All One Sky FOUNDATION

Helping ALL people prosper in a changing climate

Economic Tools for Climate Change Adaptation

PRIVATE REAL ESTATE DECISIONS

September 2015

FINAL REPORT

BRITISH COLUMBIA

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Climate Resilience at **ALL ONE SKY FOUNDATION**

www.allonesky.ca | helen@allonesky.ca | 403-471-6247

About ALL ONE SKY FOUNDATION

All One Sky Foundation is a not-for-profit, charitable organization established in 2010 to take action on climate change through education, research and community-led programs. We focus on helping vulnerable populations at the crossroads of climate, environment and energy. Key areas of concern are climate change adaptation and energy poverty. Our vision is a society in which all people live in warm comfortable homes, in communities that are able to respond and adapt to a changing climate.

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For more information on climate change impacts and adaptation, please visit adaptation.nrcan.gc.ca

Written by Richard Boyd, Jeff Zukiwsky and Tim Pringle for the Climate Action Secretariat, the British Columbia Ministry of Environment

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ALL ONE SKY FOUNDATION

PO Box 19012
809 49th Avenue SW
Calgary, Alberta
Canada
T2S 1A0

+1.403.471.6247

www.allonesky.ca

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1 EXECUTIVE SUMMARY

The effects of climate change are already apparent in British Columbia (BC), with observable changes in temperature, precipitation, and extreme weather events over the last century. Scientific evidence suggests the climate will continue to change over coming decades and centuries, bringing potentially significant economic, social, and environmental consequences for the province.

The real estate sector plays a crucial role in providing people with places to live and work. Its assets and infrastructure, with their long lifecycle, are vulnerable to climate change. The impacts of climate change must be addressed at each stage of the real estate life-cycle (from land acquisition, through development, occupancy, renovation and redevelopment). If not, climate change could render some real estate developments too uncomfortable or risky to live in, too expensive to operate and manage, too costly to insure, and not sufficiently profitable to attract capital from investors.

Actions to better manage impacts arising from changes in the climate are known as "climate change adaptations". They can take the form of technologies, procedures and practices, behaviours, etc. that can be undertaken in anticipation of impacts (before they occur) or in response to impacts (after they occur). Anticipatory actions tend to be more cost-effective and less social disruptive. Private individuals and businesses can in principle implement anticipatory adaptations across the real estate life-cycle.

However, the market often does not give the right price signals for individuals and businesses to make the best choices to prepare for a changing climate. A number of "barriers" hamper the ability of markets to efficiently allocate resources—natural, financial, human, social, and physical capital—to manage current and future climate-related risks in a way that would deliver net social benefits. Even where the market does send people the right signals, a number of behavioural anomalies and biases mean they do not necessarily make choices that are in the best interests of themselves or the broader society. This situation creates a case for local and provincial government intervention to ensure more socially sound adaptation choices are made by private individuals and businesses.

To better understand decision-making in the real estate sector and where it may break down in the context of climate change adaptation, we looked at the real estate development process as a whole, before choosing three areas that usefully illustrate the case for intervention. These three areas (planning developments, property occupancy and renovation, and property redevelopment) provide a reliable case study of the barriers to efficient adaptation decisions by private individuals and businesses in the sector, and the economic instruments that governments in BC could potentially use to overcome them.

Briefly, some of the barriers to socially sound adaptation decision-making in the three areas include various kinds of imperfect information, prices (and incentives) that do not reflect the true social costs and benefits of different choices, a range of behavioural anomalies and biases, and elements of existing policy that encourage unsound adaptation in the real estate sector.

To complement the existing planning and regulatory toolkit available to governments in BC, we identify several economic instruments that could *in theory* be used to overcome these barriers:

- Modifying existing Development Cost Charges (used by local governments to recover the capital costs of infrastructure for new developments) to also provide an incentive for developers to integrate climate resilient design into new developments at the planning stage;

- Property-level upgrade programs (similar to the energy efficiency programs offered by utilities in BC) offering financial incentives, information and technical assistance to increase the adoption of climate resilient measures and practices in existing properties (targeting both the land and buildings);
- Transferable Development Credits schemes that allow local governments to shift development away from high-risk flood zones to more suitable areas, by allowing development rights to be bought and sold on the open market, and then permanently cancelled on high-risk flood zones;
- Mandatory disclosure of climate-related hazards facing a property in real estate transactions to overcome problems with imperfect information for buyers; and
- Using the latest thinking from behavioural psychology and economics (often coined "choice architecture") to guide the design of financial incentives and the provision of information to maximize the effectiveness of the above instruments.

Finally, we offer these recommendations to the provincial government (and in some cases, local governments) to induce socially sound adaptation choices in private real estate decisions:

- Reform (e.g., reduce, restructure, or eliminate) perverse subsidies that fuel the self-reinforcing cycle of continued growth in coastal or riverfront zones prone to flooding;
- Reform property transfer taxes in order to not "lock-in" private property owners to high-risk areas; and not deter property owners from undertaking improvements to increase their resilience to climate hazards;
- Fund and design a pilot program(s) to incentivize property owners (initially in a narrow target market, e.g., single-family homes in areas prone to flooding risks or wildfire risks) to upgrade their buildings, structures and land with measures to reduce climate-related risk;
- Conduct a feasibility study into the use of Development Cost Charges as *both* (1) a tool to incent developers to incorporate sound adaptation measures into new developments and (2) a fiscal tool to recover the capital costs attributable to new development;
- Expand BC Real Estate Association's requirement to disclose deficiencies to potential buyers to include climate-related hazards;
- Consider amending Section 14 of the *Real Estate Development Marketing Act* to include mandatory disclosure of natural hazards in disclosure statements;
- Consider updating the *Local Government Act* to allow local governments to use Development Permit Areas or another regulatory tool, to facilitate managed retreat strategies in high risk coastal areas (e.g., designating "retreat" and "receiving" zones);
- Conduct a feasibility study into the use of Transferrable Development Credits to support a strategy of managed retreat from high-risk flood zones, where "hold the line" and "remain in place" policies are unlikely to stay viable as the climate changes further;
- In support of a managed retreat strategy, investigate regulatory options to restrict the construction of property-level flood defenses by property owners; and
- Produce a guide to the use of "choice architecture" that policy-makers at all levels of government could consult when designing interventions to promote desirable adaptation actions and behaviours. The guide should inform the use of choice architecture to both: (a) directly induce desirable adaptation behaviours by people in the real estate sector; and (b) to enhance the cost-efficiency of economic instruments to the same ends.

2 INTRODUCTION

2.1 PROJECT CONTEXT

Climate changes are already apparent in British Columbia (BC), with observable changes in temperature, precipitation, and extreme weather events over the last century (BCMOE, 2015). Mean annual temperature over all regions of BC has increased by about +1.2°C since the early 1900s (Jost and Weber, 2012), with northern and interior regions experiencing greater increases in average temperature than coastal regions (Heap, 2007). Over the same period, mean annual precipitation has increased by about 20 per cent (Jost and Weber, 2012). Furthermore, the south west coast has experienced a number of severe winter storms and storm surges in recent years, while the interior of the province has seen a notable increase in wildfires (Heap, 2007).

The weight of scientific evidence suggests the climate will continue to change over coming decades and centuries. Indeed, many of the climatic changes projected for the next 30-40 years may be "locked in"—the result of past greenhouse gas (GHG) emissions. Further changes in climate beyond the 2050s depend on how well global GHG emissions are reduced from this day forward. The impact of these changes for BC will be numerous and diverse, and include economic, social, and environmental consequences.

Real estate—in particular, infrastructure and buildings—has an expected design life of between 20 and 100 years; some developments may well be used for much longer.[1] Both new and existing developments will therefore likely experience the full extent of projected climate change this century across their lifecycle. It is vital that potential climate-related impacts are considered at each stage of the real estate lifecycle (i.e., land banking and packaging, land development, building and construction, occupancy, renovation and redevelopment). If they are not, then the long-term sustainability of real estate developments could be compromised by a range of outcomes, including premature or accelerated deterioration, reduced service life and functionality, increased service disruptions and emergencies, increased likelihood of catastrophic failure, increased repairs and maintenance, increased health and safety risks, and increased discomfort and loss of well-being for building occupants (McMahon and Williamson, 2010; and Burton, 2012). In short, climate change could mean that some real estate developments prove to be too uncomfortable or risky to live in, too expensive to operate and manage, too costly to insure, and not sufficiently profitable to attract capital from investors.

If the impacts of climate change are appropriately managed by decision-makers in the sector, real estate is more likely to have a long and successful future. Certainly, climate resilient developments could become better investments and command higher prices.

Actions (technologies, practices, behaviours, etc.) to adjust to changes in the climate are collectively referred to as "climate change adaptation". Broadly speaking, these actions can be taken in response to climate change as it occurs or in anticipation of projected climate change. Unlike the mitigation of GHG emissions, which requires collective action at a global scale, effective adaptation can be undertaken by

[1] Henceforth, "real estate" shall refer to: land and anything fixed, immovable, or permanently attached to it such as appurtenances, buildings, houses, landscaping, fences, fixtures, improvements.

individuals and businesses at a provincial, regional or local scale. Decisions can be taken with respect to the location, design (e.g., site layout, building envelopes, ventilation and cooling equipment, drainage systems, water use, outdoor spaces, etc.), and management of private real estate to minimize vulnerability to climate change (GLA, 2005).

In a world with perfectly functioning markets for all goods and services, efficient adaptation would be facilitated through normal market transactions; prices would provide rational individuals in the real estate sector with the right incentives to reduce climate-related risks to levels judged to be optimal for society. However, markets seldom function perfectly and may not even exist for certain goods and services. Moreover, people do not always behave rationally. A number of "barriers" hamper the ability of markets to allocate resources—natural, financial, human, social, and physical capital—to manage climate-related risks in a way that would deliver net social benefits. For example, inconsistent, poor quality, or inadequate information on natural hazards, such as storm surge or drought, can prevent individuals and businesses from efficiently managing risks associated with these events.

Prominent barriers to efficient adaptation by actors in the real estate sector fall into two broad categories (Bräuninger, et al., 2011):

1. **Market failures**

   Market failures occur when freely-functioning real estate markets, operating without adequate government intervention, fail to deliver outcomes that are satisfactory from the point of view of society. This happens when the private returns which an individual or business receives from carrying out a particular action (like undertaking adaptations to climate change) diverge from the returns to society as a whole—resulting in a sub-optimal amount of adaptation. Real estate markets can also fail when the individual or business does not have sufficient information to recognize the returns from climate change adaptation.

2. **Behavioural failures**

   Even when markets are providing the right price incentives to individuals and businesses, alongside accurate and adequate information, people do not always respond in a 'perfectly rational' way. There are a number of anomalies and biases that affect the way people process information and make decision. These behavioural failures can also result in a sub-optimal amount of adaptation.

In addition, existing policies, regulations and institutions can create perverse incentives that distort adaptation behaviour. The presence of these barriers means that private adaptation actions:

- Could be the wrong sort of actions;
- Could be insufficient;
- Could be over and above what is needed;
- Do not occur at the right time; or
- Do not take place at all.

These are all examples of what is known as "maladaptation". Each type of maladaptation will result in sub-optimal levels of climate change adaptation for society. As a result, community welfare derived from market factors (income, wealth) and non-market goods and services (health, environmental amenity) will be lower than it otherwise would be in the absence of market and behavioural failures. This provides the

justification for government intervention—to overcome the offending barriers and help markets reallocate resources to improve how individuals and businesses adapt—by, for example, ensuring property prices or insurance premiums reflect the risks faced, or costs borne, by individuals or businesses in the real estate sector.

Government intervention in real estate markets can take various forms, but typically includes direct regulation (e.g., zoning and sub-division bylaws, building code, setbacks and buffers, etc.) and, the theoretically preferred alternative, economic instruments (e.g., financial instruments and incentives using existing markets, creating new markets for tradable credits or rights, economic tax and subsidy reforms, choice architecture, etc.). The static and dynamic efficiency advantages of economic instruments versus direct regulation in improving imperfect market outcomes are well documented (OECD, 2003; and EFTEC, 2004). The primary advantage of well-designed economic instruments is that they would allow a given level of climate-related risk reduction to be achieved at lower overall cost than traditional regulations. In addition, economic instruments, among other things, permit individuals and businesses greater autonomy in deciding how to adapt, create ongoing incentives for individuals and businesses to design new and improved adaptation actions ensuring that climate risk management becomes ever cheaper over time, and they reduce the information burden on government.

2.2 PROJECT OBJECTIVES

Against this background, the objectives of this project are to:

- Identify the main activities in the real estate development process (i.e., land acquisition, construction and building, occupancy, renovation and redevelopment) in BC and how they are vulnerable to the impacts of climate change;
- Identify "intervention points" in the real estate development process at which private actors (e.g. private developers, and owners of residential, commercial and industrial real estate) could make decisions that reduce climate-related risks and deliver net social benefits;
- Identify economic instruments that the provincial government or local governments in BC could *in theory* apply in order to overcome barriers to good adaptation choices by private actors at these intervention points;
- Identify existing local and provincial government policies and regulations that either support or hinder the effective implementation of the identified economic instruments; and
- Make recommendations to further investigate and develop the identified instruments to support effective adaptation choices in real estate decisions.[2]

Economic instruments that raise funds for adaptation actions or that directly fund actions are outside the scope of the project, including public-private-partnerships.

A further justification for government intervention in markets—besides correcting market and behavioural failures—is to manage the distributional consequences of climate change adaptation.

[2] This is an exploratory study. Its purpose is to provide the provincial Government with a starting point for more detailed investigation of the viability of the identified economic instruments.

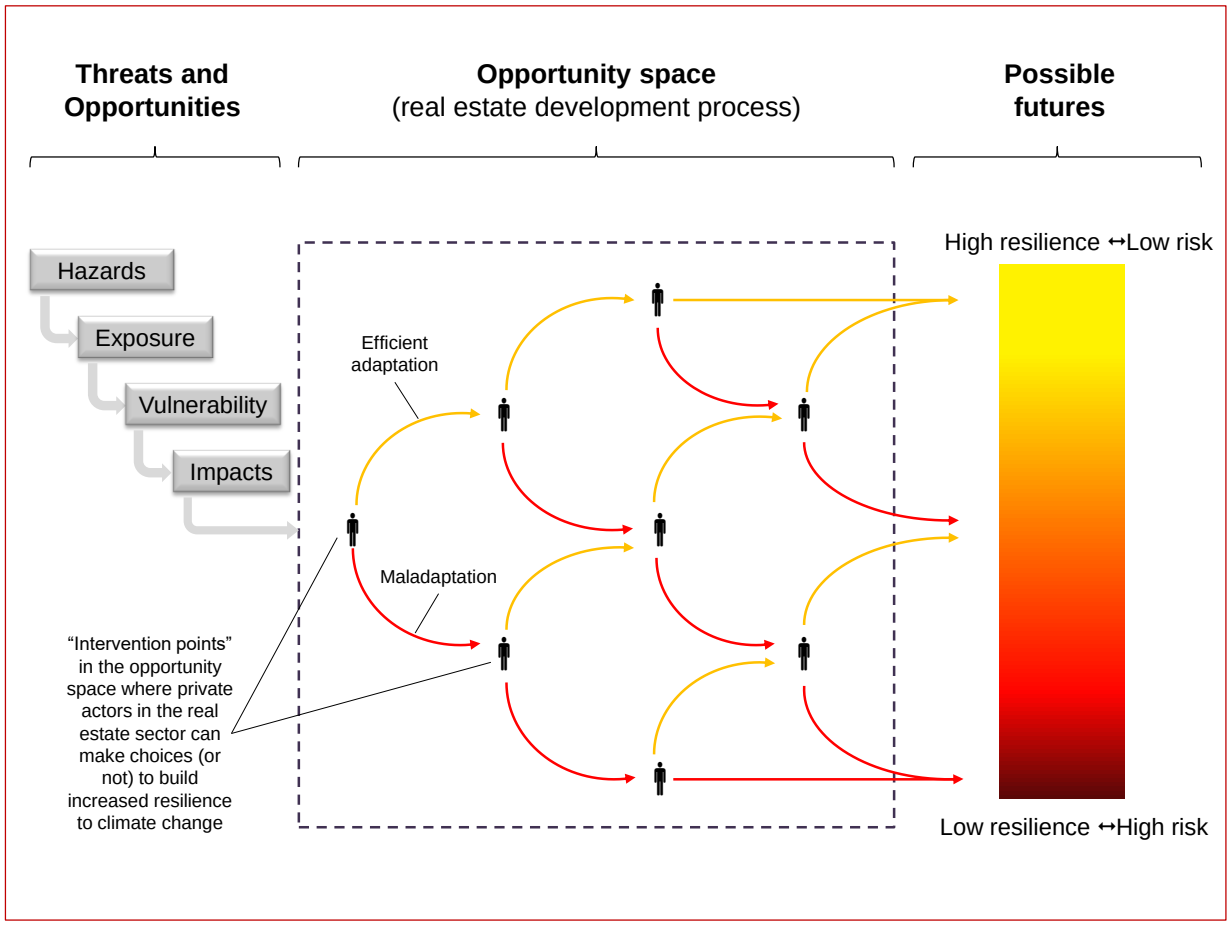
Government has a role to protect vulnerable groups and address equity concerns arising from the distribution of adaptation costs and benefits. Consideration of government "tools" to these ends is outside the scope of this project.

2.3 PROJECT APPROACH

Our overall approach to the project is grounded in the concept of "climate resilient pathways" (see Denton, et al., 2014). In the current context, climate resilient pathways are trajectories for real estate development in BC that combine adaptation and mitigation to reduce climate change and its impacts in order to achieve long-term sustainable growth. While the focus of this project is adaptation to climate change impacts, it is crucial not to lose site of the fact that global mitigation actions taken in the short-term (including by actors in the real estate sector) will shape the longer-term needs for adaptation in the sector. In the short-term, the adaptation needs of real estate are influenced by current and committed climate change (i.e., climate change linked to past emissions). Furthermore, the integration of mitigation and adaptation actions can generate mutual benefits, as well as co-benefits for sustainable real estate development. Interactions between mitigation and adaptation responses by real estate actors can also have negative consequences, providing further impetus to analyzing them jointly—some adaptation actions, such as increased use of air conditioning, can increase GHG emissions.

The concept of a climate resilient pathway for real estate in BC is shown in Figure 1.

Figure 1: Concept of Climate Resilient Pathways for Real Estate in BC



Source: Adapted from Denton, et al. (2014)

Note:

The vulnerability of specific real estate assets and processes will be a function of:

- Exposure to location-specific climate hazards (e.g., developments in floodplains, low-lying coastal areas, drought susceptible regions, high risk wildfire areas, etc.);
- Sensitivity of real estate to those hazards, in turn, affected by the state of infrastructure and housing stock, etc.; and
- Capacity of actors to cope with, or adapt to, impacts, in turn affected by access to pertinent information, technical expertise, access to capital, etc.

The report is structured around this concept. Moving from left to right across Figure 1:

Private real estate in BC faces many social, economic and biophysical stressors, including multiple climate change hazards, such as increasing temperatures, changing precipitation patterns, and rising sea levels. These hazards present many threats and opportunities (or negative or positive impacts). The magnitude of these impacts depends, among other things, on the vulnerability of the real estate exposed to particular hazards.

In **Section 3** we outline the potential impacts of climate change on private real estate in BC

The real estate development process (or life-cycle) represents an "opportunity space", containing multiple decision points where private actors can make choices that either appropriately manage or fail to appropriately manage climate change impacts. By "appropriate" we mean in the best interests of society.

In **Section 4** we describe the real estate development process in BC and identify the main activities-decision points

Depending on the choices made by private actors different futures are possible, with differing levels of climate resilience and risk. Actors could make decisions (take actions) throughout the opportunity space that result in an efficient level of adaptation, leading to a low risk–more resilient future for real estate in BC (orange pathways). Alternatively, actors could make decisions that result in some form of maladaptation, leading to a high risk-low resilient future (red pathways).

In **Appendix A** we identify a range of adaptation actions and behaviours (by hazard) that private actors could take to manage climate change impacts

At each decision point throughout the opportunity space, markets may fail to provide private actors with the right incentives (price signals and other information) to appropriately manage climate change impacts. Furthermore, even if markets functioned perfectly, a number of behavioural biases and anomalies may impede the ability of actors to use that information in a rational manner. In both cases, actors will likely make decisions leading to a high risk-low resilient future.

In **Section 5** we investigate potential barriers to efficient adaptation decisions by private actors in the real estate sector

This sub-optimal outcome provides a rationale for government intervention—in the form of economic instruments—to overcome key barriers at each decision point and thereby help private actors make efficient adaptation choices that puts the sector on a low risk–more resilient pathway. Each decision point thus provides an opportunity for the application of economic instruments.

In **Section 0** we identify economic instruments that government(s) in BC could use to overcome barriers to good adaptation choices by private actors

3 THE NEED FOR CLIMATE ADAPTATION BY REAL ESTATE

3.1 INTRODUCTION

Climate changes are already apparent in BC, with observable changes in temperature, precipitation, and extreme weather events over the last century (BCMOE, 2015). Insurance data shows that these changes are already presenting challenges to the real estate sector, as it continues to expand and drive economic development in the province. Worryingly, existing challenges look set to amplify as the weight of scientific evidence suggests the climate will continue to change over coming decades and centuries.

In this section we describe the main potential impacts of climate change on real estate in BC, with a view to the 2080s given the average lifespan of most real estate assets.

3.2 CLIMATE TRENDS AND PROJECTIONS FOR BRITISH COLUMBIA

Trends in our past climate show how the climate has changed and provide a useful window into the future. Analysis of climate trends in British Columbia show increasing temperatures over the last century, with the greatest changes occurring in northern and interior regions. There are also trends in seasonal warming. Over most of the province, the greatest warming occurred during winter months and the least warming occurred in the autumn (BCMOE, 2007). The exception is the southwest, where the greatest warming occurred in the spring. Analysis of precipitation trends shows that total annual precipitation (over the period 1950–2001) has increased in several regions of British Columbia. The Okanagan and North Coast regions show the largest increases. Eastern British Columbia has been receiving less precipitation on an annual basis. Winters throughout most of the province have been drier, whereas spring and summer seasons have been wetter (BCMOE, 2007).

Future climate projections for British Columbia are taken from the Pacific Climate Impacts Consortium (PCIC) plan2adapt tool. Table 2 summarizes projections for British Columbia. The projections provided in Table 2 are for the 2080s (i.e., the average value over the 30-year period 2070-2099). This time period is chosen to account for the 50-100 year average lifespan of new real estate assets or those in the early stages of their lifecycle—assets include houses and other buildings, storm and sanitary sewer networks, water supply networks, roads and bridges. Climate projections for the 2050s will be more relevant to real estate assets in the middle of their lifecycle (such projections are available at www.pacificclimate.org).

As evident from the climate projections captured by Table 2, there is little variation in projected values across regions of British Columbia. The exception is summer precipitation, which is projected to either be stable or slightly increase in northern regions, and decrease in coastal and southern regions. All of British Columbia will become warmer and wetter with significantly less snowfall and fewer heating degree days.

Table 1: Climate Projections for British Columbia for the 2080s

Climate variable	Region[1]	Projected change for the 2080's (range)[2]
Mean Temperature (°C change)	Province wide	+2.7°C (+1.7°C to +4.5°C)
	Southern	+2.7°C (+1.6°C to +4.4°C)
	Northern	+2.8°C (+1.8°C to +4.6°C)
	Coastal	+2.3°C (+1.2°C to +3.5°C)
Annual Precipitation (% change)	Province wide	+9% (+4% to +17%)
	Southern	+8% (+3% to +15%)
	Northern	+9% (+2% to +27%)
	Coastal	+8% (+2% to +17%)
Summer Precipitation (% change)	Province wide	+0% (-13% to +7%)
	Southern	-10% (-28% to +1%)
	Northern	+2% (-9% to +19%)
	Coastal	-10% (-25% to +3%)
Winter Precipitation (% change)	Province wide	+13% (+5% to +23%)
	Southern	+11% (+3% to +26%)
	Northern	+16% (+2% to +29%)
	Coastal	+9% (+3% to +21%)
Spring Snowfall (% change)	Province wide	-70% (-88% to -18%)
	Southern	-74% (-89% to -14%)
	Northern	-70% (-89% to -22%)
	Coastal	-73% (-86% to -13%)
Heating Degree Days (change in degree days)[3]	Province wide	-973 degree days (-1554 to -608 degree days)
	Southern	-975 degree days (-1541 to -581 degree days)
	Northern	-1006 degree days (-1633 to -638 degree days)
	Coastal	-847 degree days (-1283 to -446 degree days)

Source:

Pacific Climate Impacts Consortium (PCIC) plan2adapt tool (www.pacificclimate.org)

Notes:

1 For simplicity, proxies were used to represent three different regions of British Columbia. Proxies are based on the plan2adapt projections for Forestry Regions of British Columbia. Southern British Columbia = Thompson and Okanagan; Northern British Columbia = Northeast; and Coastal British Columbia = West Coast. Not all parts of BC are represented by these three proxies.

2 The projected change reported is the mid-point value from an ensemble of more than 15 Global Climate Models (GCM) and two specific GHG emissions scenario combinations (a high A2 and a lower B1scenario) provided by the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. The ranges in brackets represent the 10th percentile and 90th percentile results within the ensemble. Changes are expressed relative to the average value over the 30-year meteorological baseline period (1961-1990).

3 Heating degree days (HDDs) are useful in determining heating energy demand. HDDs are determined by multiplying the number of days that the mean daily temperature (average of daily maximum and minimum temperatures) is below 18°C by the number of degrees below that threshold. For example, if a given day saw a mean temperature of 14°C that day would contribute 4 x 1 = 4 HDDs to the total.

3.3 IMPACTS OF CLIMATE CHANGE ON REAL ESTATE

Insurance data shows a significant increasing trend in severe weather damage to buildings and other infrastructure over the last half century (Munich Re, 2014). Nonetheless, research systematically investigating the impact of projected climate change on "real estate"[3] is sparse (Morton et al., 2011). This is surprising given the lifespan of real estate (in particular, vertical development) of up to 100 years or more. One would therefore expect some existing real estate, and certainly most development over the coming decades, to still be in use under climatic conditions very different to those experienced today. Climate change could make these developments too uncomfortable or risky to live in, too expensive to operate and manage, too costly to insure, and not sufficiently profitable to attract capital from investors for renovations.

Potential climate-related impacts on real estate are summarized below. Impacts are also commonly referred to as "consequences" or "outcomes" in the risk management and adaptation literature. They refer to effects such as premature or accelerated deterioration of buildings, reduced service life and functionality, increased service disruptions and emergencies, increased repairs and maintenance, increased adverse health and safety outcomes, and increased discomfort and loss of occupant well-being. Impacts arise from the interaction of climate and non-climate hazards occurring during a defined time horizon (the 2080s) and the vulnerability of real estate exposed to those hazards. The vulnerability or propensity of real estate to be adversely affected by a climate hazard depends on both its sensitivity to the hazard and capacity to adapt.

It is clearly not feasible within the scope of this study to account for exposure, adaptive capacity, non-climate hazards, and sensitivity to harm when characterizing climate-related impacts on real estate. These factors will moderate the level of impact (e.g., minor ➞ moderate ➞ critical). Furthermore, it is not feasible to account for the likelihood of impacts occurring (e.g., rare ➞ possible ➞ almost certain). As such, the identified impacts are not true "risks" in the strictest use of the term.[4] The identified impacts represent *potential* effects, of unknown magnitude, from the assumed exposure of real estate to climate hazards, and before any additional anticipatory adaptations.

Potential impacts are organized by climate hazard, distinguishing between slow-onset climate-related physical events (e.g., increasing temperatures, precipitation, and sea-level) and sudden-onset climate-related extreme physical events (e.g., storm surge, extreme precipitation and flooding, wildfires, damaging storms, drought, and heatwaves).

[3] The term "real estate" was defined in Section 2.1 to mean: land and anything fixed, immovable, or permanently attached to it such as appurtenances, buildings, houses, landscaping, fences, fixtures, improvements.

[4] Risk is the product of impacts (or consequences or outcomes) and the likelihood of those impacts.

3.3.1 Slow-onset Climate Impacts

Increased Temperature

Potential impacts on real estate from projected increases in mean annual temperature (MAT) by the 2080s include (Camilleri, 2000; Boyle et al., 2013; and McMahon and Williamson, 2010):

- Increased summer cooling requirements for buildings and increased load on air conditioning with implicit capital and operational cost implications;
- Premature weathering and reductions in the lifespan of building materials, especially plastics and coatings;
- Increased heat stress on occupants, construction workers, and property managers. Discomfort (loss of well-being), loss of working days, loss of productivity, loss of experience, etc.;
- Increased ultraviolet radiation, which is a major cause of polymer (i.e., plastic, rubber, wood lignin) degradation, affecting the life span of many products used in buildings;
- Increased freeze-thaw cycles and deeper frost penetration in some parts of the province where reduced snowfall allows frost to penetrate deeper;
- Increased odour and potential infestation from decaying waste and compost; and
- Building and infrastructure damage associated with dry soil movement (subsidence due to drying of soils).

There may also be some benefits from continued warming—notably, reduced space heating and water-heating requirements. The desirability of certain areas for real estate development may also increase—e.g., in northern British Columbia.

Note that potential impacts from extreme temperatures and heatwaves are considered in Section 3.3.2.

Increased Precipitation

Potential impacts on real estate from projected increases in mean annual precipitation (MAP) by the 2080s include (Camilleri, 2000; Boyle et al., 2013; and McMahon and Williamson, 2010):

- Increased water infiltration to foundations and increased risk of foundation fractures;
- Increased chemical degradation, through efflorescence and corrosion, of building materials and components and reduced structural integrity;
- Increased biological degradation (e.g. through mold growth) of building materials and components and reduced structural integrity; and
- Visual impacts to building facades through chemical and biological degradation and deterioration of materials.

Note that potential impacts from extreme precipitation (including riverine and overland flooding, landslides, and erosion) are considered in Section 3.3.2.

Sea-level Rise

Ocean temperatures are also rising and as the oceans warm, they expand, raising sea-levels. In addition, global warming is also melting ice caps, mountain glaciers, and land-based ice sheets—all contributing to sea-level rise.

Ocean levels can be measured either in absolute or relative terms. Absolute sea-level is the height of the ocean surface, whereas relative sea-level is the ocean height in relation to the continental crust. Relative sea-level is primarily determined by absolute sea level, but is also affected by vertical land movement from tectonic activity, sedimentation, ocean circulation patterns, wind velocity, atmospheric pressure, salinity, wave heights and isostatic rebound (the adjustment of the land following the retreat of glaciers from the last ice age) (Thomson et al., 2008; and BCMOE, 2007).

Absolute sea-levels, as well as maximum sea-level are increasing across the coast of British Columbia (Walker et al., 2007). On the coast, sea-level rise has occurred in most locations, but varies depending on rates of land uplift and subduction. Historic rates of sea-level rise along the coast vary from a high of +9.8 cm per century in Prince Rupert, to +1.0 cm per century in Vancouver, to -16.8 cm per century in Tofino, owing to significant land uplift on the West Coast of Vancouver Island.

Projections of future sea-level rise, for the purposes of infrastructure planning on the coast, are approximately 0.5 metres to the year 2050, 1.0 metre to the year 2100, and 2.0 metres to the year 2200 (Ausenco Sandwell, 2011).

The potential impacts of sea-level rise will vary depending on the location-specific factors noted above, as well as the vulnerability of the coastline to erosion—a function of local relief, geology, and shoreline composition (Okey et al, 2012).

If shoreline barriers (e.g., seawalls and dikes) are not sufficiently high, a one to two metre rise in sea level could render much coastal real estate vulnerable to inundation. Potential impacts of projected sea-level rise by the 2080s include (Boyle et al., 2013; BCMOE, 2013; Okey et al., 2012; Ausenco Sandwell, 2011; Thomson et al., 2008; Abeysirigunawardena and Walker, 2008; BCMOE, 2007; and Walker et al., 2007):

- Permanent inundation of low-lying lands and property, including high amenity areas (beaches, coastlines) that may hold (high value) potential for real estate development;
- Rising water tables and reduced drainage capacity;
- Permanent loss of roads and access to coastal land and property;
- Increased coastal erosion and inundation of coastal infrastructure, with potential loss of infrastructure functionality and higher maintenance and insurance costs; and
- Contamination of fresh water aquifers and deterioration of drinking water.

Note that potential impacts from storm surge and coastal flooding are considered in Section 3.3.2.

3.3.2 Sudden-onset Extreme Events

Storm Surge, Coastal Flooding and Erosion

Storm surge refers to a temporary increase in the height of the sea due to extreme meteorological conditions, such as low atmospheric pressure and strong winds (Stanton, Davis and Fencl, 2010). The impacts of a storm surge can be magnified by high tides as well as by sea-level rise.

Trends in storm surge activity on the coast of British Columbia include increases in yearly maximum sea-levels (Abeysirigunawardena, Smith, and Taylor, 2011), which are increasing at a rate of +3.4 mm per year over the period 1943 to 2000 (Graham and Diaz, 2001). In addition, storm intensities on some parts of the coast have increased (Graham and Diaz, 2001).

Some predictions for the future storminess of the climate suggest fewer, but more intense storms, while other predictions suggest more intense and more frequent storms and wave action (Abeysirigunawardena et al., 2009; Pike et al., 2008; Parry et al., 2007; and Stanton, Davis and Fencl, 2010). Similar to sea-level rise, the actual impacts of storm surges will vary spatially depending on the vulnerability of the coastline to erosion (Okey et al., 2012). Storm surge could have various impacts on coastal infrastructure in British Columbia (Stanton, Davis and Fencl, 2010; Camilleri, 2000; Abeysirigunawardena, Smith, and Taylor, 2011; and Graham and Diaz 2001):

- Damage to banked land, buildings and infrastructure, and managed green spaces;
- Injuries, fatalities, and disruption to livelihoods;
- Inundation and flooding of low-lying lands and property, including high amenity areas (beaches, coastlines) that may hold potential for real estate development;
- Increased foreshore erosion and infrastructure impacts, including temporary loss of infrastructure functionality and higher maintenance and insurance costs;
- Contamination of fresh water aquifers and impacts to drinking water quality; and
- Road and access closures from temporary flood inundation.

Extreme Precipitation—Riverine and Stormwater Flooding, and Landslides and Erosion

Extreme precipitation events in British Columbia have been increasing over the last 50 years, particularly in the summer season and for short duration events (Burn et al., 2011). Such events are also projected to increase in intensity, duration and frequency in the future, both on the coast and interior regions of British Columbia. Risk from riverine flooding will vary by watershed. Potential impacts of extreme precipitation events on real estate by the 2080s include (Pinna Sustainability, 2014; Camilleri, 2000; Kharin et al., 2013; Boyle et al., 2013; Burn et al., 2011; ICLR, 2010; Heap, 2007; Murdock, Bennett and Werner, 2007; Rodenhuis et al., 2007; Pike et al., 2008; Jakob and Lambert, 2009; and Murdock et al., 2013):

- Increased exceedance of stormwater infrastructure capacity and inundation and flooding of low-lying lands and property, either through:

- Infiltration flooding, where the soil around a foundation becomes saturated with groundwater, or groundwater levels exceed the height of the basement floor, or
- Sewer backup, when underground sewer systems surcharge due to high water volumes;

- Road and access closures (e.g. washouts of roads and bridges) disrupt livelihoods, cause construction delays, etc.;
- Damage to, loss of, buildings, green spaces and infrastructure (piped water, drainage, sanitation, communications, power, gas, etc.);
- Injuries and fatalities, and mental disorders (stress and anxiety) to exposed occupants and workers; and
- Deterioration of sources of drinking water from increased turbidity and pollution run-off.

Wildfire

Climate change is projected to increase the frequency and severity of wildfires, owing to increases in summer temperatures, very hot days, longer warm spells, reduced summer precipitation, fuel accumulation, extended droughts and pest outbreaks. One projection for British Columbia suggests both an increase in the seasonal fire severity rating and an increase in fire season length of one to two weeks by 2045 (BCMFR, 2006). Fire starts have also been projected to increase by between 21 per cent and 190 per cent by 2100 (Taylor et al., 2009). Potential impacts on real estate from wildfires and associated smoke by the 2080s include:

- Damage to, loss of, buildings, green spaces and infrastructure (communications, power);
- Road and access closures disrupt livelihoods, cause construction delays, etc.;
- An increase in burned landscapes could decrease visual quality of areas and reduce property values, the desirability of certain areas to live and work;
- Wildfires lead to hydrophobic soils which can increase risk of flooding and erosion with associated impacts (see above);
- Loss of visual amenity from smoke; and
- Injuries and fatalities, mental disorders (stress and anxiety), and respiratory illnesses to exposed occupants and workers.

