

Assessing the Canadian Commercial Real Estate Sector's View and Preparedness regarding Flood Risk

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

The process of climate change, with its projected occurrence of extreme weather events, such as flooding, has clear implications on the Canadian Commercial Real Estate (CRE) business sector. CRE businesses, which are exclusively used for business activities and commercial profit making purposes, are impacted directly and indirectly from flooding. There is a serious need for understanding potential flood vulnerability and climate change adaptation within the CRE property framework. A conceptual understanding of the extent and scale of the effect of flooding on the CRE properties would be worthwhile for relevant stakeholders.

Realizing an increase in the frequency and intensity of flooding events in Canada, the main question this research poses is “are Canadian CRE companies motivated to engage (implement) climate change adaptation to de-risk their commercial properties from extreme impacts of flooding.” To answer this question, the research adopts an approach of strategic and critical evaluation of literature to grasp fundamental knowledge of the CRE business vulnerability (BV) to climate change and flooding, and understanding literature surrounding climate change adaptation to de-risk the sector from extreme impacts of flooding. A survey questionnaire provided insight into Canadian CRE companies’ awareness of flood vulnerability and knowledge of potential flood impacts on their commercial properties, and awareness of a climate change adaptation framework to manage the flood risks.

It was noted through survey responses that most CRE companies view climate change and flooding as a serious problem, although many companies are not well-aware of flood impacts (direct or indirect) that can disrupt their commercial properties’ operations. In fact, the CRE sector does not take risk of flooding as one of their priorities. This is in part due to differential attitude towards their knowledge and experience of flooding. Findings also revealed that knowledge of a climate change adaptation framework to manage the flood risks is lacking in this sector which poses a serious threat in the wake of extreme flooding situations in Canada. At the same time, results showed the important role governments and insurance industry can play in facilitating climate change adaptation efforts in the CRE sector.

Overall, the results showed lack of a perception of Canadian CRE companies towards flood vulnerability, which plays a significant factor in their lack of motivation towards implementing a climate change adaptation framework, which is highly concerning for the economic activity of the CRE sector and the Canadian economy. Companies are somewhat motivated – perhaps because of the federal government’s and the insurance industry’s potential funding initiatives – to implement risk awareness and risk assessment processes, but are not extensively motivated to implement risk management process to comprehensively de-risk potential impacts of flooding in their commercial properties. However, the perception can certainly change with the increasing magnitude and severity of floods and it is possible that the financial implications of floods on CRE properties will be visible in the future. This study is extremely useful for those involved directly/indirectly with the Canadian CRE sector in developing an understanding of the vulnerability of this sector in the context of flood risk.

Keywords: Climate Change, Flooding, Commercial Real Estate, Vulnerability, Direct Vulnerability, Indirect Vulnerability, Climate Change Adaptation

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Chapter 1: Introduction

Commercial Real Estate (CRE) properties, which are business properties (excluding residential and industrial properties) solely used for commercial-profit making purposes and includes stores, malls, restaurants, hotels, office buildings, medical and hospital, are a central component of national assets and Gross Domestic Product (GDP), and therefore have a broad significance to every country's economic prosperity (USA Economy, 2016). Likewise, the Canadian CRE properties are very crucial to Canada's economy and standard of living. The planning, design, development and construction of CRE properties, and subsequently their daily operations, generate significant amounts of economic activity. Taken together, the Canadian CRE sector generates \$65 billion in annual economic activity. Additionally, the sector provides workspaces for millions of Canadians, along with a place for Canadians to eat, shop and play. As millions of Canadians travel to and from properties constructed and operated in the CRE sector, a contribution is made to the fundamental value of our communities, the Canadian economy and our social framework (REALpac, 2013).

The CRE office sector, in particular, generates any array of benefits for the Canadian economy. In the 2013 report by the REALpac (Real Property Association of Canada), the financial benefits in the construction and investment in office buildings and the ongoing operations of these buildings produced \$20.8 billion in annual economic activity in Canada, comprising capital investment, renovations and the upgrading of existing building, which are considered the direct benefits to the national economy. In addition to the direct benefits, the report accounts for additional economic activity in new construction, improvements, property management and brokerage. Simultaneously, the CRE office sector supports 111,600 high-

paying professional jobs, generates \$6.9 billion in personal and other sources of income, generates \$4.4 billion in corporate profits earned by small-and medium sized companies, contributes \$2.5 billion in personal and corporate tax revenues for the federal and provincial governments, and contributes substantial revenue to municipalities and school boards across Canada through realty taxes (Brent, 2014).

In general, capital investment in the office CRE sector represented approximately one-third of the total capital investment in the overall CRE sector in Canada. By province, Ontario accounted for the largest share of capital investment in office buildings in the country, representing 40.8% of Canada's total, followed by Alberta (23.8%) and Quebec (17.7%). Ontario also leads in the regional economic contribution in construction spending on new buildings and ongoing operations of these buildings, followed by Alberta and Quebec (Brent, 2014).

Climate change causing extreme weather events, in particular flooding, has the potential to have a significant economic impact on the CRE properties. Flooding is one of the most damaging natural disasters and due to high level of economic impact, it is receiving increasing attention in the scientific community owing to the prospect of several projections of increased magnitude and frequency (Jha, Bloch and Lamond, 2012). Commercial properties can be affected directly by physical impacts of flooding, or indirectly based on the social, economic and political assumptions associated with the condition of the assets at risk. This is important for commercial properties which are susceptible to business interruptions and closure caused by flood events (Zhang, Lindell & Prater, 2009).

Despite the importance of the CRE sector to the national economy, most current research studies have focused on other Canadian business sectors, public infrastructure and residential properties (Canadian Natural Resources, 2008), failing to engage the CRE sector towards changing climate and risk of flooding. This enhances the need to better engage the CRE sector and better analysis of the potential flood impacts. An understanding of the extent and scale of the effect of flooding on commercial properties would provide useful insight for the benefit of key stakeholders, such as CRE Board of Directors, CEOs, senior management, commercial property owners/managers, property buyers, and all levels of government, insurance companies, investors, occupiers, customers, suppliers, employees, and emergency service holders. Before this thesis investigates the impacts of flood risk in the CRE sector, it is crucial to understand what climate change is, followed by understanding flooding and its impacts.

1.1 Climate Change and its impacts

A growing body of scientific literature provides clear evidence that “climate change will continue for many decades, and even centuries, regardless of the success of global initiatives to reduce greenhouse gas emissions” (Lemmen, Warren and Lacroix, 2008, p4). Climate change, caused by increased greenhouse gas (GHG) emissions, has been a contributing factor to a number of environmental, social and economic issues and the impacts are being felt in many regions around the world. According to the Intergovernmental Panel on Climate Change (IPCC), climate scenarios suggest that the mean global temperatures are likely to increase by 1.4-5.8°C over the present century. This increase will cause warming of minimum and maximum temperatures, decreases in sea-ice cover, shifts in species distributions and an increase in global average sea level. The IPCC has also concluded that there will be increases in annual

precipitation, heavy precipitation events, and extreme high temperatures (Government of Canada, 2014).

Over Earth's history, the climate has changed considerably due to natural processes, but in the last 50-100 years these changes have been much bigger and happened much faster than any such changes the planet has seen in the recorded history of humans. IPCC, in its fifth assessment report, explained that the warming of the climate system is in no doubt, and since the 1950s, many of the observed changes are unprecedented over decades to millennia (IPCC, 2012). According to the IPCC, human activities have been the dominant cause of the rapid warming seen during this time and climate change poses significant challenges to our ways of life on Earth.

GHG emissions, comprising mainly carbon dioxide (CO₂), nitrous oxide (N₂O) and methane (CH₄), absorb radiation from the Earth's surface, clouds and gas molecules and trap it as heat within the lower levels of the atmosphere. The relatively recent expansion of human population and their activities through industrialization, agricultural development, deforestation and the burning of fossil fuels such as oil, gas and coal have released much higher quantities of GHGs and at a much faster rate. This has the impact of disrupting the natural balance of atmospheric gases, creating a general trend of increased heat trapping and warming of the Earth's surface. Because gases are easily distributed through land-scale atmospheric circulation, the heat trapping effects the whole planet, which is termed global warming- the major driving force in man-made climate change (ADB, 2013).

For Canada, the climate situation is not different. It is known that even after introducing significant measures to reduce greenhouse gas emissions, some additional degree of climate change is inevitable and would have economic, social and environmental impacts on Canada and the Canadian communities. Although impacts would vary on a regional basis, all areas of the country and virtually every economic sector would be affected. Increases in temperatures are projected and would vary on a seasonal basis, being greatest in winter and on a daily basis, with nights warming more than days (Government of Canada, 2014). Impacts of changing climate on many physical and biological systems, such as snow and ice cover, rivers, lakes and sea levels, and plant and animal distributions, are unequivocal in Canada. In addition, there will be an increase in the occurrence of heat waves, forest fires, storm-surge, coastal erosion and extreme weather events with observed climate trends (Lemmen, Warren & Lacroix, 2008). With expected changes in climate and precipitation patterns, increased frequency and intensity of an extreme weather event – flooding – has become one of the greatest challenges to cope with to date.

1.2 Floods and the damage they cause

The focus in the literature is overwhelming on flooding impacts as summarized in a series of IPCC assessments (Bijlma and others, 1996; Mclean and others, 2001; Nicholls and others, 2007a). Undoubtedly, it is the most widespread weather-related hazard, which can virtually occur anywhere. Floods are natural phenomena, but they become a cause for serious concern when they exceed the coping capacities of affected communities, damaging lives and properties. Floods are the most frequently occurring destructive natural events, affecting both rural and urban settlements. Not only in Canada but worldwide extent of damage caused by this natural disaster is constantly on the rise (Munich-Re, 2010). Several reasons have been identified for the increased number of flood events pertaining to natural and anthropogenic factors. Among the

natural factors, floods usually occur from a combination of meteorological and hydrological extremes, such as extreme precipitation and flows, snowmelt and erosion. In the case of anthropogenic activities, interference to the natural flow of rivers, development and high rate of urbanization, failure of control structures and construction of inappropriate structures are the causal reasons that lead to flooding. Urbanization is the defining feature of the world's demographic growth, with the populations of cities, towns and villages swelling and as a result, floods are affecting more urban areas because of unplanned development in floodplains, aging drainage infrastructures, increased paving and other impermeable surfaces, and a lack of flood risk reduction activities which contribute to the impacts experienced (Jha, Bloch & Lamond, 2012).

Flood risk mainly encompasses two aspects- the hazard itself, i.e. the probability of its occurrence and the consequences during and after the event. This involves the need to separately assess the damaging impact of flooding alongside other physical and environmental investigations. Damage can be direct and tangible with immediate physical contact of flood water which could affect lives, buildings and infrastructures, agriculture, industry machinery, equipment inventories, and other products. Indirect and non-tangible damage includes loss of economic production to flooded areas, loss of job, migration, disturbance in market supply and market prices, physical and mental stress, disruption of normal life and livelihood (Messner and Meyer, 2005).

Descriptions and categorizations of floods also vary and are based on a combination of sources, causes and impacts. Based on such combinations, floods can be generally characterized

into river floods, overland floods, coastal floods, groundwater floods or the failure of artificial water systems. Based on the speed of onset of flooding, floods are often described as flash floods, urban floods, semi-permanent floods, and slow rise floods (Jha, Bloch & Lamond, 2012).

Table 1 describes the types and causes of floods.

Table 1: Types and causes of floods

Types of Flooding	Causes Naturally occurring	Human induced	Onset time	Duration
Urban flood	Fluvial, coastal, flash, groundwater	Saturation of drainage and sewage capacity	Varies depending on the cause	From few hours to days
Pluvial and overland flooding	Connective thunderstorms, severe rainfall, breakage of ice jam, glacial lake burst, earthquakes in resulting landslides	Land uses changes, urbanization. Increase in surface runoff	Varies	Varies depending upon prior conditions.
Coastal (Tsunami, storm surge)	Earthquakes. Submarine volcanic eruptions. Subsidence, coastal erosion	Development of coastal zones. Destruction of coastal natural flora	Varies but usually fairly rapid	Usually a short time however sometimes takes a long time to recede
Groundwater	High water table level combined with heavy rainfall	Development in low-lying areas; interference with natural aquifers	Usually slow	Longer duration
Flash flood	Can be caused by river, pluvial or coastal systems; convective thunderstorms	Catastrophic failure of water retaining structures. Inadequate drainage infrastructure	Rapid	Usually short - often just a few hours
Semi-permanent flooding	Sea level rise, land subsidence	Drainage overload, failure of systems, inappropriate	Usually slow	Long duration or permanent

		urban development. Poor groundwater management		
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(Jha, Bloch & Lamond, 2012)

1.3 Flooding in Canada

As mentioned above, floods are usually defined in terms of the destruction caused and their frequency of occurrence. In Canada, they are recorded as one of the most costly natural disasters in terms of property damage causing billions of dollars. Flooding in Canada is usually caused by heavy rainfall, which is caused by thunderstorms – or warm, moist air rising rapidly that causes flash floods (Government of Canada, 2014). Canada has experienced more flood events in its history, occurring five times as often as wildfires, the second most frequent natural hazard in Canada. Between 1900 and 2005, there were 241 recorded flood disasters in Canada (Sandink, Kovacs, Oulahen & McGillivray, 2010).

The five worst flood disasters in terms of economic losses start with 1950 Winnipeg, Manitoba floods. Heavy rainfall in the last week of April and early May caused heavy floods causing property damages. The total cost of the flood was about \$125.5 million (equivalent to approximately \$1 billion in 2016). In 1954, Hurricane Hazel was the worst storm to hit Ontario. About 225 mm of rain fell in less than 48 hours and the damages were reported to be around \$100 million (total damage cost of \$1 billion in 2016). The 1997 Red River Flood was arguably one of Manitoba’s worst where flood waters reached 10 m high and many people lost their properties. The damage toll came to \$51 million in 1997 terms. A massive outbreak of severe weather in August 2005 in Toronto was caused by intense flash flooding. The city received more than 100mm of rain over the course of a couple of hours, while Environment Canada’s

headquarters in Downsview got as much as 130mm rain causing huge damage to infrastructure. The insured losses cost to be around \$500 million. Lastly, the spring catastrophic floods of June 2013 occurred in two of Canada’s top economic cities- Calgary and Toronto. Heavy rainfall caused flash floods in the Alberta foothills in 2013, which led to unprecedented flooding throughout Calgary that shut down many businesses in the city core for weeks. Physical damage to these businesses cost insurers more than \$2.25 billion in claims, which represents the most significant insurance loss in Canadian history. Weeks later a similar rain event generated significant urban flooding in Toronto. Almost 126mm of rain fell over a 7-hour period. This intensity broke a record set by Hurricane Hazel in 1954 as the most significant amount of rain to fall over a 24-hour period (Martins, 2014). Below is the graph showing Catastrophic Insurable Losses in billions of dollars caused by several extreme weather events in Canada in 30 year period.

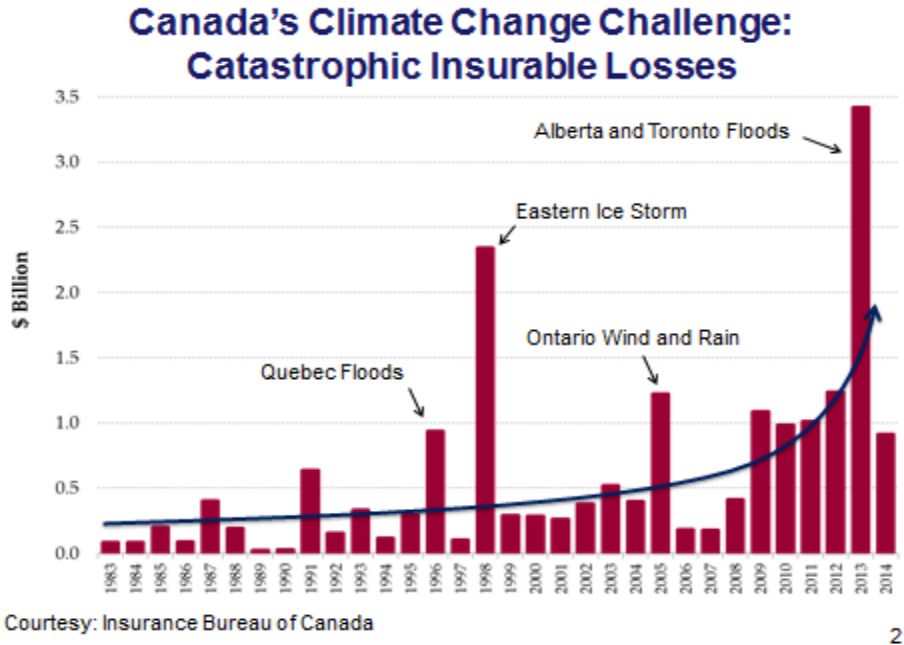


Figure 1: Catastrophic Insurable Losses (in Billions of dollars) in Canada caused by Climate Change

With the increasing pressure of development, population expansion, land use changes and changing nature of climate with higher temperatures, increased rainfall, and sea level rise acting as drivers, flood risk is likely to increase in the future (Foresight, 2004). Because of this, Canada's infrastructure is vulnerable from the unprecedented flood risks. One type of infrastructure is buildings and their contents that can be directly and indirectly impacted by flooding in a range of ways. Flooding could also disrupt many of the important services buildings are designed to provide. Flooding in underground spaces, basement floors and utility facilities under the ground is typical. Direct impacts from flooding are the physical damages caused to buildings and their contents, whereas indirect impacts refer to changes in regulations, consumer preferences or financial markets driven by climate change (Jha, Bloch & Lamond, 2012). Commercial Real Estate (CRE) is one such business sector directly and indirectly impacted by flooding.

As shown in figure 1 above, the 2013 flood events in Calgary and Toronto have been estimated by the Insurance Bureau of Canada (IBC) to have cost about three times the normal yearly claim experience. The insurance industry paid out \$2.2 billion in claims in Alberta alone that year — while claims in southern Ontario from severe flood totaled \$1.2 billion — a total of \$3.4 billion in claims from flood events for the year (Noakes, 2015). Interestingly, 75% of the claims were from commercial business properties alone (Kane, 2013).

The insurable losses from these floods could have been avoided if CRE property owners/managers/stakeholders had shown more awareness and response through climate change adaptation – risk awareness, risk assessment, risk management and monitoring/evaluation –

measures. The reason behind such ignorance can be partly attributed to the lack of attention by stakeholders as well as researchers towards the CRE sector in Canada. Perhaps most alarming is that many CRE sector professionals do not consider natural disaster such as flooding to be an important issue. Even a minor flood event can impact the ability to maintain a building, while a major event can have a material effect on a company's operation and financial condition (Claims Journal, 2013). Regardless of the immense importance of the CRE sector to the Canadian national economy, most current research studies are either partly or fully focused on residential properties or other built infrastructures in Canada. It has been recognized that new research is required to gain better understanding of the nature and characteristics of flood risk in the CRE sector, identify the key elements that directly or indirectly have an impact on the physicality and operations of assets under threat, and focus on identifying climate change adaptation measures to de-risk this sector from impacts of flooding, which is identified as the purpose of this thesis.

1.4 Research Question

In an effort to gain a better understanding of the Canadian CRE companies' knowledge regarding impacts of flooding and their motivation towards implementing a climate change adaptation framework in the sector, the following research question has been proposed:

Realizing an increase in the frequency and intensity of extreme weather events from climate change, such as flooding, are Canadian CRE companies motivated to engage (implement) a climate change adaptation framework to de-risk their commercial properties from extreme impacts of flooding?

1.5 Research Objectives and Target Audience

The objective of this research is to investigate the *climate-induced flood vulnerability in the Commercial Real Estate sector in Canada*. Investigation will review the extant body of literature to develop an understanding of the theories, principles and concepts of flood vulnerability and climate change adaptation in the context of CRE business sector. A survey which assesses the Canadian CRE sector's view and preparedness regarding flood risk will be analyzed and will answer the research question on motivation of CRE companies towards implementing climate change adaptation. Conclusions will be drawn in the end on how Canadian CRE sector is vulnerable from climate-induced flooding and recommendations will be made for future research.

Survey key findings demonstrate that Canadian CRE companies lack adequate knowledge on the risk of flooding. This lack of a perception makes the Canadian CRE sector highly vulnerable from impacts of flooding – both direct and indirect. The lack of a perception towards flood risk plays a significant factor in CRE companies' lack of motivation towards adopting climate change adaptation practices, which is highly concerning for the economic activity of the sector and the economic activity of Canada. In fact, the risk of flooding is not considered a priority risk in the CRE sector. The companies support risk awareness education and risk assessment training initiatives, but are not extensively motivated to implement risk management adaptation measures to comprehensively manage the risk of flooding in their commercial properties. However, the perception can certainly change with the increasing magnitude and severity of floods, and the financial implications from flooding will be visible in

the future. The key findings are discussed explicitly in the discussion section (chapter 5) of this research.

In the wider context, the first group of beneficiaries from this study will be those stakeholders who are directly and indirectly related to the CRE sector in Canada. These stakeholders can be classified as CRE CEOs, Board of Directors, property holders or owners, managers, property buyers, all levels of government, insurance companies, investors, occupiers, customers, suppliers, employees, and emergency service holders. The second group of beneficiaries will be the scientific community who will benefit from this area of study which has been neglected until today.

The next section will review the extant body of literature to develop an understanding of the theories, principles and concepts of climate change impacts/vulnerabilities. It will further examine a climate change adaptation framework in many business sectors around the world, which will be helpful to understand flood vulnerability causes and climate change adaptation in the CRE business sector.

Chapter 2: Literature Review

2.1 Climate Change and Business

The business sector is likely to face significant risks as a result of climate change. The business community has been aware of the ongoing climate change risks and current and future climate change policies. Many businesses have taken steps to reduce greenhouse gas emissions voluntarily, while many have taken into account some climate change impacts. However, very few businesses are incorporating climate change risks in their business planning. As climate trends become clearer and uncertainty surrounding future changes is reduced, more businesses will want to take action now by considering adaptation to climate change. These actions will not only manage risks but will also involve economic opportunities (OECD, 2011).

According to OECD study, much less attention has been paid to the role of the business (private) sector in fostering adaptation. The findings in the study show many private businesses around the world, such as manufacturers, agriculture and mining businesses, transportation, utilities, real estate businesses, retailers and distributors that have failed to implement adaptation because of their lack of education and motivation towards it (OECD, 2011). Moreover, government policies regarding adaptation revolve around protecting mostly public goods and assets (including the natural environment). It is not feasible, nor appropriate, for governments to bear all the costs of adapting to the impacts of climate change. It would also be inefficient and inappropriate for governments to make decisions on behalf of businesses and individuals that are better placed to understand and manage their own risks. Therefore, given that most of the assets and activities at risk from climate change are owned or managed by private sector, it is reasonable to expect that private businesses must manage climate change risks by incorporating

adaptation. Simultaneously, countries' success in adaptation depends heavily upon the decisions made within the private sector. Therefore, it is very important to understand how the business sector is responding to the threats and opportunities arising from climate change. This understanding can help improve the development of policy frameworks in the private sector that are conducive to adaptation and identify if there are currently barriers to action (OECD, 2011).

Climate change represents a new and somewhat daunting topic for many businesses. The challenge is compounded by the diverse and uncertain projections of changes in temperature, precipitation patterns, extreme events, and other impacts. The following sections outline key impacts and vulnerabilities of climate change to the business sector, and the sector's initial adaptation responses to climate change.

2.1.1. Impacts in the Business sector

It is widely recognized that climate change poses potential risks to businesses in the form of current and possible future greenhouse gas regulations and emissions trading systems, changing attitudes of shareholders and consumers, evolving product markets, and actions taken by competitors. Equally, the physical effects of climate change – changes in temperature and weather, water availability, and other changes – can affect business processes, fixed assets like buildings, and resource availability. However, relatively few businesses have climate impacts on their “radar screens” (Sussman & Freed, 2008).

Climate change impacts vary considerably across many different sectors of the business economy: it can affect the ways businesses operate, impact the profitability of their operations,

and create opportunities. A number of studies have identified the types of risks that the impacts of climate change impose on different sectors. Although the impacts are detrimental to some sectors, virtually all businesses face the possibility of property damage, business interruption, supply chain and raw materials risks, reputational risks, financial risks, product demand risks, regulatory risks and changes or delays in services provided by electricity and water utilities (OECD, 2011). Table 2 below illustrates the potential impacts of climate change on selected business sectors.

