Understanding Resistance to Flood Risk Mapping: A Test of Climax Thinking in Southwestern Nova Scotia

By

Samantha Claire Howard
Department of Earth and Environmental Science

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Dalhousie University
Halifax, Nova Scotia, Canada

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DALHOUSIE UNIVERSITY

Department of Earth and Environmental Sciences
Halifax, Nova Scotia
Canada B3H 4R2
(902) 494-2358

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AUTHOR: Samantha Claire Howard

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Abstract

As a result of climate change, flooding is projected to become more severe and frequent. Flood risk mapping delineates areas of past and potential future flooding, and allows for informed decision-making regarding personal and community planning. However, there has been resistance to flood risk mapping, with opponents citing potential decline of property values. This thesis explores resistance to flood risk mapping through the lens of climax thinking. Climax thinking considers why people exhibit resistance to proposed land use changes, allowing for better understanding of the prevalence and nature of resistance to change. The aim of this study was to examine flood experiences, explore the presence of resistance to flood risk mapping, and analyze if climax thinking could explain this resistance. To address this aim, surveys were administered in the towns of Liverpool and Bridgewater in Southwestern Nova Scotia. The survey elicited flood experiences and opinions of residents. We found that approximately one third of the respondents in these communities have experienced flooding, yet the majority have not seen a flood map, nor were they concerned about the impact of flooding in the near future. Resistance to flood mapping was present in one sixth of the sample, with the main underlying reason for this resistance being concerns about loss of property value. Climax thinking was a significant predictor of this resistance, specifically in the dimension of ignorance of their ability to adapt or the recognize the impact of their adaptation decisions on others in their community. These results can be applied in order to implement provincial flood risk mapping in a manner that will be accepted by individuals and communities, as resistance can likely be reduced through community-centric framing programs that help reduce potential real estate value loss.

Chapter 1: Introduction

1.1 Motivation

Climate change is a challenge that we must work together to overcome in order to continue living on our planet. One of the biggest impacts of anthropogenic climate change felt globally is the increase in natural disasters (Helmer & Hilhorst, 2006; Stocker et al., 2013). Flooding, in particular, has dramatically increased globally, and is projected to stay on this trajectory given current climate policies and the steadily increasing impacts of climate change on the extreme weather events (Hirabayashi et al., 2013).

Flood risk maps are topographical maps which show where floods are expected to occur, and are based upon hydrologic, geomorphic, hydraulic, and land use data for a specific location (Marco, 1994). Mandatory flood risk mapping has been used at a community level in many jurisdictions to prepare for the impending threats of climate change, as it allows for more informed decision making regarding property ownership, construction, and public safety (Valiquette et al., 2019; Wilby & Keenan, 2012). It has helped municipalities in regional planning, and individuals in property management and decision making. In Nova Scotia, the concept of mandatory flood risk mapping and subsequent constraints on property development has been met with heavy resistance in the Shubenacadie area, despite the proven benefits in other jurisdictions (Bradley, 2016; Mcclearn, 2019).

Understanding the public perception of flood risk mapping is critical, as province-wide flood risk mapping is currently being legislated via the *Coastal Protection Act* in Nova Scotia, passed in 2019 (Campbell, 2020; Withers, 2021, *Coastal Protection Act*, 2019). The Act is aimed at protecting Nova Scotia's natural coastal ecosystems, as well as protecting Nova Scotians from

the impacts of coastal erosion, sea level rise, and flooding (Campbell, 2020). Provincial flood risk mapping standards are being created by the Nova Scotia Department of Municipal Affairs (Valiquette et al., 2019). Communicating flood risk mapping to the public in a way that is met with minimal resistance will be essential to having such mapping implemented by municipalities for intended public and private planning and adaptation purposes. In this project, we examine public perception of flood risk mapping in Nova Scotia, specifically in the southwestern region, through the lens of climax thinking theory.

1.2 Conceptual Framework: Climax Thinking

Understanding the perceptions of resistance to landscape change in this thesis is guided by a recent theoretical framework proposed by Sherren (2020) called climax thinking. Climax thinking is a theory which seeks to elucidate why people tend to think that the current landscape is in its final and ideal form (Sherren, 2021). This theory is based on Frederick Clements' concept of succession in plants, in which a climax community is one that dominates a site after a predictable series of previous differently structured plant communities (Clements, 1916). Essentially, people tend to perceive the current landscape as having reached the climax, and fail to acknowledge future, past, or other landscape uses (Sherren, 2020). Although succession theory is not currently used in ecological research (as it has been supplanted by non-equilibrium theory, which supports the everchanging state of the natural world), social scientists may envision a 'climax' state as being attainable and even desirable, as evidenced by work around sense of place and place attachment (Agyeman et al., 2009; Batel et al., 2013).

Climax thinking is hypothesized to have two potential causes: exceptionalism and ignorance (Sherren, 2021). Exceptionalism suggests that people set themselves apart from the

need for change, and are unwilling to consider past, future or more distant people on equal terms. Ignorance suggests a lack of awareness of past changes or future needs, or the way that resisting change can impact others (Sherren, 2020).

Climax thinking also exists, in both forms, across dimensions of time and space (Sherren, 2021). Dimensions of time distinguish between past and future, and space between self and other. In its temporal dimension, climax thinking is in part characterized by thinking that future generations are less important, or that current arrangements will be sufficient for them. This is how the framework applies to flood risk mapping, revealing cognitive dissonance in the sense that people often wish they had had flood risk mapping when they bought their home, but do not want it now that they own their house, in fear of potential impacts on property and resale value.

1.3 Background: climate change and flood risk mapping

Climate change adaptation is a concept that is increasingly central to the discipline of environmental science, as we plan for changes in climate that will impact the planet and human lives. Climate change adaptation strategies vary greatly in scope and size, with the overall goal of easing effects of climate change on people and the planet, while increasing awareness of anthropogenic activities causing climate change (Moser & Ekstrom, 2010).

Climate change adaptation techniques differ across disciplines. Flood risk maps have been used in many jurisdictions as a form of adaptation (Wilby & Keenan, 2012). Flood risk maps inform where flood risks are located geographically, helping identify which areas are at high and low risk of flooding. Flood risk mapping allows for increased public knowledge of impending flood risks, and these maps are key tools for governmental decision making (Stevens

& Hanschka, 2014). Despite their proven benefit in many jurisdictions, the rollout of mandatory flood risk mapping has been met with resistance in Nova Scotia (Bradley, 2016).

1.4 Summary of Literature and Knowledge Gaps

Previous literature on flood risk mapping has predominantly focused on its critical importance, and the ways in which particular regions can improve flood maps (Stevens & Hanschka, 2014). Within the Canadian context, Thistlethwaite et al. (2018) explored how flood experience and risk perception influences the behaviour of homeowners, and found that those most prepared for floods, and who have adopted their own flood plans, are typically those with higher income who own their houses. This was a landmark study examining public perception and awareness of flooding in Canada, and leaves room for further research into the barriers faced by people who are not aware of the risks of flooding or who are not inclined to plan for this risk. Further literature on flood mapping in Canada shows that the current state of publicly available flood risk mapping is poorly standardized (Stevens & Hanschka, 2014), and many Canadians find it difficult to access and interpret these plans (Mcclearn, 2019).

To examine and understand potential resistance to flood risk mapping in Southwestern Nova Scotia, it is necessary to explore which existing theories might provide explanatory power and a useful lens through which to conduct our research. Climax thinking is a new theory which has been previously used to explore resistance to wind energy land use transitions (Chappell et al., 2020) and coastal adaptations such as retreat from the coast (Sherren & Sutton, 2019). It offers potential insights which can help unite the literature on land use change, and more broadly to help understand individual and population barriers to climate change adaptation.

Risk perception theory can also be explored as a potential predictor of resistance to flood risk mapping (Harlan et al., 2019). Risk perception has previously been used to assess preparedness for, and perceptions of, natural disasters, including flooding (Harlan et al., 2019). Recent research, however, has shown that risk perception is a weak predictor of mitigation behaviours when it comes to floods (Bubeck et al., 2012). It is still unknown whether risk perception can assess attitudes of resistance to adaptation measures, including flood risk mapping.

1.5 Introduction to Study

In this study, we sought to understand perceptions of flood risk mapping, and possible resistance to it, in Southwestern Nova Scotia. The purpose of this study was to broaden our understanding of the amount of resistance to flood risk mapping within the region, and to explore the causes of this resistance, through measures of climax thinking, socio-demographic factors, risk perception, and flood experience. These factors were chosen based on previous literature due to their potential to explain resistance. Using the results of this study, provincial policy makers in Nova Scotia can adapt communicative framing techniques to minimize resistance during the provincial rollout of flood risk mapping.

The overall aim of this thesis was to explore if, and why, there is resistance to flood risk mapping in Southwestern Nova Scotia, and if resistance can be explained by climax thinking. This study is guided by three principal research questions:

1. What are the experiences of flooding in the region?
2. What are the major concerns of residents regarding the rollout of flood risk mapping?
3. Can climax thinking be used to understand and explain these concerns?

The first question seeks to gain a general understanding of flood experiences and perceptions of flood activity in the region. The second question seeks to quantify resistance to flood risk mapping across the population, and understand how this resistance relates to demographics, experience of flooding, home ownership, risk perception, and other potential causes of resistance. The third question seeks to measure climax thinking, to examine whether this novel theory can be used to explain resistance to flood risk mapping among the sampled population, in comparison to alternative variables (e.g., risk perception, age, property value, parental status).

This study took place in Southwestern Nova Scotia, which allowed for a geographically defined scope of the research. The southwestern region, along with the majority of the province of Nova Scotia, is predisposed to coastal flooding due to its coastal geography (Bush et al, 2019). Within the southwestern region, the town of Liverpool, one of the towns selected for this research, has experienced significant coastal flooding, as recent as October 2019 (Bradley, 2019). Bridgewater, also located in the southwestern region of Nova Scotia, was the other community selected for this research. It is bisected by the LaHave River, which has a history of overland flooding (Webster et al., 2014). The entire southwestern region of Nova Scotia was hit hard with flooding in April 2015 and has had an increase in flood activity in recent years (CBC News, 2015), therefore many residents will have personally experienced the impact of flooding on their homes and communities.

1.6 Summary of Approach

We addressed the research questions using a mail out survey to houses in the communities of Bridgewater and Liverpool in Southwestern Nova Scotia, in order to get a

representative sample of the population who might be impacted by mandated flood risk mapping. The survey consisted of questions regarding flood experience, flood risk perception, experiences with and attitudes about flood mapping, climax thinking, and demographics. These results were then coded and analyzed using descriptive statistics, bivariate and multivariate correlation analysis, and regression modelling. Results can be used to inform policy surrounding the mitigation of impacts from flooding across Nova Scotia through flood risk mapping, and to help in the understanding of public sensibilities regarding land use change for climate change adaptation in general.

Chapter 2: Literature Review

This literature review explores the increase in flooding globally, in Canada, and in Nova Scotia, and the critical need for adaptations to address flooding. One important adaptation strategy is flood risk mapping, which has been mandated (and will soon be rolled out) across Nova Scotia as a principal component of the 2019 *Coastal Protection Act*. This strategy has important benefits, but in Nova Scotia, past efforts at the local level have been met with community resistance (Bradley, 2016). Climax thinking is a theory through which this resistance can be explored, and understanding resistance is critical to successful implementation of flood mapping that will be useful and effective. This review is informed by scientific journals, conference presentations, personal communications, and newspaper articles. This diversity of perspectives is essential in understanding the social and scientific perspectives and implications of this research.

2.1 Climate Change Adaptation

Climate change adaptation is required to mitigate the effects of anthropogenic climate change, which is climate change resulting from, or produced by, human beings or human activity (IPCC, 2012). Literature on climate change adaptation is increasing but still limited (Ford et al., 2011), yet there is critical need to understand the effectiveness of climate change adaptations. Our collective window to adapt is smaller than we may assume; most effects of climate change are not felt until 30 years after actions have taken place (Marshall, 2014). Adaptation measures must take into account urgency and a diversity of perspectives, yet perspectives on and barriers to adaptation, particularly for individuals of lower socioeconomic status, are often disregarded (Castells-Quintana et al., 2018). Within a rural context, critically important when studying Southwestern Nova Scotia, continued coastal defense does not pay for itself in the value of what is protected, leaving those in rural areas less protected than those living in urban settings (OECD, 2019). Yet, the perspective of those in rural areas is seldom prioritized (OECD, 2019).

There is a general consensus in the literature that despite resources and knowledge, there is a lack of political will with regards to climate change adaptation, which is largely fueled by the lack of public engagement (Ford et al., 2011). Currently, much of the adaptative infrastructure we depend upon is based upon dated understandings of anthropogenic climate change, despite the existence of accurate models to correctly predict future need for increased adaptation. Members of the public and policy makers are less inclined to trust adaptation techniques such as flood mapping due to this perceived inaccuracy (Adger & Barnett, 2009). Additionally, adaptation goals and plans are highly contingent on context: different

communities will respond to climate change adaptation differently, and much of the cultural and historical context that people fight to protect is often invisible to policy makers (Adger & Barnett, 2009). It is critical to consider the context in which an adaptation measure is being implemented in order to make it effective. This is often not done, and it is a principal reason why many adaptation strategies have failed.

2.2 Flood Increase

Climate change adaptation is essential when preparing for impending natural disasters, and the increase in natural disasters that has been seen in the past 50 years can largely be attributed to anthropogenic climate change (Helmer & Hilhorst, 2006). One of the most significant natural disasters that has increased globally in both intensity and abundance is flooding. Flood risk is projected to increase due to a combination of factors, including sea level rise and increased frequency and severity of extreme precipitation events, both of which can be attributed to anthropogenic climate change (Kundzewicz et al., 2014). This increased risk is further related to other factors (e.g., snowmelt, soils freezing, and urbanization) also entangled with anthropogenic climate change (Hirabayashi et al., 2013; Kundzewicz et al., 2014). Globally, about 41% of land will see an increase in flood risk in coming years, and this land that will be affected is predominantly inhabited by humans (Hirabayashi et al., 2013).

Although there is evidence that anthropogenic activities are contributing to an increase in global flood activity, there are contradictory findings regarding the specific role of temperature in flood increase. Yin et al. (2018) examined historical data and concluded that extreme flood events are increasing globally, and this increase can be partially attributed to flash floods and storm runoff which are increasing with global increase in temperature. Wasko

et al. (2019) argues that the results presented by Yin et al. (2018) do not support an increase in flooding, but rather an increase in global streamflow related to changes in snowmelt with increase in temperature. Despite the divided literature on the role of temperature and its ability to influence flood activity, the literature in the field agrees that flooding will increase as a result of anthropogenic activities such as urbanization and land use changes.

In Canada, there is a projected trend of increase in flooding (Bonsal et al., 2019; Bush et al., 2019). It is projected that flood increases will impact the entire country, with Nova Scotia experiencing a significant risk of extreme flood increase as a result of sea level rise (Bonsal et al., 2019). Nova Scotia's coasts are expected to experience a 75-100cm sea level rise by 2100, which, along with parts of Newfoundland, is the highest projected increase nationwide (Bush et al., 2019). Sea level rise is particularly extreme in Atlantic Canada because the land is sinking due to isostatic rebound, while global sea level is increasing (Bush et al., 2019). This changing coastline is already being observed across the province. In Halifax, sea level is expected to rise by 20cm in the next two to three decades, which is projected to result in four times as many coastal flooding events annually (Greenan et al., 2019). This will also contribute to coastal erosion and will put coastal communities at risk (Greenan et al., 2019). Overland flooding is also increasing across the province due to increase in rain, bigger storms, and land use changes. Nova Scotia's increase in flooding will also be impacted by an increase in extreme weather events, where there is medium-to-high confidence that there will be increased precipitation contributing to increased urban flooding in the near future (Bonsal et al., 2019). Across the province, there is a need to adapt to the impending risks of flooding, as well as other impacts of anthropogenic climate change.

