Final Report

MAKING SUSTAINABLE DEVELOPMENT HAPPEN

SD481 - Sustainability Governance & Leadership

by

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CONTEXT

Weather-related disasters like floods, storms and wildfires are getting more frequent, more extreme and more expensive. Future disasters are inevitable, yet their growing frequency and magnitude of destruction substantially are exacerbated by the decisions Canadians make in where and how we build core infrastructures. As cities and communities continue to grow, these events will affect more lives, businesses, and the nation's economy. In fact, one of the United Nations' 17 Sustainable Development Goals (SDG) being SDG 9 - 'build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation' (United Nations, 2022).

It's time we address the elephants in the cities - our buildings. Currently, there are two major technical issues stopping Canada from making progress with SDG 9. Firstly, a recent worldwide report finds that none of the building codes in use in the surveyed countries, including Canada, addresses future climate risks – all are focused on addressing risk based on past weather experiences and extreme events. Building codes largely rely on historical data, usually only updated on a 10-year cycle on average, so as weather becomes more severe from year to year, the underlying data simply does not accurately reflect all potential risks to the build environment (Global Resiliency Dialogue, 2021). Secondly, the current National Building Code of Canada is objective-based, meaning every technical requirement achieves one or more of that Code's stated objectives, which are safety, health, accessibility, fire and structural protection of buildings, and energy and water efficiency. These are minimum requirements, and because majority don't an incentive to build better than Code, our buildings are designed mainly to ensure the safety of occupants after a disastrous event, not to ensure the operationality afterwards (National Research Council Canada, 2022). This implies a serious capacity gap - an inability to provide shelters and basic services for citizens after a hazardous event. There are some local initiatives trying to address this, such as the Integrated Building Adaptation and Mitigation Assessment Process in BC Housing proposing a more holistic design process, but it is still in pilot, not mandatory and project-tailored so it can't be scaled up in the foreseeable future (Pacific Institute for Climate Solutions, 2020).

It is vital that BC's most important buildings can function properly post-disaster, not only to ensure business continuity with limited impacts, but also to minimize economic loss. According to the Canadian Institute for Climate Choices (2020), the average cost per disaster has jumped

1250% since the 1970s - a typical storm or flood that cost roughly $8 million in the early 1970's now costs over $110 million. In Canada, flooding is the single largest cause of damage and loss to homes and buildings, and the Vancouver region of BC is a hotspot of concentrated risk for coastal flooding (Canadian Institute for Climate Choices, 2021). Within the same report, researchers estimate that coastal flood damage costs in the Vancouver area are currently about $30 million annually on average. By the end of the century, damages are projected to be up to $510 million annually under the low-emissions scenario and up to $820 million annually under the high-emissions scenario. Moreover, flood risk in urban areas is not limited to existing homes and buildings—cities are continuing to approve new development in areas already known to be at risk of flooding. As noted earlier, 10 per cent of permits approved for new building in Vancouver between 2017 and 2020—representing $1 billion in value—were in a known 100-year floodplain. To top everything off, about 70 – 80% of local government assets in BC are not insured, which means the impact of a major regional disaster could cripple the economy and prevent recovery of local communities (City of Vancouver, 2018).

The costs of climate change impacts on infrastructure also go beyond the price of physical damage and repair, as the loss of services and reliability will have far-reaching economic as well as social consequences. When infrastructure is put out of commission or made less reliable by more frequent damage, the services that it provides—transportation, power, healthcare, communications, and shelter, to name a few—are also interrupted and the costs of delays could be in the billions annually. Disasters disconnect people from friends, schools, work, and familiar places. They may cause permanent harm to one's culture and way of life, and greatly impact the most socially and financially marginal people. If the University of British Columbia was destroyed by a tsunami, the loss to all the different academic and social cultures across faculties and student organizations would be enormous. People's sentimental connection to a heritage building can be considerable as it counts towards one's cultural identity. In addition, disasters may have long-term consequences to the health and collective well-being of those affected. Such events often hurt or kill pets and destroy natural ecosystems that are integral parts of communities. Damage from climate change, or the threat thereof, could have far-reaching implications for the stability of the financial system and the availability of capital and insurance (source 3). Disasters clearly disrupt populations in ways that are difficult to articulate, let alone assign monetary worth.

