CHAPTER 5: **INDUSTRY**

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KEY FINDINGS

There is relatively little published research describing climate impacts on Canadian industry, or assessing industry's response in terms of adaptation, despite some potentially significant economic implications. The impacts of climate change and the adaptive actions taking place are best documented in the more weather-sensitive industries, such as property insurance and tourism. There are potential opportunities through expanded markets and products for these sectors if they successfully implement adaptive actions. For the industry sector as a whole, available information indicates:

- Industrial activity is sensitive to variation in weather and extreme events, with considerable differences in the types and extent of impacts on production, operations, and revenue between and within sectors.
- Changes in industry practices have been predominantly reactive, responding to variation in the weather or extreme events, rather than proactive anticipation of future climate change. Examples of adaptation tend to be isolated rather than representative of a clear trend within the sector.
- Adaptive actions implemented by industry vary widely by sector, and may be under-reported for strategic reasons. Tourism and insurance could take advantage of potential opportunities through adaptive actions.
- There is little published research about indirect impacts of climate change on industry, such as changes associated with consumer demand, supply chains, real estate or other assets, adaptation by other sectors, legal liability or government regulation.
- Barriers towards effective adaptation include limited information on local impacts to businesses, uncertainties about the costs and benefits of different adaptive actions, and limited market demand for the implementation of adaptation.

1. INTRODUCTION

This chapter assesses the impact of variation in weather and weather extremes on Canadian industry, and prospects for adaptation to reduce the risk of adverse impacts or realize the potential for gain both currently and under anticipated climate change. It focuses on five industries – property insurance, tourism, residential construction, manufacturing, and trade – and does not address industries discussed elsewhere in the assessment, including power generation, forestry and mining (Chapter 3), agriculture (Chapter 4), health care (Chapter 7), and transportation (Chapter 8).

Available adaptation research tends to focus on sectors with clear relationships with ecosystems or inputs that are sensitive to climate change, such as agriculture, forestry and water management (Willbanks et al., 2007). There is relatively little published research concerning other service or goods producing sectors. This chapter provides a sample of industrial activity in these other sectors in Canada. Some, such as insurance and tourism, have growing bodies of Canadian and international research, while others such as residential construction, manufacturing and trade remain under-analyzed. Proprietary concerns about disclosing information that could hurt competitiveness has been cited as one reason why there is not more information available on adaptation strategies across industry (Agrawala et al., 2011). Of the sectors discussed in this chapter, insurance and tourism are most exposed to climate change impacts, and are the most advanced on developing adaptive actions. Manufacturing and residential construction are less exposed to these impacts, and have only recently started to consider climate change adaptation. Trade markets are arguably the least vulnerable of the sectors discussed, and there is very little evidence that export sectors are developing adaptive actions (Figure 1).

Climate risks for Canadian business include direct impacts, such as damage or costs linked with extreme weather, and indirect impacts, including changes affecting consumer preferences, government regulation, or financial and legal liability associated with ineffective or lacking response to climate change. For the most part, industry has yet to develop effective adaptive approaches to reduce sensitivity to these impacts. There is evidence, however, that industry does respond to existing extreme weather and climate variation through adaptive actions, such as changes in building codes or supply-chain management, which could be used to promote adaptation to climate change. Climate change also offers market opportunities through the provision of new services and products for some sectors, but realizing these opportunities is contingent on effective adaptation.

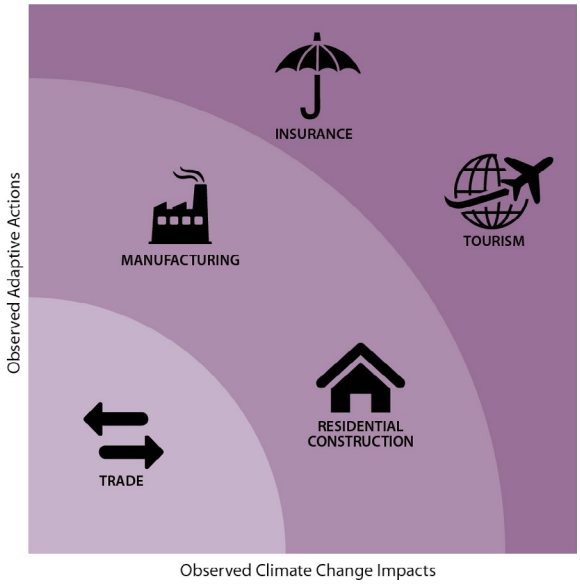

FIGURE 1: The exposure of each sector to climate change impacts, compared to their observed adaptive actions.

2. ECONOMIC CONTEXT

In 2011, Canada's Gross Domestic Product (GDP) grew to exceed $1.7 trillion (Industry Canada, 2011). About one third of Canadian production is in goods producing industries – including agriculture, oil and gas extraction, mining, forestry, construction and manufacturing. Manufacturing and construction account for the majority of goods production in Canada (75 percent by sales) and are assessed in this chapter. About two thirds of Canadian production and employment is in service industries – including banking and insurance, retail trade, transportation, schools, hospitals, other public services, and tourism. Tourism and insurance account for 5 to 15 percent, respectively, of the service industry in Canada (Industry Canada, 2011).

2.1 INSURANCE

Insurance companies had $116.6 billion in income in 2011, the ninth largest of Canada's 22 industries (Statistics Canada, 2012a). Insurance includes a number of different sub-sectors

including life and health, and property and casualty insurance companies. Some insurance sectors, such as life insurance, do not currently appear sensitive to variation in the weather (Mills et al., 2001). However, property insurance, and to a lesser extent auto insurance, experience significant swings in costs and earnings with weather variation. In fact, weather damage claims have recently emerged as the largest expense for property insurance companies in Canada (IBC, 2012a; McBean, 2012).

Climate change and the potential increase in the frequency of severe weather has emerged as a significant priority for property insurers (McBean, 2012; Robinson, 2012). The property insurance sector also provides risk-transfer services that generate economic incentives that support adaptation throughout the economy. For these reasons, this chapter focuses on the Canadian property insurance sector. Property insurance companies have been operating in Canada for more than 200 years. Several hundred companies provide property insurance and auto insurance coverage, representing Canada's most competitive financial industry (IBC, 2009). The industry includes a mix of large, mid-sized and smaller companies located across the country.

2.2 TOURISM

In 2011, tourism generated $78.8 billion in revenues, representing approximately 2 percent of Canada's gross domestic product, and over 603 000 direct jobs (Government of Canada, 2012a). Many of these jobs are within small businesses and in small communities and rural areas (TIAC, 2012). The contribution of tourism to the Canadian economy is significantly less than other G20 nations, as Canada has fallen from 7th to 18th in international arrivals over the past decade (TIAC, 2012). The World Travel and Tourism Council (2012) forecasts steady growth in Canada's tourism sector between 2012 and 2022 (an average of 2.9 percent per year), and the tourism industry and federal/provincial governments are optimistic that major tourism growth is possible (Canadian Chamber of Commerce, 2012; Government of Canada, 2012a; TIAC, 2012) as international arrivals are projected to increase to 1.8 billion by 2030 (UNWTO, 2011).

While tourism is an important economic driver in every region of Canada (Table 1), it has even greater importance at the community scale, where it is a dominant economic sector in park gateway communities, "cottaging" districts, and many other destinations. It represents a key economic revitalization strategy where traditional resource-based economies have declined (Government of Canada, 2005, 2012b; Scott, 2011).

Province and Territory	2011 Gross Domestic Product (2002 Constant $)	2011 Tourism Employment (Jobs)
Newfoundland	$316M	8136
Prince Edward Island	$121M	2866
Nova Scotia	$683M	16 636
New Brunswick	$438M	12 090
Quebec	$5357M	130 018
Ontario	$9797M	226 781
Manitoba	$903M	22 628
Saskatchewan	$677M	18 063
Alberta	$3063M	69 308
British Columbia	$4913M	96 877
Yukon/Northwest Territories/Nunavut	$147M	N/A
Total	**$26.415B**	**603 400**

TABLE 1: The economic contribution of tourism across Canada *(Source: TIAC, 2012).*

2.3 RESIDENTIAL CONSTRUCTION

The residential construction industry involves spending on both new houses and renovations. The sector accounts for approximately 6 percent of Canada's GDP and was Canada's fastest growing industry over the last decade (TD Economics, 2011; Statistics Canada, 2012b). In 2011, 843 763 Canadians (7.1 percent of working Canadians) were employed by the construction sector (Statistics Canada, 2012b, 2012c).[1] Although the sector suffered a decline in spending and employment after the 2007-2008 financial crisis, conditions improved somewhat in 2011 (CHBA, 2011).

Growth in the residential construction sector in Canada is driven by low levels of unemployment, low interest rates and immigration. The Canadian Home Builder's Association (CHBA) anticipates new home starts will be steady over the next few years, but should increase in response to immigration and demographic pressures (CHBA, 2011).

2.4 MANUFACTURING

Manufacturing is Canada's largest and most diverse industrial sector. The annual income of Canada's manufacturers in 2011 was greater than all of the other goods-producing industries combined (Industry Canada, 2011). Several tens of thousands of companies participate in the sector, including large international companies and many mid-sized and smaller firms.

[1] These statistics refer to the construction industry as a whole, which includes commercial construction in addition to residential construction. Residential construction is the focus in this chapter, but these statistics provide an indicator of the sector's importance for the Canadian economy.

	Exports of Goods and Services			Imports of Goods and Services			G&S Balance
	2011	2011 Share	% growth over 2010	2011	2011 Share	% growth over 2010	2011
World	523 293	100.0%	11.8	555 594	100.0%	9.4	-23 201
U.S.	370 255	69.5%	10.5	337 772	60.8%	7.6	32 483
EU	55 334	10.4%	12.6	61 095	11.0%	10.6	-5761
Japan	12 612	2.4%	15.3	10 816	1.9%	-5.9	1796
Rest of World	94 192	17.7%	16.4	145 911	26.3%	14.7	-51 719

TABLE 2: Canada Goods and Services Trade by Region, 2011 ($ millions and annual % change) *(Source: DFAIT 2012)*.

This sector has experienced significant challenges in recent years due to the global economic crisis, appreciation of the Canadian dollar and weakness in export markets. Most manufacturers have experienced some disruptions from severe weather events, such as delays in securing critical supplies, challenges in making on-time deliveries, and disruptions from power failures (Pegg, 2011; Campbell, 2012).

2.5 TRADE

International trade contributes to 35 percent of Canada's GDP (World Bank, 2012). In 2011, Canadian exports were worth over $458 billion and its imports were worth over $455 billion on a balance-of-payments basis (Statistics Canada, 2012d).

Table 2 lists Canada's goods and services trade by region in terms of dollars and percentage change over 2010. Canada's most significant trade partners remain the United States and to a lesser extent the European Union (EU) and Japan.

In 2011, imports from Japan dropped by 5.9% due in large part to the earthquake and tsunami, which devastated that country's economy. This demonstrates how natural disasters can impact Canadian trade markets. Overall, however, Canada's trade markets improved in 2011 and grew by 10.6% over the previous year (DFAIT, 2012). Canada's largest source of exports is industrial goods and materials, followed by energy products, machinery and equipment and automatic parts. Machinery and equipment represent Canada's largest source of imports, followed by industrial goods and materials and automotive products (DFAIT, 2012).

3. OVERVIEW OF FINDINGS FROM PAST ASSESSMENTS

Past Canadian assessments (Environment Canada, 1998; Lemmen et al., 2008) tended not to analyze climate change adaptation within Canadian business and the industry sectors addressed in this chapter. Some sectors, specifically tourism and insurance, were discussed because of their high sensitivity to climate impacts such as extreme weather. Other sectors with less observable exposure to climate impacts, such as manufacturing or residential housing, have not received significant attention. Therefore, past assessments provide only a limited perspective on climate change adaptation for Canadian industry outside of tourism and insurance.

Discussions on insurance in past Canadian assessments and those of the Intergovernmental Panel on Climate Change (IPCC) address the industry's role in promoting adaptation and the financial risk linked with climate change. The IPCC discussion suggests that the industry could be sensitive to significant risk through a series of high-cost events taking place over a short period of time. In 2005, hurricanes Katrina, Wilma and Rita all resulted in substantial economic and human losses, and are cited as an example of this type of risk (*see* NRTEE, 2011). Other concerns discussed in past assessments include the prospect that insurance availability could become more limited if the risk of extreme weather increases in some regions (Sauchyn and Kulshreshtha, 2008), and that insurance could become too expensive for many seeking coverage who live in locations exposed to significant climate risks from hurricanes or flooding (Wilbanks et al., 2007). With respect to promoting adaptation, the price of insurance can serve as an economic signal to communicate risk and play an important role in encouraging risk-averse behaviour. Insurers can raise rates for industries or property exposed to climate risks, and lower rates if clients make investments in adaptive capacity (Wilbanks et al., 2007).

Discussions of tourism in the IPCC Fourth Assessment Report and a special report commissioned by the World Tourism Organization and the United Nations Environment Programme recognize the climate sensitivity of the sector and the importance of climate change adaptation, particularly for national and community economies highly dependent on tourism (Wilbanks et al., 2007; Scott et al., 2008). Both assessments document the wide range of direct impacts (e.g. from changes in temperature, precipitation and the frequency of extreme weather), and indirect impacts (e.g. changes in water availability or quality, lost snow cover or beach area, operational and travel costs, and consumer preferences and destination reputation) on global tourism and major tourism destinations. Destination-level impacts are documented in the regional chapters of both assessments. Tourists have tremendous capacity to substitute the place, timing and activities related to travel and an improved understanding of consumer adaptive responses was considered crucial for effective adaptation by tourism businesses and the communities that rely on them. The international assessments conclude that climate change will alter the competitiveness of destinations world-wide and that all destination communities will need to adapt, whether by reducing risks or realizing opportunities (Wilbanks et al., 2007; Scott et al., 2008).