2.3 Climate Change Adaptation Techniques

Modern life is built upon the underlying expectation of a stable climate, and climate change is beginning to perturb systems which we have evolved to use and take for granted over the past 12,000 years of developing modern civilization (NASA's Global Climate Change, n.d.). This underscores the urgent need for effective climate change adaptations.

Climate change adaptation techniques are ways in which humans can help ease the effects of climate change. These techniques encompass a range of physical, social, and cultural methods which help to prepare us for change, and ideally encourage us to engage in more climate-friendly behaviours (IPCC, 2012). Adaptation techniques can include improving building codes, building flood defences (e.g., dikes), developing drought-tolerant crops, diversifying forests, setting aside corridors to help species migrate, among other techniques (European Commission, 2016). A common and useful adaptation technique used to prepare for the impending risks of future floods is flood risk mapping.

2.4 Flood Risk Mapping

Flood risk mapping is a tool which highlights zones that may be at risk of flooding during severe storm events or as a result of sea level rise. It is used by policy makers, government representatives, and members of the public for risk assessment, flood forecasting, land-use regulation, flood remediation, watershed planning, and emergency management (Valiquette et al., 2019). It is a critical climate change adaptation strategy because it can help individuals and communities appropriately prepare for the impending threats of flooding, which is becoming more frequent as a result of climate change (Helmer & Hilhorst, 2006). Many communities across the United States are underprepared for flooding events due to a lack of accurate

information regarding flood risk in their geographic regions (Pralle, 2019). Currently, one of the most important flaws in flood risk mapping is that it is based on historical models that do not accurately represent future flood risk, even though the technology to accurately predict and map out this risk is available (Pralle, 2019; Wilby & Keenan, 2012).

As shown in Figure 1, flood risk maps, in order to be effective, must incorporate more than just historical flood data (de Moel et al., 2009). Accurate flood risk maps create models based on historical data, digital elevation models created using LiDAR taken from the affected area, water level changes and hydraulic water modelling, as well as other parameters in order to precisely and accurately predict the impacts of flooding (de Moel et al., 2009). Standardization of flood risk mapping in Nova Scotia will ensure that flood risk maps are kept up to date and accurate for all areas, to allow for informed decision making.

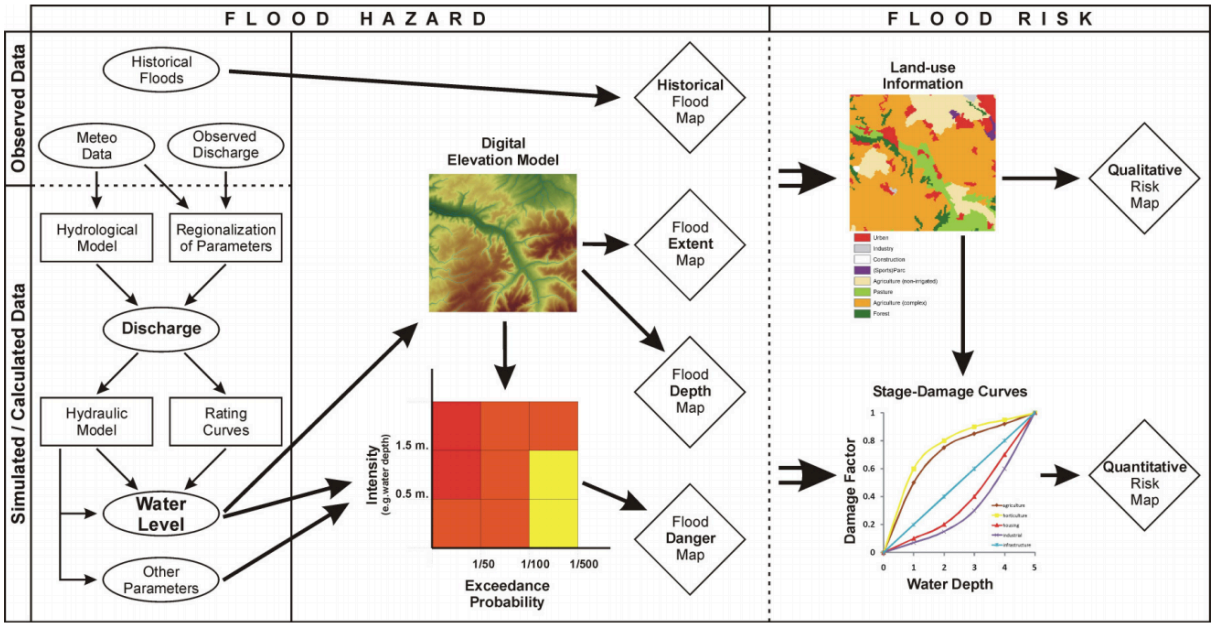

Figure 1: Flow chart of how modern-day flood risk map models are created, from de Moel et al., 2009.

Across Canada, flood risk mapping has been implemented as a provincial responsibility. As shown in Figure 2, many provinces, including Newfoundland, have implemented robust flood risk mapping. Figure 2 shows a flood risk map for the Corner Brook region, including predictions of the affected areas for 1 in 100 and 1 in 20 year floods (Newfoundland Enironment, Climate Change and Municipalities, 2013). Despite many provinces having some mandatory flood mapping in place, provinces where municipalities do not receive outside assistance in creating flood maps generally have outdated maps which are not useful as planning or decision-making tools (Stevens & Hanschka, 2014). In Nova Scotia, some municipalities have produced incomplete flood mapping, and this has not been standardized provincially. Focused studies on flood risk have occurred throughout the province. It was found, for instance, that in Annapolis Royal, a 100-year flood (modelled after the Groundhog Day Storm of 1976) would return in 66 years with current sea level rise but could return in 22 years with a possible upper limit of sea level rise (220 cm/century) (Webster et al., 2014). In the District Municipality of Lunenburg, which includes the town of Bridgewater, there is coastal flood mapping that was released in 2014, however there is no inland flood mapping (M. Devaux, personal communication, November 2020). Within the District Municipality of Queens, which includes Liverpool, there is no flood mapping made available to the public. The only flood preparedness material specific to this region is found in the Municipal Climate Change Action Plan (MCCAP), which indicates that flooding has been increasing within the District Municipality of Queens over the past 100 years and is predicted to worsen in the near future with increases in storm surges and sea level rise (Region of Queens Municipality, 2014).

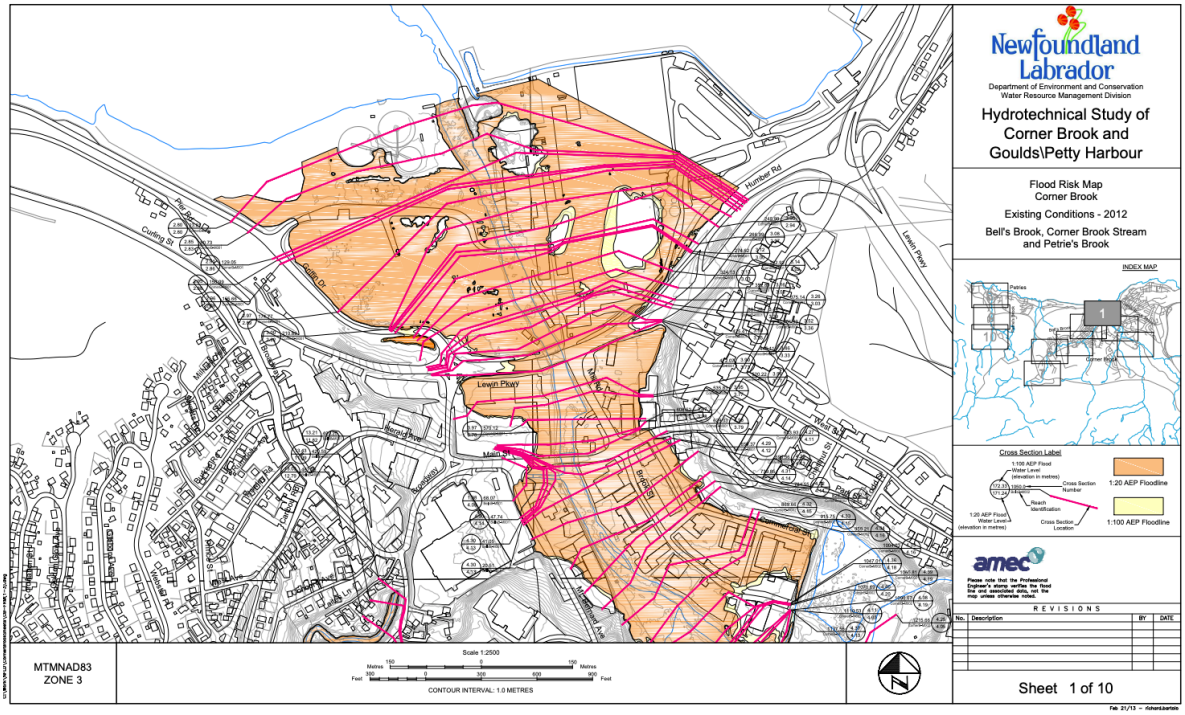

Figure 2: Example of public flood risk mapping from the Corner Brook region of Newfoundland (Newfoundland Enironment, Climate Change and Municipalities, 2013).

In addition to municipalities and the provincial government, there are Non-Governmental Organizations (NGOs) across the province advocating for accessible and accurate flood risk mapping. NGOs play an important role in creating tools, like flood risk mapping, for the government to use. In particular, Coastal Action, a Mahone Bay-based NGO focused on promoting restoration, conservation, and enhancement of the environment along Nova Scotia's South Shore, has created a flood risk mapping tool for the town of Lunenburg (Clarke & Stevens, 2021).

2.5 Resistance to Flood Risk Mapping

Despite the clear need for flood mapping in Nova Scotia, its implementation has often been met with resistance. In July 2016, Shubenacadie residents protested against proposed municipally mandated flood risk mapping, with the principal claim that their property value

would dramatically decrease (Bradley, 2016). There has also been resistance to appropriate flood preparedness, including maps, in Ontario, with muniticpalities and developers citing concerns of cost and upkeep of appropriate flood risk maps and other measures (Moghal & Peddle, 2016). Flood risk mapping, when implemented, must take into account concerns of local residents in order to be a useful, clear, and accepted planning and climate change adaptation tool. In this study, we sought to explore the prevalence of climax thinking as a possible underlying factor, among others, that can explain resistance to flood risk mapping, such that policy can be implemented in a way that mitigates resistance.

2.6 Climax thinking

Climax thinking is a working theory that was developed to attempt to understand psychological resistance to land use changes. It is a theory which considers how, when faced with proposed land use changes, people often exhibit resistance to these changes, and conclude that the current land use it at its final and ideal form. There is a disparate literature across fields of application, however there are few unifying theories to explain these resistances. The climax thinking framework has been proposed to help understand resistances, in order to better prepare communities for land use changes that are forthcoming as a result of climate change (Sherren, 2021).

Climax thinking has been used in previous studies to explore resistance to climate change-related land-use changes, including coastal adaptation (Sherren & Sutton, 2019) and wind energy land-use transitions (Chappell et al., 2020; 2021). Although this is newly applied to the human psyche, climax thinking is based in Frederick Clements' concept of succession in plants, where one climax community dominates after a series of successive differently structured

communities (Clements, 1916). This has been abandoned in favour of non-equilibrium models in ecology, but not in society. With climax thinking, individuals think they are currently in the climax community, and experience psychological barriers to understanding that the land use was ever different in the past or could ever be different in the future (Sherren, 2021).

Climax thinking is thought to be caused by either exceptionalism or ignorance (Sherren, 2021). When caused by ignorance, it suggests a lack of awareness of a person in considering alternative past or future land uses or the way that one's own land use decisions impact others. When caused by exceptionalism, it suggests that people set themselves above the need to consider other alternative land uses or people on equal terms to themselves. Both of these forms of climax thinking can be present across dimensions of time and space. Dimensions of time consider differences between past, present, and future land changes, and space consider land changes between oneself and others (Sherren, 2021). In its temporal dimension, climax thinking is characterized by thinking future generations are less important, or that current arrangements will suit them, while the past dimension tackles the idea that past generations were more 'primitive', so land changes they faced were not as severe as today's threats (Sherren, 2021).

Climax thinking, as a theoretical concept in social sciences, can be challenging to assess. Assessment of climax thinking can be done through survey-based measurements that are later correlated with other measures of resistance or actual behaviour, through which resistance to change can be explored. Chappell et al. (2020) used a mail out survey-based approach using old landscape photographs to assess climax thinking, where demographic characteristics were gathered along with assessment of climax thinking through both Boolean (yes/no) and Likert

(agree-disagree) scales, both of which are easily codified but still allow for a diversity of answers. Sherren and Sutton (2019) used a hybrid survey and focus group method to assess climax thinking, where surveys were undertaken by participants both before and after the focus group to assess climax thinking. The focus group discussion was structured around framing experiments, encouraging participants to think about the past, future, or space relative to their coastal landscapes, and it was found that two of the three framings reduced climax thinking after the focus group compared with before. Climax thinking can be assessed effectively through survey-based research, and past research has shown that framing plays key role in how people think about land use changes, so it is essential to be mindful about how surveys are framed.

2.7 Survey Based Assessment of Risk Perception

Risk perception is defined in the social sciences as the "process of collecting, selecting, and interpreting signals about uncertain impacts of events, activities, or technologies" (Wachinger et al., 2013). Our risk perception informs our preparedness and actions when faced with uncertain events, such as flooding (Harlan et al., 2019). Assessment of risk perception when faced with natural disasters has been measured using Likert-based scales in much of the previous literature. A survey assessing hurricane risk used Likert-scale responses for questions such as "How likely do you think it is that a hurricane will disrupt your daily activities during the next hurricane season?". Items from the scale were then assessed using Cronbach's test (Trumbo et al., 2014). Other literature has examined how risk perception can be impacted by a variety of demographic factors including age, gender, income, and preparedness in case of natural disaster (e.g., distance to nearest medical facility, swimming skills, first aid skills, etc.)

(Sattar & Cheung, 2019). In natural disasters, including flooding, measurement of risk perception includes combined measurements of the probability of an event and its perceived severity (Bubeck et al., 2012). Despite its importance, current literature agrees that risk perception is a weak predictor of mitigation behaviour when it comes to floods (Bubeck et al., 2012). Flood risk has been measured in previous literature using Likert scales, for example in a study conducted on flood risk perception of residents in urban centres in the United States, Harlan et al. (2019) asked survey-based questions including "How likely or unlikely do you think it is that a flood will affect your residential area within the next 10 years?". Flood risk perception can be measured using surveys, similar to that for other natural disasters (e.g., hurricanes), yet this often fails to assess attitudes towards adaptation behaviours. More research is needed to explain resistance to adaptation.

2.8 Knowledge Gaps

Currently, it is unclear how Nova Scotians feel about flood risk mapping, and why some residents exhibit such resistance to it, despite its proven benefits. It is critical to understand the reasons why homeowners in particular are resistant to this inevitable change, in order to successfully implement municipal flood risk mapping. Understanding reasons for resistance would allow, for example, the Department of Municipal Affairs to recommend strategies to municipalities to decrease resistance from homeowners, and help foster collective understanding and a collective sense of responsibility for adapting to the impending realities of climate change. Additionally, there is a lack of understanding in the current literature as to why people are resistant to land use changes overall. We need to test if climax thinking can be used to help explain this resistance and can contribute to the growing body of knowledge on barriers

to climate change adaptation and mitigation. This research will help to address these gaps identified in the literature, and work towards deeper understanding of reasons for resistance to climate change adaptations. Through the literature, there is a clear need to understand the core reasons behind resistance to flood risk mapping, which is not only important and timely in the Nova Scotian context, but may ultimately help inform the future of flood risk mapping in other jurisdictions.