Proactive investment in infrastructure adaptation is the most cost-effective way to protect the services that people, businesses, and the economy depend on (Canadian Institute for Climate Choices, 2021). The report also states that building and moving homes out of high-risk areas can reduce the costs of coastal flooding by 2100 up to 90 per cent or up to $1 billion every year. Mitigation, or aiming for better-than-code design, represents a sound financial investment. A study examined five sets of mitigation strategies and found that society enjoys a benefit-cost ratio (BCR) of 4:1 for investments to exceed select provisions of the 2015 International Residential Code (IRC) and International Building Code (IBC). In addition, designing new buildings to exceed the 2015 IRC and IBC would result in 87,000 new, long-term jobs, and an approximate 1% increase in utilization of domestically produced construction materials (National Institute of Building Sciences, 2019). Here, "cost" means the up-front construction cost and long-term maintenance costs to improve existing facilities or the additional up-front cost to build new ones better. "Benefit" refers to the present value of the reduction in future losses including reductions in deaths, post-traumatic stress disorder, property repair costs, sheltering costs, direct and indirect business interruptions and so on.

From a political standpoint, a new high-importance or post-disaster building is often funded partially by the public through tax revenues, and there are many individuals who will never use the building so it is reasonable that the public is critical of government spending. Still, new builds are generally perceived by the public to be beneficial to society, and as such, they are common points of policy for new governments to propose to gain support from the voting public and influential entities. Political policy can be for new housing initiatives, such as the Canadian Federal Government's $4 billion investment into a housing accelerator fund to combat the high cost of housing in Canada (Government of Canada, 2022), or it can also be the construction or renovation of a high-importance or post-disaster building. Before the 2010 Vancouver Winter Olympics, the municipal and provincial governments were directly involved in the renovations to BC Place and the development of LEED-certified condos and utilities in the False Creek area (City of Vancouver, 2022). Vancouverites benefit from the experience of a world-class stadium and a community integrated with innovative sustainable technologies while the local governments benefits from public favour and increased economic activity in the False Creek area. The point being, initiating a project that is deemed socially beneficial by the public eye may help shed more favourable light on the acting government.

Environmental-wise, a lack of climate risk information, transparency, and regulation is leading to bad infrastructure decisions. In Canada, very little information is available regarding current or future climate risks to infrastructure (Canadian Institute for Climate Choices, 2021). For example, they estimate that at least a half million buildings at risk of flooding in Canada are not identified by government-produced flood maps. Even bigger information gaps exist for other major climate hazards, including wildfire. In the absence of this information, few infrastructure owners or investors are able to assess and manage existing climate risks, let alone future risks associated with climate change. On another note, there is the consideration of what kinds of hazards should it be expected to experience: acute shocks, such as earthquakes or disease outbreaks, or chronic climate stresses, such as prolonged droughts or increasing temperature, or both (Lower Mainland Facilities Management, 2018). Both can have severe consequences which impact entire populations if their respective risks are not mitigated. However, the more risk-preventing strategies are adopted, the more resilient a building becomes, but often at the cost of more building materials or technologies. Using more building materials not only increases the cost of construction, but also increases the environmental footprint of the building. According to a report published by RDH Building Science Inc. and BC Housing (2021), improving building resilience should consider mitigation of climate change risks and adapting to future climate change risks. To mitigate against climate change risks, it is important that greenhouse gases emissions and material consumption associated with the design, construction and management of resilient buildings is minimized. To adapt to future risks, the buildings must also follow the most comprehensive resiliency planning available.

CASE STUDY

To ensure building resilience - meaning fully operational post-disaster - we acknowledge the need to tackle both existing buildings and new buildings. For this case study, we focus on examining the possibility of **improving building resilience, for all newly constructed high-importance and post-disaster buildings in Metro Vancouver, to ensure operational continuity after a hazardous event.** We want to focus on new buildings because the resiliency standards they are held to can continue to improve, while existing buildings are not required to conform to updates to building codes and by-laws and only need to meet updated codes if major renovations are made. Currently, the National Building Code of Canada is objective-based, meaning buildings are designed mainly to ensure the safety of occupants after a code-level disastrous event, not to ensure the operationality (Archer, 2005). We aspire to see building developments in Metro Vancouver adopt an industry leader approach which mandates high-importance and post-disaster buildings to be operational following a natural hazardous event.