Lemmen et al. (2008) provides a regional assessment of climate change impacts for Canada, including those related to tourism (Table 3). The report indicated that the Canadian tourism sector could experience net gains as a result of climate changes, based largely on a longer warm-weather tourism season and attendant increase in domestic and international tourist activity, as well as a relatively improved competitive position in the international tourism marketplace (Bruce and Haites, 2008). Winter sports tourism is the most exposed to risks as a result of warmer winter temperatures and reduced snowfall.

While past assessments have frequently included a focus on infrastructure, they rarely discuss the implications for residential construction. They generally conclude that climate change will exacerbate existing climate risks faced by home owners. For example, an increase in the intensity and frequency of rainfall will intensify existing issues related to basement flooding for homes with aging sewer systems (Wilbanks et al., 2007). However, there is no direct discussion of adaptation action in the residential housing sector.

Research on climate change adaptation within the Canadian manufacturing sector also remains quite scarce, and is generally addressed in previous assessments in the context of infrastructure and transportation. Direct impacts include

Region	Key Risks	Opportunities
North	Infrastructure at tourist sites is at risk from degrading permafrost, flooding	Travel season and accessibility will increase as temperatures warm and sea ice declines
Atlantic Canada	Tourism infrastructure at risk from coastal flooding and erosion linked with extreme weather and sea level rise	Longer warm-weather tourism season will benefit communities
Quebec and Ontario	Winter sports tourism (skiing, ice-fishing, snowmobiling) will suffer from warmer winter temperatures and more variable snowfall and ice conditions Winter festivals could be negatively impacted Cold water sport fisheries will be reduced Water quality and wild fires could affect tourism in some communities	Summer tourism activities (e.g. golfing, fishing, boating, park visits) will benefit from longer warm-weather season
Prairies	Water availability for fishing and recreation could decrease Forest fires more likely with warmer temperatures Winter sports tourism will suffer from warmer temperatures and variable snowfall	Summer tourism activities (e.g. golfing, fishing, boating, park visits) will benefit from longer season
British Columbia	Skiing and other winter recreation activities will suffer from reduced snowfall Forest fires could increase in the interior Sport fishing will be affected as water levels and temperatures change Transportation access to tourist sites will be vulnerable to landslides, flooding and forest fires	Tourist operators will benefit from expanding summer recreation activities

TABLE 3: Regional Climate Impacts for Canadian Tourism *(Sources: Bourque and Simonet, 2008; Chiotti and Lavender, 2008; Sauchyn and Kulshreshtha, 2008; Vasseur and Catto, 2008; Walker and Sydneysmith, 2008)*.

those that affect industrial activity in specific locations, in addition to the supply chain that maintains production at these locations (Wilbanks et al., 2007). Indirect impacts include changes in the availability of the inputs (e.g. timber, electricity), consumer preferences for certain products (e.g. more demand for air conditioners, less demand for heaters), or the regulations that govern manufacturing (e.g. stricter cooling standards) (Wilbanks et al., 2007).

Previous research on climate change adaptation and Canadian trade markets is also limited (Bruce and Haites, 2008). The impact of mitigation policies on Canadian and U.S. export markets has been analyzed (e.g. Lister, 2008; Aldy and Pizer, 2011), but research on the sensitivity of Canada's trade networks to climate change and potential adaptive actions was not found in the literature. Previous assessments note the potential sensitivity of Canada's global and continental trade patterns to climate change, with a strong focus on natural resource products (i.e. from forestry, agriculture, fisheries, energy and water) (*see* Bruce and Haites, 2008). Focus was also placed on supply-side issues, while impacts on longer-term demand for Canadian exports were considered speculative (Bruce and Haites, 2008). Climate change impacts on transportation are also important to international trade. Marine and coastal ports on the Atlantic and Pacific coasts that provide important access for trade goods face disruptions linked with the rising sea-level or extreme weather (Vasseur and Catto, 2008; Walker and Sydneysmith, 2008). Damage from freeze-thaw cycles and extreme weather on road networks is another transportation impact that would have implications for international trade (Walker and Sydneysmith, 2008). In terms of adaptation, previous assessments suggest climate change should be considered in the construction of important transportation infrastructure. For example, bridges in coastal regions could be constructed to withstand projected sea-level rise (Vasseur and Catto, 2008).

4. RISKS, OPPORTUNITIES AND ADAPTATION

4.1 INSURANCE

Damage to homes and businesses caused by severe weather has been increasing for several decades in Canada and elsewhere around the globe. In fact, loss and damage due to intense rainfall, hurricanes, tornadoes, wildfires and winter storms has recently grown to surpass fire and theft and now represents the largest cost for the property insurance industry in Canada (McBean, 2012). In 2011, the Canadian insurance industry paid out a record $1.7 billion for property damage claims linked with weather events, part of an increasing trend in these types of losses (Robinson, 2011; Figure 2). The increase in insured losses primarily involves basement flood damage claims, but there has also been an increase in damage claims paid due to wind and wildfires (McBean, 2012). Figure 3 identifies some of the major extreme weather events that have occurred in Canada over the last 10 years and the costs associated with the damage they caused. For the most part, Canadian insurers have been able to maintain profitable balance sheets, although one-third of the industry reported underwriting losses in 2012 (Dickson, 2012).

Several factors contributed to the increase in severe weather damage to property across Canada – including more people and property at risk, aging infrastructure, and changes in climate (McBean, 2012). There has not yet been a study for Canada to estimate the contribution of climate change to the cost of claims that have been paid by insurers (Kovacs, 2012). Research using international insurance loss data suggests that socio-economic factors, such as increases in wealth, increases in the number and value of properties at risk, and deterioration of the capacity of public infrastructure, explain most of the reported increase in property damage, with little contribution to date resulting from climate change (Choi and Fisher, 2003; Bouwer, 2010). This conclusion is consistent with findings in the IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (IPCC, 2012).

There is considerable evidence that climate change will bring more intense rain events (Min et al., 2011) that can overwhelm Canada's aging urban sewer systems and cause

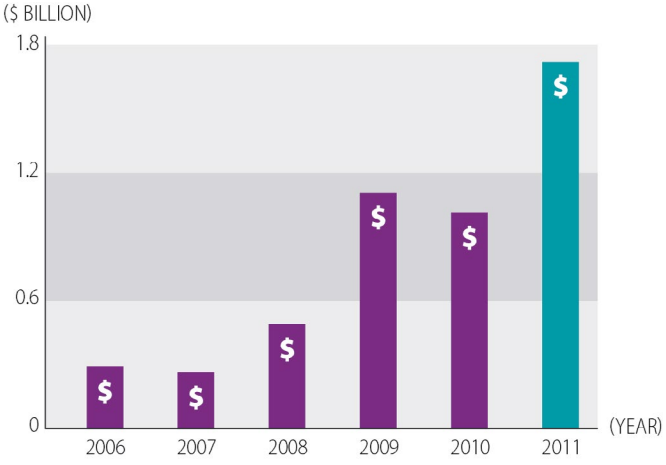

FIGURE 2: Catastrophic insurance losses in Canada from 2006-2011 ($ billions). Estimated total losses for full year in constant dollars *(Source: Robinson, 2011)*.

significant damage to homes and businesses. This, in turn, is expected to affect the frequency and severity of basement flooding events. There is also evidence that warming will bring about an increase in the severity of Atlantic hurricanes (Kunkel et al., 2008; Senevirate et al., 2012), likely resulting in more insurance claims for damage from wind and heavy rain in eastern Canada. There is concern that climate change will increase the frequency and severity of summer storms across North America, such as tornadoes, hail storms and lightning events (Peterson et al., 2008), potentially increasing damages and losses. There is also considerable evidence that the area burned by wildfire will increase (Wotton et al., 2010; Handmer et al., 2012), adding to the risk of fire damage to homes and businesses located in wildland-urban interface areas. Although there have been important advances in international research on climate extremes, there is a gap in such research in Canada (Kovacs, 2012, *see* Chapter 2 - An Overview of Canada's Changing Climate). Despite this, insurers are convinced that climate change will significantly increase the risk of claims over the next few decades (Mills, 2009a, 2009b; McBean, 2012; Thistlethwaite, 2012).

Some US reports have also suggested that climate change could increase auto insurance and liability insurance claims (Mills and Lecomte, 2006). Extreme weather events such as hail or snow events increase auto insurance claims, as witnessed in Manitoba, for example, when hailstorms generated a significant amount of auto insurance claims during 2012 (MPI, 2011). Some US insurance trade journals have raised the prospect that Directors and Officers Liability insurance claims could increase if courts find these executives negligent for ignoring climate change risks (Mills, 2007). Although liability claims could be a risk for insurers, U.S. and Canadian courts have yet to issue any decision that holds a firm liable for a particular climate change impact (Bobelian, 2012).

While there is a growing consensus in the Canadian insurance industry that the risk of loss and damage will increase in part due to changes in climate, research on opportunities for the Canadian insurance sector is less robust (McBean, 2012). There is evidence from the global insurance market, however, that insurers are starting to explore potential market opportunities linked with climate change (*see* Mills, 2009b). Incentives in property insurance contracts for "rebuilding right" after a damaging weather event are becoming more popular among some U.S. and European insurers. Products that use parametric and index-based coverage for agriculture or livestock weather-related losses are starting to emerge in some developing countries. Insurers are also exploring products to cover risk for new renewable energy technologies. Markets for these products could help insurers adapt to increases in property related losses by generating alternative revenue streams (Mills, 2007; 2012).

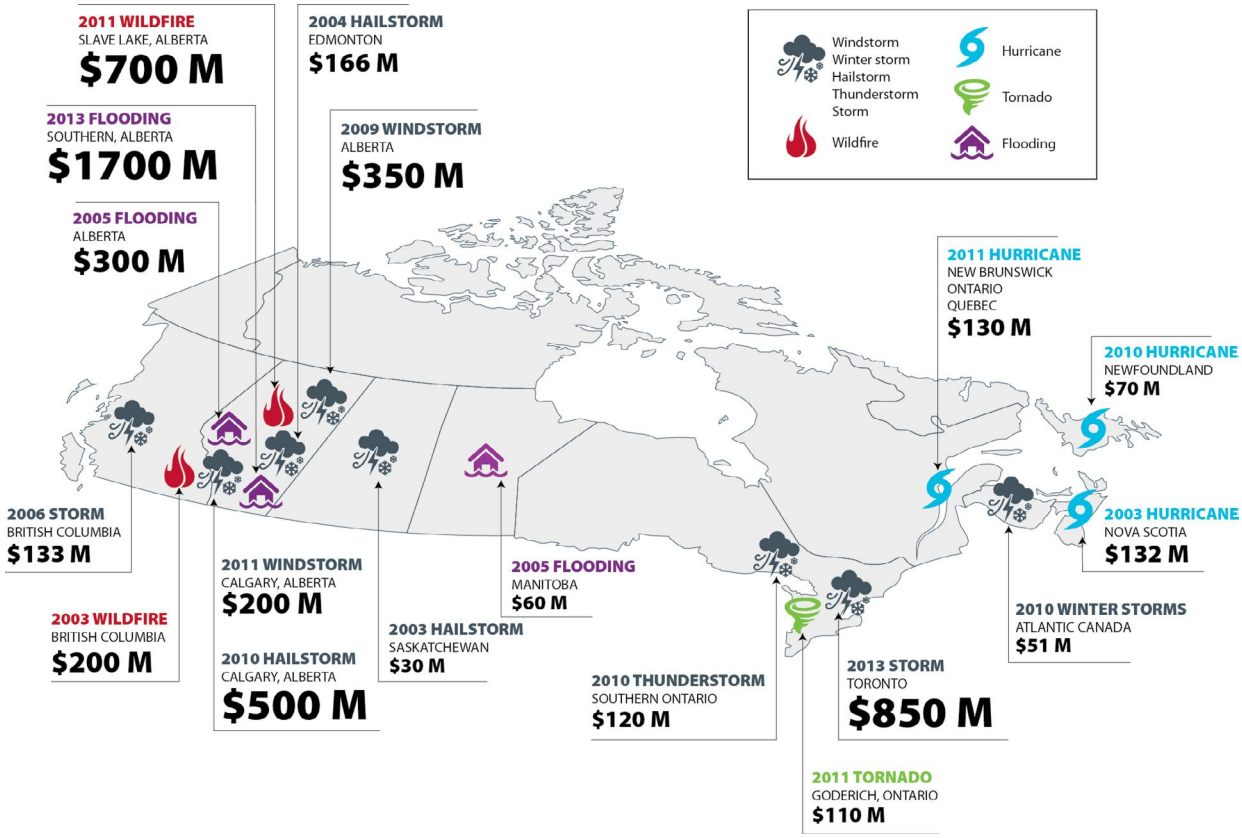

FIGURE 3: Insured losses from extreme weather events in Canada *(Sources: IBC, 2008, 2011b, 2013a, b; McBean, 2012).*

ADAPTATION

Adaptation taking place in the insurance industry is better documented than most other industry sectors in both the international literature (Dlugodecki, 2009; Kunreuther et al., 2009; Mills, 2009a, 2009b; UNEP FI, 2009; Thistlethwaite, 2012) and a number of Canadian studies (Dotto et al., 2010; Kovacs, 2012; McBean, 2012). Coverage adjustments, price increases and purchasing reinsurance contracts represent several important adaptive actions that insurers can use to reduce their exposure to costs generated by extreme weather and climate variability.

