Market Adaptation to Climate Risk: Evaluating Property Insurance Pricing in Vulnerable Coastal Communities

by

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AUTHOR'S DECLARATION

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

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Abstract

Financial recovery through insurance is critical to restoring socio-economic livelihoods as severe weather and water damage rank as the leading causes for property insurance claims across Canada. As climate change increases the frequency, intensity and duration of extreme weather, the availability and affordability of property insurance markets could deteriorate as the insurance sector absorbs economic losses generated by damage. To sustain insurance coverage, property owners and insurance must adapt to manage climate risks and adjust to physical hazards, specifically coastal, inland and urban flooding, which is the largest cause of property damage in Canada. This study is designed to test the pricing of risk in the property insurance market and reveal how insurance companies insure property in vulnerable coastal communities. To test for this, six market indicators will be used to evaluate the insurability of markets in coastal communities in Nova Scotia and Prince Edward Island (PEI). Residential property insurance quotes were obtained from active insurers to determine the extent of risk sharing and risk based pricing using the indicators. The findings are evaluated using statistical analysis and looks for signs that could lead to a market failure manifested as shortages in availability and affordability. The nature of insurance provides an opportunity to explore alternative approaches to protecting property in vulnerable communities through a variety of recommendations. By evaluating property insurance markets to physical hazards associated with climate change, this paper addresses a significant gap in insurance and climate change adaptation research. While insurance economics scholars have identified the source of market failures, they have yet to assess how markets should adapt to climate risk in vulnerable coastal communities. With a unique focus on the understudied economic proxy of insurance market vulnerability, this research contributes to the growing field of climate change adaptation.

Acknowledgements

My sincere thanks goes to my supervisors Dr. Jason Thistlethwaite and Dr. Blair Feltmate who provided me an opportunity to develop my academic capacity and who supported this research from its inception. I would also like to thank my committee members Dr. Olaf Weber and Dr. Michael Wood for their support and advice. Lastly, I would like to thank my wife for her enduring support throughout this process.

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Quotation

"No one takes a longer term or more carefully calculated view of the future than the insurance sector. And there can be few other sectors which are so directly affected, at the end of the day, by climate change."

HRH Prince Charles

1 Introduction

As climate change increases the frequency, intensity and duration of extreme weather, the availability and affordability of property insurance will decrease as the sector absorbs economic losses generated by property damage. Coastal communities are particularly exposed to natural hazards that can increase uncertainty for insurers and lead to shortages in the availability and affordability of insurance coverage. Uncertainty, specifically information asymmetries related to changing exposures to natural hazards generated by climate change, requires insurers to adopt more conservative approaches to coverage decisions by raising rates and limiting coverage. Climate change therefore has the potential to generate insurance market failures in some locations where coverage is simply too expensive for policyholders to purchase or insurers to provide. This research will assess the vulnerability of insurance markets to market failures by applying six indicators designed to reveal uncertainty generated by the proximity to natural hazards which are influenced by climate change. Potential failures of an insurance market will not only affect those who rely on insurance for disaster recovery but also government programs which depend on insurance to mitigate the impacts on their limited resources. Assessing insurance markets at the community level can lead to improving local adaptation/resiliency decision-making.

Most research on coastal vulnerability to climate change focuses on quantifying and assessing the impacts of physical change (O'Brien, et al., 2004). By looking at insurance, an additional layer of information is provided that acts as an important economic indicator for vulnerability. When factoring in aging public utilities, infrastructure and historically poor land use decisions, insurance markets in coastal communities may be at risk in their current state when considering the future impacts of climate change (Canadian Institute of Actuaries, 2014). Furthermore, the academic community has historically overlooked the role of insurance in socio-economic research which leads this research to depend on grey literature and a limited selection of peer-reviewed academic journals. Studying market adaptation to climate risks contributes to the growing field of climate change economics and risk management.

1.1 Objectives

This research aims to accomplish the following goals:

1. Develop a better framework for evaluating insurability in coastal communities exposed to the impacts of climate change.
2. Assess the challenges for insurers and property owners associated with mitigating exposure to climate change risks.
3. Contribute towards research on sustaining post disaster socio-economic recovery methods through insurance by identifying potential strategies for reducing vulnerability to climate change risks.

1.2 Research Questions

The relationship between increasing climate change risks and the role of insurance raises some important questions:

1. How can insurability be assessed for its contribution to economic vulnerability?
2. How are insurance markets currently responding to the likelihood of increasing natural disaster due to climate change?
3. How can insurance markets adapt to the uncertainty generated by climate change in coastal communities?

1.3 Scope

This research will conduct an evaluation of insurability for property owners in Shelburne County, Nova Scotia and Charlottetown, Prince Edward Island (PEI). With respect to Nova Scotia, the study focuses on two coastal communities in Shelburne County: the Town of Shelburne and the Town of Lockeport (Figure 1). These communities have varying degrees of exposure to coastal weather events and climate change (see Appendix D & E). They have small-scale economies with a history of long-term property ownership. Climate change scenarios and mapping exercises have been previously conducted on the two coastal communities and Charlottetown to show the potential impacts of severe weather events and rising sea levels (Prince Edward Island Department of Environment, Labour and Justice, 2011; Province of Nova Scotia, 2015; Richards & Daigle, 2011; Minano, 2015).

The property insurance market will be measured using the established insurability indicators in this research through an assessment that evaluates insurability. Insurability is defined as the capacity of a market to support available and affordable insurance (Mallon, Lamb, & Wormworth, 2014). To relate this to climate change risk, vulnerable and non-vulnerable addresses will be compared to reveal differences and similarities among insurers and risk pricing practices. Locations will be obtained from a publicly available GeoWeb tool (http://adaptns.ca/) and reports that provide maps of present and future coastal flood exposures (see Appendix D & E). The vulnerability of these addresses is strongly linked to their proximity to the coastline and addresses further inland are considered non-vulnerable in comparison.

Figure 1: Research Study Sites (Minano, 2015)

1.4 Problem Statement

Property damage is increasing across Canada due to a combination of poor land development decisions, insufficient investment in infrastructure and an increase in severe weather which is correlated to anthropogenic climate change (Canadian Institute of Actuaries, 2014). Socio-economic risk management tools to reduce economic uncertainty such as property insurance may no longer be effective when considering climate change scenarios. Looking at the insurability of Atlantic Canada coastal communities in relation to socio-economic vulnerability has yet to be assessed by the academic community to determine if it is prepared or responsive to the threats of climate risk. This gap is unfortunate as insurance plays a significant role in managing the risks generated by extreme weather and climate change.

2 Literature Review

This section will explore the role of insurance in societal risk management, the existing market-based and public-based strategies to reduce the impact of natural hazards on communities, and the capacity of these strategies to manage natural hazard risk in the era of climate change. The objective is to demonstrate that existing mechanisms to manage climate change risks are insufficient in their current state from the perspective of research on climate change adaptation. Climate change creates uncertainty in insurance markets that could reduce availability and affordability. To evaluate uncertainty, climate change adaptation researchers have developed a strategy known as a vulnerability assessment. Vulnerability assessments represent a first step towards assessing uncertainty in the insurance market in coastal communities. Three main bodies of literature were reviewed: the economics of property insurance in Canada, climate change impacts in Canada, and climate change and natural hazard mitigation strategies that can be used to reduce uncertainty in insurance markets (Table 1). The following conceptual framework will help guide the literature review and sort the information to provide a structuralized flow to it.

Table 1: Literature Review Topical Summary

Insurance in Canada	Climate Change and Socio-Economic Uncertainty	Methods to Reduce Uncertainty	Gaps in Literature
Benefits of Insurance Shared Risks Insurance Rating • Actuarial Science • Underwriting Insurance Market Failures • Fraud • Pooling • Moral Hazard • Adverse Selection • Over/Under Insuring	Arctic Ice Loss Sea Level Rise Forecasts and Trends Economic Implications for Atlantic Canada Rising Overall Uncertainty	Methods Insurers Use to Reduce Risk: • Price Discrimination • Pooling • Risk Communication Methods Used by Public Entities to Reduce Risk: • Land-use/Mapping • Relocation • Disaster Aid • Building Codes	Insurance neglected as a factor to assess climate change vulnerability The value of insurability in socio-economic risk management Insurance as an economic proxy of insurance market vulnerability

2.1 The Role of Insurance

Insurance can protect property owners from a physical and financial loss to their property and is fundamental to the operation of housing markets (Mallon, Lamb, & Wormworth, 2014). In its simplest form, insurance acts as a way to transfer risk and to mitigate future losses for the policy holder. On a macroeconomic scale, property insurance can help rebuild communities and help local economies recover from disasters, which is important for maintaining and preserving the quality of living standard associated within a community. Without insurance, economic costs from these hazards must be absorbed by taxpayers through natural disaster assistance, or directly by homeowners in the event assistance is not available. It is for this reason that the Bank for International Settlements (BIS) argues that the availability of private insurance is correlated to an increase of 1% in Gross Domestic Product in the aftermath of a natural disaster (von Peter, von Dahlen, and Saxena 2012). Indeed, the availability of private insurance represents a significant source of economic welfare as a mechanism that helps a community recovery from natural hazards, but also incentivizes risk-adverse behaviour through higher premiums (Botzen and Van Den Bergh 2012).

In Canada, most property owners are required to carry insurance if their home is mortgaged through a financial institution (Insurance Bureau of Canada, 2014). Although many consumers may view insurance as a checklist item for a mortgage or a business license, it is important from a financial recovery perspective if an accident or catastrophe occurs. Fire, theft, wind and storm damage are some of the perils which insurance is designed to help individuals and businesses recover from. Beyond the legal requirements, insurance also is the primary method of risk management for homeowners against perils. Monthly premium payments can be an affordable way to offer "peace of mind" against many perils.

Premiums are collected from policyholders and placed into a pool (also known as a reserve) which provides payouts for covered losses to those who participate. Insurers generate revenue based on the fact that losses (claims paid) are less than the gross premiums collected from policyholders. If these losses are greater than the premiums, the company is likely operating at a loss. Thus, premiums are often increased to account for high claims volumes until a balance is

returned in favor of the premiums (Kunreuther, 1996). As claims increase in frequency and severity, premiums are likely to increase to account for this activity.

2.1.1 Economics of Insurance

Insurance acts as a "pool" as individual premiums are placed into a fund which is used to payout the losses of the few for specific perils like fire. This concept of insurance has deep roots within all modern-era economic trade based systems. Import and export systems began utilizing commercial insurance as early as 1756 when sending cargo shipments over the Atlantic Ocean. Due to the collective agreement of the participants, there is a responsibility to reduce the amount of claims from happening. Policyholders in the pool should act out of best interest for all of the participants. Ideally no claims ever occur so that premiums stay minimal. An adequate fund has resources to payout a large amount. This is an indication that there is a shared incentive for all policyholders to refrain from making claims (Stone, 1999).

By agreeing to pay into a risk sharing pool, the individual does so for their own benefit and according to Stone (1999), this can also provide reason to cooperate with others so that premiums remain affordable for all participants in the risk sharing pool should they need help. It is an example of collective action in order to protect members of a community which face a common threat. In doing so, insurance can be a governance mechanism for social progress by providing sense of security, fostering collaboration and ultimately strengthening a sense of community (Stone, 1999). Insurance shares this characteristic with disaster aid which is also funded by participants through taxes as a means of protecting their community.

2.2 Insurance Rating

Central to all property insurers pricing models is the actuarial department which uses scientific and mathematical techniques to determine what the premiums of today need to be in order to cover future losses. Traditionally, actuaries collect historical data such as claims information, disaster statistics, geographic data and anything else that can be quantified to determine the likelihood of a claim occurring. When the likelihood of an event can be determined or estimated, a price can then be assigned to the risk. The concern is that these traditional actuarial pricing methods based on historical data sets are no longer relevant in today's era of climate change (Canadian Institute of Actuaries, 2014). In multiple annual Ceres reports, authors concluded that actuarial models must improve their analysis and incorporate climate change factors to remain profitable (Mills, Roth, & Lecomte, 2005, Mills & Lecomte, 2006, Mills, 2008). "Regardless of the relative weights of anthropogenic climate change and increased exposure (quantifications premature), rising uncertainty would complicate the fundamental actuarial and pricing processes that underlie well-functioning insurance markets" (Mills, Roth, & Lecomte, 2005). The consequences of climate change are uncertain, but so are other factors which have been leading to increasing claims for Canadian insurers. These factors include aging infrastructure, lifestyle changes and construction related issues (Canadian Institute of Actuaries, 2014). As a consequence, the next generations will live in a different and perhaps more uncertain era that any of our past generations which means business solutions must prepare and adapt accordingly to survive.

2.2.1 Underwriting Insurance

Property insurance is traditionally priced by an underwriter or underwriting software that attaches a price point to each component of coverage within a policy. In other words, underwriters rate the applicant based on multiple variables to determine the applicant's insurance price. Insurers try to reduce uncertainty by identifying the different types of customers based on individual customer characteristics in order to distinguish the level of risk (Thomas, 2012). An application for insurance confirms this as there are dozens of questions requiring personal information; some are mandatory, others voluntary. For many insurers, underwriting criteria consists of a variety of rating factors. Most common are the COPE factors: construction, occupancy, protection and exposure (Table 2). All these factors can be used to determine the

price of insurance for an individual risk, such as a home. Questions on insurance applications for property often include many factors as shown in Table 2.

Table 2: COPE Factors for Insurance Pricing (Insurance Institute of Canada, 2011)

COPE+ Factors	Description and Examples
Construction	• Building Construction Type (i.e. wood frame) • Year Built • Date of Renovations and Updates (i.e. Electrical) • Heating, Ventilation, A/C details (i.e. Oil furnace) • Number of Storeys, Basement Finished/Unfinished • Roofing Materials and Age (i.e. Shingles, 20 years old)
Occupancy	• Owner Occupied or Tenants? • Home business operations • Number of occupants • Other uses • Seasonal Usage
Protection	• Distance to nearest fire hydrant • Distance to nearest fire departments • Volunteer Fire Department • Sprinklers and Smoke/CO2 detectors installed? • Security and Alarm Systems • Property Security such as fencing and surveillance
Exposure	• Neighboring property usage • Location hazards • Natural features; flood plains, coastal zone • Water hazards • Crime and theft rates of community
Loss & Insurance Claims History	• Previous claims on property, type and cost • Previous claims by owner • Payment and cancellation history

This expansive list of rating criteria is used to determine the likelihood of claim which in turn is used to generate a premium to cover the statistical chance of that potential claim. This is typically referred to as an actuarial exercise and every insurer has their unique way of conducting this type of exercise (Canadian Institute of Actuaries, 2014).

Private insurance is an important tool for homeowners to manage extreme weather risks because it can improve economic efficiency, manage risks and promote risk mitigation measures (Botzen & van den Bergh, 2008; Kunreuther, Meszaros, Hogarth, & Spranca, 1995; Mills, 2005). Recent

studies by the insurance industry have stated that climate change scenarios must be factored into business models (Toumi & Restell, 2014). When climate risk has been incorporated into property insurance risk pricing models, the outcomes are concerning as long-term solvency is threatened and forecasting techniques become insufficient (Swart, Raskin, & Robinson, 2004). Suggestions for including climate change as an insurance pricing factor in specific coastal communities may be lacking due to insufficient research and examples that pertain to Atlantic Canada.

2.3 Insurance Market Failures Linked to Climate Change

The ambiguity of risk increases with climate change uncertainty, which can also lead to increases in the likelihood of insurance market failures (Botzen & van den Bergh, 2008). Although the insurance industry can help climate proof vulnerable communities, the insurance market is likely to respond by incorporating climate change uncertainty into their business model when setting rates, premiums, coverages, limits and payouts (Mills, 2005). Insurance market failures can be attributed to one or a combination of these factors, but in the context of climate change the most significant concern is an information asymmetry (Botzen & van den Bergh, 2008). The most common outcome of information asymmetries involve adverse selection and moral hazards, which are capable of market disruption in communities with higher exposures to climate change. Together, these market disruptions can lead to a "crisis of availability and affordability" where the conditions for insurability are no longer sustainable given the level of uncertainty (Mills, Roth, & Lecomte, 2005). This section will explore how climate change can create, influence and/or accelerate specific types of insurance market failures.

