable development on campus to measure progress, share success and achieve the targeted goals. Wellbeing, resiliency and biodiversity are the emerging goals of existing UBC policies and guidelines.

Project objective

UBC is currently working on resiliency initiatives to prepare the campus for natural and human-made hazards. Intended to advance the goals set by the GBAP, this research project lays a foundation in understanding resilience and its applications to the UBC building context. The objective of this project is to develop an understanding of resilience principles and strategies adopted by organizations and institutes around the world and review the recently developed RELi rating system for resilient design + construction. The project study will contribute to the growing body of knowledge that seeks to improve the building design and operation of campus buildings to support UBC's goal of improving the resiliency, health and adaptability of the UBC community.

Research methodology

The research, divided into six parts, explores the topic of resilience with a broad perspective at varying scales and narrows down to the applicability of the concept to the context of UBC. This method aims at learning what resilience means in different settings and what are the strategies and tools that can be adopted to make the UBC campus more resilient and adaptable.

Part 1 focuses on understanding how various organizations and institutes define resilience and what are the principles, strategies, initiatives and tool/assessments adopted by them.

Part 2 identifies the policies and actions taken by the federal and provincial government to address resilience at national and provincial level, and provide public safety and security.

Part 3 studies the initiatives taken by Canadian cities within the framework of the 100 Resilient Cities organization, and the stages of plan implementation carried out by each city.

Part 4 reflects on the actions taken by the UBC Vancouver campus so far and discuss the next possible steps through interviews with key UBC stakeholders: Jennifer Sanguinetti, Managing Director of Infrastructure Development, Matt Dolf, Director of Wellbeing Strategic Support and Penny Martyn, Green Buildings Manager at Campus and Community Planning.

Part 5 includes an overview of the RELi rating system and its correlation with other green building standards such as LEED.

Part 6 involves identifying gaps and opportunities for resiliency in UBC's built environment, which will inform the resilience initiatives of the GBAP.

Project scope

The following parts are included in the project's scope:

- Reviewing the work initiated by organizations, institutes, the federal and provincial government and Canadian cities.
- Reviewing the existing UBC policies and studies related to resilience strategies.
- Reviewing the RELi standard
- Providing recommendations based on the gaps identified.

The following parts are excluded in the project's scope and could be reviewed in-depth in future studies:

- Reviewing the resilience plans of the cities outside Canada and 100 Resilient Cities.
- The best practices study for building and community resilience.
- In-depth technical analysis of the standards and strategies.
- Detailed technical analysis of GBAP components like energy, water, waste, materials, biodiversity, health and wellbeing associated with resilience.
- In-depth analysis of the application of the RELi standard to UBC campus buildings through pilots or case studies

Part 1: Resilience Initiatives

Organizations around the world are making efforts at a local, national and global level to strengthen the social, economic and environmental fabric of different regions at varying scales through the perspective of 'Resilience'. The concept of resilience has been evolving in recent years across the sectors of development, and adapted to enable long-term survivability of the communities.

Part 1 of the project studies the principles, strategies, plans and recommended tools of six distinguished organizations. They were found to be distinct in some domains and similar in others based on their perspectives towards resilience and area of expertise. The table below lists the organization and their field of work.

Organization	Location	Focus	Role
Prairie Climate Centre (PCC)	Canada	Climate change at city level	Communicating the science, impacts, and risks of climate change through maps, documentary video, research reports, and plain-language training, writing, and outreach.
Resilient Design Institute (RDI)	USA	Resilience in buildings, community, region & ecosystem	Offers customized consultation to building and community projects, and creates solutions to face challenges posed by climate change, natural disasters and other disruptions.
US Climate Resilience Toolkit	USA	Climate resilience in built & natural environment	Provides tools, case studies, information, training courses and subject matter expertise to build climate resilience.
USGBC's Centre for Resilience	USA	Resilience through advocacy in green buildings and infrastructure	Advocacy and certifications for the design, construction and operation of buildings and communities to enable environmentally and socially responsible healthy environment.
100 Resilient Cities (100RC)	Internati onal	Physical, social and economic challenges at global level	Provides necessary resources to 100 cities part of the 100RC to develop a roadmap to resilience.
Stockholm Resilience Centre	Sweden	Interdisciplinary research on topics that focus on socio-ecological systems	Advancing research for governance and management of socio-ecological systems to secure ecosystem services for human well-being and resilience for long-term sustainability through publishing, policy and practice interactions, and education programs.

Table 1.1 Prominent organizations with their focus and work contribution

What is resilience?

Resilience emerged out of the need to address and adapt to the changing environments. For more than a decade, The Rockefeller Foundation has continued pioneering work in rural and urban regions on climate resilience. By 2012, the idea of resilience as the critical lens through which to consider not only climate change but also disaster risk reduction more generally, including financial shocks, terrorism and slow-moving chronic stresses, was gaining traction globally (ARUP & The Rockefeller Foundation 1)

The definition of resilience in the City Resilience Framework developed by The Rockefeller Foundation and ARUP aligns considerably with the six studied organization's understanding of resilience. 100 RC defines resilience as “the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience".

In terms of climate change, resilience is often framed with two other concepts: mitigation and adaptation. In this case, mitigation refers to the reduction of emissions of greenhouse gases or fossil fuels until their total eradication; adaptation refers to initiatives and measures that reduce the vulnerability of natural and human systems to climate change; and resiliency refers to the capacity of an ecosystem to absorb disturbances, without significantly altering its structural and functional characteristics, and can return to its original state after the disturbance factor has ended. (SGK PLANET)

In terms of resiliency in the built environment, the RELi framework presents five lenses of living design which embodies each other, namely, regeneration- to replenish, resilience- to adapt, restoration- to repair, sustainability- to endure and wellness- to thrive. There are multiple cross-over patterns with resilience. For example, energy efficiency leads to a cross-over between sustainability and resilience. As explained by Evan Reis, executive director and co-founder of the U.S. Resiliency Council:

> “Sustainability is about the building having a low impact on the environment. Resilience is about the environment having a low impact on the building.” (Facilitiesnet)

Resilience is multifaceted and linked to various prospects of the social, economic, environmental, cultural and political development of a region. Resilience is about having a balance between proactivity and reactivity and being well-integrated to inform the solutions to disruptions. Each of the organization displays multidimensional integrations and is evolving to assess their knowledge and practice.

Resilience principles

Each of the organizations analyzed in this study has a set of principles according to their focus. It was observed that these principles have remarkable overlaps while specifically tailoring to their field of work. The principles recognized among the organizations are summarized in Table 1.2. The definitions mentioned in the table below are directly cited from the list of organizations and is a culmination of significantly overlapping and stand-alone principles. Please refer to Appendix A for identified principles of each organization.

The principles of each organization lay a foundation and play a pivotal role in developing their strategies, followed by the execution of the action plans. These principles evolve out of the organizations understanding of resilience and their scope of work. The set of principles aims in guiding the design and projects in a forward-looking, risk-aware, inclusive and integrated way.

Principle	
Flexibility	Adopting alternative strategies with changing circumstances through new knowledge and technology.
Inclusiveness	Need of broad consultation and views to create a sense of shared ownership.
Integration	Bringing together a range of distinct institutions and systems.
Reflectiveness	Learning from past experiences and informing the future decisions.
Resourcefulness	Recognizing alternative ways of using available resources.
Robustness	Well-conceived, managed and constructed systems.
Redundancy	Creating spare capacity to accommodate disruptions.
Transcending scale	Applicable at different regional scales and time scales from immediate to long term.
Basic human needs	Providing basic human needs and be equitably distributed.
Simple ways	Passive or manual override systems which are more resilient than complex systems
Anticipating interruptions	Adapting climate change, non-climate related natural hazards and anthropogenic actions.
Protecting nature	Adapting strategies that protect the natural environment and applying lessons from nature that will enhance resilience for living systems.
Social equity	Strong, culturally diverse communities face better during the times of stress and disturbance.
Strong Advocacy	Manifesting the advocacy activities at all levels of government.
Manage connectivity	Well-connected systems can recover from disturbances quickly, but overly connected systems may lead to rapid spread of disturbances.

Table 1.2 Resilience principles adapted by the organizations

Resilience strategies

Resilient initiatives require highly contextual responses as each setting or region faces unique challenges which cannot be generalized. Some of the organizations analyzed provide context-specific strategies to achieve resilience.

The Prairie Climate Centre has conducted nine studies on building a climate-resilient city as a climate change adaptation strategy for Calgary and Edmonton. The research series outlines steps that cities can take to engage in climate risk management in a range of areas, including transportation, agriculture, electricity infrastructure, disaster preparedness and emergency management. The strategies are proposed in the reports under the nine topics of Economics and Finance; Agriculture and Food Security; Urban Ecosystems; Transformational Adaptation; Transportation Infrastructure; Water Supply and Sanitation Systems; Electricity Information and Communication Technology Infrastructure; The Built Environment; Disaster Preparedness and Emergency Management. (Prarie Climate Centre)

The key strategies proposed in the urban ecosystem and built environment reports are as follows: (Prarie Climate Centre)

- Adapt climate-smart design to provide long-term strategic benefits to the city.
- Respond to actual or projected climatic changes.
- Mitigate Urban Heat Island (UHI) effect through spatial planning, selection of building materials and green high-density urban spaces.
- Adapt Architectural protocols such as LEED and EcoDistricts which encourage patterns of resource use and community dynamics.
- Expand and make active use of natural spaces and green infrastructure.
- Consider asset management systems for urban ecosystems and natural landscapes.
- Restore and rehabilitate projects to assist in the recovery of natural spaces that have been degraded, damaged or destroyed.
- Conduct assessments and long-term monitoring of the project functioning and maintenance systems.

The Resilient Design Institute (RDI) believes that every project is different and offers customized consultations. RDI takes a multifaceted lens to rethink the built environment and proposes a list of strategies to achieve resiliency at building, community, regional and ecosystem scales. Some of the critical strategy suggested by RDI include: (Resilient Design Institute)

Building Scale

- Model design solutions based on the projected climate data.
- Reduce dependence on complex building controls and systems.
- Optimize the use of on-site renewable energy & carry out water conservation practices.
- Adapt passive survivability in the buildings during power outages and when hazard strikes.