Chapter 3: Methods

3.1 Study Area

This research took place in the communities of Liverpool and Bridgewater in Southwestern Nova Scotia, as can be seen in yellow in figure 3 below. These communities provide a prime study area because together they experience both coastal and overland flooding, and have had flood experiences in living memory (Yzaguirre et al., 2015; 2016). Bridgewater, with a population of about 8000 residents (Government of Canada, 2017b), is located at the mouth of the LaHave river, one of Nova Scotia's largest rivers, making it a provincial hotspot for overland flooding. Liverpool, with a population of about 4000 (Government of Canada, 2017a), is located on the coast, and is very susceptible to coastal flooding. Bridgewater and Liverpool were chosen to provide an adequately large sample size to receive the mailout, along with a diversity of both coastal and overland flood experiences.

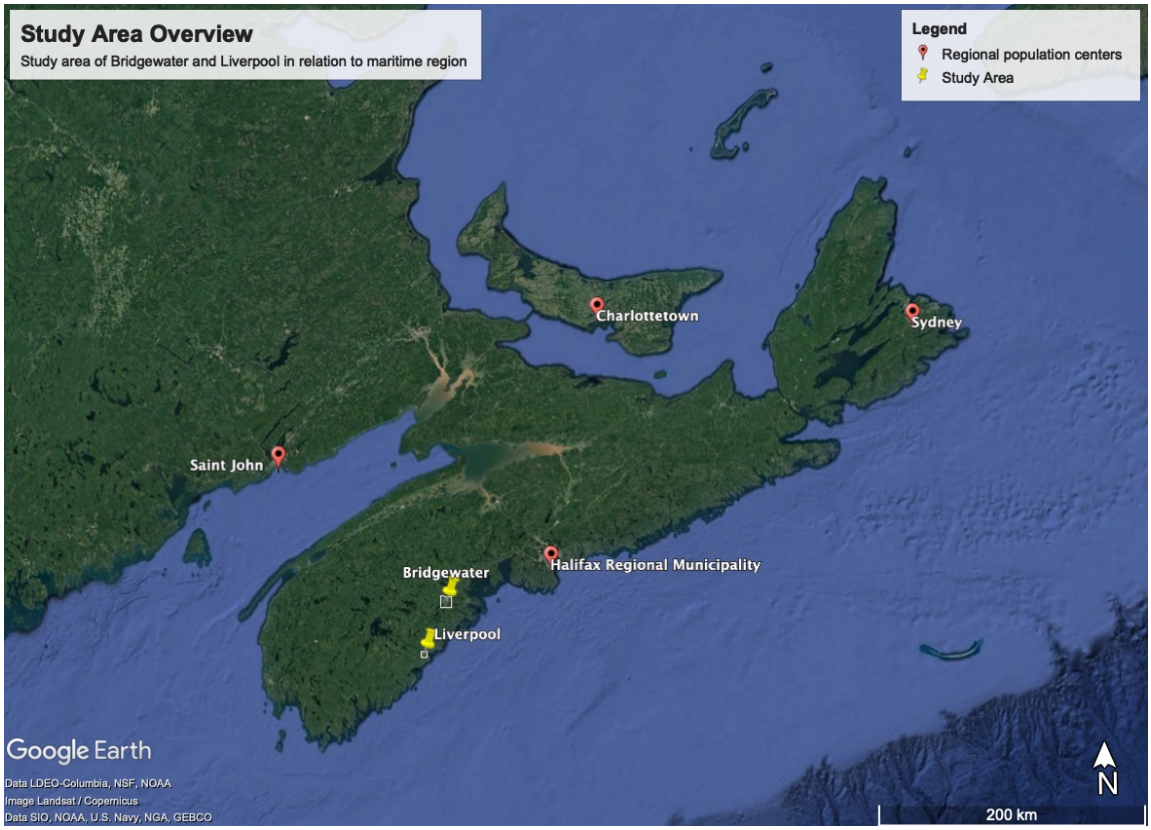

Figure 3: Study Area Overview (Created by Samantha Howard using Google Earth Pro, March 2021)

3.2 Study Sample

A purposive cluster sampling technique was used to establish a study sample of representative participants, representing households within communities prone to flooding. The communities of Bridgewater and Liverpool were chosen based on a dataset found in Yzaguirre et al. (2016) which geographically referenced all mentions of flooding in media outlets across the province of Nova Scotia between 1992 and 2014. Within the southwestern region of the province, these two communities had many media mentions of flooding, which indicates flood activity, but this may also be a reflection of the fact that these are some of the most populated communities in the region, with more media outlets than surrounding areas. In

Bridgewater, there were flood mentions in 2003, 2005, and 2011, and in Liverpool there were floods mentions in 2011 (Yzaguirre et al., 2016). There have also been recent media mentions of severe flooding in Liverpool, including news about floods in March and December 2019 (Tutton, 2018; CBC News, 2019).

3.3 Data Collection

Data collection took place using a single mail out survey, distributed through Canada Post Admail via Russell House Marketing. This technique was chosen as this research was conducted during the COVID-19 pandemic, so this was the easiest way to administer the survey remotely to a spatially designated area. Canada Post Admail allowed us to identify all 8372 addresses in Bridgewater and 4049 addresses in Liverpool, who all received our invitation card (detailed in Appendix 1). This card included both a long and short weblink, as well as a QR code to access and fill out the online survey. The survey was hosted on Opinio software, accessed through Dalhousie University. Prior to completing the survey, participants were asked to read the online consent form and could choose to click on an external link to access a full-length consent form if they so desired (detailed in Appendix 2). Participants then completed the survey, which was shown as four separate webpages; one page per question category (flooding, flood mapping, landscape priorities, demographics). After completing the survey, participants were optionally redirected to a separate survey, unlinked to responses to the first, where they could enter a giveaway for a Tim Horton's gift card as an incentive. All data from the surveys were downloaded and stored exclusively on two personal computers (belonging to Samantha Howard and Kate Sherren; 2 copies total). Once data collection was completed the Opinio site was deactivated, and all online copies were destroyed.

3.4 Survey Design

The survey asked participants 34 short questions and took on average 9 minutes and 30 seconds to complete, which was slightly over the 5-7 minutes indicates on the consent form. The survey used to collect data for this study was comprised of four main question categories: flooding, flood risk mapping, landscape priorities, and demographics.

The flooding question set sought to understand flood experiences and flood risk perception. It asked participants about past floods in their region, as well as if they have noticed any changes in flood severity or abundance in their region throughout their time living there, and their perceptions about how likely it is that future flooding will occur and impact them. This section used predominantly constrained response style questions and Likert scales, with the option for participants to detail their experiences at the end with an optional short answer question. These qualitative responses are not addressed systematically in this thesis, however they are used to support prevailing themes from the quantitative data.

The flood risk mapping category sought to explore their understanding of the current flood risk mapping available in the region, as well as their opinions on how and when flood risk mapping should be available. It asked participants if they were aware of any flood mapping in the region, and if so, if they could share additional details (i.e., when it was created), if they believe there should be flood risk mapping made publicly available, and if flood history or risk should be disclosed at the point of sale or lease of a property. This section used predominantly Likert scales, with the option for participants to expand on further experiences or concerns in an optional short answer question.

The landscape priorities section explored climax thinking across all dimensions of both ignorance and exceptionalism, in past, present, future, and space-based framing. This allowed for results to inform which dimensions of climax thinking are most prominent. The questions were modelled after those used by Sherren & Sutton (2019), but applied to the context of flood risk mapping. All questions were statements, and asked participants to rate how much they related to them on a Likert agree-disagree scale.

Finally, demographic questions sought to understand if the demographic of respondents to the survey was representative of the population in the area. It also captured possible alternative explanatory factors for flood risk mapping perceptions, such as being a parent, income, age, and gender.

3.5 Data Analysis

The results collected from the online survey were analyzed using Microsoft Excel (basic statistical modelling) and R (creating the regression models). The regression analysis sought to explain resistance to flood mapping among the surveyed population, and possible underlying reasons for this resistance. The predictor variables used to explain resistance were climax thinking, flood experience, flood type, perception of flood change, flood risk assessment, having seen a flood map, sex, education, and if property was owned or rented. These key predictor variables were developed by coding and scaling results from the survey.

Descriptive statistics were first examined to characterize the surveyed population, including property ownership, being a parent, and town of residence. Following this, the demographic distributions of our data were compared to that of the 2016 census to assess the representativeness of our sample. Next, flood experiences were analysed using descriptive

statistics to explore the amount and types of floods among the surveyed population. Scales for flood risk assessment and perceptions of flood change were created based upon the combination of responses to risk assessment related questions. Perceptions of resistance to flood mapping were explored through responses to questions asking participants to rate how much they agreed with statements about flood risk mapping. Dimensions of climax thinking to include in the survey were explored through correlation of responses to statements about flood risk mapping to climax thinking questions. Cronbach's alpha was used to test the internal strength of the climax thinking question scale. Finally, a regression analysis was conducted to explore the relationship between resistance to flood risk mapping and possible explanatory variables of climax thinking, flood experience, flood type, perceptions of flood change, flood risk assessment, having seen a flood map, sex, education, and ownership of property. Other unsignificant variables were eliminated from the final regressions based upon lack of responses, in order to strengthen the validity of the models.

3.6 Validity of method

The sources informing the validity of each section of survey questions are described in Table 1. Our methods were informed by previous survey-based methods of climax thinking and risk perception. The climax thinking questions were adapted from studies by Sherren and Sutton (2019) which looked at climax thinking within the context of coastal adaptation, and Chappell et al. (2020), which explored past dimensions of climax thinking with regards to land attachment for wind farms in the Chignecto region of Nova Scotia. Risk perception questions were based on other studies (e.g., Harlan et al., 2019; Wachinger et al., 2013) which looked at flood risk perception among various demographics, and were adapted to the regional context

of Southwestern Nova Scotia. Flood risk mapping questions were informed by the current availability and state of municipal flood risk mapping in the communities and current municipal climate change action plans (M. Devaux, personal communication, November 2020; Municipality of the District of Lunenburg, 2013; Region of Queens Municipality, 2014). Demographic data was validated through comparison to 2016 Canadian census data for the towns of Liverpool and Bridgewater (Government of Canada, 2017a, 2017b). Finally, the survey received approval from the Dalhousie Research Ethics Board (REB #2020-5436) prior to being sent out to participants, and was pilot tested with community members of various age groups and technological abilities to ensure questions were understandable and the survey was easily accessible.

Table 1: Sources informing the validity of survey questions.

Question section on survey	Seeking to explore	Informed by
Flooding	Flood experiences and risk perception	Risk perception theory
Flood risk mapping	Opinions on and knowledge of current flood risk mapping in the communities	Current state of flood risk and municipal climate change action plans
Landscape Priorities	Climax thinking	Climax thinking measures in previous research
Demographics	Demographics of surveyed population	2016 Canadian Census profiles for Liverpool and Bridgewater

3.7 Limitations of methods

The methods of this study face several limitations. The first limitation is that it was only accessible to those with appropriate technology and internet access, and to those who are able

to read English. There was also no way to ensure that the survey was not completed more than once by a single person or household, due to the anonymity of the data and the distribution approach. Finally, there is an element of self-selection present in the study, as individuals are more likely to respond to the survey if they are somehow interested in the subject matter or research. In order to minimize this final limitation, all demographic data was compared to current census data from the communities of Bridgewater and Liverpool. This comparison is discussed in chapter 4, however no significant discrepancies were present.

The delimitation of this study is that only it will only confidently inform resistance to flood risk mapping for residents specifically in the communities of Bridgewater and Liverpool, and cannot be fully generalized to apply to the larger Nova Scotia population or beyond.

Chapter 4: Results

4.1 Overview

This survey was sent out to 12,421 addresses, 8,372 of which were in Bridgewater and 4,049 of which were in Liverpool. 277 responses were received, which was an overall response rate of 2.2%, giving an overall margin of error of ±6% at confidence level of 95%. Among respondents who indicated their town, 31% were from Liverpool and 69% were from Bridgewater, which aligns with relative town size.

Response rates are low and response bias is thus significant among single mail out surveys. In order to account for this, we explored how representative our sample is in comparison to demographic data collected in the 2016 census. As shown in Figure 4, the majority of survey respondents were between the ages of 60 and 79. These older age groups

were overrepresented, while there was underrepresentation of those aged 20 to 29 and 45 to 49. Additionally, there were no respondents over 85.

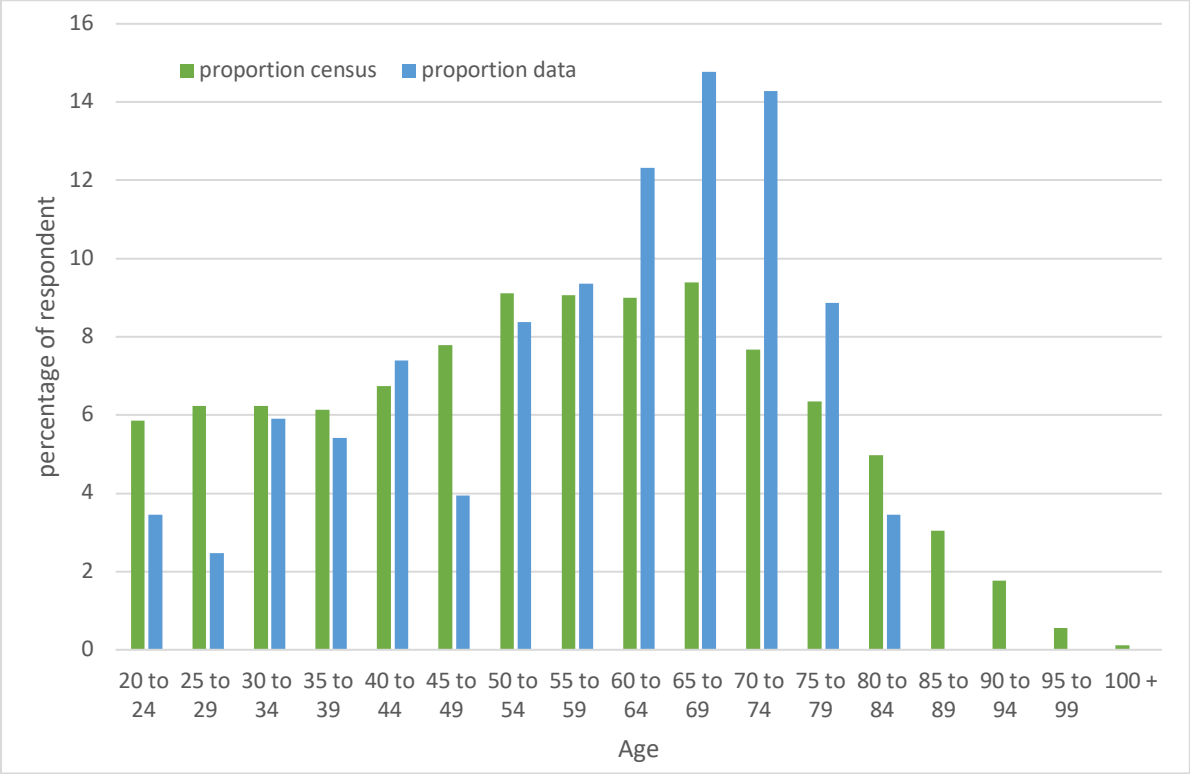

Figure 4: Age distribution comparison to 2016 census data. (Statistics Canada, 2017)

The survey data had a mild overrepresentation of male respondents (6%), and underrepresentation of female respondents (8%), shown in Table 2. Additionally, there is an underrepresentation of those with a household income of $49,999 and below, while there is an overrepresentation of those with a household income of $50,000 and above (Table 2).