Extreme Temperatures and Heatwaves

Heat waves are rare hot extremes or prolonged periods of abnormally hot weather—precisely how many days, and how high the temperatures must rise for an event to be classified as a heatwave, are variously defined (Kinney et al., 2008). Globally, increasing temperatures are "virtually certain" to increase the frequency and magnitude of warm days and nights, and decrease the frequency and magnitude for cold days and nights, leading to an increase in the frequency and intensity of heat waves (Seneviratne et al., 2012). Rare hot extremes are also projected to become more frequent in Canada—with a one-in-20-year extreme hot day projected to become about a one-in-five year event by the 2050s (Warren and Lemmen,

2014). Potential impacts of extreme temperatures and heatwaves on real estate by the 2080s include (McMahon and Williamson, 2010; Boyle et al., 2013; and Camilleri, 2000):

- Increased loads and shifting peak demands for space cooling, with associated capital and operational cost implications;
- Increased heat stress on occupants, construction workers, etc. leading to discomfort and potential health (including premature deaths) and safety implications;
- Increased odour and potential infestation from decaying waste and compost;
- Damage to buildings and infrastructure associated with dry soil movement (subsidence due to the drying of soils);
- Construction and renovation delays and loss of work days during heatwaves; and
- Increased demand on water delivery and collection systems, increasing pressure on water supply infrastructure and water resources.

Water Shortage, Drought

Projected changes to temperature and precipitation through the 2080s will affect water availability. Current trends in BC and across Canada show reductions in the proportion of total precipitation falling as snow as well as the spatial coverage and duration of snow cover, affecting the timing and amount of spring runoff (Bush et al., 2014; and BCMOE, 2015). Rising mean annual temperatures are also influencing evapotranspiration and water loss to the atmosphere with implications for the water balance—manifested as changes in the amount and timing of water availability (Bush et al., 2014). Research across Canada suggests that the future climate will consist of more intense dry extremes and droughts, which could increase seasonal aridity and reduce freshwater availability in some areas (Bush et al., 2014). Potential impacts on real estate by the 2080s include (Kovacs and Thistlewaite, 2014; Eclipse Research Consultants, 2010; and Boyle et al., 2013):

- Reduced quality of water supply due to warmer water temperatures and lower stream flows in late summer;
- Damage to buildings and infrastructure associated with dry soil movement (subsidence due to the drying of soils);
- Increased drought risk and potential water shortages with implications for health, livelihoods, the aesthetic quality of the landscape, and quality of life generally within some real estate developments in certain areas (e.g., Southern BC and the Okanagan) and seasons (late summer and early autumn);
- Increased demand on water delivery and collection systems, increasing pressure on associated infrastructure with associated capital and operating cost implications; and
- Increased competition for scare water resources between sectors (e.g., agriculture, industrial, residential, commercial, environment, etc.) and between developments along water courses or on aquifers.

Damaging Storms

Damaging storms include: deep low pressure systems, severe thunderstorms and other high wind events, hailstorms, lightning events, and traditional winter storms, such as blizzards, extreme snowfall events, and ice storms / freezing rain events. Even under existing climate conditions these events are having a significant impact on British Columbians (Heap, 2007; and Warren and Lemmen, 2014). Although projections for the future are uncertain (Rummukainen, 2012), there is some indication that storm events may increase in frequency, intensity, or both in the future (Warren and Lemmen, 2014; and Field et al., 2012). Potential impacts on real estate from damaging storms by the 2080s include (Abeysirigunawardena et al., 2009; Field et al., 2012; and Boyle et al., 2013):

- Damage to, loss of, buildings and infrastructure (piped water, drainage, sanitation, communications, power, gas, etc.), and managed green spaces (including trees);
- Disruption to critical services (temporary power outages, loss of heating, loss of communications, loss of water supply);
- Loss of other amenities for occupants;
- Injuries and fatalities, and mental disorders (stress and anxiety) to exposed occupants and workers; and
- Road and access closures (e.g. washouts of roads and bridges) disrupt livelihoods and supply chains for commerce, lead to construction delays, disrupt renovation, etc.

4 REAL ESTATE DEVELOPMENT PROCESS

"*Real estate development is the continual reconfiguration of the built environment to meet society's needs*" (Miles et al, 2000).

4.1 INTRODUCTION

Human settlements require land and other resources to provide shelter, food, transportation, utilities, and meet other needs of residents. Generally, the process of altering land from its natural state for human settlement is called development or land use, or both.[5]

Property owners and developers make decisions about land use that range from simple home renovations to large complex industrial projects. Private real estate decisions are those made by owners (entities that have title to a real estate asset), developers, or both, who are not government corporations. Execution of these decisions requires ownership of land. It also requires access to capital, an understanding of public process (i.e., regulatory environment), management capacity, knowledge of markets, and the ability to deliver and maintain a completed real estate asset. Eventually, these assets will be updated, renovated and, ultimately, replaced.

Two streams of private real estate decisions generate the activity that plays such a large role in the provincial economy (see Box 1).

1. Developers undertake projects that shape the built environment. They turn an idea into a plan to create housing, commercial space, public amenities, and many other services desired by the market and host communities. In doing so, developers take on considerable financial risk. Often execution of a large-scale development process requires partnerships to help secure a suitable site, architectural input, financing, access to technical consulting, quality construction expertise, and other expertise. Developers must get approving authorities to understand their plan and reach a decision to approve it once the overall design has met the objectives of the official community plans. This often-lengthy process is meant to ensure that both the community and the developer realize intended benefits and avoid a result that detracts from community well-being.
2. Property owners make decisions governing selling, buying, maintaining, and renovating or upgrading vertical real estate. In short, property owners and would-be property owners deal with assets already created by the development process. The decisions of property owners in aggregate strongly influence market trends. Examples include willingness: to install water saving devices (e.g., aerated tap fittings) and appliances (e.g., low-flow toilets); to install fire resistant materials (e.g., for interior walls, roofing, siding, windows, doors, etc.); to convert to more efficient HVAC systems; and to adopt new technology (e.g., for passive cooling). This post-development area of real estate activity creates business opportunities for materials suppliers, designers, decorators, small builders, and many other entrepreneurs.[6]

[5] Land may also be set aside for conservation purposes, such as watersheds to provide sources of potable water, to aid flood control, to provide habitat for flora and fauna, etc. This is commonly referred to as preserving natural capital.

[6] In September 2013, TD Economics reported that "*Canadians have ramped up spending on home renovations and improvements. At 7 per cent per year since 2003, spending gains in this area have outshone other components of household spending. During the 1990s, outlays for home*

Box 1: Significance of Real Estate Related Activities to British Columbia Economy

In British Columbia, real estate related activities, including construction, contribute significantly to the economy. The construction sector comprised 7 per cent of provincial Gross Domestic Product (GDP) in 2011, while the finance, insurance and real estate sector—the largest service sector industry—accounted for 25 per cent of provincial GDP. From 2002 to 2011 the construction sector expanded 63 per cent, growing significantly more than the national average over the same period (34 per cent). This strong growth was driven primarily by development in the oil and gas sector. The construction sector was also the largest employer in the goods-producing sector in 2011.

From January 2012 to June 30, 2014 residential construction investment in British Columbia increased 14.4 per cent and housing starts grew 10.2 per cent.

Source: BC Stats (2012)

In this section, key actors, stages and decision points in the real estate development process are described. These decision points provide opportunities for the application of economic instruments to promote socially sound adaptation choices, which are explored in subsequent sections.

4.2 THE REAL ESTATE DEVELOPMENT PROCESS

Multiple models of the real estate development process (also referred to as the "real estate development life-cycle") are documented in the literature (e.g., Zuckerman and Blevins, 1991; Jarchow, 1991; Roulac, 1996; GLA, 2005; and Kohlhepp, 2012). A holistic real estate development process comprises five broad stages (see Figure 2):

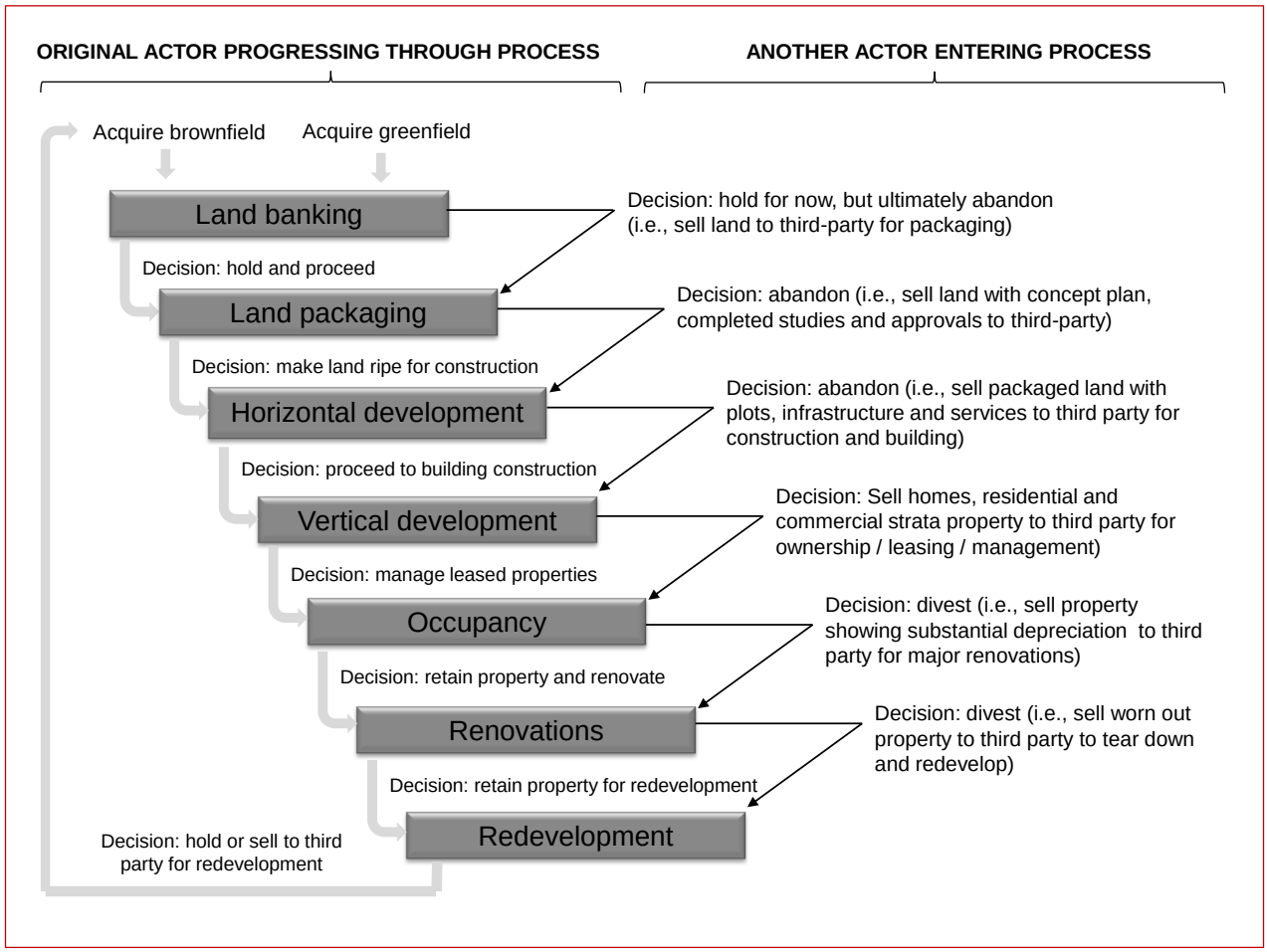
1. Land banking and packaging (early-stage planning);	Acquisition
2. Land development or vertical development (mid-stage planning);	Construction
3. Construction and building (horizontal development) (final-stage planning);	
4. Operation and maintenance; and	Occupancy
5. Renovation, disposal and redevelopment.	Disposition

These five stages reflect the more detailed process described in *Real Estate Development – Principles and Process* (Miles et al, 2000) and *The Real Estate Development Matrix* (Kohlhepp, 2012). The typology of the completed land and buildings works may range from a single house to a complete community, which includes open space, parks, institutional, commercial and residential buildings, and other structures.

Broad decisions and actions that actors and practitioners involved at each stage of the real estate development process are summarized below. The process may be very complicated; it is not possible to list every detailed decision that may be made.

renovations accounted for just over 25 per cent of total residential investment. Currently, that share is almost 40 per cent. Accordingly, the sector's economic importance has grown significantly over the past decade." (TD Economics, 2013)

Figure 2: Real Estate Development Process – Adaptation Opportunity Space



Source: Adapted from Kohlhepp (2012)

4.2.1 Land Banking and Packaging

In anticipation of future market needs, individuals or corporations may undertake land banking and packaging. This involves purchasing properties to be held for future sale into the market when potential investment gains are suitable. Often it is a corporate group that acquires a site for future development, which it will carry out in a new corporation created for the specific purpose. The motivation to create the new corporation (in British Columbia) includes liability and tax concerns. The sale of the development site to the new corporation will involve profit taking by the original investor(s).

Box 2: British Pacific Properties

Perhaps the best-known land banking strategy in British Columbia is the British Pacific Properties (BPP) acquisition in 1933 of 4700 acres in West Vancouver above three fledgling seaside neighbourhoods. The city promoted the sale to avoid bankruptcy. Owned by the Guinness family of London, BPP committed to $5 million of immediate development and paid for the construction of the Lions Gate Bridge. Real estate development by BPP continues today.

Source: West Vancouver Archives (www.memorybc.ca)

Land-banked sites may be green-field or brown-field (previously built out). In each case, a similar decision path will be followed in anticipation of the site gaining value until it is sold for (re)development. Some land banking occurs inadvertently. For example, a school district may have purchased land for future schools; however, demographic changes may have rendered the site surplus to requirements providing the school district the option of selling it.

When an individual or corporation acquires a site for future development, it will plan for development under one or more of the types of subdivision permitted under the *Land Title Act* in British Columbia, of which there are five (BC Ministry of Transportation and Infrastructure, 2014):

- A **fee-simple subdivision** results in a separate indefeasible title for each lot created under the *Land Title Act*;
- **Strata subdivision** allows development where fee-simple land is divided into multiple units, with all unit owners having a right to use common elements. There are three sub-types ❶ bare land strata, ❷ building strata, and ❸ phased strata subdivision;
- A **cooperative association** or shared interest subdivision may be created under the *Real Estate Development Marketing Act*. Developers sell shares in a land owning company;
- Development on **Indian reserves** falls under federal jurisdiction unless it conforms to part 24 of the *Land Title Act*; or
- **Leases** under Section 73.1 of the *Land Titles Act*, with leases exceeding three years or with an option to extend beyond three years are considered subdivisions.

The type of subdivision will determine the nature of the ownership that buyers of a development will have. For example, strata owners have an interest in their dwelling unit as well as common property. Fee-simple owners have total control of their property.

Table 2 through Table 5 illustrate a typical decision-making path for a potential mixed-use development of residential and commercial (e.g., retail, office, services, etc.) real estate, highlighting the broad decisions, actions, actors and practitioners at each stage in the development process. A suitable site would be urban or suburban. The actors and practitioners may be internal (employed in a development group), or engaged by contracts as required. These individuals can make decisions (and encourage actions) that result in a socially sound level of adaptation, leading to a low risk–more resilient development. Note that a number of decisions and actions may be repeated at each stage of the development process (and thus appear in more than one table).

Table 2: Broad Decisions and Actions, Actors and Practitioner—Land Banking and Packaging

Actors / Practitioners	Decisions / Actions
Purchaser: individual, corporation, or corporate group	Review market trends and estimate future needs for a large scale development on a large site (several acres or more)
Real estate analyst	Review histories of potential sites Carry out environmental and other technical reviews
Planning consultant	Check whether zoning and official community plan objectives are in place Establish whether the site can be re-zoned
Land owner, developer	Consider the potential site for development by purchaser of site or by another, third-party developer or development group
Lawyers, accountants	Acquire the site that meets anticipated use and investment return targets
Land owner, developer, and approving authorities	Hold site until conditions make it ripe for sale or obtain zoning changes and development permit (building permits are obtained at the next stage of the process)
Site developer	Prepare the site for development and sale
Sub-contractors	Create land development concept; prepare financing package
Land owner, developer	Sell the site to developer(s) (henceforth, referred to as a development group)

4.2.2 Land Development

There are two primary influences on the potential of a site for real estate development. These are ❶ policies and objectives within the Official Community Plans (OCPs), including growth strategies and ❷ zoning and sub-division bylaws. In real estate terminology, the developer looks for the highest value (private return) and best use possibilities for the site. At this stage of the real estate development process, the development concept gets shaped by the site possibilities and community objectives as expressed in the OCP and zoning bylaws. In some jurisdictions regional growth strategies are also relevant. The development concept includes all land uses and their locations, proposed number and types of residential units, the amount and type of commercial and retail space, as well as other features (parks, roads, community facilities, schools, natural areas, etc.).

In order to produce the development concept, the proponent will have invested in market research and detailed feasibility analyses (Miles et al, 2000). The proposed development not only needs to attract buyers, it has to meet the expectations of the public sector as expressed in official plans and zoning bylaws. Local governments have power under the *Local Government Act* to regulate development – primarily through zoning. Local governments may also use the comprehensive development district process (as in Burnaby) to increase the amount of interaction with proponents concerning real estate projects that may be proposed.

Table 3: Broad Decisions and Actions, Actors and Practitioner—Land Development

Actors / Practitioners	Decisions / Actions
Lead developer and partners (legal and accounting)	Propose real estate development concept to potential partners and possibly form development group (corporation).
Development group	Draw up initial plan concept. Consider the broad external context: transportation, floodplain, watershed, natural areas, etc. Work with owned site; or, purchase a site; or buy an option to purchase the site
Real estate analyst, appraiser	Calculate investment returns based on development options
Consultants	Carry out technical reviews (environmental, seismic, geotechnical), archaeological assessment, etc. Carry out market review, or feasibility study. Is there a suitable demand for the proposed residential units, commercial and other space?
Development group	Decide if feasible: proceed or abandon
Approvals by local government and other authorities	Revise development plan and review with approving authorities: local government, Environment, Health and Transportation ministries, and Government of Canada Fisheries. Modify development permit
Development group and planning consultants	Make sure the development plan aligns with zoning bylaws and OCP objectives (density, amenities, mix of land uses, attainable housing, environmental protection, etc.) Present development plan in public process. Illustrate design objectives that serve OCP values Make final plan adjustments. Sign contracts with sub-contractors. Pay development fees to local government
Development group and sub-contractors	Prepare site, install infrastructure and services Install rainwater retention measures, protect ecological assets, and utilize natural systems (water retention, habitat, buffer zones, etc.). Implement materials handling and waste management plans
Development group	Decide to proceed to construction and building (next state) or sell developed site. Will costs be covered and suitable profit gained if the project proceeds? Arrange construction financing (or not if the site and plan will be sold to another developer or development group)
Development group and consultants	Prepare detailed building plans and obtain building permit(s)

4.2.3 Building and Construction

The previous two stages of the development process should result in a site that is "ripe for investment." Land development is complete and utility services, roads, rainwater systems, and prepared building sites have been constructed. The proposed vertical development will be governed by the zoning (or re-zoning) and the objectives and policy of the OCP. Construction and building are now ready to commence.

Sometimes, at this point in the process, the development site and building plans are sold to another development group. This entity will have reviewed the development plan and building plans, and calculated the prospects for a suitable return on investment once the buildings have been sold or leased, or a combination of both.

Table 4: Broad Decisions and Actions, Actors and Practitioner—Construction and Building

Actors / Practitioners	Decisions / Actions
Development group and partners	Form the construction team, including key consultants
Development group and sub-contractors	Sign contracts with sub-contractors; set the construction timetable
Development group and planning consultants	Finalize building plans and obtain approvals from authorities
Development group	If not yet arranged, put construction financing in place; buy insurance, post-performance bonds, etc.
Development group and sub-contractors	Carry out construction and building Implement materials handling and waste management plans Deal with change orders
Engineers	Carry out inspections of works
Approving authorities	Carry out inspections at stages of construction
Development group and consultants	Market the project—sales, leasing
Development group and sub-contractors	Complete construction, connect services, test systems (ventilation, heat, smart controls, electrical, plumbing, windows, etc.) and technology (heat pumps, geo-thermal, solar, grey water, etc.) Prepare buildings for occupancy

4.2.4 Operations and Maintenance

At this stage of the real estate development process, the construction and building has been completed. The completed site with buildings, etc. would likely be sold by the development group and new actors and practitioners would become involved with the newly created assets, including: pension funds (as investment owners); households; leaseholders; property managers; strata corporations; building operators (engineers and others); sub-contractors providing irrigation systems, landscape installation and

maintenance, repairs, etc. The new owners and leaseholders will be motivated to keep the real estate assets well maintained and the related costs as reasonable as possible.

In the example of mixed-use residential and commercial real estate, for specific buildings the developer or development group will form a strata corporation with responsibility for management and maintenance of the common areas and grounds. Likely, the strata will engage a property management company to look after maintenance, repairs and replacement needs.

This stage of the real estate development process has an unknown life time. A well-constructed building that is properly maintained, updated and renovated might last for 100 years or more in British Columbia.

Table 5: Broad Decisions and Actions, Actors and Practitioner—Operations and Maintenance

Actors / Practitioners	Decisions / Actions
Development group and partners	The completed and commissioned building is sold to an investor, or sold to individual buyers and leaseholders Form a strata corporation, for specific buildings Building operations turned over to the strata (or investment owner) Building deficiencies are corrected for owners / leaseholders
Owners of strata property (investment owner and individual owners through a strata corporation)	The following plans may be defined and adopted: • Establish a common fund for annual and periodic repairs including renovations • Maintain and repair the common property – especially the building envelope • Establish a contingency reserve fund • Emergency evacuation • Landscape maintenance • Operation of building systems
Individual strata property owners	May decorate their units, replace appliances and finishings
Fee-simple owners	Decide to maintain, repair, remodel, or renovate their properties; replace mechanical, heating and electrical systems; add new technology (e.g., solar PV or thermal, heat pumps, rain waters collection, etc.)

4.2.5 Renovation, Disposal and Redevelopment

This stage of the real estate development process refers to properties that have suffered from lack of maintenance or that may be badly outdated. Properties may be affected negatively by changes (e.g., renovations or redevelopment) in nearby properties and exposure to nuisance and risks (e.g., noise, soil subsidence, flooding, debris and debris flows, wildfire, odour, etc.). Properties that have declined to the point that renovation is infeasible may be disposed of and replaced. Redevelopment projects follow the same process as new real estate development projects.

Decisions concerning renovation, disposal and redevelopment may not follow a typical path. However, the following actors influence outcomes (Kohlhepp, 2012):

- **Property Renovator**: This actor acquires a "*property with substantial economic or physical depreciation and creates value by curing these deficiencies then repositioning and operating the building until he property is ready for redevelopment*."
- **Property Redeveloper**: This actor buys a "*property with such serious physical or functional deficiencies that the improvements must be torn down and redeveloped for another use. This essentially begins the real estate development process all over again*."

Individual homeowners also participate in the residential renovation market. "More money was spent renovating homes in Canada than building new ones during the 12 months to the end of June 2014 according to data compiled by the Bank of Montreal"(Globe and Mail, 2014). Renovation decisions by homeowners range from upgrading rooms (e.g., kitchens, bathrooms) and finishings to additions and rebuilding on some, or the entire, original building footprint (CMHC, 2014). Specific renovation projects may involve (CMHC, 2014):

- Repair of foundations and supports;
- Structural upgrading to meet seismic requirements;
- Renewal of building envelope (and insulation–exterior and interior) to current code;
- Roofing (and roof overhangs), rainwater systems, windows and sealants;
- Utility systems (heating, ventilation, lighting, etc.), particularly energy efficient options; or
- Enhancements, such as natural lighting, low emissions materials, energy efficient appliances, water saving appliances, etc.

4.3 Opportunities to Promote Good Adaptation Choices

4.3.1 Decision Points—Intervention Points

Figure 2 highlights the highest-level decisions that private actors are confronted with across the real estate development process. For instance, at the conclusion of the "horizontal development" stage the developer(s) could:

a. Decide to sell the packaged land with plots, infrastructure, and services to a third-party for construction and building ("vertical development"); or

b. Decide to retain the packaged land and undertake construction and building itself.

Private actors are also confronted with a range of more detailed decisions at each stage, many of which were discussed above. The left-hand-side of Table 6, for example, lists key activities during the vertical development stage requiring private actors to make choices. These choices—in theory—have the propensity to influence (positively or negatively) the impacts of climate change on real property (by affecting the exposure, the vulnerability, or both the exposure and vulnerability of infrastructure, buildings or people to specific climate hazards). Table 7 attempts to summarize the degree to which

decisions by private actors at each stage in the development process could influence climate change impacts on real property. The length of the arrow indicates whether decisions taken by private actors at a particular stage in the development process could have a low (L) or high (H) influence on impacts arising from a specific hazard.

Table 6: Broad Intervention Points to Influence Efficient Adaptation Choices by Private Actors at Vertical Development Stage

Decision point-intervention point	Opportunity for influence
Design buildings and landscaping	Encourage building and landscaping designs to incorporate measures that reduce risks from relevant climate hazards at development location
Prepare finance and legal package for construction/building, including insurance	Design risk-financing products to incent actions to reduce risks prior to events, in addition to aiding recovery after events
Establish construction/building timetables	Influence timetables to account for possible interruption from relevant climate hazards at development location
Draft and negotiate contracts with sub-contractors for construction/building work	Mainstream desired climate change adaptation practices and behaviours into contracts (e.g., provisions for extreme heat events, provisions for water conservation, etc.)
Create and implement marketing strategy for finished buildings ready for occupancy	Mandate or incent voluntary disclosure of climate-related risks within marketing materials for potential buyers and tenants

Each of the more detailed decision points also provides local and provincial government policy-makers with opportunities to intervene and promote more efficient climate adaptation choices—i.e., adaptation actions and behaviours that yield net social benefits. Looking again at the vertical development stage, the right-hand-side of Table 6 shows opportunities where policy-makers could exert influence to promote better adaptation choices by private actors at the key decision points. At some decision points, private actors may face many choices over which policy-makers could exert influence.[7] By way of example, Table 8 lists specific adaptation measures that could be incorporated into the design of buildings (the first decision-intervention point in Table 6) to help mitigate risks arising from specific climate hazards.

[7] A wide range of adaptation measures that private actors could take to manage risks from various climate hazards are presented in Table 10 through Table 19 in Appendix A.

Table 7: Propensity of Decisions by Private Actors to Influence Exposure and Vulnerability to Hazards

Real Estate Development Process Stages							
Climate hazard	Land banking and packaging	Land development	Construction and building	Occupancy	Renovation	Redevelopment	Adaptation Actions
Increased temperature	L → H	L → H	L → H	L → H	L → H	L → H	Table 13
Increased precipitation	L → H	L → H	L → H	L → H	L → H	L → H	Table 14
Sea level rise	L → H	L → H	L → H	L → H	L → H	L → H	Table 15
Storm surge, coastal flooding, erosion	L → H	L → H	L → H	L → H	L → H	L → H	Table 16
Extreme precipitation, flooding, erosion, landslides	L → H	L → H	L → H	L → H	L → H	L → H	Table 17 and Table 19
Wildfire	L → H	L → H	L → H	L → H	L → H	L → H	Table 18
Extreme temperature and heatwave	L → H	L → H	L → H	L → H	L → H	L → H	Table 20
Water shortage, drought	L → H	L → H	L → H	L → H	L → H	L → H	Table 21
Damaging storms	L → H	L → H	L → H	L → H	L → H	L → H	Table 22

Source: based on expert judgement of project team

Note: "L" suggests that the propensity of decisions taken by private actors to influence (positively or negatively) the impacts of climate change on real property (either by affecting exposure and / or vulnerability of infrastructure, buildings or people to specific climate hazards) is LOW; "H" suggests that the propensity of decisions taken by private actors to influence (positively or negatively) the impacts of climate change on real property is HIGH.

Table 8: Examples of Measures to Incorporate into Building Design to Mitigate Risks from Specific Climate Hazards – Vertical Development Stage

Climate hazard	Examples of design choices
Increased temperature and heat waves	➡ Use green or brown roofs to limit heat absorption ➡ Use larger floor-to-ceiling heights to allow for future cooling mechanism retrofits ➡ Use thermally reflective surfaces (high albedo) for roof, siding and facades
Extreme precipitation and flooding	➡ Install moisture resistant flooring and wall finishes in the basement ➡ Install on-site water retention and management techniques (e.g., rain gardens, pervious surfaces, stormwater tank, etc.) ➡ Install sanitary sewer backwater valve to reduce risk of sewer backup
Sea level rise	➡ Install electrical, heating, ventilation, plumbing, air conditioning equipment and other service facilities above the projected sea level height ➡ Accommodate sea-level rise through structural modifications (e.g. raised foundations, stilts, platforms, etc.)
Wildfire	➡ Install fire resistant materials (for interior walls, roofing, siding, windows, doors, etc.) ➡ Install backup power (generator) for water supply system
Damaging storms	➡ Install heating strips on flat roofs to prevent blockage of drains by ice ➡ Install impact resistant roof covering to protect from hail storms ➡ Install wind-resistant roofing materials (e.g. polymer modified shingles)

4.3.2 Case Examples

Across all stages in the real estate development process there are over 30 key decision-intervention points, and at some of these points private actors may face many adaptation choices (as evident from Annex A). To keep the scope of the project manageable, it was decided to focus on three decision-intervention points as case examples. The purpose of these case examples is to allow us to identify pertinent barriers to particular decision-intervention points in the real estate life cycle, and to identify at one economic instrument that could—in theory—be used to overcome those barriers. As an exploratory study, the goal is to identify instruments with promise in a particular application, to describe how they work, to outline key challenges to their successful implementation in BC, and to make recommendations to further investigate their viability. The three chosen case examples are:

1. **Real estate development process stage**:

Land packaging

Relevant actors:

Developers (individual, corporation, or group of corporations), real estate analysts, planning consultants, lawyers, accountants, financial institutions, technical consultants (engineers, architects, EIA specialists), approval authorities

Potential goal of government:

For developers and their partners to mainstream a socially optimal level of climate change adaptation into "plans" for the provision of housing, commercial space, public amenities, and other services desired by the market and host communities

Main climate hazards addressed:

- Sea-level rise
- Storm surge, coastal flooding, erosion
- Extreme precipitation, flooding, erosion, landslides
- Wildfire
- Extreme temperature and heatwave
- Water shortage, drought
- Damaging storms

2. **Real estate development process stage**:

Occupancy (minor upgrades) and renovations (major upgrades)

Relevant actors:

Fee simple property owners, strata corporations, tenants, financial institutions, technical consultants (engineers, architects, contractors), equipment suppliers, real estate agents, approval authorities (building code)

Potential goal of government:

For owners of real estate to upgrade their properties with climate resilient and resistance measures to try to minimize the present value (investment plus residual damage) social costs of climate change. Upgrades are most cost-effectively undertaken together with other building envelope, equipment or landscape renovations to the property.

Main climate hazards addressed:

- Increased temperature
- Increased precipitation
- Sea-level rise
- Storm surge, coastal flooding, erosion
- Extreme precipitation, flooding, erosion, landslides
- Wildfire
- Extreme temperature and heatwave
- Water shortage, drought
- Damaging storms

3. Real estate development process stage:

Redevelopment

Relevant actors:

Fee simple property owners, strata corporations, tenants, lawyers, (re)developers, financial institutions, real estate analysts, planning consultants, real estate agents, approval authorities

Potential goal of government:

To help markets provide appropriate price signals to property owners to encourage an optimal level of managed retreat from locations prone to (mainly) coastal and fluvial flooding, where such a policy is justified.

Managed retreat is the term used to describe the gradual shifting of (private, public or both) property and activities away from hazards (such as coastal processes) threatening them, thereby eliminating exposure to the hazard. Retreat can potentially occur at two scales depending on circumstances: (1) shifting buildings back from the hazard (e.g., sea) within existing property boundaries; or (2) if relocating buildings within existing properties is not possible then the next stage in retreat is to relocate salvageable buildings (and whole communities) to another location.

Managed retreat may be justified where, for example: the construction and maintenance costs of protection works are higher than the capital values of the assets to be protected; the wider community is either unable or unwilling to pay for the costs of maintaining protection works indefinitely; etc.

Main climate hazards addressed:

- Sea-level rise
- Storm surge, coastal flooding, erosion
- Extreme precipitation, flooding, erosion, landslides
- Wildfire
- Water shortage, drought

Note: See, for example, CIWEM (2006); Turbott (2006); Alexander, et al. (2012); Siders (2013); and Tinker (2013); and Kousky (2014)

We use the three case examples as follows:

- In Section 5, succeeding a general exploration of potential barriers to efficient adaptation decisions by private actors, we identify barriers specific to each case example; and
- In Section 0, we identify at least one economic instrument that government(s) in BC could use to overcome the identified barriers to good adaptation choices in each case example.

5 BARRIERS TO GOOD ADAPTATION DECISIONS

5.1 INTRODUCTION

In a world with perfectly functioning markets for all goods and services, efficient adaptation to climate change would be enabled through normal market transactions; prices would provide rational individuals in the real estate sector with incentives to reduce risks arising from climate hazards (or "climate-related risks" for short) to socially optimal levels. However, markets seldom function perfectly and may not even exist for certain goods and services. Moreover, people do not always behave rationally. A number of "barriers" hamper the ability of individuals or businesses to use their resources—natural, financial, human, social, and physical capital—to manage climate-related risks in a way that would deliver net social benefits. For example, inconsistent, poor quality, or inadequate information on hazards, such as the frequency and /or intensity of storm surge or drought, can prevent people from efficiently managing risk associated with these events.

In this section we investigate potential barriers to efficient adaptation decisions. We begin by developing an in-depth understanding of how market failures and behavioural failures could impede efficient adaptation to climate change (see Box 3 for an explanation of what we mean by market failures and behavioural failures). We subsequently apply this knowledge to identify potential barriers to optimal adaptation in each of the three case examples.

The presence of such barriers means that private adaptation actions could: be the wrong sort of actions; be insufficient; be over and above what is needed; not occur at the right time; or not take place at all.

Box 3: The Meaning of Market Failures and Behavioural Failures

Market failures

Market failures occur when freely-functioning real estate markets, operating without adequate government intervention, fail to deliver outcomes that are satisfactory from the point of view of society. This happens when the private returns which an individual or business receives from carrying out a particular action (like undertaking adaptations to climate change) diverge from the returns to society as a whole—resulting in a sub-optimal amount of adaptation. Real estate markets can also fail when the individual or business does not have sufficient information to recognize the returns from climate change adaptation.

Behavioural failures

Even when markets are providing the right price incentives to individuals and businesses, alongside accurate and adequate information, people do not always respond in a 'perfectly rational' way. There are a number of anomalies and biases that affect the way people process information and make decision. These behavioural failures can also result in a sub-optimal amount of adaptation.

5.2 ADAPTATION AS AN INVESTMENT DECISION

From an economic perspective, adaptation choices fundamentally involve investment decisions that trade-off typically (higher) initial capital costs and uncertain (lower) future damage costs.[8] Consider a decision to upgrade an existing home with flood resistance and resilience measures.[9] In the simplest case, the initial capital cost comprises the full purchase price of (say) door guards, as well as all installation costs where relevant. In other cases, where a home is already undergoing renovations or repairs, the initial capital cost is given by the *difference* between the purchase and installation cost of a baseline product (e.g., new carpet for the ground floor, new permanent internal doors) and an otherwise equivalent product that provides essentially the same services, but reduces the consequences of flooding (e.g., polished concrete floors, readily removable internal doors). The decision whether to make the investment to reduce flooding risk requires weighing the initial capital cost, whether full or incremental, against the expected reduction in future private damage costs. Damage costs of concern to private households include both tangible costs (e.g., physical damage to buildings and contents) and intangible costs (e.g., inconvenience of post-flood recovery, welfare losses from injuries, anxiety, depression, etc., loss of life, etc.).

Assessing the reduction in future private damage costs requires the household to form expectations of uncertain future flood damages both with and without the installed measures. Retrofitted flood resistance and resilience measures are unlikely to completely eliminate future private damage costs to all possible flood events—i.e., some level of residual damages will likely persist when exposed to (say) a 1-1000 year flood—though they are expected to be lower than they would otherwise be in the absence of the measures. Comparing the *expected* future private damage costs to the initial capital cost of the installed measures requires expected future damage costs to be discounted to present dollar equivalents—using a discount rate appropriate to the household. All else being equal, the private household's optimal decision would entail choosing a level of flood resistance and resilience upgrades that minimizes present value (investment plus residual damage) private costs.[10] Defining both investment and damage costs more broadly to include, for example, unpriced environmental externalities, society's optimal decision involves minimizing present value (investment plus residual damage) social costs.[11] [12]

[8] Adaptation actions may also entail changes in annual operating and maintenance costs, in addition to the initial capital outlay. In these cases, the trade-off is between (higher) lifecycle adaptation costs and uncertain (lower) future damage costs.