- Provide redundant electric, food and water supply systems, for use during the event of damage and emergencies.
- Consider an option for human waste disposal in the event of non-operating municipal systems.
- Specify products and materials that will not off gas or leach hazardous substances in the event of flooding or fire damage.

Community Scale:

- Build or facilitate social structures that strengthen the fabric of community.
- Design communities to minimize dependency on transportation fuels sourced from far away.
- Practical and functional use of natural spaces and an increase in green-density urban areas to reduce the heat-island effect.
- Rely on natural, biological erosion-control solutions that will grow stronger over time.
- Create community facilities that can serve as gathering places during emergencies and interruptions and outfit such facilities with access to key services, including water, electricity for charging cell phones, etc.
- Ensure the resiliency of cell phone towers so that communications can be maintained during times of emergency.

Appendix A contains detailed information on the definitions, principles and strategies by the six organizations reviewed in this study.

Tools

Tools can aid in enhancing the resilience value and ensure progress throughout the project, ideation, design, and delivery process. The six reviewed organizations recommend the use of a range of tools and information for different steps of resilience, which can be applied to projects of multiple scales. These tools are classified and summarized in Table 1.3. More information about what each of the tools is can be found in Appendix B.

The tools divided into six categories based on the purpose of the tools with their respective subcategories based on the application to a scale such as a building, community, city, region or an ecosystem.

Certification category includes the rating systems for green buildings, green infrastructure, power systems, earthquake resistance and sustainable and resilient neighborhoods and cities.

Climate database includes data and information of regions, cities or a particular area on future projected climate presented through reports, maps, templates and graphics.

Framework category includes a set of frameworks designed by organizations as a first step towards action to successfully achieve the goals.

Infrastructure database category includes information or guidelines on how to address resilience through numerous studies and research.

Qualitative diagnosis and Workshop handbooks categories are tools provided by 100RC to aid in the successful designing, planning and execution of resilient city strategy plans for the participating 100 cities.

Category	Sub-category	Tools
Certifications	Infrastructure	• Infrastructure Resilience Professional (IRP) • Envision
	Buildings and community	• RELi 2.0
	Buildings	• LEED • Living Building Challenge
	Power systems and electricity infrastructure	• PEER
	Project site	• SITE
	Cities	• LEED for cities
	Earthquake	• REDi
	Neighbourhoods	• EcoDistrict
Climate Database	-	• Climate Atlas of Canada • Plan2Adapt • PCIC Climate Explorer
Framework	-	• One Planet Living • City Resilience Index • CCEL Community Resilience
Infrastructure Database / Guidelines	Building Design	• MBAR Resources: Design Discussion Primers
	Infrastructure	• PIEVC Protocol 2008
	Infrastructure	• Climate Change Hazards Information Portal (CCHIP)
Qualitative Diagnosis (100 RC)	Cities	• Assets and Risk Tools • Local Area Risk Assessment • Resilience Accelerator • Tactical Urban Resilience
Workshop Handbooks (100 RC)	Cities	• COLAB • Opportunity Assessment • Problem Framing • Project Scan Tool • Resilience Garage • Resilience Value Realization • Systems Studio

Table 1.3 List of recommended tools to achieve resilience at various scales of urban development

Part 2: Federal and Provincial Policy

Federal government initiatives

The Government of Canada contributes towards resilience through the Pan-Canadian Framework on clean growth and climate change under adaptation and climate resilience. The aim of this initiative is "to grow the country's economy while reducing emissions and building resilience to adapt to a changing climate." This framework is applicable at the federal, provincial and territorial level in Canada. Climate-Resilient Buildings and Core Public Infrastructure Initiative, Building Regional Adaptation Capacity and Expertise (BRACE) program, Emergency Management Framework and National Disaster Mitigation Program (NDMP) are some of the resilience associated programs engaged through the Pan-Canadian framework.

The objectives of this framework are:

- Translating scientific information and traditional knowledge into actions
- Building climate resilience through infrastructure
- Protecting and improving human health and wellbeing
- Supporting particularly vulnerable regions
- Reducing climate-related hazards and disaster risks

Provincial government policy recommendations

The Government of British Columbia encourages local governments around the province to take action through planning and policy strategies. On the BC government website there is a page on 'Local Government Planning for Sustainability and Resilience', in which they provide guidance on economic, social and cultural, and environmental planning policies that can be incorporated into regional growth strategies and official community plans, to support community sustainability and resilience. Some examples of these planning policies include:

- Anticipating and planning to reduce future costs of infrastructure, servicing, health care and climate change impacts.
- Encouraging community design that facilitates physical activity, community connection, housing affordability, food security, and accessibility to services, among others.
- Supporting the natural environment and ecosystems, reducing greenhouse gas emissions, and protecting agricultural land and green space.

The BC government also defines resilience as a "community that has the capacity to adapt to changes such as shifting demographics and housing affordability, and "bounce back" from events such as economic downturns and the effects of a changing climate." These sustainable and resilient communities are characterized as compact, complete, centred, and connected, and consider natural assets and hazards.

Finally, they also include a Guide to Green Choices: Ideas & Practical Advice for Land Use Decisions in British Columbia Communities, which is a much more comprehensive document that provides practical advice and ideas for green communities in making land use decisions. The guide is meant to assist communities of all types and sizes, and it's designed to help maximize creativity and adaptability. It focuses on seven issues or needs: green settlement patterns, protection of natural features, settlements integrated with nature, vital economies for communities, role of transportation links, social aspects of sustainability, and strong local food supply. (Ministry of Community Development)

BC Housing initiatives

Mobilizing Building Adaptation and Resilience (MBAR) is a multi-year, multi-stakeholder knowledge and capacity building project led by BC Housing, with participation of more than 30 organizations, including national, provincial, and local agencies, as well as industry partners. This project aims at stabilizing communities in a natural disaster by helping building owners and occupants better protect their investments and adapt to anticipated climate change stresses (e.g. higher precipitation, warmer summers, fire-related air pollution) and shocks (e.g. severe flooding, fire, windstorms).

The objectives of MBAR project include:

- Building capacity through piloting integrated adaptive and resilient design solutions into building design and renovation projects, addressing the combined effects.
- Creating a training curriculum that is informed by real-life application experience based on at least five pilot projects. Pilot building types include residential buildings, care facilities, schools, public/institutional buildings, and senior, social and Indigenous housing.
- Creating multiple forms and stages of training to gradually and systematically increase the number of experienced, educated, informed and aware practitioners.

MBAR provides resources such as the 'Design Discussion Primers' for different topics including air quality, fire, floods, heat waves, power outages and emergencies, seismic events and severe storms. These documents outline design and operations strategies, as well as community benefits and potential design conflicts. In addition, BC housing also provides a MURB Design Guide, which is aimed at enhancing the livability and resilience of MURBs.

Part 3: Resilient Strategies of Canadian Cities

Four cities in Canada—Calgary, Montreal, Toronto and Vancouver—are members of the 100 Resilient Cities (100RC). Pioneered by the Rockefeller Foundation, 100RC is dedicated to help cities around the world become more resilient to the physical, social and economic challenges that are a growing part of the 21st century (100 Resilient Cities). 100RC looks at urban resilience holistically by understanding the systems that run the city, their interdependencies and the risk factors associated with them.

100RC supports incorporating a resilience perspective that involves not just the shocks but also the stresses that disrupt the functioning of the city gradually on a day to day basis. Shocks are sudden and sharp events that threaten the city, including floods, earthquakes, fires, etc. Stresses are slow-moving hazards that weaken the fabric of the city, including high unemployment, inefficient public transportation system, housing crises, food and water shortage, endemic violence, etc. The degree and urgency of shocks and stressors vary from city to city and is profoundly contextual.

Canadian Cities' Resilience Framework

There are three phases of actions to be taken by each city as a part of 100RC. The first phase involves preliminary resilience assessment (2017-18); the second phase requires a resilience strategy plan for the city (2018-19); and the third phase entails strategy development and implementation (2019-21). Calgary, Montreal, Toronto and Vancouver have all completed phase 1 and phase 2, which includes the preliminary assessments and a strategic plan which will inform phase 3. Table 3.1 outlines at a very high level each of the city's major challenges and the focus of their resilience strategies.

City	Resiliency Challenges
Calgary	"As the center of Canada's oil and gas industry, Calgary hopes to insulate its economy from shocks caused by fluctuating oil prices as it develops more robust responses to natural disasters".
Montreal	"Aging infrastructure, an aging population, and wide temperature swings top Montreal's list of resilience challenges".
Toronto	"A growing city, Toronto is addressing rising inequality while developing responses to increasing severe weather events".
Vancouver	"Vancouver is working to maintain its high quality of life in the face of rising housing prices and environmental uncertainty".

Table 3.1 Resilience challenges of the four Canadian cities

Each Canadian city has its own set of critical shocks and stressors, and the strategies developed to address the issues are identified in the preliminary assessment reports. The City Resilience Framework (CRF) guides the resilient city strategy of the four Canadian cities, which helps

understand the complexities of each city and identify drivers for resilience. The resilient city strategies as per the CRF are described in terms of four dimensions: health and wellbeing, economy and society, infrastructure and environment, and leadership and strategy. Each dimension contains three drivers guided by seven underlying principles, i.e., flexible, inclusive, integrated, redundant, robust, resourceful and reflective. Figure 3.1 illustrates the CRF and its components as described above.

Figure 3.1 City Resilience Framework – The Rockefeller Foundation | ARUP

Vancouver Resilient Strategy

The City of Vancouver has been developing its resilient strategy framework with 100RC since 2017 and recently released the Resilient Vancouver Strategy in June 2019. The strategy builds

upon five guiding principles, structured around three priority areas. Each priority area comprises of focused objectives that present high-level direction and actions that are near-term opportunities to enhance resilience. Several actions are already underway, and others will be refined and initiated between 2019 and 2021 (Vancouver Resilient Strategy, 47). Table 3.2 summarizes Vancouver's main shocks and stressors, as well as the guiding principles and priority areas identified in the Vancouver Resilient Strategy document.