Table 2: Examples of climate change risks in various business sectors

Sector	Potential Business Risks resulting from climate change impacts
Electric Utilities	<ul style="list-style-type: none"> • Peak electricity demand due to warmer and more frequent hot days in some regions could exceed the maximum capacity of current transmission systems and will be combined with system stresses due to heat • Increased risk of damage to facilities and infrastructure from extreme and unpredictable weather conditions • Uncertainty over energy output from hydroelectric plants due to potential water shortages • Uncertainty over water supplies for cooling power plants
Mining	<ul style="list-style-type: none"> • Extreme weather events, like flooding, increase physical risk to business operations
Integrated Oil and Gas	<ul style="list-style-type: none"> • Natural disasters and weather changes can lead to negative business impacts
Food, Tobacco, & Beverages	<ul style="list-style-type: none"> • Risk of food supply and operations interruptions due to extreme weather events • Longer term weather trends may affect reliability and quality of fresh produce supply • Physical risk to water supply and raw materials • Greater risk of animal infections, insect infestation, plant disease, wildlife damage
Building Design & Construction	<ul style="list-style-type: none"> • Extreme weather events may disrupt transport for site deliveries and affect site work, restricting work-days • Infrastructure affected by extreme weather events • Excessive heat in summer will affect construction processes and onsite workforce • Design standards and Building codes may need to be clarified or upgraded in response to changing climate

	<ul style="list-style-type: none"> • Insurance may be more expensive or difficult to obtain for existing buildings, new buildings, and during the construction processes
Insurance	<ul style="list-style-type: none"> • Increased need to develop catastrophe models to evaluate capital adequacy and overall natural catastrophe exposure • Disruption to business operations become unpredictable and more financially relevant • Competition for water resources between agricultural and urban development increases commercial risks with impacts on crop insurers • Prolonged periods of poor weather or extreme events increase costs of claims and make it more difficult to deal with high volumes of claims
Agriculture	<ul style="list-style-type: none"> • More refrigerated distribution and storage required and problems with livestock transportation in summer heat • Damage to transportation infrastructure or disruptions in services due to floods, etc. creating problems with transporting raw materials • Limited availability of water and potential interruption of supply to irrigation systems • Equipment and other investments, as well as expertise of farmers and workforce, are linked to specific crops, which may become unprofitable or may no longer be viable • Quality issues: overheating of grain, or availability of water for pre-washed products • Access to land during flood or extreme rain conditions • Farm buildings affected by extremes of wind, heat, rain
Real Estate businesses	<ul style="list-style-type: none"> • Delays and disruptions in construction projects, damage to buildings and drainage problems. Additional costs due to temperature changes and increasing cooling loads • Regulatory risks leading to changes in building and design requirements • Financial risks leading to loss of value
Motor Manufacturing	<ul style="list-style-type: none"> • Supply chain interruptions and vulnerable transport systems carrying high value products around the world (e.g., one ship carries over \$60 million of product) • May need vehicles that tolerate new extremes of climate, including greater intensity of rainfall (affecting seals, wipers, tires) and increased need for cooling • Process environment will become hotter with increased need for cooling—particularly important for comfort/health of workforce and performance of production processes • Increased drying time for painted products as a result of increased humidity

(CDP, 2007; UKCIP, 2005; IPCC 2007b; OECD, 2011; Overbye et al. 2007)

While some businesses are taking weather hazards into account in planning, others have failed to respond to the potential risks climate change impacts may cause to their businesses. Many businesses are more likely to have concerns only about the physical impacts of climate change such as damage to company assets and infrastructure, interruption of operations and business continuity, or damage to products due to extreme events. In fact, climate change impacts that may also affect a company's business models and other activities, as mentioned in Table 2 above, are sometimes not understood or underestimated by most businesses (OECD, 2011). Although, the insurance industry has been a leader for a number of years in identifying climate-related risks to property, health, crops, business interruption, and other activities subject to insurance, they have failed to get the government's and business groups attention in urging for incorporating more preparedness measures and disaster policies in the business sector in the face of increasing weather related hazards.

Some businesses have begun to experience the impacts of climate change due to decline in the business activities and economic growth. While warmer weather may be a boon for hikers and bikers, businesses that rely on snow and cold temperatures – including winter tourism and some diamond mines – are beginning to feel the bite of warmer winters. Warm weather in Central Ontario's Blue Mountains resorts and ski has caused a downturn in winter tourism economy. Many ski alleys in the area remained closed in December 2015 and first half of January 2016 due to unseasonably no snow and warm weather (Amours, 2015). Meanwhile, according to *The New York Times*, resorts in the Swiss Alps are investing in new spas and other non-ski attractions in order to continue to lure tourists as projections call for diminished snowpack due to climate change (Williams, 2007).

Diavik Diamond Mines Inc. in Canada is another business who is impacted by climate change. The company hauls thousands of tons of equipment, fuel, and supplies it needs for its mining operation on an “ice highway” built over frozen rivers, lakes and tundra 200 miles northeast of Yellowknife. It has been reported that in 2006, the roads were shut down early due to higher temperatures. Besides, the ice never got thick enough to support the weight of big trucks. Faced with the choice of slowing operations, Diavik executives opted to haul the mine’s diamond output using an expensive airlift (Carey, 2006).

Where some businesses have started to experience climate change impacts, many other businesses, though, still have the perception that these impacts – temperature rise, hydrology changes, extreme weather events, sea level rise and many more – are either irrelevant or too uncertain and their businesses are not vulnerable to the impacts. Climate change is a reality and businesses must understand the potential risks related to the impacts of climate change. It is high time that businesses should also consider the potential risks related to supply chains and other business models, and not just the physical property damages. In order for that to happen, it is very important to distinguish different types of vulnerabilities present in the business sector. It will be prudent to take climate change vulnerability into account if it materially affects a company’s operations, its value chain, or its broader commercial environment. Consequently, understanding whether adaptation is necessary – and what adaptation can accomplish – requires taking a closer look at the different types of vulnerabilities on businesses. Next section breaks down the direct and indirect vulnerabilities that cause different risks to many different businesses.

2.1.2. Vulnerability

Vulnerability, as definitions imply, is a powerful analytical tool for describing different stages of susceptibility, to harm, powerlessness and marginality of both physical and social systems and guides the normative flow of action to enhance welfare through risk reduction (Adger, 2006). The World Bank has divided vulnerability into two major dimensions: hazard exposure and capacity to cope. Hazard exposure is the presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected by a hazard, whereas capacity to cope is the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences of hazards. World Bank has also proposed that higher the capacity to cope, the lower the level of vulnerability and vice versa (Sharma et al., 2000).

Vulnerability can be both direct and indirect. Direct physical damage to a company's assets can be attributed to direct vulnerability (Kappes, Papathoma-Kohle & Keiler, 2012), and indirect vulnerability in a company can be caused by affected business continuity and performance of business, which can happen due to incurring loss by taking time to recover from its disrupted state of operation (Alesch, Holly & Naggy, 1998; Gissing. 2002; Parker, 2009; Tierney, 2007). Understanding direct vulnerabilities is uncomplicated and most of the time they can be easily anticipated, while indirect vulnerability is more complex, uncertain, and difficult for businesses to predict (Beerman, 2011).

Direct and indirect vulnerabilities vary widely depending on the respective businesses, though in the long term, the indirect vulnerability poses a similar threat to the growth and

survival of a company as the direct vulnerability. As we understand that direct and indirect vulnerabilities have their own category of risks, it is very important to consider carefully each and every risk caused by these aspects of vulnerabilities. Table 3 and 4 below provides an overview of potential direct and indirect vulnerabilities, respectively, caused by climate change, and provides a general description of each and highlights different business sectors that might be particularly vulnerable.

Table 3: Overview of potential direct vulnerability business risks from climate change

DIRECT VULNERABILITY BUSINESS RISKS		
Risk	Description	Vulnerable business sectors
Physical Assets and business premises	<ul style="list-style-type: none"> • Risk from extreme weather events and changes in climatic conditions will affect the structure and interior and exterior of buildings. • Physical assets will be at risk of damage from extreme weather events or sea level rise. 	All sectors that have properties, particularly Commercial Real Estate.

Table 4: Overview of potential indirect vulnerability business risks from climate change

INDIRECT VULNERABILITY BUSINESS RISKS		
Risk	Description	Vulnerable business sectors
Efficiency of operations	<ul style="list-style-type: none"> • Some industrial processes and business activities are temperature or climate sensitive and some require constant cooling. • Productivity of these processes and activities can be affected and operational costs can rise due to the need for technical improvements or damage control. 	Food industry, Information and communication technology, Manufacturing
Logistics	<ul style="list-style-type: none"> • Extreme weather events can result in major disruptions to logistics, including transport arrangements, supply chains, utilities, and other essential infrastructure services. • Just-in-time and single source supply systems increase a company's vulnerability to such disruptions. • This will affect business continuity and costs. 	Retail industries Logistics companies

Competition over resources	<ul style="list-style-type: none"> Climate change will act as another stressor in regions already experiencing water stress. It can also affect the availability of water in non-water scarce regions. This will directly affect the operations of businesses that rely heavily on water supplies. Competition over scarce resources can lead to conflicts and undermine a company’s “social license to operate” or the acceptance and approval of the communities in which they operate. This is particularly the case if water is diverted to industries and away from local communities and farmers. 	Electric utilities Food and Beverages
Reputational risks	<ul style="list-style-type: none"> Competition over scarce resources and business impacts on essential ecosystems can lead to reputational risks. This is a particular risk factor in countries vulnerable to climate change, with large parts of the population depending on climate-sensitive resources. Conflicts over protection of assets, for example, business districts being better protected than – or even at the cost of – neighboring communities. Examples include cases where communities are not included in sea wall protection planning or may even be adversely affected by flood diversion schemes. 	Beverages Commercial Real Estate Insurance
Financial drivers	<ul style="list-style-type: none"> Operational costs and business continuity costs can increase due to a combination of climate risk factors. Institutional investors and banks are increasingly interested in the investment implications of climate change. Governance of climate change risks is coming under closer scrutiny. 	Electric utilities, Commercial Real Estate properties, Mining, Agriculture, Forestry
Increased Insurance costs	<ul style="list-style-type: none"> With greater risks from climate change impacts such as sea level rise and extreme weather events, premiums may increase. Insurance may no longer be available for certain assets and in very vulnerable regions. Insurance companies will see an increase in claims and will need to manage the increasing unpredictability of business disruptions. 	All sectors
Changing markets	<ul style="list-style-type: none"> Changing demand for goods and services and impacts on customer access can reduce sales. 	All sectors, particularly retail
Workforce	<ul style="list-style-type: none"> Extreme weather events and changes in the 	All sectors, particularly

	<p>distribution of vector-borne diseases can lead to more lost days.</p> <ul style="list-style-type: none"> • Health and safety risks may increase where business operations are prone to extreme weather events. 	property construction
Loss of Biodiversity	<ul style="list-style-type: none"> • Changing weather patterns and rising ocean temperatures are additional stressors threatening species vital to business operations. 	Pharmaceutical Fisheries

(Gerry et al., 2010; WBCSD, 2008; Frances & Randall, 2008)

The above-described vulnerabilities define the kind of risk exposure businesses can face from human-induced climate change. The risk exposure may result in adverse business outcomes. These outcomes – business interruptions, increased investment or insurance costs, or declining financial measures such as value, return, and growth, or other measures of business success – will be determined by the types of climate impacts a business is exposed to and the likely risk exposure on the business (Sussman & Freed, 2008). IPCC and EPA explain that the risk of adverse impacts of climate change is a function of probability and outcome; in this case, the probability of business exposure to climate change and potential outcomes (impacts) of that exposure (IPCC, 2007 & EPA, 2004).

Figure 2 below draws a pathway by showing some examples of risks of climate change that can affect businesses. This figure – entitled the “Risk Exposure of Business”- illustrates three types of risks. Core operations risk, which is a direct vulnerability business risk, is shown in the innermost circle. Value chain risk, which is considered an indirect vulnerability business risk, is shown in the middle ring; while the outermost ring also displays an indirect vulnerability business risk – the risk that arise because of broader changes in the economy and infrastructure (Sussman & Freed, 2008).

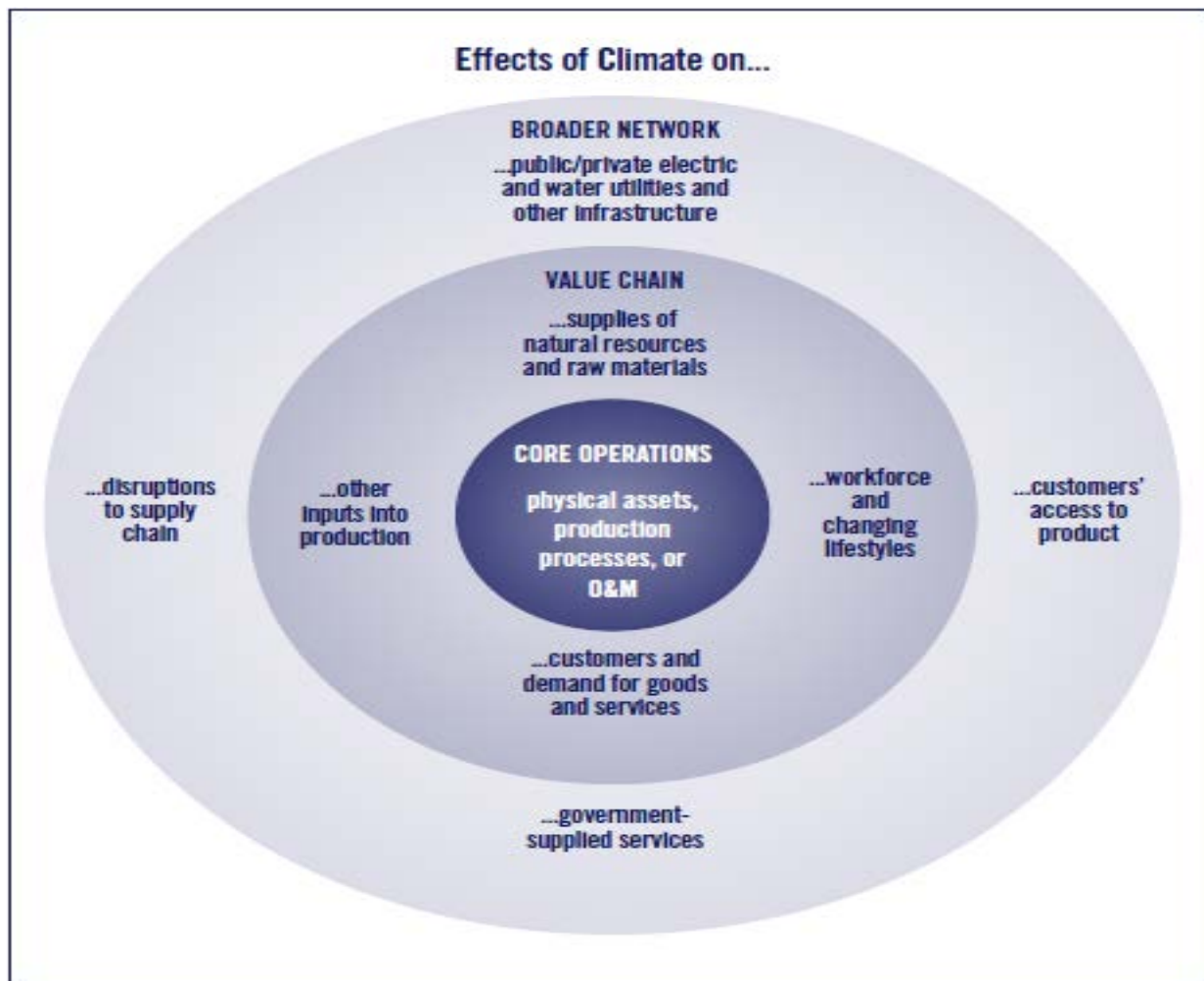


Figure 2: Risk Exposure of Business

In turn, the vulnerability and risk exposure in the business sector from climate impacts can be managed by adaptive actions of the businesses, ranging from awareness to assessment to management of the risk (OECD, 2011). Adaptive capacity is defined as the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (Brooks, Kelly & Adger, 2005).

Adaptive capacity of a business to deal with differential hazards varies from short to long term. For instance, the vulnerability, or potential vulnerability, of a system to climate change that is associated with anticipated hazards in the medium to long term will depend on that system's ability to adapt appropriately in anticipation of those hazards. Similarly, vulnerability to hazards associated with climate vulnerability that may occur in the immediate future will be related to a system's existing short-term coping capacity rather than its ability to pursue long-term adaptation strategies (Brooks, Kelly & Adger, 2005).

With direct and indirect vulnerabilities and the impacts they cause to respective businesses already being observed, it is no surprise that successful adaptive capacity of a business will require recognizing and acting on climate change impacts from an early stage – often before the impacts occur – and identify appropriate responses (Chegini, 2005). Next section highlights a climate change adaptation framework – risk awareness, risk assessment, risk management and monitoring/evaluation – which is already used by many businesses and can be used by many others to de-risk climate change impacts and improve the coping capacity.

2.1.3. Adaptation measures in the Business sector

Several research papers have been developed on climate change adaptation strategy for businesses and have produced a simple four-stage process. Each process builds on the results of the preceding ones.

2.1.3.1. Risk Awareness

The first process involves promoting risk awareness about the impacts of climate change. For many businesses, disruptions caused by climate change, particularly extreme weather events suggest that increased risks exist today and can be costly (Crawford & Seidel, 2013). However as the time goes and uncertainty around several climate impacts increase, extreme weather events

and the disruptions caused by it are often forgotten as other business priorities take over. Therefore, a deeper understanding of the risks of climate impacts must be developed across many business sectors as a foundation for short to long term realistic business planning and decision-making.

Risk awareness should begin with understanding how a changing climate can affect a business. Businesses should demonstrate a clear understanding on the growing concern of GHG emissions, and must report their efforts to achieve emissions reductions and energy efficiencies. Impacts on the business from past climate-related events such as storms, droughts, and unusually hot and cold seasons and the responses to such events must also be reported by all businesses. Companies may use their websites to demonstrate their awareness of climate change and engage in awareness-raising exercises, thereby illustrating climate change issues, highlight their initiatives to address them, and in some cases publicize the results of their awareness-raising campaigns (OECD, 2011). Simultaneously, businesses should also be aware whether such events will likely increase in frequency and intensity in a changing climate, and if these events will cause the operational, financial, strategic, or other kinds of risks for the businesses (Business Primer, 2012). Businesses should scan the available research to learn how the climate and its potential impacts can change in the different regions where they operate. As climate change varies in many regions, awareness regarding differential risks will involve many industry associations for actions and will help stakeholders realize that actions implemented today can reduce exposure to climate change (Thistlethwaite & Feltmate, 2014). Additionally, businesses can also look beyond the regions where they operate to identify any direct or indirect

vulnerability in the regions where the suppliers and customers are located (Business Primer, 2012).

Some businesses, however, have already recognized the importance of risk awareness. For example Hydro-Quebec, an electricity firm in the province of Quebec, has developed a comprehensive program to tackle climate change. The business considers properly analyzing the risks of climate change, particularly water, the main resource for Hydro-Quebec, and adopting the right adaptation strategies to protect it from extreme weather events (Hydro-Quebec, 2014). Upon consultations with staff from different divisions, the firm has also started identifying other areas of business activity that are sensitive to changing climatic conditions. Hydro-Quebec has been making a considerable investment in research on changing climate, business impacts, and adaptation. Increasing knowledge on this issue has improved their planning, design and operational decisions (Business Primer, 2012).

Furthermore, a business should be harnessing knowledge of various climate risks with employees and any stakeholders involved with the business. Successful adaptation will only work if everyone is aware of the risks related to climate change, thereby establishing a common understanding of the issue. Involving representatives of operations, legal counsels, finance, etc., to the table will cultivate awareness and ownership of the adaptation challenge (OECD, 2011).

Business sector can also raise climate awareness by drawing input and assistance from international organizations and partnerships. For example, the UNEP Finance Initiative Climate Change Working Group has coordinated with several business organizations to promote climate

change risk awareness and engagement in adaptation to climate change (OECD, 2011). On the other hand, Swiss Re also fosters risk awareness both within the organizations and among stakeholders and helps deliver sustainable measures for profitable business activities (Swiss Re, 2015).

2.1.3.2. Risk Assessment

Step 1: Identify Business Risks

This is the second process of developing a climate change adaptation strategy. Risk assessment requires research into climate change risks found in the first process and the identification of adaptation strategies to manage those risks (Thistlethwaite & Feltmate, 2014). Businesses can assess the risks and opportunities from a changing climate as they relate to the five areas: i) site conditions, physical assets and infrastructure ii) processes and workforce iii) raw materials, supply chains, and logistics iv) products, services and markets v) regulatory risks, changing standards, and business reputation (Business Primer, 2012).

As mentioned in the risk awareness process, working in partnerships with many international known organizations is beneficial for many businesses. Businesses can gain valuable information and knowledge at low cost, organizations can share best practices to help accelerate action, adaptation success can be built at a faster rate, and it can influence government action on adaptation in the private sector (Business Primer, 2012). Intact Financial Corporation, for instance, teamed up with the University of Waterloo to support research on climate change risk assessment and policy action on six adaptation priorities plan for Canada: city infrastructure, biodiversity, freshwater resources, aboriginal communities, agriculture, and property and

casualty insurance. The project includes an outreach and advocacy plan and, through it, a commitment to engage policymakers, among others (Feltmate & Thistlethwaite, 2012).

Step 2: Prioritize Risks to Manage

Prioritizing risks is very important in the risk assessment process. The main focus of this is that businesses need to establish a set of evaluation criteria to determine which risks demand immediate action (particularly current and short-term climate change risks), and which risks demand gradual actions (particularly long-term climate change risks) (Business Primer, 2012).

Generally, current and short-term risk assessments feature direct vulnerability associated with climate change. Businesses can do risk assessment on direct damages and operating losses in areas they operate. OECD research explains that businesses can divide each risk on the scale of one to five, according to the intensity and importance of the risks to the businesses. This risk assessment can be used as a one-to-five-year business timeline and can be used as an input to the five-year short-term risk free strategic plan. Some companies may regard indirect vulnerabilities as significant short-term risks. These companies focus particularly on extreme weather events, including storms and heavy rain, and on extreme temperature events. For example, these risks are considered important for utilities sector where climate can affect the supply of their services to customers and negatively affect companies' production. Also, variability of temperatures can affect water availability, which can be regarded as an important short-term risk assessment for water and energy production companies (OECD, 2011).

On the other hand, conducting assessments of long-term climate risks can be difficult as they can require specialized skills in the use of scenarios and projections. However, businesses can base their risk assessments on IPCC projections or commission studies from external consultants to develop future risk models. For instance, Rio Tinto Alcan, a Montreal based global producer of bauxite, alumina and aluminum, has been investigating the long term impacts of climate change on operations and major projects. Rio Tinto has used external consultants' expertise to develop climate projections through to 2060. The value of developing and applying these projections includes spotting opportunities in new geographies, identifying new risk dimensions, and enhancing competitiveness (OECD, 2011).

While some companies in the business sector have realized the importance of risk assessment, other companies that have already been affected by climate events in the past now often monitor climate variability in order to reduce their vulnerability to future events. Entergy, a Gulf electric utility, witnessed the costly impact of climate-related events. In 2005, hurricanes Katrina and Rita cost the firm \$1.7 billion, spelling out a clear business case for action to assess and manage climate risks. Since that time, Entergy has worked with Swiss Re to assess the corporation's asset exposure to wind-related damage, sea level rise, and increased storms. They have also assessed the cost-effectiveness of actions to protect the region from future climate damage. Entergy is now equipped with a sound financial basis from which to allocate resources and implement priority actions, such as improving standards for offshore platforms and enhancing levees for refineries (Williams, 2011).

Step 3: Appraise Adaptation Options

Once the climate change impacts on businesses have been assessed and prioritized, assessment of adaptation strategies to de-risk the impacts is necessary. Through adaptation, vulnerability can be reduced by transferring or spreading risks, reducing risk exposure, and avoiding risk. Businesses should identify a long list of adaptation options by considering managing specific climate-related risks and to build system resilience. Businesses might have to think beyond their business boundaries, considering collaborating with infrastructure providers, suppliers, and others in the supply chain. Businesses must conduct a qualitative assessment of each option by preferring the options with proven effectiveness to address the risk or opportunity, options that are flexible to course adjustments, options that benefit the business regardless of climate outcomes, and options that yield co-benefits (Business Primer, 2012).

Before adaptation options are selected, those identified must be evaluated through cost-benefit analysis to assess their appropriateness. Information on the cost-benefit of various adaptation strategies are sometimes difficult to assess. For example, it is difficult to assess whether investments in the improvement of metal cladding on a building located in a hail zone will yield a return either through the avoidance of damage or lower insurance costs. For this reason, the scenario planning exercise should emphasize cost data on the impact of historical climate risks, including higher service rates, property damage, changing insurance premiums, retrofits, and even changes to tenant retention rates. Cost data can then be compared with the benefits achieved through implementing a range of adaptation strategies. An assessment of benefits can also be informed by historical data on the return-on-investment of similar strategies, such as drainage improvements to a business's parking garage to protect against flooding. Thus,

scenario planning exercise using current and future climates can be used for understanding how the benefits of adaptation strategies might increase relative to an increase in costs caused by climate change impacts (Thistlethwaite & Feltmate, 2014).