2.3.1 Adverse Selection

Adverse selection can be detrimental to competitive markets with the ability to eliminate them entirely (Akerlof, 1970). Adverse selection can exist where individuals who live in high risk areas (hazard prone) take advantage of the relatively cheap insurance premiums despite knowing that they are more likely to make a claim than others who live in more protected areas. High risk areas will be more exposed to climate change uncertainty, which means policy holders may not be paying sufficient premium to cover their risk. In addition, since insurance premiums reflect the average loss, adverse selection can lead to market failures where insurance is underpriced for potential exposures. To overcome adverse selection, insurers would require precise site specific

characteristics of the property and a pricing model to account for it (Botzen & van den Bergh, 2008).

2.3.2 Moral Hazards

The purchase of insurance can present a moral hazard as policyholders may feel that the insurance policy alone is sufficient to manage risk and fail to take further actions that could reduce losses to their property. Insurance can inadvertently create a false sense of security to the point that policyholders fail to take precautionary measures resulting in an inefficient level of risk prevention (Botzen & van den Bergh, 2008). It is now stipulated in many insurance contracts that the policyholder must have demonstrated that they took reasonable measures to prevent a loss before coverage is triggered (Sandink, Kovacs, Oulahen, & McGillivray, 2010). Climate change creates a moral hazard in insurance markets as the availability of coverage limits incentives for property owners to take actions that could protect them from future increases in exposure to natural hazards (Surminski & Oramas-Dorta, 2014). Moral hazards can be attributed to market failures (Akerlof, 1970) specifically in natural disaster-prone insurance markets (Hudson, Botzen, Czajkowski, & Kreibich, 2014) if policyholders rely on insurance as a first line of defense rather than the last.

A potential market solution to moral hazard is to offer premium discounts in exchange for clear demonstrated actions that reduce risk (Hudson, Botzen, Czajkowski, & Kreibich, 2014). One of the most prominent examples of this can be seen when a homeowner installs a back flow prevention valve in their sewer outlet pipeline. Many insurance companies will provide a discount on the property insurance premium if homeowners install the valve since it reduces the likelihood of a sewage back-up claim (Canadian Institute of Actuaries, 2014).

2.3.3 Pooling Failures & Fraud

The size and composition of an insurance pool determines how the pool will function and operate (Insurance Institute of Canada, 2011). In order for premiums to be proportionate to the risk, property owners with similar houses, contents and demographics are often pooled together. If they share the similar risk, then theoretically they should all have similar premiums until a loss occurs to one or many. To keep insurance affordable, insurance pools are rarely small. The larger a pool, the lower the premiums are as it spreads the costs over a great number of participants.

However, when a pool become too large the premiums can become spread out so much they no longer accurately represent the risks. High-risk participants and fraudulent participants can make more claims, and take advantage of the system. A recent example in Alberta illustrates that the increasing frequency and severity of hail events has resulted in attempts by fraudulent contractors to take advantage of desperate individuals to do repair work which is not vetted by insurers (Reichert, 2014). If climate change projections for more frequent and severe hail storms are expected, insurance claims will not be as significant when insurance pools are too large. Policy holders with low risk will inevitably be subsidizing the high risk properties when the pool of insureds is too large, thus masking the risk and impacts of climate change.

2.3.4 Under Insurance

When purchasing insurance for a home or property, the amount of insurance required is essential to ensuring that the item being insured will be replaced or repaired to the same (or better) standards. When a policy does not have enough insurance, it may be more affordable but it will ultimately be insufficient to cover the item and expose the policyholder to penalties and costly out-of-pocket expenses. Insurance brokers and agents are licensed to provide property owners valuations as to what they should insure to, known as insuring-to-value (ITV). Insurance valuations are meant to cover the replacement cost of the home, and thus should not be determined by real estate markets or tax assessment values. Instead, they should consider the reconstruction cost of the home and take into consideration things like building materials and labour rates. It is essential that property owners insure to the correct value. Individuals may not insure to the correct value for their needs given the uncertainty around the potential impacts of climate change and the cost of new building material. Failing to consider the potential of climate change could lead unsuspecting homeowners to underinsure their properties (Saxe, 2013).

2.3.5 Uncertainty of Future Claims

Uninsured perils can impact the insurance industry when large scale disasters occur because of the wide range of damage. When a large flood occurs in an urban area, sewers can back up, pipes can rupture, power outages are possible, building foundations may become unstable, and soil movement can wash away roadways. Even though flood was an exclusion on all residential property insurance policies, insurers still paid out over $3.4 billion in 2013 due to flooding events in Southern Alberta and Toronto (Insurance Bureau of Canada, 2015). In coastal areas,

the proximity to coastline can predispose a property to climate change as resultant wind and rain damage can jump significantly if the property is simultaneously exposed to sea level rise and erosion (Prince Edward Island Department of Environment, Labour and Justice, 2011). Coastline properties have increased exposure to claims associated with sewer backup and structural damage due to wind or ice. Property owners with previous insurance claims will keep paying higher premiums for coverage if they continue to make property damage claims. The potential for insured losses to increase due to climate change could result in greater claims activity which contributes to increases in future premiums. When combining the potential for an increase in claims activity, an increase in premiums and the risk of climate change, market failures could occur in property insurance markets.

2.4 Climate Change and Uncertainty

Research on climate change in Canada reveals how changes in the environment are likely to cause uncertainty for insurers. This section will focus on the current state of climate change research in Canada and the uncertainty it creates for insurance markets. The Canadian federal government's Ministry of Natural Resources Canada commissioned a report in 2014 titled "Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation". This report was aimed at the widespread impacts that climate change could have across all levels of government, industry and socio-economic stakeholders. The study concluded that virtually every aspect of the Canadian environment and the functions of the country will be subjected to and impacted by climate change. A central dataset was used to illustrate that Canada's climate is changing, with observed changes in air temperature, precipitation, snow and ice cover and other indicators (Warren & Lemmen, 2014). For insurance markets, sea-level rise and an increase in the frequency of storms and intense precipitation constitute the most significant risks. These will be explained below.

2.4.1 Arctic Ice Loss and Sea Level Rise

In the coming decades, global sea levels are expected to undergo a rapid rise, up to 10 times faster than a century ago and should be a legitimate concern to insurers in coastal communities (Smith, 2006). In addition to rising waters, severity and frequency of North Atlantic Hurricanes is expected to increase based on medium-term forecast modelling conducted by Risk Management Solutions (RMS) (Lloyd's, 2014). Figure 4 illustrates the increase in sea level rise from the Eastern Atlantic coast recorded at Battery Park in Lower Manhattan, New York City.

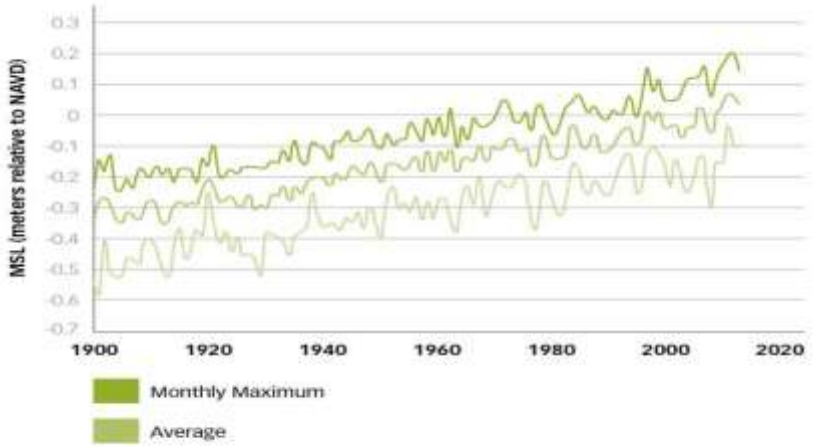

Figure 2: Monthly mean and monthly range of mean sea level (in meters) as recorded at the Battery (NYC). (Lloyd's, 2014)

This rise in sea level was one of the major contributing factors to Superstorm Sandy breaking 16 historical tide records along the east coast (Lloyd's, 2014). The graph above shows approximately 20cm of sea-level rise at the Battery Park since the 1950s. With all other factors remaining constant, this sea-level rise was attributed to 30% of the ground-up surge losses in New York alone (Lloyd's, 2014). Trends in arctic sea ice loss reveal one of the sources contributing to sea level rise. Less sea ice results in higher sea levels. As a result of warmer temperatures rapidly increasing the amount of sea ice being lost, the moisture content of our atmosphere is increasing through the evaporation process. The graph below illustrates a time series of the percentage difference in ice extent in March and September relative to the mean values for the period 1970-2000 (Perovich, Meier, Tschudi, Gerland, & Richter-Menge, 2015).

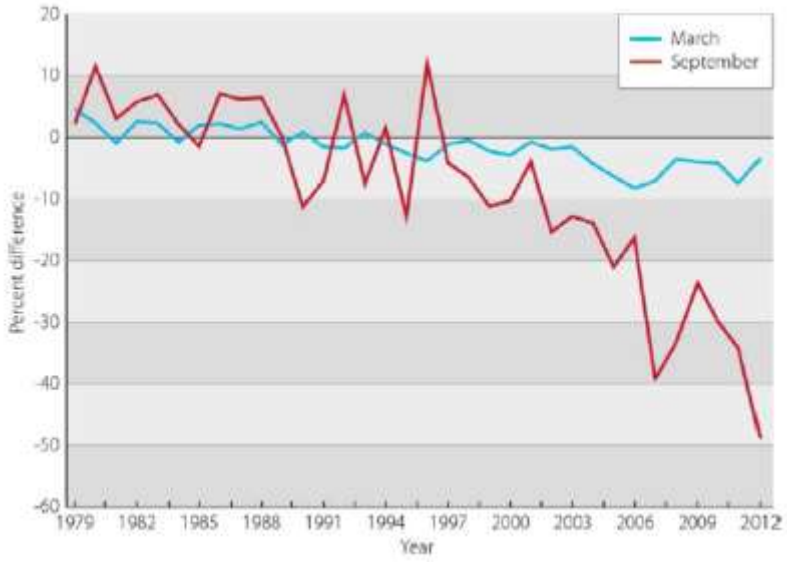

Figure 3: Trends in Arctic Sea Ice from 1979-2012 (Warren & Lemmen, 2014) (Perovich, Meier, Tschudi, Gerland, & Richter-Menge, 2015)

The projected sea-level rise in Atlantic Canada has been thoroughly researched with consistent findings that suggest sea levels will rise between 5cm and 20cm along the Atlantic Canada coastline by the year 2050 (Sandink, 2011, Minano, 2015).

2.4.2 Storms and Precipitation

The forecast for climate change is largely seen as a continuation of the illustrated trends above, however there are specific changes which pertain to Atlantic Canada, including: heavy precipitation, snow cover duration, snow depth, future sea level and seasonal Arctic sea ice (Table 3).

Table 3: Examples of projected changes in the climate system for Atlantic Canada (Warren & Lemmen, 2014)

Weather Trends	Projected Changes
Heavy precipitation	More frequent heavy precipitation events are projected, with an associated increased risk of flooding.
Snow cover duration	Widespread decreases in the duration of snow cover are projected across the Northern Hemisphere with the largest changes in maritime mountain regions, such as the west coast of North America.
Snow depth	Maximum snow accumulation over northern high latitudes is projected to increase in response to projected increases in cold season precipitation.
Global sea level rise by year 2100	Estimates of the magnitude of future changes in global sea level by the year 2100 range from a few tens of centimetres to more than a metre. Over millennia, global sea-level rise may eventually amount to several metres.
Seasonal Arctic sea ice	A nearly ice-free summer is considered a strong possibility for the Arctic Ocean by the middle of the century although summer sea ice may persist longer in the Canadian Arctic Archipelago region.
Changes in storm surge severity	The projected increase in mean sea-levels in Atlantic Canada will contribute to increasing extreme high water levels such as storm surge and coastal flooding.

2.4.3 Climate change and uncertainty in insurance markets

The costs of natural disasters have been rising steadily in Canada. Figure 8 illustrates the trend line of catastrophic losses in Canada where insurance payments were paid. The costliest year on

record was 2013 when insured losses amounted to over $3 billion, which were largely influenced by flood events in Alberta and Ontario (Insurance Bureau of Canada, 2014).

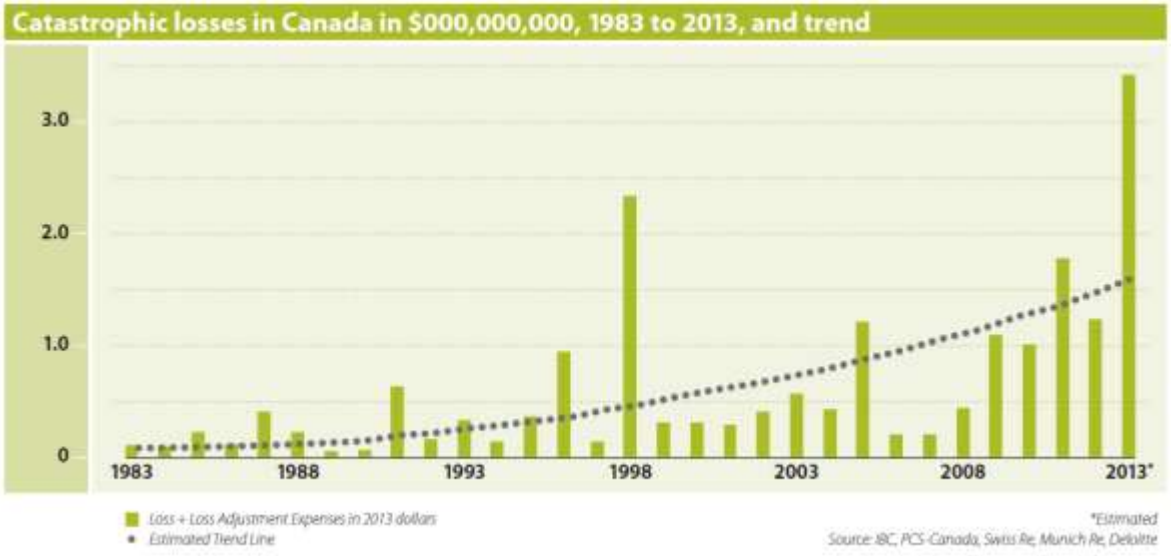

Figure 4: Catastrophic Losses in Canada (Insurance Bureau of Canada, 2014)

In addition to insured losses increasing, the frequency of large scale disasters has been steadily increasing since the 1980's on a global level according to global reinsurer MunichRe (MunichRe, 2015).

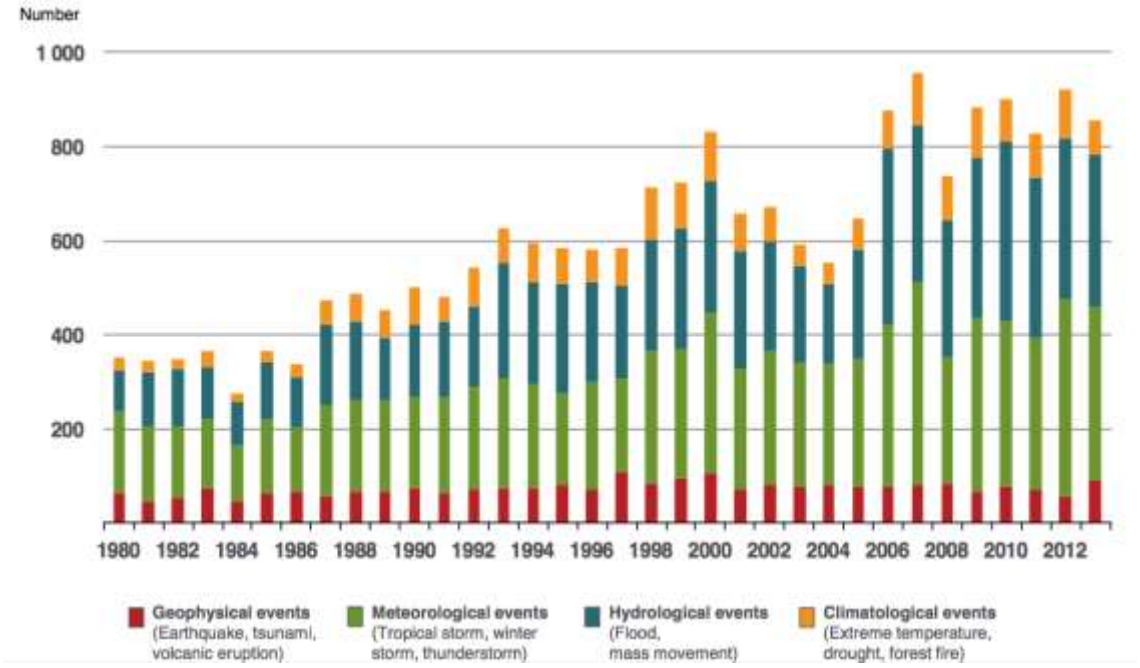

Figure 5: Frequency of Large Scale Events 1980 - 2013 (MunichRe)

The greater the uncertainty of the probability of an event and the magnitude of losses, the greater will be the insurance premium charged (Kunreuther, Meszaros, Hogarth, & Spranca, 1995). Premiums are higher to account for the risks taken by insurance companies caused by uncertainty about the frequency and magnitude of future claims (Botzen & van den Bergh, 2008). Areas where premiums are higher would likely correlate to a high chance of loss and thus, higher potential claim payouts. This could lead to future insurance becoming less affordable and available in these areas. As infrastructure ages and severe weather increase, those who live in vulnerable areas are likely to make a claim. The methods that insurers have to reduce uncertainty in the next section (Section 2.7) are only effective when the marketplace and weather related events are predictable.

