



current practices

A Systematic Review of the Literature on
Business Adaptation to Climate Change
2 of 4



Network for
Business Sustainability

Business. Thinking. Ahead.

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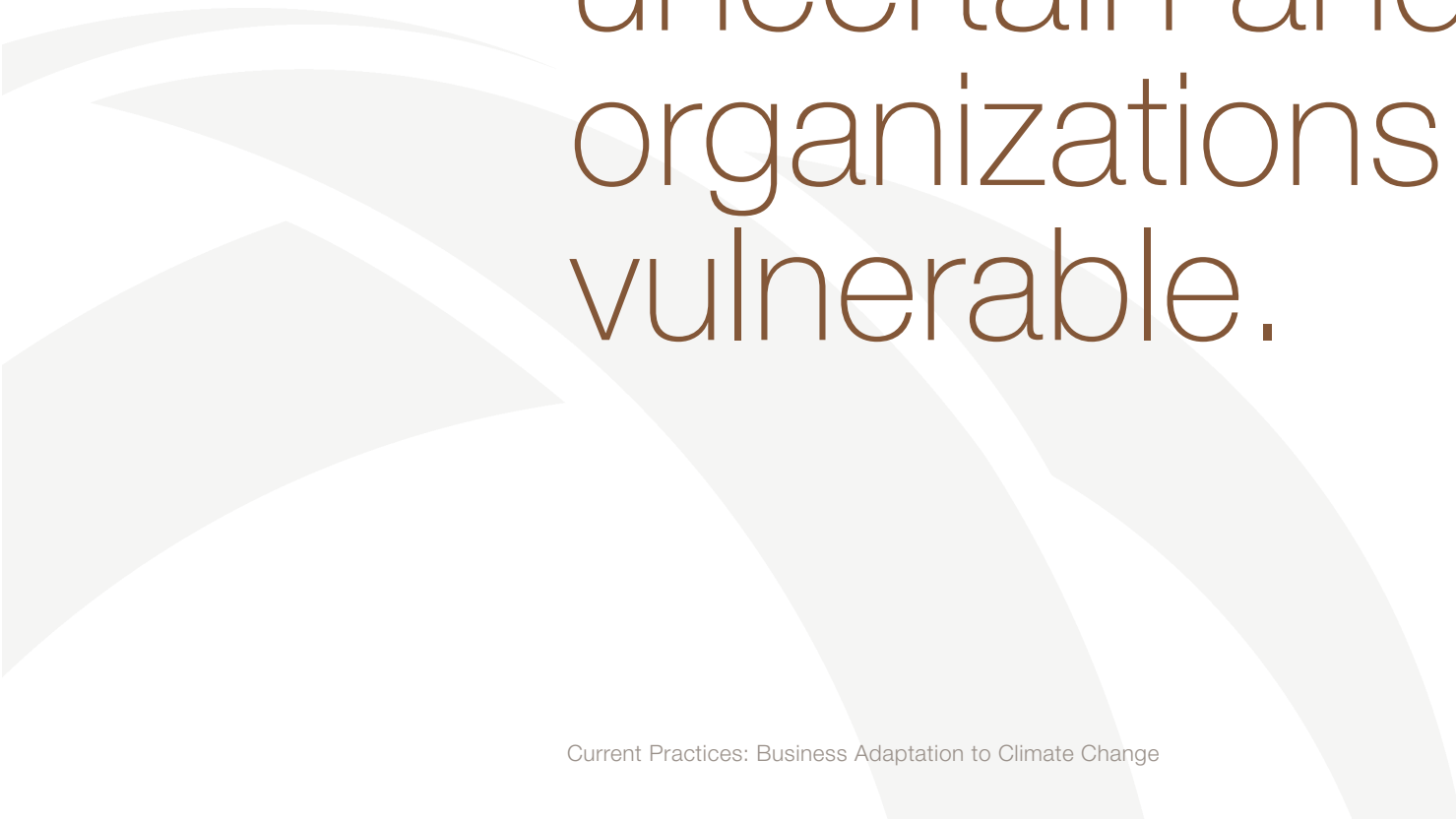
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In the short-term,
risks and
opportunities
vary by sector.



In the long-term,
everything is
uncertain and all
organizations are
vulnerable.

executive summary

Climate risks and opportunities are often sector-specific, so adaptation strategies must also vary by sector.

SUMMARY

Climate risks and opportunities are often sector-specific, so adaptation strategies must also vary by sector. The insurance sector is a leader in risk assessment, and the agriculture and tourism sectors in their awareness of climate impact. The finance sector, although highly vulnerable, is in a position to influence adaptation measures across all sectors. Managers should work within and across sectors to evaluate the risks and opportunities and develop appropriate strategies for their organization. In addition to developing sector-specific studies, researchers should conduct cross-sectoral studies to discover common concerns and solutions and promote collaboration among sectors.

BACKGROUND

There is a growing consensus among researchers and policy makers that adaptation is a central strategy in dealing with the impacts of climate change. Adaptation is most commonly described as ‘adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities’ (IPCC). In 2008-2009 the Network for Business Sustainability commissioned a systematic review to synthesize the current state of research and practice of business adaptation to climate change. This report, the second in a four part series, presents a sector-by-sector analysis of risks, opportunities, drivers, strategies, and barriers and gaps to adaptation.

FINDINGS

Some sectors are leaders in adaptation to climate change: the insurance sector in risk assessment, and agriculture and tourism sector in their awareness of climate impact. The finance sector, although highly vulnerable, is in a position to influence adaptation measures across all sectors. The water sector is facing more risks than opportunities. Tourism regions are impacted differently by climate change, but ski and coastal tropical destinations are the most at risk due to their dependence on ecological resources for recreation. Adaptation strategies in the energy sector include technological innovation (low carbon energy), building infrastructure (power grid capacity and transmission capability), and behavioural and market strategies (encouraging energy conservation). Despite sectoral differences, executives across the board see climate change as both a risk and an opportunity.

IMPLICATIONS FOR MANAGERS

Managers need to increase awareness of and efforts towards adaptation to climate change:

- Collaborate within your sector to share knowledge and address common risks. Leading organizations can share knowledge with lagging organizations and be perceived as leaders. Collaborate across sectors and with academics and other stakeholders to innovate new solutions.
- Evaluate the risks and opportunities for your sector and organization and develop appropriate strategies.

IMPLICATIONS FOR MANAGERS

Researchers must gain and share knowledge on business adaptation to climate change:

- Develop sector-specific adaptation measures: technical, managerial, financial, and behavioural.
- Study vulnerable sectors (e.g. water, agriculture, energy) to discover opportunities and develop strategies.
- Conduct cross-sectoral studies to discover common concerns and solutions that can promote collaboration among sectors.

METHODS

A systematic review of multiple and varied resources – from the public sector, the private sector, and academia, dating from 1997 to early 2009 – revealed 201 sources pertinent to business adaptation to climate change. An interpretive narrative synthesis was employed to distil the large volume of varied data into accessible and intelligible frameworks. The sources discussed 15 sectors, including insurance (35 studies), agriculture (22 studies), tourism and recreation (20 studies), energy (17 studies), water (15 studies), building and construction (16 studies), finance and banking (8 studies), and mining (5 studies).

OTHER REPORTS FROM THIS STUDY

This is the second report in a four-part series. The other reports are available from nbs.net. Report 1: Concepts & Theories; Report 3: Case Studies and Tools; Report 4: Knowledge Gaps and Future Research; and Study Methodology.

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¹ The contents of this report do not necessarily reflect the opinions of Oversight or Advisory Committee members.

introduction

This report discusses how adaptation to climate change is occurring in practice in various sectors and provides detailed summaries of risks, opportunities and strategies for sector leaders and laggards.

