

Birchall, S.J., MacDonald, S., Slater, T. (2021). Anticipatory Planning: Finding balance in climate change adaptation governance. *Urban Climate*.
<https://doi.org/10.1016/j.uclim.2021.100859>.

Anticipatory Planning: Finding balance in climate change adaptation governance

S. Jeff Birchall^{1*}, Seghan MacDonald¹, Tara Slater¹

¹School of Urban and Regional Planning, Department of Earth and Atmospheric Sciences, University of Alberta, Canada

1-26 Earth Sciences Building
Edmonton, Alberta
Canada T6G 2E3

*Corresponding author: jeff.birchall@ualberta.ca
ORCID: <https://orcid.org/0000-0002-4508-6720>

As climate change progresses, local governments are being forced to find ways to adapt to worsening environmental, economic, and infrastructure impacts. The city of Fredericton, New Brunswick has a long history of river and overland flooding; however, more recent changes in local weather patterns have led to an increase in flood risk in the area. For more than a decade, decision-makers in Fredericton have worked to mainstream adaptation action within municipal policy in order to address the growing flood risk. Through anticipatory spatial planning and incremental infrastructure upgrades, the city aims to proactively mitigate the impacts of climate change on day-to-day life. Framed through evolutionary governance, this article investigates the relationships between actors and institutions, as well as power and knowledge in order to uncover long-standing path dependencies that hinder comprehensive climate change adaptation action. While Fredericton can be considered a success story in many ways, this research reveals flawed multi-level governance structures and economic development goals as major barriers to effective adaptation in practice. As climate impacts worsen, balancing economic and political interests with adaptation action will require new approaches to adaptation governance.

Key words: multi-level governance; mainstreaming; climate change policy; path dependencies; urban planning

Highlights

- Anticipatory planning can be effective when facing increasing climate change impacts
- Mainstreaming adaptation in policy can help balance economic needs with climate action
- Multi-level governance can accelerate progressive adaptation through enhanced collaboration
- Institutional barriers at the regional level can hinder effective local adaptation planning

1. Introduction

Climate change is inarguably a global issue, yet the effects are felt most acutely on a local scale, with local governments often best suited to assess local vulnerabilities (Measham et al., 2011; Nordgren, Stults & Meerow, 2016; Dale et al., 2020). Decisions about land use, infrastructure, hazard mitigation, emergency preparedness and water resources are often made at the municipal level, which puts local governments in a position to integrate climate and adaptation considerations into planning and management activities (Nordgren et al., 2016). Additionally, municipal governments operate at the scale that is most responsive and accessible to citizens, which can strengthen governance and public buy-in for adaptation action (Dale et al.,

2020). Regardless of the opportunity found in local adaptation action, it can be challenging for local governments to prioritize proactive adaptation in planning and policy—especially when balancing a multitude of economic, social and political interests.

Complementary and collaborative action at all levels of government can aid local adaptation efforts (IPCC, 2014; Oulahen et al., 2018), and drivers of climate innovation have been found to include leadership at multiple levels of governance (Dale et al., 2020). This suggests that multi-level governance presents an opportunity for effective adaptation action. Indeed, multi-level governance action can help sustain innovation in local climate adaptation while expediting the scale and size of change in current development pathways (Dale et al., 2020; Zen et al., 2019). More specifically, regional governments can accelerate adaptation innovation through proactive legislation, financial incentives and resources, policy instruments, and continuous measurement and reporting (Dale et al., 2020). Despite opportunities presented through multi-level governance, however, inadequate collaboration, lack of local autonomy, and misalignment of policies between different levels of government can be a significant barrier to implementing successful long-term adaptation planning (Williams, 2020; Oulahen et al., 2018).

A further barrier to comprehensive adaptation action is a lack of mainstreaming within local policy (e.g. Vogel et al., 2020; Birchall, 2020). Due to the high variability of climate change impacts, proactive adaptation policies designed to reduce the vulnerability of communities, are crucial for increasing local resilience (e.g. Vogel et al., 2020; Oulahen et al., 2018). However, literature suggests that when an agenda for adaptation does exist, it is often peripheral and marginalized, which can put it in competition with other economic, political and social activities (Kithiia & Dowling, 2010; Carter et al., 2015).

Despite the challenges, mainstreaming climate change adaptation can help local governments balance environmental concerns with economic and political interests (Runhaar et al., 2018). Integrating climate change adaptation within long-term strategic and spatial planning carries many benefits, including increased policy efficiency through capitalizing on synergistic actions and goals (Tanner et al., 2019; Grafakos et al., 2019; Giordano, 2012). For example, the greening of urban spaces reduces flood risk while also contributing to quality of life and improving biodiversity (Runhaar et al., 2018). Embedding adaptation goals in sectoral plans and policies can also be more efficient from an administrative and budgetary perspective (Runhaar et al., 2018).

While many avenues of scholarship focus on factors that constrain local adaptation, it is less common to see instances of anticipatory and integrated adaptation planning done well. This paper seeks to add to the discussion by investigating the response to flooding in Fredericton, and how the relationship between the municipal and provincial governments influence the city's climate change narrative. Given that many other big-river-adjacent cities face similar climate challenges, findings from this research may provide communities with knowledge of the benefits of an integrated and anticipatory approach to adaptation planning as well as an understanding of the effects of multi-level, nuanced government interplay and power imbalance. It's our hope that this research can help other communities uncover avenues for balancing economic, social and political interests with environmental ones—ultimately increasing their resilience to climate change hazards.