Furthermore cost-benefit analysis should be used to prioritize adaptation strategies that will be cost-effective across a range of short, medium and long-term timelines. For example, Anglian Water, a water and sewerage service company in East Anglia, the driest region in the UK, face a number of challenges due to climate change risks and have undertaken an assessment of the risks to their current operations. The company then used scenario planning exercise by using cost data from historical climate impacts on the company to identify both procedural and operational adaptation measures, which are being used to inform their short, medium and long-term planning. For short and medium-term planning, they are managing seasonal changes in climate by improving network resilience and managing the supply/demand balance through water metering, water efficiency programs and leakage control. For long-term planning, the company is ensuring that current and future assets are designed to be resilient to the impacts of climate change for the next 40 years and beyond (Anglian Water, 2009).

2.1.3.3. Risk Management

Implement Adaptation measures:

After assessing and prioritizing potential risks and adaptation strategies in the risk assessment stage, a plan must be developed by businesses to implement adaptation strategies. Due to the uncertainty around changing future climate, decision-making to implement adaptation strategies can be very difficult and challenging for most businesses. Though, companies that effectively take this implementation process will generate first-mover competitive advantages by

making use of the services and technologies needed to avoid the significant costs associated with climate change. Other benefits of implementing adaptation measures in the business sector include gaining new market opportunities, meet consumer and stakeholder/investor expectations, and staying ahead of government regulations (Thistlethwaite & Feltmate, 2014).

Businesses should prepare an implementation plan that includes roles and responsibilities amongst everyone related to the business, implementation requirements and investments, possible implementation challenges and ways to address them, tasks and timelines, and a stakeholder engagement and communication strategy (Business Primer, 2012). According to OECD, investment for adaptation implementation can be prioritized according to “no-regret” or soft and hard adaptation measures (OECD, 2011).

“No Regret” or Soft Adaptation measures:

These measures address current climate variability concerns and are co-beneficial to existing business operations, while also supporting resilience to climate variability and risks. In some cases, they are likely to have been undertaken irrespective of predicted climate change impacts. Such measures usually entail adapting existing procedures and operations to be more flexible or resilient to climate change. Examples include early warning systems, insurance schemes, green infrastructure such as restoration of wetlands, commercial changes in products or services, strategic changes such as relocating facilities, diversifying the supplier base, outsourcing production across many facilities, providing additional storage facilities in flood affected areas, or financial strategies to protect the business (CCCEP, 2015 & OECD, 2011). Businesses tend to implement no-regret or soft adaptation measures as they cost less compared to

hard adaptation measures and are easier when dealing with uncertain climate and policy contexts. In other terms, no-regret/soft adaptation measures are designed for short-term climate risks and are the most common response system amongst private sector companies (OECD, 2011).

One company that is implementing no-regret/soft adaptation measures is Rio Tinto. As mentioned earlier, Rio Tinto has worked with external consultants' to assess long-term climate impacts and adaptation measures. However, the business is also facing some short-term risks, particularly water issues for their mining production. Since water is critical for exploration, mining, processing, smelting and refining, Rio Tinto faces problems of water scarcity due to their locations in arid zones and high competition for water with other users. Therefore, the company has developed a water strategy that aims at improving the company's efficiency in the use of water and its exploitation through new knowledge and technology. To address the water issue, several no-regret/soft measures, such as water recycling, the reuse of water from a tailings dam, the use of technologies to minimize evaporative water losses, and efforts to raise awareness on water conservation issues have been implemented to ensure good performance of the business (OECD, 2011).

On the other hand, some companies have undertaken adaptive measures driven by likely changes in the consumer demands. Consumers in some countries are already feeling the impacts of increased water scarcity and high water prices. To address these issues, Unilever, a consumer goods manufacturing company operating in 180 countries worldwide, has immediately launched a fabric conditioner called Comfort One Rinse to be used for hand-washing laundry which will reduce the amount of water required to rinse detergent from clothes by two thirds. As a result, an

average of 30 liters of water per wash will be saved while at the same time it will reduce the effort and time needed to hand-wash laundry (Unilever, n.d.). This is a perfect example of no-regret/soft adaptation measure undertaken by Unilever to address the potential water scarcity impact of climate change faced by the consumers.

Hard Adaptation measures:

These measures have a specific adaptation purpose and entail actions such as adjusting infrastructure and technology, often requiring significant investments. The implementation of hard adaptation measures commonly relates to industry sectors that are reliant on long-term assets (CCCEP, 2015). Examples include divestment from buildings located in areas vulnerable to coastal plains, or investments directed at “flood proofing” these buildings by raising electrical equipment from the bottom floor. For any hard adaptation measure, the budget implications must be analyzed to start saving the resources necessary for its implementation (Thistlethwaite & Feltmate, 2014).

While most businesses opt for no-regret or soft adaptation measures, some big corporations have to make considerable investments in hard adaptation measures for their business continuity. For example, the Greater Toronto Airport Authority (GTAA), one of the largest airports in North America, experienced extreme rainfall and flooding in June 2013. While the airport did not suffer huge economic losses, the airport authorities have noted that future climate change may lead to more severe weather, creating flooding risk for the airport. In response to this risk, GTAA decided to undertake an engineering vulnerability assessment of infrastructure using the PIEVC Protocol. The Protocol is a step-by-step process to conduct an

engineering vulnerability assessment on infrastructure due to climate change. Risk assessment was conducted and found that the airport infrastructure is vulnerable to weather related risks and that these risks could threaten airport infrastructure, while potential flooding of runways, taxiways, aircraft maneuvering areas, access to roads could cause operational delays and physical damage to airport property. In response to this risk, GTAA is spending roughly \$100,000 to improve stormwater management infrastructure around the airport, and Spring Creek Triple Cell Box Culvert which is designed to convey flooding during an extreme storm event. Investments for improving these hard adaptive measures will address vulnerabilities of the facilities to current and future climate change at the 2050 time horizon (GTAA, 2014).

On the other hand, Hurricane Katrina in 2005 in New Orleans proved to be one of the major disasters in the city's history. Most of the businesses, including commercial and public, suffered huge physical losses and operational failures. Total damages reported were estimated around \$2billion (Burton & Hicks, 2005). Since then, the energy utilities have indicated their vulnerability to climate change impacts, and have now started investing in improving their infrastructures through hard adaptation measures to ensure a greater resilience to climate change impacts and to avoid consequent energy supply disruptions. Responses included building electrical transmission centres away from forests to avoid tree damage to transmissions during storms, and flood-proofing power plants. Furthermore, many plants along the coasts that are sensitive to sea-level rise have barriers implemented around the plants to ensure more resiliency to future climate change (OECD, 2011).

2.1.3.4. Monitoring/Evaluation of implemented Adaptation measures

Once businesses have implemented adaptation measures to manage their prioritized risks, establishment of a Monitoring and Evaluation (M&E) framework of those adaptation measures is important. *Monitoring* refers to the ongoing, systematic collection of data, and enables management to check whether an initiative is on track in achieving set objectives, and allows them to identify and assess potential problems and success. *Evaluation* enables an understanding of effectiveness of measures taken over time, as well as the strengths and weaknesses of project or program design. It can highlight what is and what is not working, provide the necessary evidence to determine effectiveness, and provide lessons which can assist in improving existing projects and the design of new projects (Natural Resources Canada, 2014).

The complex and long-term nature of climate change places a strong emphasis on embedding M&E as a continuous and flexible process (UKCIP, 2011). Such an approach can stimulate a process of ongoing improvement, and can help business sector understand adaptation from different perspectives. M&E is important because it can *evaluate the effectiveness* of whether the goals and objectives of a particular adaptation measure have been met, it can *assess* the costs, benefits, risks and timeline of a measure, *provide accountability* by showing commitments and expectations, *assess the outcomes* of a measure and the impacts that it has had, *improve learning* regarding future adaptation measures, and *compare results* with other similar measures at other locations. Most importantly, conducting M&E of implemented adaptation measures will enable businesses to make better, more informed decisions in the future and strengthen future adaptation measures (Natural Resources Canada, 2014 & UKCIP, 2011). As well, a company must also inform the stakeholders of the company about useful information on

investments and constant M&E of implemented adaptation measures for continuous improvements (Thistlethwaite & Feltmate, 2014).

One of the most straight forward means of evaluating performance is to compare outputs and outcomes against what your project or programme intended to achieve. In this case, we are looking at evaluating the performance of adaptation measures through its purpose and objectives. Several studies have developed an Adaptation Logic Model to examine the M&E of adaptation measures. By developing such model, it is possible to examine the objectives and outputs of adaptive measures in addition to evaluating if the objectives have been met (UKCIP, 2011).

Although there are many ways to build Adaptation Logic Model for M&E, businesses can use a 10-step process for examining M&E of implemented adaptation measures, developed by Kusek & Rist (2004). Figure 3 below shows this 10-step Adaptation Logic Model for M&E.



Figure 3: 10-step Adaptation Logic Model for Monitoring and Evaluation of implemented Adaptation measures (taken from Kusek and Rist, 2004)

The role of each step has been described below (Natural Resources Canada, 2014):

- 1) *Conducting a readiness assessment* in order to determine the capacity of the business organization to develop an M&E model for implemented adaptation strategies
- 2) *Agreeing on outcomes to monitor and evaluate* in order to help focus and drive resource allocations
- 3) *Selecting key indicators to monitor outcomes* in order to assess the degree to which the outcomes of the adaptation measures are being achieved
- 4) *Gathering baseline data on indicators* in order to describe and measure the initial conditions being addressed by the outcomes
- 5) *Planning for improvement* by selecting realistic targets and recognizing the short-term and long-term outcomes of the adaptation measures
- 6) *Monitoring results* by establishing data collection, analysis and reporting guidelines
- 7) *Evaluating results* in order to identify information that will support future decision-making
- 8) *Analyzing and reporting findings* by determining what findings are reported to whom, in what format, and at what intervals
- 9) *Using the findings* by getting the information to the appropriate stakeholders in a timely fashion so they can take the information into account when making decisions
- 10) *Sustaining the M&E system within the organization* by recognizing the long-term process involved in ensuring the longevity and utility of M&E.

After implementing adaptation measures according to prioritized risks, businesses must implement this 10-step Adaptation Logic Model for M&E of adaptation measures. Altogether, this model can be used to collect information and data of any implemented measure to provide

regular feedback, and the information produced can be used to inform decision-makers and other stakeholders of a company for continuous improvements in other adaptation measures. Yet, conducting M&E in business sector will be as challenging as implementing adaptation measures. The key for businesses, however, is to sustain the M&E program over time for best adaptation results (Natural Resources Canada, 2014).

2.2 Climate Change and Commercial Real Estate – Studies around the globe

CRE sector – one of the richest sectors with a global investable real estate worth about US\$50 trillion (La Salle, 2015), is potentially vulnerable from climate change impacts. Climate change poses clear and material risks to the CRE sector. In addition to the physical and social impacts of extreme weather, growing regulatory pressures and changes in market preferences are impacting investment performance (IIGCC, 2013). Until the early 2000s, many researchers were ill-informed about climate change risks that may make the CRE business sector vulnerable. However with rising risks of climate change exposing vulnerability of every business, there is growing evidence across geographies that many researchers have started to realize and assess the potential impacts of climate change in the CRE sector, and that a climate-friendly and sustainable CRE sector can both preserve and increase asset value.

Studies from Australia, the United Kingdom, Malaysia, Singapore, Canada and the United States make a convincing case that the financial performance of the CRE businesses is vulnerable from unprecedented impacts of climate change. Therefore, an increasing number of institutional investors and their stakeholders have started to recognize climate change as their fiduciary duty to manage risks, with leaders in CRE systematically integrating climate risks and

opportunities into existing investment and asset management processes (Thistlethwaite & Feltmate, 2014).

Australia:

A report by Australian National University and Investors Group on Climate Change assessed climate change risks and opportunities for investors in the CRE sector. In Australia, the property and construction sector is already financially vulnerable to extreme weather events such as cyclones, bushfires, high temperatures, hailstorms and flooding. Several impacts are rising insurance prices, physical damages to long life fixed assets, supply chain and operational failures. The report suggests that climate change is forecast to further increase the exposure of property and construction sector, including CRE properties, to climate, energy and carbon price risks. The Australian CRE sector is identifying the most cost-effective measures to mitigate energy costs and carbon risks (reduce exposure) and adapt to physical risks (to build resilience to climate change) (Smith n.d.). Figure 4 below identify some extreme weather climate change impacts, forecast changes, potential business risks and adaptation strategies used in the report.

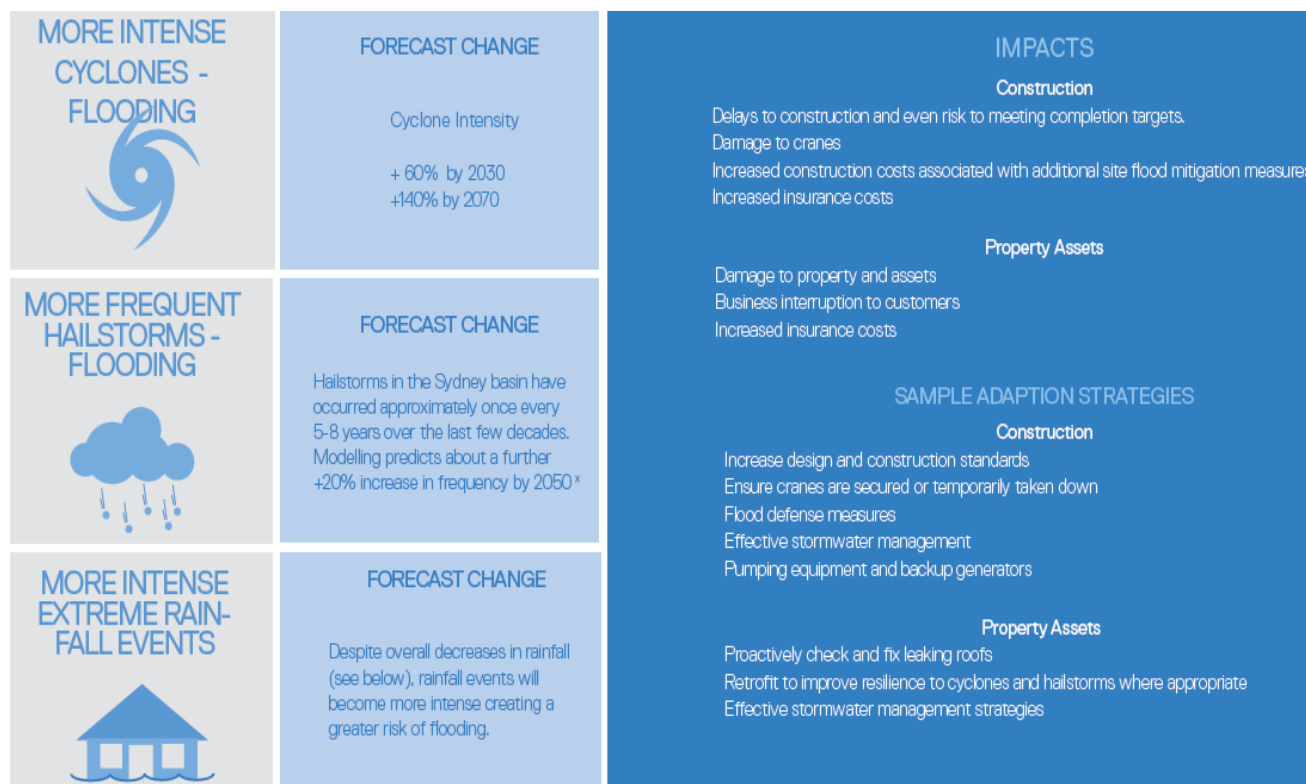


Figure 4: Climate change risks, forecast change, potential impacts and adaptation strategies (Smith, n.d.)

United Kingdom:

In the United Kingdom, natural disasters are on the rise and flooding has been one of the major sources of concern, exceeding the coping capacity and damaging life and property. The UK CRE sector with an estimated turnover of £3200 billion and employing about 22.8 million people with an average growth rate of 2.2% since 2008 (BIS, 2010), is highly vulnerable to the increased occurrence of floods. A study done on impact of flooding on the value of Commercial Property in the United Kingdom by School of Built Environment, University of Wolverhampton stresses that commercial properties exposed to proximity of flood source, higher probability of flood events, and flood characteristics (water depth, velocity and extension) are highly susceptible to flood risk. The study defines that the knowledge of the impact of flooding on CRE

properties is important for both the stakeholders of the company and the insurance companies for property valuation, risk transfer and risk management. Much like the OECD study on many businesses' lack of awareness of climate risks on the business operations, this study also states a fact that many CRE owners are not aware of flood risks to their businesses and this ignorance can be partly attributed by the lack of attention by stakeholders as well as researchers towards CRE sector so far. Considering the immense importance of the CRE sector to United Kingdom's economy, this research study identifies the direct and indirect impacts of flooding on commercial assets under threat, and recognizes adaptation measures in the form of hazard adjustment plan to reduce the cost of flood damage to the commercial properties (Lamond, Bhattacharya, Proverbs & Hammonds, 2011).

Singapore:

Climate change has gained increasing focus in Singapore. The paper – Climate Change Risks and Changing Face of Real Estate – explains that extreme weather events caused due to climate change have increased in intensity and frequency and are capable of reducing the life span of commercial buildings in Singapore. According to the authors Pidugu and Velpuri, the effect of climate change on the investment portfolio performance is linked to decreasing operational performance mainly caused due to extreme changes in weather conditions. Property owners must know about the changing occupier needs and the investor's preferences due to the impact of climate change. The authors also cautioned that the risk of not acting towards curbing global emissions that accelerate climate change can be costly for property owners. In this paper, an attempt is made to identify and analyze climate change short-term and long-term risks in CRE. The authors strongly focus on the need to do risk assessment of climate change risks, and

emphasize on the solution driven approach to mitigate the unforeseen risks in real estate market. In particular, emphasis in this paper is given to develop green buildings for real estate to mitigate and reduce GHG emissions (Pidugu & Velpuri, 2012).

Malaysia:

Climate change is playing a decisive role in Malaysian property business and management, though, not much research has been done to understand the potential impacts of climate change in the Malaysian Real Estate sector (Parkinson, 2009 & Warren, 2010). However, the paper – Possible Impacts of Climate Change on Real Estate sector of Malaysia – has stressed that Malaysian CRE sector is vulnerable to variable climate and related extremes. The authors analyze the current and future knowledge of climate change to understand its possible impacts on real estate sector of Malaysia and aim to help property owners and stakeholders to adopt necessary changes to reduce negative impacts. The study identified rising temperatures, changing precipitation patterns, and increasing frequency and severity of extreme weather events as Malaysia's main climate threats which may pose risk of direct property damage and increase property maintenance cost. Potential indirect business risks may include constraints in water and energy resources, property and insurance price rise, reputational and regulatory risks, and operational failures. To manage these risks, the authors stress on adopting green building technology and building retrofication which will increase the property value and consequently property market (Shahid, Minhans, Muthuveerappan, 2012).

Canada:

A report by KPMG – Climate Change: Risks and Opportunities in the Canadian CRE Market – has identified that climate change is the greatest challenge of our century, and perhaps the old commercial buildings are a major source of both direct and indirect greenhouse gas (GHG) emissions. Direct GHG emissions come from the on-site combustion of fuels for heating and cooling, as well as the on-site use of refrigerants, which are powerful greenhouse gases. Indirect emissions come primarily from the GHGs released from fuel combustion related to producing construction materials and electricity used in the buildings. This will not only cause regulatory/reputational risks for a business, but an old property may get exposed to severe flood damages and other climate impacts. The main challenge for property owners/operators, investors, and tenants will be to improve environmental performance on CRE properties. According to the report, constructing green buildings is an ideal solution. Benefits include easier facility zoning and permitting, reduced tax burdens, and potentially lower insurance premiums. Additional advantage of green buildings is attracting more tenants/workers. The author suggests that the greening of Canadian CRE sector is considered a fundamental change. Real Estate groups that want to attract the best deals must realize this change. This will help them reduce climate risks, while enhancing business opportunities on their CRE properties (Jeffreys, 2009).

United States:

Hurricane Sandy in October 2012 turned out to be one of the most costly natural disasters on record in the United States. The storm swept the New York City (and areas around the city), causing \$19 billion in property damages (Sharp, 2012). CURE (The Center for Urban Real Estate), a research firm at Columbia University in New York, introduced a paper authored by

Jesse M. Keenan which examined the adaptive strategies and capacities of real estate firms in the New York City in the face of climate change and the increased probability of urban flooding. Through a research survey, the paper identified that after Hurricane Sandy an estimated \$950 million of repairs were in CRE properties alone. Interestingly, majority of the repairs were attributable to dry flood proofing and the placement of critical building systems on higher floors. The paper uses a multi-criteria adaptive capacity model built upon an interrelation of awareness, strategy and observed decision space(s), and uses 6 case studies which seek to identify what and how internal and external influences are shaping the actions and strategies of firms to adapt. The article examines the propositions that: (A) firms with observable climate risks have undertaken some adaptive strategies which are principally driven by known and immediate risks to the firms' financial bottom line; (B) firm strategies attribute little to no influence in their decisions to impacts relating to social and environmental impacts; and, (C) firms with the comparatively most robust adaptive capacities will be those who: (i) are most aware of their vulnerabilities; and, (ii) are themselves comparatively more vulnerable to the immediate risks associated with flooding and climate change. With the evidence largely supports the propositions, the results of this research can help shape the development of intelligence and strategic units within firms as they develop a capacity to adapt to ever changing conditions (Keenan, 2015).

Through these studies, it can be said that researchers and CRE individuals around the world have started to understand the need to define climate change vulnerability and adaptive actions in the CRE sector. However at this stage, not many studies have been published directly concerning CRE assets at risk in the context of climate change impacts. Some of the common links between these studies is that CRE businesses increasingly understand that besides focusing

on mitigation efforts to curb greenhouse gas emissions, adaptive measures are also required to be implemented in the CRE sector to reflect impacts of extreme weather events. With the growing scale of activities in the CRE sector, such as building new exquisite properties for developing a country's economy, it becomes increasingly important to understand how the changing pattern of climate change, in particular flooding, impacts on the enhancement of CRE and its economy.

Chapter Summary:

The chapter provided a critical review of the literature on “vulnerability” of many business sectors from climate change impacts. The basic terminologies have been defined and two main types of vulnerability – *direct and indirect vulnerability* – in business sectors have been thoroughly discussed. Literature also stressed on a climate change adaptation framework which is or should be implemented in many business sectors to reduce the impacts of climate change. A growing number of literatures have identified a four-stage climate change adaptation process which can manage the impacts of climate change, including: *Risk Awareness* of the changing risks of climate change, *Risk Assessment* of various direct and indirect risks, and assessing various adaptation measures, *Risk Management* stage where businesses can implement the assessed adaptation measures to manage the climate change impacts, and continuous *Monitoring and Evaluation* of implemented adaptation measures which is important for future adjustments to the adaptation planning process.

Chapter 3: Research Methodology

3.1 Background

This chapter will present and explain the research design and methodology adopted for the research. The rationale behind a robust research philosophy is that research is conducted through appropriate methods that are logical and systematic to the research problem (Creswell, 2003).

The research methodology is divided in two domains of quantitative and qualitative research approaches. These research approaches offer researchers with a choice of adoption between different strategies and methods. According to Creswell, quantitative research methodology consists of rationale for verifiable knowledge, where knowledge is only considered to be reliable when it is constructed on empirical reality (2009). Two methods commonly adopted in quantitative research approach are: experiment and survey methods (Wood, 2015). On the other hand, qualitative research method is regarded as naturalistic, holistic, and inductive in nature (Creswell, 2009). In qualitative research approach, it is imperative to get close to the subjects of study to get their actual viewpoint. Commonly developed methodologies in qualitative research are: case studies, observations and interviews (Wood, 2015).

Every research approach has its own advantages and disadvantages. In order to select a research approach, Creswell suggests that a researcher must assess the phenomenon under investigation, resource, time availability, experience of the researcher and most importantly the research problem (2003, 2009). This research aims towards understanding flood vulnerability in the CRE business sector. In quantitative terms, this indicates understanding the factors affecting commercial property vulnerability with reference to flood risk. The task involves quantifying the

data collected from the real world to understand flood vulnerability in the CRE sector as discussed in the literature review. This research has driven from the onset by the search of measures that can quantitatively represent the risk and perception oriented data related to flood vulnerability. Since the objective of this research is to investigate the *climate-induced flood vulnerability in the Commercial Real Estate sector in Canada*, and based on the research question posed, quantitative research method was used which is more suitable to achieve the objective of this research.

For quantitative instrument selection, the research demanded reaching out to a larger and geographically scattered CRE companies to understand the actual situation on ground i.e., understanding the perception of Canadian CRE companies on climate-induced flooding and their de-risk actions on risk related to flood vulnerability. Therefore, a process through which the participants can openly express their views was necessary.