There is a growing consensus among researchers and a number of policy makers that adaptation should be a central strategy in dealing with the impacts of climate change. In 2008-2009 the Network for Business Sustainability commissioned a systematic review to synthesize the current state of research on business adaptation to climate change, in order to identify and advance the theory and practice in this field.

Three major questions were explored:

- Are businesses incorporating climate change into their business models and strategies? If so, how? And do differences exist across business units in terms of risks, opportunities, processes, and outcomes?
- Are certain sectors ahead of others? If yes, what drivers account for these differences, and what lessons can the leading industries offer the laggards?
- What tools and processes do businesses use to evaluate the opportunities to be gained from adapting to climate change? Are there any examples of businesses creating a competitive advantage by building adaptive capacity?

Multiple biographic databases and resources were searched – including academic studies, industry reports, think tank research, case studies, and newspaper articles – dating from 1997 to early 2009. We used a standard process for systematic reviews: definition of eligibility criteria; search for eligible titles and abstracts; selection of titles and abstracts that may be eligible; selection of eligible reports from review of full documents; and data extraction and synthesis of the material into a report. The search revealed 201 pertinent sources.

An interpretive narrative synthesis method was employed because we considered it the most appropriate to achieve the overall goals of this systematic review, particularly that of distilling an enormous amount of widely varied data into an accessible and intelligible framework for practitioners seeking to advance best practices and understand new developments in this emerging field of theory and practice. (The detailed methodology is described in a separate document, available from nbs.net.)

The research findings are available in four reports (all available from nbs.net):*

1. Concepts & Theories
2. Current Practices
3. Case Studies & Tools
4. Knowledge Gaps & Future Research

This report, “Current Practices,” discusses how adaption to climate change is occurring in practice in various sectors: including insurance, agriculture, tourism and recreation, energy, water, building and construction, and finance and banking. For each sector, a detailed summary of the risks, opportunities, drivers, adaptation strategies, sector leaders and laggards, barriers to adaptation, and gaps in climate change adaptation is given.

Report 3, “Case Studies & Tools,” goes on to discuss the knowledge gained during the systematic review – in the form of best practices, case studies, lessons learned, and tools for business.

Taking all four reports together, this study captures the current status of this critical subject of business adaptation to climate change and establishes a foundation for future work by both academic and business communities.

risks & opportunities by sector

This report is structured
on a sector-by sector basis.
The insurance sector is the most
advanced in evaluating risks.

In this report we review studies that examine which firms and sectors are adapting to climate change, and seek to identify key adaptation drivers and strategies. This literature illustrates which sectors are most at risk, and what barriers may be preventing adaptation, as well as any gaps in business practice that are identified in secondary sources. In addition, this report identifies the market opportunities of climate change that are emerging, and which sectors or firms are taking advantage of them. A table analyzing these components is given for each sector.

A few broad cross-sectoral studies (KPMG, 2008; Pricewaterhouse Coopers, 2008) have attempted to synthesize climate risks and impacts for the business community as a whole. While these are useful as an introduction, due to the variability of climate impacts, risks and opportunities across sectors, the authors believe a sector-by-sector analysis is more comprehensive and arguably more useful.

In 2008, KPMG classified four types of risk that all companies, across sectors, may face as a result of climate change. These are physical risks including weather related risks and changes in ecosystem productivity, regulatory risks including new legislation, risk to reputation, and risk of litigation. Potential risks vary on a sector-by-sector basis, from low to high levels of risk. For example, the agricultural sector is more likely to be exposed to physical risks as a result of climate change, whereas the telecommunication sector has a low level of physical risk to climate change. Nonetheless, cross-sectional research on perceived risk to climate change by

the Carbon Disclosure Project and PricewaterhouseCoopers in 2008 (Carbon Disclosure Project, 2008b) found that 84% of FTSE companies, 79% of S&P companies, and 89% of Global 500 companies surveyed reported risks to their operations from climate change.

Opportunities also vary considerably on a sector-by-sector basis. For instance, the firms operating in the high technology industries may have tremendous opportunities by inventing new technologies for water innovation (water conservation and improved quality), energy innovation (extracting energy from new sources, improving renewable energy technology), transport innovation (reduced fuel use or carbon output), and biotechnological innovation (pharmaceuticals and developing weather resistant seeds). Conversely, the water sector has seemingly few opportunities beyond water conservation measures and improved infrastructure. The aggregation of data in the global Carbon Disclosure Project study of 2008 finds perceptions of climate change opportunities on par with risks. Notably, 85% of FTSE companies, 79% of S&P companies, and 89% of Global 500 companies surveyed reported business opportunities extending from climate change.

The specificity of climate risks and opportunities suggests that adaptation strategies are generally sector specific and firm specific. Comprehensive analyses of risks, opportunities, strategies, and barriers, are often presented on a sector-by-sector basis, with the exception of only two studies that attempted to amalgamate

business risk, and only one study attempting to amalgamate business opportunity. As such, this report has been structured on a sector-by-sector basis in order to provide a comprehensive overview of the risks, opportunities, adaptation strategies, and barriers to adaptation that businesses face.

The literature provided adaptation information on the following 15 sectors: insurance (35 studies), agriculture (22 studies), tourism and recreation (20 studies), energy (17 studies), water (15 studies), building and construction (16 studies), finance and banking (8 studies), mining (5 studies), forestry (4 studies), infrastructure (3 studies), food and beverage (3 studies), information technology (2 studies), transportation (1 study), chemicals (1 study), and manufacturing (1 study).

INSURANCE SECTOR

The 35 studies reviewed on the insurance industry suggest that the sector sits at a crossroads on climate change adaptation. On the one hand, the literature views the insurance industry as a potential victim of heightened risk exposure primarily due to the increased existence and probability of catastrophic weather events. On the other hand, the literature also perceives the insurance industry's unique position to both take advantage of opportunities for new insurance products related to climate change and be a catalyst for promoting adaptation across all sectors.

The literature has generally focused on risk as losses to the industry due to property damage, health insurance losses, life insurance losses, and third-party liability claims resulting from climate change (Dlugolecki, 2008; Hecht 2008; Maynard 2008). Another significant risk to the industry is the potential loss of geographic and sector specific markets due to uninsurable climate risks. Risk modeling has become

significantly more complex due to the extreme variability and unpredictability of climate related events as the global climate system changes (Dlugolecki, 2008).

However, some literature emphasizes the potential market opportunities for the sector as a whole to take a leading role in policy and product development. Insurance is uniquely positioned to take on a role in public-private partnerships for mitigating greenhouse gas (GHG) emissions and lessening climate change, and co-coordinating a triple dividend (adaptation, disaster management, and sustainable economic development). As well, opportunities may lie in new product development such as green insurance products, catastrophe bonds, and weather derivatives. For example, Swiss Re is developing a \$60 million sustainability-based investment and venture capital portfolio to encourage the development of green energy technologies (Deering and Wade, 2002).

Major adaptation initiatives in the insurance sector, to date, have focused around building institutional networks which allow for collaboration to address the common risks to the industry. For example, the two most prominent initiatives globally, which were repeatedly referred to in industry studies, are the ClimateWise consortium and CERES. ClimateWise is a collaborative insurance initiative which is a group of over 40 leading companies and organizations in the insurance industry that collaborate to analyze and reduce risks among their client base. CERES is a US network of companies, investors, environmental organizations, and public interest groups collaborating to advance climate change solutions in insurance such as more sophisticated risk modeling, promoting risk reducing behavior through insurance, and developing new insurance products.

Table 1 below offers a detailed summary of the risks, opportunities, drivers, strategies, leaders, barriers, and gaps in climate change adaptation in the insurance sector.