2. Fredericton, New Brunswick

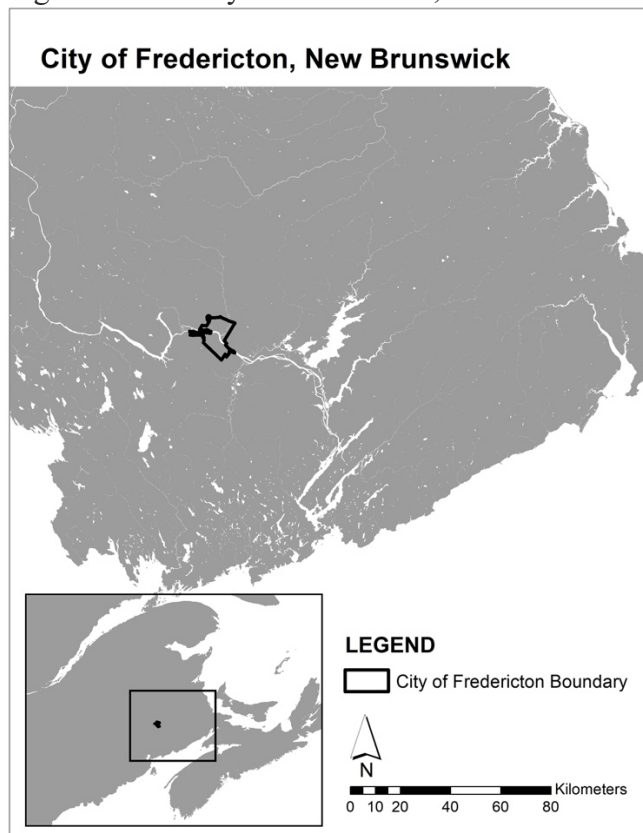
Climate change impacts have been heavily felt in Atlantic Canada, with regions projected to experience relative sea-level change higher than the global average during the coming century (Bush & Lemmen, 2019). Where local sea level is projected to rise, the frequency and magnitude of extreme high water-level events will likely increase, resulting in increased flooding; leading to

infrastructure and ecosystem damage (Bush & Lemmen, 2019). Significant precipitation increases have also been observed, which further increases the region's vulnerability to flood-related events (Bush & Lemmen, 2019). From 2009 to 2014, the Province of New Brunswick saw a three-fold increase in disaster financial assistance programs triggered by flooding, compared to the previous five years. The floods of 2018 cost the New Brunswick provincial government approximately \$74 million, a number that will likely increase as the longer-term damage from coastal, overland and river flooding becomes apparent (Poitras, 2019).

Fredericton, the capital city of New Brunswick, is a community situated inland adjacent to the St. John and Nashwaak rivers (Figure 1). The region has seen a 1.5°C increase in mean annual temperature over the past century with 1.1°C of that change occurring over the last three decades (City of Fredericton, 2020). These increasing temperatures are projected to lead to changes in precipitation patterns as well as increased flooding in the region (City of Fredericton, 2020).

Fredericton is an intriguing case because of the local government's interdependent relationship with the provincial government as well as the city's long-standing efforts towards adaptation, mainly through infrastructure upgrades in response to flooding (City of Fredericton, 2020). The community's reaction to the effects of climate change are evident not only in the city's formalized policy approach, but also in its cultural narrative. The structure and trajectory of multi-level governance pathways, as well as deeply ingrained path dependencies have played an important role in determining how the city approaches adaptation planning.

Figure 1. The City of Fredericton, New Brunswick.



The following is the information used to create the map: Coordinate System: NAD 1983 CSRS New Brunswick Stereographic; Projection: Double Stereographic; Datum: D North American 1983 CSRS; Data Source: The Province of New Brunswick; Government of Canada; ESRI; Date Created: September 24, 2019.

3. Approach

Grounded in urban planning, this research aims to explore interactions at the community scale and understand, from a local perspective, how climate change adaptation features in local government policy (from discourse to practice), in Fredericton, New Brunswick. With specific attention to the relationship between local climate impacts and the influence on critical infrastructure and the built form, and with evolutionary governance theory (EGT) as a lens, this research explores the factors that have encouraged and enabled adaptation thinking in Fredericton.

The study included an on-site (first-hand) observational component, which took place between July 2017 and November 2018. This allowed for a better understanding of the physical setting of the community, and the interactions that take place in this space (Merriam & Tisdell, 2016). The study also included the review of relevant strategic policies (e.g. Climate Adaptation Plan, Fredericton City Centre Plan, Growth Strategy, The Municipal Plan) in order to determine how climate adaptation is incorporated into long-term community policy and planning (e.g. long-term and environmental plans, zoning regulations).

This study included the assessment of key actors (government decision-makers) through semi-structured interviews. Municipal and provincial key actors were selected purposively using a combination of criterion and snowball sampling; key actors were engaged based on their expertise and ability to provide insight into how adaptation manifests in practice, and how leadership at different levels prioritize adaptation. Key actors included municipal senior managers and an elected official, as well as officials from the provincial government (Table 1). A range of interviewees (n=11) were involved in this study in order to provide a breadth of experience and perspective on climate change impacts and local government response, as well as an understanding of interactions between local and regional levels of government.

Table 1. Key actors.

Department/ Unit	Code	Formal Interview (minutes)
City of Fredericton, New Brunswick		
Planning & Heritage	FD1	110
Engineering and Operations	FD2	70
Emergency Management	FD3	90
Growth and Community Services	FD4	110
Forestry	FD5	70
Councillor (and Chairman of Council's Public Safety and Environment standing committee)	FD6	70
Economic Development	FD7	60
Environmental Leadership	FD8	50
Government of New Brunswick		
Regional Emergency Management	NB1	50
Climate Change Secretariat (infrastructure specialist)	NB2	70
Climate Change Secretariat (executive)	NB3	70

During the semi-structured interviews, dialogue was guided by a protocol which followed a hierarchy of questions; from broad initiating questions to relevant probes. Sections were designed to generate discussion linked to climate impacts and risks, extent of adaptation inclusion in strategic policy, and the nature of action implementation. The protocol was flexible design, and influenced by the initial observational research and strategic policy review, as well as the study's theoretical lens.