2.4.4 Economic Implications of Climate Change in Atlantic Canada

For the last consecutive 19 years, PEI saw higher than normal annual average temperatures according to Dr. Adam Fenech, Director, Climate Lab, and University of Prince Edward Island (UPEI). Fenech found that PEI is shrinking at a rate of 28 centimeters a year (Taber, 2014). Projects undertaken by the Climate Lab have concluded that over the next 90 years, $150 million worth of real estate is at risk of disappearing into the ocean, including:

- More than 1,000 homes and cottages
- 17 lighthouses and 10 footbridges
- 146 commercial buildings
- $45-million in road infrastructure is also at risk

The economic implications of climate change are complex since it is often difficult to differentiate between costs that are and are not related to climate change. The hurricane forecasts for Nova Scotia and PEI are both calling for more severe and more frequent events by the end of this century (McBean, 2006). In 2003, Hurricane Juan caused $230 million in economic losses of which $113 million was insured (McBean, 2006). In addition to these economic losses, the cost associated with imminent hurricanes should not be underestimated. As stated earlier, the hurricane forecasts for Nova Scotia and PEI are both predicting more severe and more frequent events by the end of this century. Experts are cautioning that a Category 3

hurricane which makes direct landfall in Nova Scotia would likely cause upwards of $6 billion in economic losses across all of Atlantic Canada (Nielson & Salustro, 2011).

According to the Insurance Bureau of Canada, property claims have risen steeply in the last two decades by doubling in Nova Scotia and tripling in PEI (Dean, 2015). The threat of hurricanes is immediate and historically evident to residents in Atlantic Canada. However, sea level rise presents the greatest "hidden" danger to the society and economy of Atlantic Canada. Sea level rise contributes to the intensity of hurricanes and severe storms by magnifying the resultant coastal surges, erosion and wind damage. By the end of this century, sea levels are expected to rise anywhere from 50cm to 100cm which will ultimately affect thousands of low-lying exposed properties along the coast (McBean, 2006). These changes can be linked to insurable losses such as water damage, sewer back-ups and storm damage. These losses will impact insurability in coastal areas. Coastal communities have an increased exposure to sea level rise, coastal flooding and soil erosion which are usually excluded perils in a typical property insurance policy. Regardless, these perils both contribute to increasing damages from wind and rain which are typically insured perils (including hurricanes).

2.4.5 Nova Scotia

According to government resources, Nova Scotia is particularly susceptible to climate change because most of the population lives along the coastline, and much of the province's infrastructure is located in vulnerable areas (Province of Nova Scotia, 2015). The Province of Nova Scotia has recognized that climate change will mean a future with:

- Warmer winters with more wet weather
- Hotter, drier summers
- Change in nature of precipitation – more floods and more droughts
- More-frequent extreme storms
- Rising sea levels
- Accelerated coastal erosion (Province of Nova Scotia, 2015)

Provinces in Atlantic Canada have indeed illustrated an increasing trend in heavy rainfall events during the last half of the 20th century (Bruce, Burton, I., Martin, Mills, & Mortsch, 2000).

Forecasts from the Nova Scotia provincial government state that extreme rainfalls which happened every 50 years could now occur every 10 years (Nova Scotia Environment, 2009).

2.4.6 PEI

According to the government of Prince Edward Island, the effects of climate are already becoming evident; "Sea level is rising; storm surges are becoming more common and more destructive; and shoreline erosion and flooding is putting many homes, cottages, and businesses at risk" (The Province of Prince Edward Island, 2015). PEI depends on sand dunes and winter snow pack to protect itself from encroaching tidal forces. Warmer winter months will also attribute to less snowpack, which typically encapsulates the island like a shell to protect it, thus increasing the potential for erosion during the winter months. As sea levels rise, the erosion of shorelines and protective dunes will become more frequent (Prince Edward Island Department of Environment, Labour and Justice, 2011). Exposure to tropical cyclones and hurricanes presents a significant and growing threat to the Maritime Provinces. Extreme weather events affecting PEI have increased slowly over the last 150 years according to the Climate Lab at UPEI.

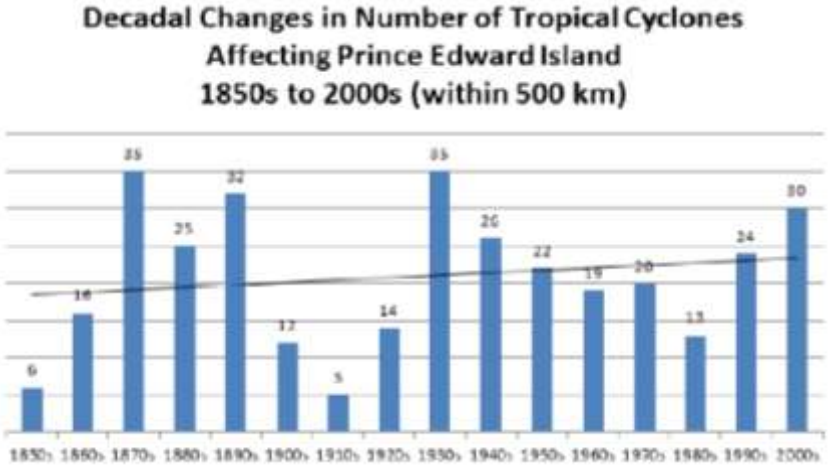

Figure 6: 150 Years of Increasing Tropical Cyclone Events, (Fenech, 2014)

Tropical cyclones and hurricanes present the greatest source of an immediate large-scale event which would create catastrophic losses across Atlantic Canada. The increasing trend of these storms, as shown in the graph above, is sufficient evidence that Atlantic will likely more frequent and more severe storms over the next several decades.

2.5 Methods for Reducing and Governing Climate Change Uncertainty

2.5.1 Strategies from Private Insurers

Insurers have a number of tools at their disposal for reducing market uncertainty that can lead to market failures. But as analysis in this section will show, these measures may be insufficient for managing the uncertainty generated by climate change.

Price Discrimination/Risk-Based Pricing (RBP)

Price discrimination is critical to the solvency of insurers because uncertainty limits the capacity of insurers to respond with a strategic and long-term approach. Rather than using the term price discrimination, the insurance industry uses the term risk-based pricing. RBP operates on the general principle that homeowners who live in high risk areas are those who will pay the highest premiums due to their exposure to potential losses (Insurance Institute of Canada, 2011). There are other means by which insurers can use RBP to minimize risk uncertainty such as deductibles, coverage limits and exclusions. However, these "normative standards" of insurance are limited. Raising premiums, limiting coverages, pulling out of markets and changing the rating models can only work to a point before insurance becomes unaffordable or unavailable which can result in intervention from regulators and government (Thistlethwaite, 2012). As the climate changes, and the frequency of extreme weather increases, price discrimination could limit the affordability of insurance in areas in close proximity to coastal climate hazards, such as sea-level rise and coastal flooding.

Pooling Uncertainty/Spreading the Risk

As discussed in section 2.4, pooling resources as insurance can be extremely effective when claim levels are low and the risk sharing pool is large. Rather than using physical addresses, insurers have historically relied on postal codes to determine the risk level of a property (Harris, 2015). Postal codes are not exact enough to use for climate change risk modeling, but they are fairly good at determining the general vicinity of most communities to perils such as floods and hurricanes. In addition, modern advances in technology that can now be used to more accurately determine the exposure level of a property, but there has been little research on insurance companies using Geographic Information Systems (GIS) as a primary rating tool for property

insurance, which could be more effective for capturing localized risks generated by climate change (Harris, 2015).

Risk Communication

In addition to RBP and pooling, insurers can also use risk communication to try and reduce uncertainty that leads to market failures. When it comes to insurability of disaster prone areas and events of low probability, the historical rarity of the event reduces the amount of people who have a memory or experience in dealing with them (Hogarth & Kunreuther, 1985). The communication of risk could easily be provided by the insurer as they likely know more about the risk than other sources. One of the key findings of a recent report states that only 10% of major US insurers have publicly addressed climate change (Ceres, 2014). There is even less evidence from a Canadian context. Figure 7 illustrates the increase in reports related to climate change published by two of the largest insurance markets in the world which are available to the public online. Reports from their websites were tallied to create this graph which displays the growing global concern.

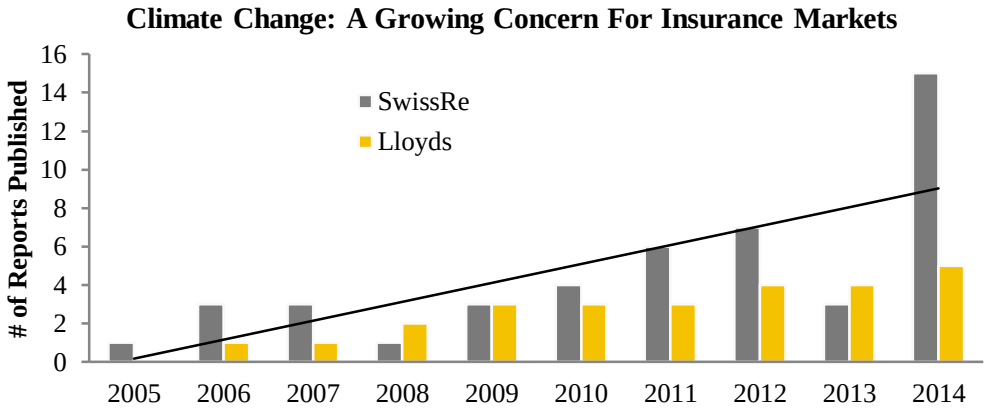

Figure 7: Reports per Year from World's Leading Insurance Markets

Climate change reporting by major insurance markets on a global scale has increased over the last decade, but there remains a large gap in local efforts by insurers. There appears to be a significant lack in communicating climate risks on property insurance at the community level.

The messaging around climate risk should to be more localized by insurers in order to properly and directly communicate the risks to property owners.

2.5.2 Strategies for Public Entities

Private insurers also depend on methods outside of their direct control to manage uncertainty. Public policy on land-use, relocation, building codes and disaster aid represent additional methods used to reduce uncertainty.

Land-Use And Floodplain Mapping

Municipal bylaws and provincial planning regulations that govern land use are some of the most important tools to protect from flooding and water related issues associated with climate change uncertainty. In order to reduce uncertainty, researchers and institutions have strongly supported stricter policy that surround land development decisions such as not allowing any development in floodplains and relocating individuals with significant exposure (Kovacs & Sandink, 2013). Strongly linked to land-use policy is the role of floodplain maps which help inform decision making. For example, Ontario conservation authorities work in managing land-use by limiting development in flood plains under a strict no development policy (Conservation Ontario, 2015) . Overall, flood mapping across Canada is currently inadequate (Insurance Bureau of Canada, 2014). Floodplains can change over time and all levels of government need to be actively monitoring and mapping watersheds and rivers which are situated around populated areas. Keeping these maps updated is critical to staying prepared and adaptation to an uncertain future associated with climate change.

Individual and Community Relocation

Relocation is another tool to reduce uncertainty. With respect to relocation versus mitigation in floodplains, the Bow Basin Flood Mitigation and Watershed Management Project suggested that:

- The best approach is not to develop in floodplains all together
- Relocation is the only certain way to avoid flood damages
- Relocation is more effective than mitigation in high-risk areas
- Mitigation measures are cheaper only in the short-run when compared to relocation

(Alberta WaterSmart, 2014)

There are 3 types of relocations: temporary (an evacuation), permanent (more common) and wholesale community relocation. Wholesale community relocation involves moving the community and all of its residents to a new community, a process which can take up to 3 years or more (Perry & Lindell, 1997). The literature which was reviewed confirms that buyout programs in the United States are effective at controlling future losses and that relocation is harder in older neighborhoods (de Vries & Fraser, 2012). Older neighborhoods have move established residents and also illustrate greater sense of community. This suggests that residents value the sense of community such as the physical characteristics of the neighborhood and the sense of social familiarity with existing neighbours. Relocation becomes harder as the community and political surroundings mature, which adds to their uniqueness and permanence thus increasing their value to society (de Vries & Fraser, 2012).

The most recent example of large-scale relocation efforts in Canada took place after the Southern Alberta flooding events of 2013 (Alberta Government, 2015). The strategy for relocating individuals in floodplains was done through a government contracted buyout program. This program had an acceptance rate of 28% and is currently undergoing a review process. The program was a responsive effort to flood victims who would likely see future flooding events again should they remain in the floodplain. Eligible homeowners were offered 100% of the 2013 municipal tax assessed value but the homeowner was responsible for the costs of moving (Government of Alberta, 2014).

Building Code Improvements

Provinces across Canada can choose to adopt the National Building Code (NBC) as the standard for the construction of residential homes or they can develop their own provided it is equal to or greater than the NBC. One of the greatest factors involved in determining the ability of a structure to withstand weather and the test of time is the standard to which it is built. Recent efforts by government and non-government groups have been aimed at improving the NBC so that building standards are better suited to deal with severe weather and climate change. The Institute for Catastrophic Loss Reduction (ICLR) is one of the most recognized not-for-profit institutions leading the discussion on making the National Building Code more resilient. For

example, by making homes stronger through improved construction methods, homes can withstand stronger winds and powerful storms, which would result in less damage. These reforms are important for the government, insurance markets and consumers, as they would reduce property damage claims and pressure on disaster assistance programs (Auld, Li, Li, & Cheng, 2012).

Public Sector Recovery Programs (Disaster Aid)

Government run programs such as disaster relief can reduce uncertainty by acting to provide financial and social support to residents in areas impacted by disaster. Medical care, temporary shelters, food and clean drinking water are critical components in the immediate aftermath. While the immediate uncertainties are managed, long term uncertainties such as rebuilding a community can also fall under the responsibility of government (Salamon, 2001). Government disaster assistance programs have a number of limitations compared to private insurance. Most importantly, these programs expose taxpayers to assessment, debt and cross subsidies that benefit some at the expense of others. For example, the Federal Emergency Management Associations (FEMA) National Flood Insurance Program has created a debt of $24 billion (Kading, 2014). The direct cause of this debt was due to underpricing of the product (Kunreuther, 1996). In contrast, the German flood insurance model offers private sector optional insurance but uptake by the property owners tends to be below 10% (Botzen & van den Bergh, 2008). The reason for low uptake is that most properties in Germany have a low to medium risk which limits demand for those who do not live in hazardous areas. Consequently, many high risk property owners in Germany do not purchase flood insurance as they believe that disaster aid funded by taxes will assist them rather than private insurance (Botzen & van den Bergh, 2008). The design of government disaster aid is not intended for recurring, predictable or highly probable losses as it places pressure on public resources (Kunreuther, 1996).

2.5.3 Limitations of Reduction Tools & Climate Change Adaptation

Reducing climate change vulnerability by using a practical adaptation initiative would require a strategy and involve tools to reduce uncertainty. Most of the tools could be considered methods to adapt to climate change if they can be improved to incorporate climate risk. In their current state, they lack this capacity and are therefore limited. The tools discussed in Section 2.7.1 and 2.7.2 are tools to help reduce uncertainty for insurers, government and the public. These tools and strategies could likely be insufficient as they fail to incorporate information on climate change risk. The limitations of each is identified and summarized in Table 4 below.