Table 2: Demographics of survey respondents compared to census data from Statistics Canada 2016 census for towns of Liverpool and Bridgewater, using percent (Statistics Canada, 2017)

Category	Census	Survey
Gender		
Female	54 %	48 %
Male	46 %	52 %
Household Income		
$49,999 and under	56 %	29 %
$50,000-$99,999	30 %	44 %
$100,000-$149,999	10 %	17 %
$150,000 and over	4 %	10 %

Of our survey respondents, 64% had attended some university and 36% had not, however this information was only provided by 72% of respondents, and was unable to be carried forward into the final regression model without significantly decreasing the number of observations. Of the 90% who of respondents who indicated, 92% owned their current properties, while only 8% were renters. On average, respondents had been at their current property for 17 years and living in their current community for 24 years. Finally, of the 91% of respondents who indicated, 72% were parents and 28% were not.

Among respondents, 32% have been affected by at least one flood at their current property, and of those experiencing floods, 54% have experienced more than one. Notably, two respondents had experienced 50 floods at their current property (Figure 5).

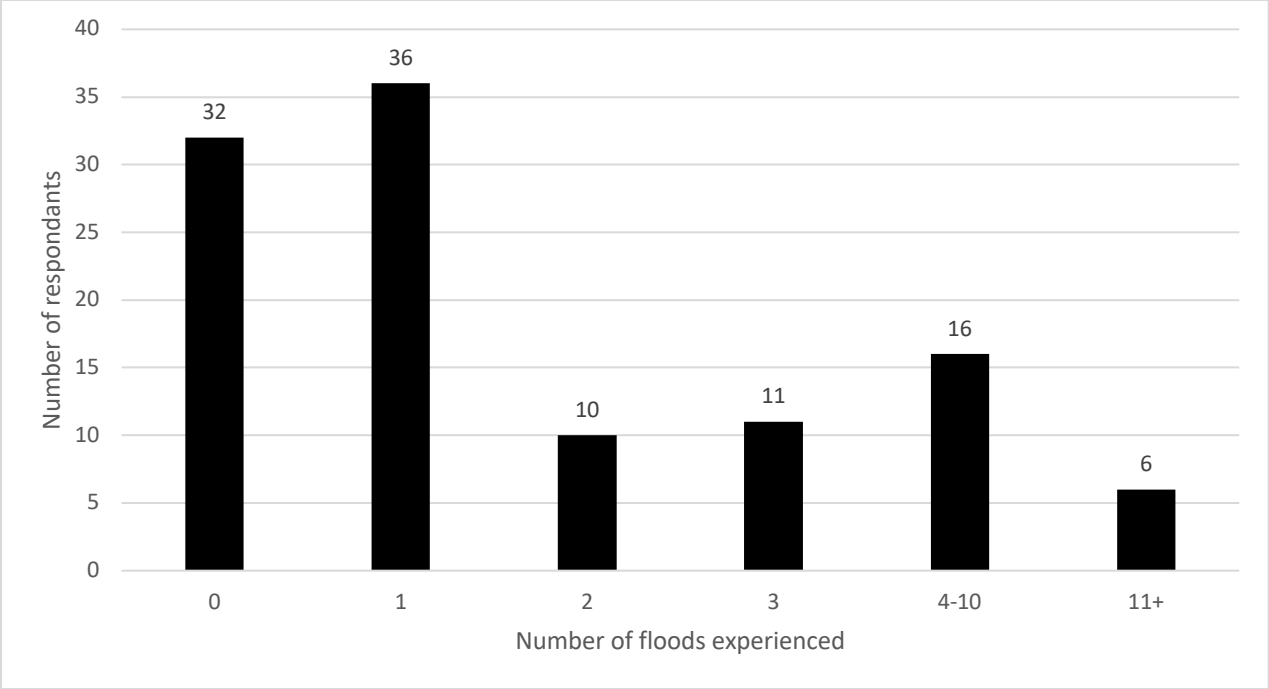

Figure 5: Histogram of number of floods experienced among respondents.

Of those who had experienced flooding, 31% have experienced coastal flooding and 69% have experienced freshwater flooding. While it was expected that this distribution would be impacted by location, as Bridgewater is more prone to freshwater flooding and Liverpool is more prone to coastal flooding, the correlation matrix (shown in Table 3) shows that being located in Liverpool was only weakly correlated with experiences of coastal flooding, and there was no correlation between being located in Bridgewater and experiences of freshwater flooding.

Table 3: Pearson's correlation of flood source and location

	coastal	*freshwater*
Liverpool	**0.31684219**	0.00552992
Bridgewater	-0.2089325	**-0.0140111**

While flooding has historically been common in the region, only 7% of respondents had been informed of flooding impacting their property before they lived there. When asked to comment on additional concerns about flooding, many noted increasing flooding, with particular concern for storm surges. One respondent noted “We live on the tidal LaHave River for 6 years, we have noticed a significant increase in storm surges where our basement floods from incoming brackish water”. There was also a general concern that much of the infrastructure they relied upon, including bridges and roads, were not appropriately built to handle future storm or flood risk, with a respondent citing “I live very near a little bridge where there is lots of current. I worry that if water levels became very high and the current very strong, it could take out the bridge”.

Only 19% of respondents indicated that they had seen a map of their region showing where flooding is most likely to occur. Some noted they had seen maps created by researchers at the Nova Scotia Community College’s College of Geographic Science Campus, with five respondents citing or alluding to a study by McGuigan et al. (2015) which used LiDAR data and GIS analysis to create a flood risk assessment of the LaHave River watershed (McGuigan et al., 2015). 84% of respondents were unsure if publicly available flood risk mapping was available for their region, 7% believed there was publicly available flood risk mapping, and 9% believed there was not.

4.2 Flood Risk Assessment

A flood risk assessment scale was created to assess how much respondents believe that a flood will impact them in the near future. This scale was based upon a standard risk assessment scale that looks at probability and consequences of events or behaviours (Harlan et al., 2019). Ordinal data was collected through two Likert scale questions assessing likelihood of future floods in the next ten years and seriousness of the impacts of a potential flood on respondents households, whose distributions are shown below in Table 4.

Table 4: Crosstabulation of responses for flood risk assessment

		Severity				
Likelihood	Not serious at all	Somewhat serious	Serious	Very Serious	Extremely serious	Total
Very unlikely	64	17	5	4	5	96
Somewhat unlikely	13	24	12	30	6	85
Neither likely nor unlikely	21	11	4	9	4	49
Fairly likely	8	7	1	4	4	24
Extremely likely	6	1		2	2	11
Total	112	60	22	49	21	265

The flood risk assessment scale was created by averaging responses for the two questions. From the distribution of the flood risk assessment scale, shown in Figure 6, below that 88% have no to moderate flood risk, indicating that they do not believe a flood will impact them at their current property in the near future. 12% of respondents were found to have high or extreme flood risk, indicating that they believe that a flood will impact them at their property in the near future with significant impacts.

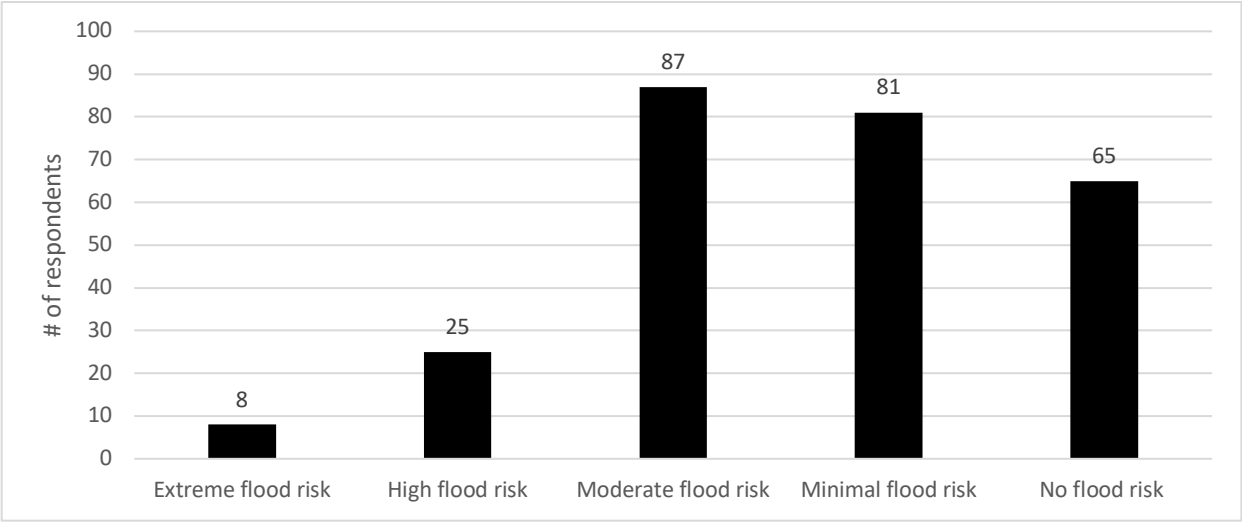

Figure 6: Scale distribution for flood risk assessment

4.3 Perceptions of Flood Change

Perceptions of flood change is a scale that measures participants' perceptions of if flooding is becoming more or less frequent or severe in their region. This scale is based upon participants' responses to questions about if and how flooding in their region is changing in frequency and severity, with responses of increasing frequency and severity having a score of +1, responses of decreasing frequency and severity having a score of -1, and all other responses having a score of 0. The response distribution for this scale is seen in table 5.

Table 5: Crosstabulation of responses for perceptions of flood change

		Frequency		
Severity	Decreasing	No change	Increasing	Total
Decreasing	8	2	0	10
No change	8	136	11	155
Increasing	1	10	44	55
Total	21	163	57	241

Each respondent was given a perception of flood change score of -2 to +2 based upon the addition of their responses to the perceptions of flood change questions. In general,

respondents who believed that flooding was increasing in severity also believed it was increasing in frequency (Table 5), however there were anomalies, including one participant seeing increasing severity but decreasing frequency (Table 5). As shown in the response distribution (Figure 7), the majority (65%) of respondents do not think that flooding is increasing in frequency and/or severity. 26% have noticed some increase in frequency and/or severity of flooding, and 9% have noticed some decrease.

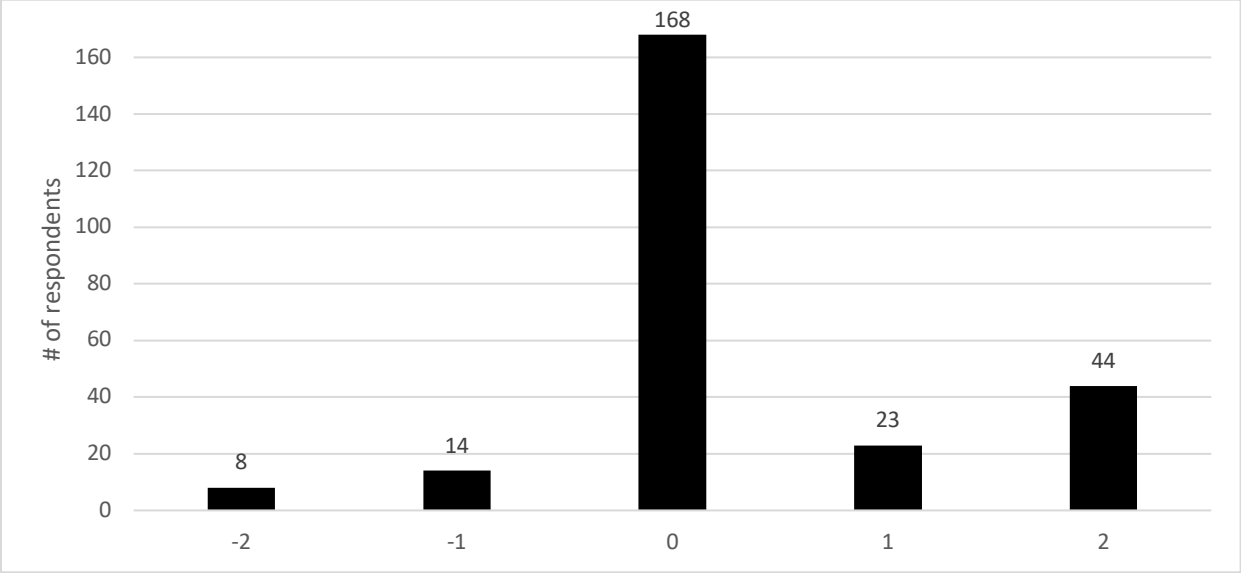

Figure 7: Scale distribution for perceptions of flood change

4.4 Perceptions of Flood Risk Mapping

To understand the presence of resistance to flood mapping as well as the potential sources of this perceived resistance, participants were asked to rate how much they agreed with certain statements about flood mapping. Questions with a positive or neutral tone (Table 6) generally solicit support for the use of flood risk mapping, and for disclosure of flood history and risk during the purchase and rental process. There was overwhelming agreement (less than 4% disagreement) for all positive and neutral statements (Table 6).

Table 6: Response distribution for perceptions of resistance

			% **distribution**				
Statement	**Tone**	***N***	strongly disagree	disagree	neutral	agree	strongly agree
Making flood mapping publicly available for my area would be too much of a risk for those who may lose real estate value. **[Real estate risk]**	Negative	255	21.57	34.90	27.45	12.16	3.92
I think flood mapping should only be available to affected landholders in my region. **[Only affected landholders]**	Negative	255	32.55	25.49	10.20	14.90	16.86
I would like there to be flood mapping for my region available to the public. **[Available to anyone]**	Positive	256	0.78	0.39	5.08	40.63	53.13
Publicly available flood mapping in my area will motivate us to prepare and adapt for the future.	Positive	255	1.18	2.75	6.67	47.06	42.35
I believe that future flood risk should be disclosed prior to signing of a lease agreement for rental properties	Neutral	254	0.39	0.39	11.42	31.89	55.91
I believe that future flood risk should be disclosed at the time of sale of a property.	Neutral	253	1.58	1.58	9.88	28.06	58.89
I believe that actual flood history should be disclosed prior to signing a lease agreement for rental properties.	Neutral	253	0.40	0.00	3.95	34.39	61.26
I believe that actual flood history should be disclosed before the sale of a property.	Neutral	255	0.78	0.39	2.75	26.67	69.41

We used negatively phrased statements to see what potential causes for resistance were present when prompted. Two questions, one regarding risk to property value, and one regarding availability of maps exclusively to affected landholders in the region, were asked (Table 6). These questions elicited more diverse distribution from respondents. The question regarding only affected landholders saw a bimodal distribution, with 57% of respondents disagreeing, 31% agreeing, and 12% remaining neutral. When asked if flood risk mapping would be too much of a risk to those who may lose real estate value, 16% of respondents agreed or strongly agreed that it would be. With this diversity of perspectives, and presence of resistance, these two statements indicating 'real estate risk' and 'only affected landholders' were carried forward into regression modelling as outcome variables to explore what factors contributed to responses to these questions, and ultimately to the presence or absence of resistance to flood risk mapping (Table 8).

4.5 Presence and Dimensions of Climax Thinking

Understanding the presence and dimensions of climax thinking was done based on response distribution to a series of 8 statements (Table 7). One statement was asked based on each of the 8 dimensions of climax thinking hypothesized by Sherren et al (2020), and tested in a previous survey-based assessments of climax thinking (Chappell et al., 2020; Sherren & Sutton, 2020). Just over 40% of respondents felt that current residents should be prioritized over future ones in flood management decisions, but only half as many (19%) believed that current flood management options would suit future generations. All dimensions of climax thinking had a diverse spread of responses.