Quantitative survey methods often use standardized questionnaires to measure perception oriented data such as thoughts, attitudes, feelings and behaviors of the samples drawn from a population (Bulmer, 2004). Surveys are considered one of the popular and one of the fundamental tools for acquiring information on knowledge and perception in natural hazard studies (Bird, 2009). Since this research required understanding perception of samples, survey method was found appropriate for data collection. Various forms of surveys include self-completion of questionnaires by respondents themselves, face to face interviews, and responses via telephone or email (Wood, 2015). For this research, self-completion of survey questionnaires

found to be appropriate due to time and resource constraints and the busy work nature of sample population in hand.

Email surveys are easier for participation. A list of flood affected CRE companies in Canada is not available; therefore, the idea of identifying emails of CRE companies' sustainability/environmental/CSR experts was adopted. Advantages of email surveys are that it can reach to samples of diverse educational, social and economic background regardless of their level of technological literacy. Self-administered email surveys also help to avoid interviewer bias, provides written records from population and is convenient for the respondents to answer.

It is important to understand that most CRE companies differ in terms of their size, number of divisions, person responsible for administering different activities in different management level, and knowledge about the survey questions. According to various natural disaster researchers, these complexities can lead to low response rate, which is not uncommon (Bosher et al., 2007). Researchers have advised to follow-up on regular basis such as sending reminders which allows respondents to perform an informed choice to respond to the questionnaires to increase response rate.

3.2 Survey Instrument

To understand CRE business flood vulnerability and climate change adaptation, 9 sections were identified: Perception of climate change, Flood-plain maps, Flood impacts in the CRE sector, Flooding as a priority risk in the CRE sector, Educating property owners/managers, Adaptation Risk Assessment, Adaptation Risk Management, Building codes, and Incentivizing Risk Reducing Practices. Overall, these sections were picked for the purpose of identifying perception-related data of commercial property holders towards existing flood risk and their

motivation towards implementing adaptation measures on their company assets. Detailed explanation of how these sections identify CRE sector's adaptive capacity is described in the results chapter.

After identifying these 9 sections, a survey instrument was generated. The questionnaire strategy was planned following the University of Waterloo's ethical protocols. The name of the university, department, researcher's and supervisors' name was printed on the survey as well as the contact information of researcher was provided to the survey respondents to seek clarification in case they were in any doubt. A brief outline (purpose) of the research was attached with the survey questionnaire emphasizing the nature of the research. Following the guidelines set by the university's ethics department, respondents were reminded of their confidentiality and anonymity which would be maintained at all times. In addition, time required for filling up the questionnaire was also stated (~10 minutes as determined by taking the average time taken by 5 volunteer participants during pre-testing of the survey). Through these 5 volunteer participants, validity of the survey was also checked to learn lessons and modify the instrument for the full stage survey. Based on the comments and responses of the 5 volunteer participants, some changes were made to the design of the instrument. Main comments were redundancy, length and wording of some of the questions. Changes were made as advised.

A total of 18 statements were finalized that were divided among 9 sections identified. The statements were mostly designed as close-ended statements in order to not allow the respondents to provide unique or unanticipated answers, but rather choose from a list of pre-selected options of Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree, and Don't

Know. Flow of the statements were maintained reasonably well so that the respondents find it easier to answer when they are remembering an old event. Also, extra space was provided after each statement for respondents to express their views if they wanted to provide further comments or information to what is already been indicated.

Once the survey was approved by the university ethics committee, it was administered to 30 Canadian CRE companies. Company information was identified from the REALpac website, which is Canada's most influential company overlooking the CRE property industry in Canada. About 80 companies – mostly private, and few public sector companies – are listed on the website and every company was either emailed or called through telephone to obtain emails of representatives of Sustainability, Environment or Corporate Social Responsibility (CSR) related departments from their companies. Ultimately, only 30 companies responded with the emails of the representatives from the above listed departments. The reason behind this is that not every CRE company in Canada has sustainability or environmental related departments, and the companies that did provide emails of their sustainability representatives are presumably very active on rising environmental issues in Canada, and have therefore appointed a sustainability representative in their respective companies to observe the impacts of environmental risks on their assets. Out of the 30 companies, 18 (60%) completed responses were returned which were usable for analysis. Given that survey response rate for disaster research studies is usually low, the response rate for this survey was marginally good. Out of these 18 CRE companies, 17 companies belonged to the private sector, while 1 company represented the public sector. Out of the 17 private companies, 42% of the companies are characterized by large assets and significant capital investment. The remaining responses were from small and medium sized firms with

relatively fewer CRE operations and small capital investments. Since the survey was made completely voluntary for all the participants, 17% of the sample population did not attempt the survey nor gave any explanation not to participate despite constant efforts made by the researcher through telephone (voicemail) and emails to fill out the survey. 7% of the participants (2 participants) specified no time to fill out the survey due to their busy work schedules, while another 7% of the participants reasoned out that their companies prohibit participating in research surveys. About 10% of the participants explained that they do not have the knowledge or right expertise in their respective companies to answer the questions on this flooding and adaptation subject.

The survey respondents did not entirely differ from the sample population in a discernible way as the affiliations of most respondents in their respective companies matched the target sample population, which were Sustainability, Environment and CSR representatives of CRE companies. From the 18 respondents, 33% of the respondents were Directors Sustainability and 28% of the respondents were Vice Presidents Sustainability of their companies, which shows that most respondents are representatives of Sustainability which was the researcher's target sample population. Other respondents' affiliations in their respective companies include Real Estate Analyst, Director Shared Services and Facilities, Building Sustainability Specialist, VP Property Management, and Design Engineer which indicates that the respondents are senior-most, experienced personnel, who have diverse job backgrounds but are important representatives of sustainability from their companies.

3.3 Data Exploration and Analysis Strategy

Preliminary data exploration and chi-square analysis was undertaken to explore the patterns in the collected survey data and to measure likelihood of the observed (independent) and

the actual (dependent) data. Exploration and understanding the nature of collected data through use of chi-square analysis was employed to determine p-values for the purpose of data significance. In this research, a chi-square of 0.05 was used to measure data significance. The chi-square value in each test was calculated to be less than 0.05, therefore, the researcher was confident in rejecting the possibility that no association exists between the independent and dependent variables and that the observed association occurred by chance less than 5 times in the sample type the researcher used. For the purpose of these analyses, Microsoft Excel 2010 was used. Exploration of data using chi-square analysis was important for understanding the suitability of the data for the purpose of further analysis such as understanding CRE companies' perception regarding flood risk and climate change adaptation measures.

Chapter Summary:

The research design and methodology was discussed in the chapter above. Starting from the analysis needs of this research, the chapter covered a detailed explanation of the rationale and philosophy behind choosing the particular research method. The adopted research method is quantitative in nature. The target population for survey questionnaire administration is the Canadian CRE firms' Sustainability executives with differential flood risk status. The results chapter below will show a detailed exploration of the collected data.

Chapter 4: Results

The previous chapter has outlined the research methodology derived from the research needs. Based on the research design, data was collected and reviewed. This chapter will focus on exploration of the data collected via questionnaire survey. The aim of this results chapter is to access differences of opinions among CRE respondents regarding flood vulnerability and adaptation measures in the CRE sector. The self-administered survey questionnaire was formulated to gather extensive information from the respondents to gain better understanding of the present flood vulnerability situation which could impact Canadian CRE properties. As mentioned above, 18 closed-ended statements were used on the survey that were divided among 9 sections. Responses of the survey participants to these 18 statements are presented below.

Perception of Climate Change

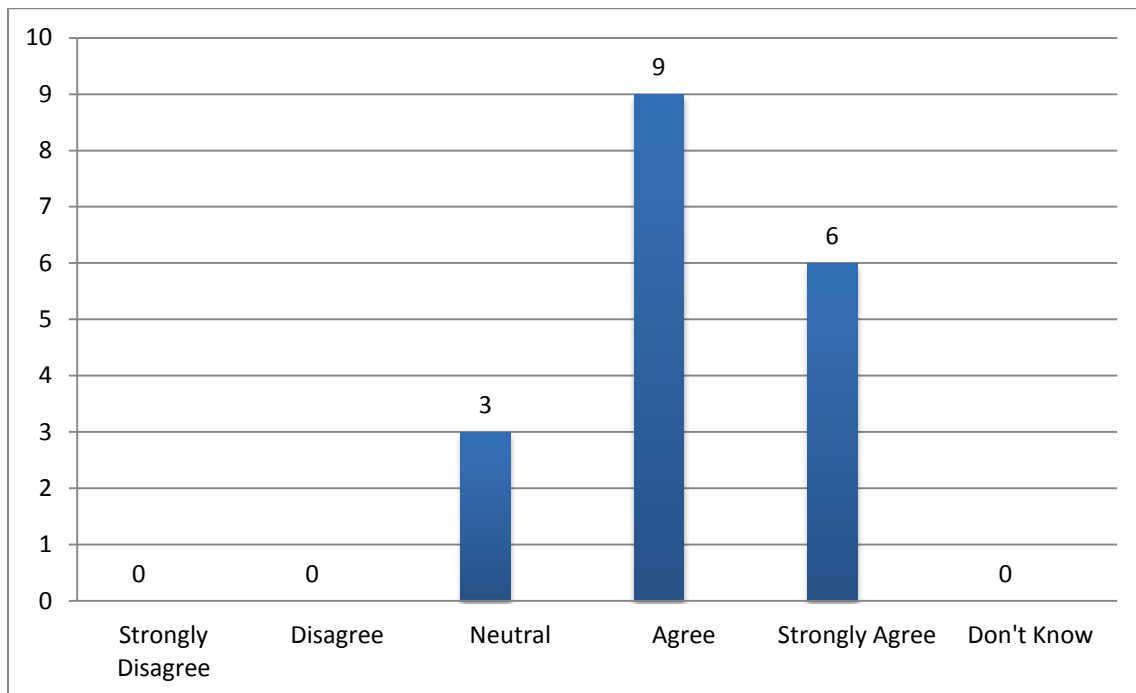


Figure 5: Climate change will cause a material future change in the frequency and magnitude of flooding in Canada.

Climate change has emerged as one of the greatest threats in Canada. Climate change impacts causing extreme weather events, importantly flooding, in Canada are constantly on the

rise and have impacted many business sectors. As we recall, June 2013 floods in Calgary and Toronto turned out to be very costly in terms of commercial property damages and business interruptions (Kane, 2013). From this viewpoint, CRE respondents were asked about their perception of changing climate and flooding in Canada. Figure 5 chart confirm that changing climate represents a serious problem for Canada. It shows that about 50% CRE respondents agree and 33% strongly agree that climate change will increase the frequency and magnitude of flooding in Canada.

Flood-plain Maps

Updated floodplain maps are essential to avoid/reduce impacts of flooding. Floodplain maps incorporate most current data on the water flow, storm tides, rainfall, drainage flooding, snow melting and climate change, and can help to determine property's actual risk. A recent report by The Co-Operators suggested that current floodplain maps are outdated which are not usable to assess increasing flood risk (Feltmate & Thistlethwaite, 2014). To avoid losses in the CRE sector from floods, it is an urgency to develop Canada's floodplain maps as it would address risk of flooding and will be useful for commercial property owners/managers to adequately protect the properties from flood risk, steer development of commercial properties out of a floodplain area or, if a property is permitted to be developed in a floodplain area, determine what adaptation measures need to be put in place to protect the property from future flood events and the property should further not qualify for federal disaster assistance. From this standpoint, CRE respondents were asked for their perception on whether Canadian floodplain maps should be updated to reflect future extremes, which level of government holds responsibility for updating, their perception on potentially prohibiting building of new CRE

properties in recognized floodplains, and if the properties are built, they should not qualify for disaster assistance after a flood event.

Statement 2 (figure 6) chart shows that almost 90% of the respondents believe that Canadian floodplain maps need to be updated to reflect future precipitation and flood events. Statement 3 (figure 7) chart shows that most CRE respondents (56%) believe the Federal government has to take responsibility to coordinate the standards required to harmonize and update floodplain maps, followed by 33% that consider the provincial government and 11% think it should be the role of the municipal government to update the maps. For statement 4 (figure 8) regarding prohibiting development of commercial properties in floodplains, respondents had mixed views. Equally, 28% respondents agree and disagree prohibiting future commercial development in floodplain areas, while 22% were neutral to their opinions. However, 11% respondents strongly agree and 5% strongly disagree to the statement. Similarly, respondents were divided on their views of not receiving federal disaster assistance for a new commercial property built in a floodplain area that can potentially get flooded. It is observed in figure 9 that 33% of the respondents were neutral to the statement; however, 22% of the respondents strongly disagreed and 11% disagreed to the statement. In contrast, 22% respondents agreed in favor of CRE companies not qualifying for disaster assistance if they build new commercial properties in the floodplain areas. Figures 6, 7, 8 & 9 are shown below.

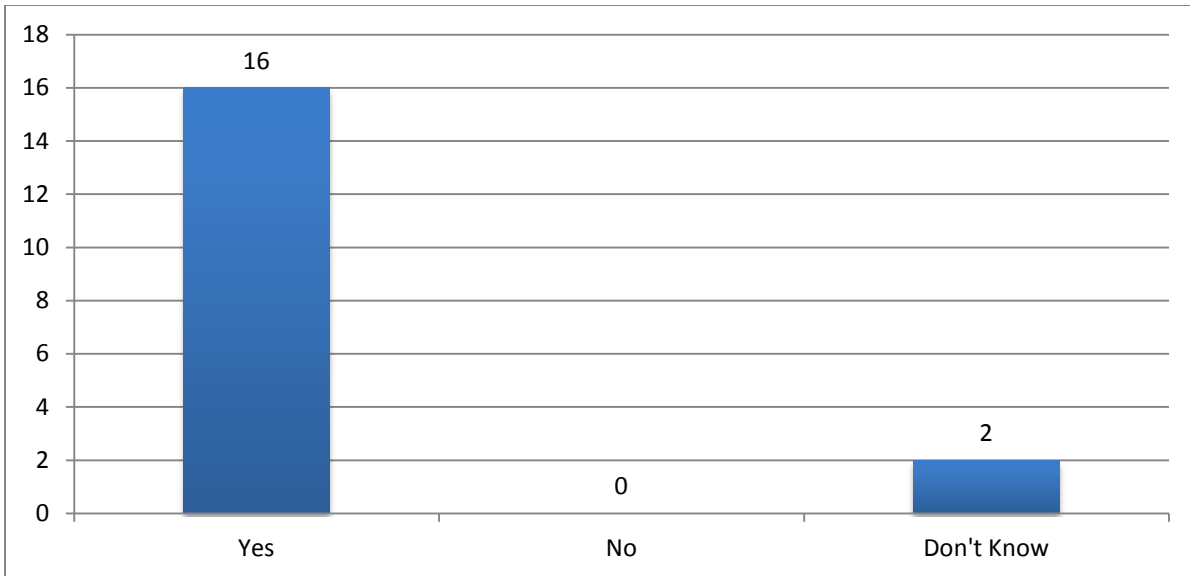


Figure 6: Should flood plain maps be updated to reflect new and future extremes in precipitation?

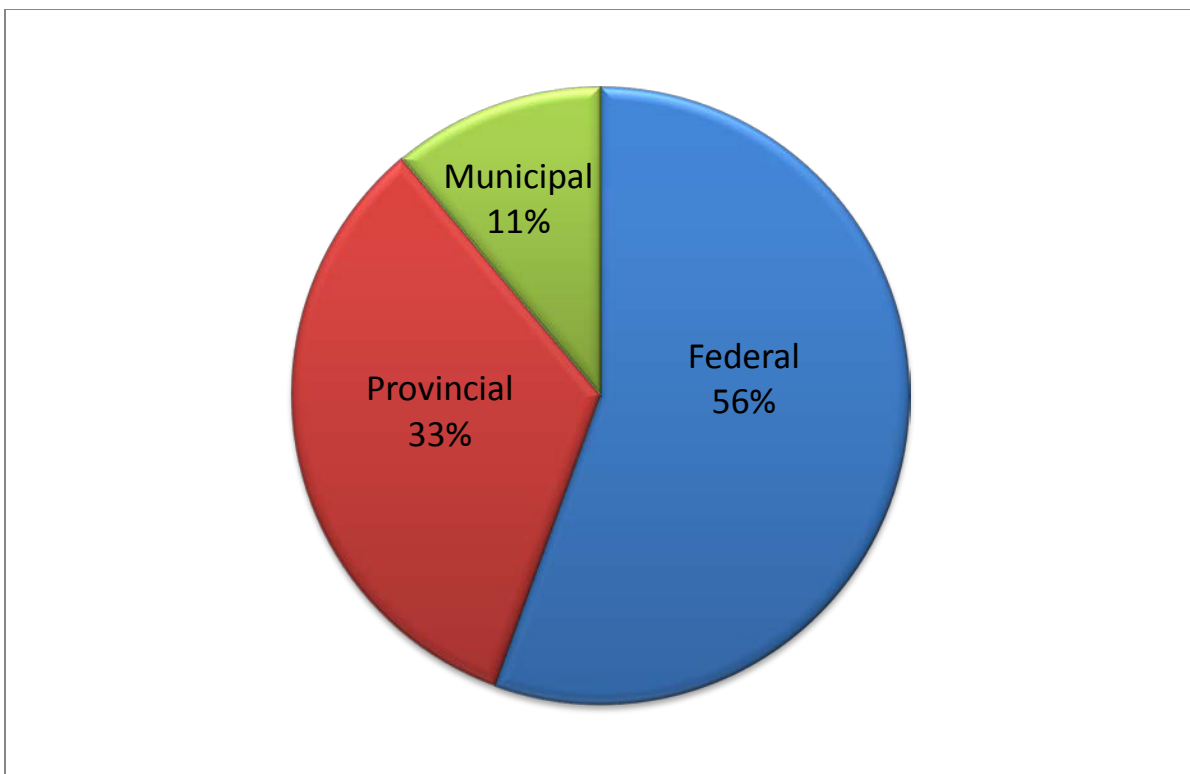


Figure 7: Updated flood plain maps for urban centres should be funded by which level of government

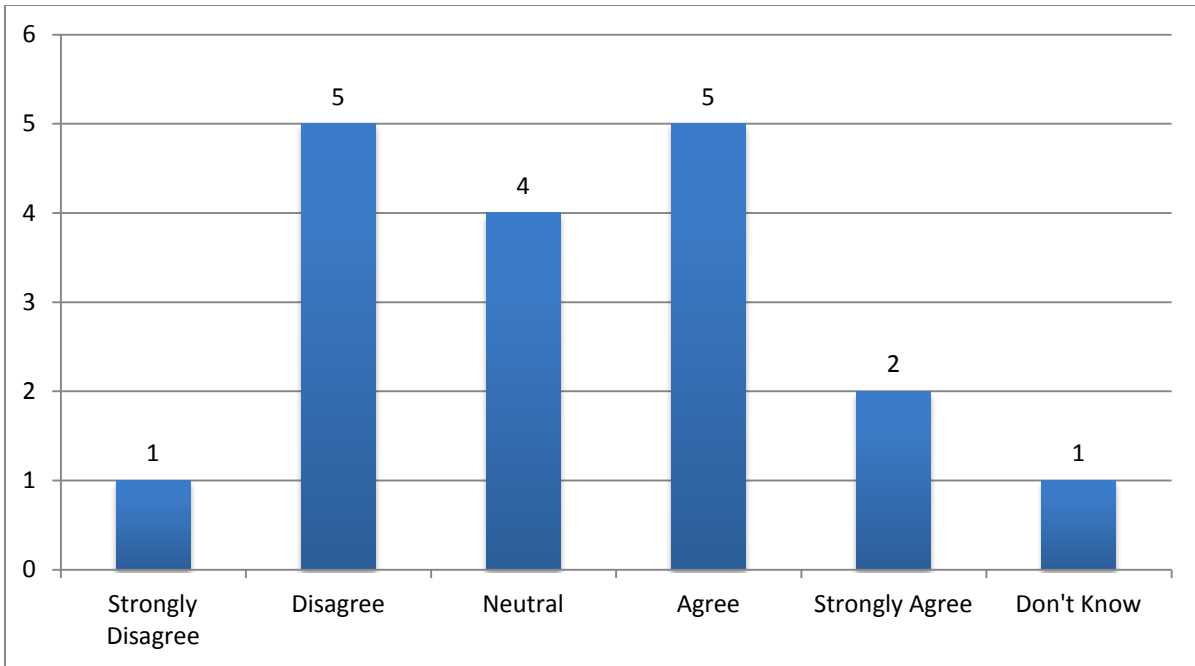


Figure 8: Commercial Real Estate properties should not be built in recognized floodplains.

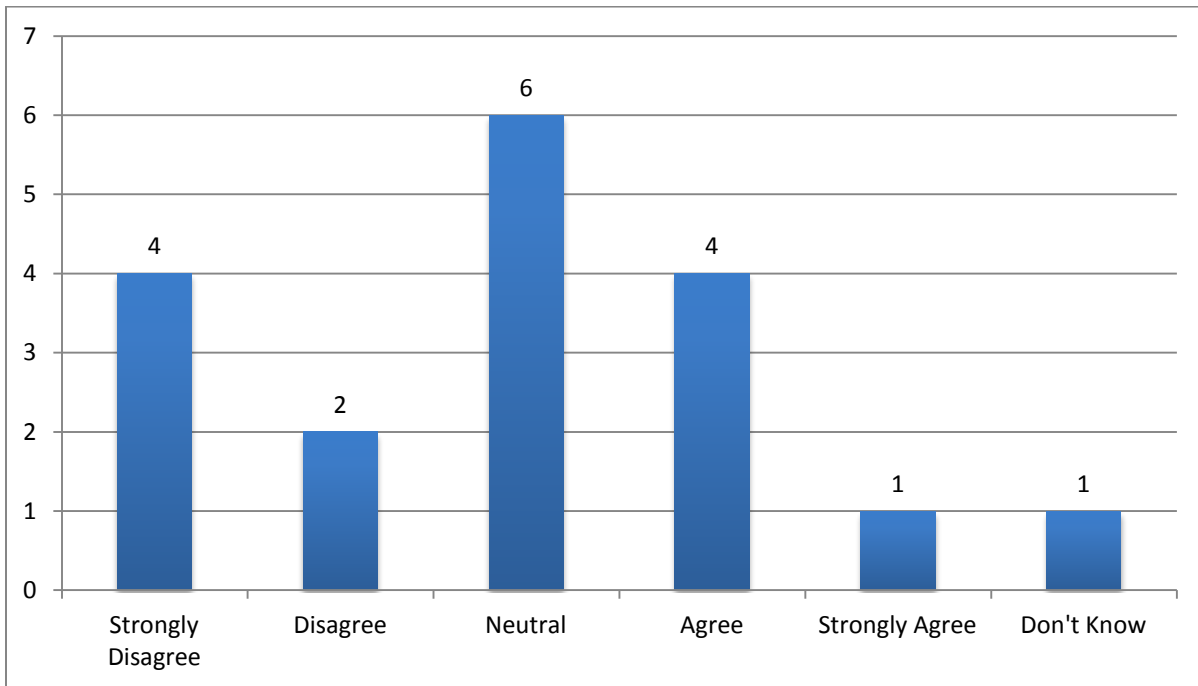


Figure 9: From this point in time onward, new Commercial Real Estate properties built in floodplains should not qualify for disaster assistance.

Flood impacts in the Commercial Real Estate sector

Businesses must understand potential impacts of climate change and flooding on the physicality of the assets, business operations, supply chains etc. As mentioned in the literature above, there are many direct and indirect flood vulnerabilities that can potentially impact the Canadian CRE properties. From this standpoint, CRE respondents were asked if their companies’ understand how flooding may impact the ability of their CRE properties’ to operate. The findings of this statement were concerning as only one-third of the respondents believe their companies’ are aware of the flood risks that can impact their CRE properties’ operations, while two-thirds of the respondents think their companies’ are somewhat aware of the flood risks. Given that there is a rise in the number of flood events in the country, it seems that gaining knowledge on flood impacts – both direct and indirect – is in fact not on the agenda of many Canadian CRE companies, which can prove detrimental in the future for the companies and the Canadian economy. Simultaneously, lack of in-depth knowledge of direct and indirect impacts of floods will deter decision-making on implementing effective adaptation in the sector.