Higher costs linked with an increase in damage from extreme weather have led to some adaptation within the insurance sector. While some property insurers have adjusted the coverage they offer in response to extreme weather, such as no longer offering sewer backup insurance in communities with recurring losses, the overall change in coverage offered has been limited relative to some U.S. insurance markets. For example, despite the fact that the 1998 ice storm in eastern Ontario, southern Quebec and parts of Atlantic Canada led to more than 700 000 loss claims by homeowners, there has been almost no reduction in the winter storm coverage property insurers offer to homeowners and businesses over the past decade (Dotto et al., 2010). Similarly, several hundred homes were destroyed by fire in Slave Lake and Kelowna, but there has been no change in the availability and extent of fire coverage (*see* Sandink, 2009). This differs from some coastal U.S. insurance markets, where hurricane loss events have led to a reduction in the extent and availability of insurance (Mills and Lecomte, 2006). It appears that the very competitive nature of the Canadian property insurance industry makes companies willing to provide coverage if they can expect to secure a fair price for assuming the risk.

While changes in the extent and availability of insurance coverage have been minimal, rising loss and damage claims have increased the price homeowners and businesses pay for insurance (Marr, 2011; Mills, 2012). Canada's insurers are starting to use the price of insurance to provide an incentive for adaptation. For example, some insurers establish the price and availability of sewer backup coverage based on the presence of loss prevention actions by the policyholder, like the installation of a backwater valve (Sandink, 2011). Primary insurance companies also actively manage the risk of catastrophic loss and damage events through reinsurance contracts. Reinsurance companies sell contracts to primary insurers that offer to cover a large portion of the costs from rare, but significant loss events. Insurance companies are assessing their potential severe weather costs when they determine, for example, the capital they will hold, the reinsurance protection they buy, pricing, and the coverage offered to consumers. Industry practices have been adapting in this way as companies learn more about the climate risks they face (Mills, 2009a; 2009b).

Although adaptive actions that attempt to address future climate change are emerging, recent surveys of the sector by regulators confirm that such actions remain quite scarce. A U.S. survey conducted by the National Association of Insurance Supervisors revealed that only 11 out of 88 companies surveyed had adopted formal climate change policies (Leurig, 2011). In 2011, a Quebec survey found that a minority of insurers have taken formal adaptive actions. For example, four out of the nine insurers that responded to the survey indicated that they evaluate the link between climatic events and claims by collecting regional weather data (AMF, 2011). It is important to note that these survey results might be influenced by concerns among insurers that information on adaptation is proprietary and sharing it could hurt competitiveness.

The use of climate change risk disclosure surveys by regulators represents a potential tool to promote adaptation within the financial industry. As more information on climate change risk is disclosed, investors, shareholders and regulators will be able to identify firms that are overly exposed to climate change risks. Investors and shareholders concerned about the return on their investments could put pressure on these firms to implement adaptation strategies. The Carbon Disclosure Project (CDP; *see* Case Study 7 in Chapter 3) - a non-profit and voluntary UK initiative - has adopted this disclosure strategy and now hosts the world's largest database on climate change risks. Securities regulators have also responded to efforts like the CDP by increasing their scrutiny of the financial sector's exposure to climate change risks. Several new regulations have emerged in the last few years that target improved disclosure of climate change risks among publicly listed firms (*see* Case Study 1).

Insurers have a range of more robust adaptive actions they could employ to take advantage of their existing expertise and products. These actions include pricing climate change risks into insurance contracts, developing forward-looking models that integrate climate risk information, and promoting adaptation among external stakeholders, to help preserve the availability of insurance. Pricing climate change risks represents a considerable challenge for the industry. Traditional actuarial analysis is not well suited to predicting rare and significant loss events and relies on historical data, which is of limited value to understanding the future impacts of climate change on claims (Olcese, 2010). Actuarial analysis has also been structured to predict fire and theft risk, rather than weather-related risks (AMF, 2011). In the U.S., regulatory risk has been cited as another barrier to integrating climate change risks into pricing (Leurig, 2011). Insurers are concerned that the price increases necessary to cover climate change risks could make rates unaffordable and regulatory interventions could force rate reductions. U.S. regulators have intervened in the past by forcing insurers trying to recoup costs after significant loss events, such as Hurricane Katrina, to reduce their rates (Thistlethwaite, 2012).

Some insurers and industry trade associations have begun to adapt their modeling practices to address limitations in traditional actuarial analysis. For example, U.S. risk modellers have developed "near-term" catastrophe models that place more statistical weight on recent weather and climate variables (e.g. warmer Atlantic ocean temperatures), which are more effective at capturing the climate signal (Eeuwens, 2009). Insurance companies have also begun to research how climate models could be used to inform pricing practices (IBC, 2012a; McBean, 2012). The Association of British Insurers and the UK Met Office recently collaborated in a project that used climate models to understand how water damage will change in response to climate change (Dailey et al., 2009). The Canadian Institute of Actuaries (CIA) is working on the development of an Actuaries Climate Change Index that insurers could use to better qualify climate change risks. The index tracks climate abnormalities by comparing historical information with present weather trends. This information is then combined with socioeconomic data on vulnerability to understand how climate extremes change the risk of a loss event for different markets (Soltera Solutions, 2012). The Insurance Bureau of Canada is also partnering with a number of communities to develop a municipal risk assessment tool (MRAT) to improve data and management of the risk of sewer backup damage (IBC, 2012b). Tools such as the MRAT (*see* Case Study 2) and research on the attribution of climate change to rising insurance losses can help generate financial data on climate change risks (Kovacs, 2012).

Despite these advances, more research is needed before climate change models and analysis can be used to better price insurance contracts. Any change in the way insurers price risks will be examined by both policyholders and regulators. The insurance industry must not only generate a technical consensus within the industry on the right practices for pricing climate change risks, but also work with stakeholders to ensure pricing remains affordable (Thistlethwaite, 2012). For this reason, in addition to their own research, insurers are partnering with academia (e.g. CCAP, 2012; ACT, 2013) and engaging external stakeholders to promote adaptive actions. For example, insurers are working with homebuilders, consumers and governments to raise awareness of climate risks and develop tools to assess and manage risks. Examples include building demonstration homes with features beyond those required under the current building code, which can prevent damage from a category 4 hurricane, category 2 tornado, or an intense rainfall event (ICLR, 2007).

Overall, the insurance industry appears to have the capacity and expertise needed to adapt to climate change. Insurers are implementing several adaptive actions, including adjusting coverage and pricing, researching the use of climate models to inform pricing practices, and engaging with stakeholders with influence over infrastructure and building codes. However, the industry needs more information on the financial implications of climate change and adaptation (UNEP-FI and SBI, 2011). While using climate models, increasing premiums for certain kinds of coverage, and assessing the vulnerability of financial reserves to rare

CASE STUDY 1

CLIMATE CHANGE RISK FINANCIAL DISCLOSURE

Financial disclosure of climate change risks is one of the most effective tools for promoting climate change adaptation. Information produced through this disclosure could generate a comparable market signal that investors use to justify investments in firms that promote climate change adaptation as a risk management strategy. In 2012, the UK government announced that any company listed on its London Stock Exchange would be required to disclose their greenhouse gas (GHG) emissions (Secretary of State for Environment, Food and Rural Affairs, 2012). This regulation is the world's first mandatory reporting requirement for GHGs and sets an important precedent among financial regulators. U.S. and Canadian securities regulators have also issued guidance to the effect that climate change impacts are material risks that meet the threshold for disclosure (SEC, 2010; CSA, 2012). Regulations such as this suggest that securities regulators and investors are starting to scrutinize exposure to climate change risks. For the insurance industry and other financial service providers, this scrutiny could incentivize adaptive actions, such as higher risk premiums on financial products exposed to climate change risks

Shareholders are particularly interested in climate change risk information. In recent years, shareholders have filed a number of resolutions asking the companies they invest in to provide information on their ability to manage climate change risks (Ceres, 2013). The U.S. Securities and Exchange Commission (SEC) recently strengthened the power of shareholder resolutions pertaining to climate change risk. Some financial institutions had been able to ignore these resolutions by arguing that it was not a part of 'ordinary business'. In February 2013, the SEC announced that companies would no longer be able to ignore these regulations and climate change impacts are material risks that must be disclosed to investors.

Measurement of climate change risk exposure represents one of the significant challenges that must be addressed to improve disclosure. The Canadian Institute for Chartered Accountants (CICA) is trying to improve the measurement of climate change risks for financial reporting. The CICA has developed guidance that reporting organizations can use to identify information on climate change risk that is material or "decision-useful" to investors (CICA, 2009). Over time, this effort will help generate a market signal through financial disclosures that communicates to investors which firms are most exposed to material climate change risks, and those that have reduced these risks through adaptation.

weather events constitute important first steps, information on the contribution of climate change to financial risk and the risks involved with implementing adaptive actions remains unclear. A lack of policy and regulations supporting the implementation of adaptation for infrastructure and buildings represents a second barrier for insurers, which is also mentioned in literature on other sectors (Mills, 2012). In the absence of information to help insurers price exposure to climate change risks, and without improvements in the design of existing and future infrastructure, insurers may not price insurance contracts at a level that is affordable to businesses and homeowners (Mills and Lecomte, 2005).

CASE STUDY 2

THE MUNICIPAL RISK ASSESSMENT TOOL (MRAT)

The Insurance Bureau of Canada has identified climate change as a priority issue for its members (Robinson, 2011; McBean, 2012). One of the most significant challenges facing the insurance industry is a lack of data on the risks related to weather extremes. The Municipal Risk Assessment Tool (MRAT) is designed to help insurers underwrite risk related to extreme rainfall events (IBC, 2011a). Damage from extreme rain is mostly generated by flooded basements when municipal sewers become overwhelmed.

To better understand the risks related to basement flooding, the Insurance Bureau of Canada (IBC) brought together a team of experts including hydrologists, climate scientists, risk managers and infrastructure engineers to develop a tool that identifies risk zones for exposure to basement flooding at the neighbourhood level. Data on existing basement flooding damage trends, hydrology, and existing infrastructure is combined to produce a hazard map that shows a "visual representation of sewer backflow risk zones". These risk zones are based on historical and future climate information, and focus municipal and insurer attention on vulnerabilities that will grow as the climate changes.

For municipalities, the tool will help to calculate costs and benefits for additional investments in infrastructure, provide information on the potential impacts of climate change, and update return periods for extreme rainfall. For insurers, this tool will help make the underwriting process more accurate. Generating this type of information on risk exposure is challenging and invites scrutiny from those who could be paying higher insurance rates. Municipalities, for example, will be hesitant to provide information to insurers that could raise insurance rates for particular neighbourhoods. Insurers, on the other hand, could face reputational risks from consumers if they raise rates to levels that some find unaffordable.

4.2 TOURISM

With its close relationships to weather and the natural environment, climate change is anticipated to have extensive impacts on the sustainability and competitiveness of tourism destinations and major tourism market segments around the world. Recent rankings of the impacts of climate change on tourism worldwide have consistently identified Canada as a country with the potential to improve its competitive position as an international destination (Deutsche Bank Research, 2008; Scott et al., 2008). Weather-related shifts in outbound tourism and domestic tourism spending in Canada, a lengthened and improved warm-weather tourism season, and reduced sunshine destination travel in winter would benefit the Canadian tourism sector (Wilton and Wirjanto, 1998; Bigano et al., 2007; Scott et al., 2012a). However, the role that a wide range of non-climatic factors (e.g. fuel prices and transportation costs, border restrictions, currency fluctuations, international reputation, demographic and market trends) play in determining visitation from the U.S. and overseas, and how these will interact with climate change, is not well understood.

As domestic tourism accounts for 80% of tourism spending in Canada (Government of Canada, 2012b), one research priority has been to determine the potential impacts of climate change on major domestic tourism markets (Scott, 2006). Understanding distinctive regional and local-scale impacts, and how the competitiveness and sustainability of major tourism markets could be altered by climate change, are essential for adaptation planning.

PARK SYSTEMS

National and provincial parks are among Canada's most renowned tourism attractions. Studies of weather and park visitation estimate that under climate change, visitation could increase across the country. If current demand patterns remain, increases will be greatest in Atlantic Canada, Ontario and Quebec, and could be as much as 30% in the national park system by the 2050s (Jones and Scott, 2006). Potentially higher visitation brought about by an extended warm-weather tourism season has several economic, service and ecological implications for park agencies in Canada (Jones and Scott, 2006; Lemieux and Scott, 2011). Changes in the frequency and magnitude of extreme events such as wind storms, floods, and forest fires will also pose a challenge to park agencies, in terms of infrastructure damage, visitor safety, and business interruptions (Lemieux and Scott, 2011; Scott et al., 2012b). For example, in 2011, repairs and cleanup in the aftermath of extreme weather events cost Parks Canada over $14 million (Lindell, 2012).

WARM-WEATHER RECREATION

With effective adaptation, major warm-weather tourism markets in Canada could benefit from projected climate change. The golf industry and golf tourism destinations across much of the country could see increased season length and demand, with the largest gains of up to 40 days as early as the 2020s in the Great Lakes and Atlantic regions (Scott and Jones, 2007). Adaptation to increase irrigation efficiency will pose a particular challenge in regions with limited or declining water resources.

The projected increase in golf seasons is also a reasonable proxy for the potential extension of other warm-weather tourism seasons, including theme/water parks, zoos, boating, fishing and beach recreation (Jones and Scott, 2006; Dawson and Scott, 2012). For example, in the City of Toronto, which operates 14 public beaches on its waterfront, the climatically suitable swimming season would increase up to 30 days in the 2020s and up to 60 days in the 2050s (Scott and Jones, 2006). Maintaining water quality will be a critical adaptation challenge, because as lake temperature warms, oxygen-carrying capacity is diminished, which can contribute to enhanced algae growth and other water pollution issues that degrade the aesthetics of beaches and pose a health risk to swimmers (Foghaden, 2012; NOAA, 2012). Even larger season extensions are likely for other important water-based tourism activities that require ice-free conditions (e.g. boating, canoeing).