[9] Flood "resistance measures" aim to prevent flood waters reaching the inside of buildings (e.g., door-guards, flood skirts, airbrick covers), whereas flood "resilience measures" aim to minimize damage caused by flood waters if they manage to enter buildings (e.g., basement tanking, water-proof wall plaster, raised utility services) (DEFRA, 2007).

[10] Formally, the household minimizes welfare losses by equating marginal private investment (or lifecycle) costs to marginal residual private damage costs.

[11] For society, welfare losses are minimized by equating marginal social investment (or lifecycle) costs to marginal residual social damage costs.

[12] A primary goal of economic instruments is to internalize these unpriced environmental externalities into the decisions made by private households and developers (i.e., to make these private actors pay for their externalities). With all externalities internalized, households and developers—in pursuing their own private agenda—will still make socially desired choices, all else being equal.

5.3 BARRIERS TO OPTIMAL LEVELS OF ADAPTATION

5.3.1 Adaptation Deficit

In a world with perfectly functioning markets for *all* goods and services, decentralized adaptation would be facilitated through normal market actions, with price signals giving private individuals or businesses ("actors") incentives to reduce climate-related risks to socially optimal levels. A rational actor faced with flooding risks would decide whether or not to invest in flood resistance or resilience measures on the basis of the calculation described above. With perfectly functioning markets and all externalities internalized, rational actors will be able to make the choices that best suit society's needs. Under such circumstances, the fact that so few actors have so far adopted flood resistance or resilience measures would simply tell us that such measures are not yet justified on social cost-benefit grounds. However, an examination of insured and economic (uninsured) losses from climate-related natural disasters in Canada since 1950 shows that they have been rising at an exponential rate. In 2013 insured losses from severe weather events totalled $3.2 billion—the highest year-end losses in Canadian history (IBC, 2014). Insured losses associated with severe weather in each of the four preceding years hit $1 billion. The scale of these losses suggests underinvestment in climate adaptation relative to some notion of the socially optimal level of adaptation. Such underinvestment is sometimes described as an "adaptation deficit" (Burton, 2009; and Fankhauser and McDermott, 2013). As the IBC data show, the adaptation deficit is increasing and is likely to become significantly larger with projected climate change.

Economists have postulated a number of reasons to account for the adaptation deficit (Bräuninger, et al., 2011; and Productivity Commission, 2012), in much the same way they have sought to explain the "energy efficiency gap" between actual and optimal energy use (Jaffe and Stavins, 1994; Jaffe, et al., 2004; and Gillingham, et al., 2009). Most of the explanations posited in the literature for levels of adaptation (or energy efficiency) falling short of what might be considered socially optimal are couched in terms of a range of market barriers.

5.3.2 Market Barriers, Market Failures, and Behavioural Failures

A market barrier may be defined as any disincentive to the adoption of an adaptation measure or behaviour. It can be anything that limits the ability of individuals or businesses to use their resources—natural, financial, human, social, and physical capital—to manage climate-related risks in a way that would deliver net social benefits (Productivity Commission, 2012).

The existence of market barriers could result in under-adaptation—where adjustments by individuals or businesses are insufficient, which would explain the adaptation deficit. Market barriers may also result in other forms of maladaptation (see Box 1). Consequently, community-wide wellbeing may be reduced from the level it would otherwise be if the market barriers did not exist.

Box 4: Forms of Maladaptation

Maladaptation may arise from:

- Inaction: for example, a failure to adjust water resources management to account for climate changes;
- Over-adaptation: for example, where adjustments are made that are proven to be unnecessary given the climate ultimately realized (a sea wall built to withstand 4m of sea level rise that never occurs);
- Under-adaptation: for example, where adjustments are insufficient in that they do not achieve the maximum potential reduction in losses for the climate ultimately realized; or
- Incorrect adaptation: for example, where adjustments are made, but are later found to be either not adaptive or counter-adaptive, actually increasing impacts above what they could have been given improved ex-ante adaptation.

Each of these outcomes gives rise to unnecessary costs. For example, for over-adaptation, resources are wasted through unnecessary investments. For under-adaptation, society experiences unnecessary damages, and may incur additional costs from retrofitting or replacing assets prematurely to withstand a different realized climate.

Source: Ranger et al. (2010)

Irrespective of the form of maladaptation that market barriers may create, their presence signifies a potential role for government intervention to help markets reallocate resources to improve how actors adapt. However, not all market barriers are market failures (or, more subtly, "imperfections") as defined in classical welfare economics. This is a crucial distinction in terms of justifying government intervention.

For example, in the context of energy efficiency, uncertainty about energy prices (and thus the actual cost savings from installing energy saving technologies), combined with the irreversible nature of these investments, is often cited as a barrier to the adoption of these technologies. Specifically, the uncertainty is said to lead actors to use irrationally high discount rates to analyze the present value of energy cost savings. But uncertainty, in and of itself, is not a source of market failure. It is perfectly acceptable for actors to take uncertainty into account when making investment decisions, and to apply relatively high discount rates to irreversible investments whose benefits are uncertain. To the extent that actors' true discount rates are high for these reasons, this does not constitute a market failure.

The qualitative attributes of new energy saving technologies, which may make them less desirable than standard, less efficient technologies, is also cited as a market barrier to energy efficiency. One example is the perceived quality differences between compact fluorescent light bulbs (CFLs) and incandescent light bulbs—differences that include hue of the light, the appearance of the bulbs, the time to reach full intensity. However, these quality differences are what economists refer to as intangible costs, which are very real to the actors contemplating the acquisition of CFLs, and do not correspond to a market failure that ought to be addressed by government intervention. In principle, actors may have similar concerns over the qualitative attributes of technologies to mitigate climate risks.

Market failures, in contrast, occur when one or more of the conditions necessary for markets to operate efficiently are not met—conditions that include:

- Perfect information (actors have all the relevant information necessary to understand the costs and benefits of their choices);

- Perfect mobility of resources (there are no barriers to enter and exit the market, with free flowing capital, labour and other resources);
- Perfect competition (no single actor can influence the market price or market conditions, and products are identical and interchangeable);
- No transaction costs (there are no costs associated with making a market transaction that are not accounted for in the price of the product itself from the buyer's or seller's standpoint, such as the cost to a buyer of locating a suitable supplier);
- No externalities (there are no unpriced effects, such as environmental damage, that accrue to a third party or third parties other than the buyer and seller of the product); and
- No public goods (all goods are characterized by increasing marginal costs and have well-defined property rights, so that potential buyers can be excluded from consumption if they fail to pay).

When any of these ideal conditions are not met, a market failure exists, and markets—left to their own devices—will not achieve a socially optimal allocation of resources for adaptation. Even if the conditions are met, the desired level of adaptation may still not result from market actions because actors do not behave rationally. Classical welfare economics assumes market participants are rational in their behaviour—carefully weighing their own costs and benefits in making economic decisions to maximize their utility.[13] Hence, with perfectly functioning markets, an actor would be expected to take decisions that maximize well-being or profit—or in the current context, minimize the present value costs (adaptation investment costs plus residual damage costs) of a given climate-related risk. There is substantive evidence nevertheless that consumer decisions are not always perfectly rational—and indeed suffer from systematic biases ("behavioural failures") that may lead to sub-optimal levels of investment in adaptation.[14] Behavioural failures describe decision-making that is inconsistent with the maximization of individual well-being, even when individuals are provided with the appropriate information and incentives.[15]

5.3.3 Socially Optimal Levels of Adaptation and the Costs of Interventions

The presence of market failures or behavioural failures will result in an inefficient allocation of resources for adaptation if markets are left to their own devices; their presence provides a *minimum* justification for government intervention to improve social well-being. While businesses face some of the same issues as individuals, competitive forces serve to somewhat moderate the importance of behavioural failures for decision-making in firms (Shogren and Taylor, 2008). Hence, government intervention to promote good adaptation decisions by businesses is primarily concerned with overcoming relevant market failures—i.e., to focus on inefficiencies that relate to either market structure or the incentives of businesses. In contrast, promoting good adaptation decisions by individuals primarily requires interventions to remedy both relevant market failures and behavioural failures.

Importantly, the mere existence of market failures and behavioural failures, which are pervasive, is not sufficient to justify government intervention. It is also necessary to demonstrate that the benefits arising

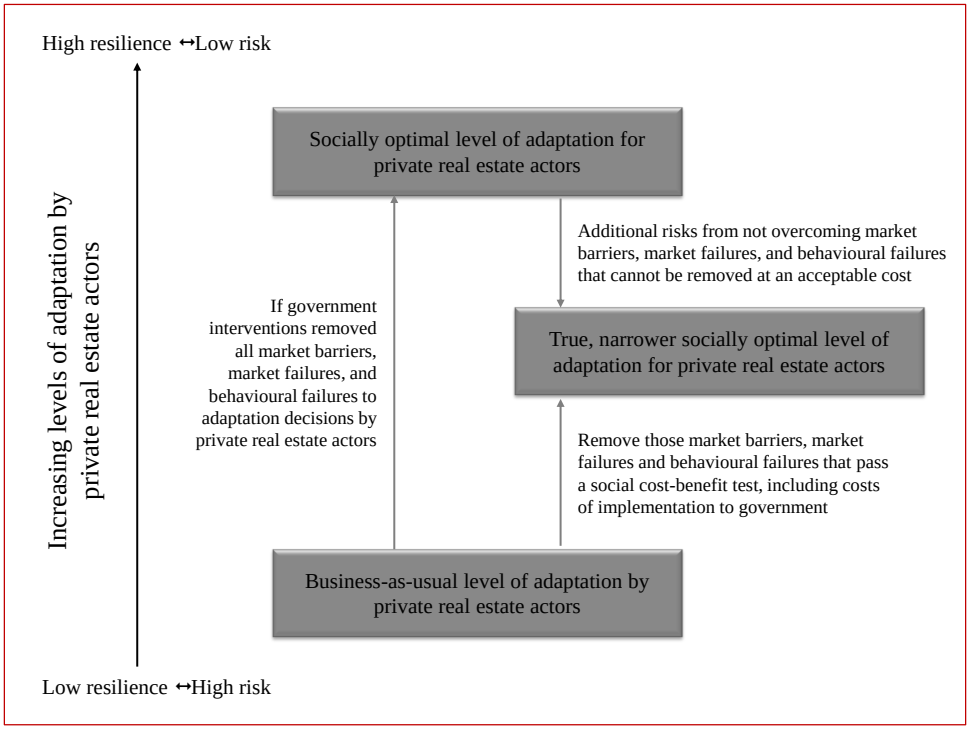
[13] Utility is the term economists use to refer to an individual's level of satisfaction, happiness, well-being or personal benefit.

[14] Shogren and Taylor (2008), Venkatachalam (2008), Brown and Hagen (2010), Shogren, et al. (2010), Pollitt and Shaorshadze (2011), Baddeley (2011), and Gsottbauer and van den Bergh (2011) provide reviews of this evidence in the context of environmental, energy and climate policy.

[15] Specifically, behavioural failures describe decision-making that is inconsistent with "rational choice theory", which is discussed below.

from such intervention exceeds the cost of implementation to government (Productivity Commission, 2012). The optimal level of adaptation desired by society as a whole *if* all market failures and behavioural failures where to be corrected will therefore typically be greater than the narrower, true socially optimal level, since overcoming some of the failures may be so costly that it is not worth doing (see Figure 3). Furthermore, by definition, for market barriers that are not market or behavioural failures, it will not be possible to design policy interventions that pass a social cost-benefit test. If there is no market or behavioural failure, removing that barrier does not increase community well-being (Jaffe and Stavins, 1994). With these caveats in mind, in the remainder of the document we nonetheless consider all market barriers that may prevent actors in the real estate development process from managing climate-related risks in a way that could deliver social benefits. Whether or not an intervention(s) to redress a specific barrier(s) passes a social cost-benefit test is a question that would need to be answered through subsequent analysis, on a case-by-case basis.

Figure 3: True Socially Optimal Level of Adaptation



Source: Based on Jaffe and Stavins (1994)

5.4 RELEVANT MARKET FAILURES

5.4.1 Externalities

Externalities are costs (or benefits) arising from an activity that are faced by members of wider society who are not party to that activity, and thus have no control over it. An independent individual or business makes decisions that control the activity, but those actors do not pay for the impacts of the activity on

wider society. When an economic activity takes place, there are normally two groups affected: the buyer and the producer (seller). But sometimes, the economic activity has an effect on people who are not directly involved. Because these effects are on a person who is external to the activity, they are called "externalities". Externalities can be either positive or negative—that is, the economic activity of one person or group can have either a positive or negative "spill-over" onto other people.[16]

Both negative and positive spillovers could influence efficient levels of climate change adaptation, resulting in too much of an activity that leads to maladaptation, or not enough of an activity that enhances adaptive capacity (Productivity Commission, 2012). For example, a private land owner could construct a seawall to protect his or her property from sea-level rise. If the seawall increased erosion at adjacent properties, it could result in a negative externality if the costs of that erosion is not reflected in the costs of the seawall, or borne by the private land owner who constructed it. As a result, the land owner will likely not take these external costs into account when making decisions about how best to protect his or her property to sea-level rise. Similar negative externalities could result from decisions taken by private land owners to protect their property from riverine flooding, where flooding risks at near-by properties and infrastructure are increased.

Positive externalities can arise from learning-by-doing, whereby the adopter of a measure to reduce climate-related risks creates knowledge about the measure through its use, and others freely benefit from the information generated about the existence, characteristics, and performance of the measure. In the context of energy demand-side management programs, two types of learning-by-doing spillovers are distinguishable: "free-drivers" and "program spillovers" (Jaffe et al., 2004). Free-drivers are individuals who do not participant in the program, but who install energy saving technologies due to hearing about them from program participants. Program spillovers occur when participating individuals install additional energy saving technologies, without financial incentives or technical assistance, due to what they learned through participation in the program. Both types of positive externality would be equally applicable to programs to retrofit existing homes and businesses for climate-related risks.

Governments can subsidize activities that generate positive externalities (e.g., grants, subsidized loans, tax credits, etc.). Conversely, the main interventions to redress activities that generate negative externalities involve direct regulation, tradable quota schemes, or tax instruments. The goal of these interventions is not necessarily to totally curtail all activities that generate negative externalities, but rather to ensure that resources are allocated by real estate actors in a way that takes account of the benefits and costs of the activities for all society as a whole.

[16] For negative externalities the general issue is one of costs: there are costs that are borne by participants in an economic activity, and then there are costs that are borne by third parties (e.g., damages to aquatic ecosystems caused by contaminated run-off, respiratory illnesses that result from exposure to polluted air). The costs that the participants bear—the costs to the producer that are transferred to the buyer via the market price—are termed "private costs". The costs that are transferred to non-participants are termed "external costs". From the perspective of wider society, which includes those individuals experiencing the external costs, too much of the offending economic activity is taking place. That is, the collective welfare of society would be improved if the economic activity generating the external costs was curtailed (but not necessarily stopped entirely). This provides a rationale for government intervention—to "internalize" the negative externality within participant's private costs. Faced with higher costs, both producers and buyers will reduce the level of the offending activity. Internalizing external costs is typically accomplished using direct regulation, tradable quota systems, or tax instruments. The same analysis applies to positive externalities, except the general issue is now one of unpriced benefits, which are under-supplied from society's perspective.

5.4.2 Public Goods

Public goods are goods or services which, once provided to one person, are then available to all people at no additional cost (Productivity Commission, 2012). Public goods have two defining characteristics:

1. Consumption by one person does not reduce the quantity of the good or service available to others; and
2. Once the good or service is produced, it is difficult for the supplier to stop people from using it who do not pay for it. This is also referred to as the "free rider problem".

Public goods tend to be intangible items; that is, things which are difficult to grasp with the hands. Many public goods fall into the category of information or knowledge—two key determinants of adaptive capacity.

The free-rider problem means that, in contrast to private goods, businesses cannot sell or charge for each unit of a public good that is consumed. The profit motive for the private sector to provide public goods is thus very weak. As a result, public goods tend to be under-provided in the absence of government intervention. If the public good is valued by society, community well-being will be lower than it otherwise would be in the absence of government provision or support.

Some goods or services needed for effective adaptation exhibit public good characteristics, and are therefore undersupplied by the market (or not provided at all). Governments can enhance community well-being by ensuring the appropriate provision of these goods and services.

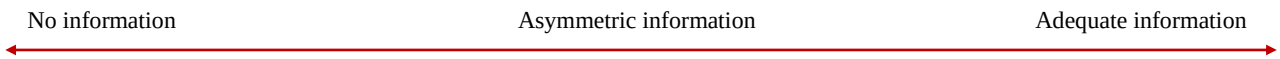
Information and knowledge can be a public good with benefits for many, including those who did not invest in creating it. Because individual businesses are unable to fully capture the benefits from their innovation efforts, which instead accrue partly to other businesses and consumers, they underinvest in creating knowledge. This will result in underinvestment in the R&D of technologies and practices to manage climate impacts. Furthermore, early adopters of a new technology or practice can be a useful source of information for others, who can learn from the successes and failures of early adoption. The act of installing, for example, flood resistance and resilience measures is itself a source of useful information for others. Individuals and businesses may therefore be reluctant to install these measures now, preferring instead to wait and benefit from the learning experience of early adopters. This is sometimes labeled as the second-mover advantage (Markides and Geroski, 2005). However, the act of adoption creates a positive externality by providing information to others for which the adopter is unlikely to be compensated. The presence of this positive externality justifies government intervention.

Early-warning systems for climate-related risks (e.g., heat extremes, flooding, severe storms, etc.) along with hazard maps for vulnerability assessments also have public good characteristics, and will tend to be underprovided by markets in the absence of government support.

5.4.3 Imperfect Information

Imperfect information can lead to market failure where individuals and businesses have inadequate information to make well-informed decisions. In the context of climate change adaptation, the issue of access to information relates to both information about the performance of adaptation measures and

information about the costs of climate-related risks. The quality and extent of information may be thought to lie along a spectrum:



At one end of the spectrum there may be no or very little information to help real estate actors make informed decisions—possibly, because of the public good nature of the required information (discussed above). In these cases, the government may need to commit to provide the information itself, or alternatively, to fund its provision by the private sector. Relevant information may also be available to individuals, but the process of gathering it (because of search or other transaction costs) and processing it (because of cognitive constraints) may not be costless. Under these circumstances, individuals may trade off the benefits of making better decisions using better information against the costs of gathering and processing it. They may gather information until they can make "acceptable" decisions, which may be privately rational given their knowledge base and the costs of adding to it, but that are less than socially optimal, because armed with all relevant information about (say) emerging adaptation measures or practices, they might rationally choose these actions more often. To redress this situation of "rational ignorance" government could undertake an information expansion and outreach program.

At the other end of the spectrum, all real estate actors have adequate information to make the best choices. However, because of behavioural failures (discussed in Section 5.5), this does not guarantee socially optimal adaptation choices.

In the middle of the spectrum, information is available, but its distribution may be asymmetric—i.e., the available information is unevenly distributed between actors in the real estate market. In economics, information asymmetry exists when one party (e.g., a land or property owner) to a transaction holds relevant information, but is unable or unwilling to transfer this information to the other party (e.g., an insurer, a lender, a prospective buyer, etc.). As a consequence two problems arise which may impede efficient climate change adaptation by real estate actors: (1) adverse selection; and (2) moral hazard.

Adverse Selection

Adverse selection is often described as a situation where one side of a transaction (e.g., the purchaser of insurance) knows something about itself that the other side (e.g., the insurer) does not. It is also described as a situation where one side of a market (e.g., buyers of real property) cannot observe the type or quality of the good (e.g., real property) on other side of the market (e.g., sellers of real property), and the side of the market with the information acts opportunistically to take advantage of this asymmetry. For these reasons it is sometimes called a "hidden information" problem. Note that adverse selection, in contrast to moral hazard, occurs before entering into the transaction.

One way adverse selection could impede effective adaptation by real estate actors is by restricting the availability of insurance at affordable and adequate premiums. In insurance markets, adverse selection arises when: (a) the risk of loss varies across buyers; (2) insurers are not perfectly informed about those differences; and (3) buyers have superior information. At a given premium, more property owners with higher-than-average risk of loss are likely to purchase more insurance than are home owners with lower-than-average risk of loss. Adverse selection therefore increases the premiums that an insurer must collect

in order to cover average expected claims. This may make some types of insurance not viable. Low-risk property owners might be unwilling to buy coverage at a premium rate that is sufficient to allow an insurer to cover average expected claims for both low- and high-risk property owners. Equally, high-risk property owners might be unwilling to buy coverage at a premium rate that is not subsidized by low-risk property owners. Indeed, these exact issues are currently being debated in Canada as insurers consider the viability of providing insurance for overland flooding:

> "*Insurers identified the "inability to charge adequate premiums" as the second most significant risk associated with the implementation of overland flood insurance. Without affordable and adequate premiums, insurers argued that the business case to implement flood insurance lacks credibility. The inability to charge adequate premiums was linked with the problem of adverse selection. Because flooding only happens in specific locations in Canada, insurers argued that premiums would have to be priced at levels that are too expensive for consumers in these areas to ensure an adequate premium base to cover losses. If premiums cannot be priced at affordable levels that adequately compensate insurers, flood insurance fails to meet a key standard for viability. To improve the affordability of these premiums, the market penetration would have to expand by offering coverage in lower risk areas. Yet, insurers were skeptical whether lower risk populations would even accept these premiums, since the lower risk group would effectively be subsidizing the cost for those living in the higher risk areas*." [Thistlewaite and Feltmate, 2013]

Insurers can reduce adverse selection by grouping buyers into classes with different expected claim costs. Adverse selection will be less problematic the more accurate the classification. Classification also provides buyers with an incentive to take steps to limit losses and thereby qualify for lower premium rates. Making insurance compulsory can also constrain adverse selection by forcing low-risk property owners to buy coverage. But this has distributional implications: is it right to force low-risk property owners to subsidize high-risk property owners?

A similar problem arises in transactions where it is too costly for buyers to tell which goods are "high-quality" goods and which are "low-quality" goods. If buyers and sellers have perfect information about quality differences between goods, the prices of the various goods will simply adjust to reflect those differences. There are certainly many markets in the real world in which it may be very costly or even impossible to gain accurate information about the quality of goods being sold. The example often cited is the market for second-hand cars, but the same issues are relevant to the (resale) housing market, where the quality of real property is affected by, among other things, certain climate-related risks. When a consumer buys a used car it may be very difficult for him or her to determine if it is a good car or a "lemon". By contrast, the seller of the used car may have a pretty good idea of the quality of the car. Likewise, buyers of real property may find it difficult to accurately ascertain to what extent (say) a home is at risk to climate hazards. Sellers, on the other hand, may have a better idea of potential risks from past experience. In both cases, this places buyers at the mercy of opportunistic sellers.

The problem is, when an individual decides to try to sell a high-risk home he or she affects buyers' perceptions of the quality of the average-risk home on the market. Since buyers have inadequate information to accurately differentiate between the climate-risks faced by different homes, this lowers the price that prospective buyers are willing-to-pay for the average-risk home, which in turn hurts the people who are trying to sell low-risk homes. If too many high-risk homes are offered for sale it makes it difficult for the owners of low-risk homes to sell their property—and the homes that are most likely to be offered for sale are the ones that people want most to get rid of.

Signaling can overcome this form of adverse selection. Owners of low-risk homes can signal the relatively lower vulnerability of their property through (say) voluntary or mandatory risk disclosure ("labelling") programs. In the car market, sellers can offer warranties to help potential buyers distinguish high-quality vehicles from lower-quality ones; sellers of low-quality vehicles will not offer warranties because they would lose too much money.

Moral Hazard

Another interesting problem that arises in insurance markets is known as the moral hazard problem. Consider the home insurance market again and suppose for simplicity that all homes are located in a community with identical likelihoods of wildfire risk, so that there is no problem of adverse selection. Then again, the likelihood of fire may be affected by the actions taken by home owners. For example, a home with a fire resistant building envelope is less likely to be vulnerable to wildfire than a home without such features.

When an insurer sets premium rates it has to take into account the incentives that home owners have to take actions to mitigate risk. If no insurance is available, home owners have an incentive to take the maximum possible amount of care. If it is not possible to purchase home insurance with wildfire cover, then all home owners in the community would (say) have fire resistant building envelopes, an on-site emergency water supply, in-home sprinkler system, etc. In the absence of appropriate insurance coverage, the home owner bears the full cost of his or her actions, which provides an incentive to invest in mitigating risk up to the point where the marginal benefit from taking more care just equals the marginal cost of doing so.

If a home owner can purchase appropriate insurance coverage, then the cost of having his or her home damaged by fire is much less. After all, if the home is affected by fire then the owner simply has to report it to the insurance company and he or she will get an insurance payout to repair it. This lack of incentive to take actions to mitigate risk is the source of moral hazard. Moral hazard refers to a situation where an individual that bears no risk may behave differently compared to situation when they are fully exposed to risk.[17] Note that the moral hazard problem, in contrast to the problem of adverse selection, occurs after entering into a transaction.

If the actions taken by home owners to mitigate risks are observable there is no problem. An insurer can base the premium rates on the amount of care taken. The insurer can have one premium rate for properties that installed (say) sprinklers and a different rate for those that do not. But normally the insurer cannot perfectly observe relevant actions taken. This leads to a paradox: each home owner wants to buy more insurance and insurers are willing to provide more insurance if home owners continue to take an acceptable level of care. However, insurers cannot do that if they cannot perfectly observe the level of care taken by households, because if they provide (more) insurance, home owners would start to take less care. This can result in the absence of insurance cover for particular risks, in turn limiting the range of

[17] Two key features of moral hazard are (Varian, 1990; and Katz and Rosen, 1998):

1. The presence of hidden action. One party (the insurer) is unable to observe the action of the other party (the home owner). For this reason moral hazard is sometimes called a "hidden action" problem.
2. The party, whose actions are hidden, either through acts or omissions, increases the probability of a "bad" outcome.

climate risk management options open to real estate actors. Indeed, the potential for moral hazard is one key reason why insurers in Canada question the viability of providing insurance for overland flooding:

> Insurers are "*unsure about the effectiveness of flood insurance as an incentive for policyholders to take mitigative actions to reduce flood risk*. […] *Flood coverage may limit the incentives for policyholders to invest in mitigation knowing that they do not have to pay for flood damage*." [Thistlewaite and Feltmate, 2013]

In general, insurers want customers to face some part of the insured risk so they have an incentive to take appropriate care. Consequently, most insurance policies include "deductibles" or "co-payments" (see Box 5).

Box 5: Managing Moral Hazard in Private Insurance Markets

There are two principle approaches insurers employ to discourage moral hazard:

1. A **deductible** (or "excess")—a provision in an insurance policy under which the person buying insurance has to pay the initial damages up to some set limit. If the moral hazard is of a type that is likely to increase the likelihood of a loss, then the insurer will typically use deductibles. This is because the use of a deductible saves the insurer money, not only by encouraging greater care by policyholders, but also by reducing the cost involved in processing and dealing with a large number of small claims.
2. A **co-payment**—a provision in an insurance policy under which the policyholder picks up some percentage of the bill for damages when there is a claim. If the moral hazard is of a type that will increase the size of a payout, then the insurer will typically use co-payments. This is because the larger the loss the policyholder suffers, the larger the co-payment. Policyholders thus have an incentive to keep the size of the losses down.

Governments could also intervene—introducing taxation on activities which increase risk and subsidizing activities that improve the care a policyholder takes. However, as with private insurers' decisions relating to deductibles and co-payments, setting appropriate tax and subsidy rates suffers from imperfect information.

Source: Katz and Rosen (1998)

Financial Liquidity

Golove and Eto (1996) describe another case of asymmetric information which may hinder access to capital for investment in energy saving technologies (though equally applicable to investment in capital-intensive adaptation measures). This occurs when individuals or businesses are unable to transfer information to prospective lenders about the relative certainty and magnitude of operating cost savings from investments in energy efficiency upgrades, and therefore the likelihood of repayment. As a result, borrowers may be unable to obtain financing or may only be able to obtain financing at less than favourable terms (i.e., at an interest rate and amortization period that is, respectively, higher and shorter than it otherwise would be in the absence of the asymmetric information). This in turn leads to underinvestment in energy efficiency relative to the social optimum. The problem of information transfer between property owners and lenders will likely prove more problematic in the context of investment on climate risk reduction measures—in terms of convincing lenders of the expected cash flows (difficult to monetize risk reductions and associated losses avoided) from the investments.

Recognizing that actions to reduce operating costs and enhance cash flows also help borrowers repay mortgages, some lenders offer mortgage products that reward a property owner for energy efficiency investments—when it comes to setting the interest rate, amortization period, or the size of the mortgage. Equally, investment in adaptation measures would help borrowers remain solvent and better able to make repayments in the face of climate change. This may justify the provision of similar mortgage products rewarding borrowers for investment in risk reduction measures.

5.4.4 Misaligned Incentives

Misaligned or split incentives can also result in market failure. This is commonly labeled the "principal-agent problem" and occurs when one party (the agent) has the authority to act on behalf of a consumer (the principal), but does not fully reflect the consumer's best interests or preferences.

The landlord-tenant relationship is the classic example of misaligned incentives—frequently cited as a key barrier to energy efficiency in buildings (IEA, 2007). If the landlord decides the level of energy efficiency in a building (e.g., he or she buys the energy-using equipment), while the tenants pay the energy bills, the landlord has little incentive to invest in energy efficient equipment—particularly when the tenant has incomplete information about the energy efficiency of the building. In this case, the landlord may not be able to recoup the extra costs of energy-efficient appliances in the (higher) rent charged for the building. Equally, when the landlord pays the utility bills, he or she may have an incentive to purchase energy-efficient equipment, however, the tenant has no incentive to conserve (use less) energy. In either case, the level of building energy efficiency will be less than the social optimum, creating a market failure (Jaffe and Stavins, 1994). The extent to which landlord-tenant relationships may lead to a less than socially optimal level of investment in adaptation measures in rental properties has not yet been empirically investigated. Hence, it is difficult to gauge how much of an issue it truly is in the context of climate change adaptation. While some of the benefits from investments in risk reduction measures could accrue to tenants (e.g., improved health and safety, less disruption, reduced damage or loss of personal property) a significant portion of the benefits would also accrue to the landlord (e.g., reduced damage to or loss of equipment, buildings and other assets, safeguarding rental income by keeping the building viable for occupancy).

Even if landlord-tenant relationships were shown not to present a significant barrier to optimal levels of investment in adaptation in the rental market, many other forms of misaligned incentives exist, for example:

- Developers, architects, engineers and builders select site layout, building materials, equipment, and managed landscapes for prospective building occupants;
- Existing owners / occupants determine building performance for future owners / occupants through the investments they make (or do not make);
- New property buyers (and builders) determine the pool of real property available to buyers in the resale market; and

- Organizations in which different departments or business units have split responsibility for capital investment budgets and operating cost budgets to pay (say) water, insurance and energy bills.[18]

It is easy to envisage these situations leading to underinvestment by real estate actors in climate adaptation relative to the social optimum.

5.5 BEHAVIOURAL FAILURES

To facilitate economic analyses of complex behaviours, classical welfare economics builds a simplified model of economic life by assuming that there are only two main types of actors: firms and households. The model also makes a number of simplifying assumptions about how these two types of actors behave and interact. Notably, both sets of actors are assumed to interact in perfectly competitive markets. Situations when this assumption breaks down were highlighted above. Equally vital, firms are assumed to maximize *their* profits from producing and selling goods and services, and households are assumed to maximize *their* utility (or self-interest) from consuming goods and services. In addition, households (or specifically, individuals within the household) are assumed:

- To have stable or fixed preferences;[19]
- To have access to all the relevant information bearing on the decision at hand; and
- To be able to fully process this information in order to reach the optimal (utility maximising) decision, based on a calculation of the expected costs and benefits—costs and benefits need not necessarily be defined in terms of money.

Hence, we have "homo economicus"—an entirely rational individual blessed with full access to perfect information, motivated entirely by self-interest and a desire to maximise their own happiness, and possessing the cognitive abilities of a super computer to accurately weigh the costs and benefits of any given course of action.

Not surprisingly then, evidence from behavioural experiments and real-world observations indicate that our behaviour deviates systematically from what the classical economic model would predict. When individuals make poor decisions the traditional model says it is purely the result of misinformation or a lack of information. But we rarely collect, read or properly absorb all of the information that is available when making a decision. The type, complexity and volume of information available, and the way in which it is communicated and by whom, all have a significant impact on the likelihood we will read, understand and use it efficiently. As a result, individuals are observed to make seemingly irrational choices that deviate from what the classical economic model would predict. Such irrational aspects of decision-making are often referred to as "behavioural failures", to parallel the more familiar market failures discussed above (Pollitt, et al., 2011; and Shogren, 2012a and b).

[18] This organizational disconnect between capital and operating budgets is often described as a financial barrier to accessing capital for investment in property upgrades—primarily in the context of energy efficiency, but equally relevant to investments in capital-intensive adaptation measures. In both instances funds for investment are sourced from owners of capital budgets while the benefits accrue to owners of operating cost budgets.

[19] Specifically, individuals know what they like and how much they like it relative to all other things, and that this rank-ordering is stable over time.

Both forms of departure from the classical economic model would result in a less than socially optimal allocation of resources by markets to climate change adaptation. This implies that local and provincial government policy-makers when designing economic instruments to promote climate adaptation will have to think about correcting for both market failures and behavioural failures, and to do so simultaneously. Failure to account for behavioural anomalies may lead to inefficient instrument design. For example, offering incentives for inherently interesting tasks or for pro-social behaviour, offering too much or too little incentive, and offering too many options can all be counterproductive (Kamenica, 2012).

Even in a perfectly functioning market, the presence of behavioural failures alone provides justification for government intervention in private decision-making—when real estate actors know what climate adaptation choices are best for them, but still cannot make those "correct" choices (Shogren and Taylor, 2008). Government intervention—whereby private individuals are "nudged" toward a socially desirable outcome, while still respecting their freedom to choose—has been called "libertarian paternalism" (Thaler and Sunstein, 2003).

5.5.1 Sources of Behavioural Failures

The main departures from the classical economic model indicated by observed behaviour in experimental or real-life settings can be grouped under the following main themes (Mullainathan and Thaler, 2000; Shogren and Taylor 2008; Pollitt, et al., 2011; Shogren, 2012a; and Madrian, 2014): (1) bounded rationality or imperfect optimization; (2) prospect theory and importance of reference points; (3) bounded self-control and time-varying discount rates; and (4) bounded self-interest (pro-social behaviour and fairness).

Bounded Rationality

The phenomenon of bounded rationality emerged from the work of Herbert Simon in the 1950s, who contrasted decision-making from the perspectives of both economics and psychology (see, for example, Simon 1955 and 1979). Contrary to the assumptions of classical economic models, Simon maintained that individuals do not seek to maximise their utility from a particular course of action (since they cannot assimilate and digest all the information that would be needed to do so). Even if everyone had access to all the information required, their minds would be unable to process it properly. The human mind necessarily restricts itself—it is bounded by "cognitive limits" in processing information.

Hence, in many different situations individuals seek something that is "good enough", something that satisfies some minimum requirement or aspiration goal. When shopping, for example, we aspire to something that we find acceptable, something that moves us toward our goal, although it may not necessarily be optimal. Due to limits on information, time, or cognitive abilities, we consider in sequence choices among a somewhat arbitrary subset of all possible options, and when we come across an item that meets our aspiration goal, we buy it. This real-world behaviour is what Simon called "satisficing"—a combination of two words: "satisfy" and "suffice".

One consequence of satisficing is individuals tend to apply simplifying "judgement heuristics" to complicated decisions (Tversky and Kahneman, 1974). Judgement heuristics provide useful mental

shortcuts, such as rules-of-thumb, that help us make decisions quickly and with less effort.[20] For example, when individuals assess the likelihood or probable impact of a course of action, they do so by recalling similar examples that readily spring to mind (the "availability heuristic"). Memorable and traumatic events are deemed more likely. If asked to judge the likelihood of being affected by a future wildfire, we will tend to overestimate the likelihood if I have been caught in a wildfire in the past—even if past events are completely unrelated to future probability (PSI, 2006).

Judgement heuristics can lead to systematic biases rather than idiosyncratic errors of judgement.[21] This is a concern for policy-makers as systematic biases, if ignored, will result in inefficient climate adaptation (see Table 2).