Table 4: Climate Change Limitations of Uncertainty Reduction Tools

	Uncertainty Reduction Tool	Limitations
Tools for Private Insurers	Price Discrimination/Risk-Based Pricing (RBP)	If natural disasters continue to rise and be influenced by climate change, current pricing models will make insurance unaffordable
	Pooling Uncertainty/Spreading the Risk	Creating larger pools to spread risk can lead to fraud and market failures and fail to respond to local exposures to climate change.
	Risk Communication	Consistency is difficult when there are dozens of insurance companies with different coverages and advice competing with each other.
Tools for Public & Other Entities	Land-Use And Flood Zones	Flood maps must continually be updated as floodplains can change. Existing development is exposed and new developments are still permitted where future climate risk is not considered.
	Individual and Community Relocation	People do not wish to move. Relocating individuals and/or communities to “safer” locations may still be exposed to other climate change risks such as wind and hail.
	Building Code Improvements	Building codes are primarily designed for public safety and energy efficiency and rely on historical data.
	Public Sector Recovery Programs (Disaster Aid)	These programs are reactive, and do not generate incentives for actions that support pre-disaster or climate change risk mitigation.

Research on adaptation provides some solutions, specifically the idea of using vulnerability analysis. Insurance scholars have not yet employed an evaluation on insurance vulnerability in the context of climate change and adaptation scholars have yet to apply this approach to insurance.

Adaptation presents itself as one method for communities to reduce climate change vulnerability (Smit & Wandel, 2006). The evaluation of adaptation is designed "to estimate the degree to which modeled impacts of climate change scenarios could be moderated or offset" (Smit & Wandel, 2006). This can be achieved through research that focuses on the implementation processes for adaptations, also known as practical adaptation initiatives (Smit & Wandel, 2006). In the climate change field, adaptations can be constrained by broad economic–social–political arrangements and where those constraints are particularly binding, adaptation may be considered as attempting to change those broad economic-social-political structures themselves (Smit & Wandel, 2006).

2.5.4 Vulnerability Assessments

Reducing vulnerability is critical to adapting to climate change. The climate risk in coastal communities creates a level of vulnerability and uncertainty which can be assessed. Once it is assessed, meaningful adaptation measures can be designed and employed. One of the fundamental steps in identifying and assessing uncertainty is to analyze the vulnerability of a system. According to Smit & Wandel (2006) "The vulnerability of any system is reflective of the exposure and sensitivity of that system to hazardous conditions and the ability, capacity or resilience of the system to cope, adapt or recover from the effects of those conditions (pg.286)". The amount of exposure and protection thus determines how well a human settlement can recover, rebuild and return back to its pre-disaster state. Vulnerability assessments have been employed by researchers and professionals to identify and highlight important information to stakeholders to reduce uncertainty. The framework for vulnerability assessment is intended to identify sources of vulnerability and develop adaptation strategies which are practical for the community (Smit & Wandel, 2006). A review of vulnerability assessment studies indicates that frameworks should be developed specifically for each application and must consider qualitative and quantitative parameters. There is no standard framework for assessing vulnerability, but there are some key elements which the literature presents that are worth presenting. The core concept is that vulnerability must be assessed at local/community levels since vulnerability can only have meaning to individuals when placed in a social context (Ordonez & Duinker, 2015). Understanding what a community values is critical to determining how to assess vulnerability of those values. Recent climate change vulnerability assessments in Canada have been designed

from the local level up and must always consider three main concept according to researchers (Fussel & Klein, 2006; Ordonez & Duinker, 2015) : 1) exposure to climate; 2) sensitivity to change; and, 3) adaptive capacity (ability to change successfully). One of the main determinants of adaptive capacity is related to socio-economic and political systems (Smit & Wandel, 2006), such as the availability of insurance. Insurance can act as an economic proxy of vulnerability at the local level if it can be assessed. This research will focus on how insurability can be used to illustrate socio-economic vulnerability to climate change. The role of economic vulnerability is an important pre-condition for effective adaptation and looking at insurability is considered a new approach to this.

There have been several vulnerability assessments related to climate change risk mapping across the Atlantic Provinces which have employed a variety of techniques. Flood-risk mapping and sea-level rise mapping have been the most common. Most of these projects depend on technological radar systems such as Lidar to collect data and generate maps. Components such as global positioning systems (GPS) and geographical information systems (GIS) are used to map geological characteristics of the study area. Future scenarios and the effects of climate have been recently mapped out by researcher Andrea Minano who can be credited with developing the AdaptNS webtool (Minano, 2015). Existing vulnerability assessments have yet to incorporate insurability as a socio-economic factor. Climate change scenarios help assess uncertainty by simulating the "what-if" scenarios. Incorporating more socio-economic data such as insurability (affordability and availability) could improve this type of vulnerability assessment to be more valuable to the local community. Vulnerability assessments often lack important economic proxies. The Canadian national assessment titled "Canada in a Changing Climate" (Warren & Lemmen, 2014) argues that insurance is missing in adaptation research. In a local context, such economic information is critical for governments in justifying investments in climate change adaptation strategies. This study will address these gaps by evaluating property insurance markets to climate change risks.

2.6 Literature Review Findings

By analyzing insurability and vulnerability, this research can help address an important gap in providing needed economic information to improve climate change adaptation. Research exists on insurance that identifies how market failures can occur and what contributes to them. The research on climate change shows that uncertainty will increase and so could insurance market failures. Existing tools to reduce this uncertainty for insurance markets are limited and not effective from the perspective of climate change researchers. The methods used by insurers to reduce uncertainty are temporary fixes to symptoms of a problem and can lead to affordability and availability problems. The methods used by public entities (Governments) are subject to political environments, tax payer funding and bureaucratic processes which can also be insufficient.

Adaptation is one way to address limitations. Conducting vulnerability assessments can be valuable for determining where future problems could occur within local communities. These problems would be resultant of a valued societal component being compromised, such as health care, education or economic conditions.

Vulnerability assessments can be improved by incorporating socio-economic data such as property insurance metrics. The major gap in the literature is that insurance is missing as a factor in assessing economic vulnerability. This research will attempt to demonstrate this gap, and that insurance is vulnerable to climate change based on information asymmetries which could lead to insurance market failures.

Insurance offers an additional layer of information for analysis on climate change impacts by providing an important economic indicator for vulnerability. This helps address a significant gap in understanding how climate change risk can contribute to insurance market failures. The following section will develop a framework based on a series of insurance market indicators to assess how these markets are likely to respond to climate change.

3 Methodology: Improving Insurability Indicators

Insurability is defined as the capacity of a market to support available and affordable insurance (Mallon, Lamb, & Wormworth, 2014). In order to measure insurability, insurance premiums must be collected and tested for affordability and availability criteria. Since the concept of measuring insurability is a relatively new field of academic research, there is ample room for improvement of the insurability assessment. The methodology section will first critique the existing insurability study and the four indicators which it produced and utilized. It will examine the strengths and weaknesses of these previously established indicators and propose a revised method which incorporates benchmarks and also produces a more replicable process. Additional indicators will be added which test the principles of insurance, risk-based pricing (RBP) and risk pooling. By strengthening the established indicators and adding two more indicators, the insurability assessment will provide a better sense of any economic vulnerability signals to property owners. This insurability assessment can also provide a snapshot of market behavior useful to other stakeholders with an interest in the property insurance market subject to this research. The outcome of the insurability assessment is to provide an economic proxy valuable to vulnerability assessments and other exercises in socio-economic climate risk assessment.

To date, there has been one known study conducted on "insurability". This study titled *Buyer-Beware: Home Insurance, Extreme Weather and Climate Change* (Mallon, Lamb, & Wormworth, 2014) was used to assess insurability for Australian property owners. However, it was not used as a mechanism to assess insurability as a factor contributing to vulnerability in climate change adaptation research. Nonetheless, this study provides the basis for a framework that can help assess economic vulnerability, particularly market uncertainty that contributes to shortages of availability and affordability. The insurability of a property is based on the capacity for something to be insured by an insurance market; it can be measured by two components; availability of insurance and affordability of insurance. Uncertainty with regards to insurability can be derived from using six different insurability indicators that measure affordability and availability from multi-variant criteria: high premiums/deductibles, availability gaps, price variation, and property pricing differences among various sources. The original four indicators from the Australian study have been critiqued below and proposed revisions are presented to strengthen them.

3.1 Indicator 1: High premium or deductible

To identify heightened premiums, the price of individual properties is compared to the average in both high and low risk locations. According to the research on insurance pricing, premiums should represent the degree of risk being insured. Thus, premiums should be relatively higher in riskier or more exposed locations such as coastal zones, all else being equal (i.e. standardized property and applicant criteria). The higher price can act as a risk signal to buyers because it reflects a greater risk and thus, greater uncertainty when factoring in natural disasters. Premiums that are not heightened, but appear to be in vulnerable areas, are subject to questioning because they do not follow the principle of risk-based pricing. High premiums in areas exposed to coastal hazards suggest that insurers are incorporating uncertainty into their assessment of risk. If premiums are not risk-adjusted to uncertainty, markets could be exposed to an information asymmetry and vulnerable to shortages in availability and affordability as climate change risk increases.

3.1.1 Critique & Revisions

This indicator can show if one or more insurer(s) may be quoting a similar risk much higher than the competition. This indicator illustrates the benefit of shopping to consumers as insurance premiums can change between insurers. Due to competitive market forces, there are too many reasons and variables for this that may be company specific. The reasoning behind this behavior cannot be determined unless the insurance company explains why. Extremely high premiums should be questioned, but insurers are not obligated to explain due to few regulations. A heightened premium can only be viewed as an outlier, but it is still valuable to observe in order to measure insurability.

3.2 Indicator 2: Absentee Insurers

Some insurers may not quote risks in certain locations which could act as an indicator of exposure to risk. Availability gaps can emerge for various reasons, such as loss history in that location, market desaturation and foreseeable future losses (Mallon, Lamb, & Wormworth, 2014). These gaps demonstrate uncertainty as only a limited number of insurers willing to offer coverage. This can be considered a macroeconomic condition associated with absentee insurers who link the locations with unprofitable business operations due to a strong likelihood of claims

occurring. Uncertainty generated by coastal hazards may already be compelling some insurers to stay out of riskier markets. Insurers who appear to be offering coverage in the area through advertisement will be approached and it will be assumed that if they refuse to offer coverage or only offer partial coverage then it is due to geographic exposure. Justification for this assumption is that if all else is equal aside from the address then this is a likely explanation as to declining coverage. The nature of commercial insurance is different in that each policy is unique and coverages are more diverse in order to cater to the variety of business types which are insurable. For this reason, commercial insurance quotes are not obtained in the insurability research.

3.2.1 Critique & Revisions

It can be easy to determine insurers as absent when online quotes are not provided. Many small insurers may not quote online and they should not be labelled as "refusing to quote" because of this. In order to overcome this shortcoming, this research will use a broker to find quotes when online quotes are unavailable. The exact number of insurers who are licensed to offer property insurance in Nova Scotia and PEI is constantly changing and cannot be easily determined.

In the Australian study, the number of insurers polled was not provided and therefore we cannot tell if the same amount were asked in the same regions or not. There is no way to determine what percent of market share is being represented by this method. Since this indicator shows if one or more insurers refused to only provide online quotes, it's a simple presence/absence test. There is no benchmark for how many insurers are expected to respond to quotes, also known as an acceptable response rate. To determine what an acceptable response rate is, this research will target the top 10 insurers in the province/region which will account for at least 80% of market share. This is more representative of the market. An acceptable response rate must be determined. To accomplish this, the response rate in this study will be compared to an average response rate determined by broker industry experience.

3.3 Indicator 3: Price Sheer

The physical location of the property has varying degrees of exposure to climate risk. This should translate to price variation for each property. It could also produce variations in prices between insurers to illustrate their pricing strategies for locations with higher risk exposures. The price variation indicator looks at the price differences between quotes amongst competing insurers for the same risk, assuming that all other contributing factors to property insurance pricing are the same. Large price variations for the same property could be a sign of an information asymmetry between insurers where one may know more information or a lack of information. When a high degree of variation exists, it signals that insurers have a disagreement on how to price insurance and suggests that they have significant differences in their rating models. Price differences with a ratio greater than 2 (highest quote is double that of the lowest) would indicate a significant and questionable imbalance (Mallon, Lamb, & Wormworth, 2014).

3.3.1 Critique & Revisions

The indicator fails to compare premiums to a national average and only compares premiums amongst the collected quotes. There is no benchmark being used to determine affordability and therefore this indicator lacks a comparative value. To address this issue, this research will compare premiums collected to the average property insurance quote for the region/country.

3.4 Indicator 4: Underinsurance

Underinsurance is evident when the amount of insurance purchased does not adequately cover the value of replacing a home of equal value which can result in penalties or only partial payouts from insurers. When property owners choose to ignore the estimated value to insure their home to (provided by either intermediaries or insurers), they are placing themselves at risk of underinsuring.

3.4.1 Critique & Revisions

The Australian study failed to provide what the other value is that they are comparing to in order to determine this indicators values. The average replacement cost is never defined in the study and it only refers to a normal replacement cost without any justification as to what this is. Furthermore, it assumes that building code changes to adapt to climate change will only be more

expensive – which may or may not be the case for certain changes. Since the market is competitive, each insurer may value the home differently. Therefore, this research will determine the average replacement cost for study area using 3rd party software (iClarify) and then compare this average to the insurer provided replacement costs. If property owners trust the insurer provided value, which is assumed in the Australian study, then it can be simple to assess this indicator. However, this indicator is dependent on the insurer providing the replacement cost. If we do not assume that property owners insure to whatever value they are told and determine their own value instead, then other valuation methods such as real estate value and property tax assessment may act as influencers.

To address this issue, this research will look at how close these other valuations methods are to the 3rd party replacement cost value. Municipal tax assessment and real estate values are two figures which could mislead property owners into underinsuring their property. This indicator takes the suggested insurance value and compares it to the municipal tax assessment and real estate values to show the percentage differences in these two figures. The gap between the two values suggests evidence that insurers are incorporating uncertainty about the valuation of property into their assessments.

3.5 Additional Indicators

Although the study tested insurance affordability and availability across Australia by using a set of 4 indicators to measure insurability, it did not investigate if the core principles of insurance were being followed. This research proposes that these must also be assessed and should be subjected to evaluation as they are critical to calculating insurability.

3.5.1 Indicator 5: Risk Based Pricing (RBP)

In order to assess RBP, this study will introduce a new indicator to do this. This research will compare the premiums in vulnerable coastal areas to less vulnerable inland locations in the same region to see if premiums are based on exposures to coastal proximity. Furthermore, it will test for significance between predetermined GIS selected vulnerable location premiums and non-vulnerable location premiums. Statistical analysis will be used to test the significance between the premiums in different risk zones.

If the entire region is vulnerable, then proximity to coast would not be a strong indicator to distinguish risk levels.

3.5.2 Indicator 6: Risk Pooling

The second principle of insurance, risk pooling, will determine if risks of the same degree are being pooled together. High risks should be pooled with other high risks, and low with low. If this is not done, then cross subsidization between the two occurs which creates moral hazards. Determining how risks are pooled can be done by observing the postal code, risk level and premium quoted.

Historically, insurers have rated based on postal code in Canada. All premiums could be the same within the same postal code regardless of risk level. An indication of risk pooling is possible, but the sample size in this study may hinder the ability to exactly determine risk pooling.

3.6 Rationale

This research will attempt to test for insurability within selected coastal communities in Atlantic Canada. Insurability can be used to help assess economic vulnerability and act as an important economic proxy of climate risk. The challenges involved in using insurability as a mechanism to inform vulnerability are important to recognize (limitations are discussed in Section 4.7). Insurance markets can reveal evidence of uncertainty in their assessment of climate change risk through heightened premiums, absentee insurers, price variance, and high reconstruction costs relative to other property valuations. Insurance market vulnerability can be analyzed by looking at indicators that reveal information on the potential for market failure. Insurance markets are vulnerable to climate change and subsequent market failures if any number of the following conditions are met:

1. Insurers are not pricing based on physical, individual exposure (RBP)
    a. This can lead to adverse selection
2. Insurers appear to be pooling different levels of risk together
    a. This can lead to moral hazards
3. Insurance is hard to find/unavailable

    a. This can lead to poor uptake in insurance and places pressure on government resources
4. Significant differences between insurers pricing
    a. This can create market dislocation
5. Reconstruction costs differ from other property valuations.
    a. This can result in under/over insuring

In addition, this study addresses a gap on research on insurability in Canada which has been previously identified by a national assessment that found insurance to be missing as a factor in adaptation research (Warren & Lemmen, 2014). If insurance acts as a tool for societal risk management, then climate change creates uncertainty that could disrupt it. Research on insurance has yet to inform vulnerability assessments as a supporting indicator for socio-economic risks to local communities. Research supports that this will be the first insurability analysis of its kind conducted on Atlantic coastal communities. This research assumes that individuals within the study areas value their property and value the benefits of insurance.