Resilient Strategy for Vancouver City	
Key Shocks	• Earthquakes • Coastal and riverine flooding • Forest fires / Air quality • Extreme weather and temperatures • Oil spills • Public health emergencies- Opioid crises • Infrastructure failure and disruption • Hazardous materials • Residential fires
Key Stressors	• Affordability • Aging population • Debt and low wages • Food security • Homelessness • Gender inequity • Lack of diversity in decision-making • Poverty • Racism • Social isolation • Increasing demand and aging civic facilities • Aging buildings • Water system and resources • Climate change • Food system resilience • Regional infrastructure and supply chains
Guiding Principles	• Reconciliation • Equity and intersectionality • Sustainability • Recovery • Reciprocity
Priority Areas	Priority 1: Thriving and prepared neighborhood Priority 2: Proactive and collaborative city Priority 3: Safe and adaptive buildings and infrastructure

Table 3.2 Details of Vancouver resilience strategy

Part 4: UBC Resilience Plans and Initiatives

UBC accommodates a high population of students, staff and faculty, which places significant responsibility on the campus to provide a secure and healthy environment. So far, UBC has been working in four different areas to achieve resilience: climate change, health and wellbeing, seismic resilience and risk management. . The initiatives for each of these areas, as well as the policy and department it is being led by, are described in Table 4.1.

Initiative	Policy/Action	Department	Scope
Climate Change Mitigation and Adaptation	UBC Climate Action Plan & UBC Green Building Action Plan	UBC Campus and Community Planning	Operations and building assets (incl. academic and residential buildings) of the UBC Vancouver campus
Mental Health + Resilience	UBC Wellbeing Strategic Framework	UBC Wellbeing	Health and wellbeing for students, faculty, staff and the UBC community
Seismic Resilience Plan	Seismic Mitigation Plan	UBC Infrastructure Development	Buildings, utilities and operations of UBC Vancouver campus
Risk Management	-	UBC Risk Management Services	UBC operations

Table 4.1 UBC Resilience initiatives and focus areas

Climate Change

Climate change, and in particular, climate adaptation of UBC buildings is an emerging component in the UBC Green Building Action Plan (GBAP). The goal of this component is to build resilience in UBC buildings and landscape to be able to respond to both anticipated and unpredictable climate change. As part of the GBAP's Climate Action Component, UBC issued a 'Climate Ready Requirements' guideline for the UBC buildings applicable to small and large new buildings, as well as major project renovations. This initiative aims at making buildings at UBC '2050 ready' by making changes to the design, construction, and operation of buildings and landscapes which are necessary to adapt to the future climate. (Campus + Community Planning)

The objectives of the 2050 Ready initiative are:

- Providing design strategies that ensure the building undergoes low-cost retrofits for the predicted climate in 2050 to maintain thermal comfort and rainwater management.
- Designing for a climate-adaptive landscape with resilience to drought and floods.

- Providing strategies to consider indoor air quality for the predicted climate in 2050. (Campus + Community Planning)

Mental Health + Resilience

The UBC Wellbeing Strategic Framework visions to promote health and wellbeing where the people and community can flourish by creating vibrant, sustainable environments and well-connected communities. Wellbeing Strategic Framework promotes wellbeing in Collaborative Leadership, Mental Health & Resilience, Food & Nutrition, Social Connection, Built & Natural Environments and Physical Activity. (UBC Wellbeing)

The mental health and resilience priority area aims to enhance the mental health literacy among UBC community, creating a supportive campus culture, providing resources to faculty, staff and students to understand mental health issues, and improve resilience and coping skills by creating healthy environments. The framework is outlined to support the community to find a place of belonging and recognize positive mental health, which will eventually improve the coping strategies of the people and build compassion for each other in the times of crisis.

Seismic Resilience Plan

UBC Infrastructure Development is creating a prioritized action plan on several key priorities, addressing campus buildings, utilities and operations. The Seismic Resilience Plan aims at mitigating the risk of injury or death as a result of a seismic event and ensuring that the risk is addressed immediately within the University's logistical and financial capacity.

Seismic planning was undertaken initially in the 1990s with seismic upgrades of 25 buildings. The update for the seismic mitigation plan was then initiated in May 2016 to incorporate the latest science with best practices and to ensure a reduction in the seismic risk of the UBC buildings.

Guiding principles developed under this plan are: (UBC Seismic Resilience Project Team 2)

Life Safety: The prime importance is considering the safety of students, faculty, staff and visitors.

Alignment with Existing Principles and Processes: The seismic upgrades and renewals will align with the University's existing planning process.

Bold Vision, Pragmatic Implementation: The vision supports a disaster-resilient university that withstands the impacts of any hazard events while executing the work within the financial and logistical constraints of the university.

ARUP, a consultant team, conducted 'Seismic Resilience study' published in April 2017 which undertook a risk assessment and recommended resilience strategy to UBC, followed by a 'Detailed Seismic Evaluation of Buildings' study in January 2019. The former study aims at refreshing the previous assessments, quantifying seismic risks to people, assets and core functions on campus, and identify critical vulnerabilities in buildings, utilities and operations. This

study identifies the structural vulnerabilities of the UBC Vancouver building stock and categorizes them into four tiers. (ARUP 1-5). The later study conducted a detailed engineering evaluation using advanced seismic modelling for shortlisted 18 buildings in IV, which are at the highest risk of collapse. The sophisticated models identify the weaknesses, point of failures and predict the best estimate for the collapse probability. (UBC Seismic Resilience Project Team 2-4)

Risk Management Services

UBC Risk Management Services works with faculty, researchers, students, and administration to identify, assess, and mitigate UBC's strategic, academic, operational, financial, hazard, and reputational risks. RMS empowers the UBC community by weaving risk management into the fabric of UBC operations and enables to view risk management as critical to implementing the University's strategy. RMS categorizes there are of works under health & safety, environment protection, emergency preparedness, insurance, privacy & information security, and training. (UBC Risk Management Services)

Each of these areas plays a vital role in contributing towards resilience at UBC Vancouver campus.

Health & Safety: RMS provides technical expertise and guidance to support the primary objective of university departments to ensure the health and safety of the people and the environment.

Environment Protection: RMS supports the university departments to meet their environmental obligations through audits, consultation and environmental management systems.

Emergency Preparedness: RMS manages the emergency preparedness at UBC to prepare for, prevent, respond to and recover from emergencies that could affect the UBC community.

Insurance: RMS plays a role in minimizing the economic impact of loss or damage to the physical assets of the university.

Privacy & Information Security: RMS manages the privacy and information security aiming to reduce the risk of a privacy or information security breach impacting the UBC community. In support of UBC's strategic plan, RMS enables strategic risk acceptance.

Training: RMS provides educational courses and training in several fields of expertise.

Future Steps

Table 4.2 summarizes the next steps extracted from interviews and action plan reports. Each initiative evolves at an emerging, strategy planning, implementation, functioning and update or upgrading stage. The climate adaptation component under the GBAP is at an emerging stage, which identifies resilience aspect in the plan and develop strategies followed by implementation of the action plans. Mental health + resilience priority area in the UBC Wellbeing Framework developed the strategy and will move to the implementation stage. Seismic Resilience Plan has developed its action plans and is waiting for approval from the UBC board of governors. It also aims to conduct a detailed risk assessment for other building tiers. Finally, Risk Management

Services department is actively functioning with regular upgrades and providing consultation based on the campus requirements.

Initiative	Phase	Next Steps
Climate Adaptation	Emerging	• Testing the application of 'Climate Ready Requirements' on UBC buildings and implementing them along with other building guidelines and policies. • Research and best practice study on the passive survivability of UBC buildings, focusing on passive system primarily and then relying on secondary. • Execution of the five year implementation plan under the GBAP with short-term priority actions.
Mental Health + Resilience	Implementation in-progress	• UBC Cares: Increasing community members who feel mental health is a priority for 2025. • Increasing mental health literacy by 10% for students, staff and faculty across all indicators by 2025. • Study on shocks around food security. • Study on food system availability in case of emergencies.
Seismic Resilience Plan	Plan approval in-progress	• Development of an overall implementation plan while considering potential funding sources, project logistics, planning constraints, and consultations. • Completion of non-detailed evaluations of buildings identified by ARUP. • Completion of seismic retrofit of existing buildings and seismic design for new building guidelines. • Awareness of the plan among the public.
Risk Management	Functional	Updates only

Table 4.2 UBC Resilience initiatives and future steps

Part 5: Overview of RELi 2.0 Rating System

The RELi 2.0 rating system is a holistic, resilience-based rating system that combines design criteria with the latest integrative design process for new neighbourhoods, buildings, homes and infrastructure. The RELi standard was pioneered by Doug Pierce, a senior associate and architect at Perkins + Wills, Minneapolis office. The first version was developed and released in 2014 by the collaborative work from the Institute for Market Transformation to Sustainability (MTS) and its RELi collaborative. The U.S. Green Building Council (USGBC) incorporated the RELi rating system into their certification portfolio, and in 2017 created RELi 2.0. The USGBC, in conjunction with the MTS, has been managing RELi since then. (RELi)

The RELi rating system is an evolving product and will be developed over time as knowledge, research and experience build greater understanding. It is still in the pilot phase, where Christus Spohn Shoreline Hospital in Corpus Christi, Texas in the U.S are the pilot projects have been certified. (RELi)

The rating system is prepared for environmentally and socially resilient design and construction at building and neighbourhood scale. It aims at creating buildings and neighbourhoods that are shock resistant, adaptable, regenerative and healthy through a blend of foresight, diversity and capacity.

The RELi 2.0 rating system assumes that, within four days after the occurrence of a major event, there will be an emergency response from the federal/state emergency authorities. Therefore, the rating system is not intended to provide guidelines for indefinite building and community operation following a catastrophe. (USGBC)

Working with RELi 2.0

Similar to other rating systems such as LEED, the RELi certification is also based on a point system. There are four certification levels: RELi Certified, RELi Silver, RELi Gold, and RELi Platinum, ranging from 300 to 800 points. There are 15 mandatory requirements within the rating system that do not carry any point value. The optional credits have point values which allow the project to seek the certification level that fits the project requirements and needs. RELi recommends selecting a balanced set of credits as an approach to develop project-specific resiliency scenarios. The standard is currently applicable to new construction only. (USGBC)

The RELi 2.0 rating system introduces four realms relating to the building design process, construction and occupancy of the project throughout its lifetime. The realms include eight leading categories and one optional category. Table 5.1 explains the divisions of the realms and categories and can be understood as follows:

The ‘Pre-planning discovery & system thinking design’ realm includes one category namely ‘panoramic approach’ (PA) which focuses on a holistic and integrated design and construction process of the project.