Prospect Theory

In the classical economic model an individual's preferences among different courses of action are assumed to be context independent—i.e., not influenced by reference points such as their current endowment of assets nor influenced by the way available choices are presented (or "framed"). Kahneman and Tversky investigated this assumption through a series of experiments and observed that reference points do in fact matter when people make decisions, especially in the presence of uncertainty. They developed "prospect theory" to explain their findings (Kahneman and Tversky, 1979). A number of decision-making behaviours with implications for climate change adaptation derive from prospect theory, including:

- The value an individual assigns to a course of action, such as raising the habitable areas within their home to reduce flood risk, is a function of change, in a positive (gain) or negative (loss) direction, from a starting point. In prospect theory, the starting point is referred to as the reference point. The value an individual attaches to raising the habitable areas of their home derives from the difference between the reference point and the amount of any positive or negative shift away from it—in this case, the difference in flood risk with and without raising the habitable areas. This differs from the classical economic model, which assumes the value of an action derives exclusively from the final outcome (i.e., the level of flood risk with habitable areas of the home elevated), and not the magnitude or direction of change from the reference point. Among other things, the emphasis on change from the reference point means that individuals might accept an adaptation action in one situation that they reject in another—if the reference point is different;
- Individuals are progressively less sensitive to change as they move further away from the reference point. Differences between small gains or losses close to the reference point are assigned a high value (are more impactful), whereas differences further away from the reference point are assigned smaller values (are less impactful). For instance, the difference between reducing damages from a 1-100 year flood from $10,000 to $5,000 will seem rather large to an individual, but reducing damages from $100,000 to $95,000 will seem relatively small, even though the objective difference ($5,000) is identical;

[20] A key concept underpinning judgement heuristics is "accessibility". The rule of thumb is more accessible to the individual than a probability-based calculation of expected costs and benefits, and thus is preferred (especially under time pressure or while under a heavy cognitive load) (Darnton, 2008).

[21] The use of judgement heuristics is not irrational—they allow individuals to reduce the effort (or transaction costs) associated with decision-making. When heuristics become problematic, from an economic perspective, is when decisions based on heuristics are biased and when these biases are systematically repeated (PSI, 2006).

- Individuals exhibit loss aversion. A negative change (loss) from the reference point is assigned greater value than a positive change (gain) of an objectively identical amount. The prospect of losing $100 in a gamble, for example, seems worse than the prospect of winning $100 seems good. In other words, losing (or giving something up) hurts more than a comparable gain pleases. The classical economic model assumes individuals are neutral to losses or gains of an equivalent amount. Loss aversion is typified by the endowment effect, whereby individuals assign greater value to what they already possess than they do to an equally attractive alternative. It also presents a bias towards the status quo in almost any decision-making context.
- Individuals have real difficulty with computations involving extreme probability events, such as 1-100 year storms. This leads to "editing"—to simplify matters people sometimes treat extremely likely but uncertain events (e.g., with greater than 99 per cent likelihood of occurrence annually) as if they are certain, and on other occasions, treat extremely unlikely events (e.g., with less than 1 per cent likelihood of occurrence annually) as impossible, so they can be ignored. The problem with this strategy is that extremely unlikely events do occur occasionally, and extremely likely events do not happen every so often.
- Individuals tend to overweight low-probability events and underweight medium- to high-probability events. Events judged to be unlikely to extremely unlikely are given more psychological weight than they deserve in decision making, especially when associated with vivid and salient experiences (e.g., the Okanagan Mountain Park and McLure wildfires in 2003). A classic consequence of this phenomenon is insurance—we are willing to take a sure loss (pay a premium) today to prevent the small likelihood of a larger loss in the future. In other words, people are risk averse in losses when the probability of severe loss is very small. This observation also helps explains worst-case scenario planning. Equally, events judged to be somewhat likely to almost certain are treated with less importance than they merit. For instance, reducing the likelihood wildfire risk from 50 per cent to 25 per cent does not have the same impact as reducing the likelihood from 25 per cent to no chance at all. This is called the certainty effect.
- Individuals are influenced by the way a particular decision is described (or framed). The classical economic model assumes that our preferences are unaffected by the way a choice is presented. Yet there is substantive experimental and real life evidence that indicates the way in which individuals react to a problem or decision is determined by the way in which information is presented. For example, as we exhibit loss aversion, framing a decision in terms of gains or losses can have such a profound influence on behaviour. People are less likely to choose an option framed as a loss from a reference point compared to the same option framed as a gain from a reference point.

Key anomalies and biases resulting from the above decision-making behaviours are described in Table 2.

Bounded Self-control

Many of the choices individuals face involve outcomes that unfold over time. Adaptation to climate change is no different—adaptation decisions typically involve trading-off investments (sacrificing resources) made today with uncertain (lower) future damage costs. The classical economic model assumes people exhibit "time-consistent" (or "dynamically consistent") behaviour when making such trade-offs. Specifically, trade-offs between receiving rewards today and receiving them with delay are independent of when that delay occurs: if an individual prefers $10 now to $15 next week, then that same

individual must also prefer $10 in 51 weeks to $15 in 52 weeks. In other words, the mere passage of time (with no new information) does not change the preference of this individual to forgo $5 in order to have $10 without a week delay. Time-consistent behaviour implies people have a constant discount rate and use "exponential discounting" when determining the present value of future costs and benefits.

But people often seem to deviate systematically from the exponential discounting model. People are observed to *excessively* favor gratification (or avoid non-gratification) now at the expense of future gratification—as the following quotations demonstrate: [22]

- "Next week, I'll start exercising";
- "Next month, I'll quit smoking"; and
- "Next year, I'll start saving for retirement".

We often believe that whatever we are doing right now is far more important than what we will do tomorrow (Thaler, 1981). This suggests that people are relatively less patient in the near term, implying higher discount rates relative to the discount rates they use for actions in the far distant future; here people are more patient with lower discount rates (Shogren, 2012). This behaviour, where peoples' discount rates change over time, is known as "hyperbolic discounting" (Groom, et al., 2005; and Hepburn, 2006). With hyperbolic discounting, at some point in the future people's preferences can change, resulting in inconsistent choices and plans (Pollitt and Shaorshadze, 2011). For instance, the same individual in the above example may prefer still prefer $10 now to $15 next week, but with hyperbolic discounting, they may now instead prefer $15 in 52 weeks to $10 in 51 weeks. With exponential discounting the individual's preferences would not reverse like this, because the delay of one week is shared between the two options.

The tendency of individuals to excessively favour immediate rewards (and the avoidance of immediate cost) over longer-term rewards is known as "present bias" (O'Donoghue and Rabin, 2000). Present bias helps to explain "self-control problems" like addiction, low savings rates for retirement, accumulating debt on credit cards, and procrastination (Pollitt and Shaorshadze, 2011). Procrastination (waiting when we should do something) is, of course, a potentially serious impediment to efficient climate change adaption that requires individuals to make immediate sacrifices.

Bounded Self-interest

The classical economic model assumes that individuals operate as independent decision-makers, unaffected by the preferences and behaviour of others: *homo economicus* is only self-interested—any non-self-interested acts are irrational. The opposite of pure self-interest is altruism. An altruistic individual is solely concerned for the well-being others, with no thought about oneself. While it is overly idealistic to assume that altruism is the chief driver behind our behaviour, it is reasonable to assume that some elements of altruism enter into most people's decision-making. Certainly, observed behaviour in experimental or real-life settings supports the notion that we do care to some degree about others, and we also care about what others think of us (and our choices) (see, for example, Charness and Rabin, 2002 and

[22] "Excessive" means relative to exponential discounting; with exponential discounting individuals still prefer present gratification to future gratification, other things equal—just not as much as individuals that exhibit "hyperbolic discounting".

Bergstrom, 2006). We are concerned about fairness, we adhere to social norms, and we act pro-socially (Pollitt and Shaorshadze, 2011).

The importance of this for climate change adaptation policy design should not be understated. The way in which other people behave and the internal motivations that influence the choices we make are just as likely to bias adaptation decision-making as judgement heuristics, loss aversion, present bias, etc. (PSI, 2006). Two important non-self-interested behaviours are:

- **We are strongly influenced by what others do**. There are very few situations (if any) in which our actions are not dictated by the social situation we are in and the people we are around. Social norms are the "rules" that tell us how to behave within a society or group. They have been found to strongly influence a variety of behaviours across a wide range of situations—e.g., not smoking in public, being quiet in a library. Social penalties for non-compliance can influence actions in negative ways; social benefits that derive from conforming can influence actions in positive ways (Jackson, 2005). Bearing social norms in mind when designing interventions can enhance their long-term effectiveness; this mainly involves telling people what other people would do in a similar situation. We are much more likely to comply with social norms when we are consciously aware of them—if the norm is desirable (i.e., promotes good adaptation decisions by actors in the real estate sector), let people know about it. Moreover, the "messenger" is very important. We are particularly open to influence from experts, people in authority, or from people whom we respect or like (Dawnay and Shah, 2005).
- **People are motivated to "do the right thing"**. Our behaviour is sometimes motivated by a desire to advance the common good—the general good of society. We see our own well-being as connected to the larger well-being of society. In many situations, this means people are often willing to participate in the provision of public goods / the creation of social benefits. For example, a home owner may be willing to plant his or her garden with grass instead of pavement or decking (reducing the functionality of the garden) with the knowledge they are creating a range of social benefits: flood risk reduction for neighbouring properties, better water drainage of the surrounding area, and more habitat for wildlife. Understanding people's motives for contributing to the common good is crucial for designing effective adaptation policy instruments. In general, people have both intrinsic motivations (where we do things for our own inherent reward) and extrinsic motivations (where we do things for some external—possibly financial—reason). It has been shown that extrinsic motivations can "crowd-out" intrinsic motivations (Frey and Jegen, 2001). There are many situations where we do things for other people for which we would be insulted if they paid us—e.g., doing volunteer work, having a friend over for a meal (Dawnay and Shah, 2005). In these situations, receiving a payment detracts from the feeling ("warm glow") of having done something good.[23] This means that financial rewards, deadlines, the threat of punishment, etc. to promote good adaptation decisions by real estate actors can be counter-productive, if not appropriately designed and targeted, as tools can decrease people's intrinsic motivation (Kamenica, 2012; and Madrian, 2014).

[23] One reason this might occur is if an individual cares about the inferences that others make about them. In this situation, introducing a monetary incentive for a pro-social act reduces the extent to which engaging in it credibly signals altruism to others (Bénabou and Tirole, 2006). So, monetary incentives can reduce that individual's willingness to do good deeds.

5.5.2 Anomalous Effects and Decision Biases from Behavioural Failures

Just increasing the availability of information is not necessarily the simple solution it seems to promoting efficient climate change adaptation. As the above discussion highlights, the presence of a number of behavioural failures means we may not use available information rationally, in ways that support efficient adaptation. Equally, financial incentives designed to influence adaptation choices can backfire if they are not structured to account for relevant behavioural failures. In short, the behavioural failures presented above give rise to a number of systematic biases and anomalies that can impede efficient climate change adaptation in different ways; these are summarised in Table 2.

Table 9: Key Biases and Anomalies Facing Decision-makers in the Home and at Work Arising from Behavioural Failures with Implications for Efficient Climate Change Adaptation

Bias or anomaly	Description
Overconfidence bias	In the context of climate change adaptation, if people (decision-makers in the home or at work) are overconfident, they would tend to believe any risk they face is lower than it is in reality. This will weaken their incentive to mitigate the risk. It also has implications for insurance as an adaptation tool. For a start, underestimating risk will lead people to underinsure. It also weakens the case for (government) compulsory insurance as a mechanism to overcome asymmetric information in insurance markets. In the presence of asymmetric information problems, compulsory insurance is often proposed as a government intervention, since it can improve the well-being of all insured individuals. However, when there is a significant fraction of overconfident individuals in the marketplace, compulsory insurance ceases to improve the well-being of all insured, because it makes low-risk people worse off—they end up overpaying for larger amounts of insurance than they would otherwise want with voluntary insurance.
Loss aversion	People are much more sensitive to a loss than a gain of equivalent size. Because losses loom larger than gains (i.e., hurt more), people tend to be risk-seeking when the decision-making context is perceived to involve losses, but risk-averse when the decision-making context is perceived to involve gains. As a result, more energy will be spent trying to avoid or recoup losses than will be devoted to attaining gains. This has implications for the effectiveness of adaptation policies, if people (e.g., a realtor) can be encouraged to make public commitments to (say) disclosing known climate-related risk to prospective buyers; people will go out of their way to fulfill their commitments to avoid loss of reputation. Loss-aversion also has implications for policy design, when "punishments" or "rewards" are being considered to incent preferred adaptation actions. In general, a stick (e.g., tax, charge, or fine) provides a much stronger disincentive than a similar-sized carrot (e.g., subsidy) provides an incentive. Loss-averse individuals dislike price increases (from the imposition of a tax) more than they like gains from price cuts (from the introduction of a subsidy); consequently, they will cut back purchases when prices increase more than the extra amount they would buy if the price decreased. A further consequence of loss aversion is that differences between adaptation options (including doing nothing) will seem more important if they are framed in terms of losses or negative aspects rather than if they are framed in terms on positive aspects or gains (framing effects). Hence, highlighting the costs of inaction can be useful in spurring adaptation actions or behaviours, including legitimizing policies like managed retreat. Equally, people are unlikely to choose an option framed as a loss from their reference point compared to the same option framed as a gain from the reference point. Loss aversion also induces a preference for maintaining the status quo (status quo bias) and reluctance to give up an item we already own or services we already receive (endowment effect).

Endowment effect	Individuals are more reluctant to give up or sell something once they own it, than they are interested in acquiring it if they do not. One implication of this effect is that selling prices are frequently higher than buying prices. In fact, it is not unusual for the selling price (our "willingness-to-accept compensation") to be up to 20 times the buying price (our "willingness-to-pay"). The reason is that buyers are gaining an item and thus value it less than sellers who are losing the item. When we consider selling an item or giving something up, we think emotively about all of our past experiences using it, rather than thinking rationally about our use of it. This presents challenges to policies (e.g., tradable development rights or buy-out programs as part of managed retreat) designed to encourage people to sell or exchange real property in hazard prone areas, and relocate to 'safer' areas. Economic incentives to encourage people to give up (say) their homes may need to be much higher than anticipated in order to overcome the endowment effect, particularly given how emotionally attached we can get to our homes.
Framing effects	Individuals are strongly influenced by how possible choices are presented to them. People tend to be somewhat passive decision-makers—we accept information that is handed to us. By framing information in a certain way, people will interpret the information provided differently: is the glass half full or half empty? For instance, framing a decision in terms of gains or losses can exert considerable influence on behaviour. If one course of action is dressed up as a loss, and another as neutral or as a gain, we will tend to avoid the apparent loss—even when the outcomes of both courses of action are numerically identical. For example, even though the following two statements convey exactly the same information about managing flood risks, because they are framed differently, one is expected to be more effective than the other: o Message A: "Installing flood resistance and resilience measures on your home could save you around $5,000 in the event of a 1-100 year flood"; or o Message B: "If you don't install flood resistance and resilience measures on your home it could cost you around $5,000 in the event of a 1-100 year flood". Message A emphasises the benefits of installing the flood resistance and resilience measures, whereas message B stresses the costs. Because losses (i.e., costs) loom larger than gains, framing a retrofit program using message B will likely be more effective than using message A. Individuals are also heavily influenced by who presents them with choices, in addition to how the choices are framed. The weight we give to information depends greatly on our reaction to the "messenger". For example, the perceived authority of the messenger influences the weight we attach to information—suggesting that information will prove more effective when delivered by experts or our peers. We may also irrationally discard information provided by a messenger we dislike. In some situations, people have developed a dislike of government interventions; a more effective strategy for influencing behaviour in these circumstances may be to use third party messengers.

Choice overload	Individuals have difficulty in making a decision when presented with too many options. When faced with a decision involving too much choice or a difficult choice, people may choose not to change their behaviour at all, delay any decision, or choose the easiest option—typically the default option (see status quo bias below). For example, studies show that more people buy an item when they are presented with only a handful of options than when presented with a large set of options. While the provision of an extensive set of options may initially be seen as desirable, it ultimately proves demotivating. This has implications for the design of programs that offer retrofit measures to increase the climate resilience of real property—basically, focus on a few key measures.
Crowding-out effects and fairness	People do not exclusively act in their own self-interest, only considering financial costs and benefits to themselves when making decisions. They often act pro-socially—contributing to the provision of public goods / creation of social benefits—even if this imposes personal costs. The motivations underlying pro-social acts can have different implications for the design of effective incentives to promote good adaptation by real estate actors. Consideration should be given to the balance between intrinsic and extrinsic motivation for pro-social acts, as well as our sense of fairness. Pro-social behaviour is governed by intrinsic motivations (where we do things because it makes us feel good—the "warm-glow" effect) and extrinsic motivations (we do things for some external reason—for financial reward or because we are ordered to). Adaptation instruments providing extrinsic motivations may "crowd-out" intrinsic motivations and be counter-productive (de-motivating). It is important to consider how real estate actors perceive the behaviours policy makers are trying to change: o If the behaviour is normally considered "the wrong thing to do", it can be counter-productive to introduce punishments (e.g., a tax, charge, fine, etc.). Attaching punishments to undesired behaviours can legitimize those behaviours in the mind of individuals (having "paid" for their misdeed they have a clean conscience). This can result in punishments having counter-productive effects, with real estate actors continuing with the undesired behaviour together with accepting the punishment; and o If it is normally considered the "right thing to do", it can be counter-productive to introduce financial rewards. Providing (even small) monetary incentives for desired behaviours that otherwise tend to carry some warm feeling of having done something good, can reduce intrinsic motivation and lead to lower effort relative to having no monetary incentive at all. In either case, monetary reward (punishment) decreases (increases) the behaviour the policy-maker is trying to change—the exact opposite of what the classical economic model would predict. People's willingness to contribute to social good is also influenced by a sense of fairness. When formulating adaptation incentives policy-makers should appeal to this sense of fairness. For instance, most of us are conditional co-operators—we will contribute to social good if we are sure that others will do the same (i.e., other will not free ride on our efforts). One consequence of this is that increasing contributions by others will increase the likelihood of our own contribution. Hence, monetary incentives designed to reward cooperation will prove effective in certain situations, such as encouraging managed retreat from areas prone to severe flood risk. Managed retreat will be substantially more effective if all property owners jointly relocate. This suggest the use of a smart subsidy that creates an explicit network externality between neighbouring properties by paying an additional agglomeration bonus when individual property owners retire land adjacent to other retired land, creating a continuous buffer zone.

Anchoring bias	Individuals use points of reference in order to make decisions. Anchoring is the term used to describe our tendency to rely too heavily on one specific reference point (the "anchor")—typically, the first piece of data, information or evidence offered—when making decisions. During decision-making, individuals use this initial value to make subsequent judgments about a course of action. Once an anchor is set, decisions are made by adjusting away from that anchor. For example, the initial price listed for a home sets the standard for subsequent negotiations, so that prices lower than the initial list price seem more reasonable, even if they are still higher than what the home is truly worth. Attaching disproportionate weight to one reference anchor when making decisions is problematic in two ways: 1. Seemingly arbitrary first impressions, data, or information can serve as anchors when we evaluate options, leading us to discount other relevant factors. For example, a potential home buyer may focus excessively on the "fully re-modelled kitchen" advertised at the top of a web-page, and use this criterion as the basis for establishing the value of a home, rather than considering (say) its exposure to flood or wildfire risk; and 2. The adjustments we tend to make away from an anchor are typically insufficient. For example, the minimum payment shown on a credit card statement anchors our decisions—leading us to make smaller repayments than we otherwise would make if not exposed to a suggested minimum payment. Whether we like it or not, our minds keep referring back to the recommended number. By manipulating anchors, and thus by changing the points of reference, policy-makers can nudge people towards a desired adaptation action or behaviour. This may prove effective at moments when people enter a new situation, such as moving house or place of business. Anchoring may also be used to influence the outcomes of negotiations during (say) development approvals.
Availability bias	Individuals employ mental short-cuts when assessing the probability or likely consequences of a course of action. We judge the probability of events, for instance, by how quickly and easily examples can come to mind. That is, we make decisions based on knowledge that is readily available in our minds, rather than searching out and examining all pertinent information. What first comes to mind is more likely. For example, an individual asked to judge how likely they are to be involved in a future landslide, will assess the likelihood as much higher if they have been caught in a landslide in the past—even if past experiences are completely unrelated to future probability. For that individual, probability estimates are biased by the vivid salience of their own personal experience. Most of the time we use this "availability heuristic" without even realizing it. Nevertheless, as with any mental shortcut, sometimes the availability heuristic can lead people to make mistakes—pursue courses of action that are not optimal. We inadvertently assume that readily-available instances, examples or images represent unbiased estimates of true statistical probabilities, not because they are more or less common, but only because they stand out in our minds. This is especially true with sensational headlines, typical of extreme weather events. Similar decision errors can also stem from the related "representativeness heuristic". In this case, the likely consequences of an event are judged by the degree to which it is representative of something similar and familiar. For example, an individual may (erroneously) judge the likely consequences of stormwater flooding to be equivalent to those of fluvial flooding.

Present bias	People are observed to excessively favor satisfaction (or avoid non-satisfaction) now at the expense of future satisfaction. We believe that whatever we are doing later will not be as important as what we are doing right now. That instant satisfaction overpowers any thought of later regret. By placing greater importance on immediate outcomes, people exhibit a bias to the present—aptly known as "present bias"—which applies to gains and losses: o Immediate gains are typically perceived to be more valuable than similar sized gains arising after a delay. Delayed outcomes are devalued, so people often satisfy themselves with small gains in the short-term, at the expense of greater longer term benefits. o Losses in the short-term are regularly avoided, even if this leads to larger future costs. Present bias helps to explain a number of "self-control problems" like addiction, low savings rates for retirement, the accumulation of debt on credit cards, and procrastination. A preference to receive positive outcomes early leads individuals to yield to immediate temptations that they may later regret. Present bias has two important implications for efficient climate change adaptation in the real estate sector: o Individuals will often underestimate the importance or relevance of something that might happen in the distant future. This means that the benefits of adaptation actions that mitigate risks arising primarily from projected climate change will be heavily devalued—making them less attractive. Adaptation actions that chiefly mitigate the risks of current climate variability and extremes, or that generate immediate co-benefits, will see their benefits devalued much less, and thus fare much better. In general, people will devalue the benefits of adaptation actions more if the risk reductions are perceived small, there is a long delay until they are realized, and they are uncertain. o Individuals will tend to procrastinate in the face of near-term costs, or put off unpleasant tasks, even if they yield large future benefits. This will naturally present a barrier to adaptation actions that require individuals to make immediate sacrifices of time (e.g., to fill out application forms for home retrofit programs or negotiate bilateral trades in a Tradable Development Rights scheme) or money (e.g., to pay up front for measures to enhance the climate resilience of a property or surcharges on top of development cost charges). Understanding present bias is important for designing effective incentive schemes for climate change adaptation. For instance, as immediate losses provide a stronger disincentive than long-term rewards provide an inducement, the incentive package of a building retrofit program should, if possible, be devised to: (a) avoid or reduce up-front expenditures by individuals; (b) avoid or reduce paperwork and processing times; and (c) provide individuals access to tools or decision aids to ease the selection of the best action. In the context of (a) requiring individuals to pay for upgrades in cash (and later file for a rebate) involves a salient loss—as cash must be handed over. Paying via a (subsidized) loan makes a transaction more abstract; individuals are less likely to feel the loss associated with paying. Including deadlines or expiration dates in incentive schemes (or other interventions requiring active choice) can also help overcome procrastination, as can the use of commitment devices that allow people to meet self-set goals. The latter can be effectively facilitated by providing incentives that encourage people to "pre-commit", such as the provision of subsidies which are dependent upon persistent achievement of goals. In addition, it has been observed that commitment devices are usually more effective when the costs of failure increase. One common method to increase such costs is to make commitments public—in this case, breaking the commitment will lead to reputational damage.

Status-quo bias	An implication of loss-aversion is that people have a strong tendency to remain at the status quo—to avoid action and avoid change—because the perceived disadvantages of leaving it loom larger than the perceived advantages. We are biased towards avoiding potential negative impacts generated by change, even when those impacts are less than from making no change at all. This bias is one of the reasons that the manipulation of default options (the alternative an individual receives if they do not explicitly request otherwise) can be a powerful policy tool. Many public policy choices have a no-action default imposed when an individual fails to make a decision. Bias for the status quo means individuals tend to stick to the default option, even if it is chosen for them. Hence, the default option can be structured to influence decision-making to maximise social benefits without restricting individual choice. Indeed, setting defaults is often regarded as the proto-typical instrument of "libertarian paternalism". For example, there is evidence that the use of opt-out defaults (i.e., consent by default, unless explicit opposition is registered by the donor or saver) can substantially raise organ donation rates and contributions to savings schemes, relative to the use of opt-in defaults (i.e., no consent is presumed, unless it is made explicit by the donor or saver). In the context of climate change adaptation, opt-out defaults could similarly be used to incent greater take-up of insurance or the penetration of (say) flood or fire resistance measures in new buildings. In general, the manipulation of default options is particularly useful where individual choice involves, or is perceived to involve, significant time or effort and when the stakes are high—as would be the case with many climate adaptation decisions, given the inherent uncertainty, lack of accessible information, and large potential consequences of inaction.
Salience effects	When confronted with a complex decision individuals tend to unconsciously filter out a lot of information as a coping strategy. We are drawn to the most psychologically vivid and observable factors, and attach disproportionate weight to those factors. This may influence adaptation decisions—for example, potentially contributing to an overemphasis on the (highly observable) initial investment costs versus the (difficult to observe) expected value of risk reductions, leading to an underinvestment in adaptation. A further consequence of salience is that individuals will tend to overestimate the likelihood of something vivid, that they can easily imagine or have recently experienced, especially if it would be particularly frightening (natural disaster) or particularly existing (winning the lottery). Natural disasters can thus provide a "policy window"—creating a period of increased attention for climate change adaptation, and increasing motivation for adopting new policies (e.g., managed retreat) or setting new norms (enhanced building code). When designing (dis)incentives for good adaptation choices, salience also means that immediate (and therefore more vivid) losses will provide stronger disincentives to action than long-term rewards (risk reductions). As a result, adaptation policies should, if possible, be designed to reduce cash outflows now or target immediate losses from current climate-related risk—the latter is consistent with prioritizing no-regret actions. For example, designing retrofit programs that avoid the need for up-front costs to be covered by households will likely prove successful—participants in a program to retrofit water conservation measures to address future water shortages could be offered interest-free loans to be repaid as part of their water bill. The repayments could be structured so they are fully offset by the water bill savings, making the equipment appear effectively free.

Sources: Tversky and Kahneman (1974); Thaler (1980, 1981 and 1999); Samuelson and Zeckhauser (1988); Ajzen (2000); Iyengar and Lepper (2000); O'Donoghue and Rabin (2000); Frey and Jegen (2001); Pearce (2002); Kahneman (2003); Thaler and Sunstein (2003); Dawnay and Shah (2005); PSI (2006); Ariely (2008); Productivity Commission (2008 and 2012); Pollitt and Shaorshadze (2011); Johnson, et al. (2012); Kamenica (2012); Shogren (2012); and Madrian (2014).

Note: The biases and anomalies in the table apply to decision-makers both in the home and in business. However, as stated in the main text, standard decision-making processes and rules will typically minimize their impact on the choices made by businesses.

5.6 CASE EXAMPLES

Prominent market barriers to achieving the stated adaptation goal in each of our three case examples are presented below. Note that limitations to the implementation of economic instruments to overcome these barriers are discussed separately in Section 0.

1. Real estate development process stage:

Land packaging

Relevant actors:

Developers (individual, corporation, or group of corporations), real estate analysts, planning consultants, lawyers, accountants, financial institutions, technical consultants (engineers, architects, EIA specialists), approval authorities

Goal of government:

For developers and their partners to mainstream a socially optimal level of climate change adaptation into "plans" for the provision of housing, commercial space, public amenities, and other services desired by the market and host communities

Main climate hazards addressed:

- Sea-level rise
- Storm surge, coastal flooding, erosion
- Extreme precipitation, flooding, erosion, landslides
- Wildfire
- Extreme temperature and heatwave
- Water shortage, drought
- Damaging storms

Market barriers to achieving goal faced by actors:

- No or lack of developer / client awareness of climate-related threats and opportunities
- Uncertainty about climate impacts at a local scale, lack of confidence in projected impacts at a local scale
- Low demand for climate resilient development by prospective clients
- High perceived investment costs versus low perceived benefits
- Insufficient return on investment or payback (real estate market yet to be fully convinced that the perceived additional costs of climate resilient plans and design are supported by the benefits)
- Skepticism that real estate market will capitalize climate-related risk reductions in property prices
- Unwillingness to pay additional costs (developers perception that climate resilient real estate is more expensive to develop than business-as-usual developments)
- Lack of government incentives (including mandatory disclosure of risks and government subsidies)
- Perceived limited availability of adaptation technologies or practices
- Unproven (and potentially unreliable) technologies and practices—perception that climate resilient plans are untried, untested and untrue
- Developers are reluctant to venture into "new territory" due to the possibility of exposing themselves to unforeseen liabilities
- Concern that climate resilient plans fall outside the boundaries of what is defined as "code" or "accepted practice" by local governments (inconsistent with OCPs)
- Perverse subsidies—development is sometimes subsidized by public dollars for infrastructure (both initial construction and maintenance or repair)
- Misaligned incentives—developers create site plan for prospective occupants of the development
- Negative externalities (e.g., environmental and health & safety impacts, emergency services and recovery costs) and positive externalities (e.g., learning-by-doing, spillovers)
- Public goods—loss (or under provision) of a range of public goods to surrounding communities (e.g., habitat, recreation opportunities, aesthetics, etc.)
- Range of behavioural biases and anomalies (notably, present bias, status quo bias, availability bias, overconfidence bias)

2. Real estate development process stage:

Occupancy (minor upgrades) and renovations (major upgrades)

Relevant actors:

Fee simple property owners, strata corporations, tenants, financial institutions, technical consultants (engineers, architects, contractors), equipment suppliers, real estate agents, approval authorities (building code)

Goal of government:

For owners of real estate to upgrade their properties with climate resilient and resistance measures to try to minimize the present value (investment plus residual damage) social costs of climate change. Upgrades are often most cost-effectively undertaken together with other building envelope, equipment or landscape renovations to the property.

Main climate hazards addressed:

- Increased temperature
- Increased precipitation
- Sea-level rise
- Storm surge, coastal flooding, erosion
- Extreme precipitation, flooding, erosion, landslides
- Wildfire
- Extreme temperature and heatwave
- Water shortage, drought
- Damaging storms

Market barriers to achieving goal faced by actors:

- No or limited awareness by property owners, tenants or the market generally of climate-related threats and opportunities
- Uncertainty about climate impacts at a local scale, lack of confidence in projected impacts at a local scale
- Information is not directed at relevant audience / decision-makers
- Low demand for climate resilient property by tenants and market generally
- Lack of technical expertise—to know what adaptation measures to install and how to properly install them
- Transaction costs—do not know where to get trusted advice and information
- Unproven (and potentially unreliable) technologies and practices—perception that adaptation upgrades are untried, untested and will adversely affect other attributes of the property
- High perceived investment costs versus low perceived benefits
- Insufficient return on investment or payback versus competing uses of owner's capital
- Uncertain ownership period—concern that property will be sold before investment is paid back
- Skepticism that real estate market will capitalize climate-related risk reductions in property prices
- Unwillingness to pay additional up from costs
- For owners needing to debt finance upgrades—no or poor credit rating or collateral, concern over balance sheet debt-ratio (for corporations)
- Lack of government incentives (including mandatory disclosure of risks and government subsidies)
- Property transfer tax is levied on land and improvements, including risk mitigation upgrades
- Owners of rental property are reluctant to venture into "new territory" due to the possibility of exposing themselves to unforeseen liabilities
- Concern that adaptation upgrades do not comply with "code" or "accepted practice" by local governments (inconsistent with zoning, sub-division and other bylaws)
- Misaligned incentives—between landlords and tenants and between owners / tenants and insurers (moral hazard)
- Negative externalities (e.g., environmental and health & safety impacts, emergency services and recovery costs) and positive externalities (e.g., learning-by-doing, spillovers)
- Range of behavioural biases and anomalies (notably, choice overload, present bias, status quo bias, availability bias, overconfidence bias, salience effects, fairness, anchoring bias, framing effects)

3. Real estate development process stage:

Redevelopment

Relevant actors:

Fee simple property owners, strata corporations, tenants, lawyers, (re)developers, financial institutions, real estate analysts, planning consultants, real estate agents, approval authorities

Goal of government:

To help markets provide appropriate price signals to property owners to encourage an optimal level of managed retreat from locations prone to (mainly) coastal and fluvial flooding, where such a policy is justified. Managed retreat may be justified where—e.g., the construction and maintenance costs of protection works are higher than the capital values of the assets to be protected, the wider community is either unable or unwilling to pay for the costs of maintaining protection works indefinitely, etc.

Main climate hazards addressed:

- Sea-level rise
- Storm surge, coastal flooding, erosion
- Extreme precipitation, flooding, erosion, landslides
- Wildfire
- Water shortage, drought

Market barriers to achieving goal faced by actors:

- No or limited awareness by property owners or the market generally of climate-related threats and opportunities
- Uncertainty about climate impacts at a local scale, lack of confidence in projected impacts at a local scale
- Information is not directed at relevant audience / decision-makers
- Skepticism that real estate market will capitalize climate-related risk increases in property prices (in theory, the price of a property should approach zero as tide line encroaches the building envelope)
- Uncertain ownership period—property owners will move before threshold that triggers managed retreat is met
- The costs, time and general inconvenience of relocating
- Desirability of living in high-risk areas, like in on sandy coasts
- Negative perception of allowing valuable land to be lost to the sea
- Cultural resistance to change
- Lack of government incentives (including mandatory disclosure of risks and adequate compensation)
- Lack of clarity on roles and responsibilities across government, and between public and private sector
- Concerned about potential for litigation, lack of clarity on liability for decision-making—e.g., potential for "takings" challenges
- Zoning / sub-division by laws—e.g., height to boundary, yards, vegetation clearance, etc.
- Perverse subsidies—property owners do not bear the full cost of their decision to live in locations prone to severe flooding (e.g., development is sometimes subsidized by public dollars for infrastructure and protection work (both initial construction and maintenance or repair), the costs of flooding and erosion are also not borne fully by communities or private property owners because of Disaster Financial Assistance)
- Property transfer tax inhibits the mobility of resources
- Negative externalities (e.g., environmental and health & safety impacts, emergency services and recovery costs) and positive externalities (e.g., creation of habitat, recreation opportunities)
- Range of behavioural biases and anomalies (notably, loss aversion, endowment effects, present bias, status quo bias, overconfidence bias, salience effects, fairness, anchoring bias, availability bias)

6 ECONOMIC INSTRUMENTS TO PROMOTE GOOD ADAPTATION DECISIONS

6.1 INTRODUCTION

At key decision points throughout the real estate development process various market failures and behavioural failures may result in a range of maladaptations by private actors, leading to sub-optimal levels of climate change adaptation for society as a whole. As a result, community well-being will be lower than it otherwise would be in the absence of these barriers to efficient adaptation. This provides a rationale for government intervention—to overcome the offending barriers and help markets reallocate resources to improve the adaptation choices made by private actors in the real estate sector. The primary aim of government policy-makers is to place the sector on a low risk–high resilience pathway.

In this section we identify economic instruments that the provincial government or local governments in BC could use to overcome barriers to good adaptation choices by private actors in the real estate sector. We begin by describing the range of policy tools available to government, before looking at individual economic instruments that could be used to overcome key barriers to good adaptation choices in each of our three case examples. We find that the most effective policy response for each case example will combine regulatory tools with economic instruments designed to overcome case specific barriers, as well as economic instruments to overcome barriers cutting across all three case examples.

6.2 POLICY TOOLKIT

Policy tools to promote efficient adaptation decisions by private actors in the real estate sector can be categorized in a number of ways (Agrawala and Fankhauser, 2008; Bräuninger, et al., 2010; Butzengeiger-Geyer, et al., 2011; Koehler, et al., 2014; and Macintosh, et al., 2014).[24] We distinguish three broad categories of adaptation policy tools available to government(s) in BC:

1. Planning and regulatory tools;
2. Economic instruments; and
3. Spending tools.

Each category can have one or more primary objectives (Butzengeiger-Geyer, et al., 2011). The main objective of planning and regulatory tools (e.g., zoning and subdivision bylaws) is to mandate desired adaptation actions by private actors. Economic instruments can have multiple objectives:

[24] For example, Bräuninger, et al., 2010 delineate between: subsidies; taxes and fees; licenses, permits and variations; other market-based instruments; financial instruments; public-private partnerships; and risk financing instruments.

- To incent adaptation actions or behaviours by private actors (e.g., subsidies, taxes, charges, tradable quotas);
- To raise funds and mobilize resources for adaptation (e.g., taxes and charges);
- To spread financial risks across private actors and taxpayers (e.g., insurance, disaster aid); and
- To efficiently allocate resources to desired adaptation actions (e.g., tradable quotas).[25]

Spending tools obviously seek to raise funds and mobilize resources for adaptation (e.g., capital spending programs through the budgetary process), but can also help spread financial risks across actors and efficiently allocate resources to specific adaptation actions (e.g., public-private partnerships). As noted in Section 2, spending tools are outside the scope of this project and are not considered further; the focus of this report is on instruments to incent socially sound adaptation actions or behaviours by private actors.