Achieving our goal would work towards the realization of Sustainable Development Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. (United Nations, 2022) Improving the resiliency of the built environment also positively connects with SDG's 3, 4 and 11. SDG 3 - good health and wellbeing - is impacted by the ability to provide essential care to patients in hospitals, especially after a hazardous disaster. (United Nations, 2022) Likewise for SDG 4 - quality education - the resiliency of the education system can be measured by its ability to provide a safe learning environment for youth during times of disaster and difficulty. (United Nations, 2022) Ensuring there are safe public spaces for everyone is a target of SDG 11 - sustainable cities and communities. (United Nations, 2022) These safe public spaces are to be accessible at all times, and therefore must be designed to be operational, even during a disaster.

Achieving excellent built resilience does have challenges and negative connections to other goals of Metro Vancouver. One of which is the negative connection between building innovative public infrastructure and SDG 12, responsible production and consumption. (United Nations, 2022) Emissions from the production of common building materials like cement or steel are significant factors to global climate change, and unfortunately, there are not many resilient substitute materials which have reduced environmental footprints.

Definitions:

- Resilience: Resilience is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events. Resilience takes two forms when it comes to climate change: minimising worsening climate loads by mitigating emissions and adapting to a changing future climate. Mitigation reduces the impact of the hazards; adaptation reduces our vulnerabilities. These two aspects of resilience (mitigation and adaptation) are the basis for the Low Carbon Resilience approach. (RDH Building Science, 2021).
- High-importance: Buildings that are likely to be used as post-disaster shelters, such as schools and community centres. Plus manufacturing and storage facilities containing hazardous substances dangerous to the public if released. (Ontario Association of Architects, 2016)
- Post-disaster: Buildings that need to remain operational following a disaster such as hospitals, power generating stations, communications facilities, fire, rescue and police stations (Ontario Association of Architects, 2016)
- Hazardous event: The occurrence of a natural or human-induced phenomenon in a particular place during a particular period due to the existence of a hazard. (United Nations Office for Disaster Risk Reduction, 2018). **We will use the term 'critical buildings' to imply both high-importance and post-disaster buildings.

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LOGFRAME	Project Summary	Indicators	Means of Verification	Risks/Assumptions
Goal	Improving building resilience, for all newly constructed high-importance and post-disaster buildings in Metro Vancouver, to ensure operational continuity after a hazardous event.	. Direct economic loss attributed to disasters . Percentage of buildings in disaster prone locations . Annual number of buildings with a completed HRVA . Ratio of new critical buildings to population	. Economic impact assessment . Historical natural hazard mapping data . Emergency Management BC HRVA Worksheet Database . Population census	. New high-importance and post-disaster buildings provide improved post-disaster resilience to Metro Vancouver . Improved building resiliency design results in improved building resiliency performance during a hazardous event
Outcome	A comprehensive RSF is used in RFP for new critical buildings Critical building project design and management teams are knowledgeable of LCR design principles	Project proposals for new critical buildings mitigate and adapt to climate change hazards Project teams have completed the mandated curriculum	Project Proposal detailing the resilient design of the new critical building Individual employees are verified by the relevant certification organisation	Comprehensive RSF is enforced upon contractors by governments New critical building project teams successfully implement knowledge from mandated curriculum to the project
Output	A comprehensive RSF is created Resilient design strategy courses are made available to employees	A comprehensive list of resilient design strategies utilising LCR practices informs the framework Full resilient design curriculum is offered through professional development channels	RSF Document outlining building resiliency best practices Mandated courses are facilitated through channels which all employees have unrestricted access to	. Current minimum resiliency standards for critical buildings can be improved . RSF is required for all new critical building RFP's Employees are able to complete the mandated curriculum
Activity	MECCS issues a RFP for consultation on creating a comprehensive RSF Mandate resilient design strategy courses for crown corporation and public-sector employees involved in critical building projects	A comprehensive list of natural hazards to be mitigated and adapted to in Metro Vancouver is established Resilient design strategy courses are designed and selected by MECCS	RFP Document outlining RSF deliverables Verified resilient design strategy curriculum recognized by relevant crown corporations, agencies and ministries	Comprehensive consultation resources about RSF are available and attainable . The professional development resources are available and attainable . Professional development courses can be mandated

Logframe Justification

We suggest two activities (represented by 2 different colors) which will help Metro Vancouver attain the goal of improving the resiliency of newly constructed critical buildings to a level of operational continuity after a hazardous disaster. Through both activities, Metro Vancouver should see an establishment of exceedingly high resiliency standards and an increase in awareness of Low Carbon Resilience (LCR) principles at the developer/contractor level.