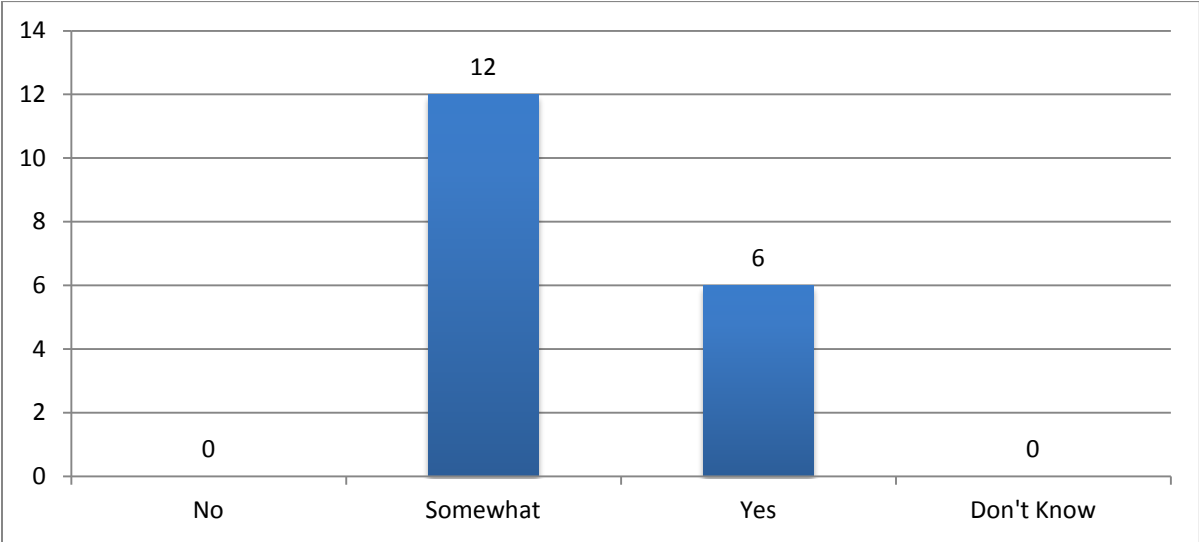


Figure 10: Your company has a firm understanding of how flooding may impact the ability of your Commercial Real Estate properties’ to operate.

Flooding as a priority risk in the Commercial Real Estate sector

As we recall, floods have been the number one reason for significant number of property damages in the past in Canada. Many businesses get affected by it, though, a number of businesses do not consider flooding as a priority risk to prevent/reduce future damages. From this point of view, statements 7, 8 and 9 on the survey were designed that highlight the concern regarding if flooding is considered a priority risk in the CRE sector. Respondents were asked whether their companies' consider incorporating climate-induced flood risk potential into new CRE properties design, whether their companies' disclose/discuss climate change and flood risk issues in the companies' annual reports, and whether their companies' consider flooding as a priority risk when developing or updating their CRE properties' risk assessments and emergency management plans.

The findings of statement 7 (figure 11) show that only 28% of the respondents believe their companies' are incorporating flood risk potential into new CRE property design, while 56% respondents mentioned their companies' sometimes incorporate flood risk potential and 1 respondent thinks his/her company has never incorporated flood risk potential into new CRE property design. Surprisingly, 11% (2 respondents) do not know any information regarding this statement. The findings of statement 8 (figure 12) regarding CRE companies discussing/disclosing climate change and flood risk issues in annual reports are more confounding. 28% respondents believe their companies' always report climate change and flood risk issues in annual reports, while 28% also think their companies' sometimes report these issues. On the other hand, 22% respondents mentioned their companies' have never reported such issues and 22% also do not possess any knowledge regarding their companies' reporting

climate change and flood risk issues in annual reports. Statement 9 (figure 13) findings were inclined towards good areas as almost 44% respondents believe their companies' always and 44% also believe their companies' sometimes consider flooding as a priority risk when developing or updating their CRE properties' risk assessments and emergency management plans. 2 respondents have no knowledge regarding this concern. Figures 11, 12 & 13 are shown below.

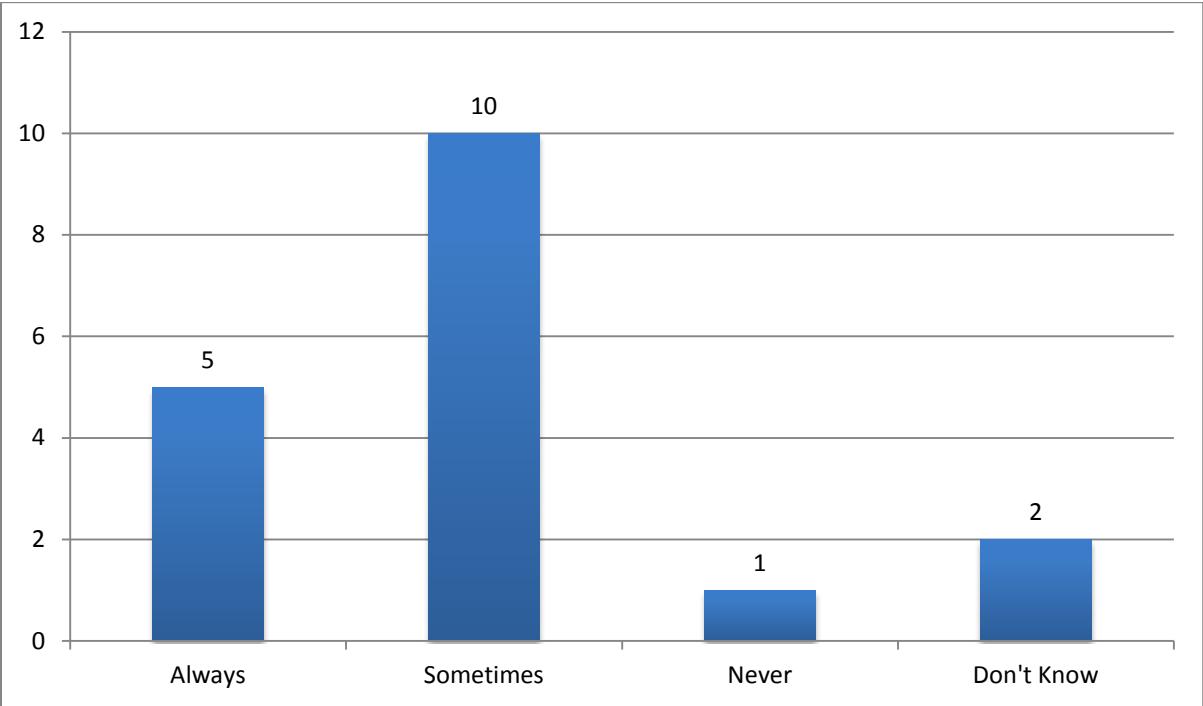


Figure 11: Your company incorporates flood risk potential into new Commercial Real Estate property design.

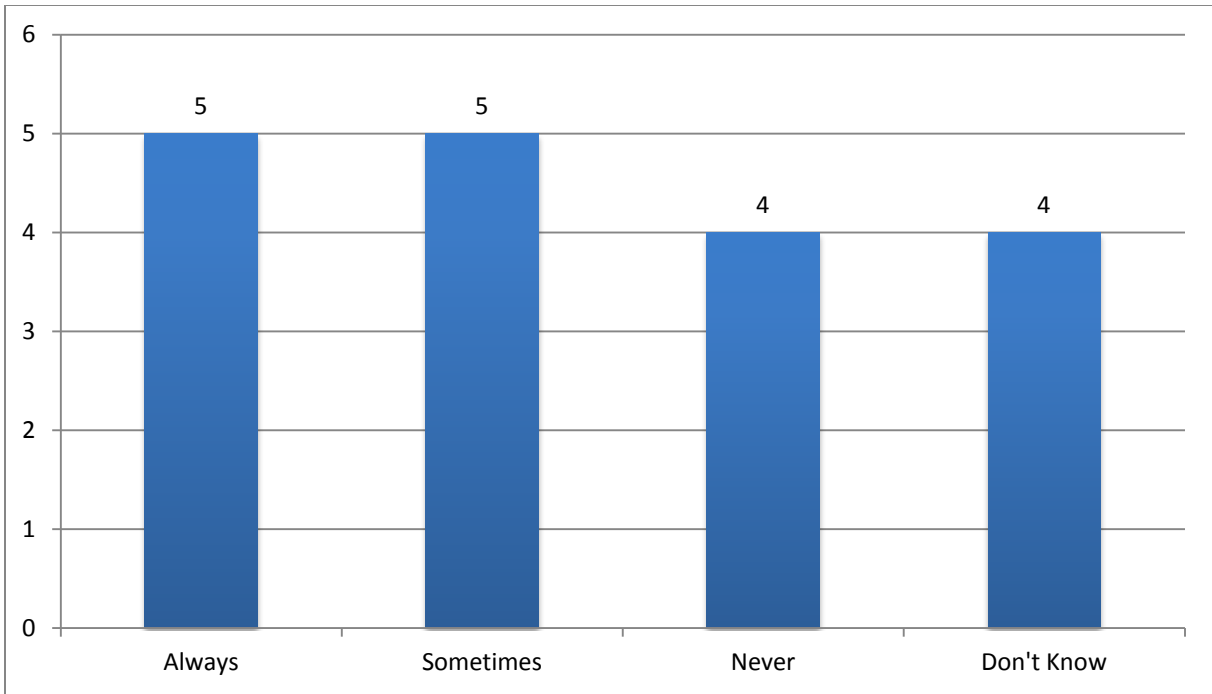


Figure 12: Your company discloses/discusses climate change and flood risk issues in your company's annual reports.

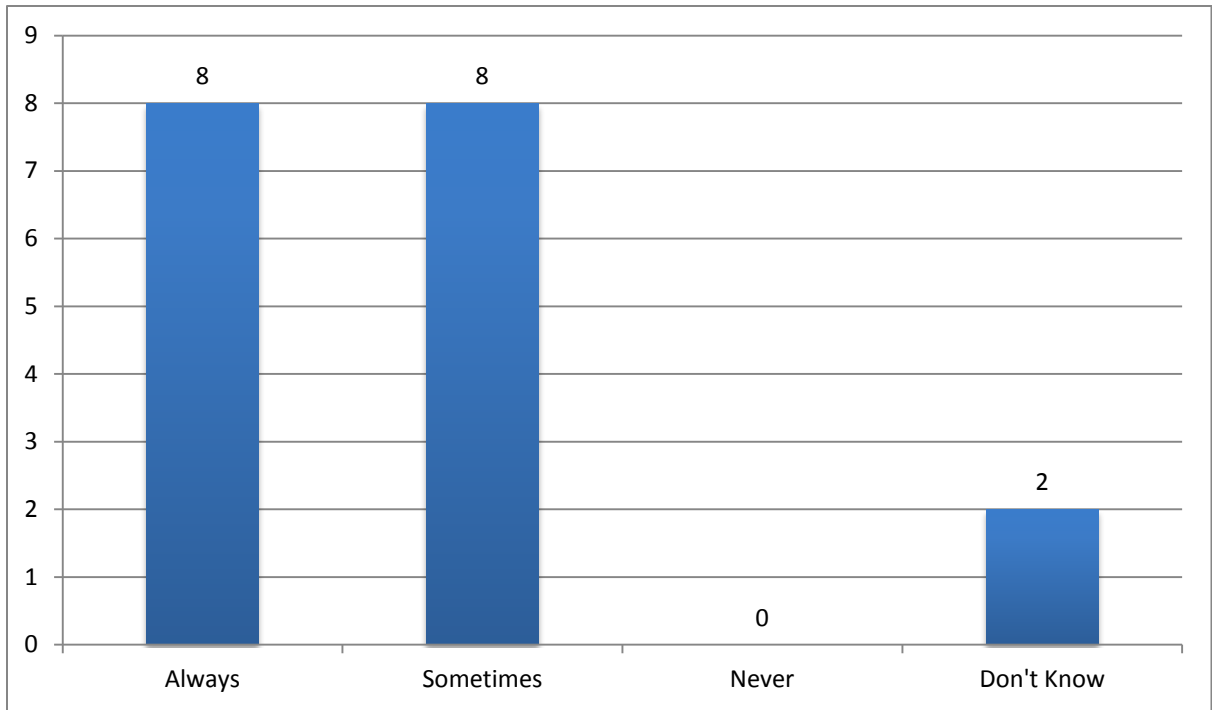


Figure 13: Your company considers flooding as a priority risk when developing or updating your company's Commercial Real Estate properties' risk assessments and emergency management plans.

Educating property owners/managers

Education on any particular issue is an important first step to prevent/reduce consequences. Education, through risk awareness methods, on how impacts of flooding can affect CRE properties is a first step to advance adaptation to climate change (Business Primer, 2012). Education, on changing climate and future flood risk scenarios, is an indicator for CRE owners/managers to be aware of the climate issues happening now and in the future. From this viewpoint, statements 10 and 11 were designed to analyze perception of CRE respondents in regards to a national campaign which should be launched to educate CRE owners/managers to lower the probability of flooding from negatively impacting their companies' properties, as well as which government or industry should hold responsibility to support this campaign. Overall, the findings reveal support for research on flood risk awareness methods that can help CRE property owners/managers reduce flood damage to their company's properties, and an organized campaign should be launched to deliver such information. Statement 10 (figure 14) findings saw 83% respondents agreeing to this idea which show that CRE officials are keen to get educated on risk of flooding through a proposed national campaign, while 1 respondent each were neutral, disagreed or do not know about the need of this campaign. In regards to statement 11 (figure 15), respondents were divided on who should support this campaign. 44% respondents each see Insurance Industry or Federal Government as the potential leaders to support this campaign, while 6% respondents each were in favor of Provincial Government or Builders.

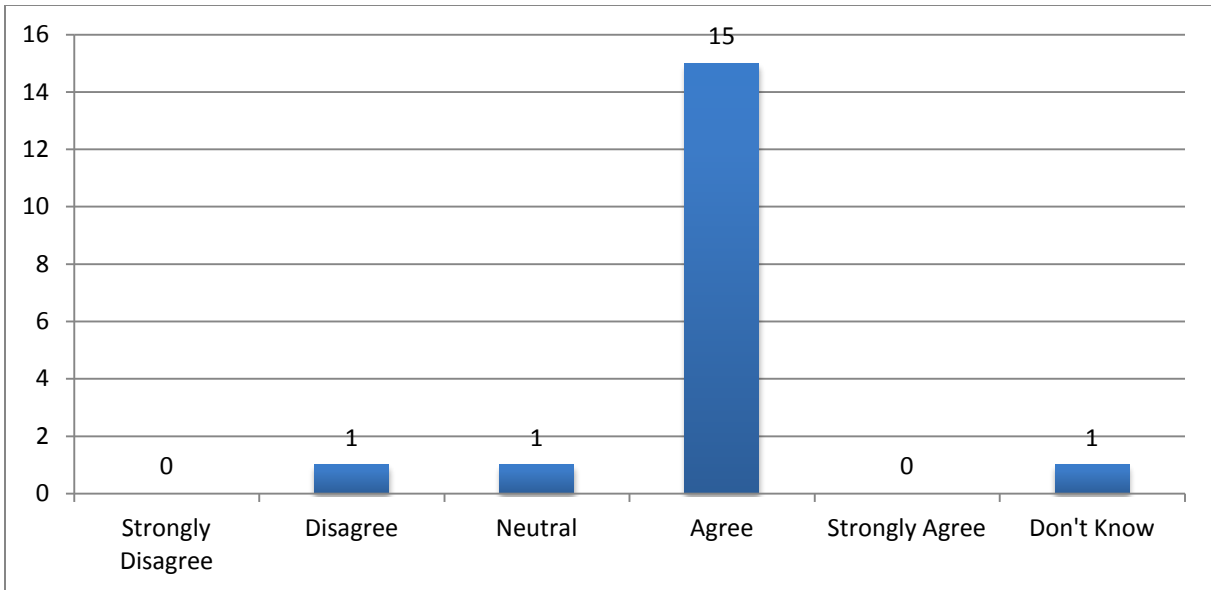


Figure 14: A national campaign to educate Commercial Real Estate owners/managers to lower the probability of flooding from negatively impacting their company's properties should be launched.

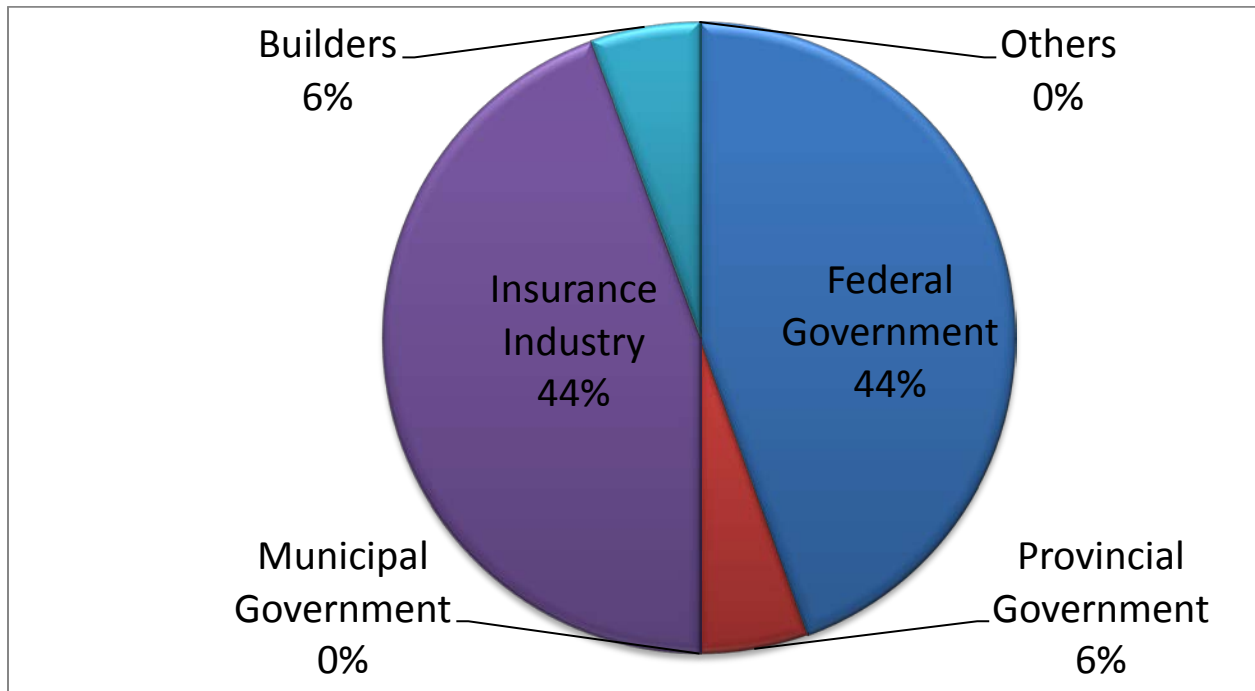


Figure 15: Responsibility to support a national campaign to educate Commercial Real Estate owners/managers to lower the probability of flooding from negatively impacting their company's properties should reside with which body

Adaptation Risk Assessment

Risk assessment is the second step to advance adaptation to climate change. As mentioned above, this is a very important process which requires companies to assess and prioritize potential flood risks that impact their CRE properties the most. In addition, this process also requires assessment of adaptation strategies to manage those risks (Thistlethwaite & Feltmate, 2014). From this standpoint, statements 12 and 13 were designed to analyze perception of CRE respondents if they believe a national audit should be undertaken to assess the preparedness of CRE properties in reference to flood potential, as well as which government should fund this assessment. As is evident based on figure 16, support for a national assessment of the flood preparedness of CRE properties was substantial as 56% CRE respondents are in favor of this assessment, while 17% (3 respondents) each were neutral or disagreed to this national assessment. Two respondents do not know if this national assessment is required. Nonetheless, the findings of statement 13 (figure 17) show that 61% respondents believe that the federal government is ideal to fund this type of assessment, while 22% respondents think the funding should come from the provincial government. 17% respondents chose not to answer.

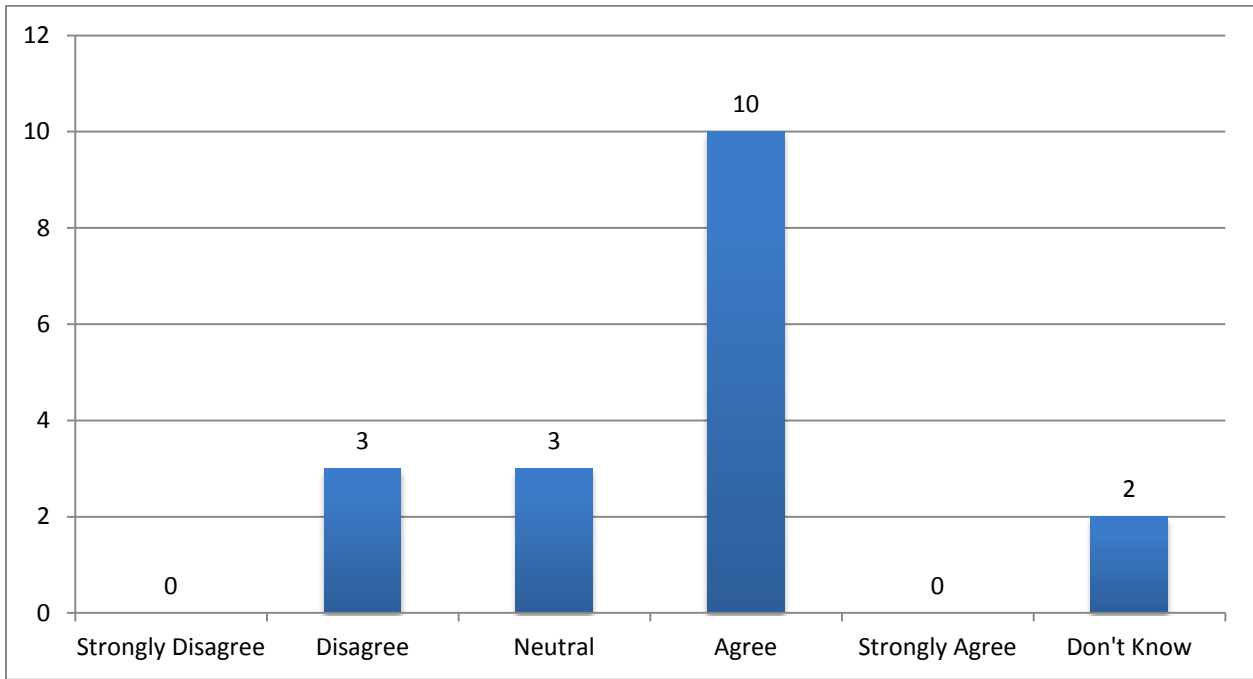


Figure 16: A national audit to assess the preparedness of Commercial Real Estate properties in reference to flood potential should be undertaken.

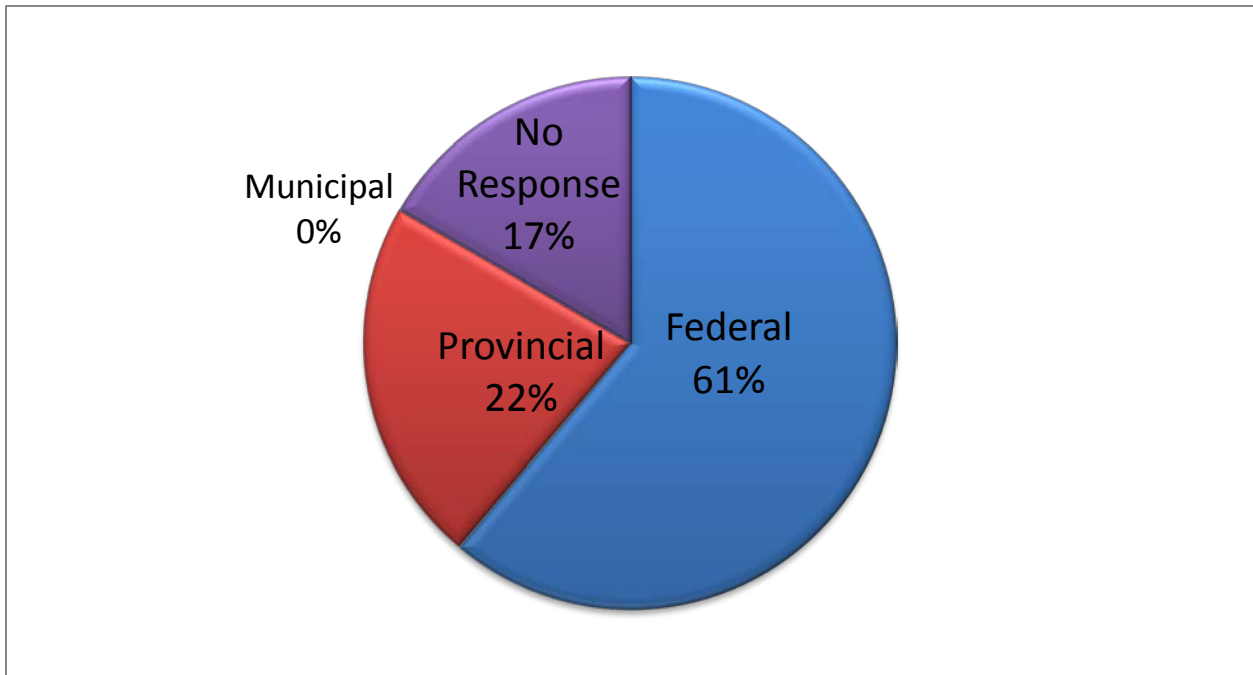


Figure 17: A national audit to assess the preparedness of Commercial Real Estate properties in reference to flood potential should be funded by which level of government

Adaptation Risk Management

After analyzing the perception of CRE respondents on risk awareness and risk assessment processes (Figures 14-17), statements 14 and 15 on the survey were intended to see if Canadian CRE companies have implemented risk management adaptation strategies, or have implemented any other means to de-risk their CRE properties from flooding. As we recall, risk management is the most integral and potentially the most difficult process to advance adaptation to climate change. After potential risks and adaptation strategies are prioritized in the risk assessment phase, companies must implement those adaptation strategies to reduce flood impacts (Thistlethwaite & Feltmate, 2014).