3.7 Data Standardization & Collection Method

3.7.1 Overview

In order to poll multiple insurance companies and have quotes that are comparable, the request for quotation must be standardized. This will require the property and the applicant to be representative of the average home and the average homeowner in the sample size. Next, this research will select sample sites from coastal communities in Atlantic Canada. Both urban and rural settings will be analyzed to help control the data. To select sites which are associated with varying levels of climate risk, information will be taken from vulnerability mapping exercises which have been previously conducted. The maps are compiled from GIS data and utilize catastrophe modelling. Research on insurance suggests that catastrophe modelling can help adaptation planners, including insurers, by simulating "what if" scenarios (LeBlanc & Linkin, 2010).

The coastal communities and properties involved in this research have been obtained from a climate change modelling tool which selects sites based on estimated location of the land parcel

and distance from ocean exposure (see Appendix D & E). The climate change modelling tool, AdaptNS, displays present and future potential coastal flood exposure due to climate change (Figure 13) and can be used to generate catastrophe models. The scenario used in this research will be an extreme storm surge in the year 2100. An "extreme storm surge" is defined as an event that has a less than 1% probability of occurring in a year (Richards & Daigle, 2011; Minano, 2015). Approximately half of the selected addresses will be situated in vulnerable risk zones as determined by the climate change modelling tool and the other half will be situated in non-vulnerable risk zones which are likely to be more protected from coastline exposure as they are located further inland (see Appendix D & E).

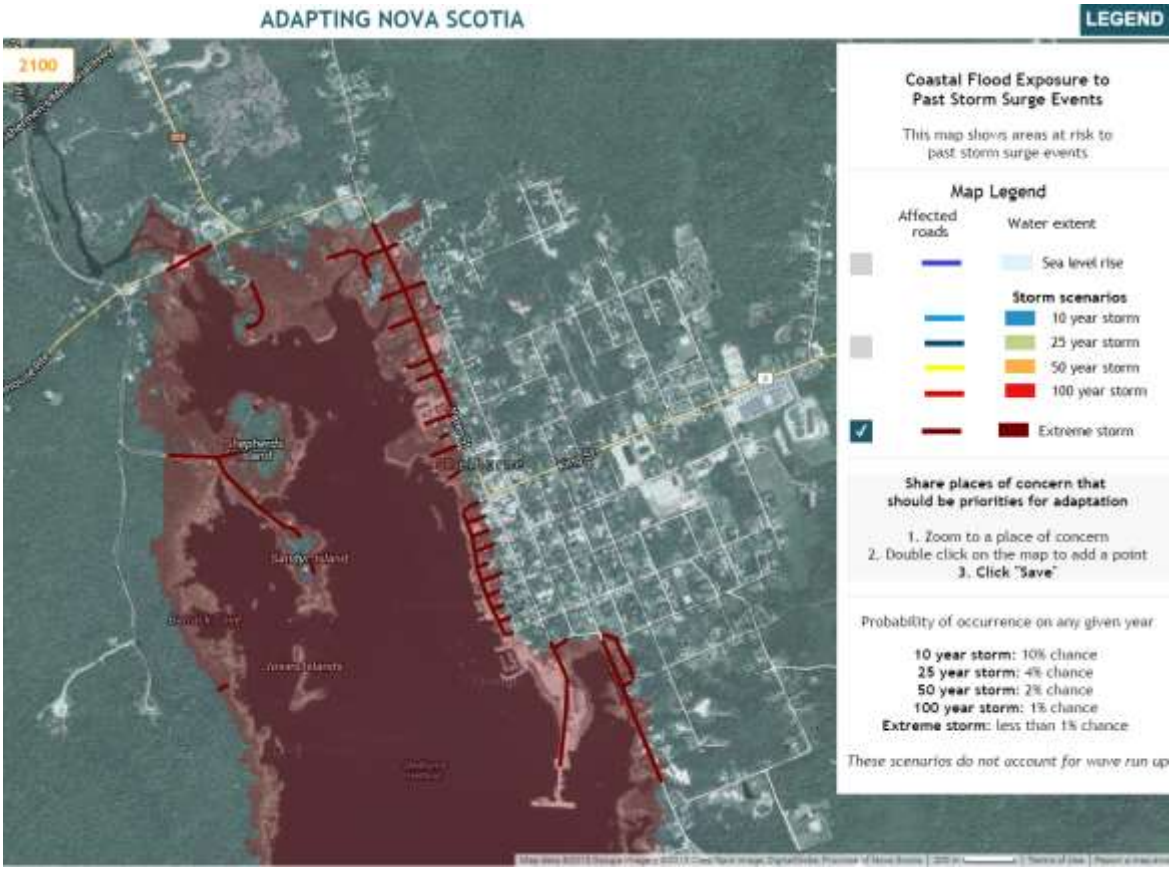

Figure 8: Screenshot of AdaptNS.com (Minano, 2015)

Demographic information for the locations was obtained from City-Data.com which aggregates publicly available data obtained from government and non-government sources. Shelburne and Lockeport, Nova Scotia are home to about 2500 residents with approximately 1000 detached single-family dwellings (City-Data.com, 2015). The city of Charlottetown, PEI is home to

about 35,000 people including 7200 detached homes, 1300 semi-detached homes and roughly 5000 apartments (City-Data.com, 2015). Vulnerable locations and non-vulnerable locations were selected based off previously conducted vulnerability assessments. The first two images below illustrate properties which are subject to an extreme storm in the year 2100 which incorporates sea level rise and erosion into the modelling. Vulnerable addresses are those located in the pink shaded coastal area and the non-vulnerable sites are found outside this shaded area.

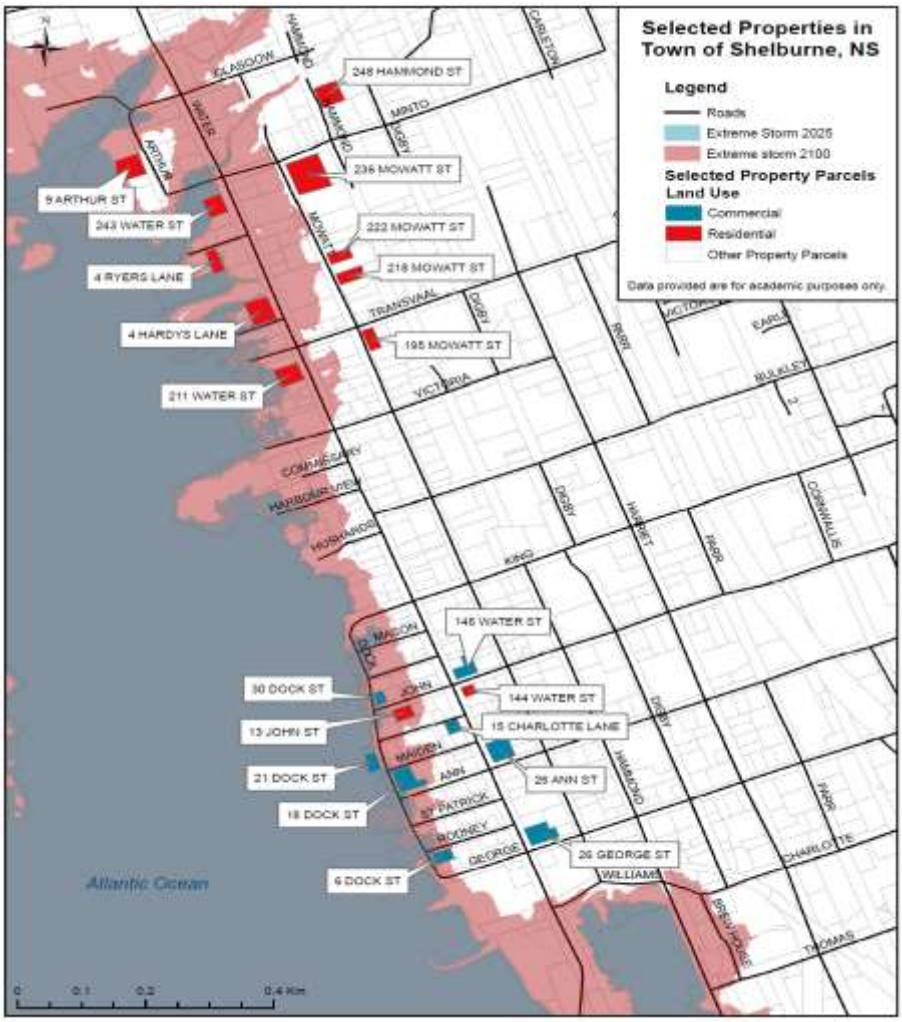

Figure 9: Shelburne, NS: Vulnerable and Non-Vulnerable Selected Sites (Minano, 2015)

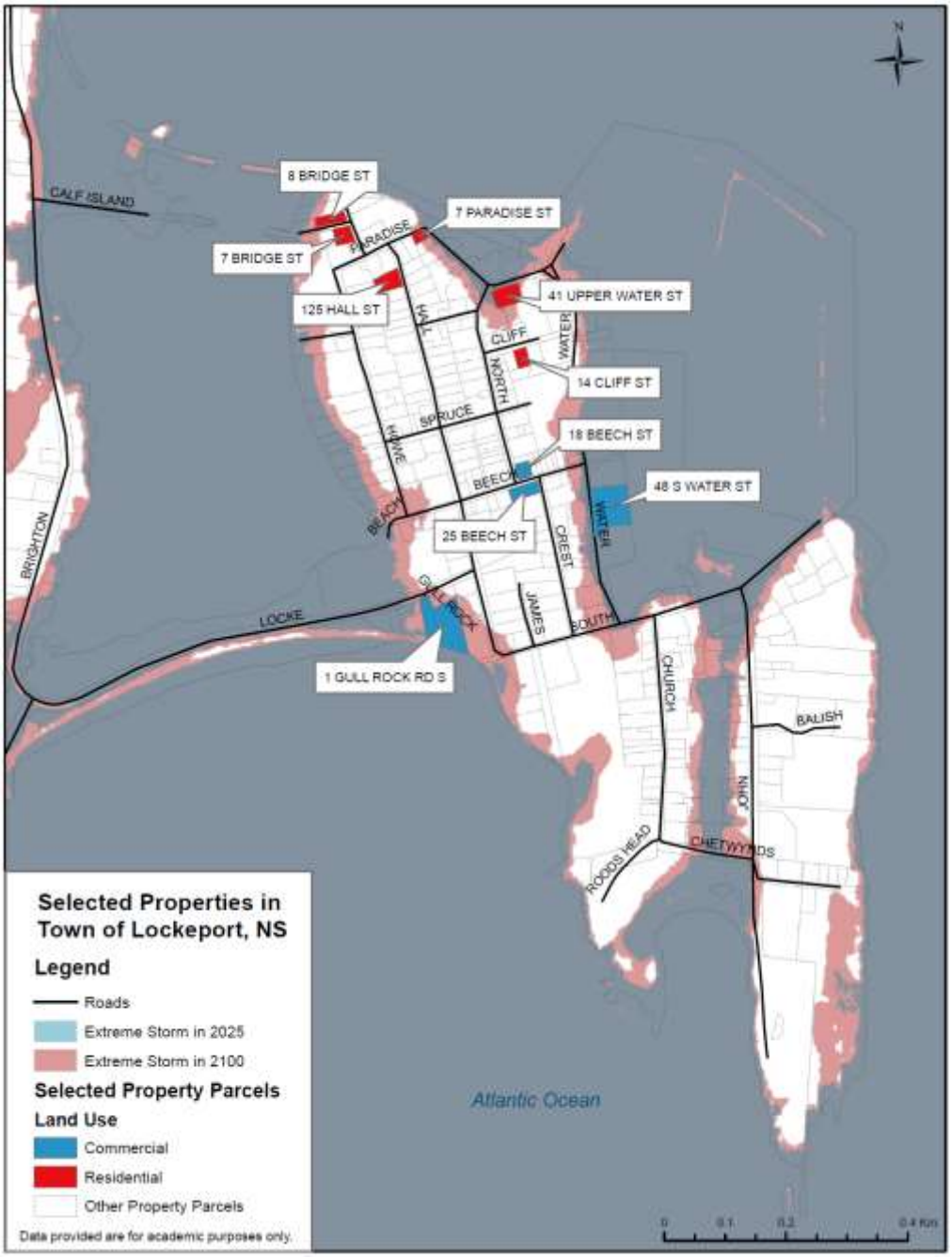

Figure 10: Lockeport, NS: Vulnerable and Non-Vulnerable Study Sites (Minano, 2015)

For Charlottetown, PEI, vulnerable and non-vulnerable locations are displayed separately and have been given their own maps. These maps show the impacts of the same extreme storm in year 2100 with the incorporation of climate risk data provided from multiple sources such as the Nova Scotia Geoscience Survey and Natural Resources Canada.

Figure 11: Charlottetown, PEI: Vulnerable Study Sites (Minano, 2015)

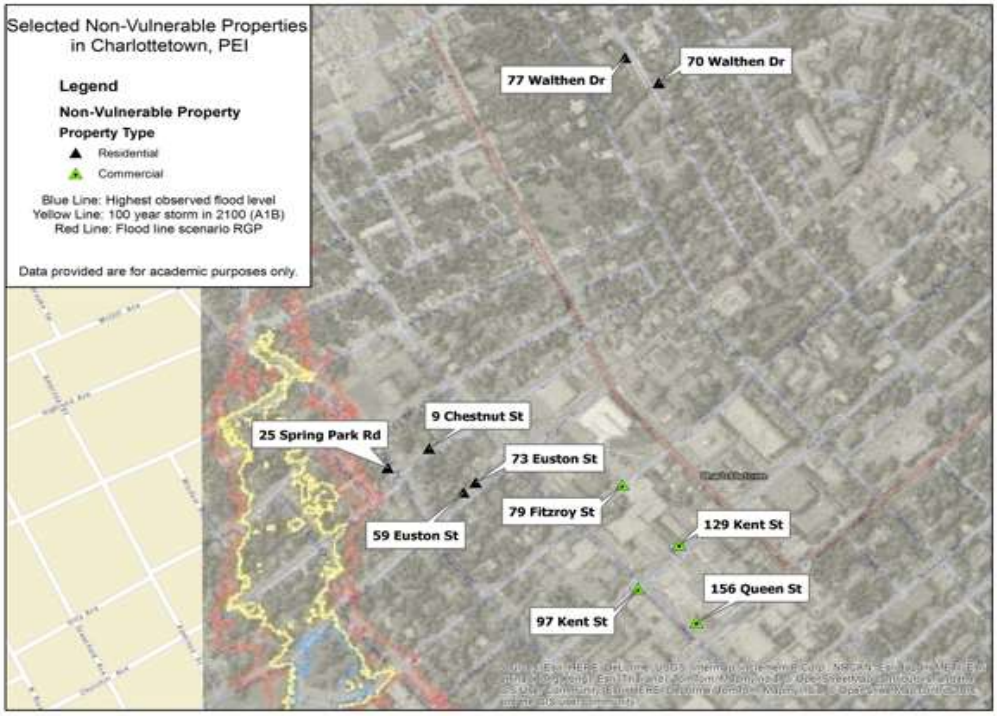

Figure 12: Charlottetown, PEI: Non-Vulnerable Study Sites (Minano, 2015)

3.7.2 Standardization of Residential Physical Properties

A standardized residential profile for properties in Nova Scotia and PEI was developed using a software which is available to insurance brokers known as iClarify (see Appendix B & C). This software provides physical details of most addresses across Canada with support from resources like Google Earth. With iClarify, it is possible to determine the age of the building, construction type, adjacent exposures and many other characteristics. The iClarify software is generally accepted across the insurance industry as being accurate, reliable and up to date.

The information from iClarify was be collected for every residential address in Nova Scotia and PEI in the sample size. This information was then be sorted to determine the most common characteristics found for residential properties. A standardized property will be created to control the variability and will help provide a method for comparison. The goal is to quote the same type of building in different geographic locations as determined by its vulnerability to climate change (identified by the AdaptNS GeoWeb tool).