The second realm, 'Risk Adaptation + Mitigation for acute events' includes two categories, 'hazard preparedness, short-term hazard preparedness, mitigation + adaptation' (HP) and 'hazard mitigation + adaptation' (HA) which deals with the preparedness of the building to face any emergency events in short or long term.

The third realm, 'Comprehensive Adaptation + Mitigation for Resilient Present & Future' includes 'community cohesion, social + economic vitality' (CV), 'productivity, healthy + diversity' (PH), 'energy, water + on-site food production' (EW), and 'materials + artifacts' (MA), which focuses on resource efficiency and long-term survivability of the project.

The fourth realm, 'Applied Creativity & Contextual Factors for Resiliency' includes one category called 'applied creativity' (AC) which involves in awarding innovative and unique ideas in the project.

Realm	Categories
Pre-planning, Discovery & System Thinking Design	PA: Panoramic Approach
Risk Adaptation + Mitigation for Acute Events	HP: Hazard preparedness, short-term hazard preparedness, mitigation + adaptation
	HA: Hazard Mitigation + Adaptation
Comprehensive Adaptation + Mitigation for Resilient Present & Future	CV: Community Cohesion, Social + Economic Vitality
	PH: Productivity, Health + Diversity
	EW: Energy, Water + On-site Food Production
	MA: Materials + Artifacts
Applied Creativity & Contextual Factors for Resiliency	AC: Applied Creativity

Table 5.1 RELi rating system's realms and categories

RELi 2.0 is a comprehensive certification which draws credits from LEED, Envision, 2030 palette and well-researched supporting documents. It is currently being piloted and only available for projects that are in the process of attempting LEED certification. RELi's formatting is intentionally similar to LEED, making it quickly readable to the LEED users. (USGBC) Table 5.2 includes a list of wider topics considered in the RELi 2.0 rating system to achieve resilience and the credit references required to be addressed in the respective topic.

Application	Credit Reference
Hazard Preparedness, Social Cohesion and Regional Economics	Unique RELi prerequisites and credits
Integrative Design Process	ANSI Integrative Process Standard (MTS developed)
	Integrative Living Design Process

Disaster preparedness	Red Cross, Ready Rating Program
Emergency Management	FEMA 141 Guide
	U.S. Small Business Administration
Safer Business and Environment	Fortified V1
	Urban Green Building Resiliency Task Force
	EPA Vulnerable Zone Indicator + Environ Facts
	Nuclear Regulatory Commissions
Sustainable Infrastructure	Envision V2.0
	Centre for Active Design
	Sustainable Sites Rating System V2.0
	LEED V4
	Energy Star / 2030 Palette

Table 5.2 RELi credit references and applications

RELi credit system

The certification applies for projects at building and community scale. Building scale includes infrastructure, homes and buildings, while community includes campus, neighbourhoods and districts. Each credit system is divided into three sections, namely structure, community and, structure + community. The credits consist of either of the three sections based on the topic requirements. The structure represents a single building or a group of buildings with its immediate surroundings represented as a community. The details of the scale of the structure and breadth of the community has not been mentioned which makes it unclear to draw the scale of project to be considered for RELi certification.

The credits are divided into 8 categories ranging from topics like hazard preparedness, mitigation and adaptation; community development and productivity; and energy, water and materials. A description of each of the categories and the credits they contain can be found below.

PA- Panoramic approach: This category focuses on the pre-design development of the project and introduces measures to establish a comprehensive and integrated system to realize a successful resilience project. As the context of resilience is multidimensional and complex, panoramic approach lays a network and aids in understanding various layers of integration in a project. PA credits assist in establishing sustainable and resilient management systems, considering commissioning and long-term maintenance, and addressing any conflicting regulations and policies.

HP- Hazard Preparedness, short-term hazard preparedness, Mitigation + Adaptation: This category aims at measuring the project preparedness and emergency planning for frequent hazardous and extreme events. The credits help in understanding the

emergency systems, requirements and actions to be taken for the community survival in case of the hazardous events. HP credits include emergency planning, access to water, food, care supplies, and additional provisions for the community. It also involved educating the community and having a good communication system.

HA- Hazard Mitigation + Adaptation: This category strives at long-term and advanced hazard preparedness at building and community scale. The credits consider the project site location, safe and adaptive building design, transit accessibility, environment safety and passive survivability during extreme weather and hazardous events. The credits emphasize on fundamental and advanced emergency operations during and after the event occurrence to obtain resilience. Some of the measures include passive thermal safety, thermal comfort, lighting design strategies, water and services supply, and back-up powers.

CV- Community Cohesion, Social + Economic Vitality: This category aims at improving the quality of life of the communities affected by the project by incorporating community views and participation, utilizing local labour and resources, improving community connectivity, and engaging with corporations and organizations. The credits highlight community connectivity through promoting walkability, public transit, non-motorized transit, mixed-use commercial and housing with public or community spaces. Economic value is specified by developing local skills, long-term employment, and using regionally sourced and manufactured material and products.

PH- Productivity, Health + Diversity: This category intends to improve the health and productivity of the building and community occupants, habitat and ecological systems. The credits propose to improve productivity, health and diversity by promoting physical activity through active design, improving the indoor air quality, providing views to the outside, producing opportunities to improve social equity among diverse groups of people, communities and institutions, avoiding the use of toxic and polluting fertilizers and pesticides, and protecting the biodiversity.

EW- Energy, Water + Onsite Food Production: This category aims at achieving water efficiency, energy efficiency, rainwater harvesting, producing food, resilient landscape and renewable energy, and reducing the environmental impacts for human and ecological use. The credits focus on using minimum resources and having the least impact on the environment while fulfilling the needs of the building and community occupants. This includes improving the balance of human development and the use of resources in the long term and during power outages or loss of cooling or heating fuel.

MA- Materials + Artifacts: This category intends to review the ecological and economic lifecycle of all materials used on the project, and reduce environmental and health impacts by using materials that limit exposure to toxins, considering a full life cycle design for durability, adaptability and flexibility, extensive use of recycled, reusable and

remanufactured materials, and reducing the environmental impact associated with the extraction, harvest and production of virgin materials.

AC- Applied Creativity: This is an optional category similar to the LEED Innovation and Design credits. The credit intends to provide the opportunity to the projects and designers to be awarded additional points for exceptional performance.

In order to obtain a credit, the project must comply with the recommended RELi requirements or credits drawn from different standards. RELi credits referenced to other standards as requirements adopt a particular credit of one standard only or from multiple standards. The following table (Table 5.3) presents the number of RELi credits in each category that are either defined by the RELi 2.0 standard (counted in the RELi 2.0 column), or referenced to other standards (counted in all other columns). The main standards that are referenced are LEED, including new construction (LEED NC), neighborhood development (LEED ND), and pilot credits (LEED Pilot), as well as Envision. Other reference standards include Fortified, 2030 Palette, Active Design and REDi.

Category	No. of Credits	RELi 2.0	LEED NC	LEED ND	LEED Pilot	Envision	Other
PA- Panoramic approach							
Requisite	3	1	2	-	-	2	-
Credits	7	2	-	-	-	5	-
HP- Hazard Preparedness, short-term hazard preparedness, Mitigation + Adaptation							
Requisite	2	2	-	-	-	-	-
Credits	4	4	-	-	-	-	-
HA- Hazard Mitigation + Adaptation							
Requisite	4	4	-	-	-	-	1
Credits	5	4	-	-	-	-	1
CV- Community Cohesion, Social + Economic Vitality							
Requisite	1	-	-	-	-	1	-
Credits	8	4	3	2	1	3	1
PH- Productivity, Health + Diversity							
Requisite	2	1	2	-	-	1	-
Credits	6	1	2	-	-	3	1
EW- Energy, Water + Onsite Food Production							
Requisite	2	-	2	-	-	-	-
Credits	6	3	5	5	-	1	2
MA- Materials + Artifacts:							
Requisite	1	1	1	-	-	-	-
Credits	7	5	2	-	-	-	-
TOTAL	58	32	19	7	1	16	6

Table 5.3 RELi credit requirement references

The RELi credits must comply with recommended RELi requirements or credits drawn from different standards. RELi credits referenced to other standards as requirements adopt a particular credit of one standard only or from multiple standards. Some credits have optional paths of compliance, which means that projects could achieve the credit using either LEED or Envision, for example, depending on the certification they are already pursuing.

LEED and Envisions are adopted widely for the structural and community requirements of RELi credits. RELi provides a unique set of requirements for several credits with guidance, specifically for the credits that are not covered by any of the existing referenced standards.

The RELi requisites of the PA, PH, EW and MA categories, draw the majority its requirements from LEED NC, while the CV and PH categories draw from Envision. The HA and HP categories rely mainly on requisites from RELi itself. In terms of the credits, the PA category in RELi profoundly relies on Envision credits, while the HP and HA categories appear to be relatively new domains of measuring resilience containing credit requirements suggested by RELi. The CV category is broadly ranged and extensively referenced from LEED, Envision and RELi. The PH category consists of credit requirements equally from LEED and Envision, while the EW and MA categories draws its credit requirements from LEED NC, LEED ND, and RELi.

Part 6: Recommendations and Conclusion

Based on the information review and analysis done throughout this study and contained in this report, this section aims to identify the gaps, opportunities, challenges and recommendations for the UBC campus towards achieving resilience. The identified topics need further in-depth research and analysis, which can additionally account for future research topics on building resilience for UBC. The following key discussion points also aim to inform potential future initiatives and actions that can be taken by Campus and Community Planning and other UBC departments to implement and achieve targets identified in the UBC Green Building Action Plan (GBAP).