Table 1 **SUMMARY OF ADAPTATION IN THE INSURANCE SECTOR²**

RISK & VULNERABILITIES

- High physical risk to climate change
- Climate change is a serious threat to the future financial stability
- Losses could raise the cost of capital and volatility of insurance markets
- Shrinking return periods due to inapplicable historical modeling, incorrect rating of risks, exposure too high, claims-capacity handling too low, credit ratings too generous
- Assets may be uninsurable against extreme events
- Higher premiums
- Potential liquidity problems
- Increased volume of claims
- Potential litigation from clients and shareholders
- Disruptions to business operations become unpredictable and more financially relevant
- Claims patterns could differ from pricing data, increasing the risk that pricing is inadequate
- Changed risks not modeled (i.e. life insurance and changed exposure to illness) Increased exposure of primary insurers will increase the cost of reinsurance; large losses may decrease the reinsurers ability to meet the cost of losses
- Risk modeling will become more complex and the quality of risk management will be increasingly important
- Certain risks will become uninsurable
- Reduced reliability of historical losses information

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END OF CODING

² Adapted from: World Business Council for Sustainable Development, 2008; Sussman and Freed, 2008; Llewlynn, 2007; Harris, 2008; Packard and Reinhardt, 2007; Meder, 2007; Deering and Wade, 2002; Lenkus, 2008; Blazey and Govid, 2007; Botzen and van den Bergh, 2008; Dlugolecki and Keykhah, 2002; Dlugolecki, 2008; Lloyd's, 2007.

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OPPORTUNITIES

- New insurance products and markets (e.g., micro-insurance for the developing world)
- Green Insurance products (Green Energy, Green Auto Hybrid Car Discounts, Pay-as-You Drive Insurance, Insurance discounts on environmentally certified buildings)
- Increased demand for risk management consulting services
- Global weather risk business (catastrophe bonds, weather derivatives)
- Better capitalized insurers benefiting indirectly through weakened competitors

DRIVERS

- Insurance companies are uniquely situated to catalyze all sectors towards climate change adaptation through both education and accurate risk assessment of climate risk
- Insurance companies need to ensure that their models and prices are accurate to avoid catastrophic losses

STRATEGIES

- Develop accurate underwriting tools such as catastrophe models to establish exposure based rates for insurance
- Better risk pricing and better wording of policies
- Support the use of green technologies and sustainable business practices to help reduce GHG emissions
- ClimateWise: general insurance sector and life insurance sector have grouped together to analyze the major risks posed by climate change, and reduce these risks among their client base
- CERES Coalition working to increase disclosure of climate risks by publicly traded companies
- UNEP Financial Initiative
- Participation in the Risk Prediction Initiative (U.S. Insurers)

LEADERS

- Travelers Inc., Munich Re, AIG, Aviva, AXA, Royal and Sun Allianz, Swiss Re, Lloyds, Zurich, Gerling

LAGGARDS

- None identified

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BARRIERS TO ADAPTATION

- Cognitive
- Political
- Analytical
- Operational
- Few companies have begun to disclose climate risk, making risk assessment difficult
- Industry has yet to properly price/quantify climate liability
- Some big markets will be uninsurable by 2025
- Limited capacity for property insurance by 2035

GAPS

- Insurance industry must widen its understanding of risk
- Need better access to current scientific information
- Sector must become more proactive
- Need for updated risk-management practices through pricing and capital allocation models
- Pricing and capital markets are deficient and lacking

AGRICULTURE SECTOR

The 22 studies reviewed on the agriculture sector revealed that climate change risk is only one of a wide range of risks the industry is exposed to. Climate change is part of a much broader risk management framework that takes into account a high rate of weather variability. However, while the sector is highly vulnerable to climate change, it is also highly adaptive due to extended, historical, and regular risk exposure to weather variability (Burton and Lim, 2005; Belliveau et. al., 2006; C-CARIN, 2004; Wall and Smit, 2006). Farmers are adapting to climate change in the short term, on a

season-to-season basis, and the literature reveals that most adaptations to climate change in the sector are reactive and short term, as opposed to proactive and long term (Burton and Lim, 2005). Agriculture is highly dependent on eco-zones, and as ecosystems change due to long term climatic change, the crop varieties, pest exposure, growing season, and water availability will all likely change differently in different agricultural zones globally (Granahan et. al., 2006).

The long historical experience of agriculture with climate variability appears to place it in an unprecedented position to adapt to climate change when compared to other sectors. Experience already with crop rotations,

changing planting patterns, and modified crop varieties place producers at an advantage to grow new crop varieties as conditions of climate change. However, to do so requires appropriate and timely information which may not always be available under conditions of long term climate change. The sector, particularly in North America and Europe, is expected to experience increased productivity of crops but only if climatic change is two degrees C or less. At temperature changes of two degrees or more, any increased crop yields may be offset by extreme weather events, pest outbreaks, or scarcity of water. As well, climate change in North America and Europe will present opportunities for a longer growing season and a wider crop variety only if technology and timing match the changes synchronously.

Adaptation strategies in the sector are highly dependent on government programs, subsidies, and technological developments. Government programs for crop insurance, safety net programs, and subsidization of research and development are drivers of adaptation for producers because they mitigate losses against potential crop failure and disaster. As well, the sector's

ability to adapt depends on technological development mediated by governments, such as the development and approval of new crop varieties as well as the development of national, regional, and local weather forecasting technologies and knowledge dissemination. Other technological developments for adaptation in the sector include the development of climate resistant crops, new irrigation technologies, and conservation tillage. However, some literature reviewed (McLeman and Smit, 2006; Smithers and Blay-Palmer, 2001) noted that substantial barriers existed with both government programs and technological strategies for adaptation. In the case of government programs, disaster subsidies may reduce the incentive to adapt due to protection from losses, and implementing technology can be impaired by high cost, patent rights, and inaccessibility for small producers.

Table 2 below offers a detailed summary of the risks, opportunities, drivers, strategies, leaders, barriers, and gaps in climate change adaptation in the agriculture sector.

Table 2 SUMMARY OF ADAPTATION IN THE AGRICULTURE SECTOR³

RISK & VULNERABILITIES

- High physical risk
- High sensitivity, but high adaptive capacity
- Loss of competitive advantage from failure to recognize new growing regions
- Interruption of supply due to inappropriately sited crops and over-dependence on high-risk regions
- Changes in availability and price of commodities
- Business interruption
- Irrigation problems due to water stress
- Decreased production for rain fed crops
- Increased risk of crop loss due to weather cycle extremes
- Increased concentration of carbon can stimulate crop growth
- Disruptions to transportation systems from storms
- Livestock could be affected physiologically and through change in feed (animal welfare)
- More refrigerated distribution and storage required
- Problems with livestock transportation; Milk production decline
- Limited availability of water and potential interruption of supply
- Equipment and expertise are linked to specific crops
- Quality issues: overheating of grain, or availability of water for pre-washed products
- Access to land during flood or extreme rain conditions
- Less frequent frosts will affect quality of certain crops
- Pests/disease
- Exposure of workforce to increased heat
- Could create imbalances in ecosystems, possibly threatening species
- Farm buildings affected by weather extremes
- USA: National output estimated to peak at 2-3°C (4-5°F) increase; output falls after 5°C increase. Southern areas more likely to face reduced output of grain production. Changes in yields due to precipitation and temperature extremes, increases in pests and disease, salination of irrigation water, changes in timing of biological events.
- Canada: Insect infestations, crop damage from extreme heat, planning problems due to less reliable forecasts, increased soil erosion, increased weed growth and disease outbreaks, decreased herbicide and pesticide efficacy, increased moisture stress and droughts.
- Europe: Countries with a warmer climate will be disadvantaged. Water shortage issues could be amplified, especially in southern Portugal, southern Spain, and Ukraine. Excess heat will tend to shorten the growing season at low latitudes.
- Greatest adverse impacts are likely to be experienced by the economies of central and northern Asia, the western Sahel, coastal tropical regions of South America, and some small island states.