As shown on Figure 18, 33% respondents mentioned their companies' have implemented some means to de-risk their CRE properties' from flooding, while 55% believe their companies' are somewhat in the process of implementing. One respondent stated his/her company has not implemented any means and another respondent do not know about this information. When asked if the companies have implemented any adaptation initiatives to de-risk flood risk potential which may impact the CRE properties' operations, figure 19 shows that only 17% (3 respondents) have stated yes, whereas two respondents mentioned their companies' have not implemented any adaptation initiatives and another two respondents do not have any knowledge on this information. About 61% respondents felt their companies' have somewhat implemented adaptation strategies to de-risk flood potential which may impact their CRE properties' operations.

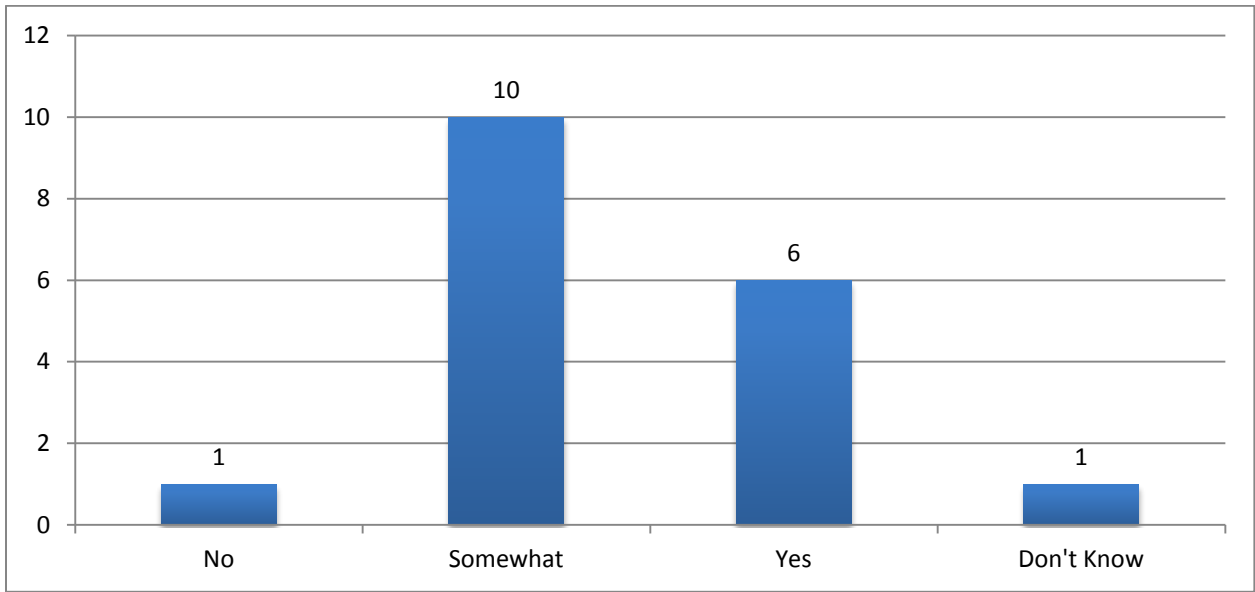


Figure 18: Your company has implemented means to de-risk your Commercial Real Estate properties from flooding

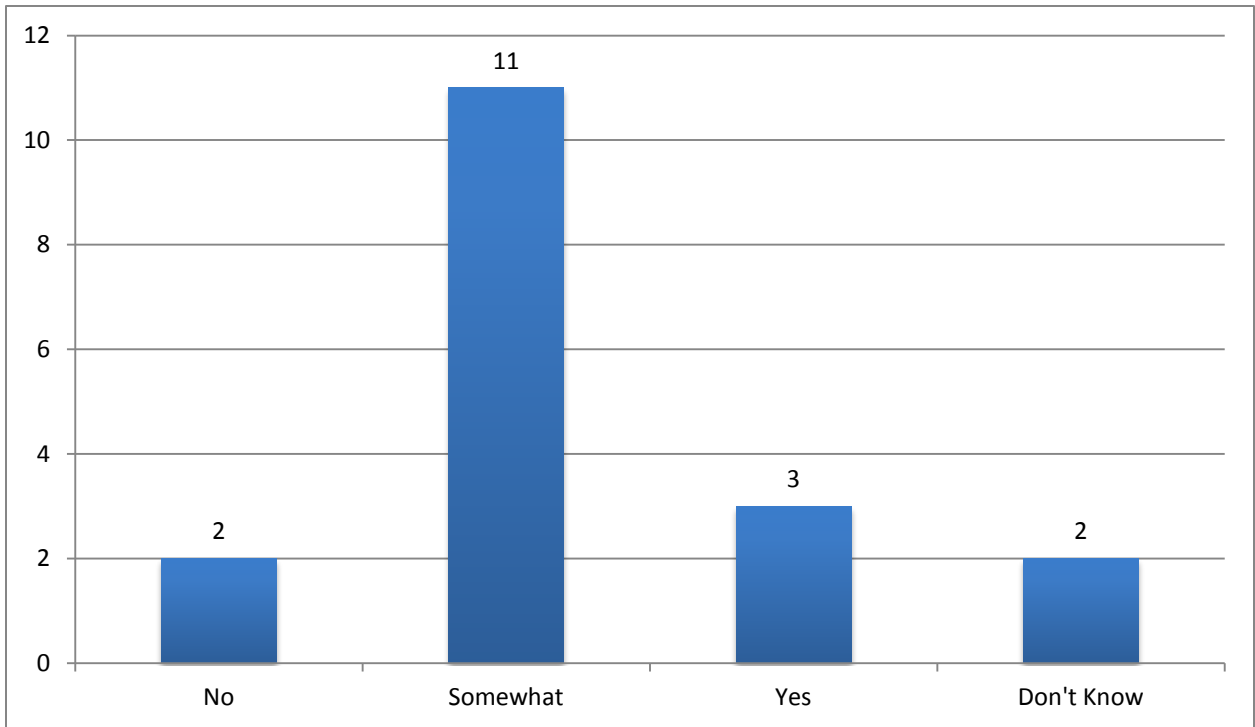


Figure 19: Your company has implemented adaptation initiatives to de-risk flood risk potential that may impact your Commercial Real Estate properties' operations.

Building Code

Building Codes have become an integral part of the building system in Canada. As climate change becomes an increasing threat, building codes are becoming stricter in regards to the impacts of the extreme weather events. Ultimately, building codes are the key to keeping the occupants in the buildings in our communities as safe as possible. Similarly, CRE building system has to adapt to the changing building codes, especially codes relative to the current and future flood-related conditions, to keep the building tenants and workers as safe as possible and to avoid any regulatory charges. From this viewpoint, CRE respondents were asked for their opinions on a National Building Code review which should be engaged in the CRE sector to identify inadequacies of the code relative to flood-related conditions. Besides, this review will address the M&E process of a climate change adaptation framework where a review of codes (resilient designs) through data collection and evaluation will identify the effectiveness of current codes or resilient designs relative to current and future flood related conditions. Figure 20 shows that 61% respondents agree this review should be proposed in the CRE sector, while 22% respondents are neutral to this review. However, one respondent disagree and another respondent strongly disagree to the building code review in the CRE sector. One respondent chose not to respond to this information.

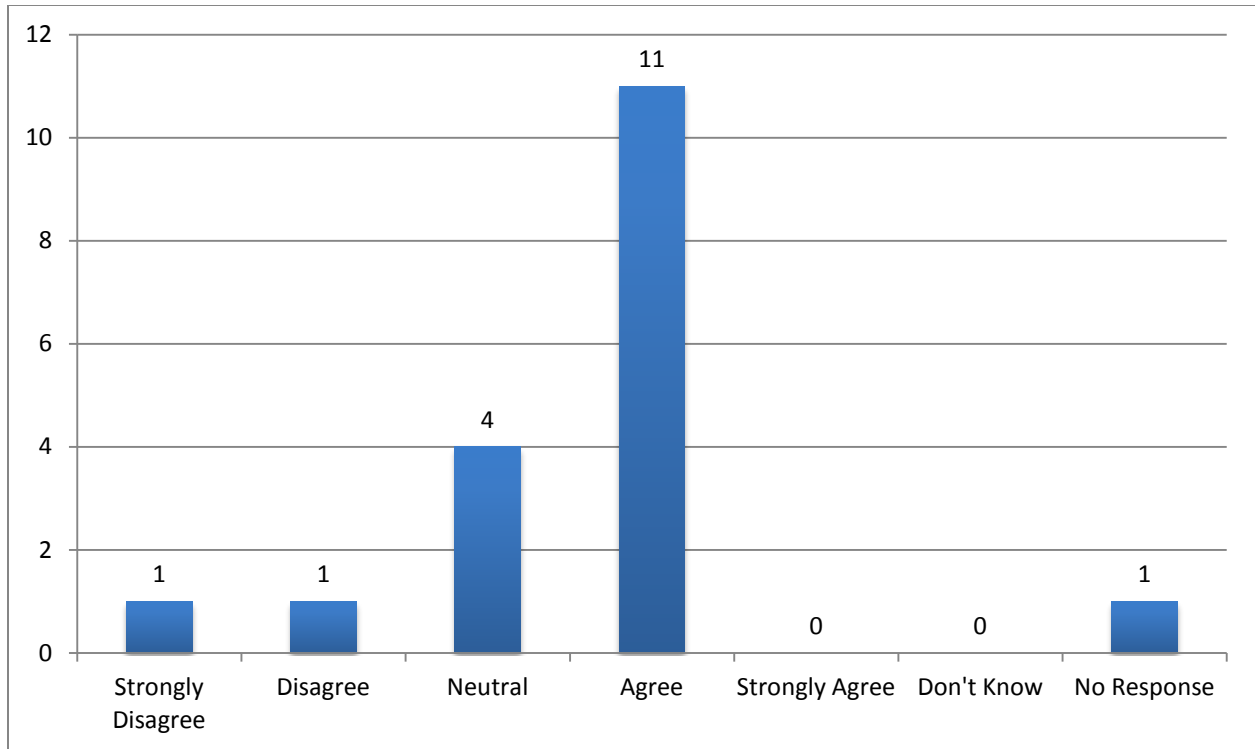


Figure 20: A review of the National Building Code for Commercial Real Estate should be engaged to identify inadequacies of the code relative to flood-related conditions.

Incentivizing Risk Reducing Practices

The last two statements on the survey were designed to analyze perception of CRE respondents over the influence of insurance industry and banking services to incentivise risk-reducing efforts amongst CRE property owners/managers. As is evident on Figure 21, there was a strong support from CRE respondents that Property and Casualty (P&C) insurers should recognize (by means of risk adjusted insurance premiums, lower deductibles, subsidies for installation of risk reducing technologies) the material efforts of CRE companies to de-risk properties relative to flood. About half of the respondents agree and 22% respondents strongly agree to the proposition. Two respondents are neutral to their opinions, while one respondent do not know if this proposition should be put forward. Two respondents chose not to respond.

On the other hand, statement 18 asked the respondents if they believe banks and credit unions should take potential flood vulnerability of CRE properties into consideration when a property inspection is being held. Figure 22 shows another strong support as 61% respondents agree to the above statement while 2 respondents strongly agree. Two respondents are neutral, however, 16% respondents (3 respondents) do not know if flood vulnerability should be considered by banks and credit unions during property inspections.

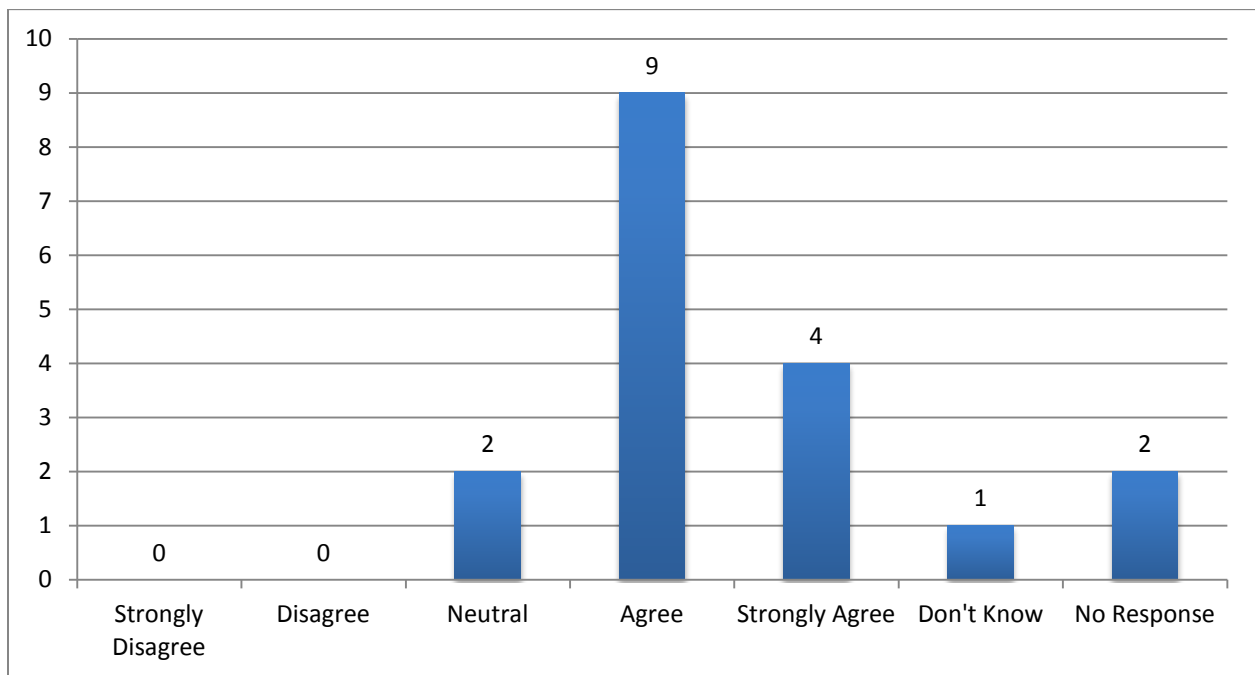


Figure 21: Property and Casualty (P&C) insurers should recognize (by means of risk adjusted insurance premiums, lower deductibles, subsidies for installation of risk reducing technology, etc.) the material efforts of Commercial Real Estate companies to de-risk properties relative to flood.

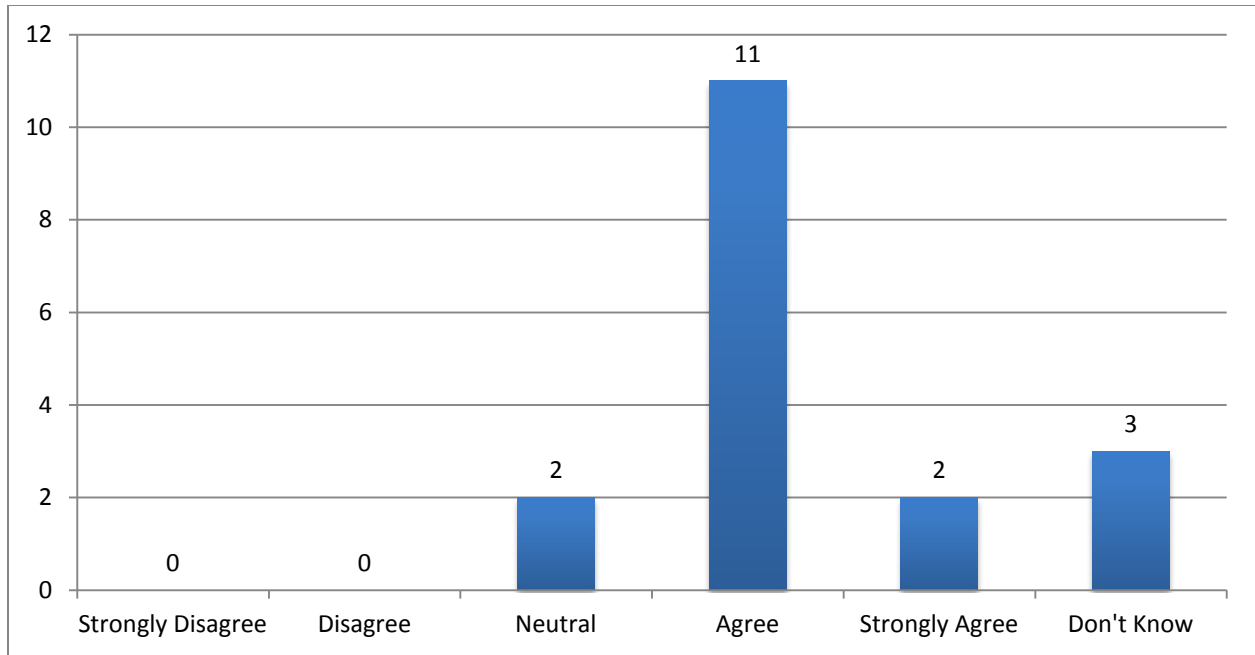


Figure 22: When issuing mortgages, banks and credit unions should require that the vulnerability of Commercial Real Estate properties to flooding be incorporated into a property inspection.

Chapter 5: Discussion

Having explored and analyzed the collected survey data through charts, this section discusses the key findings by incorporating the empirical exploration of the results section to demonstrate the perception of the CRE sector towards flood vulnerability, and the perception towards de-risking potential flood impacts through climate change adaptation. The main thesis question this research poses is if Canadian CRE companies are motivated to adopt a climate change adaptation framework in their commercial properties in the wake of the rising number of flood events in the country. This discussion chapter answers the thesis question through key findings justifying that the lack of a perception of Canadian CRE companies towards flood vulnerability plays a significant factor in their lack of motivation towards adopting a climate change adaptation framework to de-risk their commercial properties from flooding. Companies are somewhat motivated – perhaps because of the federal government’s and the insurance industry’s potential funding initiatives – to implement risk awareness and risk assessment processes, but are not extensively motivated to implement risk management process to comprehensively de-risk potential impacts of flooding in their commercial properties.

This approach of discussion on flood vulnerability in the CRE sector is expected to have significance for CRE owners/managers, allowing them to analyse the present flood vulnerability situation which can potentially impact their CRE properties, as well as it will motivate policy and other decision makers within the CRE companies to make appropriate adaptation choices in reducing flood vulnerability on the commercial properties. In addition, it will be helpful for the scientific community who will not only understand how the CRE sector is vulnerable from impacts of flooding, but it will also motivate them to study this much neglected sector from other

climate change impacts as well, and that a climate friendly and sustainable CRE sector can both preserve and increase commercial asset value.

The discussion section below is divided into two parts – first part discusses CRE companies’ perception towards understanding the risk of flooding and climate change in their CRE properties and second part discusses CRE companies’ motivation towards implementing a climate change adaptation framework to de-risk flooding on their CRE properties. Discussion on the survey data key findings are discussed below in detail.

1) Perception of Canadian CRE companies towards recognizing the risk of flooding and climate change:

Companies widely acknowledge climate change and the rise of flood events in Canada, but overlook the significance of understanding potential business impacts caused by flooding. It is apparent from statement 1 findings that many CRE companies strongly agree on changing climate which will likely cause bigger/more frequent severe weather events in Canada leading to many more flood events. This can be verified to the Canadian Natural Resources research study where much of the research suggests that the most significant climate change challenges would result from increases in the frequency and intensity of extreme climate events, such as floods and storms (Canadian Natural Resources, 2008). Furthermore, it will have a substantial affect on many Canadian economic sectors such as mining, transportation, real estate, buildings, marine and water management infrastructure. Collectively, substantial economic costs from the weather related hazards to the Canadian businesses are only expected to increase in the future due to the expected increase of extreme weather events. Such concern represents an important opportunity

for Canadian CRE businesses to establish a coordination and leadership role in implementing preparedness measures that reduce risk and improve resiliency on the commercial properties.

On the other hand, the majority of the companies stated that they either somewhat know, or do not know, of the flood impacts (direct and indirect) which may potentially disrupt their commercial properties' business operations (statement 6). This signifies that despite most CRE companies acknowledging a changing climate and an increase in the frequency and intensity of flooding events in Canada, companies generally lack a perception regarding potential flood risks which may impact their commercial properties. Some of the direct and indirect risks are described below.

Direct vulnerability: Physical Damage

Direct vulnerability relates to physical damage and limited access to CRE assets during a flood. CRE businesses with large fixed assets like many properties, equipment, furnishings, and large inventories, intermediate and finished products are more vulnerable to direct physical damage. Damage to infrastructures, buildings, loss of stocks due to lack of mobility are effects of direct vulnerability and can be very costly (Zhang, Lindell & Prater, 2009). Extensive study on flooding indicate how through different processes like water forces, pressure, energy transfers, and consequences of contaminant water have impact on damage potential (Kelman & Spence, 2004). For instance, heavy rainfall in the Alberta foothills in 2013 led to unprecedented flooding throughout Calgary that shut down many CRE buildings in the core for weeks because of physical damages (Thistlethwaite & Feltmate, 2014). BMO (Bank of Montreal) predicted that the cost of physical damages to the properties was between \$3-billion and \$5-billion (Babad, 2013).

Direct vulnerability: Geographic Location:

In the context of changing climate and intense flooding, the geographic location of a CRE property is also an important risk factor. Location is an important factor in determining exposure to flood risk and land changes that could affect building stability (Thistlethwaite & Feltmate, 2014). CRE properties located in floodplains are particularly exposed to flood risks during heavy rainfall and storms. Most CRE buildings use basements to keep important building maintenance and operations infrastructure, such as electrical and hydro systems. As a consequence, flooding of basements and ground floors can significantly disrupt the building's capacity to maintain a habitable business environment for many workers (such as no power or water supply) (Gheciu, 2013). For example, Hurricane Sandy resulted in flooding and power cuts in many commercial properties in New Jersey and New York City, leaving many offices inoperable for several months (Dwyer, 2012).

A business's exposure to direct physical damage during a flood event could more or less show the total vulnerability cause. When a business suffers from various physical damages, such as structural, non-structural, furnishings, inventories and equipments, it can be directly correlated to total loss suffered by that business (Chang & Falit-Baiamonte, 2002). For CRE business, direct damage is one of the many factors that influence loss of business during a flood event. These damages and losses can disrupt network and social activities, which can further cause indirect losses. In fact, indirect losses occur from direct losses, therefore, even if a business escapes direct damage it may be forced to close as result of indirect impacts such as disruption of

supply chain, access problems from customers and employees and so on (Tierney, 2007). Next section describes various forms of indirect vulnerability of floods in the CRE sector.

Indirect vulnerability: Business Interruption

Business interruption costs, as a result of flooding, are often more notable than direct damages. Business continuity is generally expressed through consistent performance of supply chain through various primary and secondary activities (Zhang, Lindell & Prater, 2009). Supply chain in CRE sector includes products and processes such as suppliers, producers and consumers within the market. The efficiency of well managed business often lies in this tightly integrated structure. Sometimes failure of one element of structure can cause further indirect consequences on the continuity of business. In other words, flooding may cause a ripple effect on production operations of a CRE business that could have a multiplier effect on other operations which are directly related to that business (Zhang, Lindell & Prater, 2009). This is considered an indirect impact of flooding that might imbalance the dynamic equilibrium of the market even when not under direct impact of flooding.

Moreover, CRE sector is also prone to interruptions to power supply, water, telecommunication after flooding that causes indirect effects as they disrupt business continuity enhancing vulnerability. In the U.S., power outages caused by flood disasters represent the number one source of business interruptions and annually cost as much as \$164 billion for affected firms (Mills, 2012). Without electricity, CRE properties cannot maintain most of the services. For example, elevator systems are often costly to restart after an electricity disruption. It has been reported that even two months after Hurricane Sandy disrupted power to many CRE buildings in Manhattan, 15-18 million square feet of space remained unusable (Dwyer, 2012).

Indirect vulnerability: Business Accessibility Problems

Disruption in the accessibility to CRE properties is another issue affecting indirect vulnerability. For instance, damage to roads and other transport links from flooding can delay crucial CRE business mobility and keep businesses from recovering soon. For instance, massive flooding during the June 2013 floods in parts of Alberta damaged pipelines and disrupted rail transport, which affected the oil and gas industry, a significant player in the province's economy. Many other businesses such as retail, manufacturing, wholesale, rail and utility also suffered huge economic losses because the transport supply lines were snarled by floods (Bracey, 2016). Industrial operations are also exposed to significant supply-chain risk as a consequence of flooding disruption to transportation networks. In 2011, flooding in Bangkok, Thailand damaged warehouses that stored computer hard drives and automotive parts vital to the supply-chains of companies including Toyota, Honda and Intel. The disruption contributed to quarterly losses for these companies (Freedman, 2011). It is possible that CRE, finance and insurance sectors can let their employees work remotely with flexible hours during flood disaster recovery phase; however sectors such as manufacturing and construction are helpless in such situations as sometimes they are hit hard because of damages to the roads and other transport links, which are crucial for their businesses mobility.