Recommendations

Adopting multifaceted perspective towards resilience

The study from Part 1 presents findings on definitions, principles and strategies of resilience, which is multidimensional, complex and interconnected to every aspect of development. UBC embraces the active lens of sustainability and wellness in its actions and initiatives. UBC can further adapt to resilience by performing multifaceted integrations linked to social, economic, cultural and environmental development.

Introducing central oversight on resilience

Discussing the challenges of achieving resilience at UBC in the interviews with key staff from UBC Campus and Community Planning, Infrastructure Development and Wellbeing, catering to the large scale and size of UBC was one of the key issues. The resilience strategy at UBC would benefit from having a central oversight that would ease the management of the actions and initiatives, and create a network that builds on information sharing and integrations. A chief executive officer assigned by each of the city under the 100 Resilient Cities program exemplifies this position within the municipality organization to execute a successful resilient plan for a city.

Setting up of resilience framework

UBC has done extensive amounts of work on climate mitigation, seismic resilience, and mental health and wellbeing through the vision of sustainability and resilience on campus. However, the actions taken could be considered to be isolated and lack cohesion. Resilience strategies require collaborations and addition of missing pieces through the lens of resilience. The City Resilience Index prepared by the Rockefeller foundation and ARUP, which has been widely adopted by organizations around the world, could build a foundation towards setting up a framework for UBC. A resilience framework will tie the actions of various departments at UBC and move towards achieving a resilient campus.

Collaborations with the City of Vancouver and BC Housing

The City of Vancouver, as a part of the Vancouver Resilient Strategy, approaches resilience for the city holistically and includes strategies that are highly applicable to UBC context. Similarly, BC Housing, under the Mobilizing Building Adaptation and Resilience (MBAR) initiative, which is aimed at stabilizing communities through resilience and sustainable building design, appropriately fit the UBC built environment. Potential collaborations and alignment with the city and province initiatives is recommended, and aids in understanding the critical resource availability and benefitting from the network of development.

Public participation and awareness of resilience

Under 100RC, each city conducted a public survey for measuring and assessing the critical shocks and stressors of the cities. These surveys developed an understanding of issues faced by the communities, and identified actions and targets to address them. 100RC provides multiple sets of tools that help organizations develop a framework and strategy for a city, which can be applied to the UBC context. Public participation and awareness strengthens the community response and prepares to face, recover and sustain from stressful and hazardous events.

Stressor and shock studies

As per the 2019 Undergraduate Experience Survey (UES) and relevant UBC student experience studies mentioned in the UBC Wellbeing Strategic Framework, 40% of students reported food insecurity, 24% reported being diagnosed with a mental health condition, two-thirds of under-grad students and 72% of staff and faculty don't feel part of their campus community, and 45% of students are physically inactive. These studies highlight issues that hinder the growth and development of the community and is considerably influenced by the built environment. An overall study of the shocks and stressors of the UBC Vancouver campus should be conducted to address these issues and encourage long-term resilient and sustainable solutions.

Review of UBC actions by department

UBC departments have been initiating positive and sustainable development strategies and achieving the targets set in different action plans. This work falls under different sectors operated by Campus Community Planning, Risk Management Services, Infrastructure development, UBC Wellbeing, UBC Farm on campus, and so on. Thorough understanding of the spread of existing resilience activities at UBC is required to understand the extent of these actions as part of a holistic view of resiliency.

In-depth analysis of resilience rating systems and UBC building guidelines

To be able to determine the applicability of resilience rating systems, such as RELi, to the UBC context, an in-depth review of the UBC technical guidelines, the UBC LEED implementation guidelines (and the UBC REAP standard for neighbourhood buildings), and other relevant policy is required. This study provides an overview of the RELi standard, and potential overlaps that exist with the LEED rating system. However, the RELi standard is still on the pilot phase and gaps in the implementation of this standard to building projects still exist. Therefore, it is recommended to wait until this and other resilience rating systems are public and ready for widespread adoption to conduct an in-depth analysis of the applicability to UBC buildings and the overlap between what these rating systems require and what UBC already requires from their projects through the existing guidelines mentioned above.

Conclusion

UBC has taken leaps in creating a sustainable and healthy environment through aspirational policy, initiatives and actions, and strives forward to attain resilience in the campus and the community. The study and analysis directed through this project provide perspectives of the organizations worldwide, shares inspiration from their actions and leadership, and offers opportunities to reflect on the current state of resiliency initiatives and strategies at UBC. The overall study broadly suggests the UBC Green Building Actions Plan adopt a holistic lens interlinked with social, economic, cultural and environmental aspects of community development alongside the integration of resilience under climate adaptation component. Opportunities were also identified to apply resilience frameworks beyond the built environment through holistic integration of actions that are already underway throughout the campus. The identified topics for the development of resilience within the UBC community and the building context informs the action plans and initiatives and hopes to instigate a further investigation to evolve as a resilient and vibrant community.

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Appendices

Appendix A: Resilience Context

S.no	Organization	Content:	
1	**Prairie Climate Centre** (Prarie Climate Centre)	Location:	University of Winnipeg, Manitoba, Canada
		Role:	Communicating the science, impacts, and risks of climate change through maps, documentary video, research reports, and plain-language training, writing, and outreach.
		Definition of Resilience:	"Resilience is about climate risk management. Building Resilience will be an essential urban policy and a smart investment for cities. It is brand able, and demonstrates city's willingness to embrace innovation culture." "A resilient city is one in which its institutions, communities, businesses and individuals have the capacity to function and are able to "survive, adapt and grow" in response to any kind of sudden short- or long-term disruption that they may experience."
		Focus:	Addressing climate change at the city level.
		Principles:	• **Flexibility:** Adopting alternative strategies with changing circumstances through new knowledge and technology. • **Redundancy:** Spare capacity to account for disruption and surges. • **Robustness:** Urban physical assets to be designed, constructed and maintained in anticipation of high-impact climate events. • **Resourcefulness:** Aware of climate risks, able to adapt to shocks and stresses and can quickly respond to a changing environment. • **Reflectiveness**: Learn from past experiences and inform future decisions. • **Inclusiveness:** Need for broad consultation and views. • **Integration:** Consistency in design decisions and investments.
		Strategies / Studies:	Reports on building a climate resilient city have been prepared for the following nine topics for Calgary and Edmonton: • Economics and Finance • Agriculture and Food Security • Urban Ecosystems • Transformational Adaptation • Transportation Infrastructure • Water Supply and Sanitation Systems • Electricity Information and Communication Technology Infrastructure • The Built Environment • Disaster Preparedness and Emergency Management
		Recommended tools / frameworks	• Climate Atlas of Canada • Monthly Temperature and Precipitation Delta maps • PIEVC (Public Infrastructure Engineering Vulnerability Committee) • CCHIP (Climate Change Hazards Information Portal) • Resource Efficiency: LEED, Living building Challenge • Neighbourhood planning: EcoDistrict, One Planet Living and 2030 Districts • Walk Score criteria
2	**Resilient Design institute** (Resilient Design Institute)	Location:	Brattleboro, USA
		Role:	RDI offers customized consultation to building and community projects, and create solutions to face challenges posed by climate change, natural disasters and other disruptions.
		Definition of Resilience:	"Resilient design is the intentional design of buildings, landscapes, communities, and regions in order to respond to natural and manmade disasters and disturbances - as well as long-term changes resulting from climate change." "Resiliency is a multifaceted lens which balances proactivity and reactivity to inform solutions to disruptions."
		Focus:	Addressing climate change at buildings, community, region and ecosystem level.
		Principles:	• **Transcends scale:** Applied at individual building, community, region and ecosystem scale while applied at different time scales from immediate to long term. • **Basic human needs:** Resilient systems provide for basic human needs and be equitably distributed. • **Diverse and redundant systems:** Diverse communities, ecosystems, economies and social systems are better able to respond to changes or interruptions. • **Simple, passive, and flexible systems:** Passive or manual override systems are more resilient than complex systems that require on-going maintenance. • **Durability:** Strategies that increase durability enhance resilience and should involve not only building practices, but also building design, infrastructure and ecosystems. • **Locally available, renewable, or reclaimed resources:** Reliance on local recourses provides greater resilience than dependence on non-renewable resources. • **Anticipate interruptions and a dynamic future:** Adaptation to a changing climate, non-climate related natural disasters, and anthropogenic actions call for resilient design. Responding to change is an opportunity for a wide range of system improvements. • **Promote resilience in nature:** Natural systems have evolved to achieve resilience. Adapting strategies that protect the natural environment, and applying lessons from nature will enhance resilience for living systems. • **Social equity and community:** Strong, culturally diverse communities will face better during the times of stress and disturbance. • **Resilience is not absolute:** Recognizing that total resilience in the face of all the situations is not possible, while taking incremental steps and implementing what is feasible in the short term and work towards achieving greater resilience in stages.
		Strategies / Studies:	RDI proposes a list of strategies to achieve resiliency at building, community, region and ecosystem scales through various topics on a preliminary level.
		Recommended tools / frameworks	• LEED Rating System • RELi Rating System