In order to control for variability in both residential property values, a suggested insurance to value figure will be used which is generated by using iClarify. The insured value is the cost to reconstruct the home at the same address if there was a total loss such as a fire. This value is different than the real estate values which can be found on public domain databases such as the Multiple Listing Service (MLS). MLS values are market prices which are not indicative of the cost to rebuild the structure. In many cases, the real estate value would be far greater than the cost to rebuild the structure, while in other cases it could be lower than the cost to rebuild a home. The benchmark value will be determined by averaging the values for residential properties obtained from the broker software for each sample location. This value will be known as the suggested insure-to value (SITV) and will act as the value which represents the replacement value of the home, otherwise known as insuring-to-value (ITV) (see Appendix D & E). Insurance brokers are licensed to provide customers with the suggested insure-to value and make the suggestions in the best interest of the insured so that in the event of a total loss, their policy has adequate limits to replace/rebuild everything to equal or greater value.

3.7.3 Standardization of Residential Applicants

When gathering insurance quotes for comparative research, the standardization of the applicant seeking insurance is equally as important as standardizing the property. Claims history always follows the applicant/property owner and is not attached to the physical property. Whenever a property owner applies for insurance they are rated based on their previous claims history from previous locations. The claims history of an applicant is an important rating factor. Since details on an insurance application such as claims history can affect the quoted insurance premium, a standardized applicant will be developed which represents a person who is in good financial standing and has had insurance with no claims for at least 3 years. Other characteristics associated with good financial standing will also be applied (see Appendix B & C for details). The same applicant profile will be used for all the residential properties in Nova Scotia and PEI. This process ensures that all demographic and financial information will be the same for each insurance quote in order to provide premiums which can be compared with respect to the only changing variable–geographic locations with climate change vulnerability.

3.8 Obtaining Insurance Quotes

Kanetix (www.kanetix.ca) is a public online property insurance quoting system that can be used to obtain multiple quotes from different insurance companies for residential property locations. Kanetix is known as an aggregator because it collects data from a wide range of insurance providers and organizes this data for consumers. Since Kanetix only offers quotes from a portion of the available insurance companies, direct contact will also be attempted with non-participating insurance companies via their websites. A quote will be obtained for each individual address in the sample size using the standardized property and applicant information. The data for insurance quotes will be collected though an associated broker contact because public access to the professional quoting software is not allowed. The software is known as CompuQuote and connects the broker with multiple insurance companies to which they have agreements with to provide quotes. Limitations around this are discussed in Section 4.7.

4 Findings & Analysis

The following section will assess the findings from indicators that measure insurance vulnerability to coastal hazards generated by climate change.

4.1 Indicator 1: Heightened Premiums

After gathering the quotations, a heightened premium was observed in the Shelburne/Lockeport sample. Insurer 4 was discovered to be quoting premiums more than 5 times that of market competition in the same area.

Table 5: Premiums Collected for Nova Scotia

	Address	Location	Postal Code	Insurer 1	Insurer 2	Insurer 3	Insurer 4
Non-Vulnerable - Lower Risk	7 Bridge St	Lockeport	B0T 1L0	$ 1,009	$ 794	$ 920	$ 4,102
	125 Hall St	Lockeport	B0T 1L0	$ 1,009	$ 794	$ 920	$ 4,102
	14 Cliff St	Lockeport	B0T 1L0	$ 1,009	$ 794	$ 920	$ 4,102
	236 Mowatt St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	218 Mowatt St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	195 Mowatt St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	144 Water St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	222 Mowatt St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	248 Hammond St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	15 Charlotte Lane	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
Vulnerable - Higher Risk	8 Bridge St	Lockeport	B0T 1L0	$ 1,009	$ 794	$ 920	$ 4,102
	7 Paradise St	Lockeport	B0T 1L0	$ 1,009	$ 794	$ 920	$ 4,102
	41 Upper Water St	Lockeport	B0T 1L0	$ 1,009	$ 794	$ 920	$ 4,102
	9 Arthur St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	243 Water St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	4 Ryers Lane	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	4 Hardys Lane	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	13 John St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	211 Water St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	6 Dock St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182

A heightened premium was also observed in the Charlottetown sample size. Insurer 4 was discovered to be quoting premiums nearly 2 times that of market competition in the same area. The insurer was contacted as to why they were quoting so much higher than other in both provinces but no response was obtained. Please see Section 4.8.1 for further analysis.

Table 6: Premiums Collected for PEI

	Address	Location	Postal Code	Insurer 1	Insurer 2	Insurer 3	Insurer 4
Non-Vulnerable - Lower Risk	73 Euston St	Charlottetown	C1A 1W1	$ 665	$ 575	$ 733	$ 1,093
	59 Euston St	Charlottetown	C1A 1W1	$ 665	$ 575	$ 733	$ 1,093
	25 Spring Park Rd	Charlottetown	C1A 3X7	$ 665	$ 575	$ 733	$ 1,093
	9 Chestnut St	Charlottetown	C1A 1Z5	$ 665	$ 575	$ 733	$ 1,093
	70 Walthen Dr	Charlottetown	C1A 4T8	$ 665	$ 575	$ 733	$ 1,058
	77 Walthen Dr	Charlottetown	C1A 4T7	$ 665	$ 575	$ 733	$ 1,058
	75 Fitzroy St	Charlottetown	C1A 1R6	$ 665	$ 575	$ 733	$ 1,058
	129 Kent St	Charlottetown	C1A 1R6	$ 665	$ 575	$ 733	$ 1,058
	96 Kent St	Charlottetown	C1A 1M9	$ 665	$ 575	$ 733	$ 1,058
	156 Queen St	Charlottetown	C1A 4B5	$ 665	$ 575	$ 733	$ 1,058
Vulnerable - Higher Risk	265 Dorchester St	Charlottetown	C1A 1E8	$ 523	$ 575	$ 733	$ 870
	237 King St	Charlottetown	C1A 1E8	$ 666	$ 575	$ 733	$ 1,068
	227 King St	Charlottetown	C1A 1E8	$ 666	$ 575	$ 733	$ 1,068
	217 King St	Charlottetown	C1A 1E8	$ 666	$ 575	$ 733	$ 1,068
	203 Water St	Charlottetown	C1A 1B1	$ 666	$ 575	$ 733	$ 1,093
	103 Weymouth St	Charlottetown	C1A 0B4	$ 666	$ 575	$ 733	$ 1,093
	3 Queen St	Charlottetown	C1A 4A2	$ 666	$ 575	$ 733	$ 980
	4 Prince St	Charlottetown	C1A 4P5	$ 666	$ 575	$ 733	$ 980
	2 Prince St	Charlottetown	C1A 0C4	$ 666	$ 575	$ 733	$ 980
	2 Queen St	Charlottetown	C1A 4A2	$ 666	$ 575	$ 733	$ 980

Extremely high premiums should be questioned, but insurers are not obligated to explain due to a lack of regulations which would require this. A heightened premium can only be viewed as an outlier if no other information is available, but it is still valuable to observe to assess the market. The price difference between insurers was much greater in the rural setting in Nova Scotia compared to the urban setting in PEI. This could be due to reconstruction costs and the desirability of that risk to the insurer quoting heightened premiums. It is important to note that only one heightened premium was observed being quoted in both locations and the other insurers were within close range of each other's quotes.

4.1.1 Heightened Premiums Analysis

Insurer 4 was discovered to be quoting premiums more than 5 times that of market competition in the same area. The insurer was contacted as to why they were quoting so much higher than other but no response was obtained. There are too many variables and this behavior cannot be explained unless the insurance company explains it to the public. This heightened price may be a signal that the insurer does not want to be seen as refusing to quote insurance, but yet still deter

customers from choosing them in this coastal community. Regardless of the reason, a heightened premium that is significantly greater than the average is reason to link it to information asymmetries. In this research, a heightened premium would deter an individual from selecting the insurer if they had other choices to select. Having only uncovered one insurer who is showing a heightened premium becomes more of a concern when considering the low 40% response rate which will be discussed in the next section.

4.2 Indicator 2: Availability gaps

In order to assess the response rate for the two sample sites, the methodology for this was designed to be replicable. The method for this indicator consisted of targeting the top 10 insurers in the province/region which represents at least 80% of market share. The top 10 will could be more likely provide online quotes, although this is not assumed. A licensed insurance broker was used when online quotes were unavailable to fill in missing information. In order to determine what a normal response rate is, an acceptable response rate must be determined. To accomplish this, the response rate in this study will be compared to an average response rate determined by broker industry experience. There were no studies to provide what a reasonable response rate for insurers should be. The broker contacts all believed that a 60% response rate is typically what they would expect if they submitted 10 quotes to the top 10 insurers in their province. The research method for this indicator is designed to provide a snapshot of availability.

In both Nova Scotia and PEI there were only 4 insurers that responded from the top 10 leading companies based on direct written property insurance premiums in the respective provinces. It is important to note that the insurers polled use a variety of distribution channels. This included broker based insurance companies, agency based insurance companies and direct writing insurance companies. The top 10 represent over 80% of the market share in each province and also represent different distribution channels which will help control the data. With a response rate of only 40% in each community, the accessibility of insurance was limited but still available. If a broker was used to find other residential quotes from outside the top 10 there would be an opportunity to collect more responses. Please see Section 4.8.2 for further analysis.

4.2.1 Absentee Insurer Analysis

The overall availability of insurance was limited to only the top 10 insurers providing quotes. The method used to approach insurers did not have an impact on the response rate as all insurers in the top 10 for property insurance provide quotes either online or through a broker. Of those that did, the response rate was less than half. When insurance is difficult to obtain, consumers can face frustration and even become exhausted in search of affordable insurance. As climate change risk increases, claims activity will likely increase in coastal communities due to more severe weather impacts. The existing scarcity of insurance providers indicates a further indication that availability could decrease.

Availability gaps can encourage poor uptake since it can create a more difficult environment to find insurance and limits the amount of options available. When considering climate change projections, this low response rate could be a premature signal to the decline in availability of insurance or existing concerns about the exposure of coastal communities to natural hazards. Insurers are likely responding to loss history in that location, market desaturation and foreseeable future losses (Mallon, Lamb, & Wormworth, 2014). More importantly, evidence of absentee insurers suggest uncertainty that could lead to market failure as more insurers may limit their exposure to the market as more information becomes available on climate change risk. It also presents complication for consumers who want a variety of choices to leverage the benefits of competition.

4.3 Indicator 3: Price Sheer

This indicator looks at the price differences between the lowest and highest quotes amongst competing insurers for the same risk, all else being equal (property features, applicant characteristics and coverages). Insurers who quote high premiums in comparison to others could be indicative of an information asymmetry or lack of information as some insurers could be integrating information on proximity to coastal hazards, while others are not. Price differences with a ratio greater than 2 (highest quote is double that of the lowest) would indicate a significant and questionable imbalance (Mallon, Lamb, & Wormworth, 2014). Small differences can be expected as price will vary between insurers but likely at marginal values. The ratio was determined by dividing the highest premium quoted by the lowest premium quoted (Table 6).

Table 7: Insurance Price Variation of Residential Properties in Nova Scotia and PEI

Residential Price Variation Summary for Shelburne/Lockeport

Address	Postal Code	Quotes Lowest	Quotes Highest	Ratio H/L
Lockeport, NS	B0T 1L0	$ 794	$ 4,102	5.17
Shelburne, NS	B0T1W0	$ 794	$ 4,182	5.27

Residential Price Variation Summary for Charlottetown

Location	Quotes Lowest	Quotes Highest	Ratio H/L
Charlottetown	$ 575	$ 1,093	1.90

Price variations were greater in the Shelburne and Lockeport areas but only one insurer was observed at pricing insurance at a much higher price than the others. But, the price variation between insurers can be up to 5 times greater when comparing the highest premium quoted to the lowest premium quoted in Nova Scotia. This is evidence of information asymmetry between insurers as at least one insurer is rating differently than others. For PEI, the price variance was much less and indicated a more "level playing field" of prices for consumers and more similar risk knowledge between insurers. When comparing the two quotes for the same property in PEI, no major price variations were noticed. This indicates that the averages used in this study accurately represent the sample population which helps verify the standardized property details.

As it stands, this indicator fails to compare premiums to a national average and only compares premiums amongst the collected quotes. There is no benchmark being used to determine affordability. In order to improve this analysis, a comparison of premiums collected to the average property insurance quote for Canada should take place. This will allow a price sheer to be determined based off the national average and will indicate if premiums are higher or lower than the national average. The last time a national poll was done to determine what the average Canadian homeowners paid for insurance was in 2012. At the time, research conducted by InsurEye Inc determined that the average price was $840 (Canadian Underwriter, 2013). According to the Bank of Canada's inflation calculator, after adjusting for inflation over 3 years, that number should now be $876 (Bank of Canada, 2015). The last step is to determine what the average premiums for Nova Scotia and PEI are (for all levels of vulnerability) and then calculate the price sheer compared to the national average of $876.

Table 8: Study Sample Average Premium vs National Average Premium (2012)

	Average Premium Quoted	National Average 2012	Ratio
Lockeport/Shelburne, NS	$1721	$876	1.96
Charlottetown, PEI	$753		0.86

The average premium quoted in Nova Scotia reveals that is nearly twice that of the national average. In PEI, homeowners appear to paying below the national average by about 14%. The average premium in Nova Scotia is influenced by the extremely high premium observed in Nova Scotia, but a heightened premium was also observed in PEI to a smaller degree. Please see Section 4.8.3 for further analysis.

4.3.1 Indicator 3 – Price Sheer Analysis

Using residential data from the Shelburne/Lockeport analysis, we saw that insurer 4 quoted a much higher premium in comparison to the other 3 in the sample. This heightened premium is over 5 times that of the lowest quote which indicates a significant disagreement between insurers on their pricing model. Using heightened premiums can send a risk-signal to property owners, especially those who may be considering purchasing a new home on the coast.

However, the other insurers all quoted around the same premiums which means that property owners who shop around their insurance would likely benefit the most in terms of finding the lowest premium. A low insurance premium is associated with the perception of lower-risk exposure and could easily lead to moral hazard and adverse selection. In the event of a large hurricane, those who dwell along coastal areas will experience greater damage than those further inland. The resources to rebuild or relocate the most badly damaged homes will come from the larger pool of insurance premiums, similar to how disaster aid will come from a large proportion of taxpayers who experienced little to no damage at all. A higher price signal could provide the necessary information for those homeowners to make an informed purchase and protect their assets accordingly if they choose to live in a vulnerable location. When one insurer quotes significantly higher, it signals that they perceive the a higher risk associated with that property. I this case, insurer 4 views all properties in the sample size as high risk. When factoring in climate change uncertainty and the information asymmetry this indicator presents, there is an increased potential for a market failure through adverse selection.

4.4 Indicator 4: Under-insurance/Over-insurance Influencers

This indicator compares the average replacement cost as determined by industry software with 3 other valuations; insurer provided replacement cost, municipal tax assessment value (MTAV) and real-estate market prices (MLS). The method to calculate this indicator will require the replacement cost to be determined for each sample property and calculate the average. The replacement costs will be determined by software called iClarify which licensed insurance brokers and other professionals are trained to use. This research will set the iClarify value as the value which homeowners should insure to because this would be the value a broker would advise their clients to insure to. The iClarify average will be compared to the average of insurer provided replacement costs, the average MTAV and the average MLS. The percent difference can be observed to determine how appropriate the valuation methods are and just how much they could possibly influence a homeowner who does not use a broker to help them determine their replacement cost. A homeowner may trust the insurer's suggestion, but they may also require a lower or higher value depending on a variety of factors which pertain to each individual homeowner.

Table 9: Residential Relative Pricing Summary for NS and PEI

	Average iClarify ITV	Average Insurer ITV	% of iClarify	Average MTAV 2015	% of iClarify	Average MLS	% of iClarify
Lockeport/Shelburne, NS	$218,333	$287,500	**132%**	$68,656	**31%**	$62,365	**29%**
Charlottetown, PEI	$220,230	$230,667	**105%**	$185,000	**84%**	$275,000	**125%**

What this table shows us is that if a homeowner trusts the insurer provided valuation, they could likely be overpaying to insure their property. Consumers would probably rather over-insure by a fraction rather than under-insure by a fraction since the consequences are greater for under-insuring. Homeowners could also over-insure if they based their valuation off of real estate markets, but only in Charlottetown. Property owners in Shelburne/Lockeport, NS are at a much greater risk of underinsuring their property if they used either MTAV or MLS values. Please see Section 4.8.4 for further analysis.