6.2.1 Planning and Regulatory Tools

The first response by government to a perceived policy issue, such as the failure of markets to provide an optimal level of adaptation to climate change, is often to regulate. A government may, for example, pass a law to prohibit or regulate an action or behaviour anticipated to result in maladaptation. With regulation private actors are essentially told what to do or what not to do. This traditional government response to market failures is referred to as "command-and-control" since it affords private actors relatively little flexibility in achieving policy goals.[26]

There is a long history of government use of command-and-control planning and regulatory tools to manage land use and development "in the public interest". Many of these tools can also be used to address market failures that result in a sub-optimal level of adaptation by private actors in the real estate sector. The main planning and regulatory tools that local government can use to these ends are summarized in Table 10. In some places in the table we suggest that a tool may potentially provide a vehicle to compel a specific adaptation activity. This does not mean that it is currently being used to these ends or that it is possible to do so without changes to legislation.

Table 10 also highlights how each tool could contribute to improved climate adaptation, as well as its applicability to each of our case examples—an arrow (✓) by a case example indicates that the planning or regulatory tool has a role to play in promoting good adaptation decisions by private actors, either directly or indirectly, by supporting the effective implementation of one or more of the economic instruments discussed further below.

[25] The creation of new markets, especially through the use of auction-type mechanisms, can be used to efficiently allocate scarce resources to desired adaptation actions rather than relying on governments to administratively allocate them using regulation.

[26] Local governments in BC are nonetheless looking for ways to increase the flexibility of their planning and regulatory tools—including allowing for "performance-based" design in new subdivisions and development. For example, developers may be required to retain a certain percentage of stormwater onsite, but it is up to the developer to come up with a creative solution for meeting that target—e.g., using impervious surfaces, bioswales, green roofs, etc.

Table 10: Planning and Regulatory Tools to Promote Efficient Climate Change Adaptation Decision by Private Actors in the Real Estate Sector

Adaptation Tool	Description
Official Community Plan (OCP)	An OCP provides the general guidelines for how a community aspires to develop over time. An OCP, which can be developed by municipalities and regional districts, is a statement of objectives and policies to guide planning and land use management decisions within the area covered by the plan. Both the objectives (that establish the broad direction for the future of a community) and more specific policies (that indicate the way in which local government will implement or attain the objectives, typically through regulatory tools) included in the OCP provide an overarching framework for promoting better adaptation decisions by private actors in communities. For example, objectives may aim to protect people and property or to manage risks on land subject to (say) coastal hazards, such as erosion and inundation. Policies may specify how local government plans to address coastal erosion and inundation, using (say) setbacks, the designation of "retreat zones" where private property owners could be subject to limits on hard armoring and rebuilding, etc. 1. Development plans ✓ 2. Property upgrades ✓ 3. Manage retreat ✓
Hazard mapping	Hazard maps identify areas susceptible to perils, such as wildfire, coastal flooding and erosion, stormwater and fluvial flooding, landslides, etc. The mapping of hazards provides the technical basis for planning (re)development by: o Identifying areas at risk to specific hazards; o Providing a basis for directing new (re)development away from areas at risk; and o Guiding policies to accommodate (re)development in areas where the risk can be efficiently managed (e.g., see the Natural Hazards Development Permit Areas employed by the District of North Vancouver). Hazard mapping also provides valuable information for public education, and may even encourage private actors in hazard zones to take their own proactive measures to reduce risks—and possibly encourage insurers to offer risk-based insurance cover. 1. Development plans ✓ 2. Property upgrades ✓ 3. Manage retreat ✓
Zoning	The primary regulatory tool that local governments use to management development is zoning. Zoning maps divide a community into different districts (or zones) based upon the types of uses and buildings that are permitted (e.g., residential single-family, residential multi-family, commercial, or industrial). Zoning bylaws also specify the different regulations that govern development within a zone. For example, zoning bylaws may specify the size and dimensions of buildings and structures, how far structures need to be set back from (say) streets, the density of development allowed, conditions for the provisions of amenities and use of different (bonus) densities, and different standards for public works and services. It therefore follows that zoning bylaws can help manage climate-related risks by specifying, for example, minimum building setbacks from hazards, levels of structural protection, minimum elevation requirements for buildings in high-risk flood areas, types of land use and densities, requirements for lot grading, etc. In addition, as the establishment of zoning bylaws requires public engagement, they also serve to as a vehicle to educate and raise awareness. 1. Development plans ✓ 2. Property upgrades 3. Manage retreat ✓

Subdivision	Subdivision refers to the process of developing a new legal title for property by creating several lots from one or more existing parcels, adjusting or realigning an existing property line, land dedication, or consolidating two or more properties into one lot. Subdivision can involve a fee simple property, a strata lot with no existing buildings, or an existing strata unit. Any proposed subdivision must be approved by an Approving Officer, who has the authority to consider the OCP, zoning bylaws, works and service requirements, and other relevant information to decide whether to approve (including approval with conditions) or refuse the proposed subdivision application. Subdivision can be used in conjunction with zoning to prevent or establish conditions for the subdivision of property at risk to climate hazards. For example, an Approving Officer may refuse a subdivision application if the property is, or is expected to be, exposed to climate hazards (unless appropriate adaptation is provided), or if the costs to government of providing works and services are anticipated to be excessive.				
	1. Development plans	✓	2. Property upgrades		3. Manage retreat ✓
Development permit areas	A Development Permit Area (DPA) is a set of land use objectives and guidelines relating to a specific area, as defined within the OCP or a zoning bylaw. Local governments have the authority to establish DPAs for, among other things: protecting the natural environment, its ecosystems and biological diversity; protecting development from hazardous conditions; and establishing objectives to promote energy conservation, water conservation, and reduce greenhouse gas emissions. Where a DPA has been designated, no subdivision, building construction or modification, or alteration of land can proceed unless a Development Permit has first been issued by the local government. The Development Permit outlines how the specified objectives are to be met. A DPA may specify areas of land that must remain free of development or that are exposed to natural hazards, and may specify guidelines or conditions under which the objectives for the DPA are to be addressed by developers. For example, it may require an independent professional to assess risks to a proposed development at the applicant's expense.				
	1. Development plans	✓	2. Property upgrades	✓	3. Manage retreat ✓
Building code	Local governments in BC regulate the construction and design of buildings through the building code. This code is based on the model National Building Code that the BC government then amends to address provincial needs. The code is applicable to all new building construction or significant retrofits. Building code establishes minimum standards for, among other things, the structural protection of buildings. It also contains requirements for energy and water use efficiency. Building codes can be used to reduce the sensitivity of structures to climate hazards—e.g., mitigating flood risks by specifying minimum construction levels, the use of flood resistant materials, the location of services, etc. Furthermore, builders can be provided with incentives (e.g., grants, tax-credits) to exceed the minimum standards in code. The application process (specifically, withholding approvals) may also be used encourage property owners to allow covenants on the title deeds ensuring prospective future owners are aware of the site-specific building requirements (and by extension relevant climate hazards).				
	1. Development plans		2. Property upgrades	✓	3. Manage retreat

Setbacks and buffer zones	Setbacks are building regulations that establish a minimum distance from a boundary line (e.g., street, tide line, etc.) where property owners are prohibited from building structures. Similar to setbacks, buffer zones require property owners to leave portions of their property undeveloped—in their natural state—to support natural processes (such as wetlands or vegetated areas that prevent or reduce runoff and flooding). Setbacks and buffers are commonly established through zoning, OCP bylaws and DPAs. Setbacks and buffers can be used to keep buildings and structures in floodplains and coastal areas away from portions of property that are vulnerable to flooding and erosion; they could similarly be used to limit wildfire risks. Local governments could restrict or prohibit development where sufficient setbacks or buffers cannot be accommodated. In coastal areas, buffer zones could be created to ensure development adjacent to the shoreline provides natural protection to buildings and structures, while allowing for upland migration of beaches, dunes, wetlands, etc. Setbacks and buffer zones in coastal areas could be established on the basis of projected sea-level or erosion rates over the lifetime of the development. 1. Development plans ✓ 2. Property upgrades ✓ 3. Manage retreat ✓
Permitting restrictions	When approving new developments or substantive renovations or redevelopment, local government may be able to impose special conditions / restrictions that help encourage good adaptations to climate change. These could be implemented through a variety of planning and regulatory tools, including those listed above. Example conditions / restrictions that would benefit adaptation include: o Restrictions on hard armouring—property owner agrees not to construct structural flood defenses (but may be allowed to use soft-armouring alternatives); o Removal requirements—property owner agrees to remove structures and buildings when they become inundated as the tide line recedes. In other words, development is allowed, but with the expectation that it will eventually have to cede to the rising sea-levels; o Dedications—property owner dedicates an easement to provide buffer zones; o Protection requirements— property owner is required to design new developments and associated infrastructure to be more resilient to climate-related risks; o Rebuilding restrictions—limit the ability of a property owner to rebuild buildings and structures damaged or destroyed by climate hazards. Rebuilding may be totally prohibited or limited (property owners are allowed to build smaller, more resilient structures, or required to provide for additional setbacks or buffers). Permission to rebuild may also be granted with conditions, for example, that ban hard armouring; and o Retrofitting requirements—property owner is required to install climate resilient structures or use climate resilient materials when (say) they apply for a permit to renovate or expand a building. Local government may be able to implement rebuilding restrictions through "downzoning" of high-risk areas, whereby the density of housing and development is reduced. 1. Development plans ✓ 2. Property upgrades ✓ 3. Manage retreat ✓
Acquisitions and buyouts (also considered a "spending tool" as payments are often made by government to third parties)	Local government can acquire interest in developed property, through voluntary sales or mandatory expropriation, for a range of purposes, including: construction of structural protection works (e.g., a dike) or establishing setbacks for public safety. Undeveloped land subject to natural hazards can also be acquired to prevent its development. Government could lease acquired property back to private actors until it becomes uninhabitable due to (say) sea-level rise and erosion. The lease payments would significantly offset the initial cost of acquiring the property. 1. Development plans ✓ 2. Property upgrades 3. Manage retreat ✓

Easements, conservation easements, rolling conservation easements and restrictive covenants (also considered a "spending tool" as payments are often made by government to third parties)	Easements are instruments by which a property owner grants to another party (including all levels of government) rights with respect to his or her land. This is typically done through a written agreement, negotiated between the owner and the third party, and registered on the land title. As easements are registered in the title deeds they bind current as well as future owners. Easements are typically voluntarily sold or donated by landowners (who receive tax benefits for their donation, which can be transferable). They may be negotiated as part of the development approval process or afterwards. Ownership of land conveys a bundle of rights to the owner to carry out certain activities (e.g., cut down the trees, build a house, subdivide, etc.). By signing an easement the property owner voluntarily gives up some of those rights for as long as the easement is in effect. The third party acquires an interest in the property, but not the right of exclusive possession. The original property owner may continue to make economic use of (a portion of) the property. This makes easements more acceptable to property owners than acquisition or buyout programs. An easement may be either positive (grants rights to use of the land, such as a right-of-way) or negative (restricts the use of land, such a requiring it remains in its natural state). Conservation easements are a special kind of negative easement created to preserve land in its natural state. Negative easements are similar to (restrictive) covenants. A restrictive covenant is a written agreement between two or more parties to limit the use of land (e.g., limiting or preventing building on land, or preventing its subdivision) or require it be used in a specific way (e.g., requiring maintenance of coastal wetlands, minimum building elevations, etc.). Similar to easements, a restrictive covenant will "run with the lands" and bind successors to the title. They may be used in conjunction with other regulatory tools (e.g., subdivision). Easements and covenants can be used to prevent development in areas that are vulnerable to climate hazards. For example, they could be used to limit new development in high-risk areas, limit or prohibit the construction of hard armoring, require removal of structures that come to encroach on public lands due to erosion, and (possibly) require real estate disclosure of natural hazards and associated risks. A rolling conservation easement simultaneously imposes both negative rights (preventing an owner from engaging in certain activities on his or her land) and positive rights (granting the easement holder rights to use the property for certain purposes). Local government could then draft easement terms that allow limited development in upland portions of a property at risk to (say) sea-level rise, storm surge and erosion, while preventing certain activities along the shoreline. The easement would "roll" because the terms re use / non-use would be triggered as (say) the tide line migrated inland as sea-levels rise. In contrast to traditional conservation easements that require the whole parcel be preserved in its natural state, rolling easements allow for limited development of upland portions of the property, but would prohibit the construction of hard armoring and other structures that could obstruct the natural migration of the tide line inland. As the tide line recedes and lands become inundated, the easement terms would also require that buildings and structures be removed. Removals could be financed by either public dollars or dedicated taxes levied on the eventual beneficiaries (e.g., tourists) of shorelines returned to their natural state (e.g., Additional Hotel Room Tax). Property owners receive up-front compensation (payment) for agreeing to the terms of the rolling easement, which increasingly limits development on the parcel over time. However, because they can continue to develop and use their property until rising sea levels threaten buildings and structures, compensation payments should be significantly lower than under acquisition and buyout programs, or traditional easement programs. 1. Development plans ✓ 2. Property upgrades 3. Manage retreat ✓

Sources: Titus (2011); Grannis (2011); Codiga and Wager (2011); Siders (2013); BCMOE (2013); and BCMCSCD (2015)

Note: An arrow (✓) by a case example indicates that the planning or regulatory tool has a role to play in promoting good adaptation decisions by private actors, either directly or indirectly, by supporting the effective implementation of one or more of the economic instruments discussed below.

6.2.2 Economic Instruments

Economic instruments act to change or modify behaviour by changing the incentives facing private actors. They primarily work by using market signals—that is, prices and trading opportunities—to provide an incentive to individuals and businesses to act in a way that will achieve the government's policy objective. An important category of economic instruments is fiscal measures, such as taxes and subsidies, which are used to influence pricing signals facing private actors. The direct use of markets and the creation of new markets that did not previously exist is another way that economic instruments can be used to achieve the government's objective.[27] As an alternative to intervening in decisions directly, the government can facilitate the opportunities for agents to participate in voluntary exchanges (of, for example, permits or rights to undertake certain activities) in a way that achieves the policy objective. Private actors respond to the incentives by making decisions based on their own assessment of the costs and benefits of different courses of action given the incentives put in place by the economic instrument. This is in contrast to traditional command-and-control regulations, which basically specify exactly how the policy objective is to be achieved by private actors.

Key Characteristics of Effective Economic Instruments

Effective economic instruments have three key characteristics:

- **Clearly specified objectives**.

  The objective that the economic instrument is trying to achieve must be clearly specified if it is to be an effective instrument. A clearly specified objective is also necessary to enable progress towards attaining that objective to be measured and to provide feedback to policy-makers regarding changes that may be required to the instrument. Instruments which have multiple, and possibly conflicting objectives, are highly unlikely to be effective. It may be unclear to private actors which objective is being pursued as the primary policy goal and how this impacts on the design and implementation of the instrument.

- **Coherence with other policy tools**.

  An effective economic instrument should not act against other policy tools and should complement them if they are trying to achieve a similar objective. Integration with other policy tools is important when implementing economic instruments because they must operate within the legal and institutional framework established by other instruments and regulations. Economic instruments are rarely used in isolation; they are often used in combination with other instruments and regulations to form a package of policy tools to achieve a given objective. For example, a rebate program to encourage the installation of property-level risk mitigation measures will usually be accompanied by an information campaign to further encourage program participation. In addition, an economic instrument can be used in combination with traditional command-and-control regulations. The traditional regulation could set a base requirement (e.g., like the minimum

[27] For example, in British Columbia and Alberta new markets for carbon offset projects were created as compliance mechanisms for, respectively, the Greenhouse Gas Reductions Targets Act (for the public sector) and the Specified Gas Emitter Regulation (for large industrial sources of greenhouse gases).

standards in a building code) which must be complied with, and the economic instrument could offer incentives to go beyond the minimum standard stipulated by the traditional regulation.

- **Robust monitoring and compliance mechanisms**.

  An effective economic instrument must be monitored to ensure that it is working as intended and is achieving its objectives. It is also necessary that those subject to the economic instrument comply with it.

  There may be possibilities for avoidance or evasion of fiscal instruments, which would weaken their effectiveness. For example, it may be possible to understate the level of taxable or chargeable activities and thus evade payment of appropriate taxes or charges. If the tax or charge arrangements are very complex, for instance, the incentive not to comply with them will be strong. Subsidies and quota-based schemes may be less subject to deliberate avoidance—the incentives may be such that private actors actively want to participate. The more complex the scheme, however, the greater the participation costs for private actors. High participation costs (relative to the benefits of participating) will discourage private actors from participating.

  Effective monitoring of economic instruments is particularly important given the potential uncertainty regarding their impacts. Unlike command-and-control regulation, which may, for example, set a strict limit on some activity, many economic instruments, which work through incentives, will depend upon the individual reactions and decisions of private actors.

  Because the impacts will take time to be known, there may need to be revisions to an instrument over time to ensure that it continues to achieve the government's objectives. For example, a tax on an undesirable behaviour may need to be adjusted if the impact on private actors is less or greater than anticipated when the instrument was conceived. An effective monitoring plan will help provide information necessary to make the adjustments to ensure the original objectives are met.

Types of Economic Instruments

Examples of economic instruments include, but are not limited to:

- **Financial instruments and incentives.**

  This category of economic instruments includes:

  - Subsidies. All forms of direct and indirect financial assistance to private actors to induce specific actions linked to the assistance, including grants, price support, tax credits, tax breaks, tax exemptions, accelerated depreciation. Some financial instruments—specifically, credit enhancements like soft loans, loan guarantees, interest rate buy downs, etc.—function like subsidies, directly mobilizing additional financial resources for climate change adaptation investments;

  - Taxes. Mandatory, unrequited monetary payments by private actors to government. Taxes are unrequited in the sense that services provided by government to taxpayers are not normally in proportion to their payments. For example, the annual services a property owner receives from local government are not normally directly proportional to their annual property tax payments. A percentage of a tax's revenue can nonetheless be earmarked to fund a specific service (e.g., when a "bed-tax" on hotel rooms is earmarked to pay for the

removal of inundated building and structures on as part of a managed retreat strategy). The objective of many taxes is to raise revenue for government. But taxes can also be used to influence the decisions of private actors—to incent socially optimal behaviour;

- Charges. Charges are compulsory requited monetary payments to government. The terms charges and fees are often used interchangeably. Charges are requited in the sense that the payments are collected to cover the cost to government of providing a service. Development Cost Charges, for example, are payments collected from developers by local government to offset some of the infrastructure expenditures incurred to service the needs of new development. Other local government examples include fees charged for sewer, water, and garbage collection, and charges paid when applying for a building permit. Charges could, in theory, be designed for the provision of "adaptation services" by government.
- Marketable (tradable, transferable) permits, rights, or quotas. These instruments are based on the principle that any increase in the use of (say) land by one private actor (or at one location) must be offset by a decrease of an equivalent or sometimes greater quantity by another private actor (or at another location). Hence, either total land use is reduced in a community or land use at one (high-risk) location is exchanged for land use at another (low-risk) location within a community. Tradable Development Rights are an example of this type of instrument.
- Market creation. Involves the explicit creation of a (new) market for environmental or natural resources, to encourage their efficient use and to foster recognition that these resources are scarce and valuable—and thus worth conserving. Water markets (to promote water use efficiency and conservation) provide an example of a created market that can contribute to climate change adaptation in the context of water supply shortages.

- **Risk sharing or transfer mechanisms.**

  These mechanisms can be divided into risk-financing and loss-financing instruments (Bräuninger, et al., 2010; and Butzengeiger-Geyer, et al., 2011). The former are purchased in advance by private actors and governments exposed to hazards in anticipation (i.e., before an event) of being impacted. In contrast, loss-financing instruments are arranged by private actors and governments to aid with the recovery process from a specific event, after the event occurs. The three main risk-financing instruments are:

  - Insurance. Insurance is the promise of a (larger) payout to compensate for specific future losses, should an event occur, in exchange for a (smaller) payment today. Not only does insurance enable recovery from the event, it can also be designed to incent risk mitigation behaviours.
  - Weather derivatives. A weather derivative is a risk management product that provides a private actor protection against adverse weather. In contrast to conventional insurance, where the payout is based on a demonstrated loss, the payout of a weather derivative is based on a weather index (and specifically, a specified threshold on that index). For example, the index could be millimetres of rainfall below or above a specified threshold using observations from a weather station(s).

- Catastrophe bonds. Catastrophe bonds (or cat bonds) are an example of an insurance product to create risk-linked securities which transfer a specific set of (natural disaster) risks from an insurer(s) or reinsurer(s) to investors in financial markets. Financial markets have many times the capacity of reinsurers to absorb large insurance payouts. Investors thus take on the risk of a specified event or set of events occurring in return for attractive rates of return on their investment in the bond. If a qualifying event or set of events occurs the investors will begin to lose the principal they invested and the insurer(s) or reinsurer(s) will receive that money to finance their payouts.

- **Information and education provision.**

  These instruments work to change behaviour through the provision of more information or changing the distribution of information that is available—making information which may be available to some private actors available to others. Examples of these instruments include: information and education campaigns, labelling requirements, or requirements to disclose other information to the market.

  There are a number of ways in which government action can lead to greater information provision:

  - Government can require information to be disclosed (this may require the enactment of laws requiring private actors to make information available, possibly with penalties for non-compliance or the provision of incomplete information);
  - Government can encourage information provision (without the passing of laws making it mandatory); or
  - Government can itself collect and make the information available directly to private actors.

  Information instruments are often characterised as being "light-handed" because the degree of direct government involvement in decision-making or directing behaviour is more limited than with other policy tools—they do not directly impose legally binding rules on the actual behaviour of individuals or businesses making the ultimate decisions, nor do they provide monetary incentives to make different choices.

- **Decision or choice architecture.**

  Even if accurate and timely information is generated and shared effectively, private actors in the real estate sector may not always make efficient use of it. Moreover, incentives provided by some of the instruments listed above can backfire—not result in the desired behaviours—depending on how they are presented (or "framed) to people. Decision or choice architecture reflects these observations—that there are many ways to present a choice to private actors (typically, decision-makers in the home or in businesses that policy-makers want to influence), and that what is chosen by these actors often depends upon how the choice is presented. It simply refers to the careful design of the context in which people make choices. Public sector policy-makers—the "choice architects"—have a range of tools at their disposal to influence private decisions for the greater good—e.g., reducing the number of choice alternatives, varying the order of choice alternatives, judiciously selecting default options, limiting the time for making choices, priming, etc.

- **Reform of existing maladaptive incentives in government rules or processes.**

  Subsidies can provide important economic incentives to private actors to achieve policy objectives. In practice, however, many subsidies promote inefficient and unsound economic development. Some government subsidies (discussed below in Section 6.3) provide disincentives to private actors to respond to both current climate conditions and projected climate change. Some taxes also impede effective climate change adaptation, by limiting or delaying adaptation decisions. Reforming perverse subsidies and taxes is an important pre-cursor to the introduction of other economic instruments.

Relative Strengths of Economic Instruments

A key advantage of economic instrument is that they rely on decisions made by private actors in response to the incentives they face. The individual actor therefore decides how to respond given his or her individual assessment of the costs and benefits of different courses of action. The decisions taken will reflect the preferences of the private actors involved. Economic instruments can therefore be designed in the absence of information that is unlikely to be known prospectively by government policy-makers. Often when governments use traditional command-and-control regulation, they are required to estimate or infer such information when trying to develop regulatory tools to correct market failures, which raises the likelihood of making errors.

If the economic instrument is well designed, it will put in place incentives which encourage private actors to behave in a way which facilitates the attainment of the government's policy objectives. That is, the social benefits of the instrument will be maximised by individuals and businesses acting in their own interests. The private actors will also have an incentive to minimise their costs of complying and achieving the government's objectives.

Economic instruments are, in general, very flexible policy tools in the sense that they often do not specify in detail how private actors are to behave. These instruments create and manipulate incentives, but individual actors make their own choices and decisions based on the incentives facing them. Because private actors can respond to economic instruments in both the short-term and in the longer-term, this enables both static and dynamic efficiency gains to be achieved. The static and dynamic efficiency advantages of economic instruments over command-and-control regulation in correcting market failures are well documented (see Box 6 for an explanation of these advantages).

Consideration of compliance costs should take account of the costs borne by both the private actors and the government itself. The extent of these costs will depend on the type of economic instrument being used—the type and extent of costs imposed on both the private actors and borne by government will differ widely between fiscal instruments (such as taxes and subsides) and quota-based instruments (such as tradable development rights). For example, the creation of quota-based instrument will create a range of costs for both those participating in the market and the government who is responsible for establishing and providing oversight of the newly created market. For private actors there may be direct costs, such as registering to participate, but there are also likely to be significant indirect costs, such as the costs involved in understanding the market rules and how the market operates. This could involve significant expenditure on training staff and equipping them with new skills—it may be that the introduction of (say) a tradable development rights scheme replaces other forms of traditional command-and-control regulation

(e.g., expropriation) and this may require property owners to develop a very new skill set. The government will also bear costs in setting up the trading scheme. There will be, for instance, the initial set up costs involved in putting the market framework in place, including developing and passing any legislation required. In addition, the government will bear on-going costs associated with monitoring the operation of the newly created market.

Box 6: Cost Advantages of Economic Instruments over Direct Regulations

Static efficiency (or "cheaper now"). One of the crucial properties of economic instruments is that private actors not only take different adaptation actions, but may also end up with different levels of residual climate risks. Private actors that find it relatively cheap to undertake risk reductions do more than actors that find it less feasible or more expensive, ensuring that the overall cost of a given level of risk reduction is less expensive than if all actors were required to meet a uniform standard. Or, alternatively, economic instruments offer more risk reductions for the same level of resources.

Direct regulations could, in theory, also achieve this cost-minimizing outcome. However, this would require policy-makers to set different risk reduction standards for each private actor, and, consequently, that policy makers obtain detailed information about the adaptation costs faced by each actor. Such information is simply not available to government. By contrast, economic instruments provide for a cost minimizing allocation of adaptation burden among actors without this information.

Dynamic Efficiency (or "cheaper in the future"). With direct regulation, private actors invest to meet a risk reduction standard and then stop. In contrast, placing a price on unwanted risk (say, with a tax) creates a permanent incentive for continual risk reductions. Because every "unit" of risk, effectively has a price attached to it, any utility-maximizing or profit-maximizing actor has an ongoing incentive to make further risk reductions over time. An economic instrument creates a permanent incentive for improvement and should accelerate the development of new and cheaper technologies for managing climate-related risks.

Source: OECD (2003) and EFTEC (2004)

An aspect of many economic instruments, which is perhaps less of an issue for command-and-control regulation, is the fact that in many cases these instruments work directly through prices—often increasing prices to encourage certain behaviours. These price effects are often regarded as having direct equity consequences, especially for individuals. Price increases tend to disproportionately impact lower income households. Such regressive impacts can add to the political difficulties in implementing economic instruments, especially when the price increases affect "essential" goods or services. There are mechanisms that can be used to overcome such concerns. However, it may be a costly (and possibly controversial) process to calculate the "compensation" to be given to lower-income households.

Other aspects of equity and fairness require that economic instruments are: transparent in their operations and impacts; and contain appeals or dispute resolution mechanisms.

Another issue with the use of economic instruments derives from the fact that they rely on altering the incentives facing private actors as a way of changing behaviour. It can be difficult to determine the size and form of the incentive necessary to achieve the policy-maker's objective. For example, when using a rebate to encourage households to purchase and install property-level risk mitigation measures it is necessary to determine *ex ante* what rebate level should be used. (This reinforces the important role of monitoring in ensuring the effectiveness of economic instruments.)

Timing is a further issue with the use of economic instruments. Not only may there be uncertainty with regard to the impacts of the instrument, but there may also be uncertainty with regard to when the impacts

will occur. It may take time for private actors to change their behaviour in response to changed incentives as a result of an economic instrument. (Again, this highlights the need for effective monitoring.)

The time potentially taken for economic instruments to have an impact suggests that they are unlikely to be suited to policy problems which require a rapid and immediate result.

Economic Instruments to Address Market Barriers in the Case Examples

It is clear from Section 5.6 that private actors in each of our three case examples face multiple barriers to making socially optimal adaptation choices. Some common themes nonetheless emerge that we can use to identify economic instruments to promote better adaptation choices in private real estate decisions. Barriers common to all case examples include:

- Various forms of imperfect information, which hinders awareness of risks and effective responses to those risks, and increases uncertainty of the potential costs and benefits to private actors (of both action and inaction);
- Multiple barriers relating to insufficient price signals (and incentives) that justify allocating resources (human, money, technology) to adaptation actions or behaviours, and a lack of funding mechanisms;
- A range of behavioural failures, which impairs the effective use of information (should it be available), as well as reduces the effectiveness of incentives (should they be provided); and
- Policy failures that create perverse incentive for maladaptation by private actors.

In the remainder of this section we consider economic instruments that address the above failures:

- The use of Development Cost Charges to incentivize the integration of climate resilient design into new developments at the planning stage (case example1);
- The use of property-level upgrade programs to increase the penetration of climate resilient and climate resistance measures and practices in existing properties (case example 2);
- The use of Transferable Development Credits to support managed retreat (case example 3);
- The use of mandatory hazard disclosure to overcome informational failures across all three case examples; and
- The use of choice architecture to guide the design of economic incentives and the provision of information, to maximize the effectiveness of the above instruments.

We start, however, by looking at reforms to existing maladaptation incentives identified in case example 2 and case example 3.

6.3 Reform Existing Maladaptation Incentives

Some taxes and government transfers can distort the way private actors use resources, leading to an (mis)allocation of resources that does not maximize community well-being. The same taxes and transfers may also act as a barrier to efficient adaptations to climate change—reducing the incentive for individuals

or businesses to adapt. Before investigating the merit of new economic instruments to achieve an efficient level of adaptation, policy-makers should start by reforming or eliminating distortionary taxes and transfers. This provides an easy "no-regret" or "win-win" policy response. Not only do such reforms increase community well-being by enabling resources to be used where they provide the greatest value, they also help communities better manage the risks of current climate variability and build capacity to adapt to future climate change. Two key areas for potential reforms identified in case example 2 and case example 3 are considered below.

6.3.1 Property Transfer Tax

When a private actor purchases or gains an interest in property in BC they are subject to property transfer tax (PTT), which is due upon closing.[28] The amount of PTT due is based on the "fair market value" of the land and improvements (e.g., buildings) at the date of registration.[29] The PTT is levied at a rate of 1 per cent on the first $200,000 of the fair market value of a property, and a rate of 2 per cent on the fair market value increment in excess of $200,000. For example, if the fair market value of a purchased property is $190,000 the tax owed by the buyer is 1 per cent of $190,000 or $1,900. If the property's fair market value is $750,000 the tax owed in this case is 1 per cent of $200,000 (or $2,000) plus 2 per cent of the remaining $550,000 ($750,000 - $200,000), or $11,000 for a total tax bill of $13,000.

The PTT obviously imposes additional costs on property transactions. The number of property sales will therefore be lower than would otherwise be the case in the absence of the tax. This could, in theory, impede efficient adaptation choices. By making property transactions more expensive, the PTT could make it difficult for some property owners to move away from areas at greater risk from extreme weather events—sellers unwilling to accept the risk are impeded from selling to buyers willing to accept or who are more able to adapt to the risk. This is sometimes referred to as the "lock-in" effect (Productivity Commission, 2012). Other things being equal, fewer property transactions will also make it more difficult for real estate markets to effectively capitalize climate-related risks (and risk reductions) in property prices. And this is exactly the outcome desired by policy-makers if markets are to send the right price signals to help private actors make good adaptation choices.

In addition, as the PTT is levied on the fair market value of the whole property (i.e., land and improvements) it also taxes capital improvements including, for example, property-level risk mitigation measures. This could provide property owners with a disincentive to undertake improvements that increase the resilience and resistance of their property to climate hazards, or indeed any other improvements that may be in the interests of society.

6.3.2 Government Transfers for Hazard Protection Measures and Disaster Aid

Private property owners are unlikely to make optimal decisions regarding the development or divestment of coastal or riverfront zones if they do not bear the full cost of their decisions. Development of these zones is often subsidized by government—e.g., public dollars subsidize infrastructure (including structural flood defenses), both the initial construction costs and ongoing maintenance and repair costs

[28] PTT should not be confused with annual property taxes, which are paid annually on each registered property to fund local government services.

[29] Fair market value is "the price that would be paid by a willing purchaser to a willing seller for a property (land and improvements) in the open market on the date of registration" (http://www2.gov.bc.ca/gov/topic.page?id=44BE9E3F54994721A06EEFFBC5FA06DB).

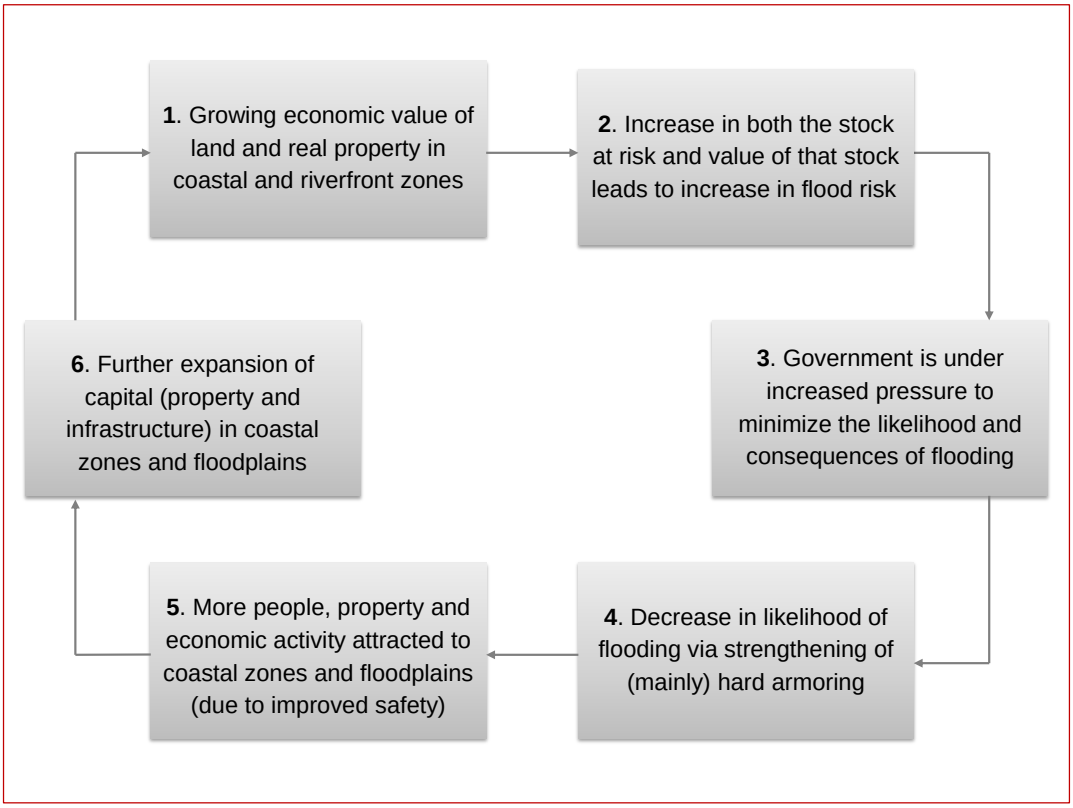
(Kim and Karp, 2012; and Kousky, 2014). Furthermore, the costs of storm surge or overland flooding events are not fully borne by private property owners because of government funded Disaster Financial Assistance (DFA)—the same can be said of other events covered by the DFA.

Thus, private property owners in protected flood prone zones benefit at the expense of all taxpayers today. And, because of the self-reinforcing cycle of government transfers that fuels growth in these areas (see Figure 4), they also benefit at the expense of future generations of taxpayers—leading to continually increasing adaptation costs (Filatova, 2013). As Figure 4 illustrates, the safer it becomes to live in a flood prone area, the more private actors would like to live and work there, the higher the total flood risk becomes, and the more the government comes under pressure to invest to increase overall protection levels, and so on (Filatova, et al., 2011). The cycle will continue in principle until (say) a social cost-benefit analysis (CBA) indicates the cost of increasing or maintaining structural protection measures exceeds the benefits of avoided damages in present value terms. To postpone or avoid the point in time when this happens, at what time communities will be exposed to significant social-economic costs, it seems prudent to investigate ways to disrupt the self-reinforcing cycle, and reverse the endlessly growing flood risk.

The "simple" solution is to reform (e.g., reduce, restructure, eliminate) the government transfers that fuel the cycle, so that private property owners bear all the costs of their investment and divestment decisions in high-risk flood areas (Bagstad, et al, 2007). In this way development in high-valued, risky areas might still occur, but development in economically marginal areas would cease. Importantly, such reforms will only result in efficient choices if the same private property owners also have access to accurate information about the risks they face (see, e.g., Section 6.7), as well as the capacity to use that information (see, e.g., Section 6.8).