WINTER RECREATION

In contrast to summer tourism markets, a degraded and shortened winter tourism season represents a risk to tourism in many parts of Canada. The risks posed by climate change to the large ski and snowmobile industries have received considerable attention by researchers, the media, and community leaders (Scott et al., 2012a). Recent record-warm winters with shortened ski seasons in Ontario and Quebec between 2000 and 2010 have resulted in a 10-15% reduction in visitations (Scott et al., 2012a), illustrating the potential impact of future warming trends. The ski tourism industry is at risk of decreased reliability of natural snow cover and increased dependency on snowmaking. In eastern Canada and lower elevations of western Canada, shortened and more variable ski seasons are projected by mid-century, with a contraction in the number of possible ski areas as operation costs increase (Scott et al., 2006; Scott et al., 2007). Despite these adverse impacts on the Canadian ski industry, market opportunities remain as available evidence suggests that impacts would be more pronounced in the New England states and California than in Quebec and British Columbia (Dawson and Scott, 2012; Scott and Steiger, 2012). Investment and real estate markets are already beginning to respond to this differential vulnerability, but comprehensive data still needs to be collected to confirm this conclusion (Ebner, 2008; Butsic et al., 2011; Scott et al., 2012a).

Snowmobiling in Canada is more vulnerable to climate change than the ski industry because the vast expanse of snowmobile trails makes widespread implementation of snowmaking impractical. Snowmobiling seasons in non-mountainous trail regions from Manitoba to Nova Scotia are projected to decline up to 60% over the next 20 years and reliable snowmobile conditions could be largely eliminated under the warmest scenarios for the 2050s (McBoyle et al., 2007). Recent market trends showing a decrease in new snowmobile sales versus all-terrain vehicles (Cycle Country, 2006) may reflect adaptation to ongoing warming trends. Cross-country ski trail networks are also largely reliant on natural snowfall, but are less sensitive than snowmobiling because less snow is required for safe and effective track setting and informal skiing activities (Jones and Scott, 2006). The net destination or regional economic impact of seasonal shifts in tourism activities across Canada remains uncertain, with further analysis needed to determine to what extent losses from winter seasons could be compensated by gains in warm weather seasons.

NATURE-BASED TOURISM

Growing evidence suggests that nature-based tourism will be influenced at the destination level by climate-induced environmental change. In Canada's north, changing ice conditions are lengthening the Arctic cruise season and providing access to previously inaccessible locations (Hall and Saarinen, 2010; Stewart et al., 2010). The number of planned cruises in Arctic Canada more than doubled between 2005 and 2010, and the market for tourists seeking to experience the Canadian Arctic by sea cruise is expected to grow as it has already in the Antarctic, Norway and Greenland (Stewart et al., 2010). Recent patterns of cruise activity provide insight into the future evolution of this tourism market, with routes near southern Baffin Island and the shores of Hudson Bay declining in recent years, while activity in more northern routes, particularly the Northwest Passage, have increased as these areas become more accessible (Stewart et al., 2010; Stewart et al., 2011). Multi-year sea ice continues to present hazardous travel conditions in the Northwest Passage and elsewhere, emphasizing the role of continued improvements in Canada's search and rescue capacity and our ability to monitor cruise ship traffic in the region to ensure safe development of this emerging tourism market (Stewart et al., 2011). Further consultations between communities and the cruise tourism industry regarding codes of conduct when coming onshore and improved collaboration with willing host communities to accommodate large numbers of tourists is also important to ensure tourism contributes to the sustainable development of these northern communities (Hall and Saarinen, 2010; Stewart et al., 2011).

Elsewhere in the north, the impacts of climate change on tourism are very different. The polar bear tourism market in Churchill, Manitoba will be threatened over the next 20 years

by declining sea-ice conditions on Hudson Bay. An onsite survey of tourists revealed that if polar bear populations were to 'appear unhealthy' (very skinny), which is already beginning to occur, only 60% of visitors would still visit the area (Dawson et al., 2010). A large majority of visitors indicated that if they could not view polar bears in Churchill, they would travel elsewhere to see them (Dawson et al., 2010), suggesting that adverse impacts in one northern destination could represent an opportunity for other communities.

Changes in biodiversity and wildlife production will have impacts on other tourism sectors as well, particularly sport fishing and hunting. For example, the recreational fishing effort (days fished) in northern Ontario will likely increase because of increased walleye productivity, while moose hunting opportunities will likely shift northward (Browne and Hunt, 2007). The implications for other economically important tourism industries, such as sport fisheries, hunting, and wildlife viewing (e.g. bird watching) remain uncertain.

The impacts of environmental change on tourism landscapes will also affect destination image and tourist demand. A survey of tourist perceptions of environmental change in Banff and Waterton Lakes national parks found that very substantial change (e.g. large losses in viewable glaciers) was required before a substantial proportion (30% or more) of visitors would choose not to visit these destinations (Scott et al., 2007). This is consistent with results of tourist surveys in diverse environments worldwide (Scott et al., 2012a).

Elsewhere in the country, other climate-related environmental changes, including mountain pine beetle forest destruction in British Columbia, lower water levels in the Great Lakes, eroding beaches and coastlines in the Atlantic provinces, algal blooms and forest fires in Manitoba, and early tulip flowering in Ottawa have been observed to impact tourism, but the impacts under projected climate regimes have not been assessed. Improved understanding of tourist perceptions and responses to environmental change are needed to inform effective adaptation strategies (Gossling et al., 2012).

The impact of environmental changes on tourism at any destination may change over time. Lemelin et al. (2010; 2012) contend that observed and anticipated climate-induced environmental change has given rise to a new market called 'last chance tourism', where tourists visit a destination or attraction before it is 'lost' to climate change. Some Canadian destinations may therefore benefit in the near term as additional tourists visit to see changing landscapes, but then see a subsequent decline in tourism activity as the environmental attraction further degrades (Scott et al., 2012a).

ADAPTATION

Tourism operators have implemented a wide range of adaptations that allow them to operate in every climatic zone in Canada. Examples include snowmaking, irrigation, air conditioning, fire-smart landscaping, seasonal business diversification, communications through web cams, direct marketing via the internet and social media, and insurance and financial products such as snow or sunshine guarantees (Scott et al., 2012a). While many of these strategies will be useful for coping with future climate change, the motivation for implementing these strategies has been almost exclusively to manage the impacts of current climate variability and extremes (Scott et al., 2012a). There is little evidence that tourism businesses, government tourism operators or marketing organizations, or tourism-dependent communities in Canada have assessed the capacity of current climate adaptations to cope with future climate change or their long-term financial or environmental sustainability (Scott and Jones, 2006; Dodds and Kuenzig, 2009; Lemieux et al., 2011; Scott et al., 2012b).

Assessments of the state of future-oriented climate change adaptation within the Canadian and international tourism sector have consistently found low, but improving, levels of climate change awareness, relatively low perceptions of climate change risk, and substantial optimism about the capacity of adaptation to overcome the challenges of climate change (KPMG, 2010; OECD and UNEP, 2011; Scott et al., 2012b). However, the highly competitive nature of the tourism sector has meant that for strategic business reasons, climate change adaptation strategies are not generally made public, so that the level of adaptation activity in the sector may be underestimated (Scott et al., 2012b)

Some notable examples of proactive adaptation in the Canadian tourism sector include:

- Parks Canada has begun to consider the continued melt of glaciers in Banff and Jasper National Parks as it plans for redevelopment of viewing locations and interpretive centres near these major attractions, and has also begun to accommodate coastal erosion associated with sea level rise in infrastructure planning in PEI National Park (Lemieux et al., 2011).
- The Tourism Industry Association of British Columbia has begun to develop a tourism action plan to respond to ongoing and future mountain pine beetle damage (COTABC, 2009).
- Investors in Revelstoke Mountain Resort (Revelstoke, British Columbia) have considered the potential impact of climate change on the ski industry and related real-estate markets of western North America as part of their major long-range development plan (Ebner, 2008).
- Ontario Parks has identified and evaluated a wide range of adaptation strategies across its six major program areas (Policy, System Planning and Legislation; Management Direction; Operations and Development; Research, Monitoring and Reporting; Corporate Culture and Function; and Education, Interpretation and Outreach), including several related to recreation, tourism and interpretive education (Lemieux et al., 2008).

- Whistler Blackcomb (Whistler, British Columbia) has undertaken a comprehensive assessment of its climate risk and developed a multi-strategy adaptation plan (NRTEE, 2012a) (*see* Case Study 3).

Despite these examples, future-oriented adaptation in the tourism sector appears to remain a low priority. Important needs for further action include better information that tourist operators can use to understand the impacts of climate change and the cost-effectiveness of potential adaptation approaches, and the creation of policy and possibly regulations to support adaptation. For example, the paucity of data on the costs and benefits of adaptation is viewed as a significant obstacle to effective adaptation in the tourism sector (Lemieux et al., 2011). In addition, most tourist operations are small or medium-sized enterprises that lack the expertise and capacity to assess the implications of local climate impacts for their business and implement effective adaptation strategies (Scott et al., 2008; Scott et al., 2012a).

The low level of preparedness within the tourism sector (Scott et al., 2008; KPMG, 2010) has been attributed to widespread perception in the sector that climate change adaptation is a government responsibility (Scott et al., 2012a) and that the long timeframes of climate change impacts are incompatible with the shorter timeframes of business planning, thereby restricting adaptation action to low priority status. This conclusion suggests that as in other sectors, there is a role for government to provide information and guidelines to help promote the implementation of adaptive actions. This finding is particularly important for a country like Canada where climate change represents both a risk and an opportunity to the tourism sector. Understanding and preparing for the opportunities that climate change could bring provides incentive for further engagement of the sector.

CASE STUDY 3

THE WHISTLER BLACKCOMB ADAPTATION PLAN

In 2009, the Whistler Blackcomb ski resort acknowledged that its success is contingent on a stable climate and that climate change is an issue that affects its entire operation. To address this concern, the resort established a "seven-step strategic framework" to limit the climate change risks facing the resort (Figure 4). The first step in the framework involved a risk assessment using climate change scenarios to generate information on how climate change will affect the resort's operations. This information was used to inform step four of the framework, which involved identifying key actions that can promote adaptation. Doubling snow making capacity, and optimizing snow cover are two key steps the resort has taken under this umbrella to reduce the impacts of warmer weather. The resort has also developed a range of "off-peak" activities, such as hiking and mountain biking, to diversify its business from being solely concentrated on winter activity (NRTEE, 2012a).

FIGURE 4: Whistler Blackcomb Climate Change Strategy.

4.3 RESIDENTIAL CONSTRUCTION

Analysis on the impact of climate change on the housing sector largely focuses on the risks linked with direct climate impacts, specifically an increase in property damage caused by more intense and frequent extreme weather. Residential homes are built with the assumption that the climate will remain static. Extreme weather linked with climate change can easily exceed the design threshold of these structures and cause damage (Auld et al., 2008). In Canada, the insurance industry has tracked a significant increase in residential property damage linked with extreme weather in the last 20 years. In fact, weather related damages have now replaced fire and theft as the most significant source of claims (McBean, 2012).

An increase in water damage caused by sewer backups and basement flooding is the biggest contributor to these claims. Water damage claims for Intact Financial Corporation, Canada's largest home property insurer, have risen from 20 to 50 percent of all property related claims in nine years (IFC, 2012). According to the Insurance Bureau of Canada, water damage accounted for almost $1.7 billion in claims in 2011(IBC, 2012c). A recent study combined historical rainfall and insurance claims data to confirm that climate change will increase water-related damage in several Ontario watersheds (Cheng et al., 2012).

The latest Intergovernmental Panel on Climate Change report on extreme weather concludes that "small increases in climate extremes above thresholds or regional infrastructure tipping points have the potential to result in large increases in damages to all forms of existing infrastructure nationally and to increase disaster risks" (Lal et al., 2012 p. 366). Studies

in Australia demonstrate that increases in wind speed can dramatically increase damage to various building structures (Coleman, 2002), while other analysis has focused on the damage caused by extreme rain, flooding, and overheating (Graves and Phillipson, 2000; Camilleri, 2001). Gradual increases in temperature and precipitation also pose a risk for residential housing as they are likely to be associated with an increase in the weathering processes that gradually deteriorate the quality of the built environment (Auld, 2008). Soil subsidence and damage to foundations is another climate change risk for residential houses, although there is no research on this topic in Canada (Swiss Re, 2011).

As noted in the discussion of insurance (section 4.1), increases in property damage cannot be wholly linked to climate change. Changes in extreme weather represent just one of several factors driving increasing rates of damage to the housing stock. A more significant factor is that more people and more property are now, more than ever, exposed and sensitive to changes in extreme weather patterns (IPCC, 2012). Aging infrastructure and housing stock, combined with poor land-use planning that allows developers to build in areas already exposed to extreme weather, intensify the effects of climate change (Cutter et al., 2012; Lal et al., 2012; Seneviratne et al., 2012).

Potential indirect impacts from climate change on residential housing include changes in the attitudes of customers (e.g. increased demand for resilient housing), increased regulatory pressure (e.g. changes to building codes), or increased financial liability (e.g. more stringent lending or insurance conditions) (Hertin et al., 2003; *see also* Sanders and Phillipson, 2003; Rousseau, 2004). These indirect impacts could play a significant role in creating the commercial incentives necessary for home builders to engage in adaptation.

There are no public data in Canada tracking climate-related damage to homes, which is why insurance information provides the best available proxy. A recent study found that home builders were not aware of a trend of increased damage, reducing the prospect that they will adapt home designs and construction practices to proactively address climate change (ICLR, 2012).

ADAPTATION

For most stakeholders within the housing sector, climate change adaptation is a new concern, with research and policy action related to climate change still largely focused on mitigation (improving energy efficiency; e.g. Parker et al., 2000; Scott and Rowlands, 2000; Hertin et al., 2003; Arup Group Limited, 2008; St. Denis and Parker, 2009; Morna and van Vuuren, 2009). An example of recent policy action is new building code provisions in Ontario that require homes to reach a fairly robust energy efficiency standard (Lio & Associates, 2010; Laporte, 2011). The sector does employ a number of tools and practices that to date have been used as reactive measures to address existing climate variability and extreme weather, but could also be used to promote adaptation.