Table 7: Dimensions and presence of climax thinking, and relationship between climax thinking and predictors of resistance. (5-scale Likert reduced to 3 for display purposes but not in modelling)

Dimension	Statement				Pearson's r: Only for affected residents	Pearson's r: Real estate risks
		Disagree	Neutral	Agree		
Past exceptionalism	I would like to think past generations that lived in this community would appreciate the property where I live.	1	14	85	0.103	-0.007
Past ignorance	One of the nice things about where I live is how little it has changed over the years.	17	30	54	0.046	0.011
Future exceptionalism	Decisions about flood management here need to consider current residents over future residents.	32	26	42	0.161	0.175
Future ignorance	Flood management options we have in place already will serve future generations well.	38	43	19	0.057	0.147
Self exceptionalism	Decision-makers should protect me and my property from feeling the impact of increases in flood risk.	9	18	71	0.036	0.039
Self ignorance	I am not able to cope with the land changes required to deal with significant increases in flood risk at this point in my life. **[Not able to cope]**	37	44	19	0.111	0.269
Other exceptionalism	My area is more deserving of public support for protection against flooding than some others in the region.	49	38	14	0.117	0.148
Other ignorance	Flood management decisions I make do not have implications for others. **[No implications for others]**	57	24	18	0.169	0.312

In order to test the internal strength of this question set to establish how internally consistent it was, Cronbach's alpha was calculated and yielded a value of 0.53, which is not internally consistent enough to create a single scale. This indicates that respondents displayed diversity within dimensions of climax thinking. Being unable to use the entire climax thinking scale due to lack of internal consistency led to correlation analysis to establish which dimensions of climax thinking could be used to further explore presence or absence of resistance to climax thinking. It was found that the dimensions of climax thinking that were overall most correlated with the outcome variables of real estate risk and only affected residents, used as our proxy for presence or absence of resistance to flood risk mapping, were the dimensions self ignorance, or 'not able to cope', and other ignorance, or 'no implications for others'. The climax thinking variables carried forward into the final regression model of 'not able to cope' and 'no implications for others' were thus determined to have the strongest relationship to presence or absence of resistance to flood risk mapping.

4.6 Examining Resistance Through Regression Modelling

We built a series of ordinal linear regression models seeking to explain perceptions of resistance to flood risk mapping among our sample. Regression models explaining resistance using both resistance outcome variables of 'real estate risks' and 'only for affected residents' were created (Table 8). Predictor variables of flood experience, flood type, flood risk assessment, having seen a flood risk map, gender, education, and ownership were carried forward into the regression models. Age, income, being a parent, and number of years in the property and community were included in preliminary regression modelling and not found to be significant, therefore they were eliminated in order to increase the number of observations

in the final models. With the elimination of these variables, the number of observations in the regression models increased by on average 100 observations.

Key predictor variables for these regression models were the dimensions of climax thinking: 'not able to cope' and 'no implications for others'. Models were built for each outcome variable both with and without the chosen climax thinking predictor variables in order to establish how much strength climax thinking variables contributed to each of these models.

The weaker models were based upon predicting the outcome variable 'only for affected residents'. In the regression both with and without the key climax thinking variables as predictors, the same predictors were found to be significant (Table 8). In both of these models, it was found that low perception of flood change (no climax: $p = 0.029$; climax: $p = 0.016$), low flood risk assessment (no climax: $p = 0.005$; climax: $p = 0.017$) and being female (no climax: $p = 0.007$; climax: $p = 0.006$) were all associated with increased resistance to flood risk mapping (Table 8). The model with climax thinking variables had an R^2 value of 0.071 and the model without had a R^2 value of 0.049, indicating that neither of these models have strong predictive power for predicting the variance in resistance to flood risk mapping related to only affected landholders (Table 8).

Table 8: Regression modelling for presence of resistance to flood risk mapping

	Outcome variable: real estate risks				Outcome Variable: only for affected residents			
	Est	*p* (sig)	Est	*p* (sig)	Est	*p* (sig)	Est	*p* (sig)
N	*237*		*236*		*236*		*235*	
Key predictors								
Not able to cope	N/A	N/A	0.29 ***	**<0.001**	N/A	N/A	0.17	0.115
No implications for others	N/A	N/A	0.29 ***	**<0.001**	N/A	N/A	0.18	0.074
Alternate predictors								
Flood experience	0.16	0.468	0.17	0.418	0.28	0.356	0.30	0.328
Coastal flood	0.12	0.656	0.05	0.827	-0.51	0.162	-0.56	0.120
Freshwater flood	-0.01	0.977	-0.17	0.441	0.03	0.931	-0.10	0.765
Perception flood change	0.09	0.266	0.14	0.084	0.25 *	**0.029**	0.28 *	**0.016**
Flood risk assessment	-0.06	0.463	-0.01	0.912	-0.32 **	**0.005**	-0.29 *	**0.017**
See flood map	-0.22	0.233	-0.26	0.128	0.47	0.058	0.44	0.075
Controls								
Sex	0.42 **	**0.003**	0.39 **	**0.003**	0.52 **	**0.007**	0.53 **	**0.006**
Education	-0.35 *	**0.017**	-0.17	0.219	-0.22	0.259	-0.11	0.591
Own	-0.06	0.816	-0.11	0.636	-0.27	0.428	-0.29	0.383
Intercept	2.59 ***	**<0.001**	0.88 *	**0.028**	3.23 ***	**<0.001**	2.20 ***	**<0.001**
Adjusted R^2	0.039		0.177		0.049		0.071	

* p<0.05 ** p<0.01 *** p<0.001

For the models predicting the outcome variable 'real estate risks', there is a significant difference in terms of strength and predictors for the model with climax thinking compared to the model without. In the model without climax thinking, being female (p = 0.003) and having a university level education (p = 0.017) were found to be significant predictors of resistance to flood risk mapping related to real estate risks (Table 8). In the model with climax thinking, presence of both climax thinking variables of 'not able to cope' (p < 0.001) and 'no implications for others' (p < 0.001), as well as being female (p = 0.003) were found to be significant predictors of resistance to flood risk mapping related to real estate risk (Table 8). In these models predicting real estate risks, the adjusted R^2 value without climax thinking variables is 0.039, while with climax thinking variables the adjusted R^2 value is 0.177. By comparing these two models, we can deduce that the climax thinking variables can be attributed to a 14% increase in the predictive power of the regression model, or increase the explanatory value of the model by 4.5 times.

Chapter 5: Discussion

In this research, our aim was to understand the presence of resistance to flood risk mapping in the Southwestern Nova Scotia region, and use climax thinking and other variables of risk perception, perceptions of change, and flood experiences to help understand and explain this resistance. In order to do this, we sent out surveys to 12,421 addresses in the towns of Liverpool and Bridgwater in Southwestern Nova Scotia, and asked about flood experiences, perspectives on and knowledge of flood risk mapping in the area, landscape priorities as a test of climax thinking, and general demographics. In this discussion, we will be exploring four

overall areas of findings: flood experiences and awareness of flood risk maps, perceptions of flood change and flood risk assessment, support for flood risk mapping in the area, and the use of climax thinking as a predictor of resistance to flood risk mapping. Following this, we will discuss limitations of the research and areas for future studies.

5.1 Flood Experiences and Awareness of Flood Risk Maps

In our sampled population of 277 respondents, 32% had experienced at least one flood at their current property. While this is a significant proportion of the population who experienced flooding at their current property, it was expected based upon media reports of flooding in the towns of Bridgewater and Liverpool that most would have experienced flooding (Bradley, 2019; CBC, 2015; Yzaguirre et al, 2016). This reduced flood experience may have been due to the specific location of a respondent's properties, as many noted in free text sections of the survey that they did not personally experience flooding as they lived on top of a hill, but had observed flooding in their region. Despite this, nearly one third of respondents having flood experience is significant.

Only 19% of respondents noted they had seen any sort of flood risk mapping for their region. Of those who had seen mapping, when asked about the source, many noted it was mapping of the LaHave River Watershed through Nova Scotia Community College's College of Geographic Sciences (McGuigan et al., 2015). Others cited having seen maps as clips on the news. Interestingly, nobody was sure about the presence of publicly accessible flood risk maps created by the municipality, and only one participant was aware of the publicly available inland flood study risk map of the LaHave River and Bridgewater area created by the Municipality District of Lunenburg (Municipality of the District of Lunenburg, 2014). This demonstrates a lack

of public awareness of available flood risk mapping in the region, even though there are these resources available for certain areas within the surveyed region. This suggests that available maps are likely not being used to inform property and preparedness decisions among residents. This could be for many reasons, including that flood risk maps are difficult to interpret without expertise and education in geology, making them largely inaccessible to the general public for use even when they may be available. Our data shows a need for improved communication and publicity of flood risk mapping when new municipal flood risk mapping is standardized and rolled out in the near future (Valiquette et al., 2019).

5.2 Perceptions of flood change and flood risk assessment

When examining perceptions of flood change among respondents, we found that 65% of respondents did not notice any change in frequency and/or severity of flooding in their region over the recent past, with 9% noticing decreased frequency and/or severity and 26% noticing increased frequency and/or severity. This demonstrates that respondents are largely not noticing change to frequency or severity of flooding in the region, despite sources indicating that both flood severity and frequency have increased in this region over the recent past. There has been a sea level rise across Nova Scotia of 30cm over the past 100 years, which has increased the frequency of coastal and tidal flooding across all regions (Municipality District of Queens, 2014). Additionally, annual precipitation within the Municipality District of Queens, which includes the town of Liverpool, has increased by approximately 40mm since 1980, contributing to an increase of inland flooding in the region (Municipality District of Queens, 2014). In Bridgewater, annual precipitation is also on a gradually increasing trajectory since the late 20th century, contributing further to the increase in flooding within the town (Town of

Bridgewater, 2014). This perception by respondents was particularly surprising, as the region was even experiencing bad flooding during the course of this research, with the town of Yarmouth, only 150km down the coast from Liverpool, experiencing severe flooding in late November 2020 (Allen, 2020). This indicates a disconnect between the reality of flood severity and frequency in the region and residents' perceptions of it.

Flood risk assessment, which was calculated using respondents' opinions on how they believe that a flood will significantly impact them in the near future, also yielded surprising results. While previous research showed that experiencing a flood is significantly likely to render one more prepared and expectant of another flood (Stevens & Hanschka, 2014), our data did not find this to be the case. In fact, while 32% of respondents had experienced at least one flood at their current property, flood risk assessment was only found to be high or extreme in 12% of respondents, while the other 88% had moderate flood risk or lower.

From these results, it can be understood that while a significant proportion (32%) of those in the region have experienced flooding, not as many are concerned about future flood risk, or are aware that flooding is increasing in frequency and severity. This may be due to lack of public awareness or availability of flood risk maps in the region (81% of residents have never seen any flood map), as well as the lack of up to date and easily accessible local flood risk resources for residents to make use of.

5.3 Support for Flood Risk Mapping

Perceptions of resistance to flood risk mapping was explored through rating of a series of questions aimed at assessing possible causes of resistance to flood risk mapping (Table 6). Responses indicated overwhelming support for flood risk mapping in the region, with less than

4% of respondents expressing resistance to positive or neutral toned statements. Within these positive and neutral statements, there was little variation among responses, with lack of response diversity suggesting low levels of resistance to flood risk mapping. The two negatively toned statements showed the widest distribution, with 16% demonstrating resistance with regards to concerns about loss of property value, and 32% expressing resistance to the public aspect of flood risk mapping, indicating that they believe flood risk mapping should only be available to affected landholders. These two variables were therefore used as proxies for resistance.

It is likely that the statement regarding 'only affected landholders' was misinterpreted by a significant number of respondents. The response distribution for the statement regarding 'only affected landholders' was the only bimodal distribution of the responses (Table 6). This statement was intended to differentiate between those who believed that flood risk mapping should only be available to landholders, and those who believe it should be available publicly to anyone. Logically, it should have had an inverse distribution to the 'available to anyone' statement (Table 6). Due to possible misinterpretation, which may be due to lack of emphasis on the word "only" in the statement, this proxy for resistance had significantly weaker predictive power in regression modelling (Table 8).

Overall, we can conclude that there is little resistance to flood risk mapping in the region, and unless participants are directly prompted by potential negative impacts, such as risk to real estate value, they are unlikely to display resistance to flood risk mapping. Even when prompted with potential negative impacts such as risk to real estate value, only 16% of respondents displayed resistance, even though this was the most cited reason for resistance

and seemed prominent in the media (Bradley, 2016). With this, we can infer that the roll out of flood risk mapping in the region will likely be met with minimal resistance, especially if concerns of loss of real estate value is addressed, acknowledged, and mitigated against during the rollout. This could be done, for example, through providing an opt-in program that guarantees sale prices of properties prior to the release of flood risk maps in the region, ensuring that at the point of sale of the property, if it is sold for less than this price, the government will top up the remainder. This could also include buyouts prior to the release of flood risk maps.

5.4 Climax Thinking as a Predictor of Resistance

In order to establish which factors contributed to the presence of resistance to flood risk mapping, which is essential for understanding how to implement flood risk mapping with minimal resistance, regression modelling was completed for both aspects of resistance based on 'only affected landholders' and 'real estate risks' (Table 8).

As previously discussed, the variable 'only affected landholders' was likely misinterpreted, which may have contributed to the significantly weaker predictive power of its associated regression models (Table 8). In these models, it was found that significant predictors of resistance to flood risk mapping were being female, decreased perceptions of flood change, and minimal flood risk assessment. With climax thinking variables, the model was able to predict 7.1% of the variance in the 'only affected landholders' outcome variable, and without climax thinking variables it was able to predict 4.9% of the variance in the 'only affected landholders' outcome variable (Table 8). Although the introduction of the climax thinking variables does increase the predictive power of this model by 2%, the climax thinking variables of 'not able to cope' and 'no implications for others' were not found to be predictive of the

outcome variable of 'only affected landholders'. Due to the likely misinterpretation of the question and the weakness of both regression models with and without climax thinking, we cannot conclude that the predictors of these models are significant contributors to resistance to flood risk mapping among the surveyed population.

For the regression models built to predict the outcome variable 'real estate risks', there were differences between significant predictors in the models with and without climax thinking, as well as the predictive power of these models. In the model without climax thinking, there was a significant relationship between resistance and being female and having university level of education (Table 8). In the model with climax thinking, there was a significant relationship between resistance and being female, and presence of climax thinking both in terms of not being able to cope with land changes ('not able to cope') and belief that one's actions don't impact others in the community ('no implication for others') (Table 8). In the model without climax thinking variables, the model predicted 3.9% of the variance in the 'real estate risks' outcome variable. In the model with climax thinking variables however, the model was able to predict 17.7% of the variance in the 'real estate risks' outcome variable. This indicates that the presence of climax thinking variables increases the strength of the model for the 'real estate risks' outcome variable by 14%. While the model without climax thinking variables has weak predictive power and cannot be used to accurately inform presence of resistance to flood risk mapping, the model with climax thinking variables is predictively strong. From this, we can infer that for each respondent, 18% of climax thinking behaviour, specifically in the dimensions of ignorance about their own ability to adapt and that their own actions have implications elsewhere, is related to resistance to flood risk mapping. Furthermore, this resistance was not

significantly associated with alternative factors that are commonly believed to contribute to resistance to flood risk mapping, such as experience of flooding or flood risk assessment.

The dimensions of climax thinking most predictive of resistance were both related to ignorance (from the taxonomy in Table 7), so it can be understood that there is a general lack of awareness of people's ability to adapt, and that their land use decisions have implications for others. This suggests a need for both public preparation measures, and also public tools, such as flood risk maps, to inform these preparation measures. This is consistent with results regarding perceptions of flood change discussed previously, indicating the overwhelming majority of respondents were not noticing any increase in the frequency and severity of flooding.

Knowing that climax thinking in terms of ignorance for both self and other is a significant predictor of resistance to flood risk mapping in the region, the rollout of flood risk mapping must anticipate these dimensions in order to reduce resistance in the community. Education, emphasizing the need for collective responsibility when adapting to climate change and extreme weather events, and focus on collective action as a community, may mitigate against some of this resistance. In other contexts where climax thinking in these same dimensions was present, exposure to attitudes focusing on the greater good and working collectively towards a common goal was effective in reducing the presence of climax thinking (Sherren & Sutton, 2020).