An example of a free-market approach to interrupting the self-reinforcing cycle of growing flood risk is the Coastal Barriers Resources Act (CBRA) enacted in the USA in 1982. The CBRA does not regulate how private actors develop their coastal land, but instead transfers the full cost from all taxpayers to the individuals and businesses who choose to build in areas at risk to coastal flooding—"*people can develop, but taxpayers won't pay*" (US Fish and Wildlife Service, 2002). Specifically, the CBRA restricts Federal financial assistance, including disaster relief assistance provided by the Federal Emergency Management Agency (FEMA) and the National Flood Insurance Program (NFIP)—for example: the NFIP cannot provide flood insurance coverage for structures built or substantially improved after the area is designated as a Coastal Barrier Resources System (CBRS) unit; and if an NFIP-insured building within a CBRS unit is substantially improved or substantially damaged, the NFIP policy will be cancelled. By reducing perverse government subsidies and helping markets work better, the CBRA seeks to increase the conservation of coastal habitat, encourage private actors to reconsider their development choices, and reduce wasteful government spending to develop, protect, and rebuild again and again (US Fish and Wildlife Service, 2002).

Figure 4: Self-reinforcing Loop of Government Transfers that Fuels Growth in Flood Risk Areas



Source: Adapted from Filatova, et al. (2011)

Recommendation 1:

The provincial government should reform (e.g., reduce, restructure, or eliminate) the perverse subsidies that fuel the self-reinforcing cycle of continued growth in coastal or riverfront zones prone to flooding. Interrupting this cycle is necessary if private property owners are to bear all the costs of their investment and divestment decisions in high-risk flood areas. Development in high-valued, risky areas may still occur, but development in economically marginal areas would cease.

Recommendation 2:

The provincial government and local governments should investigate the case for reforming the property transfer tax so that: (a) it does not "lock-in" private property owners to high-risk areas; and (b) it does not act like a deterrent to property owners to undertake improvements that increase the resiliency of their property to climate hazards (e.g., by offering a tax credit for such improvements).

6.4 DEVELOPMENT COST CHARGES

During the "land packaging" stage of the real estate development process (case example 1), the assumed goal of government is for developers and their partners to mainstream a socially optimal level of climate change adaptation into "plans" for the provision of housing, commercial space, public amenities, and other services desired by the market and host communities.

Development Cost Charges are discussed below as a potential economic instrument to help provide private actors with sufficient incentives (price signals) to integrate an optimal level of adaptation into development plans, including the choice of land for development.

6.4.1 What are Development Cost Charges?

Development Cost Charges (DDCs) are financial instruments used by local government to pay for the growth-related capital costs associated with new development or redevelopment. DDCs are imposed under the Local Government Act [Sections 932-937]:[30]

> "*to assist local governments in paying the capital costs of installing certain local government services, the installation of which is directly or indirectly affected by the development of lands and/or the alteration/extension of buildings*." (BCMCSCD, 2005)

Local governments are permitted to use DCCs to collect monies for providing, constructing, altering, or expanding roads, sewage, water and drainage infrastructure, as well as for parkland acquisition and improvement (BCMCSCD, 2005).[31] Typically, costs are recovered for: • planning; • public consultation; • engineering design; • right-of-way or parkland acquisition; • legal costs; • interim financing; • contract administration; • construction; and• contingencies (BCMCSCD, 2005).

Buildings for public worship, developments where the value of work covered by the building permit is less than $50,000, buildings with fewer than four residential units, and developments where it can be demonstrated that no new capital costs are generated or where DCCs have already been levied for the same development, are all exempt from DCCs (BCMCSCD, 2005.) Furthermore, local governments can either exempt or levy reduced DCCs for: not-for-profit rental housing; for-profit affordable housing; a subdivision of small lots that is designed to result in low GHG emissions; and a development that is designed to result in low environmental impact (BCMCSCD, 2005).

Local governments are also afforded flexibility to decide: • whether DCCs will be levied on a uniform[32] or area-specific basis[33];• when charges will be collected (i.e., DCCs are payable by parties upon obtaining

[30] In the City of Vancouver, development charges are known as Development Cost Levies (DCLs) and are governed by the Vancouver Charter.

[31] The Vancouver Charter allows the City of Vancouver to use DCCs to collect monies for: acquiring property for, and establishing, childcare facilities; and to develop affordable housing for households displaced by development.

[32] "*A municipal-wide DCC means that the same DCC rate is applied for a particular type of land use deemed to generate a similar or same capital cost burden, throughout the municipality regardless of the location of any specific development*." (BCMCSCD, 2005)

[33] "*An area-specific DCC divides the municipality into areas according to geography … for the purpose of determining the DCC. As each area has its own set of DCC projects, this results in a distinct charge for a particular type of land use within the defined area. The charges may differ substantially between areas depending on respective servicing requirements and projected development*." (BCMCSCD, 2005)

an approval of subdivision or a building permit)[34]; and• how DCCs will vary (e.g., on a density gradient (square footage) basis or per-unit (number of lots, dwellings) basis) (Baumeister, 2012).

The Local Government Act requires local governments to use monies collected from DCCs for approved services only. DCCs are implemented through a bylaw that must be approved by the Provincial Inspector of Municipalities.

Box 7: Calculating Development Cost Charges

DCCs are generally calculated in one of two ways.

1. **Average cost pricing**. With this approach a local government estimates the total net capital infrastructure costs attributable to all new development throughout the municipality over a certain time period, and divides that by the projected number of new units (e.g., lots or dwellings) that will be developed over the same time period, arriving at the DCC. As a result, the DCC does not vary according to the actual infrastructure required by a particular development or specific geographic location. With average cost pricing DCCs are levied on a uniform basis.
2. **Marginal cost pricing**. With this approach a local government estimates the DCC on the basis of the actual net capital infrastructure costs attributable of a specific development. Marginal cost pricing will result in more economically efficient outcomes.

A hybrid approach—which levies DCCs on an area basis—calculates an average DCC based on the net capital infrastructure costs attributable to new development in a given geographical area larger than a single development, but smaller than the entire municipality.

Local authorities frequently use a combination of approaches.

Source: BCMCSCD (2005) and Sustainable Prosperity (2012)

6.4.2 Development Cost Charges as an Adaptation Tool

DCCs are currently used by local governments primarily to finance infrastructure needs arising from growth. The role DCCs play as a fiscal tool should not be understated: in 2009, contributions from developers accounted for just over nine per cent of total municipal revenues in BC (Kitchen and Enid Slack, 2012). Clearly, DCCs are a valuable revenue source to fund growth. But few local governments view DCCs as a planning tool, instead relying on the regulatory tools summarized in Table 10 to influence where and when development happens. This is despite the fact that many academics suggest the way DCCs are structured can impact how and when land resources are used and how developments are designed (e.g., Skaburskis and Tomalty, 2000; Slack, 2002; Skaburskis, 2003; Clinch and O'Neill, 2010; and Sustainable Prosperity, 2012 and 2014).

As a planning tool, appropriately designed DCCs can be used to provide developers with financial incentives to achieve several policy objectives relating to urban form, including reducing sub-urban sprawl, directing growth to built-up areas, using land more efficiently—and consequently, improving air quality, reducing GHG emissions, and promoting energy efficiency. See Box 8 for an explanation of how this works. While appropriately designed DCCs can be used to influence urban form and generate net

[34] DCLs are levied by the City of Vancouver when the building permit is issued; however, developers are allowed to stagger payments if a letter of credit is provided to the City.

social benefits, it may also be possible to design them to incentivize developers to incorporate a socially optimal level of climate resilience into new developments (see below) Ng (2013) makes the case for using DCCs to mitigate climate change—specifically, GHG emissions. Unfortunately, there are no current examples of DCCs being used to promote adaptation to climate change.

Box 8: How DCCs Influence Urban Form and Incentivize Developer Decisions

Within a municipality, profit-maximizing rational developers will compare the expected net present value (NPV) of development at various locations and develop first the site(s) with the greatest NPV. The NPV of a particular development will depend on, among other things, land prices and property values. And these in turn are affected by DCCs: depending on local market conditions, some portion of DCCs are passed to homebuyers and landowners, thus inflating property prices (reducing demand) and depressing land prices (reducing supply), and some portion is absorbed by developers. Regardless, the profitability of a development for a developer is affected.

Now, assume there are two development locations within a municipality, site A and site B, that are identical in all respects except that developing site A entails higher infrastructure costs (e.g., because it is located on greenfield at the edge of town) for the municipality than site B (e.g., because it is located on brownfield in town and can make use of existing infrastructure). If the infrastructure costs are funded through a uniform DCC, the DCC rate levied at each site will be the same, and the developer will be indifferent to selecting site A or site B. If, in contrast, the infrastructure costs are financed using an area-specific DCC that recognizes the higher costs at site A, the developer will then select site B first, the lower-cost site offering the higher NPV. Hence, area-specific DCCs that reflect differential infrastructure costs shift development from higher-cost sites to more efficient, lower-cost sites within the municipality.

Evidence suggests that providing infrastructure is more costly for low-density sites than for high-density sites. To promote economically efficient land use decisions, the DCC should thus be higher per unit for low-density developments than for high-density developments. For the same reason, developments located close to existing services should pay less than those further away. As a consequence, higher DCCs for land use at the outer edges of a town can incentivize development in the inner town and thereby reduce urban sprawl.

Source: Slack (2002) and Ng (2012)

Clinch and O'Neill (2010) present a theoretical framework for designing DCCs to reflect the full costs and benefits, private and social, of new developments, and thereby encourage developers to make socially optimal location and land use choices.[35] The framework is context neutral and there is no reason why it could not be used to promote efficient adaptation choices by developers. They suggest a two-part charge comprising:

[35] The rationale for such a framework is persuasively described by Deyle and Smith (2007), who propose a similar framework operating through annual property taxes. The basic argument is an extension of the "beneficiary-pays principle" to public infrastructure and services that are necessitated by the development of land that is exposed to climate hazards. That is, consumers of government services should pay for them in proportion to their consumption.

All land is subject to some hazards (e.g., wind, hail, lightning), but risks from some hazards, such as flooding, storm surge, erosion, and wildfire vary spatially at a scale that is relevant to local land use planning. Also, vulnerability to most climate hazards varies with the nature (design, type, construction) of improvements that are made to land. Hence, where a developer opts to make improvements to land in high-risk areas, and thereby makes it necessary for local governments to provide, for instance, emergency management services and public infrastructure that is also exposed to climate hazards, they should pay the majority of the costs for planning, preparedness, risk mitigation or adaptations, response, and recovery by local government.

1. An "infrastructure charge" to recover the municipality's growth-related capital costs associated with a new development. Ideally, this charge would be based on marginal cost pricing; plus
2. A "risk charge" to make developers pay for the external costs of climate-related risk created by the planned development. Recall that external costs are costs imposed on wider society that result from choices made by the developer, but which are not borne by the developer.

In the context of adaptation, the "risk charge" would likely be based on an estimate of the net damage costs (in present value terms) of climate change at each development site, and how these costs varied with different levels of adaptation. In other words, this would involve constructing a charge that varies along a risk-gradient, analogous to a charge that varies along a density-gradient for the purpose of promoting smart growth. This may be the theoretically ideal way to construct the charge, but in practice it is likely beyond the capabilities of most local governments.

Instead of attempting to perform the calculations required to achieve a socially optimal outcome, a "second best" approach would involve making incremental dollar additions to existing DCCs, which may not be optimal, but at least represent an improvement on the status quo. With some expectation of what defines a desirable level of adaptation at new development sites, the local government could set an initial set of charges, which also recover the costs they may incur in preparing a climate risk assessment, observe behaviour among developers, and then adjust the charge accordingly. In deriving the initial set of charges the local government could start with one climate hazard (e.g., flood or wildfire risk) and a limited set of more readily quantifiable damage costs—possibly working with insurers, who may have some of the required information.

There are other opportunities to encourage efficient adaptation choices by developers within the current DCC framework in BC:

- Local governments have some flexibility over when DCCs are payable. From a developer's perspective DCCs affect both project timing and cash flows; they introduce a carrying cost for developers (Skaburskis and Tomalty, 2000). Delaying the collection of DCCs would thus benefit developers by reducing the carrying costs. Allowing developers to stagger payments or pay in installments would similarly benefit developers. Local governments could consider delaying or staggering the collection of DCCs if developers committed to implementing specific adaptation measures at the development site. The Local Government Act allows the Minister to authorize the payment of DCCs in instalments and prescribe conditions under which instalments may be paid (BCMCSCD, 2005);
- DCCs are not used to cover annual recurring costs. But the life-cycle costs of maintaining infrastructure and services in areas prone to climate hazards today will become more and more significant for local governments as the climate changes. Consideration could be given to using DCCs to recover the life-cycle costs of infrastructure arising from growth, and not solely growth-related capital costs;
- Local governments use DCCs to recover the "net" infrastructure costs attributable to new developments. Net costs are derived from estimates of total gross capital costs by subtracting: • grants and external funding; • the proportion of capital costs that benefit existing residents; • existing DCC reserve monies; • credits and rebates for specific projects; and • the municipal assist factor. According to the Local Government Act, the purpose of DCCs is to "assist" local

governments with financing infrastructure arising from new developments, rather than paying for total capital costs. As a result, local governments are required to contribute some level of financial assistance to new developments, separate from the portion of capital costs allocated to existing developments to reflect the benefits residents accrue from the new development. This contribution is facilitated through the municipal "assist factor". The assist factor can be expressed as a percentage of capital costs and in practice ranges from as low as one per cent (i.e., 99 per cent of the development related capital costs are recovered through DCCs) to as high as 50 per cent (BCMCSCD, 2005). It is largely politically, rather than technically, determined—reflecting a Council's desire to encourage development.

In theory, the assist factor could provide a vehicle for local governments to incentivize specific adaptation actions by developers—with larger assist factors rewarding lower-risk, more resilient development choices. In other words, different assist factors would be used to encourage or discourage one type of development over another—low-risk development plans (that include a number of relevant adaptation actions identified at Annex A) over high-risk development plans (which include none of these actions). As this is not the intended use of the assist factor, clarification is needed as to whether this would be permitted. Moreover, while local governments are free to discount their DCCs as they see fit, lost revenues must be recouped from elsewhere. One option is to combine higher assist factors with the "risk charge" described above to create a revenue neutral incentive scheme for developers.

6.4.3 Challenges

There are many challenges to reforming DCCs to help provide private actors with sufficient incentives (price signals) to integrate an optimal level of adaptation into development plans:

- Many factors influence where and what type of development takes place (including zoning and subdivision by-laws). Hence, the regulatory and planning tools in Table 10 will need to be analyzed to ensure they do not work against, but support, any reforms to DCCs;
- Local governments will be reluctant to implement reforms to DCCs that result in lower total revenues. In reality, local governments tend to actively look for ways to increase, not decrease, DCCs. However, it is possible—at least in theory—to make reforms to DCCs that are revenue neutral. Furthermore, the potentially offsetting impact on property tax revenues should be considered. In principle, properties in areas with improved, more resilient infrastructure and services should appreciate in value. Higher assessed values will in turn result in increased tax revenue at the existing tax rates;
- Relatedly, the importance of DCCs as a fiscal tool creates a mindset that DCCs are not a planning tool. The reliance of local governments on DCCs for revenue to finance the capital costs of growth may affect the ability of municipal staff to see how DCCs could also be used as a planning tool;
- Local governments will be concerned that development may leapfrog to a neighbouring jurisdiction with a different, more favorable DCC regime. Hence, reforms to DCCs may need to apply across the province;
- Provincial legislation sets the rules governing the design of DCCs and the use of monies collected. These rules will inhibit the ability of local governments to use DCCs to incentivize good adaptation decisions by developers, by limiting: • what services can be recovered; •eligible costs; • the use of

monies collected; • the timing of collection; etc. Changes to the Local Government Act (and DCC Best Practice Guide) would likely be required;

- Local governments may be concerned about the administrative burden of managing a more complex DCC system. Indeed, some local governments are reluctant to vary DCCs by area—never mind by (say) area and climate-related risks—due to fears about the administrative demands of managing multiple charges. There is evidence nevertheless that the administration of area-specific charge systems is no more onerous than a uniform charge system (Sustainable Prosperity, 2012 and 2014);
- In addition to concerns over the capacity of local governments to administer a more complicated DCC system, there is also the issue of whether the expertise and information exists to create a practical system that varies charges on the basis of climate-related risk (e.g., how do you calculate the expected monetary value of changes in climate-related risk attributable to a new development); and
- There may be institutional challenges associated with needing municipal staff from finance, planning, engineering services, utilities, emergency management services, etc., who typically have different agendas (recovering costs and balancing budgets versus changing behaviour to manage risk) and little interaction, to work closely together on a regular basis.

6.4.4 Other Tools

Fast-tracking the development approval process is a strategy local governments can use to encourage climate resilient developments. This would involve granting priority status to developments that incorporated desirable climate change adaptation adaptions or at least had a contemporary adaptation action plan, so that those applications receive faster processing than they otherwise would. The fast-tracking process provides an incentive to private developers to incorporate the stipulated adaptation measures.

The Local Government Act authorizes local governments to establish zoning bylaw conditions, which if met, entitle a developer to a higher density than is available for the zone. These provisions (known as "density bonuses") have traditionally been used to increase the stock of affordable housing and to conserve and create (mainly environmental) amenities. It seems reasonable to expect some adaptation measures to be considered community amenities, for example: green roofs (to reduce heat loading and stormwater runoff), the protection of green space (to provide local cooling effects and reduce stormwater runoff), and the construction of artificial wetlands or the protection of riparian areas for stormwater management.

Recommendation 3:

The provincial government should undertake a study into the feasibility of using a two-part DCC, with a "risk charge" to capture the estimated net damage costs (in present value terms) of climate change at each new development site, and how these costs vary with different levels of adaptation. Is it possible to construct a DCC that varies along a "risk-gradient", in much the same way as charges are currently constructed to vary along a density-gradient (for the purpose of promoting smart growth)? Alternatively, the same study could be conducted with respect to annual property taxes.

Recommendation 4:

Local governments should provide the option for delayed or staggered payment schedules for DCCs, in exchange for commitments by developers to mainstream socially desirable, site-specific adaptations to climate change in their development plans.

Recommendation 5:

The provincial government should consider amending DCC legislation to allow for the recovery of the life-cycle costs of infrastructure necessitated by new developments, and expand the list of eligible services to include investment in climate-resilient measures. The provincial government should also develop guidance for local governments on how to calculate the life-cycle costs of services affected by climate change.

Recommendation 6:

Local governments should remove internal "cultural and institutional" barriers preventing DCCs from being used as both (1) a planning and adaptation tool and (2) a fiscal tool (e.g., increasing cooperation and communication between planning, financing and engineering departments, as well as educating them on the potential role of DCCs as an incentive mechanism).

6.5 PROPERTY-LEVEL UPGRADE PROGRAMS

During the "occupancy" and "renovation" stages of the real estate development process (case example 2), the assumed potential goal of government is for property owners to upgrade their buildings, structures and land with eligible climate resilient and resistance measures to try to minimize the present value (investment plus residual damage) social costs of climate change.

Property-level upgrade programs are discussed as a potential instrument mix to provide private actors with sufficient: • incentives (price signals); • information and education; and • technical assistance to retrofit an optimal level of adaptation to their property. Program design should be informed by the lessons of choice architecture discussed in Section 6.8. Even considering the heading for this section, it is evident that words have power, and programs should choose the language they use carefully. The terms "audit" and "retrofit" for instance, are not effective; these are not terms that inspire, motivate, or have positive connotations. Instead, terms like "upgrade" or "improvement" will prove more effective at motivating program participation.

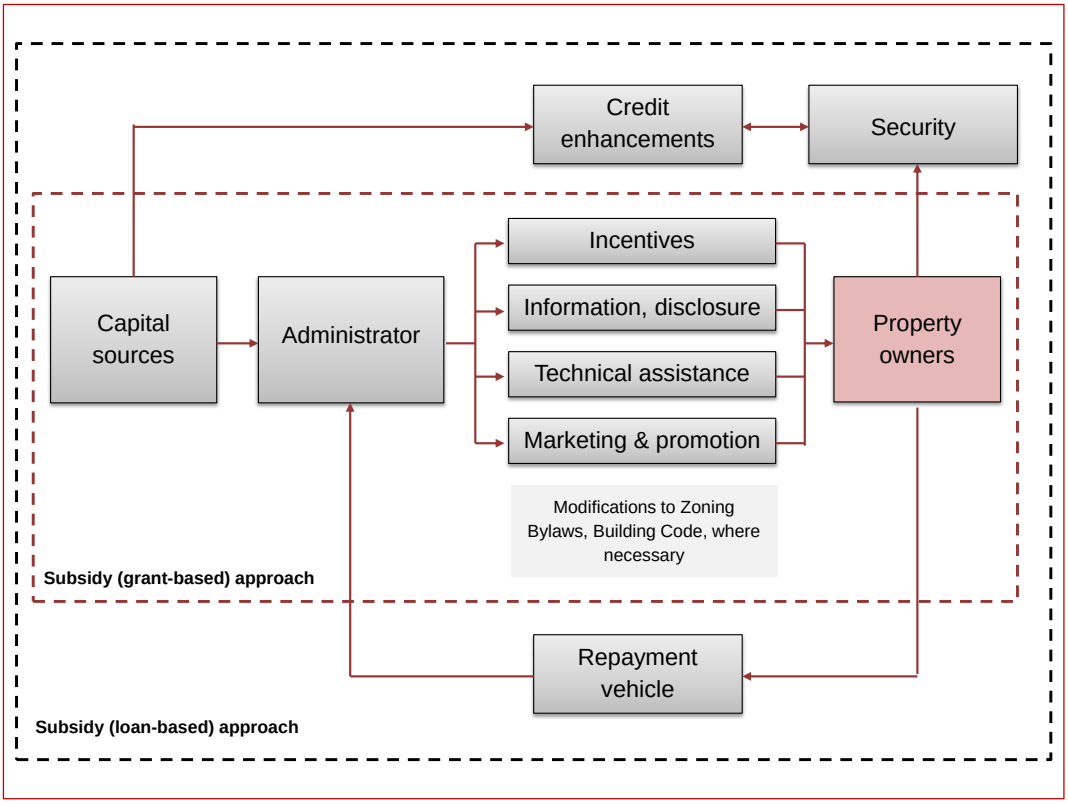
The intention of this section is solely to provide an overview of what an upgrade program could look like—and specifically, the range of broad and more detailed design issues that would need to be worked through if policy-makers were to pursue this instrument. There are a multitude of design options that

cannot be evaluated within the scope of this paper—not least because many options are case specific and depend on the program objectives, target market and available resources.

6.5.1 Elements of an Upgrade Program

A generic program for property-level climate resilient upgrades—applicable to residential, commercial, and industrial property owners—comprises up to six major elements (see Figure 5). These are: ❶ a capital source(s); ❷ a program administrator; ❸ program activities (incentives, information, technical assistance, marketing and promotion); ❹ repayment vehicles; ❺ credit enhancements; and ❻ security. A loan-based program will comprise all six elements; a grant-based program, only the capital source(s), the administrator, and program activities.

Figure 5: Elements of a Property-level Upgrade Program



Capital Sources

Funding to finance program costs (initial set-up, ongoing administration, and program activities) can be sourced from:

- The province (revenues from taxes[36], charges, levies, or debt);
- Local government (revenues from taxes, charges, levies, or debt);
- Private financial institutions (lending);
- Private insurers (reduced insurance costs for property owners);
- The property owner (cash or debt); or most likely,
- A combination of several sources.

Program Administrator

The administrator can be one of a number of actors, including government departments or agencies, independent (not-for-profit) third-parties, and various hybrids thereof. Administrators can also include private financial institutions (i.e., national or regional banks or credit unions), insurers, and for-profit third-parties (e.g., building contractors)—particularly in loan-based programs.

The administrator receives funds that cover the costs of program activities they provide directly or indirectly (via contractors), including monies loaned or granted, from a variety of sources.

Repayment Vehicles

A repayment vehicle is not needed for grant-based funding mechanisms. However, if the program is to function similar to a revolving loan fund (RFL)—perhaps capitalized by an injection of public tax dollars—a repayment vehicle is required, which aims to keep the publicly financed capital base intact over time.[37] A repayment vehicle is also required if the capital source is private.

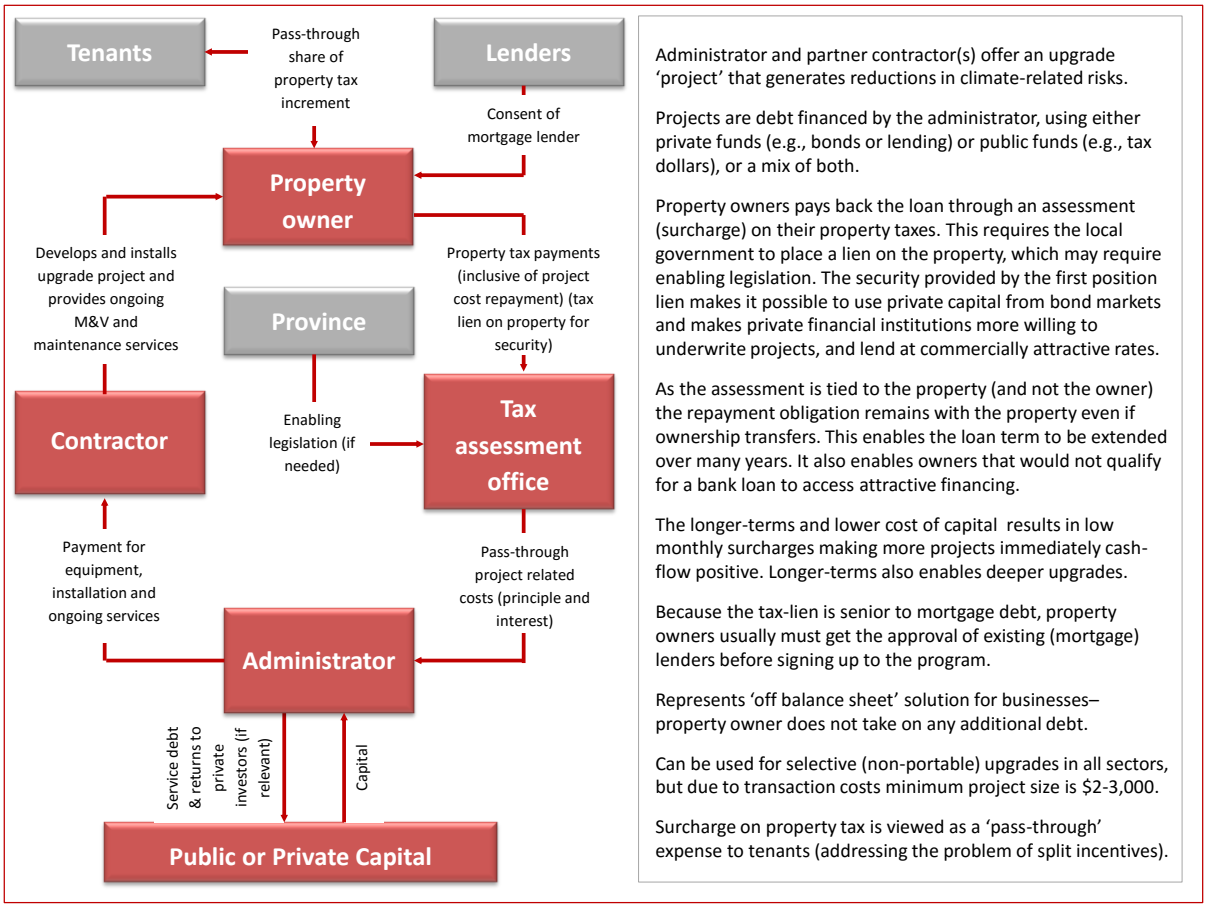
For a traditional third-party loan between a property owner and a lender (whether a private financial institution or administrator of a publicly financed RFL), the simplest repayment vehicle involves the lender sending out a regular bill to the borrower (recovering loan principle, interest and fees), collecting payments, and tracking payments and defaults. Innovative financing mechanisms (with strong securitization) are emerging in the field of energy efficiency programing, which have several advantages over traditional lending products. A promising approach that may be applicable to property-level climate adaptation programs is the Property Assessed Clean Energy (PACE) model (see Figure 6).

[36] For example, a portion of the tax revenue collected from the carbon tax could be 'earmarked' (or hypothecated) to fund a province wide property-level upgrade program.

[37] A RLF is a source of capital from which loans are made. Loans are made to borrowers (property owners) that are consistent with standard loan origination, serving and underwriting practices. As loans are repaid by borrowers, the money is returned to the RLF and becomes available to finance more projects. In this way the RLF becomes an ongoing or 'revolving' project financing tool—extending the impact of the original capital injection. The interest (or fees) paid by the borrower are inclusive of the administrators costs to manage the fund, so the capital base remains intact. RLFs are typically administered by government agencies or independent (non-profit) third-parties.

As a general rule, lenders will favor a repayment vehicle that is most likely to collect regular, full payments of principle, interest and fees. New and unfamiliar mechanisms are likely to require some form of credit enhancements and strong securitization.

Figure 6: General Structure of Loan-based Program Using the PACE Model



Credit Enhancements

Credit enhancements encompass a variety of provisions that reduce the risk of extending credit to a borrower (so-called "credit risk")—basically they are anything that improves the likelihood that loans are repaid in full and on time. The main forms of credit enhancements commonly used in programming include: • loan loss reserves; • interest rate buy downs; • loan guarantees; • a dedicated line of credit; • default insurance; and • subordinate debt.

Security

Loans can either be secured or unsecured. A secured loan is a loan offered to borrowers with collateral. The collateral provides the lender security that the principle and interest will be repaid and also what they receive in the event that a loan defaults. A property owner can effectively borrow as much as the assessed

value of the collateral. This is suitable for property owners, who can clearly offer their property as collateral, and who require larger loans—it is less suitable for tenants. In general, secured loans offer lower interest rates and longer loan terms, because the loan is backed by collateral that can be repossessed in the event of non-payment.

Unsecured loans—as the term suggests—come with no security (e.g., liens on property or fixtures). Instead, credit risks and associated losses are minimized through careful loan origination and underwriting practices. Clearly, with unsecured loans, a borrower can get qualified even when not owning a property. In the absence of collateral, loan amounts also tend to be smaller than with secured loans. Unsecured loans are therefore most applicable to tenants making selective improvements. Interest rates tend to be higher and loan terms shorter—unless backed by third party credit enhancements.

It should be fairly evident from the above discussion that several program elements interact. The presence of a strong form of security (e.g., a tax-lien on property), for example, can reduce the level of credit enhancements desired by administrators. Likewise, robust repayment vehicles can also mean that lower levels of credit enhancements are required.

Program Activities

To address all pertinent market barriers to the installation of property-level measures to increase the climate resilience of buildings, structures and land, a program needs to provide for four activities: financial incentives, information, technical assistance, and marketing and promotion.[38] These four activities are typically packaged into one of several broad program designs or models, which appeal to different sectors (see Table 11).

6.5.2 Key Design Issues

Program design will typically address the following issues:

- **Target market.**

  What types of property owners will the program target? The target market can be defined broadly (e.g., all residential, commercial, industrial properties) or narrowly (e.g., single family homes in flood-prone communities) depending on the scope and budget of the program.

- **Eligible measures.**

  What types of climate resilient upgrades will qualify for incentives under the program? For example, the US Department of Homeland Security's Resilience STAR™ Pilot Project uses the Insurance Institute for Business & Home Safety FORTIFIED Home and FORTIFIED for Safe Living standards to define eligible upgrades. Alternatively, if no suitable standards exist, a list of eligible measures—for application in specific circumstances—can be generated through a combination of climate risk assessment, engineering studies and cost-benefit analyses.

[38] Note that technical assistance and information services are commonly considered "non-financial incentives". When financial incentives are combined with technical assistance and information services—as they are in Figure 5—the program is said to offer "bundled incentives". Furthermore, the adoption of an adaptation action is a function of both the level of incentive and the program expenditure on marketing and promotion—the more you spend on the latter, the less you will need to spend on incentives, other things being equal.

Table 11: Broad Categories of Upgrade Program and Applicable Sectors

Program Category	Residential Property	Commercial Property		Industrial Property	
		Small	Large	Small	Large
Prescriptive programs Prescriptive programs that incentivize the purchase and installation of some or all of a set of pre-approved climate-related risk mitigation measures, arranged by residential, commercial, or industrial property owners.	✓	✓		✓	
Whole building, direct install programs Programs that provide a set of pre-approved climate-related risk reduction measures that may be installed at the time of a visit to the property or provided as a "kit" to the property owner, usually at modest or no cost to the property owner and sometimes accompanied by a rebate. These programs may also include a basic, walk-through assessment of climate-related risk.	✓	✓		✓	
Whole building, property assessment Programs that combine a comprehensive property-level risk assessment that identifies property-wide climate-related risk reduction opportunities. These programs generally involve multiple rebates for "bundled" risk reduction measures, looking for more substantive risk reductions.	✓	✓		✓	
Custom Programs designed around the delivery of site-specific risk reduction projects typically characterized by an extensive on-site climate-related risk assessment and identification and installation of multiple measures unique to that property. These measures may vary significantly from property-to-property.		✓	✓	✓	✓
Self-direct Programs that are designed and delivered by the property owner, using funds from the program administer			✓		✓

- **Marketing and promotion.**

  How will the program be marketed to potential participants? Developing a marketing and promotion strategy involves: • determining what channels (including the use of contractors) will be used to communicate program information to the target market; • developing marketing messages that will be effective for each market segment; and • estimating a budget for marketing activities. Marketing and promotion is an important determinant of program participation—for a given level

of incentives, increasing expenditure on marketing and promotion will increase program participation.

- **Implementation strategy.**

  What policies and procedures will govern program delivery? Prior to a program being launched, it is important to define procedures that will direct the participation process, incentive payment, and verification requirements. It is important to strike an appropriate balance between requiring sufficient documentation to validate the eligibility of property owners and the actions taken to reduce the risk of fraud, while keeping the process as simple and straightforward as possible to minimize barriers to participation. Policies and procedures governing program deliver are normally written up in a manual for program staff, as well as contractors supporting program implementation.

- **Incentive strategy.**

  Will the program offer subsidized financing or incentive payments to property owners or contractors to motivate purchases of eligible climate resiliency upgrades? Substantive evidence from years of energy efficiency programming suggests that a private property owners' decision to undertake retrofit investments depends on the net financial gain he or she accrues from the upgrade. Therefore, financial incentives provided through a program are expected to induce greater participation by property owners in upgrade activities by reducing the capital cost (and thereby improving the project's net present value).

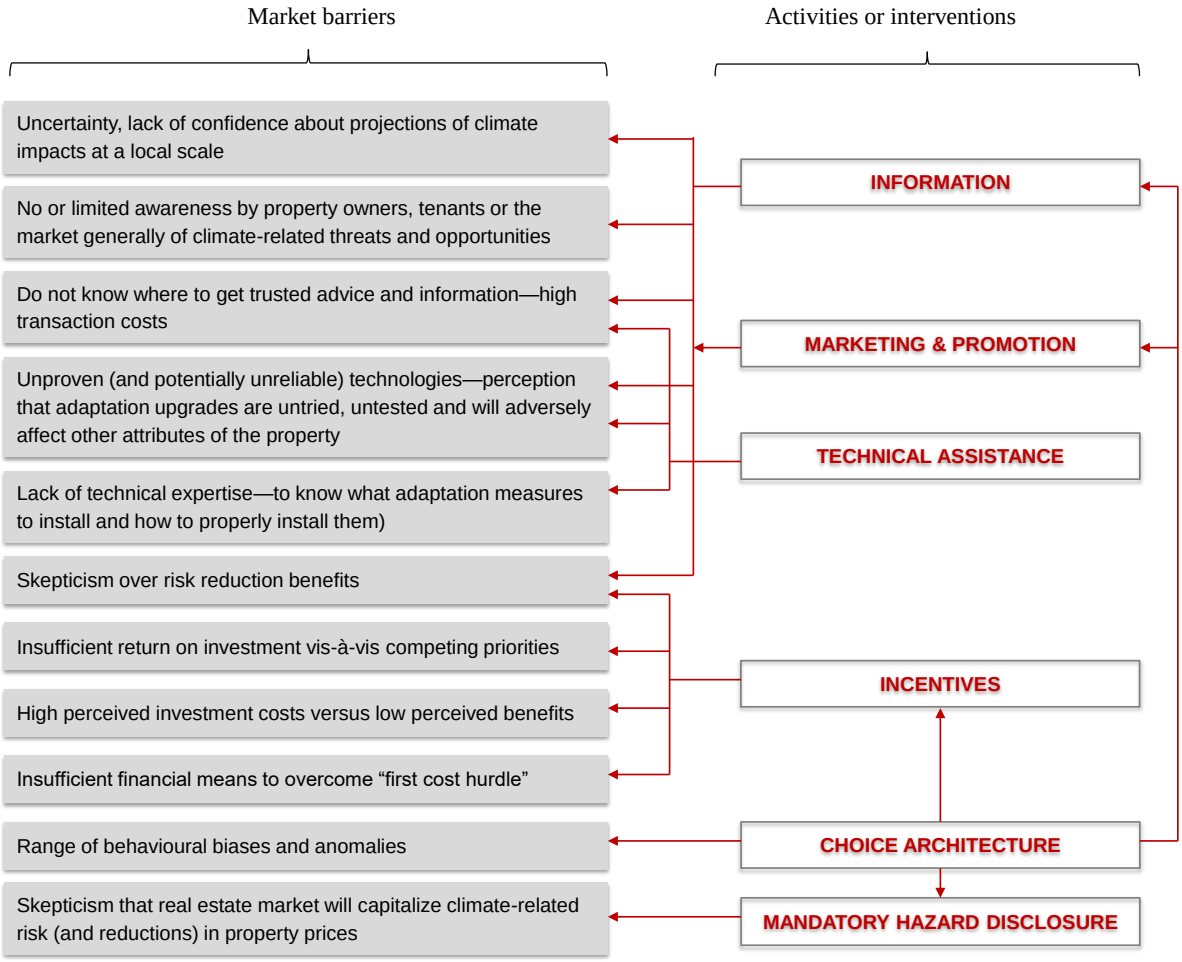
  Financial incentives can take many forms—e.g., prescriptive or custom (mail-in) rebates, discount coupons, free direct installation, soft loans, reduced mortgage rates, insurance premium discounts, building permit discounts, tax or charge credits, etc. The form of the incentive will largely depend on the capital source(s) for the program. Financial incentives can also be offered at different points in the market depending on the program model and objectives—e.g., upstream (builders), midstream (retailers), and downstream (property owners).

