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Sustainable Forestry and Nature Management MSc Degree

MSc Thesis

Analysis of the Organizational Readiness to Climate Change of the Tree Farm License 26 in Mission Municipality, British Columbia

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ABSTRACT

Given the detrimental impacts of climate change on forest ecosystems, the Canadian forest sector needs to adapt their practices by mainstreaming climate change considerations inside sustainable forest management (SFM). Canadian Council of Forest Ministers (CCFM) has developed a comprehensive framework to help organization and forest managers to start adaptation. Assessment of organizational readiness corresponds to the first step of this framework, allowing to evaluate if the organization is ready to undertake a vulnerability assessment and the following mainstreaming of adaptation options in their management. In 2012 Gray developed a methodology to assess the state of readiness which can be tailored to different contexts. However, application of this framework has been limited so far. In this work, Gray's method has been used to evaluate organizational readiness of Mission Community Forest (MCF), a community forest located in the municipality of Mission in the Canadian province of British Columbia (BC). The research is structured as follows: the first section is a literature review which summarizes information on adaptation-related concepts and adaptation discourse in the Canadian forest sector. In the second part Gray's framework has been tailored to the specific case of MCF, followed by the development of a questionnaire. 7 interviews have been carried out with relevant stakeholders either from inside or outside MCF. Then, the results have been qualitatively analyzed and integrated with information available in the literature so as to provide the final assessment. Results show that MCF knowledge network, climate awareness, values, leadership, and approach to trust and collaboration are positive contributions to MCF organizational readiness. By contrast, the assessment has highlighted a potential lack in terms of fundings, human resources, and flexibility in decision-making. This work contributes to practical knowledge about organizational readiness and Gray's framework, demonstrating that this methodology can be tailored to specific contexts and provide useful insight prior to the initiation of vulnerability assessment.

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LIST OF ABBREVIATIONS

BC   British Columbia

CCFM   Canadian Council of Forest Ministers

CCTF   Climate Change Task Force

FN   First Nations

GHG   Greenhouse Gasses

IPCC   Intergovernmental Panel on Climate Change

MCF   Mission Community Forest

NAS   National Adaptation Strategy

PICS   Pacific Institute for Climate Solutions

SFM   Sustainable Forest Management

TFL26   Tree Farm License 26

UNFCCC   United Nation Framework Convention on Climate Change

1. PREFACE

1.1. Introduction

Climate change represents an unprecedented challenge for forest ecosystems and, consequently, is bound to pose at risk Sustainable Forest Management (SFM) objectives (Andrews-Key et al., 2021; Williamson & Edwards, 2014); this matter is of relevant concern in Canada, which was one of the earliest adopters of SFM (Andrews-Key, 2018; Williamson et al., 2012; Williamson & Edwards, 2014). In fact, Canadian provinces and territories have been committed to SFM since 1992, when the Canadian Council of Forest Ministers (CCFM) published its national forest strategy (Williamson & Edwards, 2014). Climate change has been recognized as a national issue more recently, thereby frameworks for SFM – like the criteria and indicators used to define and measure Canada's achievements toward SFM – have been developed under the assumption that climate remains generally stable over time (Williamson et al., 2012; Williamson & Edwards, 2014).

Therefore, several authors claim that, in order to deal with future uncertainty, it is necessary to adapt current systems by incorporating climate change considerations inside SFM, a process called *mainstreaming* (Andrews-Key et al., 2021; Runhaar et al., 2018). In 2012, CCFM proposed an integrative approach to help various agents in the Canadian forest sector to assess their vulnerabilities to climate change and mainstream adaptation options into their management (Williamson et al., 2012). At the base of this framework there is the evaluation of readiness to climate change (Gray, 2012; Williamson et al., 2012). In fact, adaptive capacity and management are a function of several interrelated activities – e.g. climate science, decision making, public engagement, partnership; understanding the state of readiness in terms of these activities allows to understand if an organization is ready to start and implement adaptation (Armitage, 2005; Gray, 2012). In 2012 Gray developed a framework for assessing organizational readiness to climate change (Gray, 2012).

Given the wide range of jurisdictions and ecosystems across a country like Canada, and therefore the impossibility to create a universal step-by-step framework (Williamson et al., 2019), comprehensive methods like the one proposed by Gray may offer a potential

base from which developing practical assessments to evaluate readiness in a specific context. However, practical applications of Gray's framework to BC organization have been limited so far, with only one example found in the literature (Barr & Lemieux, 2021).