5.5 Limitations

Although the findings of this research are important for informing the rollout of flood risk mapping in Southwestern Nova Scotia, and understanding presence and reasons for

resistance in this region, these results are limited by both overall sample size and demographics of respondents. Our sample size of 277 respondents yielded a margin of error of ±6% at a 95% confidence level. The overall response rate of 2.2% may not have achieved an accurate representation of opinions of the entire population. Additionally, the sample did not accurately match the demographics of the region, with slight overrepresentation of respondents aged 60-79 and those with an annual household income of $50,000 or more. There were no respondents over age 85, which may have been due to the technology-based data collection method requiring access to a device and the internet, as well the mail out technique which sent one card to each address, so those in care homes or retirement facilities would not have received individual copies.

5.6 Implications and Recommendations for further research

Despite the limitations of a small sample size and skewed demographics, the results of this study provide a basis of understanding of flood experiences in the communities of Bridgewater and Liverpool, and support a general openness in these communities to the impending rollout of provincially regulated flood mapping which is currently being planned under the Coastal Protection Act (2019) by the Department of Municipal Affairs (Valiquette et al., 2019). These results also inform potential reasons for resistance to flood risk mapping, notably concerns about real estate risks, and how this resistance can be combatted through community focused communication throughout the rollout process.

These results also spark interest for further research in this area. Notably, it would be important to see if the hypothesized use of collaborative communicative framing will reduce the presence of resistance to flood risk mapping. This research would require two separate

surveys, one with community-based framing discussed in advance of questions assessing resistance, and one without. This design would likely require a sample at least twice as large in order to be able to explore comparisons between these two groups. Additionally, exploring the presence of resistance to the public availability of flood risk mapping in a way that is accurately understood by respondents in further research would help gain insight into other possible causes of resistance, underlying reasons for resistance, as well as how to mitigate against it. This would be useful as well for helping to improve measures and conceptualizations of climax thinking as it is a theory that is still in development. Finally, future research after the implementation of publicly available flood risk mapping in the region could explore the same measures of resistance, and assess if the use of accurate and publicly available flood risk mapping in the region impacts the presence of resistance to flood risk mapping, or if it alters reasons for this resistance.

Chapter 6: Conclusion

This thesis sought to understand the presence of resistance to public flood risk mapping within Southwestern Nova Scotia, and explore if climax thinking could be used as a way to understand and explain this resistance. Data was collected through a single mail out survey, collecting information on flood experiences, opinions of flood risk maps, landscape priorities as a test of climax thinking, and demographic information. The research was guided by 3 questions:

1. What are the experiences of flooding in the region?
2. What are the major concerns of residents regarding the rollout of flood risk mapping?

3. How can climax thinking be used to understand and explain these concerns?

Overall, one third of respondents had experienced flooding at their current property. Despite this significant personal flood experience and the documented increase in flooding in Liverpool, Bridgewater, and the region, 65% of respondents had not noticed any increase in frequency or severity of flooding in the region.

Resistance to flood risk mapping was identified when participants were asked about real estate risks, and if they believed flood risk mapping should only be available to landholders. While it is likely that the question about whether only landholders should have access to flood risk maps was misinterpreted, it can be concluded that a main driver of resistance to flood risk mapping in the region is concern for loss of real estate value.

Through regression modelling, climax thinking was found to be a significant predictor of resistance related to real estate risks. From understanding the dimensions of climax thinking associated with this resistance, it can be deduced that community-based framing and programs that help reduce potential real estate value loss are important in reducing resistance to flood risk mapping, and to help residents understand that their land use decisions have impacts on their neighbours.

The results of this study provide new insights into presence of resistance to flood risk mapping and the reasons for this resistance in Southwestern Nova Scotia, specifically in the towns of Liverpool and Bridgewater. Resistance to flood risk mapping is low in this region. Of those studied, the underlying factors that contribute to this resistance are not demographic factors or flood experiences, but relate to the presence of climax thinking.

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Appendix 1: Mail Out Card

Front

Hello residents of Bridgewater or Liverpool,

My name is Samantha, and I am an Honours student at Dalhousie University conducting research on flood experiences and flood mapping. It doesn't matter if you own or rent your home, if you have lived there a long time or only just moved to the area: we are interested in hearing from every kind of household. This work is being funded by the Social Science and Humanities Research Council of Canada.

I am asking for only 5-7 minutes of your time to fill out my online survey, which you can find using the link (surveys.dal.ca/opinio/s?s=60440 OR bit.ly/dalfloodsurvey) or by scanning the QR code with your phone camera. The survey will close at midnight on February 14th.

Thank you for your support of my undergraduate research, and for joining your neighbours to help prepare your region for the flooding challenges ahead.

The first 100 people to fill out the survey can enter to win 1 of 5 $20 Tim Hortons gift cards. All following respondents can enter to win 1 of 5 $10 Tim Hortons gift cards.

Thank you for your time.

Gratefully,
Samantha Howard (Student)
Faculty of Environmental Science, Dalhousie University
Samantha.howard@dal.ca

Link to Survey:
surveys.dal.ca/opinio/s?s=60440
OR
bit.ly/dalfloodsurvey

QR Code to Survey:

Scan this QR code with your phone!

Back

Appendix 2: Consent Form

DALHOUSIE UNIVERSITY

CONSENT FORM
UNDERSTANDING RESISTANCE TO FLOOD MAPPING: A TEST OF CLIMAX THINKING IN LUNENBURG

KEY POINTS

- This data is being collected for an honours thesis project at Dalhousie university
- The survey will take approximately 5-7 minutes to complete
- All the data in the main survey is anonymous- nobody will be able to trace you personally back to your answers
- There are negligible risks to participating in this survey.
- To thank you for your time, you will have the chance to be entered to win a $20 or $10 Tim Hortons gift card. This data requires us to ask for your name and contact details, but these won't be linked to your main survey answers, and will be deleted immediately after the draw.
- Research findings will be shared with representatives from your community, submitted to local newspapers, and presented at a public conference in April 2021
- Our funder expects us to lodge the data in a public repository so other researchers can use it, but we will be sure to remove any text you have typed in before we upload it.

DETAILS

You are invited to take part in a research study being conducted by Samantha Howard, an undergraduate student in the Department of Earth and Environmental Sciences at Dalhousie University. The purpose of this research is to understand the experience of people in Bridgewater and Lunenburg involving flooding, and opinions about the use and purpose of flood mapping.

If you choose to participate in this research, you will be asked to answer 34 short questions in an anonymous online survey on your opinions about flood mapping. The survey should take approximately 5-7 minutes. Anonymous means that there are no questions in the main survey that ask for identifying details such as your name, address, or email address, so your responses will never be able to be connected to you.

After you submit the main survey you have the option of entering a separate survey where you can enter your name and email address if you want to be entered into a draw for a gift card to thank you for your time. This is optional. You can choose to enter a draw for a chance to win a $20 Tim Hortons gift card if you are within the first 100 participants, and a $10 Tim Hortons gift card if you are among the subsequent participants. Entering the draws will require completing a separate survey that will be linked after submitting your main survey

responses, so that your contact information for the draw will not be linked in any way to your survey responses. We will only use the answers to this draw survey to identify the two winners, and only they will be contacted using the details; all contact details will be deleted after the draw has been completed.

Your participation in this research is entirely your choice. You do not have to answer questions that you do not want to answer (by selecting prefer not to answer, or skipping over the question), and you are welcome to stop the survey at any time if you no longer want to participate. If you do submit your survey and you change your mind later, we will not be able to remove the information you provided, as we will not know which response is yours.

All responses will be saved on a secure Dalhousie server and password-protected computers and files. Only myself, Samantha Howard, and my supervisor, Dr. Kate Sherren will have access to the full survey results. After analysis of the results, the data will be stripped of any geographically identifying information (postal code) and any short answer question responses, and uploaded to an open data website, Dalspace, for future researchers to access.

I will describe and share general findings of this research in my honours thesis, and it will also be shared with representatives from your community of Bridgewater or Lunenburg, so that they can share the results with you. I also hope to publish a peer-reviewed paper. If you would like to see the results of this research, you are welcome to attend the virtual honours thesis symposium on Saturday, April 10th, 2021. If you would like to attend this event, please contact me and I will forward the link.

There are negligible risks to you in participating in this survey. We are requesting your postal code information to compare coastal versus inland flooding location, and to understand if our results apply to the whole community. There are also no direct benefits to you in participating in this research, beyond the potential gift card draw, but this research will contribute to new knowledge on public perception of flood mapping.

If there are any questions about this study, before or after participating, please contact Samantha Howard or her supervisor Dr. Kate Sherren, at samantha.howard@dal.ca or kate.sherren@dal.ca.

If you have any ethical concerns about your participation in this research, you may contact Research Ethics, Dalhousie University at (902) 494-3423, or email ethics@dal.ca (and reference REB file #2020-5436)."

Are you aged 18 or over? Yes/No (if No, terminate survey)

If you agree to complete the survey under the terms described above, please follow the link here/click continue.

Appendix 2: Survey Questions

Flood experiences and opinions

You are invited to take part in a research study being conducted by Samantha Howard, an undergraduate student in the Department of Earth and Environmental Sciences at Dalhousie University. The purpose of this research is to understand the flood experience of people in Nova Scotia's south shore, and opinions about the use and purpose of flood mapping.

KEY CONSENT POINTS

- The survey will take approximately 5-7 minutes to complete
- All the data in the main survey is anonymous- nobody will be able to trace you personally back to your answers
- There are negligible risks to participating in this survey.
- To thank you for your time, you will have the chance to be entered to win a Tim Horton's gift card. This data requires us to ask for your name and contact details, but these won't be linked to your main survey answers, and will be deleted immediately after the draw.
- Research findings will be shared with representatives from your community, submitted to local newspapers, and presented at a public conference in April 2021
- Our funder expects us to lodge the data in a public repository so other researchers can use it, but we will be sure to remove any text you have typed in before we upload it.

If you would like to see additional details before consenting to participating, they can be found here: http://katesherren.org/katesherren/wp-content/uploads/2021/01/DETAILS-consent-form.pdf

If there are any questions about this study, before or after participating, please contact Samantha Howard or her supervisor Dr. Kate Sherren, at samantha.howard@dal.ca or kate.sherren@dal.ca.

1. **Are you age 18 or over?**

   ◯ Yes

   ◯ No

2. **If you agree to complete the survey under the terms described above, please click YES to continue.**

   ◯ YES (I consent)

   ◯ NO (I do not consent)

Start

Section 1: Flooding

This section asks questions about your experiences with flooding where you live, and how likely you think it will be in the future.

3. **Has the place (house/apartment/property) where you currently live been affected by a flood while you have lived there?**

- ◯ Yes
- ◯ No
- ◯ I don't know
- ◯ I don't remember

4. **If yes, how many floods have you experienced at your current property?**

5. **If you have experienced flooding where you currently live, has the flooding you've experienced been mostly freshwater flooding (rivers, storm drains) or coastal flooding (e.g., big waves, storm surge)?**

- ◯ Freshwater
- ◯ Coastal
- ◯ Other (i.e. plumbing/industrial) please specify:

6. **Has anyone ever told you that the place where you currently live was affected by a flood BEFORE you lived there?**

- ◯ Yes
- ◯ No
- ◯ I don't know
- ◯ I don't remember

7. **Have you noticed any changes to flood severity while you have lived there (e.g., water levels during floods or duration of flooding)?**

- ◯ Yes, severity has increased (higher water levels and/or longer floods)
- ◯ Yes, severity has decreased (lower water levels and/or shorter floods)
- ◯ No
- ◯ I don't know
- ◯ I don't remember

8. **Have you noticed if it has been flooding more often or less often than it used to, or has flooding remained consistent?**

- ◯ More often than it used to
- ◯ Less often than it used to
- ◯ No change

9. **On a scale of 1-5, how likely do you think it is that a flood will impact you and your property in the next ten years?**

very unlikely	somewhat unlikely	neither likely nor unlikely	fairly likely	extremely likely
○	○	○	○	○

10. **If a flood were to occur within the next year, do you think it would have serious impacts for you and your household?**

not serious at all	somewhat serious	serious	very serious	extremely serious
○	○	○	○	○

11. **Do you have any further experiences with or concerns about flooding**

Next

Section 2: Flood Risk Mapping

This section asks about your experience with, and opinions of, flood mapping. Flood mapping shows which places in a given region are at risk of flooding. Such mapping is publicly available in many jurisdictions, though it is not always available for all places or kept up to date.

12. **Have you ever seen a map of your region that shows where flooding is most likely to occur?**

- ○ Yes
- ○ No
- ○ Don't know

13. **If yes, do you know any additional details about the map, including who created it and when it was created or most recently updated?**

14. **Are maps publicly available for the place where you live that show what areas are at risk of flooding?**

- ○ Yes
- ○ No
- ○ I don't know

15. **I think flood risk mapping should only be available to affected landholders in my region.**

strongly disagree	disagree	neutral	agree	strongly agree
◯	◯	◯	◯	◯

16. **I would like there to be flood risk mapping for my region available to the public.**

strongly disagree	disagree	neutral	agree	strongly agree
◯	◯	◯	◯	◯

17. **I believe that actual flood history should be disclosed before the sale of a property.**

strongly disagree	disagree	neutral	agree	strongly agree
◯	◯	◯	◯	◯

18. **I believe that actual flood history should be disclosed prior to signing a lease agreement for rental properties.**

strongly disagree	disagree	neutral	agree	strongly agree
◯	◯	◯	◯	◯

19. **I believe that future flood risk should be disclosed at the time of sale of a property.**

strongly disagree	disagree	neutral	agree	strongly agree
◯	◯	◯	◯	◯

20. **I believe that future flood risk should be disclosed prior to signing of a lease agreement for rental properties.**

strongly disagree	disagree	neutral	agree	strongly agree
◯	◯	◯	◯	◯

21. **Publicly available flood risk mapping in my area will motivate us to prepare and adapt for the future.**

strongly disagree	disagree	neutral	agree	strongly agree
◯	◯	◯	◯	◯

22. **Making flood risk mapping publicly available for my area would be too much of a risk for those who may lose real estate value.**

strongly disagree	disagree	neutral	agree	strongly agree
◯	◯	◯	◯	◯

23. **Do you have any further experience with or concern about flood risk mapping that you would like to share?**

Section 3: Landscape priorities

This section explores how you think about your property and your wider region, and where responsibility lies in the face of flood risk.

24. **I would like to think past generations that lived in this community would appreciate the property where I live.**

strongly disagree	disagree	neutral	agree	strongly agree
○	○	○	○	○

25. **One of the nice things about where I live is how little it has changed over the years.**

strongly disagree	disagree	neutral	agree	strongly agree
○	○	○	○	○

26. **Decisions about flood management here need to consider current residents over future residents.**

strongly disagree	disagree	neutral	agree	strongly agree
○	○	○	○	○

27. **Flood management options we have in place already will serve future generations well.**

strongly disagree	disagree	neutral	agree	strongly agree
○	○	○	○	○

28. **Decision-makers should protect me and my property from feeling the impact of increases in flood risk.**

strongly disagree	disagree	neutral	agree	strongly agree
○	○	○	○	○

29. **I am not able to cope with the land changes required to deal with significant increases in flood risk at this point in my life.**

strongly disagree	disagree	neutral	agree	strongly agree
○	○	○	○	○

30. **My area is more deserving of public support for protection against flooding than some others in the region.**

strongly disagree	disagree	neutral	agree	strongly agree
○	○	○	○	○

31. **Flood management decisions I make do not have implications for others.**

strongly disagree	disagree	neutral	agree	strongly agree
○	○	○	○	○

Section 4: Demographic Questions

Finally, we need to know a little bit about you so that we can understand how representative a sample we have achieved of your region.