Formal interviews and follow-up occurred between July 2017 and November 2018; interviews were conducted in-person, on-site in Fredericton. The interviews were digitally recorded and professionally transcribed verbatim. Transcripts were investigated using a narrative approach: analysis first involved an initial scan to identify key points relevant to the research objectives; the following reading flagged major themes emerging from the data; high level coded/ emergent themes (e.g. key climate threats, adaptations, and strategic climate policy and planning) were compared, then classified to create concise narratives that unify the data within each category (e.g. Birchall and Bonnett, 2020).

4. Findings

4.1. Key Stressors

The St. John River and its various tributaries combine with Fredericton's primarily loamy and sandy soil (Rampton, 1984) to put the city at increased risk of river and overland flooding (e.g. FD1; FD3). According to interviewees, Fredericton floods annually during the spring freshet and varies in intensity based on precipitation amounts, snow pack, and snow melt (e.g. FD2; FD3). As climate change progresses, increased frequency and severity of precipitation events and river and overland flooding are emerging as key stressors in the Fredericton area.

4.1.1. Increased Frequency and Severity of Precipitation Events

Annual precipitation in the Atlantic region of Canada increased by 11.3% from 1948 to 2012 (Zhang et al., 2019). Locally, annual precipitation in Fredericton is expected to increase a further 6.3-8.5% by the 2050s (City of Fredericton, 2020). Interviewees corroborated this data with observations of heavy rainfall events becoming more frequent and more intense (e.g. FD2; FD4). Warmer winter temperatures have led to an increase in snow and ice storms and even heavy rain events in December (FD1). Ice storms and winter rain events can make it difficult for public works crews to clear roads, and such events also contribute to downed power lines, both ultimately increasing operations costs (FD4). With projections showing a further 2.7 to 3.7°C increase in mean winter temperatures by 2050 (City of Fredericton, 2020) these challenges are expected to persist, if not worsen.

4.1.2. River and Overland Flooding

Increasing frequency and severity of storm events in Fredericton contribute to increased river and overland flooding. Interviewees observed that, in recent years, flooding has shifted from a seasonal impact associated with spring snow melt to a year-round threat (e.g. FD1). At the same time, the frequency of severe floods has increased with three 1:100-year floods occurring in the last 11 years (City of Fredericton, 2020). Although Fredericton has a long history of flooding, climate change impacts to Atlantic Canada such as increased precipitation and sea level rise are expected to increase the city's susceptibility to flooding (FD2; Government of Canada, 2019). Not all flooding is directly from the St. John River; indeed, much of the flooding that Fredericton experiences is overland flooding associated with the smaller tributaries to the St. John River, such as the Nashwaak River (e.g. FD3). As FD1 revealed, flood waters will

even come up from surficial groundwater in some areas of the city, particularly in the downtown core.

While decision-makers in Fredericton believe themselves and residents to be well prepared for flood events: "...we've always had to adjust to the life of that river" (FD1), "we manage it and live it" (FD2); flooding will often block bridge ramps, shut down power to large sections of the city, and inundate much of downtown (e.g. FD3; FD5). Exacerbating the issue is the ongoing trend of urbanization throughout much of New Brunswick, and Fredericton in particular. A lack of jobs in rural areas is prompting migration to urban areas and the resulting increases in population density have the potential to spur development in vulnerable, potentially flood-prone areas as communities expand to accommodate new residents (e.g. NB3).

In 2018, Fredericton experienced a unique flood with sustained flood waters inundating the city for approximately two weeks (Petz & McPhail, 2018). While past floods often lasted three to four days, the 2018 flood was much more prolonged (e.g. FD1; FD3). Interviewees stated that, while the city and its residents were well adapted to the shorter floods they had experienced in the past, the sustained flooding caused considerable damage to residential properties and had negative economic impacts on businesses in the downtown which were isolated by floodwaters (e.g. FD1).

4.2. Adaptation

While the city's climate change adaptation policy is currently in development, adaptation thinking has been embedded in city policy for two decades (FD1; City of Fredericton, 2020). Adaptation action in Fredericton isn't necessarily linked to a climate change action strategy, it is more mainstreamed—considered to be an important part of good infrastructure and spatial planning (e.g. FD1). Over the past 20 years, Fredericton has been incrementally updating policies and budgets to facilitate adaptation action (e.g. FD2).

Interviewees considered their approach to adaptation to be anticipatory (e.g. FD2, FD8). Much of Fredericton's adaptation action is focused on engineering and infrastructure renewal, though they have also tried to be proactive in terms of spatial planning controls along flood plains (e.g. FD1; FD4). Their proactive approach to adaptation can largely be attributed to the regular flooding Fredericton experiences (e.g. FD1). The 2018 flood was considered by interviewees to be a galvanizing event for both the municipal government and the public; as FD5 suggested, "it's not going to get better and we're only going to get more of these [floods]" (FD5).

4.2.1. Policy

Since 2015, the city of Fredericton has updated numerous key strategic documents; implementing a new City Centre Plan, Growth Strategy, Municipal Plan, and Climate Adaptation Plan (City of Fredericton, 2015; 2017; 2020; 2020). Climate change adaptation is embedded within each of these guiding documents; often with a focus on reducing the impacts of climate change on local infrastructure. One policy within Fredericton's Municipal Plan, implemented approximately 15 years ago (e.g. FD5), states that the city will actively seek to acquire land adjacent to the St. John and Nashwaak Rivers in order to protect the river banks and facilitate public access (City of Fredericton, 2020). The Zoning bylaw reflects this policy approach, designating a large portion of property directly adjacent to the St. John and Nashwaak Rivers as open space, environment or park zones, which, among other things, seek to preserve land within a flood-prone area (City of Fredericton, 2013). This long standing policy has allowed Fredericton to incrementally purchase land as it becomes available, limiting development in vulnerable areas while also allowing the city to expand their trail system (e.g. FD6).