Building codes (Sanders and Phillipson, 2003; Lowe, 2004; Kovacs, 2012), land-use planning (Hertin et al., 2003; Deilmann, 2004; Lowe, 2004), retrofit policy (Arup Group Limited, 2008; Sandink and McGillivray, 2012); and financial planning (Hertin et al., 2003; Milne, 2004) can all be leveraged to promote climate change adaptation in the residential housing industry. The use of these tools to promote adaptation is contingent upon support from multiple stakeholders including homebuilders, regulators, the financial services sector and consumers (Figure 5).

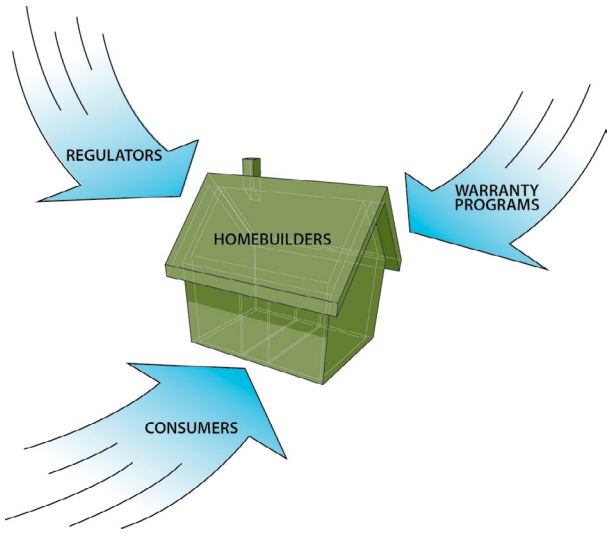

FIGURE 5: External stakeholders' role in promoting adaptation in residential housing market.

THE BUILDING CODE

Most developed countries use a standardized building code as a minimum standard for the design and construction of residential homes. To date, the Canadian building code has used data on existing and historical weather trends to inform the climate load and design values that dictate how homes are built. However, the code is often discussed as one of the most useful tools for promoting adaptation in new homes (Sanders and Phillipson, 2003; Lowe, 2004). Prescriptive guidance on more resilient building practices and updated climate load and design values based on emerging and future weather trends can be integrated into the building code as a strategy for promoting adaptation in new home builds (Auld, 2008; Thistlethwaite et al., 2012). For example, the Northern Infrastructure Standardization Initiative is designed to develop climate change information that can be used to update the codes and standards that inform construction in northern climates (SCC, 2013).

LAND-USE PLANNING

Land-use planning can be used to encourage the construction of homes in areas protected from hazards associated with existing and future extreme weather events (Richardson and Otero, 2012). Similar to building codes, land-use planning has relied on existing and historical weather to develop rules. However, as demonstrated in international examples, climate models can be used to understand how land-use must change in response to future and gradual changes in weather. In Germany for instance, GIS-based modelling of floodplains will be integrated with hydrological and climate models to inform decision-making on future land-use (Deilmann, 2004). Land-use planning can also substantially reduce damages from storm surge flooding (Mills, 2009b). The Netherlands is currently exploring new land-use planning strategies that preserve natural space in areas where climate change is predicted to increase the risk of overland flooding (Leven met Water, 2007).

RETROFITS FOR EXISTING HOMES

While the building code and land-use planning can be used to promote adaptation for new homes, existing homes remain the most vulnerable to extreme weather and climate change (Arup Group Limited, 2008). Existing housing stock has been built using older design standards and is linked to older infrastructure. Policies promoting retrofits that improve the resiliency of existing homes to extreme weather represent the most effective adaptation strategy (Steemers, 2003; Sandink and McGillivray, 2012). For example, subsidy programs have been adopted by a number of Canadian municipalities to encourage the installation of backwater valves that can help to reduce flood damage from an increase in the frequency and intensity of rainfall events (Sandink, 2011). Subsidies can also be used to finance rebuilds after extreme weather events, which are designed to improve resilience to future climate change risks (Sandink and McGillivray, 2012). For example, sealing gaps around pipes, cables, windows and door frames can limit damage linked with future flooding events (Arup Group Limited, 2008).

FINANCING ADAPTATION

Adaptation could also occur by improving financial planning. This could include expanded budgets to cover increased liability for damage to construction sites, or to purchase land that is protected from climate risks. Warranty programs, which insure a home against damage in the first years after construction, are perhaps the most exposed to climate risk (Milne, 2004). Financial reserves for these programs might have to be expanded. Insurance rates may also increase in response to more frequent and extreme weather. To reduce these costs, consumer demand for more resilient building practices is likely to grow (Milne, 2004).

It is important to note that these tools remain underutilized in Canada for the purposes of adaptation as a consequence of several barriers identified by international research. Homebuilders currently lack the information and capacity necessary to implement adaptive actions, and there is insufficient market demand to motivate such action within the sector (Hertin et al., 2003; Liso et al., 2003; *see also* Sanders and Phillipson, 2003; Lowe, 2004; Kovacs, 2012). Information is needed to gain a better understanding of local climate impacts to building design and the cost-benefit of changing designs to improve resilience to climate risks. Capacity is needed to develop the appropriate adaptation solutions, such as new design techniques or technologies (Sanders and Phillipson, 2003; Lowe, 2004). Engaging building design experts in the consideration of climate change is challenged by the spatial resolution of climate projections, which is not well suited to informing design requirements to protect homes from the severe weather likely to accompany climate change (Sanders and Phillipson, 2003; Lowe, 2004). In addition, designs based on future projections represent a substantive paradigm shift from the building code and current design approaches, which currently rely on historical experience (Lowe, 2004; Kovacs, 2012).

Market demands also impact decisions among the key players in the housing sector (Rousseau, 2004). Adaptation can add costs to the construction of a home if new technologies or design practices are incorporated. Builders are unlikely to support more resilient design practices without either: i) customer demand and willingness to pay for improvements; ii) regulations that require adaptation (i.e. building code, land-use planning); or iii) increased exposure to financial scrutiny among their investors and insurers (Hertin et al., 2003; Milne, 2004; Arup Group Limited, 2008). These market pressures also fuel opposition among builders with regard to changes in the building code or land-use planning, as they can add costs to their operations (Liso et al., 2003). Nonetheless, there is recognition that the building code is an important tool for advancing adaptation (e.g. Environment Canada, 2010), along with the need to identify ways that the code can integrate adaptation into new home building (MOE, 2011; ECO, 2012).

This analysis suggests that adaptation advances within the housing sector are largely contingent upon external stakeholders such as consumers or building code officials. Homebuilders are unlikely to implement adaptive actions without more information on local climate change risks, consumer demand, changes in the building code or land-use planning that supports more resilient building practices. Research on the costs and benefits of implementing certain retrofits or building code changes represents a particularly important gap (ICLR, 2012). Collaboration between building scientists, the insurance industry and homebuilders represents an important first step to develop this research (*see* Case Study 4).

CASE STUDY 4

BUILDING A "BETTER THAN BUILDING CODE" HOME

Climate change may bring an increase in the frequency and intensity of extreme wind events. A number of building practices that can reduce the risk of loss and damage from extreme wind events have been identified, but are rarely implemented in the construction of a new home (ICLR, 2010). As a consequence, important information that could help promote adaptation within the housing sector, such as the costs, expertise and materials needed to build these homes, is rarely generated.

The Institute for Catastrophic Loss Reduction has partnered with The Co-operators General Insurance to address this gap by constructing 'demonstration homes' that address many of the technical concerns among home builders related to building a weather-resilient home. The first house was constructed in West Point, Prince Edward Island after a fire destroyed the initial home. The design and construction incorporated several new technologies and practices that strengthen existing requirements in the building code to ensure a home can withstand extreme wind events. These building design improvements were developed through research at the Boundary Layer Wind Tunnel Laboratory at Ontario's Western University. Features are shown in Table 4.

Feature	Objective
1" (25mm) thick steel rods that anchor the floors together (between first floor and foundation)	Ensure home is anchored to the ground to mitigate "uplift" wind pressure
Braces that connect roof trusses to house frame	Mitigate risk that a roof will lift off home during intense winds
Special shingles that can withstand 200 km/h	Reduce shingle damage during high winds, which can allow rain water to penetrate home
Heavy roof sheathing connected with "ring-shank" nails	Reduce likelihood sheathing could lift off roof during intense wind
Adhesive weather-resistant strips overlaid on every roof joint in roof sheathing	Prevent water from seeping in through joints in roof sheathing
Water resistant sealing around windows and doors	Limit rain water penetration
Wind-resistant siding, fascia and soffits	Limit rain water penetration

TABLE 4: Design features and objectives of the 'demonstration home' *(Source: ICLR, 2010)*.

While such code and safety features can be built into affordable homes, more research is necessary to confirm the cost-benefit of using these features to mitigate extreme weather risk (Oulehan, 2010). Many could eventually be included in revisions to the building code, so that a future generation of homes are better capable of preventing damage from the severe weather hazards expected with change in the climate (Thistlethwaite et al., 2012).

After the demonstration house was constructed, it was subjected to hurricane winds on several occasions. The house sustained no damage as a consequence of these extreme winds. While this helped demonstrate the benefits of enhanced construction practices, more research is required to better understand whether the benefits of applying these technologies in all homes exceed the costs.

4.4 MANUFACTURING

Literature on climate change and the Canadian manufacturing sector almost exclusively addresses mitigation actions, while information on climate impacts, risks, opportunities and strategies used to promote adaptive actions is not well developed.

From international research it is clear that climate change can have a range of physical impacts on the manufacturing sector. Changes in the environment can limit the availability of certain key manufacturing inputs, such as water or timber, thereby increasing costs for manufacturers. For example, forest fires, pests, diseases and changing growth patterns could decrease forest productivity (NRTEE, 2011; *see* Chapter 3), which in turn could increase costs for manufacturing products, such as construction wood products and pulp and paper. Water shortages are a risk for industrial processes that use water for cooling, irrigation, cleaning or refining raw materials (Morrison et al., 2009).

High temperatures could limit production by creating unworkable conditions for employees (Agrawala et al., 2011). For example, international studies have suggested that higher temperatures and humidity can decrease productivity and increase health risks (Hanna et al., 2011; Kjellstrom and Crowe, 2011; Dunne, 2013). Extreme weather can also disrupt operations by damaging infrastructure and interrupting supply chains. For example, an Atlantic hurricane could disrupt vital transportation of materials and shut down supplier plants in southern Ontario (NRTEE, 2012b).

Changes in consumer demands and preferences resulting from climate change (and a growth in environmental

awareness among the public and stakeholders) present indirect opportunities and risks for several areas of manufacturing. Generally speaking, milder winters and warmer summers may increase the demand for certain consumer products and decrease it for others (e.g. increase in demand for air conditioners during the summer months; Wilbanks et al., 2007; *see* Chapter 3). Areas of manufacturing that are greenhouse gas-intensive could face risks as consumers start purchasing products that are more energy efficient, thereby helping to mitigate climate change (Ceres, 2010).

ADAPTATION

While the Canadian manufacturing sector is engaged in some adaptation initiatives (*see* Case Study 5), specific adaptation measures tend not to be reported or documented in available literature. International research does, however, provide some insight into manufacturing strategies for dealing with existing climate variability and extreme weather. These strategies have been identified as "soft measures" that could help integrate climate change adaptation across the firm or sector by integrating considerations of longer-term climate impacts (Agrawala et al., 2011).

Environmental management systems are often employed at a site level to deal with changes in energy, water availability or weather extremes (Agrawala et al., 2011). Supply-chain management is another strategy that manufacturers currently employ to mitigate risks from extreme weather. For example, developing strategies that promote flexibility in the supply chain can reduce damage from extreme weather events. The use of multiple suppliers, locating production across different facilities, and generating surpluses of certain goods that are frequently interrupted can improve the resiliency of supply chains to extreme weather and climate variability (Agrawala et al., 2011). Business continuity planning is another strategy manufacturers use to deal with extreme weather. Proactive planning that develops contingencies for an interruption can play a significant role in mitigating the cost of extreme weather (Forfas, 2011). In addition, most manufacturers buy business interruption insurance which can help to recover lost income in the event that extreme weather causes a disruption in operations (Chasan, 2012).

While the business resilience reports of the National Roundtable on the Environment and the Economy (NRTEE) focus on the broader implications of climate change for the business sector, rather than a specific focus on manufacturing, they do highlight some barriers to effective adaptation relevant to this sector and common to sectors discussed in this chapter. Manufacturers have difficulty translating climate change impacts and risks into information that is decision-useful for key processes. In addition, the sector is unsure of the cost-benefits or effectiveness of adaptation as a business strategy (NRTEE, 2012b). The research also notes that an absence of regulation or policy that encourages manufacturers to reduce their exposure to climate change impacts is an important barrier. For example, regulations that reduce the use of water for manufacturing processes in areas where water scarcity is expected to increase could be an important motivator for adaptation among firms (NRTEE, 2012b).