32. **Year of birth**

33. **Average annual household income**

- ◯ Under $10,000
- ◯ $10,000-$49,999
- ◯ $50,000-$99,999
- ◯ $100,000-149,999
- ◯ $150,000 and over
- ◯ prefer not to say

34. **Gender**

- ◯ Male
- ◯ Female
- ◯ Other
- ◯ Prefer not to say

35. **Highest level of education**

- ◯ Lower than high school diploma
- ◯ High school diploma
- ◯ Some university
- ◯ Bachelor's degree
- ◯ Professional or graduate degree
- ◯ Some college
- ◯ College degree
- ◯ Prefer not to say

Other (please specify)

36. **Do you own or rent your current property?**

- ◯ Own
- ◯ Rent

37. **How many years have you lived at your current property?**

38. **How many years have you lived in your current community?**

39. **Do you have children?**

- ◯ Yes
- ◯ No

40. **Postal Code (select first 3 digits from dropdown, fill in last 3 digits)**

N/A

Last 3 digits

Finish

Appendix 3: REB application

DALHOUSIE UNIVERSITY

Prospective Research

This form should only be used if new data will be collected. For research involving only secondary use of existing information (such as health records, student records, survey data or biological materials), use the *REB Application Form – Secondary Use of Information for Research.*
This form should be completed using the *Guidance for Submitting an Application for Research Ethics Review*.

SECTION 1. ADMINISTRATIVE INFORMATION [File No: office only]

Indicate the preferred Research Ethics Board to review this research:
[ ] Health Sciences OR [X] Social Sciences and Humanities

Project Title:
Exploring resistance to publicly available flood mapping in Lunenburg County

1.1 Research team information				
Lead researcher (at Dalhousie)	Name	**Samantha Howard**		
	Email (@dal)	**Samantha.howard@dal.ca**	Phone	**647-291-3170**
	Banner #	**B00766631**	Academic Unit	**Earth and Environmental Science**
Co-investigator names, affiliations, & email				
Contact person for this submission (if not lead researcher)	Name			
	Email		Phone	
Study start date	**January 1 2021**	Study end date	**April 30 2021**	

1.2 For student submissions (including medical residents and postdoctoral fellows)			
Degree program	Environmental Science and International Development Studies		
Supervisor name and department	Dr. Kate Sherren, School for Resource and Environmental Studies		
Supervisor Email (@dal)	Kate.sherren@dal.ca	Phone	902 403 0544

Department/unit ethics review (if applicable). **Undergraduate minimal risk research only**.

Attestation: [x] I am responsible for the unit-level research ethics review of this project and it has been approved.
Authorizing name: Dr. Tarah S.S. Wright, Professor, Department of Earth and Environmental Sciences
Date: December 18, 2020

1.3 Other reviews		
Other ethics review (if any) for this research	Where?	
	Status?	
Scholarly/scientific peer review (if any)		
Is this a variation on, or extension of, a previously approved Dal REB submission?	[x] No [ ] Yes Dal REB file #_____	

If yes, describe which components of the current submission are the same as the previously approved submission (list section numbers), and which components are different from the previously approved submission (list section numbers). You may also use highlighting to clearly indicate revised text.

1.4 Funding [ ] Not Applicable		
Funding (list on consent form)	Agency	Social Sciences and Humanities Research Council of Canada- Explore Grant Sherren PI (39173)
	Award Number	Account number: 39173
	Institution where funds are/will be held	[x] Dalhousie University [ ] Other: _____

1.5 Attestation(s). The appropriate boxes *must* be checked for the submission to be accepted by the REB

[x] I am the **lead researcher** (at Dalhousie) named in section 1.1. I agree to conduct this research following the principles of the Tri-Council Policy Statement *Ethical Conduct for Research Involving Humans* (TCPS) and consistent with the University *Policy on the Ethical Conduct of Research Involving Humans*.

I have completed the TCPS Course on Research Ethics (CORE) online tutorial.

[x] Yes [ ] No

For Supervisors (of student / learner research projects):

[x] I am the **supervisor** named in section 1.2. I have reviewed this submission, including the scholarly merit of the research, and believe it is sound and appropriate. I take responsibility for ensuring this research is conducted following the principles of the TCPS and University Policy.

I have completed the TCPS Course on Research Ethics (CORE) online tutorial.

[x] Yes [ ] No

SECTION 2. PROJECT DESCRIPTION

2.1 Lay summary

2.1.1 In **plain language**, describe the rationale, purpose, study population and methods to be used. Include a summary of background information or literature to contextualize the study. What new knowledge, or public or scientific benefit is anticipated? [maximum 500 words]

I will be completing an honours research project under the supervision of Dr. Kate Sherren who is a professor in the School for Resource and Environmental Studies. This study is seeking to understand resistance to mandated municipal flood mapping in Nova Scotia, which has already been announced and will be rolled out in coming years. There is evidence of resistance to similar initiatives in Nova Scotia, including protests in the Shubenacadie region after the rollout of flood mapping and related zoning changes in 2016 (Bradley, 2016). Predominant reasons cited are concerns about decreasing property value and infringements on historical family properties. Previous literature in floodplain mapping has focused on the dearth of publicly available flood mapping in Canada and how flood risk perception influences behavior of homeowners across Canada (Thistlethwaite et al., 2018), however there is currently no research regarding why people are resistant to the rollout of floodplain mapping, or barriers faced by people who are not aware of risks of flooding or not inclined to prepare for this risk.

I will be examining flood mapping resistance through the lens of climax thinking. Climax thinking is a theory which seeks to understand why, when faced with proposed or possible land use changes, people are stuck in the thought pattern that the current landscape is at its final and ideal state (Sherren, forthcoming). Climax thinking is hypothesized to have two potential causes: exceptionalism and ignorance. Exceptionalism suggests that people set themselves apart from the need for change, and are unwilling to consider past, future or more distant people on equal terms.

Ignorance suggests a lack of awareness of past changes or future needs, or the way that resisting change can impact others. Both causes have time and space dimensions. Dimensions of time distinguish between past and future, and space between self and other. In its temporal dimension, climax thinking is characterized by thinking that future generations are less important, or that current arrangements will suit them. This is how the framework applies to flood mapping, and reveals cognitive dissonance in the sense that many homeowners wish they had had flood mapping when they bought their house, but typically don't want it now that they own their house for fears that property value and resale will be impacted (Valiquette et al., 2019).

Through this proposed study, I seek to understand resistance to floodplain mapping, as well as people's fixed perceptions of their current landscape and land uses through the lens of climax thinking. This study is intended to broaden our understanding of resistance to floodplain mapping, and to correlate this resistance with indicators of climax thinking, along with other socio-demographic and explanatory variables of risk perception, flood experience, and being a parent. These factors were chosen due to their potential to broaden understanding of possible alternative causes of resistance, and how, if these are found to prevail, suggest framing that can be used to help mitigate resistance in the rollout of flood mapping. This information will be able to inform the policy rollout regarding provincially mandated municipal level floodplain mapping, which is forthcoming in Nova Scotia. Results from this research can be used to inform policy around mitigation of flooding across Nova Scotia through floodplain mapping, and to help understand public sensibilities regarding land use change-related climate change adaptation in general.

[] This is a pilot study.

[X] This is a fully developed study.

2.1.2 Phased review. If a phased review is being requested, describe why this is appropriate for this study, and which phase(s) are included for approval in this application. Refer to the guidance document before requesting a phased review.

[X] Not applicable

2.2 Research question

State the research question(s) or research objective(s).

- How do landowners and residents in Lunenburg county perceive publicly available flood risk mapping?
- Does climax thinking help explain resistance to floodplain mapping, compared with more conventional drivers such as flood risk perception?

2.3 Recruitment

2.3.1 Identify the study population. Describe and justify any inclusion / exclusion criteria. Also describe how many participants are needed and how this was determined.

The study population identified for this research is all households in the communities of Bridgewater and Lunenburg. These communities were purposively chosen based on of a listing of all media mentions of floods across Nova Scotia between 1992 and 2014, with these two communities having the most mentions within the District Municipality of Lunenburg (Yzaguirre et al, 2015). In order to hold statistical significance, this study will require at least 358 responses to achieve a 95% confidence level (5% margin of error) for the 5117 residences recorded in the 2016 Census of Population, which is a 7% response rate of the single mailout. A similar number is required if individuals are considered instead of households: 369 participants to achieve a 95% confidence level (5% margin of error) on 8983 adult residents. This is relevant as it is possible more than one person from a single household may decide to participate.

2.3.2 Describe recruitment plans and append recruitment instruments. Describe who will be doing the recruitment and what actions they will take, including any screening procedures.

Canada Post Precision Targeter is a service run through Canada Post which allows for targeted mail to reach certain postal codes, communities, or neighborhoods. Through this service, we are able to send out our recruitment card to the communities of Bridgewater and Lunenburg. We will be using this service to recruit participants for the survey using a single mailout card that will go to every address within the municipal areas identified. This approach is being used to reduce handling during COVID. The draft mail out postcard, which is attached, will link residents to the survey through website address and QR code. The consent form will include a place for participants to attest that they are 18 years or older, but this is the only screening and it will be self-applied.

2.3.3 If you require permission, cooperation, or participation from a community, organization or company to recruit your participants, describe the agreement obtained from the relevant group(s). Attach correspondence indicating their cooperation and/or support (required). Describe any other community consent or support needed to conduct this research. (If the research involves Indigenous communities complete section 2.11).

[X] Not applicable

While it is not required, we have written to planning officers at both Municipalities to ensure they are aware of the survey and research plan, and to ensure that our research will not come at a difficult time for them. For instance, if they happened to be surveying their citizens or rolling out flood mapping during the study, it might be confusing for residents. We received enthusiastic support from both communities to proceed.

2.4 Informed consent process

2.4.1 Describe the informed consent process:

A) How, when and by whom will the study information be conveyed to prospective participants? How will the researcher ensure prospective participants are fully informed?

Key study information will be on the invitation postcard that is received in the mail. After they navigate to the website using the web address or QR code, participants will first see a consent form which will include both a quick summary, and full details, of the purpose of the work and any possible risks it may involve. The researcher will ensure that prospective participants are

fully informed by having them actively accept the information displayed on the consent page, as well as attest that they are 18 years of age or older.

B) Describe how consent will be documented (e.g. written signature, audio-recorded, etc).

Consent will be documented electronically by having participants click on a button indicating that they understand and agree to the risks of the survey.

[x] Append copies of all consent information that will be used (e.g. written consent document, oral consent script, assent document/script, etc).

Note: If the research will involve third party consent (with or without participant assent), and/or ongoing consent, ensure these are described above.

2.4.2 Discuss how participants will be given the opportunity to withdraw their participation (and/or their data) and any time (or content) limitations on this. If participants will not have opportunity to withdraw their participation and/or their data explain why.

Participants can withdraw their participation at any time by simply exiting the tab on the browser. If the survey is closed before submitting, none of their responses will be recorded or used in the study. If participants submit partial surveys (i.e., skip questions) the answers that are submitted will be included in the final analysis. Data from the main surveys will be anonymous, so once data are submitted they will be unable to remove their answers. All this will be made clear on the consent form.

2.4.3 If an alteration/exception to the requirement to seek prior informed consent is sought, address the criteria in TCPS article 3.7A. If the alteration involves deception or nondisclosure, also complete section 2.4.4.

[x] Not applicable

2.4.4 Describe and justify any use of deception or nondisclosure and explain how participants will be debriefed.

[x] Not applicable

2.5 Methods, data collection and analysis

2.5.1

A) Where will the research be conducted?

The research will be conducted online using Opinio software, hosted through Dalhousie University. This is a software tool that works on any web-enabled device including smartphone. This means the survey respondents could be physically anywhere while the survey is being completed.

B) What will participants be asked to do?

Participants will be asked to answer or respond using Likert scales to 34 short questions or statements, in four sections, all of which are appended to this form. Two additional questions on a separate survey will be asked should they choose to enter in the incentive draw for one of two Visa gift cards.

C) What data will be collected using what research instruments? *(Note that privacy and confidentiality of data will be covered in section 2.6)*

We will be collecting information from the survey questions noted below using Opinio software. At the completion of the survey, participants will then be linked to another survey where they will have the chance to fill out their email address to be entered to win the Visa gift card draw. Only one entry per email address will be permitted. This step will decouple the survey answers from the personally identifiable information.

D) How much of the participant's time will participation in the study require?

We estimate that participation in the study will take 5-7 minutes.

[X] Append copies of all research instruments (questionnaires, focus group questions, standardized measures, etc)

[ ] This is a clinical trial (physical or mental health intervention) – ensure section 2.12 is completed

2.5.2 Briefly describe the data analysis plan. Indicate how the proposed data analyses address the study's primary objectives or research questions.

The results collected from the online survey will be analyzed using R and SPSS statistical software, in order to explain the resistance or willingness to accept flood mapping among the surveyed population. Descriptive statistics of mean and central tendency will first be used to examine overall trends in the results, such as what proportion of total respondents have flood experience. The key predictor variables that will be examined to explain this resistance to flood mapping will be climax thinking, risk perception, flood experience, and being a parent. Being a parent is a simple binary variable. Measurements of the other dependent and independent variables will be developed using exploratory factor analysis and/or Cronbach's alpha to establish how closely related the answers used to predict these outcomes are, before creating scales for each. Other demographic factors, including age, gender, income, and education, will also be included in the analysis.

Bivariate analysis, which is correlating two variables or scales with each other to see how related they are, will be conducted between the dependent variable and all of the explanatory variables. Next, a correlation matrix of all explanatory variables will be conducted, which will explore how related the variables are, and will inform if any variables are too highly correlated to be carried forward in the regression analysis. Finally, a regression analysis will be conducted to estimate the relationship between resistance to flood mapping and each of the explanatory variables, including climax thinking, being a parent, flood experience, and geographic location. If climax thinking is found to be significant, further analysis will be done to establish which dimensions of climax thinking are most influential.

Postal code data will be used in the analysis to understand the geographic distribution of the response rate in order to assess for generalizability, so that we can understand where the predictive power of our findings may be weaker.

2.5.3 Describe any compensation that will be given to participants and how this will be handled for participants who do not complete the study. Discuss any expenses participants are likely to incur and whether/how these will be reimbursed.

Participants will be compensated for their time and input by being entered into a draw for a $100 Visa gift card if they are within the first 100 participants, and a $50 Visa gift card if they are within the remaining participants. Participants will not incur any additional expenses by participating in this research given the short length of the survey.

Once participants have completed the first survey, they will be presented with a link to a separate Opinio survey where they will have the chance to enter their email address to be entered to win the Visa gift card draw. This will separate the personalized information from the survey responses, and only be used for administering the incentive. Participants who win the draw will be emailed to request a mailing address to receive the incentive. Even if they skip some questions, participants will be able to enter this draw, but they will not be able to enter the draw if they do not submit their survey responses.

2.6 Privacy and confidentiality

2.6.1

A) Describe who will have knowledge of participants' identities.

We will have contact details only for those participants who choose to enter the draw for the incentive, but those details will not be connected to the survey responses.

B) Describe the level of identifiability of the study data (anonymous, anonymized, de-identified/coded, identifying) (see TCPS Chapter 5A – types of information for definitions).

The main survey data is anonymous, and contact details elicited in the separate survey will be directly identifying but destroyed after the gift card draw is completed. The research team will not ever know which survey responses have been submitted by any particular participant.

C) Specify which members of the research team (or others) will have access to participants' data and for what purpose.

The members of the research team who will have access to participants' data will be Samantha Howard, primary researcher, and Dr. Kate Sherren, supervisor. Both individuals will be analyzing the data.