To impact the level of resiliency standards, the BC Ministry of Environment and Climate Change Strategy (MECCS) should issue a Request for Proposal (RFP) for consultation on the creation of a fully comprehensive Resiliency Standards Framework (RSF). A RSF consists of a description of the risks and hazards for a particular project, what design strategies can be used to mitigate each risk or hazard, and how each risk or hazard should be adapted to through the planning, design, construction, and management stages of the project. A similar framework was created in 2015 by the University of Minnesota Research Practices Consortium to assess building hazards, the adaptations to the hazards (design strategy), and the costs and benefits of these resiliency adaptations   We suggest the use of a consulting firm with the ability to provide substantial research resources for the compilation of a comprehensive RSF for Metro Vancouver. MECCS can ensure the comprehensiveness of the RSF by including a thorough list of current and future climate hazards in the RFP, as identified by Emergency Management BC's Hazard, Risk and Vulnerability Assessment (HRVA) Companion Guide (Emergency Management BC, 2020).

We assume the best practices from the RSF can be enforced by local governments for the planning, design, construction and management of critical buildings because of the role crown corporations as well as government agencies and ministries play in these projects. These provincial entities are commonly partnered with local governments for critical building projects, and can be mandated to exceed minimum resiliency standards set by current building codes. (Government of BC, n.d.) Furthermore, these non-private entities can enforce the adherence to the RSF on any private entity that might be contracted on the project to ensure LCR principles are followed.

Mandating paid professional development at the government level ensures future critical building projects are planned, designed, constructed and managed by professionals who are verifiably knowledgeable of resiliency standards and the design strategies used to meet these standards. We focus on mandating it for employees of crown corporations and public-sector organizations since these entities have the authority to ensure LCR principles are applied on new critical building projects they are involved in. By including LCR knowledge requirements in the roles involved with the issuance of RFP's, governments across Metro Vancouver can achieve the goal of improved critical building resilience.

An assumption we have made in developing this logframe is that the current resiliency standards as mandated by the building codes and by-laws of the City of Vancouver and British Columbia can be improved. We propose that by improving the minimum standards of critical buildings, the entire region will achieve greater resilience in dealing with natural disasters.

INDICATOR DASHBOARD

To the best of our knowledge, the number of indicators on building resilience, especially pre-disaster assessment tools, are relatively limited at the moment. Therefore, we propose 3 new indicators (marked with asterisk) and include 2 existing indicators for this case study.

1. Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters (SDGs Indicator 11.5.2)

Justification:

Developed by the UNISDR, 'Direct economic loss' in this indicator framework consists of agriculture loss, damage to industrial and commercial facilities, damage to housings and critical infrastructures (United Nations Office for Disaster Risk Reduction, 2018). For our case study, it is highly relevant as quantifying these losses help with measuring success, creating a driver for more radical actions, as well as justifying for expensive investment upfront. It helps us understand the severity of disruptions to basic services by disasters and how vulnerable our infrastructure are, in terms of economic dollars. For example, the current cost of power outage in Canada - most of which are weather-related - is estimated to be $12 billion annually. Between 2070 and 2100, Metro Vancouver's annual flood damages are expected to climb to $510 million annually, a 17-fold increase, under a low-emissions scenario; and up to $820 million annually, 27 times the current value, under a high-emissions scenario (Canadian Institute for Climate Choices, 2021). Ideally, as we move forward with project implementation, we expects the figures for this indicator to go down, at least for the critical buildings category. This implies reductions in infrastructures' damages and disruptions to basic services as new resilient critical-buildings are being constructed.

Limitations & Suggestions:

Not every country has a comparable national disaster loss database that is consistent with the UNISDR guidelines. The UNISDR also limits the economic loss to direct economic loss, excluding indirect loss and macro-economic loss. The reason is that there is not yet universally standardized methodology to measure indirect and macro-economic loss while direct loss data monitoring is relatively simpler and more standardized (United Nations Office for Disaster Risk Reduction, 2018). Our team reckons that this indicator could be narrowed down into just quantifying the direct economic loss of damage to buildings and critical infrastructures, attributed to disaster, in order to evaluate our progress more accurately.