  Higher levels of incentives can also offered for "bundled" upgrades, where property owners install multiple risk reduction measures, as opposed to single measures.

- **Intervention strategy.**

  What activities will the program employ to address the most pertinent market barriers for the target market in order to increase adoption of climate resiliency upgrades by that market?

Example Intervention Strategy



- **Evaluation, measurement and verification.**

  What approach will be used to verify installations of climate resiliency upgrades (e.g., receipts, property inspection, etc.)? How will achievement of program goals be measured and evaluated? Information management systems are vital to these ends, as well as the efficient administration of the program. Tracking and reporting functions are used to assess program performance against goals, to monitor program expenditures in relation to budgets, and to manage information about program participants. Evaluators use the "tracked" data to assess program performance, in terms of its impacts.

- **Program budget.**

  What is the annual budget for the program as a whole, and what are the allocations for major activities (e.g., incentives, information, technical assistance, marketing and promotion, administration, delivery, evaluation)?

- **Timeline.**

  What are the main implementation milestones and when do they occur?

Box 9: Examples of Upgrade Programs to Manage Climate-related Risks

Examples of property-level upgrade programs to manage climate-related risks can be found in:

- Kovacs, P., Guilbaut, S. and Sandink, D., 2014, Cities Adapt to Extreme Rainfall, Institute for Catastrophic Loss Reduction (ICLR), Toronto, ON, Canada.
- GLA, 2009, Economic Incentive Schemes for Retrofitting London's Existing Homes for Climate Change Impacts, London Climate Change Partnership and the Greater London Authority (GLA), London, UK.
- Bowker, P., 2007, Flood Resistance and Resilience Solutions: an R&D Scoping Study, R&D Technical Report, Department for Environment, Food and Rural Affairs (DEFRA), London, UK.
- DEFRA, 2008, Resilience Grants Pilot Projects, Department for Environment, Food and Rural Affairs (DEFRA), London, UK.

Information on the US Department of Homeland Security's Resilience STAR™ Pilot Project is available at: https://www.disastersafety.org/resilience-star/.

6.5.3 Challenges

Key challenges to designing effective property-level upgrade programs for the purpose of climate change adaptation are:

- Free-riders are individuals or businesses who take advantage of a grant-based program even though they would have purchased and installed the resiliency measures anyway. Free-riders increase program costs without producing additional risk reductions in the community beyond what would have occurred without the program activities. Program designs should seek to minimize free-ridership—for example, by building on surveys of the target market and an understanding of existing adoption rates, by placing greater emphasis on financing as opposed to grants.
- In the context of energy efficiency, property owners typically need to see an estimate of the monetary benefits (i.e., annual and lifetime utility bill savings) that are anticipated to accrue to them from installing upgrades during planned renovations or as part of natural equipment replacement. This becomes part of their calculus of the net financial gain from installing the upgrades—a key determinant of whether they are likely to participate in a program. Quantified energy savings (in dollars) are also a key input to the cost-benefit tests (e.g., Participant Cost Test, Total Resource Cost Test) employed by program administrators to, among other things, determine which technologies are included in a program, and which programs are included in a portfolio. Quantifying the (private and social) monetary value of reductions in climate-related risks from installing resiliency measures on a property is not straightforward. This could present a significant challenge when it comes to convincing property owners to participate in the program. It also presents a challenge to defining eligible measures and setting incentive levels (see below).
- Levels of financial incentives in energy efficiency programs are usually set with a desired level of participation in mind, and adjusted (lowered) over time as penetration of the target market

increases. Since the net financial gain to a property owner is a key determinant of his or her participation in a program, financial incentives are often set to generate a target benefit-cost ratio (as measured by the Participant Cost Test) or target simple payback. Other things being equal, including marketing and promotion efforts, a specific benefit-cost ratio is anticipated to result in a specific level of participation. This is important for setting program goals and budgets, and managing free-ridership. Setting incentive levels, program budgets, participation targets, etc. will all prove very challenging if it is not possible to quantify the monetary value of reductions in climate-related risks.

- All eligible upgrades obviously must be consistent with relevant parts of the building code and other local government bylaws.

Recommendation 7:

The provincial government should fund and design a pilot program(s) to incentivize property owners in a narrow target market (e.g., single-family homes, multifamily homes or commercial buildings in areas prone to flooding risks, or wildfire risks) to upgrade their buildings, structures and land with climate resilient and resistance measures to mitigate specific climate-related risks. The pilot should offer "bundled" financial and non-financial incentives. Consideration should be given to testing the performance of different program models (e.g., prescriptive, whole building-direct install, whole building-audit led), as well as preferences for grants or financing incentives. The potential to partner on the pilot with the insurance industry should also be explored.

6.6 TRANSFERABLE DEVELOPMENT CREDITS

Case example 3 looks at flooding and the "redevelopment" stage of the real estate development process—i.e., the point in the process where decisions are required about reusing and improving an existing development. Redevelopment can range from tweaking the exiting site to a major reconfiguration of land, with the construction of an entirely new landscape and set of buildings and uses. Case example 3 assumes that the goal of government is to help markets provide appropriate price signals to property owners to encourage an optimal managed retreat strategy (see Box 10) from locations prone to (mainly) coastal and fluvial flooding. Addressing the question of whether such a policy is justified is beyond the scope of this project.[39]

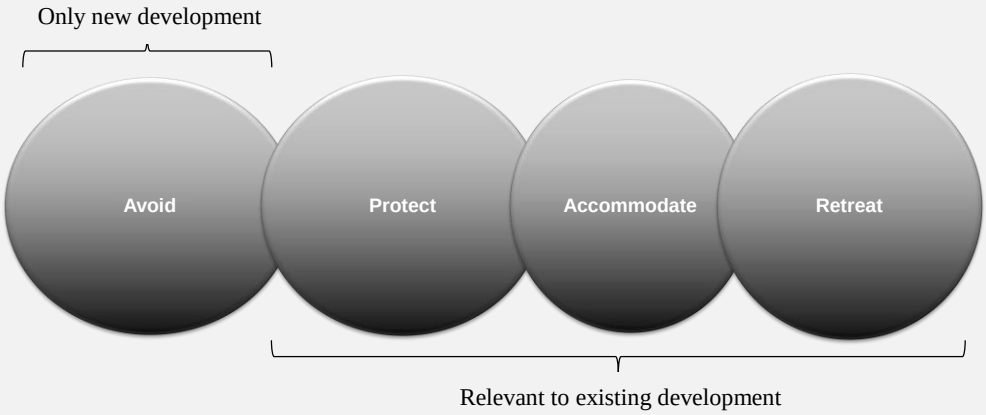
Transferable Development Credits are discussed below as a potential economic instrument to help provide private actors with sufficient incentives (price signals) to voluntarily retreat from high-risk flood zones when retreat is the preferred strategy on economic grounds. Though not the focus of this section, TDCs could equally be used to help avoid new development in high-risk locations.

[39] Managed retreat may be justified where, for example, the construction and maintenance costs of protection works are higher than the capital values of the assets to be protected, the wider community is either unable or unwilling to pay for the costs of maintaining protection works indefinitely, etc.

Box 10: What is Managed Retreat?

Managed retreat is one of four strategies to adapt to the impacts of sea-level rise and fluvial flooding, though it is mainly considered in the former context:

- **Avoid**--involves ensuring new development does not take place in areas subject to (current or future anticipated) flood and erosion hazards;
- **Protect**—involves reducing exposure of development to flood and erosion hazards using structural ("hard") and non-structural ("soft") protection methods;
- **Accommodate**—involves reducing exposure, sensitivity, or both to flood and erosion hazards by, for example, elevating houses, flood proofing buildings, drainage systems, etc.; or
- **Retreat**—involves moving people, property and infrastructure away from flood and erosion hazards.



Source: Adapted from BCMOE (2013)

6.6.1 What are Transferable Development Rights

Regulating private land use is primarily the responsibility of local governments. The chief means by which they do this is through zoning bylaws. Zoning establishes how private property owners can legally develop their properties, typically specifying, for example, whether land can be put into residential, commercial, or other uses. Zoning also regulates the intensity of use on a given parcel of land, such as the maximum number of dwelling units per acre.

However, zoning bylaws can be a blunt instrument for achieving many social and environmental objectives. The use of restrictive zoning to achieve conservation goals, for example, tends to reduce property values which means it may be contested by property owners. This usually results in some amount of low-density development being allowed. Lower property values also means reduced property

tax revenues. For these reasons, the use of restrictive zoning for conservation goals is not always embraced by local governments.[40]

Another way to achieve conservation goals without taking away the rights of private property owners is to establish a system of Transferable Development Credits (TDCs)—also called Transferable Development Rights (TDRs). TDCs, which can be used in combination with zoning, allow ownership of the development rights on a privately owned parcel of land to be separated from ownership of the parcel itself (Walls, 2012). The development rights can then be transferred from that property to another one in a different location. The property from which the rights are transferred—sold—is placed under easement or some kind of restrictions limiting development. The person to whom the rights are transferred—purchased—may subsequently use them to develop another piece of property more intensively than is otherwise allowed under its baseline zoning bylaw. In this way the property owner of the restricted parcel receives financial compensation for forgoing development and preserving his or her property. The area were development is restricted is called the "sending area" and the area to which the development rights are transferred to facilitate more intensive use is called the "receiving area".

Similar to other economic instruments, TDCs offer, in theory, a lower-cost approach to achieving conservation objectives than uniform zoning bylaws (Thorsnes and Simon, 1999). TDCs allow flexibility in development choices across property owners. This results in a situation whereby properties with the lowest opportunity costs (in terms of forgone development values) are preserved, and properties with the greatest development values are more intensively developed (Walls, 2012). TDCs have the added benefit in that they do not require public funding to compensate property owners for forgoing development on their land. All money changes hands between private property owners and developers in the marketplace for development rights that is created by the TDC program (Walls, 2012).

There are no examples to date of TDCs being used in Canada to facilitate managed retreat; two examples of municipalities using TDCs to conserve important heritage resources are provided in Box 11.

Box 11: Examples of TDC-like Programs in Canada

City of Vancouver: Transferable Heritage Density Bonuses

The goal of the program is to help protect important heritage resources. Under the program, if a developer agrees to rehabilitate and legally protect any heritage buildings within their development, the City of Vancouver may allow the developer to increase the density at that development or to transfer the bonus density to another development.

More information is available at: (http://vancouver.ca/home-property-development/density-incentives-for-developers.aspx)

City of Calgary: Heritage Density Transfer Incentive

Likewise, the goal of the program is to protect important heritage resources. Under the program, owners of "evaluated" historic resources may transfer unused density that is currently allowed at their historic property to other sites in the Downtown, if they agree to legally protecting their historic property. The bonus density can either be transferred to another property owned by the same individual or business, or transferred to another owner in the Downtown.

More information is available at: (http://www.calgary.ca/PDA/pd/Pages/Heritage-planning/Heritage-Density-Transfer-Incentive.aspx)

[40] In a climate change adaptation context, nonetheless, local government may have a different perspective, since reducing climate-related risk may reduce local government expenditures on emergency services, etc.

TDRs as an Adaptation Tool

TDCs are used most often by local governments to relieve opposition from existing property owners when attempting to preserve environmentally sensitive lands and habitat or when pursuing smart growth objectives—to channel development toward more compact urbanized areas with existing infrastructure. Many authors have suggested that TDCs be considered as part of a cost-effective managed retreat strategy—to mitigate (mainly coastal) flooding risk (Turbott and Stewart, 2006; Chang, 2008; Clinch and O'Neill, 2010; Grannis, 2011; Filatova, 2011 and 2013; Ward, 2013). However, no TDCs have yet been implemented for any purposes related to climate change adaptation (Ward, 2013).

In an application of TDCs to flood-prone zones, local government would restrict development in vulnerable areas and facilitate the transfer of development rights to upland areas where development will be out of harm's way or to areas that more defendable—where structural and non-structural protection and accommodation measures are still justified on economic grounds. TDCs thus function like a traditional "cap-and-trade" scheme used to reduce emissions of, for example, sulphur dioxide (like the Acid Rain Program in the United States) or greenhouse gases (like the Emissions Trading System in Europe). In the current context, a TDC would cap a socially acceptable level of flood risk and let the market distribute both the quantity and type of developments efficiently among zones delineated by distinct vulnerability profiles and socio-economic conditions (Filatova, 2013).

TDCs on their own do not constitute a cost-efficient managed retreat strategy; they need to be part of an instrument mix achieving two goals (Kousky, 2014):

- First, improve the market's efficiency in responding to sea-level rise, erosion, and flooding risks—by:[41]
    - Providing information, including hazard disclosure (Section 6.7);
    - Reforming perverse government subsidies for ongoing development in high-risk areas (Section 6.3); and
    - Altering property rights and incentives to relocate through TDCs; and
- Second:
    - Restricting structural and non-structural armoring on properties in high-risk areas (before relocation);[42] and
    - Enforcing bans on any new construction and building on parcels of land after relocation.

[41] Ward (2013) views flood damages as external social costs from developments in flood prone zones, while keeping land undeveloped is an external social benefit. A competitive land market ignores these costs. Thus, TDCs help internalize these externalities improving the efficiency of land markets (Filatova, (2013).

[42] Some shorefront or riverfront property owners will opt not to participate in a voluntary TDC scheme, believing they can adequately protect their property. Consequently, actual relocation within the sending area could be piecemeal, undermining achievement of the overall objective of minimizing social costs. Direct regulation of protection works on individual properties is needed, even when economic incentives to relocate can be created.

Furthermore, the context here is one in which managed retreat is the preferred strategy. Hence, all forms of protection should be prohibited, even non-structural armouring, which may be preferred over structural armouring if the chosen strategy were to "protect".

In general, if society and the Courts are reluctant to require property owners to completely abandon existing development to the sea or persistent fluvial flooding without some form of compensation, and local governments and taxpayers are reluctant to invest large sums of public dollars to compensate or protect private interests, then a TDC program may appeal to policy-makers.

6.6.2 Elements of a TDC Program

Most TDC programs have four common elements. When setting up a TDC program local governments need to establish (Turbott and Stewart, 2006; Greenaway and Good, 2008; Grannis, 2011; Walls, 2011; and Siders, 2013):

1. Sending and Receiving Areas

The sending area is the high-risk flood area which is targeted for managed retreat (from which people, buildings and public and private infrastructure will hopefully be "sent"). The no- or low-risk flood area(s) which will "receive" the transferred development rights, where increased development is permitted, is aptly named the receiving area. The designation of sending and receiving zones works in concert with zoning and other planning and regulatory tools.

The receiving area should be considered suitable from the perspective of both the developer who will purchase TDCs (i.e., the area must be desirable for building and having good market fundamentals) and the local authority (i.e., the area must have no or low climate-related risk and have suitable infrastructure and services). While TDC programs can be structured to work across jurisdictions, this does not happen often since the local government in the sending area would lose part of its tax base.

The maximum density allowed under baseline zoning at both the sending and receiving areas can exert a significant influence on the supply and demand for TDCs. Other things being equal, decreasing the maximum density allowed (downzoning) in the sending area increases the incentive of property owners to sell TDCs, since lower allowed density reduces the profits from redevelopment of the land. And decreasing the maximum density allowed in receiving areas increases the incentive of developers to purchase and use TDCs.

2. TDC Allocation Rate

The TDC allocation rate defines how many development rights property owners (individuals or businesses) in the sending areas are allowed to sell to individuals or businesses in the receiving area(s). The allocation rate is generally expressed in TDCs per acre of land. For example, the baseline zoning density in a sending area may be (say) 1 unit per 10 acres. Hence, a 100-acre parcel of land could accommodate up to 10 units (1/10 x 100). However, when setting up a TDC program the local government may allocate property owners in the sending area (say) 2 TDCs per 10 acres. This gives the property owner up to 20 TDCs to sell (2/10 x 100). The property owner now faces a choice: sell up to 20 TDCs to the receiving area; develop up to 10 units at the sending area; or something in between.

All else being equal, the higher the TDC allocation rate in relation to the baseline zoning density, the more incentive the property owner will have to sell his or her TDCs to the receiving area.

3. Density Bonus in Receiving Areas

Developers in the receiving area buy TDCs in order to build to a higher density than permitted under baseline zoning. The density bonus establishes by how much the developer can exceed the baseline density. For example, if the developer is allowed to build up to 2 units per acre using TDCs while the baseline density is up to 1 unit per acre, then the density bonus is 200 per cent.

If market conditions in the receiving area are such that building is constrained by density limits under baseline zoning, then establishing a higher density bonus can spur demand for TDCs (increasing their price).

4. TDC Requirements in Receiving Areas

In some programs the "exchange rate" between TDCs and dwelling units is 1:1. That is, developers at the receiving area need only surrender one TDC to build one additional dwelling unit. The exchange rate need not be 1:1, however. Developers can be required to surrender multiple TDCs to build a single dwelling unit at the receiving area. TDC requirements at the receiving area provide another mechanism for local governments to influence supply and demand for TDCs and thus prices.

All of the above program elements work together, and in conjunction with market fundamentals, to determine the demand and supply of TDCs and the market price for TDCs. Many (technical and legal) details would need to be worked out to design a functional TDC program to facilitate managed retreat from a high-risk flood zone ready for redevelopment (or, indeed, to discourage new development in high-risk areas).

Other Market Features

A number of other standard market features will influence the effectiveness of a TDC program for managed retreat (Walls, 2011):

- If the use of TDCs is not "by right" and developers must, for instance, also win approval from local governments before TDCs can be bought, sold or used, then they may be reluctant to participate in the program;
- If developers have other ways of obtaining density bonuses at the receiving area (through other local government programs), this will also reduce their incentive to participate in the program; but
- The presence of effective market infrastructure (e.g., brokers handle the deals, a TDC bank exists, price and transaction information is shared, etc.) will serve to encourage program participation.

6.6.3 Challenges

The implementation TDCs faces some significant challenges:

- Clearly, from the discussion above, TDC programs can be complicated to design and implement, and may require a fair amount of ongoing analysis and management to be effective. For instance, local governments need to have a good idea of housing and land market values at their existing zoning limits, if they are to understand the financial incentives that the TDC program should

provide property owners to participate. To this end, it is crucial local governments understand whether and where there is demand for additional density, as well as the value of the developed and undeveloped land in sending areas. Local governments also have a role to play in helping the market work by providing information (on price and transaction volumes), collecting and analyzing data from the program, and periodically participating in the market;

- Because TDC programs are inherently voluntary, policy-makers cannot be certain how many, and which, property owners will participate. Hence, program outcomes are uncertain. Local governments will therefore need to closely monitor TDC programs and make ongoing adjustments to program elements, as needed. This of course adds to the ongoing administrative burden. Moreover, uncertainty about future program rules acts as a deterrent to market participation;
- Most current applications of TDCs aim to control new development, not existing development. Practical and legal issues associated with using TDCs to control existing development at-risk from coastal and fluvial flooding hazards, where the objective is to remove existing buildings and structures in hazard areas, needs to be better understood;
- Legal questions may arise around whether zoning changes needed to support TDC programs violate property rights (legal entitlements), or affect them to the extent that some measure of compensation is needed; and
- In practice there may be limited opportunities to relocate buildings on the same property (one form of managed retreat) in a way that ensures any additional development on the property is risk free. The only option may be to relocate to another location.
- Consideration also needs to be given as to whether the primary goal of the TDC program is to (a) incent voluntary relocation from high-risk areas or (b) serve as a form of compensation to property owners mandated to relocate (in which case goal is really to shift the financial burden of mandatory relocation from the public to the private sector). If it is the former, the TDC program needs to provide a sufficient financial incentive to induce relocation. Creating a sufficiently high financial incentive may be a major hurdle, however, given the relatively high value of shorefront coastal property. For a TDC program to be effective—as a general rule—property in the receiving area needs to be more expensive than in the sending area. Several solutions to this hurdle are possible. Firstly, government may contribute some level of price support for TDCs in exchange for the program delivering public goods, such a natural coastal and riparian habitat. Secondly, more valuable coastal parcels may be exchanged for cheaper parcels in the receiving area via a more favorable allocation rate or an uneven "exchange rate" between sending and receiving areas. Thirdly, eliminating perverse subsidies, which boost development and prices in high-risk zones, will drive down coastal and riverfront property prices.

Recommendation 8:

The provincial government should consider updating the Local Government Act to allow local governments to use DPAs, or another regulatory tool, to facilitate managed retreat strategies in high risk coastal areas, by designating: (a) accommodation zones—areas where new (re)development is allowed, but with limits on density, limits on hard armoring, and requirements that structures and buildings be designed or upgraded to be more resilient flooding; and (b) retreat zones—areas where hard armouring is banned, the rebuilding of damaged structures and buildings is limited or banned, or the removal or relocation of structures and buildings that become inundated is required.

Recommendation 9:

The provincial government should conduct a feasibility study into the design and use of TDCs to support a strategy of managed retreat from high-risk flood zones, where "hold the line" and "remain in place" policies are unlikely to remain viable as the climate changes further. The study should also consider rolling (coastal) easements to the same ends.

Recommendation 10:

The provincial government and local governments should investigate regulatory options to restrict the construction of property-level structural ("hard") flood defenses by property owners, with the goal of identifying the most defensible approach. Such restrictions are a pre-cursor to an effective managed retreat strategy.

6.7 MANDATORY HAZARD DISCLOSURE IN PROPERTY TRANSACTIONS

6.7.1 What is Mandatory Hazard Disclosure

Disclosure in private real estate transactions involves the seller providing certain information to potential buyers either before or at the time of transfer. Prior to the emergence of disclosure *caveat emptor*—buyer beware—was the accepted maxim. Since 1991 the BC Real Estate Association (BCREA) *requires* its members to disclose deficiencies and other material facts about listed property to prospective purchasers—e.g., structural defects, asbestos, underground storage tanks, etc., but not exposure to climate-related hazards (The Arlington Group, 2014). The information is conveyed to buyers using Property Disclosure Statements (PDSs). A PDS is not required by law, however. It is also not a legally-binding warranty of a property's condition, but simply a report of what the seller knows about the property (BCREA, 2015).

The public policy objective underlying mandated disclosure of certain information is to mitigate asymmetric information, reduce search costs, and remedy the under-provision of information-based public goods. In terms of market efficiency, if prospective buyers are unaware of potential defects or the vulnerability of a property to natural hazards including extreme weather events, their bids will not accurately reflect the true costs and risk associated with that property and its location. Inadequate or asymmetric information in transactions can lead buyers to pay more than their purchase is truly worth to them when evaluated with perfect information, producing an inefficient outcome—i.e., their maximum willingness-to-pay for the property is lower with perfect information than it is in the absence of perfect information. It can also produce misallocations of land by giving distorted price signals to market actors

that potentially lead to overdevelopment of areas exposed to major natural hazards (Troy and Romm, 2006).

With climate change increasing the frequency, intensity and geographical distribution of extreme weather events and related hazards, and with increasing pressure for development in floodplains and other vulnerable areas, the mandatory disclosure of natural hazards in private real estate transactions—in addition to existing disclosure obligations—is becoming more commonplace. For example, in 1998, California passed the Natural Hazard Disclosure Law (AB 1195), which mandates sellers of a residence in statutory flood, wildfire, and seismic zones to inform potential buyers of the hazards that may affect the property by making available a written Natural Hazard Disclosure Statement before the sale is completed (Troy and Romm, 2006). Questions relating to natural hazard vulnerabilities have also been included in the existing disclosure forms in many other states—e.g., Alaska, Hawaii, Florida, Idaho, Oregon and Washington (Englin, 2006).

A well-designed mandatory hazard disclosure policy can produce several beneficial outcomes:

- Increased public awareness and understanding of natural hazards, including extreme weather events;
- Improved public health, safety, and welfare;
- Better decision-making by buyers;
- More efficient real estate market outcomes—e.g., reduced development in vulnerable areas;
- Increased consumer protection;
- More effective regulatory and economic instrument targeting private real estate decisions; and
- Increased motivation for property owners (buyers and sellers) to protect their property against natural hazards.

The effectiveness of mandated disclosure statements in delivering these outcomes will be limited, however, if buyers and sellers do not understand the information provided, believe that it is not relevant to their decision-making, or do not know how to access or use it. There is also an underlying assumption that buyers are rational when making decisions. As a result, it is important that policy-makers bear in mind the discussions in Section 5.5 and Section 6.8.2 when designing a disclosure policy.

Box 12: Summary Impacts of California's Natural Hazard Disclosure Law (AB 1195)

Based on an analysis of 20,000 housing transactions that took place in 63 urban and rural zip codes across California between January 1997 to February 2000, Troy and Romm found:

Flood-hazard disclosure

Before AB 1195 the average floodplain home sold for the same amount as a comparable non-floodplain home, but after AB 1195, a floodplain home sold for 4.1% less than a comparable non-floodplain home. This suggest a clear price effect from flood-hazard disclosure.

Fire-hazard disclosure

The price effect of fire-hazard disclosure is more complicated to decipher. Location in a state-level statutory fire zone is associated with a 3% *positive* price premium, both before and after AB 1195. However, the combination of proximity to a recent fire and post-AB 1195 disclosure does have a negative effect on the selling price. If a home in a statutory fire-hazard zone is within five kilometers of the site of a major fire that occurred in the last five years, it sold for 5.1% less after AB 1195's implementation than a comparable home in a statutory fire zone that is not near the site of a recent fire.

While AB 1195 does not appear to have induced a noticeable general decrease in home prices in fire-hazard zones, it does appear to have reduced prices somewhat in statutory hazard zones near the sites of recent major fires. Hence, it is not solely disclosure, nor solely being near the site of a recent fire, but rather their combination that results in reduced home prices.

Source: Troy and Romm (2006)

6.7.2 Key Design Issues

The design of mandatory private hazard disclosure policies needs to address several issues (this section is based largely on Englin, 2006):

Types of Hazards

What types of climate-related hazards should be disclosed, and to what extent should the influence of climate change on those, or new, hazards be captured? Examples of natural hazards that have been included in hazard disclosure statements are: flooding (including dam failure), forest fire risk, landslides and storm surge. This will largely be determined by what hazards are covered by existing legislation—adequate information and hazard maps are more likely to already be available for hazards covered by legislation.

Where hazard maps are available, a further important question is whether they should be used as a screening device for more detailed on-site investigations or are they an end to themselves.

Presentation

When must a seller disclose the hazard statement and how long afterward does the buyer have to rescind their offer? Timing of disclosure is important as the later in the process disclosure occurs, the less weight the disclosure will have in the buyer's purchasing decision. Hazard disclosure is generally mandated to occur shortly after a buyer places a purchase offer. Conversely, buyers must be given adequate time to respond to the disclosure statement and to rescind their offer if desired.

Another related question that must be addressed is who will be responsible for presenting the disclosure statement to the buyer—seller or realtor? Decisions will also be required about the format and text of the disclosure statement, and whether it will be provided separately from other obligated disclosures.

Flexibility

Climate-related hazards will vary by local government area, and often across locations within these areas. This suggests the need for the disclosure legislation (if province-wide) to be based on minimum standards that local governments are permitted to modify to suit their unique circumstances. For example, will a local government be allowed to add a hazard not included on the form, but that is important in their area, or remove a hazard on the form that is not relevant to their area?

Decision Support

Buyers will very likely need help understanding and interpreting the disclosed information, as well as tuition on how to use if effectively to make better choices. Decisions will therefore be required on how and what supplemental educational material will be provided to buyers.

Types of Properties Included

It is necessary to define the types of properties that the disclosure statement must be prepared for. The main question is whether the disclosure law applies to developed land only (e.g., single-family and multi-family family dwellings) or also to undeveloped land. Including the latter would afford developers the opportunity to learn early on in the development process which hazards are germane and thus require risk mitigation measures.

Source of Information

Where will the information come from to complete the disclosure statement? In some cases, the information disclosed is based solely on the seller's knowledge. But in California, for example, the information provided in the disclosure statement must be drawn from approved state and federal sources. In the California system third party consultants are often used to complete the forms. In other disclosure schemes it is usually the seller. When deciding on the sources of information to underpin the disclosure policy it is important to bear in mind the capacity of individuals and businesses to collate the required information on their own.

Eligibility and Exemptions:

What types of properties will be exempt from mandatory disclosure? Exemptions may include property that has never been occupied, sale to a co-owner, sale to a family members, and bankruptcies or foreclosures.

6.7.3 Challenges

Key challenges for an effective mandatory hazard disclosure policy for private real estate transactions include:

- New legislation or amendments to existing laws and regulations may be required, requiring industry wide consultation. Relatedly, it may be necessary to implement a province-wide policy—local schemes may distort real estate markets between local government areas.
- Sources of information related to natural hazards, and the effects of climate change on those hazards, are incomplete, non-existent and/or not readily available. For example, flood hazard maps do not exist for many areas, and where they do exist, are potentially outdated and inaccurate, and do not reflect the impact of climate changes on hazards. The seller's knowledge cannot be relied upon to provide adequate hazard disclosure information;
- Buyers, sellers, realtors and other sector professionals have concerns about the accuracy and temporal relevance of available maps and other information. To allay these fears, it is important that maps and information are: • accurate and based on a relevant geographical scale; • based on valid scientific information; and • regularly and appropriately updated to reflect the latest understanding of climate change;
- People do not always make better decisions when provided with more complete information (as the discussion in Section 5.5 highlights). For example, when disclosure is presented late in the buying process the purchaser may already have formed an emotional attachment to the property that will reduce the impact of the disclosed information;
- In some regions, demand for housing is so great that potential hazards receive little or no consideration in the decision-making process; and
- People are often overwhelmed by information when purchasing a home and are not motivated to take the extra step to inform themselves about natural hazards.

Recommendation 11:

The provincial government should work with the BC real estate sector to incorporate mandatory hazard disclosure statements within real estate transactions. The BC Real Estate Association (BCREA) requires its members to disclose deficiencies and other material facts about listed property to potential purchasers—e.g., structural defects, asbestos, underground storage tanks, etc. The BCREA could expand its disclosure statement requirements to include climate-related hazards or previous DFA assistance.

Recommendation 12:

The provincial government should consider amending Section 14 of the Real Estate Development Marketing Act to include mandatory disclosure of natural hazards in disclosure statements. Disclosure statements should indicate whether the property is situated in a known (or potentially active future) floodplain, avalanche path, earthquake zone or wildfire risk area, whether it has been affected by climate-related impacts in the past, and whether any hazard mitigation measures have previously been undertaken. To support effective hazard disclosure, the provincial government would need to provide readily available and easily accessible information on natural hazards to buyers and sellers.

6.8 CHOICE ARCHITECTURE

6.8.1 What is Choice Architecture

The policy tools discussed above to improve market outcomes all aim to change or shape the behaviour of private actors. The planning and regulatory tools in Section 6.2.1 compel private actors to act in certain ways. While these "command-and-control" instruments can be very effective, they are relatively costly. As a result, policy-makers are increasingly looking to less coercive and costly, yet still effective, economic instruments, such as financial incentives (e.g. subsidies, taxes, etc.) and non-financial incentives (e.g., information provision).

So, why do we need to consider more tools like choice architecture? Instruments, such as incentives and information, are intended to change behaviour by "changing minds". The assumption is that if policy-makers provide the "carrots" and "sticks", in conjunction with accurate information, private actors will weigh up the revised costs and benefits of their choices and respond accordingly. However, the discussion of behavioural failures in Section 5.5 suggests otherwise. Private actors do not always respond to incentives in a "perfectly rational" way.

This observation has given rise to alternative, equally effective, tools that policy-makers can use to influence our behaviour. These new tools focus on "changing contexts"—i.e., the environment within which we make decisions and respond to incentives. This environment in which private actors choose and make decisions is referred to as the "choice architecture". A "choice architect" has the responsibility for creating that environment. And where our behaviour changes in response to some aspect of the choice architecture which surrounds us, we are said to have been "nudged" (Thaler and Sunstein, 2008). A nudge excludes legislation, regulation and interventions that alter economic incentives (Marteau, et al., 2011).

By designing policy more closely around how our behaviour is actually influenced, the tools of the choice architect offer a potentially powerful way to enhance the impact of economic instruments, significantly improving policy outcomes, and at lower cost than using policy tools in the conventional way. For example, choice architecture can be used to overcome cognitive constraints to the processing of costs and benefits and thereby help financial incentives be more effective.

6.8.2 Tools of the Choice Architect

Choice architects (i.e., the person or persons responsible for designing economic instruments) can influence decisions in many ways—essentially by explicitly or implicitly harnessing the decision biases and anomalies in Table 9. Below we provide examples of the tools available to a choice architect to mitigate behavioural failures and enhance the cost-efficiency of economic instruments. It is beyond the scope of this project to describe these tools in any detail; our intention is solely to highlight key issues that policy-makers should think about and study when designing economic instruments.

The listed examples are drawn from the following sources: Alcott (2011); Baddeley (2011); Bénabou and Tirole (2006); Camerer, et al. (2005); Dawnay and Shah (2005); Dolan, et al. (2014); Frey and Jegen (2001); Gneezy, et al. (2011); Iyengar and Lepper (2000); Johnson, et al. (2012); Kamenica (2012);

Madrian (2014); Productivity Commission (2008); PSI (2006); Savage, et al. (2011); Shafir and Thaler (2006); Shogren (2012a and 2012b); Thaler and Sunstein (2008); Tversky and Kahneman (1981b).

- **Messenger**. Private actors can be influenced by who communicates information.

Nudges

We are more likely to act on climate impact and adaptation information delivered by someone:

- In authority;
- Perceived to be an expert;
- From a similar demographic or socio-economic group;
- From our peer group;
- We like; and
- Who provides a consistent message across all situations.

- **Salience**. Private actors are drawn to what seems most relevant to them. Our behaviour is strongly influenced by what our attention is immediately drawn to.

Nudges

When facing a decision in an information rich environment, we tend to filter out much information and focus our attention on information that is:

- Novel (unique, catches our eye);
- Accessible (right in front of us);
- Simple to understand (snappy and does not need to be deciphered); and
- Relevant (relates to our situation or experience).

- **Anchoring**. Private actors may use an initial reference point (or "anchor") in estimating the value of a decision.

Nudges

By manipulating anchors, and thus by adjusting the initial points of reference, policy-makers can nudge people towards a more desired adaptation decision. For example, a not-for-profit that funds assistance to households affected by extreme weather events could benefit from "nudging" the anchoring point: if the options for donation were adjusted from (say) $5, $10, $20, $50, $100 or other amount to (say) $25, $50, $100, $125, $150 or other amount. A donation campaign based on the second set of options will "nudge" people to donate more that they originally would have with the first set of options, even though they still have the option of donating less.

The manipulation of anchoring points may also be used to influence the outcomes of negotiations (say) when purchasing (rolling) conservation easements—the first value suggested, even if totally arbitrary, will influence the final outcome.

Policy-makers can also draw attention to the revised anchoring points by making them salient to the decision-maker.

- **Defaults**. Private actors will engage in as little active choice as possible. The default option is chosen more often than might be expected.

Nudges

The (no-action) default option can be structured to influence behaviour to achieve policy objectives without limiting individual choice. Use "opt-out" as the default option (and define the "opt-out" option as the desired risk reduction behaviour), thereby making "opt-in" (not undertaking the desired behaviour) the active choice for people. This will increase take up of the risk reduction behaviour. Moreover, this approach will prove most effective when the choice in question requires mentally taxing decisions.