4.4.1 Indicator 4 – Over/Under Insurance Analysis

Individuals who purchase insurance online and without the support of a broker or agent may risk underinsuring their property if they base their valuation off another type of property valuation. As consumers increase demand for online purchases and insurers provide more online options, this scenario could become problematic to individuals and their insurance market. Consumers must have a clear and obvious way in which they can educate themselves and be aware of the reconstruction cost of their home. The reconstruction value is not comparable to other means of valuing their property. Other means of property valuation are intended for different purposes and can vary greatly from the reconstruction cost. These other means of valuation (MTAV and MLS) are mostly likely to be significantly less than the reconstruction cost. They are not appropriate for insurance valuation purposes. Insurers may be acting conservative in their pricing of coverages by assuming higher levels of uncertainty than the real-estate property market.

4.5 Indicator 5: Risk-Based Pricing

This will compare the premiums in vulnerable coastal areas to less vulnerable inland locations in the same region to see if premiums are based on exposures to coastal proximity. This indicator used a statistical test to look for any significance between pre-selected vulnerable locations and non-vulnerable location premiums to see if they indicate different risk levels. If the null hypothesis is that insurers are utilizing RBP, we can determine if this principle is being practiced or not based on the prices being quoted in different risk zones. As an additional measure to control the data, the quotes from NS are based in a rural area and the quotes from PEI are based in an urban setting. These two settings will help control data by providing two different types of coastal communities with similar risk exposures. The average premiums of the vulnerable locations in NS were compared to the average of the non-vulnerable locations. From observing the data set, it appears evident there are no changes between risk zones, but this will be tested using statistical analysis to confirm in Section 4.8.5.

4.5.1 Indicator 5 – RBP Analysis

When RBP is not being utilized in vulnerable coastal communities, market failures could become a reality when factoring in future climate risk. The statistical analysis tested for this and RBP

appeared to be absent from the sample size. From observing the data set, it appears evident there are no changes between risk zones, but this will be tested using statistical analysis to confirm.

Table 10: Statistical Analysis for RBP

Shelburne/Lockeport, NS	
	Mean
Vulnerable	1720.95
Non-Vulnerable	1720.95
t-Test: Two-Sample Assuming Equal Variances	
t STAT	0
P-Value (two-tail)	1
T-Critical (two-tail)	2.1

Charlottetown, PEI	
	Mean
Vulnerable	761.25
Non-Vulnerable	744.425
t-Test: Two-Sample Assuming Equal Variances	
t STAT	1.92
P-Value (two-tail)	0.07
T-Critical (two-tail)	2.10

After taking the averages of vulnerable and non-vulnerable locations in NS and PEI, a two-sample assuming equal variance t-test was performed. This type of test was chosen due to the small sample size and minimal variations in premiums. All of the premiums in NS are nearly the same, which will lead the P-value to be near 1 (rounded up). In the PEI data, the P-value tells us that the hypothesis has a large degree of uncertainty. If the null hypothesis is that premiums are based on risk levels, then riskier locations should cost more to some degree. The t-test results shows us that we should reject this null hypothesis and replace it with an alternate. In this case, the alternate is that premiums are not linked to risk in the sample population because the t-STAT is less than T-Critical value in both NS and PEI samples. This finding suggests that physical location and potential exposure to a natural hazard is not incorporated into decision-making on premiums.

4.6 Indicator 6: Risk Pooling

This indicator will assess the second fundamental principle of insurance, risk pooling. Risks of the same exposures should be pooled together. High risks should be pooled with other high risks, and low with low. If this is not done, then cross subsidization between the two occurs which creates moral hazards between the low risks and the high risks. It can also lead to moral hazards. Determining how risks are pooled can be done by observing the postal code, risk level and quote premium. Historically, insurers have rated based on postal code in Canada. All premiums could be the same within the same postal code regardless of risk level. An indication

of risk pooling is possible, but the sample size in this study is too small to exactly determine risk pooling. Aside from this limitation, general risk pooling can still be observed.

The lack of differences in premiums between high and low risk areas suggest that insurers are pooling risks across geographic areas to create a large enough risk pool to keep premiums affordable. The results from the statistical test help confirm this. Multiple postal codes are being pooled together in both samples from NS and PEI regardless of exposure to climate risk/physical hazards. Insurers can draw on reserves generated by this large risk pool to compensate homeowners disproportionately exposed to coastal hazards in the event of weather damage. But, these risk pools fail to provide a price signal which correlates to the risk. Adverse selection can emerge as a consequence of this asymmetry as insurers are offering coverage in high risk areas that does not adequately price for risk exposure. In addition, without sufficient price signals, property owners are exposed to a moral hazard since they assume they are taking sufficient actions to reduce their exposure to risk. Insurance companies may not taking the adequate steps to ensure they have generated enough capital in their reserves to compensate for exposure to climate change risks. As more research on climate change risk emerges, insurers will have an incentive to adjust their risk exposure by raising rates and reducing coverage to limit moral hazard and adverse selection. Please see Section 4.8.6 for further analysis.

4.6.1 Indicator 6 – Risk Pooling Analysis

The last indicator illustrates that vulnerable and non-vulnerable addresses are all being pooled together in the same risk pool. This presents consumers with the illusion of a low premium and creates a low risk perception. In a large risk pool of policyholders, the higher risk individuals are being subsidized by the lower risk individuals. This is evident because the premiums obtained in this research show there is no change across postal codes. The uncertainty of future climate risk could magnify the extent which the lower risk individuals are subsidizing the higher risk properties and become subject to premiums which are unaffordable. Research on risk pooling that relies on subsidization strongly suggests that this masks the price associated with the risk and is ultimately unsustainable (LeBlanc & Linkin, 2010).

4.7 Limitations of Insurability Assessment

There are a number of important limitations in adopting this approach to assessing insurance vulnerability. The use of public information limits the amount of data available and the quality of data available. The sample size for example would need to be expanded to develop more evidence of the significance between climate change uncertainty and insurance pricing. This research only polls a portion of insurance companies which are licensed to sell insurance in Nova Scotia and PEI. The public access to Kanetix.ca is limited but provides access to multiple insurers which is adequate for "shopping" purposes. The data obtained was collected from March 2015 to June 2015 and is only representative of that time period. The AdaptNS climate change modelling tool is an online geographic web tool. It is an example of a larger collection of Geoweb tools that was customized for the use municipalities and citizens in Shelburne County (9 communities in total, including the Town of Shelburne and the Town of Lockeport, but not Charlottetown). The maps referenced for Charlottetown in this thesis were not made from AdaptNS. They were made using a GIS software, and some of the information in those maps is the same as those found in AdaptNS (e.g.: flood zones), but they also include other information that is not found in the tool (e.g.: specific addresses, property parcel boundaries).

For coastal communities, greater access and collection of local data is critical to pricing risks appropriately at the regional level. Postal code rating is currently utilized as a primary rating factor for property insurance (Harris, 2015). The first three digits of a postal code reveals the province, urban or rural area and the city/town; the last three digits can indicate a city block, neighborhood, or rural community but not the exact geographical location (Canada Post, 2015). Postal codes are limited and the postal code by itself is not sufficient to obtain the exact location. For this reason, it is often argued that additional information from other sources is required to determine the exact geographic location of a property (Statistics Canada, 2006).

It is important to note that there was no method developed to determine which factor each insurer puts more weight on for rating purposes. Information such as this would be competitive in nature and a strong component of the insurers business model. It would be confidential and unavailable to the public. It is also important to note that there could be multiple reasons aside from climate change for an insurer not offering coverage such as business strategies,

consolidation, management restructuring and change in appetite. Despite these limitations, the project offers an "snapshot" of the insurance market's interaction with existing and future physical hazards. Missing data and limitations associated with uncertainty insurance assumptions represented important gaps for future research projects to address.

4.8 Linking Insurability Assessment to Economic Vulnerability

Insurability can be assessed for its contribution to economic vulnerability by testing the insurance markets in areas where climate risk is likely to impact the community over long term timelines. If insurance markets show signs of poor insurability and market failure then this could act as a warning signal to both consumers and insurers. Furthermore, it can be used to advance the discussion on homeowner and market adaptation to climate risk.

There are multiple limitations outlined in Section 4.7 which provides an overview of the weaknesses of this insurability assessment research. The main strength of the assessment is that it attempts to quantify if insurance markets are priced adequately to account for current and future climate risks. It also serves to inform homeowners of the important of insurance and the many complexities it can present. The insurability assessment also tests for insurance which is affordable and available. These two key points are of great interest to those who need insurance and those who provide it. Insurability assessment can contribute greatly to helping consumers and insurers make informed decisions with all this information.

The Australian research where the first insurability assessment was presented did so from the "buyer-beware" perspective. Although it included some considerations for climate change, it did not attempt to analyze and compare zones with different risk levels. This research incorporates current and future geophysical data in order to determine how the markets are prepared for a climate change scenario. This research contributes to research on climate change vulnerability by providing a new type of assessment which can be used to support economic vulnerability assessments.

The insurance vulnerability analysis indicates evidence of uncertainty that can cause market failures even in the absence of climate change. When factoring the projections of climate

change, insurance markets in coastal communities could become increasingly vulnerable to greater claims activity and insurance market failures. This evaluation reveals that the current pooling of risk in coastal communities could jeopardize the affordability and availability of insurance if climate change projections hold true. Thus, market adaptation measures to climate risk will be essential to sustaining communities socio-economic livelihoods.

These alternate home valuation methods are misleading for insurance purposes. Real estate values for residential properties in Nova Scotia were undervalued by an average of 75% when compared to the replacement cost insurance valuation. Municipal tax assessment values were also undervalued by an average of 60% in Nova Scotia and undervalued by an average of 20% in PEI for both residential properties. Under valuing for insurance purposes can result in the property owner not receiving adequate coverage which can result in a shortage of insurance to cover replacing the home to its proper value after a total loss. Insurers may provide a value to insurer to which is based on their own estimates as to what it's replacement cost should be. They do not disclose how this calculated nor is this practice subject regulations. In PEI, real estate valuations were overvalued by an average of 20% for residential properties. Over estimating insurance can result in the property owner paying for too much coverage when it is not needed. Excessive coverage can lead to consumer mistrust if premiums are collected for unnecessary insurance coverage.

4.8.1 Improving insurability as a means to assess vulnerability

After making improvements to the insurability assessment process by modifying previous indicators and adding in 2 additions indicators, insurability can be used as a means to assess vulnerability. The insurability assessment results reveal areas that show sensitivity and exposure to market failures that could be exacerbated by climate risk. When insurability indicators can be linked to a potential market failure then an opportunity to determine vulnerability presents itself. Market failure signals can be linked to vulnerability through the likelihood of exposure and sensitivity analysis. Assessing vulnerability, as shown in the literature review, can be done by looking at the three main considerations: exposure to climate change, sensitivity to change and adaptive capacity. These three components will need quantitative and qualitative factors (or a

combination) to be selected which apply to insurability. These factors must be measureable and replicable. The vulnerability components below can be linked to the insurability assessment:

1) Exposure to climate change
    a. The insurability indicators can be used to illustrate economic vulnerability based on exposure to climate risk and environmental/weather related hazards. Indicators which relate to affordability are most valuable in determining this as we know that exposures should be properly priced. If exposures are not priced accordingly (RBP), there could be a higher degree of vulnerability.

2) Sensitivity to climate change
    a. The insurability indicators can be used to illustrate economic vulnerability using indicators which suggest impacts to the availability of insurance. Sensitivity can be gauged by how available insurance is within the sample sites. The greater the availability of insurance, the less insurance markets are vulnerable to climate risk.

3) Adaptive capacity
    a. This component of vulnerability is too difficult to calculate for two reasons. The first is that it is hard to tell how much adaptive capacity insurers have. As there is a lack of regulations surrounding the property market, this could provide freedom for insurers to adapt quickly although they could also each adapt differently from each other. However, the true adaptive capacity can only be assessed in a post-disaster situation which is a major limiting factor and thus it is not possible for this research to determine adaptive capacity of the insurance markets studied in this research.

4.8.2 Indicator Market Failure and Vulnerability Linkages

The results are suggestive of potential failures in insurance markets in the coastal communities subjected to this research. They can be linked to the traditional components required to assess vulnerability.

Heightened premiums were uncovered in NS and PEI. This illustrates an information asymmetry to a certain degree than could contribute to future market failures. However, it cannot be determined based on this alone that it would create market failures, although it could signal individual insurers appetites for not wanting to insure certain risks. As a vulnerability signal, unexplained high premiums could impact exposure if climate risk increases in coastal communities.

Insurers representing 60 percent of the markets did not provide quotes when approached. When insurers are absent, it makes it more difficult to find insurance which could result in poor uptake in insurance which a type of market failure. The less the availability of insurance is, the more a market is sensitive to climate related losses and therefore can be used to measure sensitivity in assessing vulnerability.

Price sheers where discovered in NS and PEI with a significant sheer in NS. This signals the same type of information asymmetry as heightened premiums. This indicates a high degree of variations between quotes, which means exposures are being priced differently. This can create confusion among customers and can be used to measure potential exposures in assessing vulnerability

In the over/under insurance indicator, all replacement cost valuations were different from the benchmark value. This can present a moral hazard since property owners may choose to ignore suggested values to insure their homes to. They may choose an alternative method, which could influence their amount of insurance for the worse. It could also result in overpaying for insurance that will never be used. If climate risk increases claims activity, insurers could limit their exposures by only insuring up to a certain limit, especially in areas with high claims

activity. This could limit availability and therefore links to the sensitivity component of assessing vulnerability.

Insurers were not discovered to be utilizing the principle of RBP. This presents are moral hazard because when the price does not reflect the true level of risk, individuals have little incentive to prevent damage from happening if insurance is affordable and available. This can be linked to the exposure component of assessing vulnerability because exposures are not being priced according to risk which means the market is vulnerable if claims increase or disaster occurs.

Lastly, property insurance quotes appeared to be pooled by postal code rather than proximity to coastal risks. This is can lead to adverse selection as high risk property owners who are aware of this may use it to their advantage and rely on lower risk individuals in the same postal code to subsidize their premiums. This can be linked to the sensitivity component of assessing vulnerability because prices are not determined by individual characteristics which means the entire pool is being rated the same. This could increase vulnerability to disasters and make pricing more sensitive in a post-disaster scenario

5 Conclusion & Recommendations

As climate change increases the frequency, intensity and duration of extreme weather, the availability and affordability of property insurance could decrease as the private sector absorbs economic losses generated by property damage. Coastal communities are particularly exposed to natural hazards that can increase uncertainty for insurers and lead to shortages in the availability and affordability of insurance coverage. Climate change has the potential to generate insurance market failures in some locations where coverage is simply too expensive for policyholders to purchase or insurers to provide.

This research contributes to an improved framework for assessing insurability by addressing the shortcomings in previous research and by establishing two additional indicators which test the fundament principles of insurance. Potential failures of an insurance market will not only affect those who rely on insurance for disaster recovery but also government programs which depend on insurance to mitigate the impacts on their limited resources. Assessing insurance markets at the community level can lead to improving local adaptation/resiliency decision-making. By incorporating insurance data, an additional layer of information is provided that acts as an important economic indicator for vulnerability. The role of insurance is often overlooked when decision makers and institutions discuss the implications of climate change. By focusing on the understudied economic proxy of insurance market vulnerability, this research contributes to the growing field of climate change adaptation. Limited by the availability of public information, insurer participation and a small sample size, this research was successful in revealing problems, and thus the need for market adaptation in vulnerable coastal communities. Insurability helps provide an important economic proxy that suggests factors influencing insurance vulnerability should be a priority for adaptation. Insurance can help provide socio-economic information to improve decision making and vulnerability assessments. Alternative pathways are available for reducing uncertainty that can help sustain insurance in the era of climate change. To address the gaps and oversight, recommendations and ideas for future research based on the limitations above will be presented.

From a Canadian context, this research is a relatively new way of looking at climate change impacts. There were some limitations of this research but this is a first attempt at quantifying the insurability problem, at the local level, which climate change presents to vulnerable communities. This research is serving as a pilot exercise and upscaling this research to a larger coastal community could be beneficial to researching insurance market failures and vulnerability to climate change. Upscaling could provide a useful means of gauging necessary action climate change adaptation with respect to insurance markets.