2. Building Resilience Index (BRI)

Justifications:

Building Resilience Index is a web-based hazard mapping and resilience assessment framework for the building sector. It is designed to facilitate access to location-specific hazard information, provide resilience measures to mitigate applicable risks, and improve transparency for disclosing a building's resilience information between sector stakeholders (International Financial Corporation, 2022). For our case, this indicator make it easier to assess, improve, and disclose the resilience of our new buildings. By using a standardized letter-rating system, BRI facilitates communicating resilience of buildings to relevant parties, especially to funders and insurers. Specifically, the Index identifies appliable natural hazards and vulnerabilities based on the location and design of the building across four main hazard categories: Wind, Water, Fire and Geoseismic.

Limitations & Suggestions:

The Building Resilience Index is currently available for the Philippines, but more countries will be included soon (International Financial Corporation, 2022). Another limitation is that HRI only assesses and addresses environmental hazards. After reviewing more than 40 studies, Burroughs (2017) suggests that resilience in the built environment should be viewed as a holistic, multi-dimensional, multi-scale concept that cuts across the 6 dimensions - physical, infrastructural, environmental, economic–social, political–regulatory, and organizational domains.

3*. Percentage of buildings in disaster prone locations

Justification:

For the region of metro Vancouver to properly prepare for the event of a natural disaster, it is vital to know which buildings could potentially be affected by such an event. Understanding the percentage of local buildings which can be expected to experience direct impacts of a natural disaster is a key indicator to gauge the overall risk exposure and liability faced by the region. This indicator would be informed by the various predictive mapping data on acute hazards such as flooding, earthquakes, wildfires, or extreme weather events. Information from this indicator could be used in planning measures like the budget allocation necessary in the event of a natural disaster.

Limitations:

While there is reliable predictive data for potential hazards such as flooding (GIS in Context, 2020), other hazards are much less predictable, such as seismic activity (USGS, n.d.). The innate unpredictability of certain kinds of natural hazards does create limitations to the effectiveness of this indicator for assessing the true risk exposure of the analyzed area. It is also important to note that this indicator would not indicate the risk exposure to un-mapped chronic stresses and long-term climate realities such as rising temperatures, rising sea levels, or deteriorating air quality.

4*. Annual number of buildings with a completed Hazard, Risk & Vulnerability Analysis (HRVA)

Justification:

Identifying the number of buildings, existing or newly constructed, which have conducted a HRVA helps indicate how aware a region is of the unique risks, risk drivers, and risk reduction strategies related to their buildings for that year. Monitoring of the annual number allows regional authorities to understand the year-over-year progress towards becoming more prepared to be resilient. A HRVA assesses the sources of potential harm to humans, property and environment, the likelihood of this harm occurring, and who or what this harm might adversely impact. This assessment helps inform emergency management decision makers of the strengths and weaknesses of their building prior to a hazardous disaster and can be used as a tool for comparison across different buildings or communities. Some regions around the world such as British Columbia require a form of HRVA to be conducted for all buildings and infrastructural developments as a starting point to producing an emergency response plan (Emergency Management BC, 2020). Other regions do not require the completion of a HRVA but do have emergency response plans in place which could still benefit from such an assessment. Mandating that all existing and newly constructed buildings within a region have completed a HRVA ensures a region not only knows the specific strengths and weaknesses of each building, but also how these buildings interconnect to other community infrastructure.

Limitations:

It is important to note that although a HRVA is conducted, the actions undertaken in accordance with the insights gained from the assessment is what impacts a building's resiliency. This indicator does not measure the actions taken post-analysis and is therefore limited to measuring just the completeness of the foundation for resiliency, not the resiliency of the region in practice.

5*. Ratio of critical buildings constructed within the last 10 years to target population.

Justification:

Understanding the ratio of newly constructed critical buildings which meet modern resiliency standards to the target population is important for forecasting the possible demand these buildings may need to accommodate in the event of a natural disaster. The more newly constructed critical buildings prepared to withstand the adverse shocks of a natural disaster within a region, the greater the resilience of that region. According to the City of Vancouver's *Preliminary Resiliency Assessment*, qualities of a resilient city include robustness, redundancy, flexibility, and integration (City of Vancouver, 2018). A high ratio of new critical buildings to target population would indicate a greater degree of these qualities, and therefore a greater degree of resiliency for that region as it's population grows.