4.5 TRADE

Research on the link between climate change adaptation and trade remains an emerging field. Changes to a country's comparative trade advantage and the supply chains that support global trade networks are the two most significant climate change impacts (Tamiotti et al., 2009). Countries that rely on agricultural production for a comparative advantage are most at risk from climate change (Perez-Garcia et al., 2002; Julia and Duchin, 2007; Tamiotti et al., 2009). Canada's exposure to these trade markets is minimal compared to the U.S., EU or Japan (DFAIT, 2012). There is evidence that supply chains affecting Canadian trade markets are exposed to climate change risks. For example, the 2011 Thailand floods

CASE STUDY 5

RIO TINTO ALCAN

Rio Tinto Alcan is one of the world's largest manufacturers of aluminum (NRTEE, 2012a). The smelting operations that form a large portion of Rio Tinto Alcan's business rely on large capital investments, long lead times for new developments, and lean supply chains. Ensuring that every link in the supply chain is free of delay or disruption is an important aspect of managing facilities and operations. Failing to address possible consequences of events that can disturb supply chain efficiency can result in significant losses for the company. For example, in 2011, the aluminum market suffered production disruptions as a result of flooding along the ports of the Mississippi River (NRTEE, 2012a). To improve business performance and adapt to predicted climate change patterns, Rio Tinto Alcan is developing a climate change framework which will aid them in assessing the sensitivity of the supply chain and other operations, as well as infrastructure, to risks associated with climate change.

This framework is designed to identify a wide variety of risks, including vulnerability of transport systems, potential for downtime of essential operations resulting from extreme weather events, and varied power generation capacities. It acknowledges the importance of considering climate change scenarios, and the company has formed a collaborative research alliance with the Ouranos consortium to improve its understanding of the impacts of climate change on the Lac Saint-Jean basin in Quebec. These initiatives will allow Rio Tinto Alcan to integrate climate change impacts into the risk management and adaptation portion of their business model.

disrupted supply chains to Canadian manufacturing importers (DFAIT, 2012). In-depth analysis of the climate sensitivity of Canada's trade networks with its major partners is needed.

ADAPTATION

Trade has played an important role in addressing the impact of climate variability or extreme weather on a country's economy. Research suggests this capacity could also play an important role in climate change adaptation. If a country experiences a scarcity of goods as a consequence of climate change impacts, such as a drought that limits agricultural production, other trade partners could step in and fill that demand gap (Tamiotti et al., 2009). For example, a longer growing season in Canada could lead to agricultural surpluses that would offset a scarcity of goods in other parts of the world. Adaptation in this context would involve targeting and promoting growth in sectors that may be able to address scarcity in other countries as a consequence of climate change.

Demand for climate change adaptation expertise and information is also increasing and could represent an export opportunity for some countries (UNEP-FI and SBI, 2011). As a country that experiences highly variable weather, Canadian expertise on risk management and financial risk-transfer tools that offset these risks could take advantage of more global demand.

Adaptive actions that reduce the vulnerability of trade supply chains have been discussed in previous assessments in the context of transportation (*see also* Chapter 8 – Water and Transportation Infrastructure). For example, measures such as dykes and sea walls are important to protect ports from sea-level rise or storm surges (Vasseur and Catto, 2008). These actions have often been employed in response to significant historical events and could be used to improve the resiliency of key transport hubs to climate change. Like other industrial sectors, accurate cost-benefit analysis on the implementation of adaptation to protect supply chains does not exist. The lack of this data represents an important barrier to effective adaptive actions in the trade sector (Tamiotti et al., 2009).

5. CONCLUSIONS AND MOVING FORWARD

Research on climate change adaptation and Canadian industry has tended to focus on insurance and tourism, sectors that are most exposed to climate risks. Sectors that are less climate-sensitive but important economic contributors have yet to receive significant attention from the research community. Existing studies make a distinction between "direct" climate impacts, such as extreme weather, and "indirect" impacts, such as changes in consumer demand. Most research to date focuses on direct impacts, with only limited information available on indirect impacts.

This assessment suggests that Canadian businesses are starting to integrate adaptation into business decision making, but that actions that support adaptation within Canadian industry have yet to be implemented on a wide scale. Again, the greatest progress has been documented for insurance and tourism. The case studies in this chapter reveal that industry supports adaptation when climate impacts are prioritized and understood by key stakeholders within the sector. However, documented changes in practices are largely reactive, in response to variation in the weather or extreme events, rather than being proactive in response to projections of future climate. These reactive actions often involve the same tools that industry would use to promote adaptation. Research has identified some important needs to be addressed before such adaptation is likely to occur on a wide scale. These include the development of expertise about the impacts of climate change on business within each sector, and a better understanding of the cost-benefit behind adaptive actions. Weak market demand for adaptive actions, such as changes in consumer preferences or government policies that support adaptation, also represents a barrier.

The lack of research on how to address these barriers represents an important gap. There is little research that helps translate climate data and adaptive actions into language that fits into decision-making frameworks used by Canadian industry. This includes quantification of costs and benefits related to both climate impacts and adaptation actions. Research on the "indirect" impacts of climate change, such as evolving customer preferences, financial liability or government regulations is also an underdeveloped area. Such research would help inform how businesses can be incentivized to implement adaptation. Finally, more case studies on effective business strategies for addressing existing climate risk are needed. Such case studies provide a benchmark for "business-as-usual" approaches to climate risk that can be evaluated against proactive examples of adaptation. This comparison can generate important information, such as the costs, labour, materials or management strategy required for effective adaptation in industry.

REFERENCES

ACT [Adaptation to Climate Change Team] (2013): Adaptation to Climate Change Team; <http://act-adapt.org/programs/>.

Agrawala, S., Carraro, M., Kingsmill, N., Lanzi, E., Mullan, M., and Prudent-Richard, G. (2011): Private Sector Engagement in Adaptation to Climate Change; OECD Environment Working Papers 39. Paris: OECD.

Aldy, J. E., and Pizer, W.A. (2011): The Competitiveness Impacts of Climate Change Mitigation Policies Regulatory Policy Program, Harvard University, Cambridge, MA; <http://www.hks.harvard.edu/m-rcbg/rpp/Working%20papers/RPP_2011_08_Aldy_Pizer.pdf>.

AMF [Autorité des marchés financiers] (2011): Managing Climate Change Risks; Autorité des marchés financiers; <http://www.lautorite.qc.ca/files//pdf/publications/professionnels/assurance/AMF-climate-change-web.pdf>.

Arup Group Limited (2008): Your Home in a Changing Climate. London, UK: Three Regions Climate Change Group; <http://www.arup.com/Publications/Your_home_in_a_changing_climate.aspx>.

Auld, H. (2008): Adaptation by Design: The Impact of Changing Climate on Infrastructure. Journal of Public Works and Infrastructure, 3: 276–288.

Auld, H., Waller, J., Eng, S., Klaassen, J., Morris, R., Fernandez, S., Cheng, V., and MacIver, D. (2008): The Changing Climate and National Building Codes and Standards; Ottawa, Canada: Environment Canada.

Bigano, A., Hamilton, J., and Tol, R. (2007): The Impact of Climate Change on Domestic and International Tourism: a Simulation Study, in Integrated Assessment Journal 7: 25–49.

Bobelian, M. (2012): An Alaskan Town Threatened by Climate Change Loses in Court; Forbes, September 26; <http://www.forbes.com/sites/michaelbobelian/2012/09/26/an-alaskan-town-threatened-by-climate-change-loses-in-court/>.

Bourque, A. and Simonet, G. (2008): Quebec; in From Impacts to Adaptation: Canada in a Changing Climate 2007, edited by D.S. Lemmen, F.J.Warren, J. Lacroix and E. Bush; Government of Canada, Ottawa, ON, p. 171-226.

Bouwer, L. (2010): Have Disaster Losses Increased Due to Anthropogenic Climate Change? American Meteorological Society; p. 39–46.

Browne, S. and Hunt, L. (2007): Climate Change and Nature-based Tourism, Outdoor Recreation, and Forestry in Ontario: Potential Effects and Adaptation Strategies; Ontario Ministry of Natural Resources.

Bruce, J. P. and Haites, E. (2008): Canada in an International Context in From Impacts to Adaptation: Canada in a Changing Climate, 2007, (ed.) D.S. Lemmen, F.J. Warren, J. Lacroix, and E. Bush, p. 387–424. Government of Canada, Ottawa.

Butsic, V., Hanak, E., and Valletta, R. (2011): Climate Change and Housing Prices: Hedonic Estimates for Ski Resort in Western North America; Land Economics, 87: 75–91.

Camilleri, M. (2001): Impacts of Climate Change on Building Performance in New Zealand; Building Research & Information, 29 (6): 440–450.

Campbell, R. J. (2012): Weather-related Power Outages and Electric System Resiliency; CRS Report for Congress. Congressional Research Service; <http://www.fas.org/sgp/crs/misc/R42696.pdf>.

Canadian Chamber of Commerce (2012): Top 10 Barriers to Competitiveness; Canadian Chamber of Commerce, Ottawa; <http://www.chamber.ca/images/uploads/Top10/Top10Barriers.pdf>.

CCAP [Climate Change Adaptation Program] (2012): Climate Change Adaptation: A Priorities Plan for Canada; Waterloo, ON: Climate Change Adaptation Project; <http://adaptnowcanada.ca/report/>.

Ceres (2010): Climate Change Risk Perception & Management: A Survey of Risk Managers; Ceres, Boston; <http://www.ceres.org/resources/reports/risk-manager-survey>.

Ceres (2013): Shareholder Resolutions. Coalition for Environmentally Responsible Economies; <http://www.ceres.org/investor-network/resolutions>.

Chasan, E. (2012): Q&A: An Insurer's Take on Business Interruptions After Hurricane Sandy; Wall Street Journal, November; <http://mobile.blogs.wsj.com/cfo/2012/11/02/qa-an-insurers-take-on-business-interruptions-after-hurricane-sandy/>.

CHBA [Canadian Home Builders Association] (2011): Canadian Housing Industry - Performance and Trends; Canadian Home Builders Association; <http://vancouver.ca/ctyclerk/civicagencies/housing/RPRT_Housing_Industry_Performance_and_Trends_Oct_2011.pdf>.

Cheng, C.S., Li, Q., Li, G., and Auld, H. (2012): Climate Change and Heavy Rainfall-Related Water Damage Insurance Claims and Losses in Ontario, Canada; Journal of Water Resource and Protection, no. 4, p. 49–62.

Chiotti, Q. and Lavender, B. (2008): Ontario; in From Impacts to Adaptation: Canada in a Changing Climate 2007, edited by D.S. Lemmen, F.J.Warren, J. Lacroix and E. Bush; Government of Canada, Ottawa, ON, p. 227-274.

Choi, O. and Fisher, A. (2003): The Impact of Socioeconomic Development and Climate Change on Severe Weather Catastrophe Losses: Mid-Atlantic Region and the U.S.; Climate Change, no. 58, p. 149–170.

CICA [Canadian Institute of Chartered Accountants] (2009): Building a Better MD&A: Climate Change Disclosures; Canadian Performance Reporting Board; <http://www.cica.ca/research-and-guidance/mda-and-business-reporting/mda-publications/item12846.pdf>.

Coleman, T. (2002): The Impact of Climate Change on Insurance Against Catastrophes; Melbourne: Insurance Australia Group.

COTABC [Council of Tourism Associations of British Columbia] (2009): Council of Tourism Associations of British Columbia Tourism Sector Strategy: For the Southern Interior Region in Response to Mountain Pine Beetle; <http://torc.linkbc.ca/torc/downs1/COTA_MPB_Strategy_Executive_Summary.pdf>.

CSA [Canadian Securities Administrators] (2012): Staff Notice 51-333 Environmental Reporting Guidance; Canadian Securities Administrators; <http://www.osc.gov.on.ca/documents/en/Securities-Category5/csa_20101027_51-333_environmental-reporting.pdf>.

Cutter, S., Osman-Elasha, B., Campbell, J., Cheong, S.-M., McCormick, S., Pulwarty R., Supratid, S., and Ziervogel, G. (2012): Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation; in Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, (ed.) C.B. Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, et al., p.339–392. A Special Report of the Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC); Cambridge University Press, Cambridge, UK.

Cycle Country (2006): Record All-terrain Vehicle - ATV - Sales in US Deliver Double-digit Growth Again; <www.cyclecountry.com>.

Dailey, P., Huddleston, S., and Fasking, D. (2009): The Financial Risks of Climate Change; ABI Research Paper No. 19.

Dawson, J. and Scott, D. (2012): Managing for Climate Change in the Alpine Ski Sector; Tourism Management.

Dawson, J., Stewart, E.J., Lamelin, H., and Scott, D. (2010): The Carbon Cost of Polar Bear Viewing in Churchill, Canada; Journal of Sustainable Tourism 18: 319–336.

Deilmann, C. (2004): Climate Change: Lessons from Germany; Building Research & Information, v. 32, no. 1, p. 65–66.

Deutsche Bank Research (2008): Climate Change and Tourism: Where Will the Journey Take Us?; Berlin.

DFAIT [Department of Foreign Affairs and International Trade] (2012): Canada's State of Trade: Trade and Investment Update 2012; Ottawa, Canada: Department of Foreign Affairs and International Trade Canada; <http://international.gc.ca/economist-economiste/assets/pdfs/performance/SoT_2012/SoT_2012_Eng.pdf>.

Dickson, J. (2012): Remarks by Superintendent Julie Dickson to the 2012 National Insurance Conference of Canada (presentation); National Insurance Conference of Canada, October 1, Quebec City; <http://www.osfi-bsif.gc.ca/app/DocRepository/1/eng/speeches/jd20121001_e.pdf>.

Dlugodecki, A. (2009): Coping with Climate Change: Risks and Opportunities; London: Chartered Insurance Institute.

Dodds, R. and Kuenzig, G. (2009): Climate Change and Canada's Municipal Destination Marketing Organizations; The Icarus Foundation; <http://www.theicarusfoundation.com/pdf/ExecSummaryDMOandCC_Final.pdf>.

Dotto, L., Duchesne, L., Etkin, D., Elianna, J., Joe, P., Jones, B., Koshida, G., et al. (2010): Canadians at Risk: Our Exposure to Natural Disasters; ICLR Research Paper Series - Number 48. Institute for Catastrophic Loss Reduction; <http://www.iclr.org/images/Canadians_at_Risk_2010.pdf>.