S.no	Organization	Content:	
3	**US Climate Resilience Toolkit** (US Climate Resilience Toolkit)	Location:	USA
		Role:	Provides tools, case studies, information, training courses and subject matter expertise to build climate resilience.
		Definition of Resilience:	Resilience is the capacity of the system to retain essential functions before, during and after a hazard strikes. A resilient system can bounce back completely.
		Focus:	Building climate resilience in built environment, ecosystems, food, marine, tribal nations, coasts, energy, health, transportation and water.
		Principles:	"Functional Capacity". Whether the project has faced a loss or anticipate one, the smart response is to increase the capacity to avoid suffering from an irreparable harm.
		Strategies / Studies:	Steps to resilience (framework): • **Explore hazards:** - Gathering a team of people who want to protect local assets. - Checking past weather events and future climate trends. - Listing the valuable things that could be damaged. - Determining which assets are exposed to harm. • **Assess vulnerability & risks:** - Evaluating potential impacts to assets. - Assessing each asset's vulnerability. - Estimating the risk to each asset. • **Investigate options:** - Considering possible solutions for highest risks. - Checking how others have responded to similar issues. - Reducing list to feasible actions. • **Prioritize & plan:** - Evaluating costs, benefits, and your team's capacity to accomplish each action. - Ranking the expected value of each action. - Integrating the highest-value actions into a stepwise plan. • **Take actions:** - Moving forward with the stakeholders who accept responsibility and bring resources to take action. - Checking to see if your actions are increasing your resilience.
		Recommended tools / frameworks	More than 200 tools for the defined topics and for each step of resilience is available for the USA context. Some of the them are: • Climate Explorer • Fourth national Climate Assessment Report • Vulnerability assessment reports • Brief Case Studies • Reports by government and non-government organizations
4	**USGBC: The Centre for Resilience** (U.S. Green Building Council)	Location:	USA
		Role:	Advocacy and certifications for the design, construction and operation of buildings and communities to enable environmentally and socially responsible and healthy environment.
		Definition of Resilience:	"Ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events".
		Focus:	Addressing resilience through green building and infrastructure certifications.
		Principles:	Sustainable buildings are the cornerstone to enhancing community resilience. LEED users underscores the collective commitment to building a greener future among the mounting challenges of our era. The challenge is to manifest the advocacy activities at all levels of government. • **Federal advocacy:** The federal government plays an important role in setting the policy context for risk management and in helping to finance planning and recovery. • **State and local advocacy:** State and local governments are often responsible for the immediate response to natural disasters, and they offer critical on-the-ground perspectives for understanding vulnerabilities in communities. • **USGBC's local communities:** Local communities serve a critical role in providing local perspectives and practical solutions to challenges that states and municipalities face when seeking to enhance their resilience.
		Strategies / Studies:	Metrics-based approach to assessing resilience and measuring impact, USGBC finds that resilience means: • **Design planning:** Proactive design, planning and construction for reasonably expected natural disasters to incur minimal damage • **Healthy site:** Creation and execution of a site development plan that promotes healthy vegetation, soils, and aquatic ecosystems to provide ecosystem services such as flood control • **Maintaining project site:** Design, building, and maintaining of the project site and adjacent landscapes to reduce risk of wildfire • **Catastrophic event:** Support for community recovery during catastrophic events and extended bulk power grid outages by enabling islanding and power reliability to essential services
		Recommended tools / frameworks	Rating system tools: • LEED • PEER • SITES • LEED for Cities • RELi

S.no	Organization	Content:	
5	**100 Resilient Cities** (100 Resilient Cities)	Location:	International
		Role:	Provides necessary resources to 100 cities part of the 100RC to develop a roadmap to resilience.
		Definition of Resilience:	"Urban resilience is the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience."
		Focus:	Addressing physical, social and economic challenges at global level.
		Principles:	Resilient cities demonstrate seven qualities: • **Reflective:** Using past experience to inform future decisions. • **Resourceful:** Recognizing alternative ways to use resources. • **Robust:** Well-conceived, constructed, and managed systems. • **Redundant:** Spare capacity purposively created to accommodate disruption. • **Flexible:** Willingness and ability to adopt alternative strategies in response to changing circumstances. • **Inclusive:** Prioritize broad consultation to create a sense of shared ownership in decision making. • **Integrated:** Bring together a range of distinct systems and institutions.
		Strategies / Studies:	The essential systems of a city in terms of four dimensions: • **Leadership & Strategy:** The processes that promote effective leadership, inclusive decision-making, empowered stakeholders, and integrated planning. • **Health & Wellbeing:** Everyone living and working in the city has access to what they need to survive and thrive. • **Economy & Society:** The social & financial systems that enable urban populations to live peacefully, and act collectively. • **Infrastructure & Environment:** The man-made and natural systems that provide critical services, protect, and connect urban assets enabling the flow of goods, services, and knowledge.
		Recommended tools / frameworks	Tools and assessments designed to support the Cities in achieving resilience are: • Actions and perception reports • Assets and risk tools • City resilience index • COLAB • Local area assessment • Opportunity assessment • Problem framing • Project scan tool • Resilience accelerator • Resilience garage • Resilience value realization • Systems studio • Tactical urban resilience
6	**Stockholm Resilience Centre** (Stockholm Resilience Centre)	Location:	Stockholm University, Sweden
		Role:	Advancing research for governance and management of social-ecological systems to secure ecosystem services for human well-being and resilience for long-term sustainability through publishing, policy and practice interactions, and education programmes
		Definition of Resilience:	"Resilience is the capacity of a system, be it an individual, a forest, a city or an economy, to deal with change and continue to develop. It is about how humans and nature can use shocks and disturbances like a financial crisis or climate change to spur renewal and innovative thinking. Resilience is an attempt to create a new understanding of how humans and nature interact, adapt and impact each other amid change."
		Focus:	Conducting interdisciplinary research on themes that focus on particular social-ecological systems connected to marine, urban and food-producing landscapes.
		Principles:	Seven principles for building resilience in social-ecological systems: • **Maintain diversity and redundancy:** provides 'insurance' by allowing some components to compensate for the loss or failure of others. • **Manage connectivity:** Well-connected systems can recover from disturbances quickly, but overly connected systems may lead to rapid spread of disturbances. • **Manage slow variables and feedbacks:** Managing slow variables and feedbacks is often crucial to make sure ecosystems produce essential services. If these systems shift into a different configuration, it can be difficult to reverse. • **Foster complex adaptive systems thinking:** A complex adaptive systems (CAS) approach means accepting that within a social-ecological system, several connections are occurring at the same time on different levels. It means accepting unpredictability and uncertainty, and acknowledging a multitude of perspectives. • **Encourage learning:** Social-ecological systems are always in development so there is a constant need to revise existing knowledge and stimulate learning. • **Broaden participation:** An informed and well-functioning group have the potential to build trust and a shared understanding – both fundamental ingredients for collective action. • **Promote polycentric governance:** A governance system in which multiple governing bodies interact to make and enforce rules within a specific policy arena or location, is considered to be one of the best ways to achieve collective action in the face of disturbance and change. It represents flexible solutions for self-organisations where more formal procedures seem to fail.
		Strategies / Studies:	The research themes focused on social-ecological systems connected to marine, urban and food-producing landscapes follows four streams: • **Advancing complex adaptive systems and resilience thinking:** CAS is a class of systems whose macroscopic behavior emerges from self-organized local interactions of their elements, such as actors interacting with ecosystems and with other actors. • **Patterns of Anthropocene:** Explores the anatomy and behavior of the hyper connected global social-ecological system. It studies the interactions between human activities and earth's environment, where local and regional drivers can generate global scale challenges. • **Biosphere stewardship:** Explores what kind of knowledge systems, values, management practices, behaviors, and governance arrangements build sustainability in an increasingly interconnected and turbulent world. • **Resilience science for transformation:** Explores social-ecological transformations for human wellbeing and sustainability in tune with the biosphere.
		Recommended tools / frameworks	• World Research Map • Publications on themes and streams • Engagements in science-policy-practice activities

Appendix B: Tools Description

S.no	Tools	Category	Author Organization	Tool Description
1	IRP (Infrastructure Resilience Professional) Certification 2015	Certification for infrastructure development	Engineers Canada	IRP Certification provides Canadian Engineers with competencies and additional knowledge to design, manage and plan resilient infrastructure addressing climate change.
2	RELi 2.0 Rating Guidelines for Resilient Design and Construction.	Certification for building projects and community development (Pilot)	The C3 living design project and the Relic collaborative	The Relic 2.0 rating system is a comprehensive certification system for resilient design and construction at buildings and neighbourhood scale. Relic provides assessment and planning for acute hazard preparation, and adaptation strategies, and designing and constructing for passive survivability.
3	LEED	Certification for building projects	USGBC	LEED is building design and construction standard that promotes resilience in each of its credits and also by the LEED Climate Resilience Screening Tool which evaluates resilience potential of the projects.
4	Living building Challenge 4.0	Certification for building projects	Living future	Living Building Challenge provides a holistic approach to high performance building that aims to address health, community, equity, energy, water, and beyond.
5	PEER	Certification for power system performance and electricity infrastructure	USGBC	PEER includes guidance for cities, utilities, campuses, and transit to measures power system performance and electricity infrastructure to improve the sustainability, reliability, and resilience of these systems.
6	SITES	Certification for infrastructure and project site	USGBC	SITES provides a green infrastructure framework for landscapes and is the sustainable land development and management program that aims to create regenerative systems and resiliency.
7	LEED for Cities	Certification for cities	USGBC	LEED for Cities is a pilot certification program that supports progress towards resilient cities with solutions for waste production, measuring and managing energy and water use, human experience, and transportation usage on a city scale.
8	EcoDistrict	Certification for neighbourhood projects	EcoDistricts	EcoDistrict is standard that commits to equity, resilience and climate protection at the neighbourhood scale and provides a comprehensive framework to guide urban and community development.
9	REDi Rating System	Certification for resilience-based earthquake design.	ARUP	The Resilience-based Earthquake Design Initiative (REDi™) Rating System proposes a framework for owners, architects, and engineers to implement “resilience-based earthquake design”.
10	Envision	Certification for Sustainable and Integrated Infrastructure Design	Institute for Sustainable Infrastructure	Envision is a framework that provides the guidance needed to initiate this systemic change in the planning, design and delivery of sustainable and resilient infrastructure.
11	Climate Atlas of Canada	Climate Database	Prairie Climate Centre	Climate Atlas of Canada provides climate data through maps, graphs, explanations and summaries.
12	Monthly Temperature and Precipitation Delta maps	Climate Database	Prairie Climate Centre	Delta maps show the current and projected future climatic conditions for two 30 year (2021 - 2050 and 2051 - 2080) and current data set from 1976 - 2005.
13	Plan2Adapt	Climate Database	Pacific Climate Impacts Consortium	Plan2Adapt tool provides summaries, data, maps and plots for British Columbia region on future projected climate conditions.
14	PCIC Climate Explorer	Climate Database	Pacific Climate Impacts Consortium	PCIC is an advanced version of Plan2Adapt which allows to download, visualize and locate the data for projected future climate for the Pacific and Yukan region.
15	One Planet Living	Framework	Bioregional	One Planet Living is a flexible framework that can be used by developers, builders, tourist resorts and destinations, businesses, schools and community groups towards creating a sustainable future.
16	City Resilience Index	Framework	Arup	Designed to create a resilience baseline and enable cities to measure and monitor the multiple factors that contribute to their resilience.
17	CCEL Community Resilience Framework	Framework	Centre for Community Engaged Learning, UBC	The CRF is intended to serve as an assessment tool that can be utilized to facilitate reflexivity and collaboration that will enable the Centre to orient its programming toward building community resilience.
18	CCHIP (Climate Change Hazards Information Portal)	Infrastructure development database	Risk Sciences International	CCHIP is a web-based tool that provides information to integrate climate change impacts in planning and design decisions to protect private and public infrastructure.
19	PIEVC Protocol 2008	Infrastructure development guidelines	Engineers Canada	PIEVC is an advisory body to Engineers Canada which addresses infrastructure vulnerability for current and future climate in Canada. PIEVC protocol 2008, is an assessment for public infrastructure at no financial charge through a license agreement.
20	Actions and Perception	Qualitative diagnosis	100 Resilient Cities	Developed by 100RC and Arup to support a qualitative diagnosis of a city’s resilience, contributing to the development of their comprehensive Resilience Strategy.
21	Assets and Risk Tools	Qualitative diagnosis	100 Resilient Cities	A tool that helps cities prioritizes shocks and stresses in the context of their interaction under future scenarios and identifies vulnerable physical assets.
22	Local Area Risk Assessment	Qualitative diagnosis	100 Resilient Cities	A comprehensive lifecycle assessment of risks to the achievement of targeted development and resilience outcomes at neighborhood- or district-scale.
23	Resilience Accelerator	Qualitative diagnosis	100 Resilient Cities	A partnership between 100RC and the Center for Resilient Cities and Landscapes at Columbia University, connecting multi-disciplinary expertise with cities to advance strategy and project design.
24	Tactical Urban Resilience	Qualitative diagnosis	100 Resilient Cities	An approach to neighborhood building for the testing and delivery of resilience solutions that uses short-term, low-cost, and scalable interventions.
25	COLAB	Workshop handbooks	100 Resilient Cities	A workshop bringing together partners from across industries and disciplines to drive innovation in services, tools, and products.