Limitations:

This indicator would only consider critical buildings that are built within the last decade in order to measure the recent implementation of the most modern techniques of resiliency to a region's infrastructure. The purpose of this is to indicate the recent progress, not the absolute resiliency of a region's infrastructure. This does mean that previously constructed critical buildings would not be measured, and another indicator would be necessary to gauge the ratio of all existing critical buildings to population.

DISCUSSION

About some opportunities and progresses on the greening our buildings movement: Contemporary community design within Metro Vancouver and around the world has seen a massive boom in popularity of green or low-carbon buildings, with Canada being a global leader when it comes to total Leadership in Energy and Environmental Design (LEED) certified projects. In fact, the gross lifetime economic output of all LEED projects certified in Canada from 2005 to 2015 will be over $120 billion (Maxwell, 2022). Green buildings are becoming so commonplace that The City of Vancouver has announced that all new municipal facilities will be LEED Gold certified (City of Vancouver, 2022). With the adoption of a higher environmental efficiency standard for municipal facility design and construction, the City of Vancouver is committing to investing in more costly facilities now does provide hope that the same could happen with resilient buildings in the near future.

In addition, Canada currently has a target of making all new buildings net-zero ready by 2030, with the release of an energy tiered code, would help signal manufacturers across the supply chain to invest in high-performance technologies, products, and skills needed (Beer, 2022). The measures also enjoy wide public support, with 70% of all Canadians, 77% in Quebec and B.C., and 60% in Alberta agreeing their provincial governments should require all new buildings to be highly energy efficient, Efficiency Canada said. This is great news as positive public opinion can really push a policy forward, since a municipality must take into account the socio-political climate around a new development, often referred to as the Overton window. In order to get public approval for costly critical buildings like the Vancouver Convention Center or BC Place, a prestigious international spotlight needed to be pointed at the city (Lovgreen, 2016). After the November floods in Abbotsford and area, the policy window is wide open for improving building resilience against climate hazards. With over $100 million already spent on recovery and an expected cost of over $2 billion in repairs and upgrades to critical infrastructure, a case can be made for the economic value of increasing resiliency standards for all of the built environment, not just roads and dykes (Hopes, 2022).

Some news on recent upgrades: As mentioned above, current design codes are based only on past climate observations, and do not take future climate change into account. Recognizing this gap, the National Research Council (NRC) and Environment and Climate Change Canada (ECCC), initiated a program to update the climatic design variables within the National Building

Code of Canada (NBCC) and the Canadian Highway Bridge Design Code (CHBDC). These updated climatic design variables are expected to enter widespread use via upcoming code revisions (Government of Canada, 2021). This really help further Canada's position in the United Nations Sendai Framework for Disaster Risk Reduction, a globally applicable framework, and any efforts made to understand any given disaster risk can be shared with others around the world. Therefore, by undergoing the initial steps of identify future climate risks, a project team can contribute knowledge to a global priority, co-benefitting the local project team and the greater global resilience community. (Emergency Management BC, 2020). Locally, BC has started to redevelop critical buildings like the St. Paul's Hospital and Royal Columbia Hospital in New Westminster to make them more resilient against future hazards (The Canadian Press, 2022).

Some noticeable tradeoffs and barriers that can hinder progress also exist. The biggest issue is still the upfront or capital cost, despite the clear benefits of early, proactive investment in adapting Canada's infrastructure for climate change, progress has been limited. Public and private infrastructure owners have been more concerned with short-term budgets and balance sheets than long-term planning, leaving long-term risks like climate change unaddressed. The unprecedented investments in infrastructure over the next several decades to support the net zero transition are a key opportunity to build the climate resilience of virtually all infrastructure in Canada. However, if current short-term thinking around infrastructure continues, those investments will only increase the amount of infrastructure vulnerable to climate change impacts.

Quantity vs quality could be another important tradeoff to consider. Given the limited funding, should we build a new hospital or upgrade an existing one? Should we build two code-level hospitals or one resilient and better-than-code one? There is also issues around equity. More expensive but resilient critical buildings now can come at the expense of building more homeless shelters or other infrastructure for vulnerable populations. These are just some of the barriers to consider and we acknowledge that there are many more out there. Therefore, decision makers should act with caution and try to gather all the facts before implementing a project to ensure a well-rounded and holistic approach.

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