Dunne, J.P., Stouffer, R.J., and John, J.G.(2013): Reductions in Labour Capacity from Heat Stress Under Climate Warming; Climate Change, v. 10.

Ebner, D. (2008): Deep Snow, Deep Pockets: It's a Billon-dollar Bet on Climate Change; The Globe and Mail, January.

ECO [Environmental Commissioner of Ontario] (2012): Ready for Change? An Assessment of Ontario's Climate Change Adaptation Strategy; Toronto: Environmental Commissioner of Ontario.

Eeuwens, K. (2009): Have Near Term CAT Risk Models Failed?; Reactions, June 15.

Environment Canada (1998): The Canada Country Study. <http://publications.gc.ca/site/eng/113767/publication.html>.

Environment Canada (2010): Climate Information to Inform New Codes and Standards; Environment Canada; <http://www.ec.gc.ca/sc-cs/default.asp?lang=En&n=20CD1ADB-1>.

Foghaden, C. (2012): The Blooming Paradise: Algae Blooms, Environmental Change and Tourism Impacts; Scandinavian Journal of Hospitality and Tourism.

Forfas (2011): Business Continuity Planning in Severe Weather; Dublin, Ireland; <http://www.forfas.ie/media/ffs111109-BCP_in_Severe_Weather.pdf>.

Gossling, S., Scott, D., and Hall, C.M. (2012): Consumer Demand and Demand Response of Tourists to Climate Change; Annals of Tourism Research, v. 39, no. 1, p. 36–58.

Government of Canada (2005): A Visit to Canada's Countryside: Rural Tourism; <http://www5.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=21-006-X2005005&lang=eng>.

Government of Canada (2012a): Industry Overview: Tourism; Supporting Tourism, September 25; <http://www.tourism.gc.ca/eic/site/034.nsf/eng/h_00003.html>.

Government of Canada (2012b): Canada's Federal Tourism Strategy; <http://www.ic.gc.ca/eic/site/034.nsf/eng/00216.html>.

Graves, H.M. and Phillipson, M.C. (2000): Potential Implications of Climate Change in the Built Environment; BRE Centre for Environmental Engineering.

Hall, C.M. and Saarinen, J. (2010): Polar Tourism: Definitions and Dimensions; Scandinavian Journal of Hospitality and Tourism, v. 10, no. 4, p. 448–467.

Handmer, J., Honda, Y., Kundzewicz, N., Arnell, N., Benito, G., Hatfield J., Mohamed, I.F., and Peduzzi P. (2012): Changes in Impacts of Climate Extremes: Human Systems and Ecosystems; in Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, (ed.) C.B. Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, et al., p. 339–392. A Special Report of the Working Groupsl and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK.

Hanna, E.G., Kjellstrom, T., Bennett C., and Dear, K. (2011): Climate Change and Rising Heat: Population Health Implications for Working People in Austrialia; Pacific Journal of Public Health, v. 23, no. 2, p. 145–265.

Hertin, J., Berkhout, F., Gann, D.M., and Barlow, J. (2003): Climate Change and the UK House Building Sector: Perceptions, Impacts and Adaptive Capacity; Building Research & Information, v. 31, no. 3-4, p. 278–290.

IBC [Insurance Bureau of Canada] (2008): Facts of the General Insurance Industry in Canada; Toronto: Insurance Bureau of Canada.

IBC [Insurance Bureau of Canada] (2009): Facts of the General Insurance Industry in Canada; Toronto: Insurance Bureau of Canada.

IBC [Insurance Bureau of Canada] (2011a): Municipal Storm and Sanitary Infrastructure Risk Assessment Tool Project; Insurance Bureau of Canada.

IBC [Insurance Bureau of Canada] (2011b): Southern Alberta Windstorms Cost $200 Million in Insured Damage; Insurance Bureau of Canada; <http://www.ibc.ca/en/Media_Centre/News_Releases /2011/12-22-2011.asp>.

IBC [Insurance Bureau of Canada] (2012a): Canadian Severe Weather - Events and Insured Damage; Insurance Bureau of Canada; <http://www.ibc.ca/en/Media_Centre/News_Releases/2012/05-31-2012-2.asp>.

IBC [Insurance Bureau of Canada] (2012b): Municipal Risk Assessment Tool; Insurance Bureau of Canada; <http://www.ibc.ca/en/Natural_Disasters/Municipal_Risk_Assessment_Tool.asp>.

IBC [Insurance Bureau of Canada] (2012c): IBC Reminder to Torontonians About Protecting Homes from Water Damage; <http://www.ibc.ca/en/Media_Centre/News_Releases/2012/05-31-2012-2.asp>.

IBC [Insurance Bureau of Canada] (2013a): June Alberta Floods are Costliest Insured Natural Disaster in Canadian History – Estimate of insured losses exceed $1.7 billion; Media Release, September 23, 2013, online, <ibc.ca/en/Media_Centre/News_Releases/2013/June_Alberta_Floods_are_Costliest_Insured_Natural_Disaster_in_Canadian_History.asp>.

IBC [Insurance Bureau of Canada] (2013b): Preliminary insured losses released in the most expensive natural disaster in Ontario history – IBC expects the number to go even higher; Media Release, August 14, 2013, online, <ibc.ca/en/Media_Centre/News_Releases/2013/Preliminary_insured_losses_released_in_the_most_expensive_natural_disaster_in_Ontario_history.asp>.

ICLR [Institute for Catastrophic Loss Reduction] (2007): ICLR and The Co-operators Complete Canada's First Safer Living Home; Cat Tales; <http://www.iclr.org/images/CatTales1_1_.pdf>.

ICLR [Institute for Catastrophic Loss Reduction] (2010): Home Builder's Guide: Designed for Safer Living; Institute for Catastrophic Loss Reduction.

ICLR [Institute for Catastrophic Loss Reduction] (2012): A Plan Forward: Building Practices to Increase the Resilience of Homes to Severe Weather; Toronto: Institute for Catastrophic Loss Reduction.

IFC [Intact Financial Corporation] (2012): Natural Disaster and Intact Insurance; Intact Financial Corporation; <http://library.constantcontact.com/download/get/file/1103201627468-256/Water+Damage+Fact+Sheet.pdf>.

Industry Canada (2011): Canadian Industry Statistics: GDP Canadian Economy; Industry Canada; <http://www.ic.gc.ca/eic/site/cis-sic.nsf/eng/h_00013.html#vla2b>.

IPCC [Intergovernmental Panel on Climate Change] (2012): Summary for Policymakers; in Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, 3–21, (ed.) C.B. Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, and New York, NY, USA, p. 1-19.

Jones, B. and Scott, D. (2006): Climate Change, Seasonality and Visitation to Canada's National Parks; Journal of Parks and Recreation Administration, v. 24, no. 2, p. 42–62.

Julia, R. and Duchin, F. (2007): World Trade as the Adjustment Mechanism of Agriculture to Climate Change; Climatic Change, v. 83, no. 3-4, p. 393–409.

Kjellstrom, T. and Crowe, J. (2011): Climate Change, Workplace Heat Exposure, and Occupational Health and Productivity in Central America; International Journal of Occupational and Environmental Health, v. 17, no. 3., p. 270–281.

Kovacs, P. (2012): Insurance: Aligning Price of Insurance with Risk of Damage; in Climate Change Adaptation: A Priorities Plan for Canada, (ed.) B. Feltmate and J. Thistlethwaite; Climate Change Adaptation Project, Waterloo, ON.

KPMG (2010): Climate Change and Sustainability Services; KPMG; <http://www.kpmg.com/Global/en/WhatWeDo/Advisory/Risk-Compliance/Internal-Audit/Climate-Change-Sustainability-Services/Pages/default.aspx>.

Kunkel, K.E., Bromirski, P.D., Brooks, H.E., Cavazos, T., Douglas, A.V., Easterling, D.R., Emanuel, K.A., et al. (2008): Observed Changes in Weather and Climate Extremes, in Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Caribbean and U.S. Pacific Islands; A Report by the U.S. Climate Change Science Program and the Subcomittee on Global Change Research, Washington D.C..

Kunreuther, H., Michel-Kerjan, E., Doherty, N.A., Grace, M.F., Klein R.W., and Pauly, M.V. (2009): At War with the Weather: Managing Large-Scale Risks in a New Era of Catastrophes; MIT Press, Cambridge, MA.

Lal, P.N., Mitchell, T., Aldunce, P., Auld, H., Mechler, R., Miyan, A., Romano, L.E., and Zakaria, S. (2012): National Systems for Managing the Risks from Climate Extremes and Disasters; In Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, edited by C.B. Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, et al., 339–392. A Special Report of the Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC); Cambridge University Press, Cambridge, UK.

Laporte, D. (2011): Ontario Code Tops in Energy Efficiency; The Toronto Star, August 19. <http://www.yourhome.ca/homes/article/1041046>.

Lemelin, H., Dawson, J., and Stewart, E. (2012): Last Chance Tourism. London: Routledge.

Lemelin, H., Dawson, J., Stewart, E., and Lueck, M. (2010): Last-chance Tourism: The Boom, Doom and Gloom of Visiting Vanishing Destinations; Current Issues in Tourism, v. 13, no. 5, p. 477–493.

Lemieux, C., Beechey, T., and Scott, D. (2011): The State of Climate Change Adaptation in Canada's Protected Areas Sector; Canadian Geographer, v. 55, no. 3, p. 301–317.

Lemieux, C. and Scott, D. (2011): Changing Climate, Challenging Choices: Identifying and Evaluating Adaptation Options for Conservation; v. 48, no. 4, p. 675–690.

Lemieux, C., Scott, D., Davis, R.G., and. Gray, P.A. (2008): Changing Climate Challenging Choices: Ontario Parks and Climate Change Adaptation; Natural Resources Canada, Ottawa.

Lemmen, D.S., Warren, F.J., and Lacroix, J. (2008): Synthesis; in From Impacts to Adaptation: Canada in a Changing Climate 2007, (ed.) D.S. Lemmen, F.J. Warren, J. Lacroix, and E. Bush, p. 1–20; Government of Canada, Ottawa.

Leurig, S. (2011): Climate Risk Disclosure by Insurers: Evaluating Insurer Responses to the NAIC Climate Disclosure Survey; A Ceres Report. Boston: Ceres.

Leven met Water. (2007): Towards a Climate-proof Netherlands; Amsterdam, Netherlands; <http://www.levenmetwater.nl/static/media/files/Routeplanner_eng.pdf>.

Lindell, R. (2012): Extreme Weather Hit National Parks Hard in 2011; Global News; <http://www.globalnews.ca/force%20of%20nature/6442585028/story.html>.

Lio & Associates (2010): A Study of Prescriptive Requirements for Energuide 80 in Ontario's Building Code; Report for Ontario Ministry of Municipal Affairs and Housing; Toronto; <http://www.mah.gov.on.ca/Asset8297.aspx?method=1>.

Liso, K.R., Aandahl, G., Eriksen, S., and Alfsen, K.H. (2003): Preparing for Climate Change Impacts in Norway's Built Environment; Building Research & Information, v. 31, no. 3-4, p. 200–209.

Lister, M. (2008): Climate Change, Trade and Competitiveness: Risks and Opportunities in a North American Perspective; Public Policy Forum.

Lowe, R. (2004): Lessons from Climate Change: A Response to the Commentaries; Building Research & Information, v. 32, no. 1, p. 75–78.

Marr, G. (2011): Climate Change Blamed for Spike in Home Insurance Premiums; The Financial Post, November; <http://business.financialpost.com/2011/11/17/climate-change-blamed-for-spike-in-home-insurance-premiums/?__lsa=fa67-72a2>.

McBean, G. (2012): Telling the Weather Story; Institute for Catastrophic Loss Reduction and Insurance Bureau of Canada.

McBoyle, G., Scott, D., and Jones, B. (2007): Climate Change and the Future of Snowmobiling in Non-mountainous Regions of Canada; Managing Leisure v. 12, no. 4, p. 237–250.

Mills, E. (2007): From Risk to Opportunity - Insurer Responses to Climate Change; Ceres.

Mills, E. (2009a): A Global Review of Insurance Industry Responses to Climate Change; The Geneva Papers, no. 34, p. 323–359.

Mills, E. (2009b): From Risk to Opportunity: Insurer Responses to Climate Change; Ceres.

Mills, E. (2012): The Greening of Insurance; Science, 338 (December); p. 1424–1425.

Mills, E. and Lecomte, E. (2005): Availability and Affordability of Insurance Under Climate Change: A Growing Threat for the U.S; Ceres.

Mills, E. and Lecomte, E. (2006): From Risk to Opportunity: How Insurers Can Proactively and Profitably Manage Climate Change; Ceres.

Mills, E. Lecomte, E., and Peara, A. (2001): U.S. Insurance Perspectives on Global Climate Change; Lawrence Berkeley National Laboratory, U.S, Department of Energy, University of California; <http://evanmills.lbl.gov/pubs/pdf/climate_report.pdf>.

Milne, J. (2004): Climate Change, Insurance and the Building Sector: Synergisms, Conflicts and Adaptive Capacity; Building Research & Information, v. 32, no. 1, p. 48–54.

Min, S-K., Zhang, X., Zwiers, F.W., and Hergerl, G.C. (2011): Human Contribution to More-intense Precipitation Extremes; Nature, no. 470, p. 378–381.

MOE [Ontario Ministry of Environment] (2011): Climate Ready: Ontario's Adaptation Strategy and Action Plan; Ontario Ministry of Environment, Toronto.

Morna, I. and van Vuuren, D. (2009): Modelling Global Residential Sector Energy Demand for Heating and Air Conditioning in the Context of Climate Change; Energy Policy, v. 37, no. 2, p. 507–521.

Morrison, J., Morikawa, M., Murphy, M. and Schulte, P. (2009): Water Scarcity & Climate Change: Growing Risks for Busiensses and Investors; Boston: Ceres and Pacific Institute; <http://www.thesapientsolution.com/research/20090525_Water_Scarcity_and_Climate_Change_thesapientsolution.pdf>.