In order to advance the field of climate change and its impacts on socio-economic systems, this research acts as a baseline study which can be useful to future research. Academic knowledge could be advanced in this field by conducting a follow-up study after a large disaster. Insurance data could be re-obtained from the same addresses used in this research to see how the market responded and if the indicators have changed. By increasing the current understanding of the underlying relationships between climate change and insurance in the Atlantic Canada market, it is possible to help improve local adaptation/resiliency decision-making. Assessing insurance at a community level acts as a helpful economic proxy which is currently a non-existent indicator. It could be used to advise the public and private industry of shortcoming and allow for proactive solutions before losses occur. Contribution to public policy is prospective as impacts on insurance are rarely considered with discussion of climate change mitigation and adaptation efforts.

Communities in coastal areas are significantly exposed to the effects of climate change. As they adapt to a new normal, the economic markets and social welfare systems must adapt to the increasing uncertainty. The greater the uncertainty, the less financial recovery methods such as property insurance become affordable to those who need it (greater loss frequency and severity equates to greater premiums over time). The impacts of climate change will most certainly create a scenario in which property insurance markets and government programs will have to adapt in harmonization in order to minimize the socio-economic impacts on individuals and businesses that experience severe weather events. This adaptation process could create an opportunity for a new type of insurance to evolve that works in coordination with public disaster assistance systems to pre-mitigate exposure and support effective recovery.

5.1 Recommendation 1: Peer-to-Peer insurance schemes and the benefits of smaller risk pooling

The concept of a the sharing economy has grown in popularity around the world with the emergence of ridesharing programs like Uber, housing rental services like Airbnb and crowdfunding services like Kickstarter (Malhotra & Van Alstyne, 2014) (McAlpine, 2014) (Sablik, 2014). Peer-to-peer insurance (P2P) is becoming more widespread in the wake of peer-to-peer lending which has seen moderate success in the global financial industry (McAlpine, 2014). According to recent articles, socializing insurance has the potential to lower costs for everybody and examples have been noted in Germany where P2P property insurance has been available for the last 5 years - customers can see premiums reduced by 50% on average (Schiller, 2015).

P2P insurance operates similar to a mutual insurance business model. Mutual insurance companies are owned by their policyholders; any profits at the end of the year are redistributed back to the owners (policyholders). Groups of individuals with similar risks form a smaller pool (6-15 people for example) and each a pay a risk-based premium which is directed into two funds (Figure 11). A contract with an existing property insurance company to pay for large catastrophic losses is established, but the group manages the smaller losses.

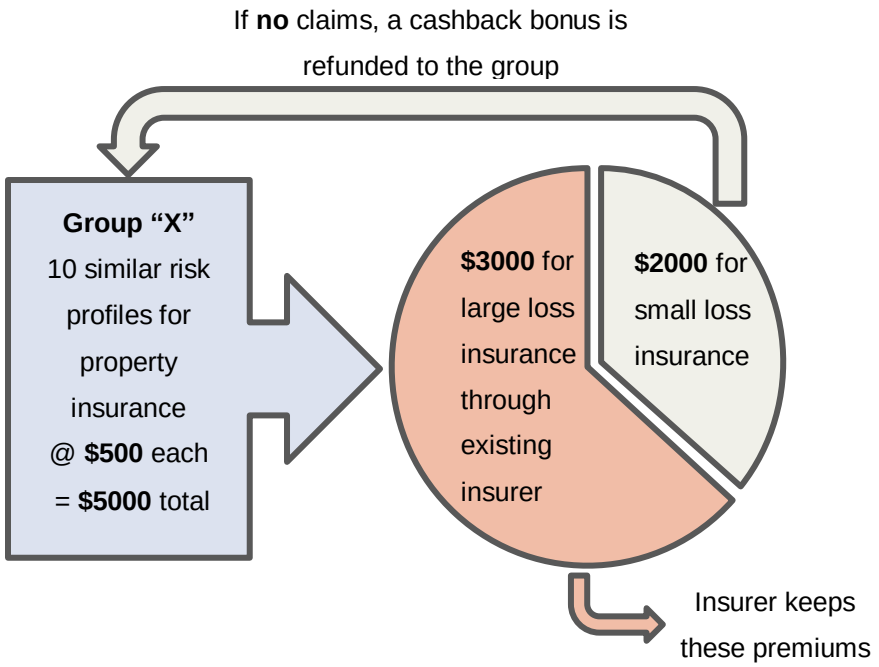

Figure 13: Example of a P2P Insurance Model

This study uncovered how large pools of risk can contribute to market failures. Climate change uncertainty will create more claims activity in vulnerable areas which can lead to an increase in fraud. One of the largest problems with large insurers and mutual insurers is that the pools are so large that the policy owners do not associate their behavior as having an impact on others in their pool. The benefits to having a smaller pool of individuals are twofold. First, if you know the people in your pool, you are less likely to jeopardize their protection. Secondly, people tend to join pools with people who they know are risk-averse to avoid claims (Schiller, 2015).

The smaller pool allows the pool members to know each other and creates shared group interests. If the policyholders collectively work to keep claims activity low, they will receive more payback at year-end. This can act as an incentive to reduce claims and fraudulent behavior (Sablik, 2014). In the case of facilitated P2P insurance, there would still be a need for insurers and intermediaries such as brokers to facilitate the group policy. Having the expertise of an insurance company and the knowledge of an insurance broker are valuable benefits to support facilitation. Insurers with an entrepreneurial mindset could find it worthwhile to explore the opportunities that P2P insurance offers. The insurance industry could demonstrate leadership and help avoid market failures related to climate change. There is still much unknown about P2P insurance because it is emerging and little academic research exists with a Canadian or North American context. Investigation of the potential P2P insurance options for vulnerable communities is worthy of pursuing due to the alternatives it offers and the disruptive potential on traditional insurance markets in vulnerable communities.

5.2 Recommendation 2: Rating Based on Climate Change Projections and GIS Data

Insurers in coastal communities should consider using geographic information systems (GIS) data to rate individual properties rather than pooling risks. In a recent survey of 99 insurance representatives from Canada and the United states, only 8% of those polled were using a by-peril rating structure (Harris, 2015). Of those that used this rating structure, an overall reduction in loss ratios by nearly 8% was observed (Harris, 2015). There is a high degree of vulnerable locations within any coastal community. Insurers need to make sure consumers are aware of

their site specific risks rather than hiding them from it by pooling them with others. For example, insurers in the UK and Germany use GIS to inform flood insurance rates (Keskitalo, Vulturius, & Scholten, 2014). The Canadian insurance market needs to explore such options for vulnerable and exposed areas where risk is higher than other locations – especially coastal communities where the impacts of climate change are a growing threat.

5.3 Recommendation 3: Provide More Public Information

A consistent theme through the data collection portion of this research suggests that insurers do not provide explanations or a breakdown of their pricing. As the property insurance market in Canada is highly competitive, there is a rationale for this behaviour. Furthermore, the regulations surrounding property insurance products is marginal in comparison to other insurance products such as private passenger automobile insurance. Insurers should consider explaining their pricing in a way which does not sacrifice competitive advantage. A descriptive pricing breakdown can help communicate to property owner the risk level of their properties. Risk-based premiums need to be explained so that higher risk property owners understand their exposure levels (LeBlanc & Linkin, 2010). In addition, some insurers still do not provide online quotations. By doing so, property owners may overlook these insurers when shopping insurance by themselves through popular online channels. This limits the perception of the availability of insurance to the public and could be detrimental to insurability. All property insurers should adopt a strong online presence and provide open channels of communication to the public who need insurance for their properties.

Appendix A: Market Snapshot for Nova Scotia and PEI

In 2010, Nova Scotia had 360 companies directly employing almost 4,500 people in their provincial insurance industry and directly contributed $468.8 million to real gross domestic product (GDP) in 2008 (Conference Board of Canada, 2010). Statistics for PEI were unavailable but it can be estimated that employment and GDP contribution would be significantly less when considering the population is 85% smaller than Nova Scotia. Nonetheless, these provincial economies play an important role in generating economic activity. In 2013, the total direct written insurance premium for personal property in all of Canada was $16.4 billion dollars (Canadian Insurance Top Broker, 2014). Nova Scotia and PEI only accounted for 2.75% or $451 million. All of the top 10 property insurers in Nova Scotia operate in other provinces. For PEI, 8 of the top 10 property insurers operate in other provinces. It is important to note that if market share were lost in these two provinces, it may not be enough to severely impact or cause failures to these companies who operate on a national scale. Even if insurers may not fail, concerns related to affordability and availability from the consumer perspective would still arise.

Rank No.	**Nova Scotia**	**Prince Edward Island (PEI)**
1	Intact Insurance	PEI Mutual Insurance Company
2	RSA Canada	The Co-operators
3	Aviva Canada	Dominion of Canada General Insurance
4	The Co-operators	Aviva Canada
5	Economical Insurance	RSA Canada
6	TD Insurance	Intact Insurance
7	Wawanessa	Economical Insurance
8	Dominion of Canada General Insurance	SGI Canada
9	Portage la Prairie	The Insurance Co. of PEI
10	Desjardins	Lloyd's Underwriters

Figure 14: Top 10 Property Insurers in Nova Scotia and PEI, by Earned Premium in 2013 (Canadian Insurance Top Broker, 2014)

Appendix B: Standardized Property Details for Nova Scotia

Nova Scotia Standardized Residential Property Details			
Details	**Lockeport**	**Shelburne**	**Description/Justification**
Replacement Cost	237 000	228 000	
Year Built	1930	1922	
Sq Ft	1461	1455	
Roof	Asphalt	Asphalt	
Basement	Unfinished	Unfinished	
Storeys	2	2	
Construction Type	Frame	Frame	
Siding	Wood Clapboard	Wood Clapboard	Vinyl is more flammable.
Bathrooms	2	2	
Heating (Type/Year Updated)	Gas/Forced Air/2000	Gas/Forced Air/2000	Most commonly used today in Nova Scotia
Additional Heat Sources	No	No	
Electrical (Type/Year Updated)	100amp/Breakers/2000	100amp/Breakers/2000	Most commonly used today in Nova Scotia
Plumbing (Type/Year Updated)	Copper/PVC/2000	Copper/PVC/2000	Most commonly used today in Nova Scotia
First Mortgage/New Owner	No	No	
# of Mortgages on Property	1	1	
Insurance Ever Cancelled?	No	No	
Years of Active Insurance	5	5	
Garage	No	No	Used Google Street View to confirm they are rare.
# of Claims in Last 7 Years	None	None	
# of Smoke Detectors	1	1	
Alarm System	No	No	
Bundled Discount with Auto	Yes	Yes	Most would have a car and likely bundled for discount
Distance to Hydrant	Within 300m	Within 300m	
Distance to Fire Hall	Within 13km	Within 13km	Volunteer Fire Department still rated as a Fire Department
Occupancy	Family	Family	
Home Business	None	None	
Backflow Valve	No	No	
Requested Coverages			
SBU	Yes	Yes	
Crime/Theft	Yes	Yes	
Liability	1 000 000	1 000 000	Third Party Liability
Standard Deductibles	1000	1000	
Policy Type	All Risk/Comprehensive	All Risk/Comprehensive	Most commonly requested. Includes Hail/Wind/Water Damage
Guaranteed Replacement Cost	Yes	Yes	

Appendix C: Standardized Property Details for PEI

Standardized Residential Proerty Details for PEI		
Details	**Charlottetown**	**Description/Justification**
Replacement Cost	240000	
Year Built	1932	
Sq Ft	1850	
Roof	Asphalt	
Basement	Unfinished	
Storeys	2	
Construction Type	Frame	
Siding	Vinyl	
Bathrooms	2	
Heating (Type/Year Updated)	Gas/Forced Air/2000	Most commonly used today
Additional Heat Sources	No	
Electrical (Type/Year Updated)	100amp/Breakers/2000	Most commonly used today
Plumbing (Type/Year Updated)	Copper/PVC/2000	Most commonly used today
First Mortgage/New Owner	No	
# of Mortgages on Property	1	
Insurance Ever Cancelled?	No	
Years of Active Insurance	5	
Garage	No	Used Google Street View to confirm they are rare.
# of Claims in Last 7 Years	None	
# of Smoke Detectors	1	
Alarm System	No	
Bundled Discount with Auto	Yes	Most would have a car and likely bundled for discount
Distance to Hydrant	Within 300m	
Distance to Fire Hall	Within 13km	Volunteer Fire Department still rated as a Fire Department
Occupancy	Family	
Home Business	None	
Backflow Valve	No	
Requested Coverages		
SBU	Yes	
Crime/Theft	Yes	
Liability	1 000 000	Third Party Liability
Standard Deductibles	1000	
Policy Type	All Risk/Comprehensive	Most commonly requested. Includes Hail/Wind/Water Damage
Guaranteed Replacement Cost	Yes	

Appendix D: Nova Scotia Data

Table 11: Residential Data Summary for Shelburne/Lockeport

	Address	Location	Postal Code	Insurer 1	Insurer 2	Insurer 3	Insurer 4
Non-Vulnerable - Lower Risk	7 Bridge St	Lockeport	B0T 1L0	$ 1,009	$ 794	$ 920	$ 4,102
	125 Hall St	Lockeport	B0T 1L0	$ 1,009	$ 794	$ 920	$ 4,102
	14 Cliff St	Lockeport	B0T 1L0	$ 1,009	$ 794	$ 920	$ 4,102
	236 Mowatt St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	218 Mowatt St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	195 Mowatt St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	144 Water St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	222 Mowatt St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	248 Hammond St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	15 Charlotte Lane	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
Vulnerable - Higher Risk	8 Bridge St	Lockeport	B0T 1L0	$ 1,009	$ 794	$ 920	$ 4,102
	7 Paradise St	Lockeport	B0T 1L0	$ 1,009	$ 794	$ 920	$ 4,102
	41 Upper Water St	Lockeport	B0T 1L0	$ 1,009	$ 794	$ 920	$ 4,102
	9 Arthur St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	243 Water St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	4 Ryers Lane	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	4 Hardys Lane	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	13 John St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	211 Water St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182
	6 Dock St	Shelburne	B0T1W0	$ 1,013	$ 794	$ 920	$ 4,182

Appendix E: Prince Edward Island Data

Table 12: Residential Data Summary for Charlottetown

	Address	Location	Postal Code	Insurer 1	Insurer 2	Insurer 3	Insurer 4
Non-Vulnerable - Lower Risk	73 Euston St	Charlottetown	C1A 1W1	$ 665	$ 575	$ 733	$ 1,093
	59 Euston St	Charlottetown	C1A 1W1	$ 665	$ 575	$ 733	$ 1,093
	25 Spring Park Rd	Charlottetown	C1A 3X7	$ 665	$ 575	$ 733	$ 1,093
	9 Chestnut St	Charlottetown	C1A 1Z5	$ 665	$ 575	$ 733	$ 1,093
	70 Walthen Dr	Charlottetown	C1A 4T8	$ 665	$ 575	$ 733	$ 1,058
	77 Walthen Dr	Charlottetown	C1A 4T7	$ 665	$ 575	$ 733	$ 1,058
	75 Fitzroy St	Charlottetown	C1A 1R6	$ 665	$ 575	$ 733	$ 1,058
	129 Kent St	Charlottetown	C1A 1R6	$ 665	$ 575	$ 733	$ 1,058
	96 Kent St	Charlottetown	C1A 1M9	$ 665	$ 575	$ 733	$ 1,058
	156 Queen St	Charlottetown	C1A 4B5	$ 665	$ 575	$ 733	$ 1,058
Vulnerable - Higher Risk	265 Dorchester St	Charlottetown	C1A 1E8	$ 523	$ 575	$ 733	$ 870
	237 King St	Charlottetown	C1A 1E8	$ 666	$ 575	$ 733	$ 1,068
	227 King St	Charlottetown	C1A 1E8	$ 666	$ 575	$ 733	$ 1,068
	217 King St	Charlottetown	C1A 1E8	$ 666	$ 575	$ 733	$ 1,068
	203 Water St	Charlottetown	C1A 1B1	$ 666	$ 575	$ 733	$ 1,093
	103 Weymouth St	Charlottetown	C1A 0B4	$ 666	$ 575	$ 733	$ 1,093
	3 Queen St	Charlottetown	C1A 4A2	$ 666	$ 575	$ 733	$ 980
	4 Prince St	Charlottetown	C1A 4P5	$ 666	$ 575	$ 733	$ 980
	2 Prince St	Charlottetown	C1A 0C4	$ 666	$ 575	$ 733	$ 980
	2 Queen St	Charlottetown	C1A 4A2	$ 666	$ 575	$ 733	$ 980

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