D) Describe measures to ensure privacy and confidentiality of study documents and participant data during the data collection and analysis phase. *[Note that plans for long term storage will be covered in 2.6.2*]

- Address: handling of documents/data during data collection; transportation or transfer of documents/data; storage of documents/data (during the study).
- If a key-code will be maintained, describe how it will be kept secure.
- For electronic data, describe electronic data security measures, including file encryption and/or password protection as applicable.
- For hard copy documents, describe physical security measures (specify location).

Once the survey is complete, all data will be downloaded onto Samantha Howard's personal computer and saved offline, the Opinio form will be deactivated and any online data deleted. This device is password protected, as is Dr. Sherren's. Only Samantha Howard will have access to the personalized data for the purpose of administering the incentive and will delete it as soon as that step is completed. After that is completed, the main survey data will be password protected at the file level.

[ ] This research involves personal health records (ensure section 2.13 is completed)

2.6.2 Describe plans for data retention and long-term storage (i.e. how long data will be retained, in what form and where). Will the data eventually be destroyed or irreversibly anonymized? If so, what procedures will be used for this? Discuss any plans for future use of the data or materials beyond the study currently being reviewed.

Main survey response data will be stored long term in Samantha Howard's personal computer. As it is anonymous at the time of collection, it can never be traced back to participants. This data will also be uploaded to an online open database, Dalspace, to make sure that other researchers have access to the data for the purposes of building on the research or testing our findings. This plan will be made clear in the consent form. However, prior to uploading to Dalspace, all geographically identifying attributes (Postal Code) will be removed, and all short answer questions will be removed, leaving only response-limited questions. This is to avoid the risk that participants say something identifying during open text questions.

[x] This research will be deposited in a data repository (ensure section 2.14 is completed)

2.6.3

Describe if/how participant confidentiality will be protected when research results are reported:

A) For quantitative results - In what form will study data be disseminated?

[x] Only aggregate data will be presented

[] Individual de-identified, anonymized or anonymous data will be presented

[ ] Other. If "other", briefly describe dissemination plans with regard to identifiability of data.

[ ] Not applicable, only qualitative data will be presented

B) For qualitative results - Will identifiable data be used in research presentations/publications? If participants will be quoted, address consent for this and indicate whether quotes will be identifiable or attributed.

[ ] Not applicable, only quantitative data will be presented

Any qualitative data used in results or publication, for instance quotes of free text survey sections to contextualize survey results, will remain anonymous, but may be attributed to the respondent's town and gender if provided on the survey.

2.6.4 Address any limits on confidentiality, such as a legal duty to report abuse or neglect of a child or adult in need of protection, and how these will be handled. Ensure these are clear in the consent documents. (See the guidance document for more information on legal duties and professional codes of ethics).

[x] Not applicable

2.6.5 Will any information that may reasonably be expected to identify an individual (alone or in combination with other available information) be accessible outside Canada? And/or, will you be using any electronic tool (e.g. survey company, software, data repository) to help you collect, manage, store, share, or analyze personally identifiable data that makes the data accessible from outside Canada?

[X] No

[ ] Yes. If yes, refer to the University *Policy for the Protection of Personal Information from Access Outside Canada*, and describe how you comply with the policy (such as securing participant consent and/or securing approval from the Vice President Research and Innovation).

2.7 Risk and benefit analysis

2.7.1 Discuss what risks or discomforts are anticipated for participants, how likely risks are and how risks will be mitigated. Address any particular ethical vulnerability of your study population. Risks to privacy from use of identifying information should be addressed. If applicable, address third party or community risk. (If the research involves Indigenous communities also complete section 2.11)

There is minimal perceived risk to the participants. Participants are not required to share information that they do not wish to share. There is no physical risk, as the survey conducted in an online environment. Participating in this study will also not be a financial burden. As we will be collecting postal code data, there is potential concern about social or political risk for communities who may be labeled as 'opposed to flood mapping', as they may be perceived as being less concerned about environmental issues. This risk will be mitigated as we will only be using geographic data collected from postal codes to differentiate between types of flooding (coastal in Lunenberg vs. inland in Bridgewater), and to accurately assess the predictive power of our findings. The communities will not be directly compared to one another in terms of resistance to flood mapping, therefore social or political risk and privacy concerns associated with this study will be negligible. The only other possible concern is the reflection upon flood experiences, which can be very emotive, but respondents can opt not to complete the survey or certain questions if desired.

2.7.2 Identify any direct benefits of participation to participants (other than compensation), and any indirect benefits of the study (e.g. contribution to new knowledge).

Direct benefits of participation for participants may be the opportunity for them to reflect on their own landscape priorities, flood risk, and flood preparedness. Indirect benefits of the study include deepening understanding about why people display resistance to flood mapping, which will help inform the rollout of more socially accepted flood mapping programs.

2.8 Provision of results to participants and dissemination plans.

2.8.1 The TCPS encourages researchers to share study results with participants in appropriate formats. Describe your plans to share study results with participants and discuss the process and format.

Study results will not be shared directly with participants so that we do not need to store personal contact details over the long term, but we will share the results with our existing contacts in the municipalities, who will be able to communicate results through their websites and council meetings. Additionally, study results will be submitted to the local Bridgewater newspaper, Lighthouse Now, as well as the Chronicle Herald. We cannot be sure that either will publish the summaries, but often such outlets are receptive to short pieces of local relevance. Study results will also be presented at the virtual environmental science honours thesis symposium on April 10th, 2021, and if participants make note of the email address, they are able to reach out via email for an invitation link to this public event. This information will be included in the consent form.

2.8.2 If applicable, describe how participants will be informed of any material incidental findings – a discovery about a participant made in the course of research (screening or data collection) that is outside the objectives of the study, that has implications for participant welfare (health, psychological or social). See TCPS Article 3.4 for more information.

[x] Not applicable

2.8.3 Describe plans for dissemination of the research findings (e.g. conference presentations, journal articles, public lectures etc.).

Research findings will be shared in the Science Atlantic Environment virtual conference on March 13th, 2021 as well at the Environmental Science honours thesis qualifying examination presentations on April 10th, 2021. Both of these events will be open to the public. After the honours thesis has been completed, a manuscript may be prepared for publication to an outlet such as *The Canadian Geographer* or *Land Use Policy*.

2.9 Research Team

2.9.1 Describe the role and duties of all research team members (including students, RA's and supervisors) in relation to the overall study.

The research team for this study includes Samantha Howard, undergraduate student, and Dr. Kate Sherren, her supervisor and professor in the School of Resource and Environmental Studies at Dalhousie University. Samantha Howard will be the primary researcher, responsible for carrying out and analyzing the research. Dr. Kate Sherren will be responsible for advising and helping in all elements throughout the research process.

2.9.2 Briefly identify any previous experience or special qualifications represented on the team relevant to the proposed study (e.g. professional or clinical expertise, research methods, experience with the study population, statistics expertise, etc.).

Dr. Kate Sherren has extensive research experience in this field, in particular in the development of climax thinking theory and testing this theory in other contexts including for coastal adaptation (Sherren & Sutton, 2019) and land use changes with wind energy farms

(Chappell et al., 2020). She has led many survey-based research projects, including with farmers in Australia and Canada, and general population surveys in Canada at the regional, provincial and national scale. Additional statistics support may be sought from the Statistical Consulting team in the Department of Mathematics and Statistics at Dalhousie University.

2.10 Conflict of interest

Describe whether any dual role or conflict of interest exists for any member of the research team in relation to potential study participants (e.g. TA, fellow student, teaching or clinical relationship), and/or study sponsors, and how this will be handled.
[x] Not applicable

2.11 Research involving Indigenous peoples
Consult TCPS Articles 9.1 and 9.2 in determining whether this section is applicable to your research.
[x] Not applicable – go to 2.12

2.11.1 If the proposed research is expected to involve people who are Indigenous, describe the plan for community engagement (per TCPS Articles 9.1 and 9.2). If community engagement is not sought, explain why the research does not require it, referencing TCPS article 9.2.

2.11.2 State whether ethical approval has been or will be sought from Mi'kmaw Ethics Watch and if not, why the research does not fall under their purview. If the research falls under the purview of other Indigenous ethics groups, state whether ethical approval has been or will be sought.

2.11.3 Describe plans for returning results to the community and any intellectual property rights agreements negotiated with the community with regard to data ownership (see also 2.11.4 if applicable). Append applicable research agreements.

2.11.4 Does this research incorporate OCAP (Ownership, Control, Access, and Possession) principles as described in TCPS Article 9.8?
[ ] Yes. Explain how.
[ ] No. Explain why not.

2.12 Clinical trials
[x] Not applicable – go to 2.13

2.12.1 Will the proposed clinical trial be registered?
[ ] No. Explain why not.
[ ] Yes. Indicate where it was/will be registered and provide the registration number.

2.12.2 If a novel intervention or treatment is being examined, describe standard treatment or intervention, to indicate a situation of clinical equipoise exists (TCPS Chapter 11). If placebo is used with a control group rather than standard treatment, please justify.

2.12.3 Clearly identify the known effects of any product or device under investigation, approved uses, safety information and possible contraindications. Indicate how the proposed study use differs from approved uses.
[ ] Not applicable

2.12.4 Discuss any plans for blinding/randomization.

2.12.5 What plans are in place for safety monitoring and reporting of new information to participants, the REB, other team members, sponsors, and the clinical trial registry (refer to TCPS Articles 11.6, 11.7, 11.8)? These should address plans for removing participants for safety reasons, and early stopping/unblinding/amendment of the trial. What risks may arise for participants through early trial closure, and how will these be addressed? Are there any options for continued access to interventions shown to be beneficial?

2.13 Use of personal health information
[x] Not applicable

2.13.1 Research using health information may be subject to Nova Scotia's *Personal Health Information Act*. Describe the personal health information (definition explained in the guidance document) required and the information sources, and explain why the research cannot reasonably be accomplished without the use of that information. Describe how the personal health information will be used, and in the most de-identified form possible.

2.13.2 Will there be any linking of separate health data sets as part of this research?
[ ] No
[ ] Yes

If yes:
A) Why is the linkage necessary?
B) Describe how the linkage will be conducted (it is helpful to append a flow diagram)
C) Does that linkage increase the identifiability of the participants?

2.13.3 Describe reasonably foreseeable risks to privacy due to the use of personal health information and how these will be mitigated.

2.14 Data Repositories
[] Not applicable

2.14.1 Identify and describe the data repository in which the research data will be deposited. What is its focus, who are its target users, who can access deposited data and under what circumstances? For how long will the data be kept in the repository?

Data will be kept in Dalspace data repository indefinitely. This is used by all Dalhousie University researchers to support open data initiatives that are valued by the Tri-council and other funders. It will be able to be accessed openly by the public and it is intended to be used for transparency and to support further research in the field.

2.14.2 Describe the data set to be released to the repository. If there is personal and/or sensitive information in the data, describe how you will prepare the data for submission to the repository and mitigate risks to privacy. Identify all fields that will be included in the final data set (include as an appendix).

The dataset that will be released into the final repository will include all questions without potentially identifying information (short answer or postal code). The questions that will not be included in the repository are marked with an Asterix (*) beside the question in the appendix, attached below.

2.14.3 Is agreeing to have one's data deposited a requirement for participation in the study? If yes, provide a justification. If no, indicate how participants can opt in or out.

Yes, agreeing to have one's data deposited is a requirement for participation in the study. Otherwise the dataset would be incomplete online, and of little value to future researchers.

Appendix 4: Complete regression models

Supplemental Table 1: Complete regression model predicting real estate risks with climax thinking variables

	Outcome Variable: Real estate risks			
Predictors	*Estimates*	*std. Error*	*CI*	*p*
(Intercept)	0.88 *	0.40	0.09 – 1.66	**0.028**
fl_exp	0.17	0.21	-0.24 – 0.58	0.418
coastal	0.05	0.25	-0.44 – 0.55	0.827
freshwater	-0.17	0.22	-0.61 – 0.27	0.441
percep_fl_change	0.14	0.08	-0.02 – 0.29	0.084
fl_risk_assess	-0.01	0.08	-0.17 – 0.15	0.912
see_map	-0.26	0.17	-0.59 – 0.08	0.128
sex	0.39 **	0.13	0.13 – 0.65	**0.003**
edu	-0.17	0.14	-0.44 – 0.10	0.219
own	-0.11	0.23	-0.57 – 0.35	0.636
nocope	0.29 ***	0.08	0.14 – 0.45	**<0.001**
noimplication	0.29 ***	0.07	0.16 – 0.43	**<0.001**
Observations	236			
R^2 / R^2 adjusted	0.216 / 0.177			

** p<0.05 ** p<0.01 *** p<0.001*

Supplemental Table 2: Complete regression model predicting real estate risks without climax thinking variables

	Outcome Variable: Real estate risks			
Predictors	*Estimates*	*std. Error*	*CI*	*p*
(Intercept)	2.59 ***	0.31	1.97 – 3.21	**<0.001**
fl_exp	0.16	0.22	-0.28 – 0.60	0.468
coastal	0.12	0.27	-0.40 – 0.64	0.656
freshwater	-0.01	0.24	-0.47 – 0.46	0.977
percep_fl_change	0.09	0.08	-0.07 – 0.26	0.266
fl_risk_assess	-0.06	0.08	-0.23 – 0.10	0.463
see_map	-0.22	0.18	-0.58 – 0.14	0.233
sex	0.42 **	0.14	0.14 – 0.70	**0.003**
edu	-0.35 *	0.14	-0.63 – -0.06	**0.017**
own	-0.06	0.25	-0.55 – 0.43	0.816
Observations	237			
R^2 / R^2 adjusted	0.076 / 0.039			

** p<0.05 ** p<0.01 *** p<0.001*

Supplemental Table 3: Complete regression model predicting only affected residents with climax thinking variables

	Outcome variable: Only affected residents			
Predictors	*Estimates*	*std. Error*	*CI*	*p*
(Intercept)	2.20 ***	0.58	1.07 – 3.34	**<0.001**
fl_exp	0.30	0.30	-0.30 – 0.89	0.328
coastal	-0.56	0.36	-1.28 – 0.15	0.120
freshwater	-0.10	0.33	-0.74 – 0.55	0.765
percep_fl_change	0.28 *	0.11	0.05 – 0.50	**0.016**
fl_risk_assess	-0.29 *	0.12	-0.52 – -0.05	**0.017**
see_map	0.44	0.24	-0.05 – 0.92	0.075
sex	0.53 **	0.19	0.15 – 0.90	**0.006**
edu	-0.11	0.20	-0.50 – 0.28	0.591
own	-0.29	0.33	-0.95 – 0.37	0.383
nocope	0.17	0.11	-0.04 – 0.39	0.115
noimplication	0.18	0.10	-0.02 – 0.37	0.074
Observations	235			
R^2 / R^2 adjusted	0.114 / 0.071			

** p<0.05 ** p<0.01 *** p<0.001*

Supplemental Table 4: Complete regression model predicting only affected residents without climax thinking variables

	Outcome variable: Only affected residents			
Predictors	*Estimates*	*std. Error*	*CI*	*p*
(Intercept)	3.23 ***	0.42	2.40 – 4.07	**<0.001**
fl_exp	0.28	0.30	-0.32 – 0.88	0.356
coastal	-0.51	0.36	-1.22 – 0.20	0.162
freshwater	0.03	0.33	-0.61 – 0.67	0.931
percep_fl_change	0.25 *	0.11	0.03 – 0.48	**0.029**
fl_risk_assess	-0.32 **	0.11	-0.55 – -0.10	**0.005**
see_map	0.47	0.25	-0.02 – 0.96	0.058
sex	0.52 **	0.19	0.14 – 0.90	**0.007**
edu	-0.22	0.20	-0.61 – 0.16	0.259
own	-0.27	0.34	-0.93 – 0.40	0.428
Observations	236			
R^2 / R^2 adjusted	0.086 / 0.049			

** p<0.05 ** p<0.01 *** p<0.001*