Interviewees laid out the city's combined approach to reducing vulnerability to flooding in Fredericton. First, the city restricts all development in the 1:20 year flood plain zone and limits development in the 1:100-year flood plain zone (FD1). Second, the city requires adaptive technologies and construction approaches in flood-prone areas like the downtown core (FD4). Critically, these approaches are not explicitly stated in the current Zoning Bylaw (City of Fredericton, 2013). However, *Imagine Fredericton: The Municipal Plan*, adopted January 2020, directly addresses the shortfalls in the current Zoning Bylaw. Under the "Environmental Sustainability and Climate Change" policies, the Municipal Plan aims to mitigate the impacts of climate change by "incorporating innovative technologies and infrastructure design" (City of Fredericton, 2020, p.53) into municipal infrastructure. It also aims to include new provisions in the Zoning Bylaw that restrict new development in areas susceptible to flooding and require "new development to incorporate flood-proofing measures, including minimum building elevations in areas that are less susceptible to flooding" (City of Fredericton, 2020, p. 54).

While adaptation has been incorporated in Fredericton's policies and actions over the years, the 2020 draft Climate Change Adaptation Plan makes explicit mention of past actions and future adaptation goals. The document has a stated goal of identifying climate change impacts and how to minimize risk while building resilience (City of Fredericton, 2020). Along with a backbone in climate change education and community partnership, the plan refers to working adaptation into existing policies, such as the Zoning Bylaw, as a way to build community resilience (City of Fredericton, 2020).

The largest shortfall in Fredericton's policy approach to adaptation appears to be the lack of restrictions on development in the downtown. Interviewees admitted that the city does limit development in certain areas, but will not restrict development in the downtown, despite its location adjacent to the St. John River and within the 1:100-year flood plain (e.g. FD4; FD7). Despite a lack of development restrictions in Fredericton's downtown, the City Centre Plan does speak to stormwater management through passive drainage and decreasing impermeable surfaces to reduce strain on the city's stormwater systems (City of Fredericton, 2015).

4.2.2. Action

Along with policy action, Fredericton has invested long-term in infrastructure renewal and upgrade projects. City Council and administration are strong supporters of adaptation action: Council is receptive to information on local climate change impacts and are considered to be "very proactive" in their support of adaptation efforts (FD3; FD5). Engineers are largely viewed as climate champions in Fredericton, pushing for infrastructure renewal, assessing how climate change impacts will affect operations, and recognizing vulnerabilities (e.g. FD4; FD8). Planners are also considered to play a large role, assessing land use designations and planning for increased density (e.g. FD3).

Interviewees stated that the city has a very strong asset management and infrastructure renewal plan (FD8). In fact, Council increases the renewal aspect of their capital program every year (FD4). In the 2020 Budget, Council dedicated 75% of the capital infrastructure funding to infrastructure renewal (City of Fredericton, 2020). In the past, this has included road upgrades, drainage management, and culvert upgrades (e.g. FD3; FD4; City of Fredericton, 2020). Interviewees also listed flood control upgrades to building design in the city centre in the form of sheet piles and pump systems (e.g. FD1; FD2).

4.3. Provincial Relations

The city of Fredericton and the province of New Brunswick work closely on climate change adaptation and emergency response efforts. Indeed, interviewees from the provincial level were impressed by Fredericton's action on climate change adaptation and consider the city to be a leader in the province (NB2 & NB3). Financial limitations at the municipal level mean that decision-makers in Fredericton rely on Federal and Provincial support for infrastructure renewal projects (FD5). Recently, New Brunswick mandated through the Emergency Measures Act that all municipalities in the province develop adaptation plans by 2020, leading to the development of Fredericton's Climate Change Adaptation Plan (City of Fredericton, 2020). Through the Emergency Measures Act, support in the form of financial resources and expertise are provided by the province in order to help municipalities identify localized vulnerabilities and develop adaptation plans (NB2).

Provincial action has also served to hinder Fredericton's adaptation initiatives. The city has committed to proactive spatial planning—limiting development in flood-prone areas. But limited restrictions in rural areas upstream of Fredericton allow for infill of wetlands and development along the St. John River. Filling of wetlands along main watercourses increases overland stormwater flow and discharge into the rivers leading to a greater chance of flooding downstream (FD1). At the same time, development in flood-prone areas adjacent to Fredericton's municipal boundaries depletes the city's resources as they are forced to provide urban and emergency response services during flood events and storms (FD1).

In terms of mitigating the costs of flood response, while Fredericton lacks the resources to purchase properties that flood every year, interviewees indicated they are hoping the province will take action to buy vulnerable properties (e.g. FD4 & FD6). However, the province admitted that pushback from residents outside of flood-prone areas discourages the province from initiating a buy-back program (e.g. NB1). Additionally, the province acknowledged that “it's hard for politicians to say no” when individuals look for relief funding after a flood (NB2) and those provincial bail outs further incentivize residents to rebuild in flood-prone areas (NB1).

5. Discussion

Due, in large part, to consistent seasonal flooding, Fredericton's approach to climate change adaptation action has been largely incremental and proactive, with various actors and institutions playing a role in mainstreaming adaptation within strategic and spatial planning policies. Through the lens of evolutionary governance, the authors seek to assess the role actors, institutions, knowledge and power have played in supporting or hindering comprehensive adaptation action in Fredericton. Path dependencies arising from persisting formal and informal institutions have shaped local and regional responses to climate change in the region.

5.1. Actors and Institutions

In the context of evolutionary governance, actors are those involved in community governance and the development of institutions (Birchall, 2020). In Fredericton, actors most significantly involved with climate change adaptation are elected officials, city planners, engineers, and emergency response officers. Institutions encompass formal and informal approaches to governance. They exist as explicit policies and regulations, but also as social norms or biases. They are especially powerful forces in determining which actions take place in a community (Berman et al., 2019).