Indirect vulnerability: Lost Customer Connections

In addition, CRE properties that get flooded and shut down for extended times can lose its customers for business which can contribute to another indirect vulnerability. Smith & Wyatt explained it as the casualty or relocation from the affected area destroying the existing customer

base (1996). Flood affected businesses in many areas lose many days of revenue, which is dependent on customers coming to the commercial properties. Consequently, this would have greater impact on small businesses like wholesale and retail firms compared to large enterprises who have great customer connections (Alesch, Holly & Nagy, 2001). For instance after 2013 Alberta floods, many Calgary restaurants and retail stores lost out on customers as the commercial properties were flooded as well as people stayed home or cancelled their leisure plans to repair and renovate their own flooded properties. For the most part, people in Calgary were not spending in the commercial properties as broadly as they were typically. To sum up, the flood disaster created a shift in where customers were spending their money, and the largest impacts were felt by CRE businesses in flood affected areas (Legge, 2014).

Indirect vulnerability: Financial Reputational Risks

As the impacts of flood on CRE properties become more outwardly evident, it is imperative that property owners/managers stay at the forefront of knowledge and actions that promote adaptation (Thistlethwaite & Feltmate, 2014). According to Institutional Investors Group on Climate Change (IIGCC), property investors recognize the importance of sustainable measures that reduce costs associated with building depreciation costs, tenant retention costs and operating costs (IIGCC, 2013). However if the measures are not recognized, reputational risks could increase for portfolios as a consequence of both physical and regulatory impacts. Portfolio managers are exposed to reputational risks among shareholders if return-on-investment (ROI) is negatively impacted by the failure to address climate change associated risks (Berridge & Cook, 2009). For instance, portfolios that are exposed to properties in locations that consistently

experience flooding will generate lower ROI from damage incurred costs, faster asset depreciation rates, or higher insurance costs.

Indirect vulnerability: Financial Regulatory Risks

In addition, regulatory risks could increase that enhances indirect vulnerability. Regulatory risk could emerge through policies that create costs for CRE building owners by requiring improvements in building design (Thistlethwaite & Feltmate, 2014). Regulations can also involve land-use requirements that will likely limit property development in areas exposed to flood risks, such as along coastlines, land located near or in flood plains (Steenhof, 2008). If property owners/managers do not comply with the regulations in the changing flood risk, heavy fines and legal action can be held against the shareholders of the property for damages or costs linked with flood impacts (Mills, 2012).

Indirect vulnerability: Financial Value Loss

The value of CRE properties is a reflection of performance of property, for example higher growth and better return in prime locations of properties have a tendency to generate higher value (Fuerest & McAllister 2009). Property value is judged by the services and facilities it provides to its occupiers. Flood disasters affect property value. Property damage, increased investments in restoration, more stringent regulations, and higher insurance and operating costs reduce revenue and profit margins, which in turn lower the value of a property. This will also lead to higher rental and lease rates, which will decrease tenant/employee retention rate. Portfolio performance will also be affected by properties whose value depreciates at a faster rate (Thistlethwaite & Feltmate, 2014). Research has shown that responses of relevant stakeholders

towards taking up adaptation measures to protect properties from being vulnerable to floods can affect level of vulnerability and hence property value (IIGCC, 2013). Consequently, this will push CRE firm stakeholders and tenants to those properties that are resilient to flood impacts.

Indirect vulnerability: Higher Insurance Rates

Insurance rates for CRE properties will likely increase given that damage from previous floods have been enormous, which will be a stress for many property owners/managers. As mentioned above, 2013 Alberta flooding was catastrophic for many CRE and other business properties. Commercial losses accounted for the majority of the damage that Canadian insurers had to pay for severe flooding where the storm put office buildings, equipment and machinery in harm's way. Preliminary estimates from Property and Casualty (P&C) insurers indicated that the physical damage to the properties cost insurers more than \$2.25 billion in claims (Nelson, 2013). There is a growing concern that the costs of insurance could increase to a point where it is no longer affordable in some of the highly vulnerable locations (Mills & Eugene, 2005). Many property owners, therefore, may charge more from their tenants, or request that they take on significantly higher liability if coverage erodes (Thistlethwaite & Feltmate, 2014).

The reason behind the lack of a perception in understanding above-mentioned potential flood risks is largely because many of the Canadian CRE companies have not experienced a greater intensity of flood events on their assets in the past. Moreover, much of the scientific research on climate change and flooding in Canada has profoundly focused on other Canadian sectors such as water resources, agriculture, forestry, fisheries, coastal zone, transportation and human-health (Canadian Natural Resources, 2008), failing to engage the CRE business sector.

Furthermore, uncertainty over future climate can also be related to the issue of overlooking on potential flood impacts. For some companies, for example, the risks can be relatively minimal, too distant in time to be of concern, too difficult to quantify, or too uncertain to support business decisions directed specifically at improving their resilience (Crawford & Seidel, 2013). Due to these reasons, internal communication within company decision-makers on resilient actions becomes challenging when they regard risk of flooding as inherently inconsistent and uncertain.

In fact, only few companies consider risk of flooding as a priority risk. It is observed from figures 11, 12 and 13 that in fact only few CRE companies in Canada regard flooding as an important priority risk. With flooding continuing to be the most common and widespread natural disaster in Canada representing one of the most significant hazards to properties, ignorance towards the risk is highly concerning. In the face of the present flooding situations and its growing business impacts, it becomes clear that CRE companies need to consider flooding as a priority risk for their businesses and provide resilience and resistance to their properties from extreme impacts of flooding. However, as with many natural hazards and passing of time, there is a human tendency to overlook the risks which justify the businesses' lack of motivation in understanding and giving importance to risk of flooding. At the same time, uncertainty and considerable investment required for several resilient designs to manage flood risks can be challenging for many CRE companies (OECD, 2011).

As shown in figure 11, it is clear that very few CRE companies are incorporating flood risk potential in new property design, while many other companies are somewhat incorporating potential risk of flooding in new property designs. Flood risk potential needs to play a greater

role in commercial property design criteria despite some of the challenges involved. By incorporating adaptive or other resilient designs, CRE companies will not only manage or reduce flood risk potential from their commercial properties but will also have first-mover advantages. This includes many options such as elevate the structure above base flood elevation, build barriers like berms, dikes and walls, or floodproofing. Dry floodproofing is the best choice for urban structures and is recognized as a most resilient design option for commercial properties (Clapp, 2015). Therefore, it is an important opportunity for CRE companies to work with construction firm contractors/builders, consultants and development managers to take proactive resilient measures in new property design to minimize flood risk potential and continue to drive necessity for flood protection to reduce the probability of catastrophic property losses due to flooding.

Reporting flooding and climate change issues in company annual reports is perhaps a meaningful way for many CRE companies to demonstrate the concern and prioritization of risks. However, the survey responses reveal that only a quarter of the companies report climate change and flooding issues in their companies' annual sustainability reports. Some of these companies mentioned that they report all environmental risks, followed by a comment on climate change. Some companies mentioned specifically that they do not report on flood risks, which is highly concerning. The low rate of reporting on flood risks and climate change issues may be because some CRE companies do not consider these issues as important, or the companies have not faced any risks related to flooding or other climate change impacts and therefore not be in a position to report on these issues. The potential financial implications of climate change and flooding on businesses are receiving increasing attention and recognition, with investors and other

stakeholders press on CRE companies to identify, assess and report publicly on the financial implications of climate change and flood risks to their businesses. This will provide a benchmark for CRE companies to improve their strategies on reducing flood impacts and avoid reputational risks.

On the other hand, almost all the companies responded showed that they consider flooding an important priority risk when developing or updating their risk assessments and emergency management plans which signifies those CRE companies perhaps maintain an environmental risk management program to help protect investment assets from losses due to flooding and other environmental issues. For many other CRE businesses that not only have health and safety policies and contingency plans for an emergency, a flood plan should also become part of a company's operational procedures. With a flood emergency plan in hand, it gives an important opportunity for CRE property managers/owners to train staff in correct flood safety procedures so they can work quickly and efficiently to protect the commercial property during a flood event or, if necessary, evacuate the premises safely. It is believed that most businesses can save between 20 and 90 per cent on the stock and movable equipment by taking action to prepare in advance for flooding (Fermor, 2016).

2) Motivation of CRE companies towards adopting a climate change adaptation framework:

Companies support the initiative of implementing risk awareness climate change adaptation in the CRE sector. Figure 14 chart reveal high support for risk awareness methods to advance climate change adaptation in the CRE sector. In general, risk awareness will help educate CRE

officials about the growing flood risks, changing flood and climate scenarios. The reason behind this support may however be coming from the recent severe flooding in Toronto and Calgary where the impacts of flooding caused billions of dollars in damages. As we recall, 75% claims out of \$3.4 billion insurance claims from Toronto and Calgary floods were from the CRE properties alone (Kane, 2013). Also, another reason for the high support is that risk awareness seems fairly new to CRE companies and have not been previously implemented in the CRE sector. Nonetheless, CRE companies do understand that this method is useful to better recognize flood vulnerabilities, and understand future flood and climate scenarios. Despite the costly nature of the methods described below, an organized campaign to deliver education on flood vulnerabilities has to be aggregated and delivered to CRE sector representatives, such as CRE Board of Directors, CEOs, senior management, property owners/managers, planners and design engineers in an effective manner.

Outreach and Communications:

Flood risk awareness education efforts across CRE firms should be targeted to employees with a wide variety of responsibilities. Actions to assess and manage flood impacts will involve employees at all levels of the firm, from senior officials to employees at all assets. While decision-making will vary across companies, staff members for risk awareness education could include: CRE firm owners, risks managers, insurance planners, strategic planners, financial risk managers, supply chain managers, business continuity and emergency response managers, property related managers and planners and sustainability officers (Crawford & Seidel, 2013).

Education outreach and communications efforts will often need to address that future flood risk conditions will not be similar to those experienced in the past (OECD, 2011). Communications with CRE employees can focus on increases in the risks associated with flooding, while avoiding debates about causality of individual events. Recognizing the importance of risk awareness education that strengthens public outreach and communications system typically increases critical elements of a company's emergency response plans (Crawford & Seidel, 2013).

Research and education:

While many studies on climate change and flooding are lengthy technical assessments not well suited for widespread distribution within companies, good examples of more accessible materials do exist. National, provincial, local agencies as well as universities are increasingly issuing reports on climate change and flooding and making themselves available to educate companies' officials and their stakeholders over potential business risks related to the impacts of climate change and flooding (Crawford & Seidel, 2013). For example in 2013, Bentall Kennedy, one of the leading CRE firms in Canada, commissioned a research study conducted by leading experts at the University of Waterloo entitled *Climate Change Risk and Adaptation*. Though, the study focused on Bentall Kennedy assets only, it can be said that many other Canadian CRE companies are equally vulnerable. The experts also recommended Bentall Kennedy to increase risk awareness, risk assessment, risk management and monitoring/evaluation of implemented measures as part of a climate change adaptation framework (Bentall Kennedy, 2014).

CRE companies in Canada can also incorporate data and information into their analysis from climate or weather sources, such as the Intergovernmental Panel on Climate Change (IPCC), Canadian National Oceanic and Atmospheric Administration (NOAA), Environment Canada and The Weather Network. Companies can work directly with scientists and researchers from these agencies and educate themselves for future flood events that can be catastrophic for their CRE properties. Such education form the basis for a variety of risk awareness efforts in the companies, including briefings for firm owners/stakeholders, webinars for employees directly involved in planning for and managing flood-related risks, informational materials and guidance for specific business units, projects or investments, and periodic updates as new information becomes available (Crawford & Seidel, 2013).

Research and education into flood events and risks are extremely important for the CRE sector. Being aware is particularly important when companies are faced with investment planning for business assets that can last for up to 50 years. Research and education are making companies understand that their properties are vulnerable from flood impacts, and they need to be aware of the adaptive measures to manage risks in the short and long-term (Crawford & Seidel, 2013). As OECD explained, being forward thinking and providing education to strategic planners of a company about changing climate and flood risks over 10, 20 or even 50 years can help them to inform decisions today about adaptive innovations and competitiveness for the future (OECD, 2011).

Companies support the initiative of implementing risk assessment climate change adaptation in the CRE sector. Similar to risk awareness, figure 16 chart also reveal high support for risk assessment methods to advance climate change adaptation in the CRE sector. In risk assessment process, methods are used to assess and prioritize the risks and adaptation measures to manage those risks. One respondent noted it would be very useful to CRE sector for a national audit to be undertaken as it will not only assess differential flood risks, but also spread awareness and research on property level resiliency. Likewise risk awareness, the reason behind support for risk assessment may also be coming from the recent severe flooding in Toronto and Calgary where the impacts of flooding caused billions of dollars in damages, and surely this initiative has not been previously implemented in the CRE sector, therefore it is fairly new to CRE companies. Undertaking a systematic risk assessment of vulnerabilities to flooding and assessing adaptation measures is perhaps a hurdle for many CRE companies, but this process is very important. Nonetheless, CRE companies do understand that this method can be useful to assess and prioritize flood vulnerabilities and adaptation measures to manage the vulnerabilities on their CRE properties. The outcome of risk assessment process will develop a competitive business that succeeds in managing flood risks and seizing opportunities in changing flood risk conditions. Some of the methods which can be used to train property owners/managers, planners and design engineers on assessing potential risks and assessing adaptation measures are described below.

Scope:

In considering potential flood vulnerabilities, CRE companies must assess risks to their core assets and business operations, including supply chain operations. It is also important to consider potential impacts on employees and communities when building resilience to flood

impacts. As shown in figure 2, the scope of risk exposure on CRE firms' core operations, value chain, and broader network must be considered for any comprehensive vulnerability assessment. Examples of some external risks include: the inability of employees to get to work, disruptions to area transportation or communications networks, and the unavailability of power and water supply. Companies should also scope out non flooding factors that affect vulnerability, such as changes in land use, changes in building codes and insurance changes. Scoping out as many risks related to flood vulnerability can ensure developing proper adaptation measures for business continuity (Crawford & Seidel, 2013).

Methods:

It is evident that there is no one standard approach for conducting a business vulnerability assessment. As we have learnt from the literature concerning risk assessment in different businesses, they use a multitude of data and tools, including past climate data, experience with recent extreme weather events, and the projections of future climate models to assess vulnerabilities (OECD, 2011). With uncertainty around changing flood conditions, some companies rely heavily on past flood events, however, these data must be adjusted to reflect the fact that flood intensity and frequency is changing in Canada and historical records likely will not accurately reflect future conditions (Struzik, 2015; Crawford & Seidel, 2013). Therefore to effectively manage the risks related to floods, CRE companies in Canada must use an array of new methods to predict future trends that may impact the companies' operations.

Furthermore, climate models produce much useful information about temperature, precipitation, or sea-level rise. However, it may require the use of additional tools to transform

the output from models into usable information. For example, the precipitation estimates from climate models must then be run through hydrologic models to project estimates of water run-off and flood intensities. These provide useful information for companies in making better informed decisions about adaptation measures (Crawford & Seidel, 2013).

Third-party Assessments:

As discussed earlier, many business sectors these days engage consultants or non-governmental organizations to help develop high-risk profiles for all operations or key production sites (OECD, 2011). Some of these consulting firms have expanded their services from initially assessing political or security risks, for example, to offering assessments related to climate risks (Crawford & Seidel, 2013). For instance, international recognized consulting companies like AON and Marsh are working with many Canadian CRE companies providing consulting services in risk control and risk management for many environmental related impacts (REALpac, n.d.). To effectively manage flood risks through risk management in the CRE sector, companies must enhance the services of these consulting companies to evaluate and prioritize flood risks and reduce impacts on business operations and supply chains through correct investment of adaptation measures.

Assessments with insurers:

CRE companies should work periodically with their insurers for assessing risks related to floods as part of efforts to limit insurance costs. Insurance industry has long been targeted by many researchers to understand and assess the risks and opportunities from climate change impacts, as many insurers are on the front lines of paying for damages from extreme weather,

thus increasing insurance costs for many businesses and homeowners (Feltmate & Thistlethwaite, 2013; Sandik et al., 2010). CRE companies must make a material effort to work with Canadian insurance companies to reduce the risks of future damage. Insurers can help CRE companies with incentives by recognizing their flood risk assessment efforts, offering risk adjusted insurance premiums, lower deductibles, and subsidies for installation of risk reducing technology (Feltmate & Thistlethwaite, 2014).

The above described risk assessment methods are capable of providing valuable information to motivate CRE companies in Canada assess potential vulnerabilities from flooding to their commercial assets, and assessing various adaptation measures to manage those vulnerabilities. Drivers behind using each method for assessing risks and adaptation measures depend on the extent to which a company has in-house risk management or scientific expertise. Above all, the companies that are motivated to implement risk awareness and risk assessment initiatives in the future supposedly understand that building resilience by implementing these methods will prepare them to capture the competitive advantages in the market that will accrue them more effectively manage the risks, especially by expanding climate change adaptation to include the fairly new, very real, very serious flood risks.

Relatively few companies are motivated to implement risk management adaptation measures.

The concept of risk management has been widely embraced over the past decade. Though, it is highlighted as a potentially more complex process compared to risk awareness and risk assessment, risk management is proven to be efficient and effective in delivering multiple goals (Sayers et al., 2011). After assessing and prioritizing flood risks and adaptation measures to

manage those risks, Canadian CRE companies can implement risk management process and take additional steps – beyond “business as usual” – to protect their properties against increased risks of flooding and climate change. Despite its importance, figures 18 and 19 results indicate that many CRE companies are not adequately motivated to use risk management process to implement adaptation measures. A small number of CRE companies (17%) have implemented risk management adaptation measures on their CRE properties’ while other companies have somewhat (61%) implemented risk management measures to more comprehensively manage risk of flooding. This is because these companies are aware and have possibly undertaken detailed assessments of direct and indirect vulnerabilities on properties that are at risk. Not only these companies understand the importance of managing/reducing potential risks due to flooding, they also recognize that implementing risk management measures on CRE properties will achieve higher value for those properties in real estate property market. Similarly, investing in adaptation and other preparedness measures against flooding can have positive effect on demand for the property in future (Joseph, Lamond & Proverbs, 2015).

In contrast, the companies that are not entirely motivated to implement risk management, or have assessed potential flood impacts but are yet to implement risk management measures, perhaps recognize the substantial costs and challenges involved in implementing appropriate measures. Moreover, these companies presumably have not motivated themselves to reach out to universities or government experts, or have not worked with their insurance companies and third-party consultants regarding knowledge and understanding of practical, meaningful and cost-effective adaptive measures to de-risk CRE properties from flood impacts. In all probability, uncertainty about future flood risk and limited availability of high-quality risk data lead to de-

motivation regarding implementing risk management adaptation. These companies seemingly accept the uncertainty associated with the effectiveness of adaptive measures, nature, timing, and/or severity of climate change and flooding, and over time disregard to invest in adaptation measures and continue with their “business as usual” viewpoint. In other words, these companies presumably understand potential risk of flooding, but due to their perception regarding uncertainty related to adaptation measures’ effectiveness, and the substantial costs related to risk management adaptation measures, they are not motivated to implement the risk management process to de-risk their commercial properties. Many CRE companies perhaps also lack in-house knowledge or expertise about flooding and climate change, lack accessible, user-friendly localized projections of future changes in climate, do not have models and tools that link projected changes in flood risks, and have a lingering perception that climate change and risk of flooding is too uncertain and long-term an issue to require near-term action (Crawford & Seidel, 2013).

Nonetheless, risk management process is extremely important for Canadian CRE sector and the types of risk management actions CRE companies can take to manage, mitigate, avoid, or transfer risks are summarized below (Crawford & Seidel, 2013).

Restrict development in flood plain areas

As mentioned earlier, Alberta flooding in 2013 was a big disaster in terms of economic losses. Though, flood plain mapping efforts over the last four decades identified 48 areas across Alberta with a flood hazard, a report by Calgary Herald news found that the government had designated fewer than half of those as risky areas, which allowed construction of expensive

properties in flood plains. The report has also learnt that it was the failure of the government to restrict development of those properties in flood hazard areas, which has now left property taxpayers on the hook for future property damages from floods and building buyouts (McClure, 2015). CRE properties that are built in the flood plains and elsewhere must fortify the properties to increase resiliency, or relocate their important assets away from floodplains. Firm owners and managers must also work with the local, provincial or federal government to identify future areas that can potentially be flooded – through updated floodplain maps – to avoid developing in the floodplains (Crawford & Seidel, 2013).

Implementation of no-regret/soft and hard adaptation measures

Different types of adaptation options are available for CRE decision-makers that can be used in implementing adaptation in the CRE properties. The most appropriate option will depend on the nature of the decision being made, the sensitivity of that decision to specific flood impacts and the level of risk which can be tolerated (Climate-Adapt, n.d.). The World Bank and Organization for Economic Co-Operation and Development (OECD) have categorized the adaptation measures into no-regret/soft and hard adaptation measures.

No-regret/soft adaptation strategies are practices that are beneficial even in the absence of climate change and flooding. If implemented in the CRE sector, these adaptation strategies will require the participatory inclusion of stakeholders, strategies are generally less-expensive, relatively flexible and will only present a short-term solution to flooding. It focuses on information, capacity building, policy and strategy development, institutional arrangements, green infrastructure and insurance. Additionally, controlling leakages in water pipes or

maintaining drainage channels around properties are considered examples of no-regret/soft adaptation measures and a very good investment from a cost-benefit analysis point-of-view. Improving properties' insulation norms is another no-regret/soft measure since it increases flood robustness and investment in these actions can often pay back the additional cost in only a few years (OECD, 2011; World Bank, 2013; Climate-Adapt, n.d.).

Hard adaptation measures imply the use of specific technologies and actions to reduce flood vulnerability. If these measures are implemented in the CRE sector, it will be for the long-term protection against flooding. Measures will be complex and capital-intensive, but relatively rigid. Measures usually include artificial human-built infrastructure such as enforcing dykes, berms around properties which can increase stability and resistance against severe flooding. Upgrading building stock is another hard measure which could enable structures to better handle flooding (OECD, 2011; World Bank, 2013; Climate-Adapt, n.d.). Above all, CRE companies must flood proof all new properties to reduce or avoid the impacts of urban/coastal flooding. This can include elevating structures above the floodplain, employing designs and building materials which make structures more resilient to flood damage and preventing floodwaters from entering structures in the flood zones. Flood-proofing has two types: wet flood-proofing which can reduce the damage of flooding by allowing flood waters to easily enter and exit a structure in order to minimize structural damage, use of flood damage resistant materials, and elevating important utilities. On the other hand, dry flood-proofing is the practice of making buildings watertight or substantially impermeable to floodwaters up to the expected flood height. CRE companies must implement this measure as it avoids the need to demolish or relocate structures

and as a result, it is often a far more cost-effective hard-adaptation approach to reducing flood risk (FEMA, 2008; Sandink and Kovacs, 2013).

Expanding or adjusting insurance coverage:

CRE companies can use insurance as a means of transferring risks associated with flood events. Insurance industry, which is society's traditional risk management industry, can work with CRE companies of Canada in balancing the costs of insurance, which are likely to increase over time with more flood events, by taking action to reduce premiums, lowering deductibles for implemented adaptation measures and the potential for damages from flood events (Crawford & Seidel, 2013). Zurich Financial services reported that insurers have the tools to play a significant role in widespread adaptation to the possible risks resulting from flooding. For example, insurers can assist CRE companies in deploying building code requirements and new technologies. Insurers could play that role again in facilitating adaptation to flood risks through coverage provisions related to resilience of building stock and infrastructure to flood events (Thorning, 2012).

Companies support the initiative of a National Building Code review in the CRE sector

As evident on figure 20, the majority of the companies believe in a National Building Code review for CRE properties. One company even noted the need for changes to the building codes to address flooding, similar to new standards and codes introduced to address energy efficiency.

A building code review can be compared to the M&E process of a climate change adaptation framework as the M&E process can *evaluate the effectiveness* of codes relative to floods and whether the goals and objectives of a particular resilient measure have been met, *assess* the costs, benefits, risks and timeline of a code, *provide accountability* by showing commitments and expectations, *assess the outcomes* of a code and the impacts that it has had, and *compare results* with other similar flooding related codes at other properties (Natural Resources Canada, 2014 & UKCIP, 2011).