S.no	Tools	Category	Author Organization	Tool Description
26	Opportunity Assessment	Workshop handbooks	100 Resilient Cities	A dedicated series of conversations and workshops designed to take stock of ideas for resilience building actions generated through the resilience strategy development process.
27	Problem Framing	Workshop handbooks	100 Resilient Cities	The tool supports the city in diagnosing needs, set priorities, and generate stakeholder buy in.
28	Project Scan Tool	Workshop handbooks	100 Resilient Cities	A rapid, multi-disciplinary collaborative assessment designed to help cities assess the resilience qualities of projects and their contribution to a city's overall resilience.
29	Resilience Garage	Workshop handbooks	100 Resilient Cities	A workshop for peer-review of corporate and municipal cases through a resilience lens.
30	Resilience Value Realization	Workshop handbooks	100 Resilient Cities	Implementing stakeholders come to a shared understanding of resilience value of a specific initiative and develop a roadmap of the steps necessary to protect it.
31	Systems Studio	Workshop handbooks	100 Resilient Cities	A multi-day workshop to tackle complex challenges by understanding them through systems' analysis.
32	MBAR Resources: Design Discussion Primers	Design Guidelines	BC Housing	Design discussion primers to consider when planning and designing your development for the following issues: air quality, chronic stressors, fire, flood events, heat waves, power outages and emergencies, seismic events and severe storms.

Appendix C: Federal and Province Policies

S.no	Department	Content	
1	**Government of Canada: Environmental and Natural Resources** (Government of Canada)	Title:	Pan-Canadian Framework on Clean Growth and Climate Change: "Adaptation and Climate Resilience"
		Type:	Policy framework
		Level:	Federal, provincial, and territorial.
		Focus:	To grow the country's economy while reducing emissions and building resilience to adapt to a changing climate.
		Objectives:	• **Translating scientific information and traditional knowledge into action** - Providing authoritative climate information - Building regional adaptation capacity and expertise • **Building climate resilience through infrastructure** - Investing in infrastructure to build climate resilience - Developing climate resilient codes and standards • **Protecting and improving human health and well-being** - Addressing climate change-related health risks - Supporting healthy Indigenous communities • **Supporting particularly vulnerable regions** - Investing in resilient infrastructure to protect vulnerable regions - Building climate resilience in the North - Supporting community-based monitoring by Indigenous Peoples - Supporting adaptation in coastal regions • **Reducing climate-related hazards and disaster risks** - Investing in infrastructure to reduce disaster risks - Advancing efforts to protect against floods - Supporting adaptation in Indigenous Communities
		Initiatives / Principles:	• **Climate -Resilient Buildings and Core Public Infrastructure Initiative:** This initiative is intended to develop capacity in Canada's construction industries to adapt to the increasing demands on our built infrastructure attributed to climate change. • **Building Regional Adaptation Capacity and Expertise (BRACE) program:** The BRACE Program takes a customized regional approach to address the unique needs of each province. BRACE encourages thematic and regional collaboration focused on areas like green infrastructure, professional training and natural resource sector climate resilience. • **Emergency Management Framework:** Describes the sharing of Emergency Management responsibilities among governments themselves, as well as with their respective Emergency Management partners. • **National Disaster Mitigation Program (NDMP):** The NDMP addresses rising flood risks and costs, and builds the foundation for informed mitigation investments that could reduce, or even negate, the effects of flood events.
2	**Government of British Columbia** (BC Government)	Title:	Local Government Planning for Sustainability & Resilience
		Type:	Planning Principle (Preliminary stage)
		Level:	Province
		Focus:	Includes planning policies in regional growth strategies and official community plans that support positive economic, social and cultural, and environmental outcomes.
		Objectives:	• **Economic** - Encourage sustainable and resilient resource use that minimizes waste and inefficiency. - Anticipate and plan to reduce future costs of infrastructure, servicing, health care and climate change impacts as a way of encouraging investments in the local economy. • **Social and Cultural** - Support community safety, health and diversity - Encourage community design that facilitates physical activity, community connection, housing affordability, aging in place, food security, substance abuse reduction, cultural diversity and accessibility to services. • **Environmental** - Support the natural environment and its ecosystems so they are better able to resist damage and recover quickly. - Reduce greenhouse gas emissions, protect agricultural land and green space, and maintain wildlife corridors, habitat and values. - Consider a "design with nature" approach that integrates natural assets such as aquifers and streams into infrastructure services so that communities are better prepared for the environmental changes related to climate change.
		Initiatives / Principles:	• Compact development that avoids sprawl, is appropriate for the local context, and supports access and affordability • Complete and mixed land use that supports the efficient movement of people, goods and services and contributes to business efficiency and quality of life • Centred focal points that support business, commerce, festivals and gatherings and serve as transportation hubs • Connected development nodes linked by transit and active transportation routes and public spaces that contribute to social connectedness and community safety • Consideration of natural assets ensuring a productive resource base that includes agricultural and forest land, and protecting assets such as tree canopies, streams, groundwater and aquifers • Consideration of hazards to ensure that development reduces vulnerability to hazards
3	**BC Housing** (BC Housing)	Title:	Mobilizing Building Adaptation and Resilience (MBAR)
		Type:	Initiative
		Level:	Province
		Focus:	Facilitating and piloting sustainable and resilient design and renovation of buildings to stabilize communities in a natural disaster and help building owners and occupants better protect their investments and adapt to anticipated climate change stresses and climate change shocks.
		Objectives:	• To build capacity through piloting integrated adaptive and resilient design solutions into building design and renovation projects, addressing the combined effects • To create a training curriculum that is informed by real-life application experience based on at least five pilot projects. Pilot building types to include: residential buildings, care facilities, schools, public/institutional buildings, and senior, social and Indigenous housing • To create multiple forms and stages of training to gradually and systematically increase the number of practitioners who are experienced, educated, informed and aware with respect to enhancing climate adaptation and resilience in building design and renovations; and to further equip those who are experienced to become trainers.
		Initiatives / Principles:	• **MBAR Resources:** Design Discussion Primers for the following topics: air quality, chronic stressors, fire, flood events, heat waves, power outages and emergencies, seismic events and severe storms. • **MURB Design Guide, Feb 2019:** Enhancing the liveability and resilience of MURBs.

Appendix D: Canadian Resilient City Plans from100 Resilient Cities Program

S.no	City	Content:	
1	Calgary (Calgary)	Key Shocks	• Financial and economic crisis • Extreme weather events: snow, wind, hail, severe storms and rainfall/flooding, drought • Cyberattack • Fentanyl crisis
		Key Stresses	• Economic uncertainty and increased unemployment • Weather and climate change • Poverty/access to housing and homelessness • Inequality and lack of social cohesion • Lack of economic diversification • Increased unemployment • Poverty rates
		Resilience Challenge	"The center of Canada's oil and gas industry, Calgary hopes to insulate its economy from shocks caused by fluctuating oil prices as it develops more robust responses to natural disasters".
		Actions	Phase 1: Preliminary Resilience Assessment (March 2018) Phase 2: Resilience Calgary Strategy (June 2019) Phase 3: Strategy Development and Implementation (future step)
		Resilience Strategy	The Calgary Resilient Strategy includes four pillars and a shared theme progressing towards 13 outcomes and 29 actions which aim to achieve specific policies, programs or practices that Calgary will initiate to reach the resilience goals. Shared theme: A future focused Calgary The theme that includes the development of resilience tools to support measurement and sustained resilience approach to planning and decision making. Pillar 1: The future of Calgary's economy All community members are encouraged and able to participate in a diverse and strong economy. Pillar 2: Inclusive futures Institutions have trusted and informed relationships with Calgary's equity-seeking communities. Pillar 3: The future of Calgary's natural infrastructure Natural infrastructure assets are identified, protected, tracked, managed and used to inform investment and planning decisions. Pillar 4: Future ready infrastructure Calgarians are supported through strategic investment in future-focused and resilient infrastructure.
2	Montreal (Montrèal)	Key Shocks	• Contamination / water shortage • Transport infrastructure failure • Energy supply failure • Transport dangerous goods accident • Terrorist attack • Major industrial accident • Pandemic • Cyberattack • Communication supply failure • Cold extreme • Heavy rain • Heat wave
		Key Stresses	• Poverty and social inequality • Aging infrastructure • Aging of the population • CC - annual precipitation change • Economic crisis • Complex governance • Affordable housing • Integration of immigrants • CC- annual temperature change • Psychological distress • Corruption • Drought • Traffic jam • Quality health services access
		Resilience Challenge	"Aging infrastructure, an aging population, and wide temperature swings top Montréal's list of resilience challenges".
		Actions	Phase 1: Preliminary Resilience Assessment (Feb 2017) Phase 2: Resilience Calgary Strategy (June 2018) Phase 3: Strategy Development and Implementation (future step)
		Resilience Strategy	The Montréal Resilient Strategy includes four major orientations with 12 objectives. Orientation 1: Taking action to support a united and safe community • Strengthen the community's capacity to adapt and react to natural and anthropogenic risks • Preserve an environment that meets Montréal's essential needs • Develop mutual aid and inclusion mechanisms to promote solidarity between citizens and reduce vulnerabilities Orientation 2: Taking action to protect our living environment • Ensure improved consideration of risks in land use and infrastructure planning • Carry out more exhaustive cost-benefit analyses on mitigation measures • Develop and sustain infrastructures to ensure the maintenance of services and essential systems Orientation 3: Taking action to sustain a diversified and innovative economy • Promote a good state of preparedness among companies and business establishments in order to deal with disturbances • Ensure the effective and secure movement of people and goods • Anticipate socioeconomic challenges and capitalize on knowledge and creativity assets Orientation 4: Taking action to promote integrated governance in the service of the community • Ensure the city's adequate state of preparedness in relation to natural and anthropogenic risks • Collaborate and share expertise in order to promote informed decision-making • Establish interactive communications between authorities and the public so as to disseminate information daily and alert citizens in the event of a disaster.