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³KMPG, 2008; Pew Centre, 2004; NRCAN, 2007; Sussman and Freed, 2008; Granahan et al., 2006; C-CAIRN, 2004; Ross, 2007; Llewlynn, 2007; WBCSD, 2008; Burton and Lim, 2005.

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OPPORTUNITIES

- Climate change could allow for new crop species and varieties to be cultivated in areas where climatic conditions were unsuitable so far
- Increased yields due to extension of the growing season and temperature increases in some regions
- Canada: Increased crop productivity in warmer temperature, possibility of growing new crops, longer growing seasons, accelerated maturation rates, and decreased moisture stress.
- Europe: Agricultural sector could benefit from moderate warming (global average temperature increase of less than 2°C) in high-latitude countries. The growing season is lengthened due to the warming in certain regions.

DRIVERS

- The degree of adaptation depends on available technology, market structure, and organization
- Appropriate government incentives and programs to adapt, which include R&D for climate resistant crop technologies (e.g. drought and flood resistant seeds), subsidies for adaptation implementation (e.g. technology transfers)

STRATEGIES

- Technological developments (new crop varieties, water management innovations for water conservation and retention)
- Insurance (commercial general liability insurance, crop insurance)
- Change farm production practices (crop diversification, dropping crops, changing planting and sowing times, change land use, irrigation)
- Change farm financial management (crop shares)

LEADERS

- None identified

LAGGARDS

- None identified

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BARRIERS TO ADAPTATION

- Weather forecasting needs to be more reliable (technological lag)
- High costs for producers
- Information on risks is not always consistent or reliable
- Genetically Modified Crops (i.e. weather resistant crops) may compromise organic marketing strategies

GAP

- There is little or no understanding of what the added stress of climate change will actually do to agriculture
- To make informed decisions farmers require information on short-term seasonal and inter-annual variability for very specific localities
- There is a general sense that long-term climate change is not, and should not be, high on the farming agenda

TOURISM AND RECREATION

The 20 studies reviewed on the tourism and recreation sector revealed that the risks in the sector can be categorized as those risks that are global and those which are regional and sub-sector specific i.e. sand, sun, and ski. The risks that can affect tourism operations globally are related to a general unpredictability due to changing weather patterns that affect where tourists travel to (i.e. islands), when tourists travel (i.e. length of season), and if they will travel (i.e. improved or worsened climate conditions at home). The UNEP study on tourism in 2008 was unique among the studies, in identifying those regions of the world most at risk to climate change: namely the Caribbean, Mediterranean, Indian Ocean and small islands, Pacific Ocean and small islands, Australia, and New Zealand. Regionally, different tourist attractions are impacted differently from climate change, but most notably ski and coastal tropical destinations are

the most at risk to changing weather patterns due to their dependence on stable weather conditions and ecological resources for recreation.

Northern latitudes stand to gain from potentially longer and warmer summer seasons, as tourists choose to either remain in country or travel abroad to other northern destinations, also potentially as a reaction to increased climate extremes and loss of attractiveness (i.e. hurricanes, flooding) in traditional southern destinations. However, these opportunities for new tourist ventures may be offset by other climate affects on northern latitudes such as intolerable city heat and forest fires limiting outdoor recreation.

Adaptation strategies in the tourism and recreation sector are typically industry specific (i.e. ski or coastal resort) and involve some combination of technical, managerial, financial, or behavioural adaptations.

Technological solutions involve innovation in protecting or recreating the natural resource base of the sector and are so far most evident in the most vulnerable industries, such as the ski industry (snowmaking technology) and coastal resort industry (cyclone building protection). Management and behavioural solutions include education of guests and staff (water conservation and towel usage), ecological protection, evacuation plans

(cyclone disaster planning), and offering more indoor activities (substitute to traditional tourist attractions).

Table 3 below offers a detailed summary of the risks, opportunities, drivers, strategies, leaders, barriers, and gaps in climate change adaptation in the tourism and recreation sector.

Table 3 **SUMMARY OF ADAPTATION IN THE TOURISM AND RECREATION SECTOR**⁴

RISK & VULNERABILITIES
<ul style="list-style-type: none"> • High level of physical risk, and risks remain underestimated • Unpredictability of tourist flows due to changing weather patterns • Reputation risk • Property damage and damaged infrastructure • Stranded assets in former tourist regions • Loss of attractiveness and scenic appeal due to weather damage (vegetation and beach damage from hurricanes in tropical destinations) or destroyed resource base (low altitude ski resorts) or lost ecological resources (forest fires and reduced camping/hiking/hunting activities) • City tourism, is sensitive to extremely hot weather • Distribution of holiday trips during the year could change • Obsolescence of destinations as they become too hot, water scarce, or at risk from wild fires and the spread of formerly tropical diseases • At Risk Hot Spots 2050-2100: Caribbean, Mediterranean, Indian Ocean, Small Island Nations, Pacific Ocean and Small Island Nations, Australia and New Zealand • Longer summer, reduced southern tourism • Destruction of ecological resources on which tourism depends (snow for skiing, coral reefs for scuba diving in tropical destinations, water system health for fishing) • Coastal Zones: Rising sea levels, coastal retreat and erosion, changing wind patterns, destruction of coastal ecosystems (coral reefs, estuaries), cyclones, heavy flooding • Northern climates: Less snow

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⁴ Adapted from Becken, 2005; Bicknell and McManus, 2006; Dawson, 2007; Dubois and Ceron, 2006; Elaser and Burki, 2002; KMPG, 2008; Gossling and Hall, 2006; Hennessy et. al., 2008; McBoyle et al., 2003; Moen & Fredman, 2007; Scott and Jones, 2006; EU, 2006; Scott et. al., 2006; UNEP, 2008.

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OPPORTUNITIES

- Northern latitudes may become more attractive destinations
- Push-pull factors: warmer temperatures in home country increase demand for domestic tourism, while colder hospitable weather at home increases outbound tourism
- Improved weather increases opportunities for outdoor recreation in northern regions e.g. golfing, hiking, camping, fishing

DRIVERS

- Climate conditions: Generally, cool destinations become more attractive as they get warmer, and warm countries become less attractive
- Customers and investors increasingly aware of potential impact on weather dependent tourist destinations
- Seasonal tourism activities (golf, skiing, costal tourism) respond to weather changes. For example, golf course opening earlier as the weather warms in the summer or ski resorts making snow as precipitation declines

STRATEGIES

- Tropical and coastal tourism, construction based measures in coastal zones (weather resistant building structures, water storage, replanting trees, self-sufficient energy supply, setting back structures in coastal areas)
- Ski tourism, artificial snow making, flexible lift ticket prices, development at higher altitudes, non-snow activities in winter, all year tourism
- Behaviour based (education, ecological protection, evacuation plan, more indoor activities)
- Diversifying markets
- Research into site location that accounts for climate change risks
- Insurance coverage (e.g. cyclone and hurricane insurance)

LEADERS

- Caribbean resorts: Sandals, Club Med, SuperClubs, TNT Vacations, and Apple Vacations are offering hurricane waivers and guarantees
- Coastal tourist resorts in Fiji: evacuation plans, cyclone proofing buildings, water, food and energy self-sufficiency.
- North American ski resorts: heavily invested in snowmaking technologies. Virtually all ski resorts in Ontario have snowmaking systems that cover 100% of ski-able terrain. In Quebec ski-able terrain covered by snowmaking is 50-90% in Quebec and 62%-98% in the USA.