MPI [Manitoba Public Insurance] (2011): Manitoba Public Insurance Annual Report; Winnipeg: Manitoba Public Insurance; <http://mpi.mb.ca/AnnualReport/AnnualReport2011/PDFs/Financial.pdf>.

NOAA [National Oceanic and Atmospheric Administration] (2012): Climate Change and Harmful Algal Blooms; <http://www.cop.noaa.gov/stressors/extremeevents/hab/current/CC_habs.aspx>.

NRTEE [National Round Table on the Environment and the Economy] (2011): Paying the Price: The Economic Impacts of Climate Change for Canada; 04, Climate Prosperity. National Round Table on Environment and Energy, Ottawa.

NRTEE [National Round Table on the Environment and the Economy] (2012a): Climate Prosperity: Case Studies; National Round Table on Environment and Energy; <http://nrtee-trnee.ca/wp-content/uploads/2012/03/cp5-case-studies.pdf>.

NRTEE [National Round Table on the Environment and the Economy] (2012b): Facing the Elements: Building Business Resilience in a Changing Climate; 05, Climate Prosperity; National Round Table on Environment and Energy, Ottawa.

OECD [Organisation for Economic Co-operation and Development], and UNEP [United Nations Environment Programme] (2011): Climate Change and Tourism Policy in OECD Countries; Paris: Organisation for Economic Co-operation and Development and United Nations Environment Program.

Olcese, A. (2010): Climate Change: A Wave of Opportunity for Property and Casualty Insurers; Beyond Risk.

Oulehan, G. (2010): Habitat for Resilience; Canadian Underwriter, October; <http://www.canadianunderwriter.ca/news/habitat-for-resilience/1000389796/>.

Parker, P., Scott, D., and Rowlands, I. (2000): Residential Energy Consumption and Greenhouse Gas Emissions: Global Context for Local Action; Environments, v. 28, no. 3, p. 11–28.

Pegg, H. (2011): Thai Floods Capsize North American Production; Autonet.ca, November; <http://www.autonet.ca/auto-news/automotive-industry-news/2011/11/24/thai-floods-capsize-north-american-production/>.

Perez-Garcia, J., Joyce, L.A., Mcguire, D., and Xiao, X. (2002): Impacts of Climate Change on the Global Forest Sector; Climatic Change, v. 54, no. 4, p. 439–461.

Peterson, T.C., Zhang, X., Brunet-India, M., and Vazquez-Aguirre, J.L. (2008): Changes in North American Extremes Derived from Daily Weather Data; Journal of Geophysical Research - Atmospheres, v. 113.

Richardson, G.R.A. and Otero, J. (2012): Land use planning tools for local adaptation to climate change; Natural Resources Canada, Ottawa, ON.: Government of Canada, 38 p. <http://www.nrcan.gc.ca/earth-sciences/sites/www.nrcan.gc.ca.earth-sciences/files/files/landuse-e.pdf>.

Robinson, G. (2011): Extreme Weather and Insurance; November, NRTEE-NBC Climate Change Adaptation Forum.

Robinson, G. (2012): P&C Insurance: State of the Industry (presentation); CIAA Luncheon, April 30.

Rousseau, D. (2004): Adapting to Climate Change: Some Observations; Building Research & Information, v. 32, no. 1.

Sanders, C.H. and Phillipson, M.C. (2003): UK Adaptation Strategy and Technical Measures: The Impacts of Climate Change on Buildings; Building Research & Information, v. 31, no. 3-4, p. 222–230.

Sandink, D. (2009): The Resiliency of the City of Kelowna: Exploring Mitigation Before, During and After the Okanagan Mountain Park Fire; ICLR Research Paper Series - Number 45. Institute for Catastrophic Loss Reduction; <http://www.iclr.org/images/ICLR_Report_Kelowna_D4_2.pdf>.

Sandink, D. (2011): Involving Homeowners in Urban Flood Risk Reduction: A Case Study of the Sherwood Forest Neighbourhood; ICLR Research Paper Series - No. 51. Institute for Catastrophic Loss Reduction.

Sandink, D. and McGillivray, G. (2012): Insurance: Adaptation for Existing Homes; in Climate Change Adaptation: A Priorities Plan for Canada, (ed.) B. Feltmate and J. Thistlethwaite; Climate Change Adaptation Project, Waterloo, ON.

Sauchyn, D. and Kulshreshtha, S. (2008): Prairies; in From Impacts to Adaptation: Canada in a Changing Climate 2007, (ed.) D.S. Lemmen, F.J. Warren, J. Lacroix, and E. Bush, p. 275–328; Government of Canada, Ottawa.

SCC [Standards Council of Canada] (2013): Northern Infrastructure Standardization Initiative; Standards Council of Canada; <http://www.scc.ca/en/stakeholder-participation/roadmaps-and-standardization-solutions/northern-Infrastructure-standardization-initiative>.

Scott, D. (2006): Climate Change and Sustainable Tourism in the 21st Century; in Tourism Research: Policy, Planning and Prospects, (ed.) J. Cukier. Department of Geography Publication Series; University of Waterloo, Waterloo, ON.

Scott, D. (2011): Climate Change and a Healthy, Sustainable Environment: An Opportunity for Recreation and Parks Leadership; Lake Louise.

Scott, D., Amelung B., Ceron, J-P, Dubois, G., Gossling, S., Peeters P., and Simpson M. (2008): Climate Change and Tourism: Responding to Global Challenges; United Nations World Tourist Organization and United Nations Environment Programme.

Scott, D., Gossling, S., and Hall, C.M. (2012a): Climate Change and Tourism: Impacts, Adaptation and Mitigation; Routledge, London.

Scott, D., Gossling, S., and Hall, C.M. (2012b): International Tourism and Climate Change; Wiley Interdisciplinary Reviews: Climate Change v. 3, no. 3, p. 213–232.

Scott, D. and Jones, B. (2006): Climate Change and Seaonality in Canadian Outdoor Recreation and Tourism-Executive Summary. Waterloo, ON: University of Waterloo.

Scott, D. and Jones, B. (2007): A Regional Comparison of the Implications of Climate Change of the Golf Industry in Canada; The Canadian Geographer, v. 51, no. 2, p. 219–232.

Scott, D., Jones, B., and Konopek, J. (2007): Implications of Climate and Environmental Change for Nature-based Tourism in the Canadian Rocky Mountains: A Case Study of Waterton Lakes National Parks; Tourism Management, v. 28, no. 2, p. 570–579.

Scott, D., McBoyle, G., Mills, B., and Minogue, A. (2006): Climate Change and the Sustainability of Ski-based Tourism in Eastern North America. Journal of Sustainable Tourism, v. 14, no. 4, p. 376–398.

Scott, D. and Rowlands, I. (2000): Integrating Technical and Social Energy Studies: Prospects for Change in the Canadian Residential Sector; Environments, v. 28, no. 3, p. 1–10.

Scott, D. and Steiger, R. (2012): Climate Vulnerability of the Ski Industry; in Climate Vulnerability, (ed.) R Pielke; Elsevier, San Diego.

SEC [U.S. Securities and Exchange Commission] (2010): SEC Issues Interpretive Guidance on Disclosure Related to Business or Legal Developments Regarding Climate Change; <http://www.sec.gov/news/press/2010/2010-15.htm>.

Secretary of State for Environment, Food and Rural Affairs (2012): Company Reporting of Greenhouse Gas Emissions by Quoted Companies; <http://www.parliament.uk/documents/commons-vote-office/June_2012/20-06-12/3.DEFRA-Company-reporting-greenhouse-gas-emissions-by-quoted-companies.pdf>.

Seneviratne, S.I., Nicholls, N., Easterling, D., Goodess, C.M., Kanae, S., Kossin, J., Luo, Y., and Marengo, K. (2012): Changes in Climate Extremes and Their Impacts on the Natural Physical Environment; in Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, (ed.) C.B. Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, et al., p. 109–230. A Special Report of the Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC); Cambridge University Press, Cambridge, UK.

Solterra Solutions (2012): Determining the Impact of Climate Change on Insurance Risk and the Global Community. Ottawa: Canadian Institute of Actuaries; American Academy of Actuaries; Society of Actuaries; Casualty Actuarial Society.

St. Denis, G. and Parker, P. (2009): Community Energy Planning in Canada: The Role of Renewable Energy; Renewable and Sustainable Energy Reviews, p. 2088–2095. Canada;a26?lang=eng&retrLang=eng&id=1870002&paSer=&pattern=&stByVal=1&p1=1&p2=37&tabMode=dataTable&csid>.

Statistics Canada (2012a): Table 187-0002 – Quarterly statement of changes in financial position, by North American Industry Classification System (NAICS), selected financial ratios and selected seasonally adjusted components; Statistics Canada, CANSIM Database; <http://www5.statcan.gc.ca/cansim/a26?id= 1870002&pattern=&p2=37&tabMode=dataTable&p1=1&stByVal=1&paSer=&csid=&retrLang=eng&lang=eng>

Statistics Canada (2012b): Construction; Statistics Canada; <http://www.statcan.gc.ca/pub/11-402-x/2011000/chap/construction/construction-eng.htm>.

Statistics Canada (2012c): Table 281-0024 - Employment (SEPH), Unadjusted for Seasonal Variation of Employeee for Selected Industries Classified Using the North American Industry Classication Systems (NAICs); Statistics Canada, CANSIM Database; <http://www5.statcan.gc.ca/cansim/a05?lang=eng&id=2810024>.

Statistics Canada (2012d): Exports of Goods on a Balance-of-payments Basis, by Product; <http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/gblec04-eng.htm>.

Steemers, K. (2003): Towards a Research Agenda for Adapting to Climate Change; Building Research & Information, v. 31, no. 3-4, p. 291–301.

Stewart, E.J., Dawson, J., and Draper, D. (2011): Cruise-ship Tourism in Nunavut, Arctic Canada: An Analysis of Resident Perspectives; Journal of Hospitality and Tourism Management.

Stewart, E.J., Tivy, A., Howell, S.E.L., Dawson, J., and Draper, D. (2010): Cruise Tourism and Sea Ice in Canada's Hudson Bay Region; Arctic, v. 63, no. 1, p. 57–66.

Swiss Re. (2011): The Hidden Risks of Climate Change: An Increase in Property Damage from Soil Subsidence in Europe; Swiss Re, Geneva; <http://media.swissre.com/documents/Soil_Subsidence_Publication_en_0718.pdf>.

Tamiotti, L., Teh, R., Kulacoglu, V., Olhoff, A., Simmons, B., and Hussein, A. (2009): Trade and Climate Change; United Nations Environment Programme and the World Trade Organization, Geneva; <http://www.wto.org/english/res_e/booksp_e/trade_climate_change_e.pdf>.

TD Economics (2011): Canada's Construction Sector Flexes Its Economic Muscle; TD Economics.

Thistlethwaite, J. (2012): The ClimateWise Principles: Self-Regulating Climate Change Risks in the Insurance Sector; Business & Society.

Thistlethwaite, J., Kovacs, P., and Kelly, G. (2012): Insurance: Adapting Building Codes for Climate Change; in Climate Change Adaptation: A Priorities Plan for Canada, (ed.) B. Feltmate and J. Thistlethwaite; Climate Change Adaptation Project, Waterloo, ON.

TIAC [Tourism Industry Association of Canada] (2012): The Canadian Tourism Industry - A Special Report; Tourism Industry Association of Canada, Ottawa.

UNEP-FI [United Nations Environment Programme Finance Initiative] (2009): The Global State of Sustainable Insurance; Insurance Working Group United Nations Environment Programme Finance Initiative.

UNEP-FI [United Nations Environment Programme Finance Initiative], and SBI [Sustainable Business Institute] (2011): Advancing Adaptation Through Climate Information Services; Geneva: UNEP-FI and Sustainable Business Institute; <http://www.unepfi.org/fileadmin/documents/advancing_adaptation.pdf>.

UNWTO [United Nations World Tourism Organization] (2011): Tourism Towards 2030 - Global Overview; United Nations World Tourism Organization, Madrid.

Vasseur, L. and Catto, N. (2008): Atlantic Canada; in From Impacts to Adaptation: Canada in a Changing Climate 2007, (ed.) D.S. Lemmen, F.J. Warren, J. Lacroix, and E. Bush, p. 119–170; Government of Canada, Ottawa.

Walker, I.J. and Sydneysmith, R. (2008): British Columbia; in From Impacts to Adaptation: Canada in a Changing Climate 2007, (ed.) D.S. Lemmen, F.J. Warren, J. Lacroix, and E. Bush, p. 329–386. Government of Canada, Ottawa.

Wilbanks, T.J., Romero Lankao, P., Bao, M., Berkhout, F., Cairncross, S., Ceron, J.P., Kapshe, M., Muir-Wood, R., and Zapata-Marti, R. (2007): Industry, Settlement and Society; in Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, (ed.) M.L. Parry, O.F. Canziani, P.J. Palutikof, P.J. Van der Linden, and C.E. Hanson, p. 357–390. Cambridge University Press. Cambridge, UK.

Wilton, D. and Wirjanto, T. (1998): An Analysis of the Seasonal Variation in the National Tourism Indicators; Canadian Tourism Commission, Ottawa, Canada.

World Bank (2012): Exports of Goods and Services (% of GDP); <http://data.worldbank.org/indicator/NE.EXP.GNFS.ZS>.

World Travel and Tourism Council (2012): Travel & Tourism: Economic Impact 2012 Canada; London, UK; <http://www.wttc.org/site_media/uploads/downloads/canada2012.pdf>.

Wotton, B.M., C.A. Nock, and M.D. Flannigan. (2010): Forest Fire Occurence and Climate Change in Canada; International Journal of Wildland Fire, v. 19, no. 3, p. 253–271.