Compelling people to make an active choice about whether to efficiently adapt also counters procrastination.

- **Incentives**. Private actors will contribute to social good if we are sure that others will do the same.

Nudges

Designing incentive schemes that reward cooperation among property owners will prove effective—individuals are more like to adopt an adaptation behaviour if others do likewise. In the context of managed retreat, for example, an effective instrument may use a smart subsidy that creates an explicit network externality between neighbouring properties by paying an additional agglomeration bonus when individual property owners retire land adjacent to other retired land, creating a continuous buffer zone against sea-level rise.

- **Priming**. Private actors' behaviour can be affected if they are first exposed (or "primed") to certain words, sensations and sights.

Nudges

Policy-makers can "prime" people to make desirable choices to mitigate climate-related risks through the judicious use of:

- Words—exposing people to words relating to drought (e.g., "desiccated rivers", "water rationing") often enough, and they will likely start to behave as if they are experiencing a drought (e.g., conserve water); and
- Visual cues—adding a happy or sad (happy) face to a water bill coveys social approval (disapproval) of water efficiency and conservation efforts; and

Also, important that policy-makers identify ways in which decision-makers are being primed unintentionally, in ways that induce maladaptive behaviours.

- **Affect**. Emotions can be powerful in shaping the behaviour of private actors.

Nudges

We experience different emotions on a daily basis, and these can exert a strong influence on decision-making. Words, visual cues, and salient events can be used by policy-makers to induce an emotional reaction that influences judgements. For example, embedding images that evoke "happy feelings" (e.g., children play in river or lake) along with the factual information you want people to act on (e.g., consequence of, and responses to, drought) can increase take up of the desired behaviour (e.g., water efficiency and conservation).

If attempting to elicit "fear" in order to change risky behaviours, be aware that:

- Creating fear without making an obvious connection to behavioural changes to reduce the source of the fear can prove counterproductive; and
- People can build up a tolerance to messages designed to shock, which can eventually reduce their effectiveness.

- **Social norms**. Private actors can be influenced by the actions of those around them.

Nudges

Social and cultural norms can result in behavioural expectations, which can be used by policy-makers to create the perception of social penalties for undesirable maladaptive behaviours and social rewards for efficiency adaptive behaviours.

- If the norm is a desirable adaptation behaviour, then let your target audience know about it;
- Relate the norm to your target audience as much as possible—tell them what other, similar people do in the exact same situation;
- If the desired effects are to become self-sustaining, then continue to tell the target audience about the norm—one touch is not enough;
- Be careful telling people about maladaptive norms (e.g., household water consumption)—it may encourage people who are doing better than the norm (consuming less water than the average household) to ease up on their good behaviour (and increase water use).

- **Incentives**. Private actors live for today at the expense of tomorrow.

Nudges

People heavily discount the distant future when sacrifices are required in the present. Consequently, temporally proximate (dis)incentives will have a much greater impact on behaviour than future (dis)incentives.

For example, providing incentives for desired behaviours through the tax code (tax credits), which inevitably necessitates a temporal delay, may not provide sufficient motivation to induce behavioural change. Similarly, the incentive package of a building upgrade program should, if possible, be devised to: (a) avoid or reduce up-front expenditures by individuals; (b) avoid or reduce paperwork and processing times; and (c) provide individuals access to tools or decision aids to ease the selection of the best action. In the context of (a) requiring individuals to pay for upgrades in cash (and later file for a rebate) involves a salient loss—as cash must be handed over.

Including deadlines or expiration dates in incentive schemes (or other interventions requiring active choice) can also help overcome procrastination—a further consequence of living for today at the expense of tomorrow.

- **Commitment**. Private actors seek to be consistent with their public promises, and reciprocate acts.

Nudges

Commitments that allow people to meet self-set goals are used to overcome self-control problems and procrastination (inertia). Providing incentives that encourage people to "pre-commit" is an effective way to overcome decision inertia—e.g., the provision of subsidies which are dependent upon persistent achievement of goals.

Commitment devices are usually more effective as the costs of failure increase. Policy-makers should thus look for ways to increase such costs—one way is to make commitments public. In this case, breaking the commitment will lead to reputational damage. The use of "contracts" is also a useful device to ensure people follow through on their commitments.

Furthermore, people are also more likely to commit to doing something if others also do the same. Policy-makers should look for ways to take advantage of such reciprocity effects when designing incentives—e. g., incorporating some form of community-wide feedback mechanism so people are aware what others in the same social group are doing.

- **Incentives**. Private actors prefer less choice to more choice.

Nudges

People do not like feeling helpless and out of control and, when they feel this was, they feel incapable of doing anything. Too much choice and information can lead to a feeling of helplessness and in turn inaction.

One way of dealing with a large choice set is simply to reduce the number of available adaptation actions. However, this has some undesirable consequences, including increasing the chances of not offering options that match the preferences of property owners.

Another option is to start with a limited set of adaptation actions (four or five non-dominating options), but provide the decision-maker with the option of considering more actions, if desired.

Policy-makers may also consider the use of technology and interactive decision aids designed to help decision-makers readily compare multiple choice alternatives in terms of their attractiveness on various feature dimensions.

In presenting choices, policy-makers should look for ways to help people believe that they have it within their power to change their behaviour in the desired ways.

- **Incentives**. Private actors are motivated to "do the right thing".

Nudges

Policy-makers should consider how people perceive the behaviour they are trying to change:

- If the behaviour is normally considered "the wrong thing to do", it might be counter-productive to introduce punishments (e.g., a tax, charge, fine, etc.). Attaching punishments to undesired behaviours can legitimize those behaviours in the mind of individuals (having "paid" for their misdeed they have a clean conscience and can continue with the undesired behaviour); and
- If it is normally considered the "right thing to do", it might be counter-productive to introduce financial rewards. Providing monetary incentives for desired behaviours that people normally feel good about doing in any event, can reduce their intrinsic motivation and lead to lower effort relative to having no monetary incentive at all.

When formulating adaptation incentives policy-makers should also appeal to people's sense of fairness. Most people we will contribute to social good if they are sure that others will do the same—and be punished if they do not. Incentives designed to reward cooperation can be effective (see below).

- **Incentives**. Private actors overweight small probabilities.

Nudges

Though not a strictly a "nudge", the fact that people tend to overweight low-probability events and underweight medium- to high-probability events suggests that lottery-like incentives may prove more effective at motivating behavioural change than conventional linear financial incentives. Lottery-like incentives seek to take advantage of the fact that: when faced with two payments of equivalent expected value—a small guaranteed payment and a much larger uncertain amount with a low probability of payment—people will prefer the latter because they overweight the low probability of the uncertain payout, believing it has a higher expected value than it really does.

Lottery-like incentives have been used successfully in the context of human health.

- **Incentives**. Private actors prefer avoiding losses rather than acquiring equivalent gains.

Nudges

Incentives to change behaviour will prove vastly more effective when framed as a loss (property owners will be charged if they fail to do something or they start with a reward and are then told they will have to give it back if fail to act as desired) than when framed as a gain (property owners are told that if undertake the desired action they will receive a financial reward). Loss-averse individuals dislike price increases (from the imposition of a tax) more than they like equivalent gains from price cuts (from the introduction of a subsidy).

Policy-makers should emphasise what property owners will lose by not taking an action to mitigate climate risks, rather than the amount they could save (the reduction in damage costs).

Recommendation 13:

The provincial government should consider producing a guide to the use of choice architecture that policy-makers at all levels of government could consult when designing interventions to promote desirable adaptation actions and behaviours. The guide should inform the use of choice architecture to both: (a) directly induce desirable adaptation behaviours; and (b) to enhance the cost-efficiency of economic instruments to the same ends. Relevant case examples will need to be developed to support the guide—currently most real world examples relate to health outcomes, savings behaviour and energy use. Consideration could also be given to making the guide applicable to climate risk management in general, including carbon and energy management

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 TOOLKIT TO INFLUENCE ADAPTATION DECISIONS

Policy-makers in BC face a situation in which some private actors in the real estate sector currently choose a high-risk, low-resilience development path (I), when a low-risk, high-resilience development path (II) is the more socially desirable outcome (recall Figure 1). In this report we identify four sets of individual tools to encourage those private actors to shift from path I to path II.

7.1.1 Tool Set 1: Planning and Regulatory Tools

Bylaws, covenants, restrictions, compliance rules, and similar forms of regulation impose behavioural constraints that private actors are compelled to comply with. In the current context, regulations could be imposed simply making path I unavailable.

7.1.2 Tool Set 2: Economic Instruments—Financial Incentives

Taxes, charges, subsidies, fiscal reform, insurance, and marketable (tradable, transferable) permits, rights, or quotas are all examples of economic instruments that provide financial incentives to private actors. Taxes and charges exert a negative influence and discourage undesirable, maladaptive behaviour. Subsidies exert a positive influence, encouraging desirable adaptation choices. Marketable permits, rights, or quotas can exert either positive or negative influence over behaviour.

Financial incentives can work well if private actors habitually weigh the costs and benefits of their decisions. In the current context, financial incentives could be used to adjust the relative costs and benefits of path I vis-à-vis path II in favour of path II, but still leave the private actor free to choose either path based on his or her own assessment of the revised costs and benefits.

7.1.3 Tool Set 3: Economic Instruments—Non-financial Incentives

Information and education tools work to change the behaviour of private actors through the provision of greater or more accurate information, or by changing the distribution of information—i.e., making information which may be available to some actors available to others who need it. Examples of these tools include: information and education campaigns, labelling requirements, or requirements to disclose other information to the market. Government can require information to be disclosed, encourage information provision, or simply collect and make the information available itself. Once a private actor is provided with relevant information, it is assumed that he or she will incorporate this knowledge into their decision-making and make informed decisions more in line with social objectives. In the current context, information could be provided that leads a private actor to revise their assessment of the relative costs and benefits of path I vis-à-vis path II in favour of path II. Similar to financial incentives, the private actor remains free to choose either path based on his or her own assessment of the revised costs and benefits.

7.1.4 Tool Set 4: Economic Instruments—Choice Architecture

As an alternative to explicitly telling private actors what they can or cannot do, or to providing them with financial or non-financial incentives to induce behavioural change, choice architecture can be used to influence behaviour by changing the context in which decisions are made. By harnessing the decision biases and anomalies arising from common behavioural failures, the choice architect can "nudge" private actors toward more socially desirable behaviours. In some contexts, the tools of the choice architect (e.g., defaults, priming, commitments, messenger, etc.) may have a significant direct impact on behaviour. The same tools can also be employed to enhance the cost-effectiveness of other economic instruments.

In the current context, the tools of the choice architect may be used to help a private actor improve information processing and overcome cognitive constraints when assessing the relative (revised) costs and benefits of path I vis-à-vis path II, inducing a preference for path II. As with the other economic instruments, the private actor remains free to choose either path based on his or her own assessment of the relative costs and benefits.

7.1.5 Tool 5: Instrument Mix

In many situations a combination of these tools will be needed to induce socially optimal adaptation decisions by private actors in the real estate sector. Indeed policy-makers generally make economic instrument choices in the context of pre-existing planning, regulatory and fiscal systems where various institutional and political factors constrain their options. This reality often leads to "layering", whereby existing policy tools are reformed to support the introduction of new instruments to the established mix of planning, regulatory and fiscal instruments.

The instrument mix that the provincial government and local governments in BC may use to induce socially optimal adaptation decisions by private actors in the real estate sector is presented in Table 12. The table also shows how each tool could contribute to improved climate adaptation decisions in each of our case examples.

7.2 RECOMMENDATIONS

In this section we offer recommendations that would support the development and use of the economic instruments discussed in Section 0 to induce more socially desirable adaptation choices in private real estate decisions. The recommendations target both the provincial government and local governments in British Columbia.

1. The provincial government should reform (e.g., reduce, restructure, or eliminate) the perverse subsidies that fuel the self-reinforcing cycle of continued growth in coastal or riverfront zones prone to flooding (recall Section 6.3.2). Interrupting this cycle is necessary if private property owners are to bear all the costs of their investment and divestment decisions in high-risk flood areas. Development in high-valued, risky areas may still occur, but development in economically marginal areas would cease.

Table 12: Toolkit to Influence Adaptation Choices by Private Actors in Case Examples

Tools	Example 1 Development Plans	Example 2 Property Upgrades	Example 3 Managed Retreat
Planning and regulatory tools:			
Official Community Plans (OCPs)	✓	✓	✓
Hazard mapping	✓	✓	✓
Zoning	✓		✓
Subdivision	✓		✓
Development Permit Areas	✓	✓	✓
Building code		✓	
Setbacks and buffer zones	✓	✓	✓
Permitting restrictions	✓	✓	✓
Acquisitions and buyouts	✓		✓
Easements, conservation easements, rolling conservation easements and restrictive covenants	✓		✓
Economic instruments:			
Fiscal reform – property transfer tax (PTT)		✓	✓
Fiscal reform – government transfers			✓
Development Cost Charges (DCCs)	✓		
Property-level upgrade programs		✓	
Transferable Development Credits (TDCs)	✓		✓
Mandatory hazard disclosure	✓	✓	✓
Choice architecture	✓	✓	✓

Note: An arrow (✓) by a case example indicates that the tool has a role to play in promoting good adaptation decisions by private actors in the real estate sector. The list of economic instruments in the table is not meant to be exhaustive; there are other instruments not discussed in this document that could plausibly be used to promote sound adaptation decisions by private actors at different stages of the real estate lifecycle. The intention of the study is not to review and evaluate all possible instruments, but rather to identify 3-6 options.

2. The provincial government and local governments should investigate the case for reforming the property transfer tax so that: (a) it does not "lock-in" private property owners to high-risk areas; and (b) does not act like a deterrent to property owners to undertake improvements that increase the resiliency of their property to climate hazards (e.g., by offering a tax credit for such improvements).

3. The provincial government should fund and design a pilot program(s) to incentivize property owners in a narrow target market (e.g., single-family homes, multifamily homes or commercial buildings in areas prone to flooding risks, or wildfire risks) to upgrade their buildings, structures and land with climate resilient and resistance measures to mitigate specific climate-related risks. The pilot should offer "bundled" financial and non-financial incentives. Consideration should be given to testing the performance of different program models (e.g., prescriptive, whole building-direct install, whole building-audit led), as well as preferences for grants or financing incentives. The potential to partner on the pilot with the insurance industry should also be explored.

4. The provincial government should undertake a study into the feasibility of using a two-part DCC, with a "risk charge" to capture the estimated net damage costs (in present value terms) of climate change at each new development site, and how these costs vary with different levels of adaptation. Is it possible to construct a DCC that varies along a "risk-gradient", in much the same way as charges are currently constructed to vary along a density-gradient (for the purpose of promoting smart growth)? Alternatively, the same study could be conducted with respect to annual property taxes.

5. Local governments should provide the option for delayed or staggered payment schedules for DCCs, in exchange for commitments by developers to mainstream socially desirable, site-specific adaptations to climate change in their development plans.

6. The provincial government should consider amending DCC legislation to allow for the recovery of the life-cycle costs of infrastructure necessitated by new developments, and expand the list of eligible services to include investment in climate-resilient measures. The provincial government should also develop guidance for local governments on how to calculate the life-cycle costs of services affected by climate change.

7. Local governments should remove internal "cultural and institutional" barriers preventing DCCs from being used as both (1) a planning and adaptation tool and (2) a fiscal tool (e.g., increasing cooperation and communication between planning, financing and engineering departments, as well as educating them on the potential role of DCCs as an incentive mechanism).

8. The provincial government should work with the BC real estate sector to incorporate mandatory hazard disclosure statements within real estate transactions. The BC Real Estate Association (BCREA) requires its members to disclose deficiencies and other material facts about listed property to potential purchasers—e.g., structural defects, asbestos, underground storage tanks, etc. The BCREA could expand its disclosure statement requirements to include climate-related hazards or previous DFA assistance[43].

[43] Both this recommendation and the one below where put forth by The Arlington Group (2014).

9. The provincial government should consider amending Section 14 of the *Real Estate Development Marketing Act* to include mandatory disclosure of natural hazards in disclosure statements. Disclosure statements should indicate whether the property is situated in a known (or potentially active future) floodplain, avalanche path, earthquake zone or wildfire risk area, whether it has been affected by climate-related impacts in the past, and whether any hazard mitigation measures have previously been undertaken. To support effective hazard disclosure, the provincial government would need to provide readily available and easily accessible information on natural hazards to buyers and sellers.
10. The provincial government should consider updating the *Local Government Act* to allow local governments to use DPAs, or another regulatory tool, to facilitate managed retreat strategies in high risk coastal areas, by designating: (a) accommodation zones—areas where new (re)development is allowed, but with limits on density, limits on hard armoring, and requirements that structures and buildings be designed or upgraded to be more resilient flooding; and (b) retreat zones—areas where hard armouring is banned, the rebuilding of damaged structures and buildings is limited or banned, or the removal or relocation of structures and buildings that become inundated is required.
11. The provincial government should conduct a feasibility study into the use of TDCs to support a strategy of managed retreat from high-risk flood zones, where "hold the line" and "remain in place" policies are unlikely to remain viable as the climate changes further. The study should also consider rolling (coastal) easements to the same ends.
12. The provincial government and local governments should investigate regulatory options to restrict the construction of property-level structural ("hard") flood defenses by property owners, with the goal of identifying the most defensible approach. Such restrictions are a pre-cursor to an effective managed retreat strategy.
13. The provincial government should consider producing a guide to the use of choice architecture that policy-makers at all levels of government could consult when designing interventions to promote desirable adaptation actions and behaviours. The guide should inform the use of choice architecture to both: (a) directly induce desirable adaptation behaviours; and (b) to enhance the cost-efficiency of economic instruments to the same ends. Relevant case examples will need to be developed to support the guide—currently most real world examples relate to health outcomes, savings behaviour and energy use. Consideration could also be given to making the guide applicable to climate risk management in general, including carbon and energy management.

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9 APPENDIX A: ADAPTATION ACTIONS FOR REAL ESTATE

Table 13: Real Estate Adaptations: Hazard - Increased Temperature

Adaptations
➡ Appropriate in-house storage of composting, waste and recycling in hot weather
➡ Conduct climate impact risk assessment when creating development concept / plan
➡ Incorporate cool pavement / road materials (permeable/natural surfaces)
➡ Incorporate external water features for evaporative cooling
➡ Incorporate food production opportunities (garden, greenhouses) into neighborhood design
➡ Incorporate passive solar site layout principles to maximize solar shading in summer and heating in winter (green spaces, trees for shading, natural ventilation, external water features, etc.)
➡ Increase inspection and maintenance of water system to avoid damage from freeze/thaw cycles
➡ Install / replace carpet with wooden or tile floor (only for ground flood rooms)
➡ Install / retrofit awnings / sun shades over windows
➡ Install / retrofit cavity wall insulation to reduce heat penetration
➡ Install / retrofit double glaze, low e coating windows to reduce heat gain
➡ Install / retrofit energy efficient (low heat) light bulbs
➡ Install / retrofit improved roof insulation to reduce heat penetration
➡ Install / retrofit natural ventilation (window openings, etc.)
➡ Irrigate vegetation so it can provide evaporative cooling in droughts
➡ Maximize light colors for paint/walls/roof to prevent heat absorption
➡ Open windows for natural ventilation
➡ Provide sheltered outside spaces and facilities
➡ Retrofit to increase airtightness of building envelope to reduce summer heating (and winter cooling)
➡ Services (water) installed at adequate depth to avoid freezing
➡ Switch off unused appliances at night that create heat
➡ Use / retrofit ground water or air source heat exchange for cooling
➡ Use / retrofit green or brown roofs to limit heat absorption
➡ Use / retrofit thermally reflective surfaces (high albedo) for roof, siding and facades
➡ Use building materials with high “thermal mass” (concrete, stone, tile) to absorb heat
➡ Use heat resistant building materials
➡ Use larger floor-to-ceiling heights to allow for future cooling mechanism retrofits

Sources: Arup, DTI and UKCIP (2005); Three Regions Climate Change Group (2008); Eclipse Research Consultants (2010); McMahon and Williamson (2010); GLA (2005); and Woking Borough Council (no date)

Table 14: Real Estate Adaptations: Hazard - Increased Precipitation

Adaptations
➡ Conduct climate impact risk assessment when creating development concept / plan
➡ Construct / retrofit with waterproof / water-resistant building materials for flooring, walls, foundation membrane, etc. (resistant to chemical and biological degradation)
➡ Ensure lot drainage allows for increased runoff – e.g., gentle downhill gradient to drain water evenly off impermeable surfaces
➡ Implement on-site water retention and management techniques (e.g., rain barrel, rain garden, pervious surfaces, etc.)
➡ Incorporate / retrofit on-site water retention and management techniques (e.g., rain gardens, pervious surfaces, stormwater tank, etc.)
➡ Install / retrofit moisture resistant flooring and wall finishes in the basement
➡ Install / retrofit wider gutters
➡ Promote tree retention on properties
➡ Reduce the amount of hard surfaces on lots and include "soft" landscaping such as vegetated areas and gardens
➡ Use appropriate backfilling, including capping backfill area with a soil that has a low porosity, for example, clay

Sources: Eclipse Research Consultants (2010); GLA (2005); and Woking Borough Council (no date)

Table 15: Real Estate Adaptations: Hazard – Sea-level Rise

Adaptations
➡ Avoid purchase / development in areas at intolerable risk to increased sea-level rise
➡ Comply with building code
➡ Comply with local bylaws
➡ Conduct climate impact risk assessment when creating development concept / plan, including coastal hazard mapping to determine feasibility of development / to determine areas susceptible to sea-level rise
➡ Consult with the insurance industry regarding the viability of the development for affordable insurance products
➡ Disclose property risk to potential buyers
➡ Ensure appropriate insurance coverage for property risk
➡ Install / retrofit electrical, heating, ventilation, plumbing, air conditioning equipment and other service facilities above the projected sea level height
➡ Install / undertake retrofits to accommodate sea-level rise (e.g. raised foundations, stilts / platforms)
➡ Install removable flood defense products to properties and infrastructure
➡ Managed retreat to withdraw, relocate or abandon high risk real estate properties / assets
➡ Obtain Provincial Permits
➡ Occupiers should consider new and projected climate risks in lease renewal
➡ Protect properties and infrastructure through structural engineered solutions, such as dikes, seawalls and groynes

Source: BCMOE (2013)

Table 16: Real Estate Adaptations: Hazard – Storm Surge, Coastal Flooding and Erosion

Adaptations
➡ Avoid purchase / development in areas at intolerable risk to projected storm surge
➡ Comply with / exceed building code
➡ Comply with local bylaws, provincial legislation
➡ Conduct climate impact risk assessment when creating development concept / plan, including coastal hazard mapping to determine feasibility of development / to determine areas susceptible to storm surge and coastal flooding
➡ Consult with the insurance industry regarding the viability of the development for affordable insurance products
➡ Develop Emergency Evacuation Plan for development
➡ Disclose property risk to potential buyers
➡ Ensure appropriate insurance coverage for property risk
➡ Ensure easy access / egress for emergency vehicles
➡ Expand budget / financing to cover costs of increased storm surge / flooding risk to building site
➡ Install / retrofit electrical, heating, ventilation, plumbing, air conditioning equipment and other service facilities above projected storm surges of given return interval
➡ Install / undertake retrofits to accommodate coastal flood risk (e.g. raised foundations, stilts / platforms)
➡ Install removable flood defense products to properties and infrastructure
➡ Managed retreat to withdraw, relocate or abandon high risk real estate properties / assets
➡ Obtain Provincial Permits
➡ Occupiers should consider new and projected climate risks in lease renewal
➡ Protect properties and infrastructure through structural engineered solutions, such as dikes, seawalls and groynes
➡ Retain a stock of sandbags for flood-prone properties and infrastructure
➡ Use ground floor spaces for flood compatible uses

Source: BCMOE (2013)

Table 17: Real Estate Adaptations: Hazard – Extreme Precipitation—Stormwater Flooding, and Landslides and Erosion

Adaptations
➡ Avoid purchase / development in areas at intolerable risk of flooding, landslides, and erosion
➡ Conduct climate impact risk assessment when creating development concept / plan, including stormwater hazard mapping to determine feasibility of development / to determine areas susceptible to flooding, landslides and erosion
➡ Consider local stormwater management engineering studies in home / lot design
➡ Construct / retrofit with waterproof / water-resistant materials (flooring, walls, foundation membrane, etc.)
➡ Consult with the insurance industry regarding the viability of the development for affordable insurance products
➡ Develop Emergency Evacuation Plan for development
➡ Disclose property risk to potential buyers
➡ Disconnect eaves trough downspouts, including proper extensions and splash pads extended away from the foundation walls
➡ Drain weeping tiles into a sump pit, pump foundation drain discharge to surface of lot and install warning device to detect high water level
➡ Ensure easy access / egress for emergency vehicles
➡ Ensure storm pipe size / gradient account for future intensity, duration, frequency of extreme rain events
➡ Grade lot to ensure appropriate drainage from buildings (no reverse sloped driveways) and gentle gradient to drain water slowly and evenly
➡ Install / retrofit electrical, heating, ventilation, plumbing, air conditioning equipment and other service facilities above height of projected flood waters of given return interval
➡ Install / retrofit moisture resistant flooring and wall finishes in the basement
➡ Install / retrofit on-site water retention and management techniques (e.g., rain gardens, pervious surfaces, stormwater tank, etc.)
➡ Install / retrofit sanitary sewer backwater valve to reduce risk of sewer backup
➡ Install / retrofit trash rack / debris screens on catch basins to collect debris (ensure debris is easily removed)
➡ Install / retrofit window wells with covers for windows close to ground level
➡ Managed retreat to withdraw, relocate or abandon high risk real estate properties / assets
➡ Minimize development, disturbance and vegetation removal on and near slopes exceeding 30 degrees
➡ Minimize the use of culverts and restrictions to stream channels to maintain natural stream patterns where possible
➡ Occupiers should consider new and projected climate risks in lease renewal
➡ Proper backfilling, including capping backfill area with a soil that has a low porosity, for example, clay
➡ Protect properties and infrastructure through structural engineered solutions, such as dikes, seawalls and groynes
➡ Retain a stock of sandbags for flood-prone properties
➡ Use permeable surfaces where possible (vegetated areas and gardens), reduce hard surfaces
➡ Visually monitor at-risk slopes for signs of subsidence and instability

Sources: ICLR (2010); and McMahon and Williamson (2010)

Table 18: Real Estate Adaptations: Hazard – Wildfire

Adaptations
➡ Avoid purchase / development in areas at intolerable risk to projected wildfire risk
➡ Clean out gutters on a regular basis
➡ Comply with building code
➡ Comply with local bylaws – e.g., wildfire risk DPA
➡ Conduct climate impact risk assessment when creating development concept / plan, including wildfire hazard assessment
➡ Confirm availability of nearby and reliable water supply for fire suppression
➡ Disclose property risk to potential buyers
➡ Ensure (construct / retrofit) defensible barriers around homes and buildings
➡ Ensure (install / retrofit) fire extinguisher(s) available and maintained
➡ Ensure address number is clearly signed and visible for quick identification by fire service
➡ Ensure appropriate insurance coverage for property risk
➡ Ensure appropriate vegetation management (e.g., grass cut short and irrigated, trees pruned and thinned, dead / dying vegetation removed, vegetation clear of combustibles)
➡ Ensure chimney is installed to code and complete with spark arrestor screens
➡ Ensure easy access / egress for emergency vehicles / fire suppression
➡ Ensure firewood storage – not within 15m of structures
➡ Ensure outdoor vents screened with mesh and roof openings plugged
➡ Ensure there is a home / building evacuation plan
➡ Ensure wildfire suppression materials are available (e.g., shovel, rake, axe, water, ladders, etc.)
➡ Expand budget / financing to cover costs of increased fire damage to building site
➡ Install / retrofit and maintain smoke alarms according to BC Fire Code
➡ Install / retrofit backup power (generator) for water supply system
➡ Install / retrofit fire resistant materials (e.g., for interior walls, roofing, siding, windows, doors, etc.)
➡ Install / retrofit gutter cover device
➡ Install / retrofit in-home sprinkler system
➡ Install / retrofit on-site emergency water supply (pool, pond or tank) for fire suppression
➡ Install / retrofit solid shutters or metal fire screens on windows and doors
➡ Locate / designate sidewalks, trails, boulevards and roads to act as firebreaks and evacuation route
➡ Locate power lines underground
➡ Managed retreat to withdraw, relocate or abandon high risk real estate properties / assets
➡ Obtain Provincial Permits

Sources: BC Forest Service (no date); and IBHS (no date, a)

Table 19: Real Estate Adaptations: Hazard – Extreme Precipitation—Riverine Flooding

Adaptations
➡ Allow wide buffers around creeks, streams and wetlands
➡ Avoid purchase / development in areas at intolerable risk of flooding
➡ Comply with municipal floodplain management provisions for floodplain setback and elevation (identified in Floodplain management bylaw, OCP, or zoning) – ensure ground floor elevations are higher than projected flood level of given return interval
➡ Conduct building retrofits to accommodate flood risk (e.g., raised foundations / door thresholds, stilts / platforms, etc.)
➡ Conduct climate impact risk assessment when creating development concept / plan, including riverine hazard mapping to determine feasibility of development / to determine areas susceptible to flooding
➡ Construct / retrofit with waterproof / water-resistant materials (flooring, walls, foundation membrane, etc.)
➡ Consult with the insurance industry regarding the viability of the development for affordable insurance products
➡ Develop Emergency Evacuation Plan for development
➡ Disclose property risk to potential buyers
➡ Ensure building can be easily exited in the event of a flood
➡ Ensure easy access / egress for emergency vehicles
➡ Install / retrofit electrical, heating, ventilation, plumbing, air conditioning equipment and other service facilities above height of projected flood waters of given return interval
➡ Install / retrofit moisture resistant flooring and (interior and exterior) wall finishes below flood line
➡ Install / retrofit non-return valves on main drains / backwater valve on the main sanitary sewer lateral
➡ Install / retrofit removable flood defense products to properties
➡ Install / retrofit sanitary sewer backwater valve to reduce risk of sewer backup
➡ Install / retrofit window wells with covers for windows close to ground level
➡ Investors / occupiers prepare and communicate disaster recovery plans for high risk properties
➡ Investors should ensure that during tender evaluation and drafting of the contractual arrangement, the main contractor explains how the effects of flooding will be managed
➡ Landlords / manager increase service charges to account for increased day-to-day maintenance
➡ Locate houses / buildings in non-flood risk areas; use areas of intolerable flood risk for amenity (e.g., parks, trails) and flood absorption
➡ Managed retreat to withdraw, relocate or abandon high risk real estate properties / assets
➡ Obtain Provincial Permits
➡ Occupiers should consider new and projected climate risks in lease renewal
➡ Protect properties and infrastructure through structural engineered solutions, such as dikes, seawalls and groynes
➡ Retain a stock of sandbags for flood-prone properties
➡ Use ground floor spaces for flood compatible uses
➡ Use permeable surfaces where possible (vegetated areas and gardens), reduce hard surfaces

Sources: ICLR (2010); McMahon and Williamson (2010); and Three Regions Climate Change Group (2008)

Table 20: Real Estate Adaptations: Hazard – Extreme Temperature and Heatwaves

Adaptations
➡ Conduct climate impact risk assessment when creating development concept / plan, including heatwave vulnerability assessment
➡ Develop neighborhood-scale heat wave early warning system
➡ Incorporate passive solar site layout principles to maximize solar shading in summer and heating in winter (e.g., green spaces, trees for shading, natural ventilation, external water features, etc.)
➡ Install / retrofit appropriate in-property storage of composting, waste and recycling materials in hot weather
➡ Install / retrofit appropriate level of cavity wall insulation to reduce heat penetration
➡ Install / retrofit appropriate level of roof insulation to reduce heat penetration
➡ Install / retrofit awnings / sun shades over windows
➡ Install / retrofit building materials with high "thermal mass" (concrete, stone, tile) to absorb heat
➡ Install / retrofit cool pavement / road materials (permeable / natural surfaces)
➡ Install / retrofit double glaze, low e coating windows to reduce heat gain
➡ Install / retrofit energy efficient (low heat) light bulbs
➡ Install / retrofit external water features for evaporative cooling
➡ Install / retrofit green or brown roofs to limit heat absorption
➡ Install / retrofit heat resistant building materials
➡ Install / retrofit light colored paint and other surface treatments to reflect heat in summer
➡ Install / retrofit sheltered outdoor spaces and facilities
➡ Install / retrofit thermally reflective surfaces (high albedo) for roof, siding and facades
➡ Use natural ventilation (window openings, etc.) and passive solar design

Source: McMahon and Williamson (2010

Table 21: Real Estate Adaptations: Hazard – Water Shortage, Drought

Adaptations
➡ Conduct climate impact risk assessment when creating development concept / plan, including availability of suitable water supply for life of development
➡ Establish water flow monitoring stations on sources of water supply
➡ Design foundations and structures to cope with increased risk of subsidence and heaving
➡ Use / retrofit vegetation requiring minimal watering (xeriscaping)
➡ Use / retrofit natural on-site water storage for outdoor water use (e.g., pond, tank, etc.)
➡ Install / retrofit district and building / dwelling unit water meters
➡ Install / retrofit water leak detection systems on major water supply lines
➡ Design / retrofit buildings to include grey water recycling as allowed by the BC Building Code
➡ Install / retrofit water efficient devices (e.g., aerated tap fittings) and appliances (e.g., low-flow toilets) and other water saving technologies
➡ Comply with building code
➡ Comply with local bylaws – e.g. water conservation DPA
➡ Obtain Provincial Permits
➡ Prepare and implement a neighborhood / subdivision drought plan
➡ Minimize indoor / outdoor water use
➡ Irrigate vegetation so it can provide evaporative cooling in droughts
➡ Install / retrofit measures to retain water on-site (e.g., rain barrels, rain garden, etc.) for outdoor water use
➡ Fix leaky water pipes

Source: McMahon and Williamson (2010)

Table 22: Real Estate Adaptations: Hazard – Damaging Storms

Adaptations
Avoid construction activities during storm events
Avoid use of rocks for landscaping in high wind risk areas
Consider prevailing wind in building / subdivision layout – minimize exposure to wind
Consult with the insurance industry regarding the viability of the development for affordable insurance products
Develop Emergency Evacuation Plan for development
Ensure all openings are rated for minimum design pressure of positive or negative 2.4 kn/m2 (50 psf)
Ensure building envelope is constructed to withstand high wind velocities (e.g., polymer modified shingles)
Ensure easy access / egress for emergency vehicles
Ensure investors / occupiers prepare and communicate disaster recovery plans for high risk properties
Install / retrofit additional moisture barrier along eaves of the roof to prevent water intrusion caused by ice dams
Install / retrofit back-up generator in building / district to protect from extended power outages
Install / retrofit back-up power source for key water supply components
Install / retrofit best practices for wind-proofing homes (50+ provisions in ICLR 2009)
Install / retrofit heating strips on flat roofs to prevent blockage of drains by ice
Install / retrofit impact resistant roof covering to protect from hail storms
Install / retrofit sufficient insulation on all exterior piping and on all piping in exterior walls, crawl spaces, attics, and basement ceilings
Landlords / property managers increase service charges to account for increased day-to-day maintenance
Occupiers should consider new and projected climate risks in lease renewal
Property owners / tenants should confirm insurance coverage for losses from storm events

Sources: ICLR (2010); Eclipse Research Consultants (2010); McMahon and Williamson (2010); and IBHS (no date, b and c)

Table 23: Real Estate Adaptations: Cross-cutting all Hazards

Adaptations
➡ Conduct climate impact risk assessment when creating development concept / plan - consider climate projections and impacts in all plans, bids, tenders and contracts
➡ Promote compact, less land-intensive development to reduce exposure to hazard
➡ Withhold or increase premium in high risk areas, in the absence of adequate risk mitigation measures
➡ Consider future climate projections in all decisions, assessments and strategic planning
➡ Develop / expand weather / climate data gathering stations
➡ Prepare and publicize climate change design guidelines for new construction and renovations
➡ Education and build capacity among real estate agents, appraisers, and assessors to identify, characterize and communicate climate-related risks and adaptations re properties
➡ Consider use of district energy / cooling / water systems in all new developments
➡ Disclose property risks to potential buyers, sellers, tenants and investors
➡ Promote adaptation / sustainable communities, buildings, homes in marketing / sales activity – market differentiation
➡ Mainstream adaptation planning into property life-cycle management
➡ Develop a financial reserve and replacement fund for adaptation actions (management phase)

Sources: GLA (2005); and CBT (2011)

ECONOMIC TOOLS FOR CLIMATE CHANGE ADAPTATION

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R. Boyd, J. Zukiwsky, T. Pringle

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PO Box 19012
809 49th Avenue SW
Calgary, Alberta
T2S 1A0

403.471.6247

www.allonesky.ca