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LEGGARDS

- None identified

BARRIERS TO ADAPTATION

- Knowledge gaps regarding the vulnerability of tourist destinations across the developing world
- Competing priorities for scarce resources (e.g. beach front property development for short term economic gain)
- Lack of knowledge implying that risks go unperceived and unacknowledged
- Insufficient financial resources to adapt even when risks are perceived (e.g. small-medium resorts unable to retrofit property and restore ecological zone due to financial constraints)
- Lack of capacity (e.g. qualified staff)
- Lack of government support

GAPS

- Research gaps: lack of regional climate models, current models imprecise, local studies not placed in context and not related to one another

ENERGY: OIL, GAS, AND ELECTRICITY

The 17 sources reviewed in the energy sector revealed that all energy producers (coal, oil, gas, electricity) will likely face some risk to infrastructure (e.g. damage to power transmission lines, off-shore oil rigs, flooding of power plants). The literature with regard to electricity generation emphasized the risk of increased consumer demand during peak periods and potential failure of power grids to meet the demand given a warming climate. Conversely, natural gas companies may see a drop in demand for their products given warmer winters. Regulatory interventions by governments enforcing new

GHG mitigation policies will see a reduced demand in carbon intensive energy products (oil and coal). As well, power generation, coal fired plants, and oil extraction are all water intensive, and may face competition from other groups including agriculture producers and public water suppliers, as water levels fall due to climate change.

Despite potential risks, the electrical energy industry stands to gain from increased consumer demand as well as societal shifting towards clean technology. Fossil fuel providers are investing in research and development of renewable energies such as geothermal, hydro, solar, wave, and wind, and bio fuels.

These energy markets are expected to grow as societies move towards low carbon economies.

Adaptation strategies include technological innovation (low carbon energy), building infrastructure (power grid capacity and transmission capability), and behavioural and market strategies (encouraging energy conservation).

Table 4 below offers a detailed summary of the risks, opportunities, drivers, strategies, leaders, barriers and gaps in climate change adaptation in the energy sector.

Table 4 **SUMMARY OF ADAPTATION IN THE ENERGY SECTOR**⁵

RISK & VULNERABILITIES

- Highly exposed to climate risks across all industry activities, from electricity generation, oil and gas extraction, energy distribution and trading
- High regulatory risk, physical risks, and reputational risks
- Reputational risk from being seen as a contributor to climate change
- Business interruption and failure to meet contractual obligations due to extreme weather events
- Interruption in fuel supply due to extreme weather and related events along the supply chain
- Shifting demand patterns in energy demand from winter to summer
- Loss in revenue due to climate impacts on customer demand, such as interruption of their businesses, decreased need for heating
- Uncertainty over energy output from hydroelectric plants due to potential water shortages
- Uncertainty over water supplies for cooling power plants
- Summer peak demand could increase beyond maximum capacity
- Hydro-electricity: Risk that decreased water volumes could be insufficient to meet peak demand
- Electricity: Coal based electricity, risk that decreased water volume could be insufficient to dilute cooling water effluent
- Damage to facilities and infrastructure (power stations, oil rigs) from extreme unpredictable weather (flooding, storm-surges, and rising sea levels)
- Hot weather may reduce the efficiency of extracting energy particularly gas
- Extreme weather events, like Hurricanes Rita and Katrina, can mean losses in oil refining capacity and consequent oil price rises

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⁵Adapted from Becken, 2005; Bicknell and McManus, 2006; Dawson, 2007; Dubois and Ceron, 2006; Elaser and Burki, 2002; KMPG, 2008; Gossling and Hall, 2006; Hennessy et. al., 2008; McBoyle et al., 2003; Moen & Fredman, 2007; Scott and Jones, 2006; EU, 2006; Scott et. al., 2006; UNEP, 2008.

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- As facilities age, and as more demand is put on them, they are more likely to fail under extreme events and incremental climate change
- Reduced energy demand for space heating in winter e.g. milder winters in the Northern Hemisphere could result in reduced energy demand
- Change in temperature, affecting efficiency of equipment operation
- Thawing of permafrost, resulting in ground shifts and instability, making exploration and production in northern regions more difficult
- Rising sea levels, threatening electricity generation facilities and refineries in coastal, riparian and estuarine locations
- Increased competition for water resources, leading to potential conflict between users such as power generators (for cooling and hydropower), public water suppliers, and the agricultural community
- Ability to generate hydroelectric energy will reduce as temperatures rise in some countries (Canada, UK, USA)
- Supply and demand balance not realized
- Disruptions in supply chain from storm events
- Increased insurance costs
- Considerable business interruption risks in the face of weather-related catastrophes, especially in oil and gas

OPPORTUNITIES

- Growth in 'clean-tech' (renewable energy, bio-fuels)
- Emerging technologies (fuel cells, photovoltaics and biomass)
- Growth in low carbon energy production
- Increased demand for energy-efficient technologies
- Increased energy demand for space cooling in summer
- Reduced costs for oil and gas exploration in the North
- Investing in carbon sequestration technology

DRIVERS

- Regulations
- Limited findings and research in this area

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STRATEGIES

- Innovative measures to deal with record power demands due to hotter summers and increased peak demand periods: conservation and demand management strategies, cool building design and better insulation
- Public outreach for energy conservation
- Move away from wet cooling power plants to dry or hybrid strategies
- Meet peak demand periods through multiple fuels and renewables
- Reimburse businesses willing to curtail daytime usage of electricity, redirect excess power from other parts of its network, and purchase additional power from other countries
- Energy conservation programs
- Invest in 'green' R&D: renewable energy portfolio investments
- Move toward decarbonized energy sources (wind, solar, and hydroelectric)
- Market and trade low carbon power
- Oil and gas technology research and development (e.g. advanced vehicles and fuel technology, and hydrogen generation technologies)
- Develop bio-fuel markets
- Invest in increased capacity and improved transmission distribution networks (hydro-electricity)
- Clean coal technology is being developed
- Nuclear technology as an alternative energy source
- Risk management and planning

LEADERS

- British Petroleum, Shell, Texaco, Hydro One Ontario, Entergy, Exelon, Florida Power and Light, and Constellation Energy

BARRIERS TO ADAPTATION

- Limited research and information (existing information on best practices is not readily available, information sharing networks in infant stage)
- Lack of available technology and decision support tools (power generation and transmission technology takes decades to research and implement, significant lag between design and implementation)
- Institutional networks between different levels of government and the energy sector have begun to develop adaptation strategies but are only their preliminary stages

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GAPS

- None identified

WATER

The 15 studies reviewed on the water sector revealed that adaptation in the sector is critical because changes in the water supply and water quality have the potential to impact all other sectors of the economy which use water as either an input or output (e.g. hydroelectricity, agriculture, mining, forestry, fisheries, food and beverages, manufacturing, transportation, and tourism). Moreover, water is a unique resource: it is necessary for all life on earth and as such it is highly connected to the social, cultural, and material fabric of society. As the climate changes, competition between actors (producers, people, and ecosystems) is likely to grow, and water scarcity and competition over access is likely to become a defining issue in the 21st century as climate change reduces the quantity, availability, accessibility and quality of water. The water sector is also different from all other business sectors covered in this study in that it remains largely public or governed through public-private partnerships throughout much of the world.

The water sector will face a variety of risks as the climate changes. Changes in rain patterns and stream flow will impact the quantity and quality of water

resources available for use. Warmer temperatures are expected to increase the demand for water while rising sea levels are expected to cause salinization and reduce freshwater supply. Regional variability will decrease freshwater availability in some regions more than others (i.e. droughts in sub-Saharan Africa). Extreme weather is expected to negatively impact the infrastructure of the water sector (e.g., flooding).⁶

Climate change presents few business opportunities for firms in the water sector. Although people tend to drink more water as the weather warms, limited or poorer quality supply will place pressure on suppliers potentially beyond capacity. However, the sector may see economic gains if innovation in water saving and water quality technologies is pursued.⁷

Adaptation strategies in the water sector emphasize the conservation of water, improved supply treatment, extracting water from new sources, and improving existing infrastructure and management capability.