When powerful actors do not place value in addressing vulnerabilities associated with climate change, resulting institutions can actually work to hinder comprehensive action. Additionally, long-standing informal institutions can reinforce harmful path dependencies,

making it difficult to enact tangible, anticipatory, and long-term change (Van Assche et al., 2017).

In the case of Fredericton, key actors appear to place significant value in adaptation action. While climate change may not be explicitly listed in conjunction with adaptive policy, elected officials and city administration have ensured that adaptive measures addressing increasing flood risks in Fredericton are incorporated in both short- and long-term strategic planning policy. Fredericton has embedded adaptation thinking into most aspects of city policy and involved actors across a variety of sectors including planning and development, emergency response, and sustainable development. This approach to adaptation is echoed in scholarship, with claims that effective strategies should not be limited to environmental or sustainability fields; and instead should engage actors from a wide range of sectors and levels of government (Clar & Steurer, 2019; Lioubimtseva & da Cunha, 2020).

Fredericton's long history of mainstreaming adaptation action within key strategic documents and policies has enabled the city to effectively address vulnerabilities on a local scale. Long-term approaches to adaptation allow for incremental action, creating opportunities to balance economic priorities with environmental ones. For example, annual increases to Fredericton's capital infrastructure renewal budget have allowed the city to invest in ongoing upgrades to roads and stormwater drainage systems, increasing resilience to major flood events and increased precipitation. Such long-term incremental approaches to adaptation can help municipal actors with limited resources build capacity for transformative adaptation (Boda & Jerneck, 2019). This is also apparent in Fredericton's long-standing policy of purchasing flood-prone riverfront property, which has allowed the city to gradually acquire land and expand public park space and protected areas that would otherwise put potential private development at risk.

5.2. Power and Knowledge

Power and knowledge as concepts should not be considered separately from the actors and institutions discussed above. Instead, power and knowledge are factors that determine the influence of relevant actors and institutions. With that in mind, building knowledge on climate change amongst decision-makers across levels of government gives power to formal and informal institutions that support adaptation action. Effective climate governance will encourage learning and innovation through multi-level cooperation (Holscher et al., 2019).

Decision-makers in Fredericton have taken significant steps to address vulnerabilities associated with local flood events. However, provincial institutions and actors have also had a hand in comprehensive adaptation action at the local level. Scholarship suggests that, while climate impacts are often felt most at the local level with local actors being the best suited to understand their adaptation needs and vulnerabilities, regional governments play important roles in developing successful local adaptation action through guidance and resource-sharing (Vogel et al., 2020; Clar & Steurer, 2019). The resulting balancing act between provincial and municipal government powers has led to both positive and negative consequences for adaptation action in Fredericton.

For example, New Brunswick's Emergency Measures Act helps decision-makers in Fredericton advance adaptation approaches while recognizing and accommodating the city's existing policies (i.e. City Centre Plan, 2015; Municipal Plan, 2020). Interviewees from the province acknowledged the need to allow Fredericton the autonomy to develop its own vulnerability assessment and adaptation plan. The role of the province is to provide expertise and funding. Support from the provincial government in the form of financial resources and knowledge, has helped Fredericton shift from an incremental approach to adaptation action to a more comprehensive approach with the development of Fredericton's Climate Change

Adaptation Plan (2020 Draft). This approach to regional adaptation action is celebrated in the literature with studies finding that communities with strong local institutions that are strengthened by regional policies are often better able to adapt to climate change impacts (Berman et al., 2019).

Alternatively, provincial flood relief programs serve to contradict Fredericton's approach to naturalization along the St. John and Nashwaak rivers. As mentioned above, provincial support in climate change adaptation is most effective in the form of knowledge and financial resources. However, when provincial priorities differ from municipal ones, conflict arises. This power imbalance is explored further below.

5.3. Path Dependencies

Path dependencies are often among the greatest barriers to adaptation action and have the potential to impede adaptation when new approaches to addressing vulnerability work against pre-existing governance institutions (Barnett et al., 2015; Eckstrom & Moser, 2014). For example, in Fredericton and New Brunswick, economic and political interests constrain comprehensive approaches to adaptation and often put short-term needs, such as development of the downtown, ahead of long-term goals.

Differing priorities between the provincial and local level have led to increased flood risk in Fredericton, with each governing body addressing flood impacts differently. Fredericton lacks the power and resources to purchase all of the properties in flood-prone areas and instead relies on the provincial government to fill this role. However, provincial actors admitted that strong political will for public support increases the likelihood that residents in vulnerable areas will receive repeated flood relief from the province in the form of financial payouts. Provincial bail outs for flood-damaged properties have created a social expectation that works against more progressive adaptation action, such as managed retreat or avoidance, that could decrease vulnerability in flood-prone areas (Butler et. al., 2016).

The short-term nature of election cycles appears to direct political priorities towards voter support, and flood-related complaints from tax-payers hold more influence over provincial policy than advocates for adaptation action. These barriers are reflected in the literature where short-term policy cycles and powerful interests favouring immediate solutions hold sway over existing governance structures; hindering more progressive long-term remedies and oftentimes leading to maladaptive actions (Holscher et al., 2019; Birchall & Bonnett, 2020). While the provincial government has taken steps to encourage local adaptation action, ongoing development in flood-prone areas supported by economic and political structures at the regional level constrain Fredericton's adaptive capacity; a trend that has been identified time and again by scholars (Moser & Ekstrom, 2010; Measham et al., 2011; Amundsen et al., 2010; Boda & Jerneck, 2019).