S.no	City	Content:	
3	Toronto (Toronto)	Key Shocks	• Urban flooding • Heat waves • Blizzards/cold snap • Interruption to energy supply • Infrastructure failure • Public health emergencies • Cyber attacks
		Key Stresses	• Poverty & social displacement • Lack of affordable housing • Traffic congestion & transit expansion • Aging infrastructure not sized for a growing population • Long term municipal financial sustainability
		Resilience Challenge	"A growing city, Toronto is addressing rising inequality while developing responses to increasing severe weather events".
		Actions	Phase 1: Preliminary Resilience Assessment (Dec 2017) Phase 2: Resilience Calgary Strategy (June 2019) Phase 3: Strategy Development and Implementation (future step)
		Resilience Strategy	The Toronto Resilient Strategy directly addresses Toronto's resilience challenges in three focus areas through 10 goals. **Focus area 1: People and Neighbourhoods** • Toronto has resilient, safe, affordable homes • Communities take action to improve resilience in their neighbourhoods • Poverty is eliminated and equity is improved **Focus area 2: Infrastructure** • Toronto is more resilient to climate change, including the hazards of flooding and heat • Infrastructure and buildings are resilient to a changing climate and reduce greenhouse gas emissions • Toronto has multiple reliable, affordable, and safe mobility options that reduce the amount of time it takes to get around **Focus area 3: Leading a Resilient City** • Civic engagement and trust in the City improve, and leadership better reflects Toronto's diversity • The City prioritizes the most vulnerable people and highest risk in decision-making • Indigenous communities have a leadership role in building resilience • Institutionalize resilience into the City's decision-making and take leadership on resilience
4	Vancouver (Vancouver)	Key Shocks	• Earthquakes • Coastal and riverine flooding • Forest fires / Air quality • Extreme weather and temperatures • Oil spills • Public health emergencies - Opioid crises • Infrastructure failure and disruption • Hazardous materials • Residential fires
		Key Stresses	• Affordability • Aging population • Debt and low wages • Food security • Homelessness • Gender inequity • Lack of diversity in decision-making • Poverty • Racism • Social isolation • Increasing demand and aging civic facilities • Aging buildings • Water system and resources • Climate change • Food system resilience • Regional infrastructure and supply chains
		Resilience Challenge	"Vancouver is working to maintain its high quality of life in the face of rising housing prices and environmental uncertainty".
		Actions	Phase 1: Preliminary Resilience Assessment (December 2017) Phase 2: Resilient Vancouver Strategy (June 2019) Phase 3: Strategy Development and Implementation (future step)
		Resilience Strategy	The Resilient Vancouver Strategy is built upon five guiding principles, and structured around three priority area with 12 objectives and 40 actions. **Guiding principles:** Reconciliation; Equity and intersectionality; Sustainability; Recovery; Reciprocity **Priority 1: Thriving and prepared neighbourhood** • Cultivate community connections, stewardship and pride • Empower communities to support each other during crises and recover from disasters • Transform the way communities understand risks and prepare for local hazards • Strengthen social and cultural assets and services **Priority 2: Proactive and collaborative city** • Elevate the voices of underrepresented groups to improve resilience outcomes • Shape an inclusive city that can adapt to changes and turn challenges into opportunities • Strengthen organizational capacity to manage risk and recover from shocks and stresses • Advance holistic, collaborative disaster risk reduction and recovery planning **Priority 3: Safe and adaptive buildings and infrastructure** • Improve building performance to protect lives, decrease displacement and accelerate recovery following earthquakes • Plan, design and upgrade civic facilities to serve the current and future needs of our diverse communities and ever-changing environmental conditions • Anticipate threats and mitigate and minimize disruption to civic infrastructure and critical services • Promote regional collaboration to assess, finance and fortify lifeline infrastructure and supply chains

Appendix E: UBC resilience plans and initiatives

S.no	Initiative/Plan	Content:	
1	**Climate Adaptation - Resilience Strategy** (Campus and Community Planning)	Framework:	UBC Green Building Action Plan
		Year:	2018
		Department:	Campus and Community Planning
		Focus Area:	Academic and residential buildings at UBC Vancouver campus
		Goal:	• UBC buildings and landscapes will have the resilience to respond to both anticipated and unpredictable changes in climate. • UBC will engage with researchers in a meaningful and ongoing way to inform building policy and guidelines around climate adaptability.
		Phase:	Detailed plan in-progress
		Actions:	• Adapting to a changing climate by using the most up-to-date climate data to guide building design and retrofits. (Yet to be implemented) • Additional guidance in the water and energy components sections address specific approaches to climate adaptation.
		Next Step / Targets:	**Five year implementation plan - short-term priority actions:** • Review current research and best practices for climate adaptation strategies in buildings. • Identify climate adaptation research opportunities for buildings and landscapes on a local, regional and global scale. • Conduct vulnerability assessments of campus buildings, landscapes and infrastructure at periodic intervals. • Integrate early guidance on climate adaptation measures into project design briefs. • Coordinate with the campus-wide Resiliency Initiative and climate adaptation strategies, as they evolve based on vulnerability assessments, evaluations and best practice review. • Implementing policies on a building and landscape scale that respond to key climate change impact areas (e.g., increased temperature, variable weather patterns, increased flood events, increased smoke, increased peak events, etc.). • Incorporate aspects into building and landscape designs to serve campus-wide emergency response preparedness in coordination with key departments, including Infrastructure Development and Risk Management Services. • Update GBAP once the Resiliency Initiative is adopted.
2	**Seismic Resilience Plan** (Seismic Resilience Team)	Framework:	Seismic Mitigation Plan
		Year:	2019
		Department:	Seismic Steering Committee (Infrastructure Development, Building Operations, Finance, Energy & Water Services, and Risk Management Services)
		Focus Area:	Buildings, utilities and operations
		Goal:	Reducing or mitigating the risk of injury or death as a result of seismic event, and to ensure that this is risk addressed immediately within the University's logistical and financial capacity.
		Phase:	Plan approval in-progress
		Actions:	• Updating the Seismic Mitigation Plan (June 2016) • Hazard assessment and building evaluation (April 2017) • Development of principles, evaluation of recommendations and execution of action plan (September 2017) • Detailed seismic evaluation of priority buildings (April 2018)
		Next Step / Targets:	**Updated implementation planning**: Development of an overall implementation plan. While considering potential funding sources, project logistics, planning constraints, and consultations for executing the building-related upgrades within the broader context of the capital planning process. **Non-detailed building evaluations:** To complete the non-detailed evaluations of buildings identified by ARUP in the Seismic Resilience Study. **Completion of Guidelines:** • **Retrofit guidelines:** To standardize UBC's approach to the seismic retrofit of existing buildings will include clear performance indicators beyond the current expectation of a certain building code level as well as a set of criteria for seismic retrofit. • **New building guidelines:** This guideline for the seismic design of new buildings will include performance criteria that target higher functionality targets than meeting current codes.
3	**Mental Health + Resilience** (UBC Wellbeing)	Framework:	UBC Wellbeing Strategic Framework
		Year:	_
		Department:	UBC Wellbeing
		Focus Area:	Health and Wellbeing
		Goal:	Enhancing mental health literacy, creating a supportive campus culture, and ensuring that faculty, staff, and students have the resources to help them understand mental health issues, and improve resiliency and coping skills, by creating environments that support them.
		Phase:	Implementation In-Progress
		Actions:	**Mental health literacy for students:** • UBC is embedding mental health literacy in student programs and curriculum, including Jump Start orientation for first-year students and student leader training for all residence advisors, Collegium Advisors, and Jump Start student staff. • Through a Teaching & Learning Enhancement fund grant, pilot projects in Engineering and Biology will be assessed for impact on students' mental health literacy outcomes. The project will include strategies for building and maintaining mental health and help-seeking efficacy. **Mental health literacy in workplace environments:** • UBC Human Resources is expanding mental health literacy for faculty, staff, and postdoctoral fellows through a diversity of evidence-based programming and health promotion activities. • Human Resources is exploring pathways for embedding mental health literacy in leadership development programs and workplace practices.
		Next Step / Targets:	**UBC Cares:**• Increase community members who feel mental health is a UBC priority by 2025.**Mental Health Literacy:**Community members have access to opportunities to develop mental health literacy:• 10% increase for students across all indicators by 2025.• 10% increase for staff & faculty across all indicators by 2025.