Table 5 below offers a detailed summary of the risks, opportunities, drivers, strategies, leaders, barriers, and gaps in climate change adaptation in the water sector.

⁶Adapted from the World Business Council for Sustainable Development, 2008.

⁷Adapted from the World Business Council for Sustainable Development, 2008.

Table 5 **SUMMARY OF ADAPTATION IN THE WATER SECTOR**⁸

RISK & VULNERABILITIES
<ul style="list-style-type: none"> • Reduction in the quantity and the quality of free water resources available • Increased water stress due to changing precipitation patterns and increasing frequency and intensity of floods and droughts • Decreased rainfall, water shortages, and shrinking water sources (e.g. Himalayas) • Variable reliability of raw water sources (change in flow, variation in water availability, decreased water availability in some regions) • Water scarcity, which could stymie business operations, particularly those of water-reliant industries • Increased pollutant loading from more intense runoff • Increased treatment costs to maintain the same quality • Salination of freshwater; Salination of groundwater reservoirs due to aquifer penetration by rising sea levels • Greater demand for water as supply shrinks; regions dependant on glacial melt • Potential damage to water supply infrastructure during heavy rains or drought • Flooding of water supply works in riparian locations, leading to supply disruption • Infrastructure upgrade costs and damage from sewer flooding, associated with flash floods • Impact on other supply chains: food and beverage, agriculture, energy, automotive, tourism, and manufacturing • Increased water scarcity • Industrial users in water-scarce areas likely to face increasing pressure to conserve water, and conflict over it, which may threaten firm license to operate
OPPORTUNITIES
<ul style="list-style-type: none"> • Increased demand for water-saving technologies and services • On very hot days, when consumers prefer water to quench their thirst
DRIVERS
<ul style="list-style-type: none"> • Awareness of water resource managers (e.g. links to the research community, interest of managers in climate change issues) • Concern over climate change threats (threats posed by climate change must be seen as equally important to other pressures) • Desire to maintain reputation • Need to meet increased regulatory requirements

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⁸Firth and Colley, 2006; KPMG, 2008; Llewlynn, 2007; PEW Center, 2008; WBCSD, 2008; Arnell and Delaney, 2006; Levinson et. al., 2008; CBI, 2008; Berkhout et. al., 2004a; Beirbaum, 2008; Easterling et. al., 2004; ICF International, 2007; Subak, 2000; Water UK, 2008.

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STRATEGIES

- Enhance the capacity to adapt through skills training, workshops, research
- Alter infrastructure or management practices to cope with impacts such as increased demand, lower water quality, etc.
- Invest in infrastructure for the containment, storage, and transport of water
- New or enhanced reservoirs
- Ground water development
- Import of icebergs
- Water metering in demand hot spots
- Conservation of water resources; technology and promotion and education of water conservation
- Water reuse and recycling
- Use and collection of rain water
- Improve water supply and treatment systems
- Desalinate freshwater sources
- Low Regret Investing: Measures with relatively low costs for which benefits under climate change scenarios are high

LEADERS

- Anglian Water
- UK water sector

LEADERS

- None identified

BARRIERS TO ADAPTATION

- Long lead time necessary for the implantation of new resource schemes
- Difficulties in exerting control over the demand for water (customers are rarely metered)
- Education strategies may be ineffective in curbing high use

GAPS

- None identified

BUILDING AND CONSTRUCTION

The systematic review found 16 sources that directly examined the impact of climate change on the building and construction sector. Many of the risks of climate change to the sector revolve around a changing regulatory environment and new building codes in a climate changed world. New material and methods in building are needed today as the life expectancy of buildings is longer, and the physical risks of buildings to climate change is significant. Moreover, work within the sector may experience unexpected disruption and delays due to extreme weather events. Additionally, these organizations and the sector may suffer losses in property value as property either becomes undesirable due to increased exposure and uninsurable due to high risk to extreme weather events.

Opportunities in the sector from climate change are few. In Northern climates later frosts may increase the days available for construction. Also, in general, opportunities for building retrofitting to meet either energy efficiency regulations or to meet new hazard codes might arise as the climate changes.

Adaptation strategies in the sector include risk avoidance, redesign, and technological developments. For example, avoiding construction in high risk areas (tropical beachfronts) or changing building locations will greatly minimize the risks the future properties might face as the climate changes. Redesign measures include taking into account flood risks, and building flood proof foundations, integrating natural defences into site design, and changing building materials to deal with warmer weather. As well, technological developments in energy efficiency, new windstorm resistant roofing, and improved supply chain management may protect the sector from some of the risks it will face in a climate changed world.

Table 6 below offers a detailed summary of the risks, opportunities, drivers, strategies, leaders, barriers, and gaps in climate change adaptation in the building and construction sector.

Table 6 SUMMARY OF ADAPTATION IN THE BUILDING AND CONSTRUCTION SECTOR⁹

RISK & VULNERABILITIES

- High regulatory risk, medium physical risk
- Litigation risk and reputational risk
- Changes in building codes
- Disruption of construction due to extreme events (restricting work days)
- Disruption in delivery of materials and transportation infrastructure (muddy site)
- Damage to building materials
- Shortened time due to increased rainfall and wind
- Increased regulation over the coming years by planning authorities for the development of carbon neutral buildings
- New regulations regarding flood zones, water savings, energy efficiency
- Reluctance of customers to buy properties in areas of risk
- Reduced or loss of property values
- Refusal of insurers to cover properties at risk, or expensive premiums
- High temperatures may restrict the amount of time that workers can safely engage in some tasks (roofing)
- Increased UV exposure to workers may increase the incidences of skin-cancer
- Infrastructure affected by extreme weather events
- Predicted physical risk with respect to commercial real estate include increases in sea level and a rising frequency and intensity of storms, including a lengthening of the hurricane season
- Functional obsolescence
- Inappropriate materials and design strategies
- Modern housing is more vulnerable to flood damage because of the greater use of chipboard floors, dry wall plasterboard, cavity insulation, and design features such as lower door thresholds to improve access

OPPORTUNITIES

- Reduced work stoppages caused by frost, thereby extending the portion of the year during which construction is possible
- New product markets such as climate proofing materials and building designs
- Locally sourced materials become more attractive

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⁹Berkhout et. al., 2004; Hertin et. al. 2003; Pew, 2008; KMPG, 2008; Llewelyn, J., 2007; Hecht, 2008; WBCSD, 2008; EU, 2006; Firth and Colley, 2006.

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DRIVERS

- Legislations and regulatory changes
- Long life span of buildings 20-100 years means that climate change needs to be planned for and taken into account in construction designs today

STRATEGIES

- Avoid construction in high risk areas
- Design flood proof buildings
- Work with government to build natural climate defenses (trees, green space)
- Products to pay for post-loss reconstruction upgrades to "green" building standards and commissioning to ensure energy savings
- Catastrophe-resistant building codes
- Redesign pricing
- Form environmental risk committees and working groups
- Retrofit older buildings
- To deal with 'hotter summers', include several features in buildings design such as shading and natural high thermal mass, shading, and natural (windows open) or mechanical (fans) night-time ventilation.
- Change building materials
- Design buildings for potential future water constraints
- Change building locations
- Technological measures (the development of new roofing technologies against more intensive wind storms; or deeper foundations against increased problems of heave)
- modular systems, prefabrication, larger drainpipes, flood prevention equipment, and improved supply chain management

LEADERS

- None identified

LAGGARDS

- None identified

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BARRIERS TO ADAPTATION

- Expect to see some polarization between the larger, more efficient companies, which would most likely choose to upgrade stock, and smaller companies without the scale or financial capacity to do so
- Expensive or impossible retrofitting

GAPS

- Companies in the sector have low perceived vulnerability to climate change, despite the exposure and risks the sector will face as the climate changes
- Builders were far more aware of the need to mitigate greenhouse gases than of the impacts that climate change could have on their businesses and sector

FINANCE AND BANKING

The literature review found eight sources on finance and banking that discusses and analyzes the implications of climate change for the sector. The finance and banking sector's broad economic participation makes it exceptionally vulnerable to climate change around the world. The finance and banking sector contains organizations that have investments, portfolios, assets, debtors, and collateral across the world. They have also invested across sectors any of which may be adversely affected as the climate changes. As such, the sector will be exposed to climate change mostly indirectly. For instance, declining values in beach front properties and extreme weather events may increase the default rates on loans in the coastal tourism sector, and climate change may reduce the collateral backing such loans, leaving the property lender exposed. As well, poor disclosure regarding climate change risks and carbon

footprints make evaluation of investments from a climate risk perspective difficult.