At the local level, economic development strategies in downtown Fredericton tend to disregard climate change impacts in favour of long-standing goals of economic growth, often competing with long-term adaptation objectives. However, decision-makers in Fredericton are working to balance economic interests with adaptation efforts. Guiding policies like the City Centre Plan and Fredericton's Municipal Plan avoid restricting development in Fredericton's downtown while mainstreaming adaptation by mandating the incorporation of adaptive measures in the form of infrastructure upgrades and building design. While Fredericton's policies may initially appear to be maladaptive in the downtown, the city's approach to mainstreaming adaptation in overarching economic development policy highlights an important necessity for successful long-term adaptation.

The balance between economic interests and adaptation efforts can significantly increase the potential for long-term successful adaptation action (Clar & Stuerer, 2019). Actions that

fulfill both adaptation action and community needs create efficiency, and can improve the long-term sustainability and scale of adaptation efforts (Mogelgaard et al., 2018; Tanner et al., 2019). Local governments, with limited resources, are more likely to succeed at adaptation if policies can accommodate socio-economic interests or even generate additional benefits (Di Giulio et al., 2018; Clar & Stuerer, 2019). Furthermore, scholarship supports the idea that integrating adaptation action within existing policy, as Fredericton has done with infrastructure upgrades, is more efficient and effective than keeping climate policy separate from urban development pathways (Tanner et al., 2019).

5.4. Beyond Path Dependencies: What Can be Done?

Path dependencies often threaten to undermine adaptation action and autonomy at the local level. As is evident in Fredericton, political and economic priorities can take precedence over adaptation action. Path dependencies both reinforce and are reinforced by the institutions, power and knowledge at multiple levels of governance. Finding a balance between long-standing priorities of economic growth, cross-scalar political powers, and proactive adaptation action can lead to more effective long-term resilience to climate impacts.

Economic, environmental and social priorities often shift with government regimes, which can create barriers to embedding long-term climate change adaptation planning. At a time of increasing partisanship surrounding climate change issues, short-term political cycles can lead to contradicting approaches or even rolling back of climate policy at the regional and federal levels when a new political party comes into power. While partisanship is a key determinant of policy outcomes at the national level, local government action is often influenced by numerous factors apart from partisanship (Gerber, 2013). Cities are of course still vulnerable to partisan belief systems and climate change adaptation is inherently political (Boussalis et al., 2019; Meerow & Mitchell, 2017). However, enhanced municipal autonomy on climate change action has the potential to lessen the impacts of political polarization at the regional and federal level. Enhancing autonomy at the local government level has been shown to improve the response to climate change (Forsythe & Evans, 2013 as cited by Williams et al., 2020).

Mainstreaming of climate policy is considered, within scholarship, to be a practical strategy to overcome the nearsightedness of four-year political election cycles (Holscher et al., 2019; Birchall & Bonnett, 2020). When climate action is woven through sectoral plans and policies, there is the potential for synergistic actions, improved resilience of development outcomes, more efficient use of resources and avoidance of investments that may lead to maladaptation (Tanner et al., 2019; Grafakos et al., 2019; Mogelgaard et al., 2018). Yet, as evidenced in the case of Fredericton, adaptation mainstreaming can only do so much when long-standing institutions and path dependencies stand in the way.

6. Conclusion

Generally, Fredericton can be seen as a success story in terms of local adaptation action, through mainstreaming incremental adaptive measures and capitalizing on support from the provincial government. The long-standing stressor of frequent flooding has galvanized both the public and local and regional governments into developing progressive initiatives and financial resources aimed at building adaptive capacity within Fredericton. The city's long-standing efforts at integrating adaptation action into numerous policies over the years has led to significant adaptation in infrastructure renewal and capacity building.

However, persisting path dependencies at local and provincial levels reveal a larger issue facing Fredericton and communities around the globe. Adaptation approaches must be considered in the context of short-term political cycles in order to be effective beyond any one

government's regime. Local governments need the autonomy to address conflicting priorities at different levels of government and enact long-term adaptation policy that won't lose momentum if—and when—political parties change power. Adaptation through spatial planning is an essential element of local capacity building; short-term economic and political priorities become meaningless when long-term climate impacts dismantle infrastructure systems.

As with many global efforts to counteract and adapt to the devastation of climate change, the answer is unlikely to be simple or straightforward. Multi-level collaboration and resource-sharing, combined with proactive adaptation mainstreaming and increased local autonomy can help communities strike a balance between economic growth and climate change resilience.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of Alberta's Human Ethics Committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Declaration of competing interest

No financial interest or benefit has arisen from the direct applications of this research. This research was supported in part by grants through the Quick Response Program, Institute for Catastrophic Loss Reduction and Cornerstone Program, Killam Research Fund.

References

Amundsen, H., Berglund, F., & Westskog, H. (2010). Overcoming barriers to climate change adaptation—a question of multilevel governance?. *Environment and Planning C: Government and Policy*, 28(2), 276-289.

Barnett, J., Evans, L. S., Gross, C., Kiem, A. S., Kingsford, R. T., Palutikof, J. P., Pickering, C. M., & Smithers, S. G. (2015). From barriers to limits to climate change adaptation: path dependency and the speed of change. *Ecology and Society*, 20(3).

Berman, M., Baztan, J., Kofinas, G., Vanderlinden, J.P., Chouinard, O., Huctin, J.M., Kane, A., Mazé, C., Nikulkina, I., & Thomson, K. (2019). Adaptation to climate change in coastal communities: findings from seven sites on four continents. *Climatic Change*: 1-16.
<https://doi.org/10.1007/s10584-019-02613-4>.

Birchall, S. J. (2020). Coastal climate adaptation planning and evolutionary governance: Insights from Alaska, *Marine Policy, Land and Sea Interaction Special Issue*.
<https://doi.org/10.1016/j.marpol.2018.12.029>.