Research within the building science, insurance and home builder community suggests that the building code represents a powerful tool for reducing the impacts of extreme weather. Governments and insurance companies must take the leadership and work with the Canadian CRE companies to acquire resources required to leverage the code. Research has shown that the building science community has developed many innovative resilient design practices; however, these remain largely unviable without cost-benefit information on their effectiveness as tools to reduce flood impacts. Government leaders and insurance companies must find an aggregated data set on the cost impacts of flooding risk with the specificity that can be linked to changes in design practices, and engage CRE stakeholders on the code development process (Feltmate & Thistlethwaite, 2014).

Lessons learned from the building codes review should be used by the CRE firms to inform adjustments to the future resiliency planning process. Any such adjustments should consider the dynamic interactions such as improving education that enable future decision-making processes, as well as the evolving nature of flood risks. A national building code review

should be taken on a periodic basis as this ensures that the codes that address risk of flooding provide the right information at the right time to inform appropriate decision-making in the future.

Companies greatly support the initiative of updated Canadian Floodplain Maps to reflect future precipitation and risk of flooding. The majority of the companies who responded have voted in favor of updating floodplain maps of Canada. One company commented that if climate change persists and extreme storms, rapid snow melt, changing rainfall patterns etc. occur, flood plain maps should be updated to include this new information/additional risk. One company also mentioned that future extreme precipitation should not be the primary driver for the need to update flood plain maps as these maps should be updated on a regular basis. From these comments, it is assumed that the Canadian CRE companies understand the importance of updated floodplain maps and will be motivated to use the maps more effectively to understand flood vulnerability, determine what commercial properties are at risk of being flooded, and to identify what adaptation measures are required in those properties to de-risk flood vulnerability. Updated floodplain maps will also allow the CRE planners to locate the properties in flood risk areas so that they can continue to serve during a flood event. As much as it helps to explain the hazard areas, updated floodplain maps will also help CRE companies understand and promote greater awareness of the risk of flooding (Linham & Nicholls, 2010). Similarly, awareness raising campaigns can be targeted for high risk CRE properties to prepare the properties for emergency flood procedures, and may also promote implementation of flood-proofing measures on the properties. In addition, floodplain maps can support planning and development by identifying high-risk locations and steering commercial property development away from those

areas. In other words, this will keep future flood risk down and encourages sustainable development (Linham & Nicholls, 2010).

Federal government and Insurance Industry can both motivate CRE companies by felicitating climate change adaptation efforts in the CRE sector and enhance sustainability. Businesses often face significant barriers when making decisions about how and when to invest in enhancing their resilience to climate change and flooding (Crawford & Seidel, 2013). While overcoming these barriers is largely an internal challenge, survey exploration showed that a number of CRE businesses believe that the federal government and the insurance industry in Canada can take steps to facilitate adaptation measures within the sector, which will motivate the CRE businesses to adopt and sustain a climate change adaptation framework in the long term.

For instance, companies revealed that the federal government and the insurance industry should be responsible for funding and delivering of risk awareness education training. In fact, several companies also noted that associations like BOMA & NAIOP can take leadership in educating CRE stakeholders on flooding risk. Research has shown that these industry associations and insurance companies in Canada are already supporting research on awareness campaigns, however there is limited support on this initiative amongst the government leaders. This gap could be related to a lack of coordination among the groups on how to educate CRE stakeholders on risk of flooding. It will be important for these groups to come collectively and commit to a more robust and public outreach program in the CRE sector (Feltmate & Thistlethwaite, 2014). Similarly, support for a national assessment of the flood preparedness of CRE properties was substantial, with majority of the companies voted in favor of the federal

government to fund the project. Federal government must be supportive of this assessment program and use it as a model for a more intensive approach to motivate CRE companies to implement risk assessment. Therefore, consensus is clear that the federal government and insurers should work collectively in facilitating climate change adaptation efforts in the CRE sector.

Simultaneously, survey results also showed that outdated Canadian floodplain maps should be updated by the federal government. With the provincial government ultimately responsible for flood plain management, the capacity and authority to coordinate the standards required to harmonize and update the maps becomes the federal government's responsibility (Feltmate & Thistlethwaite, 2014). In order to engage CRE companies to understand risk of flooding in floodplains, the government should introduce a flood risk database (similar to Flood Damage Reduction Program (FDRP), which ended in late 90s) that includes risk information, such as an inventory of commercial properties within a floodplain, the probability of flooding and potential damages. Federal government, alongside private agencies responsible for flood map data, need to constantly update to reflect changes in data, flooding and climate scenarios. Ultimately, these are the things that are highly technical and involve a lot of money, to which only the federal government has the capacity to bear the costs (Reid, 2014).

On the other hand, federal government can also mandate strict regulations on restricting commercial property development in floodplain areas and prohibiting federal disaster assistance for commercial properties built in floodplains. As is evident on figures 8 and 9, there was a large gap in the perception of CRE companies regarding prohibiting new development and current

operations of commercial properties in floodplain areas, as well as not receiving disaster assistance after a flood event, as some companies are in favor of these initiatives, while other companies strongly disagree. It is important that federal government must motivate CRE companies to get educated on risk of flooding, especially when companies evaluate development opportunities in recognized floodplains. This claim is supported by a company who suggested it should be the role of governments to monitor the development of commercial properties in recognized floodplains and educate on potential risks. Furthermore, federal government must also educate CRE companies that the value and desirability of their CRE properties located in floodplains can greatly depreciate over time with increased risk of flooding. If the property owners/managers still decide for commercial development in floodplains despite getting educated on risk of flooding and if they do not comply with the regulations (such as flood risk design potential on properties or restricting the development and current operations of properties) in the changing flood risk conditions, governments should impose heavy fines and legal action should be held against the shareholders of the property for damages or costs linked with flood impacts (Mills, 2012). As a result, this will motivate CRE companies to not develop their commercial properties in floodplains due to increased risk of flood impacts and strict government regulations.

Also, CRE companies profoundly support the initiative of insurance companies to recognize (by means of risk adjusted insurance premiums, lower deductibles, subsidies for installation of risk reducing technologies) the material efforts of companies to de-risk properties relative to flood. This service is recognized in research on climate change and flood risk as an extremely influential tool for changing behavior. CRE companies must realize that these

incentives are recognized as a potential motivator to adopt climate change adaptation measures on CRE properties. Simultaneously, climate change adaptation measures on CRE properties also affect property marketability of those properties in the CRE market. Research has shown that installed adaptation measures on CRE properties can not only subject to cheaper flood insurance premiums from insurance companies, but also enhance the desirability of those properties in the real estate market. In addition, suitability for mortgage finance due to installation of risk reducing technologies makes a property more attractive in the property market (Joseph, Lamond & Proverbs, 2015).

Chapter 6: Research Gaps, Recommendations for Future Research & Conclusion

6.1 Research Gaps

This study acknowledged that research by international and government agencies on flooding and climate change adaptation has started to discuss risks for the built environment, but does so within the larger context of residential and other public infrastructure, very narrowly focuses on commercial properties. More importantly, the most advanced efforts to explore adaptation and commercial properties involve several reports and articles developed by UK scholars and non-profit groups, which justifies a big gap that the Canadian scholars are not motivated to address risk of flooding and adaptation in the Canadian CRE sector. While the research provides an important starting point for an analysis on commercial property market, ignoring Canadian CRE sector, which contributes positively to the Canadian economy and where flood impacts are likely different from other parts of the world, is a highly concerning issue. This gap justifies that research studies on comprehensive exploration of flooding and other climate change risks within Canadian CRE property market needs to increase, describing potential vulnerabilities and the role that adaptation can play in reducing those vulnerabilities while promoting opportunities.

6.2 Recommendations

Drawing on the findings of this report, the following is a list of recommendations that can assist CRE business stakeholders and decision-makers in implementing climate change adaptation, building resilience and ensuring a sustainable commercial operations future.

- **The output from this research should be used to prioritize understanding of flood vulnerability within the Canadian CRE sector.** This research demonstrates that there is lack of a perception regarding potential flood risks which may impact the CRE properties

of Canada. All stakeholders in the CRE business sector need to understand flood vulnerability in all CRE properties. Stakeholders can create or build on communication and networking initiatives, such as multi-stakeholder forums to facilitate information on the impacts of floods across many CRE companies. Increased coordination of research on the impacts of flooding in the CRE sector would provide stakeholders with confidence to facilitate planning that improves resilience in the commercial properties.

- **Develop best practices to implement a climate change adaptation framework within the CRE sector.** Once the CRE companies have a better understanding of flood vulnerability, they must prepare to implement a climate change adaptation framework to de-risk flood vulnerability. The first step is to implement risk awareness methods, such as outreach/communications and research/education amongst every employee of the company. The second step is to get training on risk assessment methods, such as identifying and prioritizing flood impacts, and prioritizing best adaptation measures targeted at managing the prioritized flood impacts. Companies can then implement the identified adaptation measures in the risk management step, and finally implement M&E practices for continuous feedback and for best adaptation results.
- **Enhance involvement of senior CRE bodies in relation to education on flood impacts and adaptation.** Strong leadership within the sector is necessary to move forward on adaptation action. Senior-level decision-makers need to better understand the potential impacts of flooding on CRE properties and the importance of implementing a climate change adaptation framework. Education for senior CRE bodies can include: 1) the costs of climate change and flooding on the economic activity of Canadian CRE sector, and ultimately the economic activity of the country, as well as the projected costs going

forward in the absence of operationalizing a climate change adaptation framework. 2) Education on return-on-investment of proactive adaptation measures relative to costs.

- **Dispel myths around substantial costs of adaptation measures.** Identify various practical, meaningful and cost-effective adaptation measures, and prioritize those that can be executed with a positive return-on-investment. CRE decision-makers must be encouraged to incorporate adaptation practices into new commercial property design, and during scheduled refurbishments to reflect risk of flooding.
- **Gather better current and future flood risk data and identify commercial properties at risk of flooding through updated floodplain maps.** Conduct and provide detailed, region-specific flood vulnerability assessments in the CRE properties, and provide the sector with updated data on the risk of flooding and projected impacts. Update outdated floodplain maps to reflect current and future precipitation and risk of flooding, as opposed to relying on historical data. Provide the CRE companies with guidance on using flood related models to help them identify CRE properties in areas at risk of flooding. Including current and future flooding data for CRE properties located in vulnerable areas can also be used to identify adaptation response and recovery strategies.
- **Enhance federal and insurance industry commitment.** Work towards clear direction and federal/insurance industry commitment to foster dialogue and action on proactive adaptation. Key findings in this research suggest that governments, particularly federal, and the insurance industry need to step up their policies regarding updating floodplain maps to reflect future precipitation and risk of flooding, provide necessary funding to engage all Canadian CRE companies towards education and training programs for risk

awareness and risk assessment methods, and ultimately assist CRE companies to implement risk management adaptation measures.

6.3 Conclusion

Climate change and risk of flooding poses serious potential impacts to the economic activity of the CRE business sector. The sector has to play a crucial role in building resilience within economies and societies and contributing to environmental protection. Climate change adaptation needs to be framed as a critical element of sustainable development within this sector. Unfortunately, information and research on CRE business and climate change adaptation is quite scarce. Research on climate change adaptation and business has primarily focused on many other business sectors around the world and has seldom engaged the CRE sector. This sector is an important economic contributor for every country but has yet to receive significant attention from the scientific research community. Because of this gap, CRE stakeholders and investors are less informed of climate change and flood risks and many just assume that these issues are uncertain and will remain static. On the other hand, there are few existing studies which involve the real estate sector, but most of the research to date focuses on direct risks only, inadequately informing on the indirect risks which will also impact the CRE sector in a similar manner as direct risks. As a consequence, this lack of information and the lack of a perception regarding climate change and risk of flooding are exposing CRE businesses to significant vulnerabilities, as more frequent weather extremes cause property damage, increase insurance rates and operational costs, which results in an overall decrease in portfolio performances of commercial properties.

This thesis aimed at investigating climate-induced flood vulnerability in the Canadian CRE sector. The investigation suggests that business vulnerability in the CRE sector is caused by

multiple interacting drivers of flood risk. As described earlier, there are a few detailed studies developed in Australia, the United Kingdom, Malaysia, Singapore, Canada and the United States that make a convincing case that the financial performance of the CRE businesses is vulnerable from unprecedented impacts of climate change. With most of the studies suggesting focusing on improving or adopting a climate change adaptation framework to de-risk climate change impacts, the Canadian CRE sector has profoundly focused on mitigation efforts, such as reducing carbon emissions, to curb climate change and the impacts of flooding. The assessment suggests that Canadian CRE businesses are behind the UK and other developed countries' CRE businesses when concerned with decision-making on actions that support adaptation. This is documented through the survey key findings in this research which suggests that Canadian CRE companies' awareness and knowledge of flood impacts is limited which are significant barriers that impede their motivation from adopting a climate change adaptation framework in their commercial properties to de-risk flooding. Companies are somewhat motivated – perhaps because of the federal government's and the insurance industry's potential funding initiatives – to implement risk awareness and risk assessment processes, but are not extensively motivated to implement risk management process to comprehensively de-risk potential impacts of flooding in their commercial properties.

Notwithstanding the uncertainties regarding future flood risk and climate change, the thesis provides important and new insights for relevant stakeholders related directly to the Canadian CRE sector. Research has identified some important measures related to a climate change adaptation framework which should occur on a sector wide scale. This framework can help mitigate the flood risks by promoting awareness and integrating risk assessment into CRE

businesses' management systems. CRE companies who adopt this framework can be viewed as a leader in adaptation in the same way they have championed mitigation and sustainability. Adaptation places an emphasis on resiliency, which builds on the concept of sustainability by emphasizing an enhanced capacity to resist and recover from flood disruptions.

The study has provided a significant step forward in motivating the Canadian CRE companies to understand different factors of CRE business vulnerability caused by flood impacts, and how to de-risk the impacts through a four-step climate change adaptation framework. In a complex and dynamic field of research such as the commercial property sector, this study is able to present a holistic output paving the way forward for future research to develop further in this much neglected field of study, particularly in Canada.

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Appendix 1: Ethics Approval

Ethics Clearance (ORE # 20733)

1 message

ORE Ethics Application System <OHRAC@uwaterloo.ca>
To: bfeltmate@uwaterloo.ca, j2thistl@uwaterloo.ca
Cc: k3randha@uwaterloo.ca

Mon, Jun 22, 2015 at 4:12 PM

Dear Researcher:

The recommended revisions/additional information requested in the ethics review of your ORE application:

Title: Flooding and changing face of Real Estate: De-risking Toronto's Commercial Real Estate properties from flood risks through effective Climate Risk Management
ORE #: 20733
Principal/Co-Investigator: ()
Faculty Supervisor: Blair Feltmate (bfeltmate@uwaterloo.ca)
Faculty Supervisor: Jason Thistlethwaite (j2thistl@uwaterloo.ca)
Student Investigator: Karandeep Randhawa (k3randha@uwaterloo.ca)

have been reviewed and are considered acceptable. As a result, your application now has received full ethics clearance.

A signed copy of the Notification of Full Ethics Clearance will be sent to the Principal Investigator or Faculty Supervisor in the case of student research.

Note 1: This ethics clearance through a University of Waterloo Research Ethics Committee (REC) is valid for one year from the date shown on the certificate and is renewable annually. Renewal is through completion and ethics clearance of the Annual Progress Report for Continuing Research (ORE Form 105).

Note 2: This project must be conducted according to the application description and revised materials for which ethics clearance has been granted. All subsequent modifications to the project also must receive prior ethics clearance (i.e., Request for Ethics Clearance of a Modification, ORE Form 104) through the Office of Research Ethics and must not begin until notification has been received by the investigators.

Note 3: Researchers must submit a Progress Report on Continuing Human Research Projects (ORE Form 105) annually for all ongoing research projects or on the completion of the project. The Office of Research Ethics sends the ORE Form 105 for a project to the Principal Investigator or Faculty Supervisor for completion. If ethics clearance of an ongoing project is not renewed and consequently expires, the Office of Research Ethics may be obliged to notify Research Finance for their action in accordance with university and funding agency regulations.

Note 4: Any unanticipated event involving a participant that adversely affected the participant(s) must be reported immediately (i.e., within 1 business day of becoming aware of the event) to the ORE using ORE Form 106. Any unanticipated or unintentional change which may impact the research protocol, information-consent document or other study materials must be reported to the ORE within 7 days of the deviation using ORE Form 107.

Best wishes for success with this study.

Sacha Geer, PhD
Manager
Office of Research Ethics
NH 1045
519.888.4567 ext. 37163
sacha.geer@uwaterloo.ca

Appendix 2: Survey Questionnaire Information Sheet

Survey: Assessing the Canadian Commercial Real Estate Sector's View and Preparedness regarding Flood Risk



My name is Karandeep Randhawa, Masters of Environmental Studies candidate (MES in Sustainability Management) at the University of Waterloo. Currently, I am in my second year working on a research project under the supervisions of Dr. Blair Feltmate – Head, Intact Centre on Climate Adaptation, and Dr. Jason Thistlethwaite - Assistant Professor of Business and Environment in School of Environment, Enterprise and Development at the University of Waterloo. My research interest resides in understanding the climate-induced extreme weather events, with the primary focus on flooding in the Commercial Real Estate sector, and means ultimately to de-risk that sector from the impacts of flooding.

Background: The Commercial Real Estate (CRE) sector is vulnerable to the impacts of flooding, as was evident, for example, based on 2013 extreme precipitation events in Calgary and Toronto.

Relative to this background and reference to my interest, the following survey will help me to identify the CRE firm's awareness of flood risk and consequent vulnerability. The ultimate goal of applying this information is to help de-risk the sector from flooding.

As a survey respondent, please note that all of your responses to survey questions below will remain anonymous. Company participation may be recognized in a publicly available report, but there will be no attribution of responses to any survey questions. Upon completion of this report, a final copy will be sent to your email.

Commercial Real Estate company information:

Name of the company:

Commercial Real Estate Management contact information:

Name:

Title:

Email:

In reference to the statements below, please identify the response that would closely align with your view of the flood risk in the Commercial Real Estate sector. Please indicate your responses with **X**. If you wish not to answer/comment on a statement, please feel free to skip it. The survey should take no more than 12-15 minutes to complete. Upon completion, please respond by sending this email back to me – Karandeep Randhawa – at the attached email address- karandeeprandhawa39@gmail.com

Appendix 3: Survey Questionnaire

Perception of Climate Change

Climate change will cause a material future change in the frequency and magnitude of flooding in Canada.

Strongly Disagree ___ Disagree ___ Neutral ___ Agree ___ Strongly Agree ___
Don't Know ___

Comment:

Flood-plain Maps

Should flood plain maps be updated to reflect new and future extremes in precipitation?

Yes ___ No ___ Don't Know ___

Comment:

Updated flood plain maps for urban centres should be funded by which level of government (select one only):

Federal _____
Provincial _____
Municipal _____

Comment:

Commercial Real Estate properties should not be built in recognized floodplains.

Strongly Disagree ___ Disagree ___ Neutral ___ Agree ___ Strongly Agree ___
Don't Know ___

Comment:

From this point in time onward, new Commercial Real Estate properties built in floodplains should not qualify for disaster assistance.

Strongly Disagree ___ Disagree ___ Neutral ___ Agree ___ Strongly Agree ___
Don't Know ___

Comment:

Flood Impacts in Commercial Real Estate sector

Your company has a firm understanding of how flooding may impact the ability of your Commercial Real Estate properties' to operate.

No____ Somewhat____ Yes____ Don't Know____

Comment:

Flooding as a priority risk in the Commercial Real Estate sector

Your company incorporates flood risk potential into new Commercial Real Estate property design.

Always____ Sometimes____ Never____ Don't Know ____

Comment:

Your company discloses/discusses climate change and flood risk issues in your company's annual reports.

Always____ Sometimes____ Never____ Don't Know ____

Comment:

Your company considers flooding as a priority risk when developing or updating your company's Commercial Real Estate properties' risk assessments and emergency management plans.

Always____ Sometimes____ Never____ Don't Know ____

Comment:

Educating property owners/managers

A national campaign to educate Commercial Real Estate owners/managers to lower the probability of flooding from negatively impacting their company's properties should be launched.

Strongly Disagree ___ Disagree ___ Neutral ___ Agree ___ Strongly Agree ___
Don't Know____

Comment:

Responsibility to support a national campaign to educate Commercial Real Estate owners/managers to lower the probability of flooding from negatively impacting their company's properties should reside with which body (select one only):

Federal Government _____

Provincial Government _____

Municipal Government _____

Insurance Industry _____

Builders _____

Other _____

Comment:

Adaptation Risk Assessment

A national audit to assess the preparedness of Commercial Real Estate properties in reference to flood potential should be undertaken.

Strongly Disagree ___ Disagree ___ Neutral ___ Agree ___ Strongly Agree ___
Don't Know _____

Comment:

A national audit to assess the preparedness of Commercial Real Estate properties in reference to flood potential should be funded by which level of government (select one only):

Federal _____

Provincial _____

Municipal _____

Comment:

Adaptation Risk Management

Your company has implemented means to de-risk your Commercial Real Estate properties from flooding.

No ___ Somewhat ___ Yes ___ Don't Know _____

Comment:

Your company has implemented adaptation initiatives to de-risk flood risk potential that may impact your Commercial Real Estate properties' operations.

No ___ Somewhat ___ Yes ___ Don't Know _____

Comment:

Building Code

A review of the National Building Code for Commercial Real Estate should be engaged to identify inadequacies of the code relative to flood-related conditions.

Strongly Disagree ___ Disagree ___ Neutral ___ Agree ___ Strongly Agree ___
Don't Know_____

Comment:

Incentivizing Risk Reducing Practices

Property and Casualty (P&C) insurers should recognize (by means of risk adjusted insurance premiums, lower deductibles, subsidies for installation of risk reducing technology, etc.) the material efforts of Commercial Real Estate companies to de-risk properties relative to flood.

Strongly Disagree ___ Disagree ___ Neutral ___ Agree ___ Strongly Agree ___
Don't Know_____

Comment:

When issuing mortgages, banks and credit unions should require that the vulnerability of Commercial Real Estate properties to flooding be incorporated into a property inspection.

Strongly Disagree ___ Disagree ___ Neutral ___ Agree ___ Strongly Agree ___
Don't Know_____

Comment:

Appendix 4: Statistical Test Results

Survey statements	p value	
1) Climate change will cause a material future change in the frequency and magnitude of flooding in Canada.	0.000217113	Result is significant at $p < 0.05$
2) Should flood plain maps be updated to reflect new and future extremes in precipitation?	0.00000315454	Result is significant at $p < 0.05$
3) Updated flood plain maps for urban centres should be funded by which level of government?	0.027863969	Result is significant at $p < 0.05$
4) Commercial Real Estate properties should not be built in recognized floodplains.	0.030965983	Result is significant at $p < 0.05$
5) From this point in time onward, new Commercial Real Estate properties built in floodplains should not qualify for disaster assistance.	0.02693286	Result is significant at $p < 0.05$
6) Your company has a firm understanding of how flooding may impact the ability of your Commercial Real Estate properties' to operate.	0.0000652311	Result is significant at $p < 0.05$
7) Your company incorporates flood risk potential into new Commercial Real Estate property design.	0.012342121	Result is significant at $p < 0.05$
8) Your company discloses/discusses climate change and flood risk issues in your company's annual reports.	0.04677453	Result is significant at $p < 0.05$
9) Your company considers flooding as a priority risk when developing or updating your company's Commercial Real Estate properties' risk assessments and emergency management plans.	0.010053444	Result is significant at $p < 0.05$
10) A national campaign to educate Commercial Real Estate owners/managers to lower the probability of flooding from negatively impacting their company's properties should be launched.	0.000314546	Result is significant at $p < 0.05$
11) Responsibility to support a national campaign to educate Commercial Real Estate owners/managers to lower the probability of flooding from negatively impacting their company's properties should reside with which body.	0.000120129	Result is significant at $p < 0.05$
12) A national audit to assess the preparedness of Commercial Real Estate properties in reference to flood potential should be undertaken.	0.000390863	Result is significant at $p < 0.05$
13) A national audit to assess the preparedness of Commercial Real Estate properties in reference to flood potential should be funded by which level of government.	0.002358567	Result is significant at $p < 0.05$

14) Your company is identifying means to de-risk your Commercial Real Estate properties from flooding.	0.005415819	Result is significant at $p < 0.05$
15) Your company has identified adaptation initiatives to de-risk flood risk potential that may impact your Commercial Real Estate properties' operations.	0.005415819	Result is significant at $p < 0.05$
16) A review of the National Building Code for Commercial Real Estate should be engaged to identify inadequacies of the code relative to flood-related conditions.	0.00000225915	Result is significant at $p < 0.05$
17) Property and Casualty (P&C) insurers should recognize (by means of risk adjusted insurance premiums, lower deductibles, subsidies for installation of risk reducing technology, etc.) the material efforts of Commercial Real Estate companies to de-risk properties relative to flood.	0.000725366	Result is significant at $p < 0.05$
18) When issuing mortgages, banks and credit unions should require that the vulnerability of Commercial Real Estate properties to flooding be incorporated into a property inspection.	0.0000363988	Result is significant at $p < 0.05$