However, the sector is also positioned such that it can impact adaptation in all other sectors if financing includes evaluation of how potential clients respond to the challenge of climate change. Banks and financial institutions can require lenders to undertake climate change risk assessments and undertake carbon offsetting strategies by making these prerequisites for access to financing.

The finance and banking sector can greatly influence adaptation measures by offering financing for adaptation projects in all other sectors, developing microfinance schemes for developing countries, and providing consultancy and risk assessment services to other sectors. As such, there are some opportunities for the sector to find new markets, investments, and ventures as the marketplace changes due to climate change.

Some early strategies emerging in this sector are the development of sustainable development funds that invest in clean technology, advancing the sophistication of risk management tools to include climate change impacts, developing special financial instruments that are related to potential weather changes, and encouraging further research on climate change risk and impacts.

Table 7 below offers a detailed summary of the risks, opportunities, drivers, strategies, leaders, barriers, and gaps in climate change adaptation in the finance and banking sector.

Table 7 **SUMMARY OF ADAPTATION IN THE FINANCE AND BANKING SECTOR**¹⁰

RISK & VULNERABILITIES
<ul style="list-style-type: none"> • Indirect risks, exposed through investment portfolios • Macroeconomic downturn hurts business volume • Market value of securities could be impacted by climate change • Uneven and unpredictable impacts on global markets and infrastructure rebuilding • Compounding risk across entire portfolio of converging activities (asset management, insurance, reinsurance) • Property damage risks to project finance and real estate finance • Cancellation of real estate insurance exposes property lender • Physical damage to corporate assets • Regulatory and political risks • Macroeconomic disruptions impairs long-term asset appreciation • Hidden carbon liabilities affect market value of securities • Real estate holdings impaired by weather events, increased energy costs • Reduction in competitiveness of GHG-intensive business investments • Potential deterioration in project economics and investment viability due to national financial policy responses to climate change • Uninsured damage to project assets • In retail banking, customer defaults due to climatic extremes • Threat of business failure when companies cannot maintain sufficient financial capacity to deal with climate risks • Impacted by both domestic and global extreme events due to the global nature of the sector

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¹⁰ Blinnovest, 2002; Ethical Funds Company, 2008; Aspen Publishers, 2008; Firth and Colley, 2006; Desjardins and Schuh, 2008; Deutsche Bank, 2008; Dlugolecki, 2000; London Climate Change Partnership, 2006; UNEP, 2006.

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OPPORTUNITIES

- Develop new markets and demand for new products related to GHG reductions and/or adaptation to climate change
- Assess credit risks associated with climate change as well as preserve crucially important carbon sinks
- Public/private partnerships in green municipal funds, etc
- Weather derivatives
- Finance climate resilient projects
- Finance clean energy technology development
- Finance infrastructure development arising from adaptation
- Enhanced project returns from sale of credits
- Lending by commercial banks to customers for energy efficiency-related projects
- New markets in, e.g., political/regulatory risk transfer
- Innovative climate-related theme funds e.g., new energy
- Consulting & advisory services
- Microfinance opportunities in developing countries

DRIVERS

- Financial risks and losses

STRATEGIES

- Investment community has set up 'sustainable' investment funds and increasingly invests in renewable energy
- Ensure that contingency plans include 'worst-case' disasters
- Some fund managers are assessing and responding to the implications of climate change now and in the future by encouraging appropriate research into the implications of climate change, and by asking appropriate questions to reveal exposure to climate change and implications for portfolios
- Risk management of potential climate change impacts, development of sophisticated risk management tools
- Specialist financial instruments like catastrophe bonds and weather-related international trading markets
- Using the Equator Principles when investing (a set of procedures for identifying, evaluating, and mitigating environmental risks associated with project finance)
- Lending money for renewable energy/energy efficiency, and are paid back through the energy savings carbon audit and assessment of climate risks faced by clients

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LEADERS

- Global banks are better prepared than local ones
- HSBC, TD Bank and the Royal Bank

LAGGARDS

- CBank of Montreal

BARRIERS TO ADAPTATION

- Climate risks are still not a major concern

GAPS

- Wide variation in preparedness among banks
- The majority of finance executives feel unprepared to cope with the financial risks from current weather conditions

OTHER SECTORS

Data on climate adaptation in several other sectors (mining, forestry and fisheries, information & communication technology (ICT), manufacturing, transport, health, and retail) were not comprehensive or

sufficient to warrant individual sector-by-sector analysis. Therefore, available information regarding these sectors is consolidated in Table 8, and organized into risks, opportunities, drivers, strategies, leaders, barriers, and gaps in climate change adaptation.

Table 8 SUMMARY TABLE OF BUSINESS ADAPTATION IN VARIOUS SECTORS¹¹

RISK & VULNERABILITIES						
Mining	Fisheries & Forestry	ICT	Transport	Manufacturing	Health	Retail
<p>Regulatory risk</p> <p>Energy and water</p> <p>Intensive sector, already susceptible</p> <p>Vulnerable to water shortages</p> <p>Rainfall and risk of flooding creates risk of overflow of storage reservoirs containing contaminants</p> <p>Economic policies on climate change could decrease demand for thermal coal and steel</p>	<p>Physical risks</p> <p>Risk of extinction of local fish, ecosystem services severely affected</p> <p>Change in sustainable harvests and mixture for all fish populations</p> <p>Change in forest yields, growth, migration of tree species, and risk of forest fires</p> <p>Changes in fish stock and supply, changes in timber supply and rent value</p> <p>Changes in availability and price of commodities</p> <p>Business interruption and failure to meet contractual obligations</p>	<p>High users of energy, vulnerable to any damage to infrastructure or energy supply</p> <p>Increased risk of subsidence damage to communications masts and possible increased storm damage to overhead cables, disrupting operations and processes</p> <p>Higher indoor temperatures can compromise high technology and precision engineering processes</p> <p>Vulnerable to any disruption in supply chain or manufacturing processes</p>	<p>Regulatory risk</p> <p>Significant contributor to GHGs, higher energy costs</p> <p>Relatively low preparedness</p> <p>Disruption of ground and marine transportation systems as a result of severe weather</p> <p>Supply chain interruptions: Inundation of transport routes, infrastructure, and distribution facilities</p> <p>Failure to meet contractual obligations</p> <p>Transport infrastructure is vulnerable to flooding, which can cause severe disruption to services and require frequent repair</p>	<p>Regulatory risks Reputation risk</p> <p>Higher prices in raw materials</p> <p>Unanticipated changes in consumer preferences</p> <p>Disruption in supply chain</p> <p>Increased costs resulting from higher energy demand</p> <p>Disruption of coastal manufacturing facilities, transport networks, production facilities, and infrastructure</p> <p>Business interruption, asset damage</p> <p>Failure to meet contractual obligations due to extreme weather events</p>	<p>Huge impact on human health</p> <p>Rise in the number of deaths resulting from heat waves</p> <p>Outbreak and spread of disease especially water borne illnesses</p> <p>New diseases in new regions</p> <p>Increased tropical disease</p> <p>Less water; dehydration risk</p> <p>Increased premature deaths associated with Lyme disease, tick-borne Encephalitis, dengue fever and malaria</p> <p>Changing distribution of some vectors of infectious disease and allergenic pollen species</p>	<p>Weather plays a significant part in affecting consumer preferences</p> <p>Complex distribution systems make this sector vulnerable to the impacts of climate change</p> <p>Impacts in terms of supply chains and distribution</p> <p>All premises and transport systems are vulnerable to extreme weather events</p> <p>Damage to infrastructure along the retail product supply chain caused by extreme weather events</p>

¹¹ Reinhardt and Packard, 2007; NRCAN, 2007; KPMG, 2008; Firth and Colley, 2006; Llewellyn, J., 2008; WBCSD, 2008; Cogan, 2006; Medelshon, 2000; Stennes, 1998; Carey, 2006; Ford et. al., 2008; Fisher, 2005; Miller et. al., 2008; Millerd, 2005; Levinson et. al., 2008.