Birchall, S. J., & Bonnett, N. (2020). Climate change adaptation policy and planning: The role of agents, institutions and systems. *Cities*, 108. <https://doi.org/10.1016/j.cities.2020.103001>.

Birchall, S. J., & Bonnett, N. (2020). Thinning sea ice and thawing permafrost: Climate change adaptation planning in Nome, Alaska. *Environmental Hazards*.
<https://doi.org/10.1080/17477891.2019.1637331>.

Boda, C. S., & Jerneck, A. (2019). Enabling local adaptation to climate change: towards collective action in Flagler Beach, Florida, USA. *Climatic Change*, 157(3-4), 631-649.

- Borquez, R., Aldunce, P., & Adler, C. (2017). Resilience to climate change: from theory to practice through co-production of knowledge in Chile. *Sustainability Science*, 12(1), 163-176.
- Boussalis, C., Coan, T.G., & Holman, M.R. (2019). Communicating Climate Mitigation and Adaptation Efforts in American Cities. *Climate*, 7(3), 45. DOI: 10.3390/cli7030045
- Bush, E. & Lemmen, D.S. (2019). Canada's Changing Climate Report; Government of Canada, Ottawa, ON. 444 p.
- Butler, W. H., Deyle, R. E., & Mutnansky, C. (2016). Low-regrets incrementalism: Land use planning adaptation to accelerating sea level rise in Florida's Coastal Communities. *Journal of Planning Education and Research*, 36(3), 319-332. DOI: [10.1177/0739456X16647161](https://doi.org/10.1177/0739456X16647161)
- Carter, J. G., Cavan, G., Connelly, A., Guy, S., Handley, J., & Kazmierczak, A. (2015). Climate change and the city: Building capacity for urban adaptation. *Progress in planning*, 95, 1-66. <https://doi.org/10.1016/j.progress.2013.08.001>.
- City of Fredericton. (n.d.) Green Matters. Retrieved July 8, 2020, from: <https://www.fredericton.ca/en/community/environmental-leadership/green-matters>.
- City of Fredericton. (n.d.) Environmental Leadership. Retrieved July 8, 2020, from: <https://www.fredericton.ca/en/community/environmental-leadership>.
- City of Fredericton. (June, 2013) By-law No. Z-5, A Zoning By-law for the City of Fredericton. Retrieved July 8, 2020, from: <https://www.fredericton.ca/en/city-hall/zoning-by-law>.
- City of Fredericton. (February, 2015) Fredericton City Centre Plan. Retrieved from: <https://www.fredericton.ca/sites/default/files/pdf/2015feb18-citycentreplan-web.pdf>.
- City of Fredericton. (June, 2017) Fredericton Growth Strategy. Retrieved from: https://www.fredericton.ca/sites/default/files/fredericton_growth_strategy_2017_06_08_final.pdf.
- City of Fredericton. (January, 2020) Imagine Fredericton: The Municipal Plan. Retrieved from: https://www.fredericton.ca/sites/default/files/community/mp_nov12_19_final_draft_en_pac.pdf.
- City of Fredericton. (March, 2020). Climate Change Adaptation Plan [Draft]. Retrieved from: https://www.fredericton.ca/sites/default/files/cof_climate-change-adaptation-project-report_eng_mar-6.pdf.
- City of Fredericton. (2020). 2020 Annual Budget. Retrieved from: https://www.fredericton.ca/sites/default/files/cof_budget_book_2020_-_final.pdf.
- Clar, C., & Steurer, R. (2019). Climate change adaptation at different levels of government: Characteristics and conditions of policy change. *Natural Resources Forum*, 43(2), 121-131
- Dale, A., Robinson, J., King, L., Burch, S., Newell, R., Shaw, A., & Jost, F. (2020). Meeting the

climate change challenge: local government climate action in British Columbia, Canada. *Climate Policy*, 20(7), 866-880.

Di Giulio, G. M., Bedran-Martins, A. M. B., da Penha Vasconcellos, M., Ribeiro, W. C., & Lemos, M. C. (2018). Mainstreaming climate adaptation in the megacity of São Paulo, Brazil. *Cities*, 72, 237-244. <https://doi.org/10.1016/j.cities.2017.09.001>.

Ekstrom, J.A. & Moser, S.C. (2014) Identifying and overcoming barriers in urban adaptation efforts to climate change: case study findings from the San Francisco Bay Area, California, USA. *Urban Climate*, 9, 54-74.

Feinstein, N. W., & Mach, K. J. (2020). Three roles for education in climate change adaptation. *Climate Policy*, 20(3), 317-322. DOI: [10.1080/14693062.2019.1701975](https://doi.org/10.1080/14693062.2019.1701975).

Ford, J. D., Keskitalo, E. C. H., Smith, T., Pearce, T., Berrang-Ford, L., Duerden, F., & Smit, B. (2010). Case Study and Analogue Methodologies in Climate Change Vulnerability Research. *WIREs Climate Change* 1, 374–392.

Gerber, E. R. (2013). Partisanship and Local Climate Policy. *Cityscape*, 15(1), 107-124. <http://www.jstor.org/stable/41958959>

Giordano, T. (2012). Adaptive planning for climate resilient long-lived infrastructures, *Utilities Policy*. <https://doi.org/10.1016/j.jup.2012.07.001>.

Grafakos, S., Trigg, K., Landauer, M., Chelleri, L., & Dhakal, S. (2019). Analytical framework to evaluate the level of integration of climate adaptation and mitigation in cities. *Climatic Change*, 154(1-2), 87-106. <https://doi.org/10.1007/s10584-019-02394-w>

Hölscher, K., Frantzeskaki, N., & Loorbach, D. (2019). Steering transformations under climate change: capacities for transformative climate governance and the case of Rotterdam, the Netherlands. *Regional Environmental Change*, 19(3), 791-805.

IPCC. (2014). Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Kithiia, J., Dowling, R. (2010). An integrated city-level planning process to address the impacts of climate change in Kenya: The case of Mombasa. *Cities* 27(6). <https://doi.org/10.1016/j.cities.2010.08.001>.

Lioubimtseva, E., & da Cunha, C. (2020). Local climate change adaptation plans in the US and France: Comparison and lessons learned in 2007-2017. *Urban Climate*, 31, 100577.

Meerow, S., & Mitchell, C. L. (2017). Weathering the storm: The politics of urban climate change adaptation planning. *Environment and Planning A: Economy and Space*, 49(11), 2619-2627. DOI:[10.1177/0308518X17735225](https://doi.org/10.1177/0308518X17735225).

Merriam, S. B., Tisdell, E. J. (2016). *Qualitative Research: A Guide to Design and Implementation, 4th ed.* Jossey-Bass.

Measham, T. G., Preston, B. L., Smith, T. F., Brooke, C., Gorrdard, R., Withycombe, G., & Morrison, C. (2011). Adapting to climate change through local municipal planning: barriers and challenges. *Mitigation and Adaptation Strategies for Global Change, 16*(8), 889-909. DOI: 10.1007/s11027-011-9301-2.

Moench, M. (2014). Experiences applying the climate resilience framework: Linking theory with practice. *Development in Practice 24*(4), 447-464. DOI: 10.1080/09614524.2014.909385.

Mogelgaard, K., Dinshaw, A., Ginoya, N., Gutiérrez, M., Preethan, P., & Waslander, J. (2018). From Planning to Action: Mainstreaming Climate Change Adaptation Into Development: <https://www.wri.org/publication/climate-planning-to-action>.

Nordgren, J., Stults, M., & Meerow, S. (2016). Supporting local climate change adaptation: Where we are and where we need to go. *Environmental Science & Policy, 66*, 344-352.

Oulahen, G., Klein, Y., Mortsch, L., O'Connell, E., & Harford, D. (2018). Barriers and drivers of planning for climate change adaptation across three levels of government in Canada. *Planning Theory & Practice, 19*(3), 405-421. DOI: 10.1080/14649357.2018.1481993.

Petz, S. & McPhail, C. (2018, May 11) Satellite images depict scale of historic New Brunswick flood. *CBC News*, Retrieved from: <https://www.cbc.ca/news/canada/new-brunswick/st-john-river-water-levels-below-flood-stage-fredericton-1.4658277>.

Postras, J. (2019, May 21). Is climate change causing the recent floods along the St. John River? *CBC News*. <https://www.cbc.ca/news/canada/new-brunswick/future-floods-new-brunswick-climate-change-1.5134035>.

Province of New Brunswick. (2014). New Brunswick's Flood Risk Reduction Strategy. Retrieved from: <https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Flooding-Inondations/NBFloodRiskReductionStrategy.pdf>.

Rampton, V.N. (1984) Generalized surficial geology map of New Brunswick Department of Natural Resources and Energy, Minerals, Policy and Planning Division. NR-8 (scale: 1:500,000).

Runhaar, H., Wilk, B., Persson, Å., Uittenbroek, C., & Wamsler, C. (2018). Mainstreaming climate adaptation: taking stock about "what works" from empirical research worldwide. *Regional environmental change, 18*(4), 1201-1210.

Siders, A. R. (2017). A role for strategies in urban climate change adaptation planning: Lessons from London. *Regional Environmental Change, 17*(6), 1801-1810. <https://doi.org/10.1007/s10113-017-1153-1>.

Tanner, T., Zaman, R. U., Acharya, S., Gogoi, E., & Bahadur, A. (2019). Influencing resilience: the role of policy entrepreneurs in mainstreaming climate adaptation. *Disasters*, 43, S388-S411. doi:10.1111/disa.12338.

Van Assche, K., Beunen, R., & Martijn Duineveld, M. (2017). Co-Evolutionary Planning Theory. *The Routledge Handbook of Planning Theory*.

Vogel, B., Henstra, D., & McBean, G. (2020). Sub-national government efforts to activate and motivate local climate change adaptation: Nova Scotia, Canada. *Environment, Development and Sustainability*, 22(2), 1633-1653. <https://doi.org/10.1007/s10668-018-0242-8>.

Wamsler, C., Pauleit, S., Zölch, T., Schetke, S., & Mascarenhas, A. (2017). Mainstreaming nature-based solutions for climate change adaptation in urban governance and planning. In *Nature-Based Solutions to Climate Change Adaptation in Urban Areas* (pp. 257-273). Springer, Cham.

Westley, F. R., Tjornbo, O., Schultz, L., Olsson, P., Folke, C., Crona, B., & Bodin, Ö. (2013). A theory of transformative agency in linked social-ecological systems. *Ecology and Society*, 18(3).

Williams, D. S., Celliers, L., Unverzagt, K., Videira, N., Máñez Costa, M., & Giordano, R. (2020). A method for enhancing capacity of local governance for climate change adaptation. *Earth's Future*, 8, e2020EF001506. <https://doi.org/10.1029/2020EF001506>.

Yin, R. K. (2014). *Case Study Research: Design and Methods*. Fifth ed. London: Sage.

Zen, I. S., Al-Amin, A. Q., & Doberstein, B. (2019). Mainstreaming climate adaptation and mitigation policy: Towards multi-level climate governance in Melaka, Malaysia. *Urban Climate*, 30, 100501.

Zhang, X., Flato, G., Kirchmeier-Young, M., Vincent, L., Wan, X., Rong, R., Fyfe, J., Li, G., Kharin, V. V. (2019). Changes in Temperature and Precipitation Across Canada; Chapter 4 in Bush, E. and Lemmen, D. S. (Eds.) *Canada's Changing Climate Report*. Government of Canada, Ottawa, Ontario, 112-193.

February 15, 2022