Mining	Fisheries & Forestry	ICT	Transport	Manufacturing	Health	Retail
		Climate change is likely to increase the operators' energy demands: higher temperatures will result in more air conditioning in the exchanges	<p>Port and harbour facilities will need to be able to cope with changing sea levels, wind speeds, and storm surges damage</p> <p>Any disruption within the transport sector has knock-on impacts for businesses in every other economic sector</p>	Interruption in fuel supply due to extreme weather and related events along the supply chain	<p>Changing impact on malaria regions</p> <p>Reduced productivity through increased incidence of disease and overheating of working environment</p> <p>Higher health insurance costs</p> <p>Higher expectations on companies to provide medicine and health care</p>	<p>Changing shape, size and location of markets for goods and services as regional change consumption patterns change</p> <p>Changing customer expectations as consumers avoid products perceived to be causing climate change</p>

OPPORTUNITIES

Mining	Fisheries & Forestry	ICT	Transport	Manufacturing	Health	Retail
<p>Economic policies on climate change could increase demand for uranium and aluminum</p>		<p>In the position to help offset the effects of climate change as the products and services can contribute to displacement of goods, and reduction of travel</p> <p>Development and marketing of innovative products and services which reduce dependence on carbon-intensive processes and lifestyles</p>	<p>Creation of new shipping routes as sea ice patterns change</p> <p>Creation of new markets for automotive</p> <p>Equipment suitable for specific climatic conditions</p> <p>Increased investment in rail networks</p> <p>Port expansion and use of deep water ports</p>	<p>Increased demand for low-water and other sustainable products and services, including energy efficiency products and services</p> <p>Increased demand for cooling equipment systems and services during hot weather</p> <p>Increased demand for resilient products</p> <p>Increased demand of retrofitting equipment components</p>	<p>Opportunities for delivering new products and treatments to meet the challenges of new diseases and health issues</p> <p>In higher latitudes, reduced healthcare costs as winters become milder</p> <p>Development of new medicines</p> <p>Increase in respiratory diseases, 'diseases of the developing world', and tropical diseases.</p> <p>Could benefit companies manufacturing related drugs and vaccines</p>	<p>New product and service opportunities as weather changes consumer preferences</p>

STRATEGIES

Mining	Fisheries & Forestry	ICT	Transport	Manufacturing	Health	Retail
<p>Water conservation Lower GHG emissions Risk modeling</p>	<p>Develop technology to understand the spatial distribution and relative abundance of fish stocks</p> <p>Reduce non-climatic stresses and maintain genetic diversity of fish stocks</p> <p>Increase monitoring capacities</p> <p>Improve research and communication with stakeholders</p>	<p>Companies may opt for home-working, video conferencing, electronic billing, and electronic tax filing</p>	<p>Efficiency</p> <p>Lower fuel consumption</p> <p>Technological innovation (i.e. hybrid cars)</p> <p>Reduce fuel emissions</p> <p>Develop more light-weight materials, with greater electronic components</p> <p>Truck engine manufacturers will continue to invest in reduced emission engine technology</p>	<p>Develop energy efficient technologies</p>		

BARRIERS TO ADAPTATION

Mining	Fisheries & Forestry	ICT	Transport	Manufacturing	Health	Retail
				Risks largely unexplored	Largely unresponsive to risks and climate change potentials	

GAPS

Mining	Fisheries & Forestry	ICT	Transport	Manufacturing	Health	Retail
		Companies in this sector are strongly advised to have well worked out and tested business continuity plans	The auto and machinery sector should review climate risks to supply chains and logistics, particularly where extreme events have potential to disrupt			

SUMMARY OF KEY POINTS

- Information on risks, opportunities, adaptation strategies, leaders, laggards, and barriers exists sporadically on a sector-by-sector basis. There have been very few cross-sectoral studies. This may be due to various causes such as the sector specific nature of climate change, the relatively recent (since 1999) focus on this field of research, and/or proprietary access to sensitive decision-making information.
 - Climate change is clearly seen as a risk and an opportunity. The Carbon Disclosure Project (2008) finds that executives see climate change risk and opportunities both in the 80th percentile.
 - The Insurance sector is arguably the most advanced in evaluating risks and opportunities. Major adaptation initiatives in the insurance sector have focused around building institutional networks that address common industry risks through collaboration. It is likely that the Insurance sector leads in this area due to its vulnerability, but also because of its historical experience in risk management and climate-related risks.
 - The Agriculture sector is already adapting to climate change on a season-to-season basis. However, it is unclear how agriculture will adapt to climate change in the long term as the risks and opportunities are still uncertain. This sector will rely heavily on government support and intervention for climate change adaptation.
 - The Tourism and Recreation sector appears to have a general idea of the risks that it will face in light of climate change. However, only firms in regions that are already affected (Northern Mountains and Tropical Destinations) are adapting to climate change using technical, managerial, financial, or behavioural adaptations. It is unclear how tourism in other areas will be affected by climate change. It appears that stable weather is an important determinant of destination attractiveness.
 - The diversity of the Energy sector makes the evaluation of risks and opportunities arising from climate change difficult to generalize. Adaptation strategies also vary considerably from firm to firm depending on how climate change is expected to affect the sector.
 - The Water sector has the fewest opportunities arising from climate change, and for the most part will need to deal with the risks associated with changing weather and water availability and quality. Currently, the sector is adapting with conservation measures.
 - In the Building and Construction sector the greatest risk from climate change surrounds a changing regulatory environment and new building codes in a climate changed world. Opportunities in the sector from climate change are few. Adaptation strategies in the sector include risk avoidance, redesign, and technological developments.
 - The Finance and Banking sector's broad economic participation makes it exceptionally vulnerable to climate change around the world. The sector has investments, portfolios, assets, debtors, and collateral across the world and across sectors, any of which may be adversely affected as the climate changes. The Finance and Banking sector can greatly influence adaptation measures by financing adaptation projects in all other sectors, developing microfinance schemes for developing countries, and providing risk assessment services to other sectors.
- Report 3, "Case Studies & Tools," goes on to discuss best practices, case studies, lessons learned, and tools for business.

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An exhaustive list of references for the entire study (Reports 1-4) is available in the study [Methodology report](#).

about the network for business sustainability

MISSION

The Network for Business Sustainability enables business sustainability by fostering collaboration between industry and academia.

VISION

We envision a world where Canadian enterprises contribute to prosperous economies, healthy ecosystems and strong communities.

OBJECTIVES

1. Build and grow a community of researchers and practitioners of business sustainability.
2. Develop a database of state-of-the-art business sustainability knowledge that is relevant to practice.
3. Create opportunities to develop new knowledge that spurs innovation in enterprises.

ACTIVITIES

The Network funds projects to move knowledge between the communities of research and practice, organizes events that bring the members of those communities together, and enables ongoing interaction and knowledge exchange through online tools.

FUNDING

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