Thereby, the aim of this research is to apply Gray's method to assess organizational readiness of a community forest located in the province of British Columbia (BC). Communities in BC are "some of the most advanced community governed forest management arrangements in the world and have built up a level of expertise which make them well placed to deliver on local climate change adaptation" (Furness & Nelson, 2012, p.15). Local populations are more likely to be equipped and faster to plan management for the nearby forests; moreover, a local participatory governance structure may be more effective for dealing with climate uncertainty (Furness & Nelson, 2012, 2016; Rhodes, 2021). For these reasons, it is highly likely that community forests will play an important role for climate change adaptation.

The community forest chosen for this study is Mission Community Forest (MCF), also called Tree Farm License 26 (TFL26), located in the municipality of Mission. TFL26 is the first operational community forest established in BC and has become a model of sustainability across the country (Rhodes, 2021). Due to these factors, together with its multiple values, Mission community forest represents an interesting case study for the application of Gray's framework.

1.2. Research questions

1) *What is the state of readiness to climate change of the Mission Community Forest?*

   - *What is the state of knowledge and awareness about climate change and adaptation, and how is this information achieved and managed in Mission Community Forest?*

   - *What is the organizational culture and its capacity to address current climate change impacts within Mission Community Forest?*

- *How would Mission Community Forest describe the level of support, trust, and communication at a local level?*

2) *Can Gray's method act as a base for developing a practical framework for assessing organizational readiness in a specific context?*

- *Does it include all the aspects needed for community forests or does it need to be adapted? Is Gray's framework flexible enough to adapt to a specific organization?*

1.3. Objectives

1) Assess the state of readiness to undertake a climate vulnerability assessment and adaptive planning within in the Mission Community Forest

   o Assess knowledge surrounding climate change impacts in the organization and how new knowledge is acquired and managed

   o Assess the decisional power and flexibility of Mission Community Forest for decision-making regarding climate change

   o Assess the support by the indigenous and non-indigenous stakeholders at a local level, and the level of engagement and communication pursued by the organizations with these stakeholders regarding decision-making

2) Assess the adaptability of Gray's method for assessing organizational readiness in a specific context

1.4. Hypothesis

Gray's method can be used to develop a practical and context-specific assessment, analysing multiple dimensions of readiness, and identifying potential weaknesses.

2. LITERATURE REVIEW

2.1. Introduction

Thanks to recent and extensive scientific evidence, it is undeniable that climate change is a reality (IPCC, 2014; Obermaier et al., 2009; Vijayavenkataraman et al., 2012), with potentially catastrophic consequences for society and environment (Jehn et al., 2022). In response to climate change two strategies have been growingly emerging, which are mitigation and adaptation (Füssel & Klein, 2006). The objective of mitigation is to directly address climate change drivers by reducing carbon fossils emission and enhancing their sink (Füssel & Klein, 2006; Williamson & Nelson, 2017), whilst climate change adaptation is often described as the adjustment of socio-ecological systems to changing climate, aimed at reducing its risks and damage costs, and even identifying its potential benefits and opportunities (Abbasi & Nawaz, 2020; Furness & Nelson, 2016; Grüneis et al., 2016; Idrisa et al., 2012; Meijerink & Stiller, 2013; Spittlehouse, 2005; Zareen, 2012). Research and policy efforts have traditionally been more oriented towards mitigation rather than adaptation (Fankhauser, 2017; Füssel & Klein, 2006); in fact, while action for mitigation finds its root in 1992 with the adoption of United Nation Framework Convention on Climate Change (UNFCCC) – where there has been the first international commitment to stabilize the greenhouse gasses (GHG) content in the atmosphere (Fawzy et al., 2020) – recognition of adaptation importance is more recent, when it has become clear that mitigation alone is not enough to deal with climate change adverse and unavoidable impacts (Measham et al., 2011; Obermaier et al., 2009; Runhaar et al., 2018; Vijayavenkataraman et al., 2012). Impacts are still expected to occur due to past anthropogenic activities and climate inertia, even with substantial reductions in GHG emissions (Füssel & Klein, 2006; Obermaier et al., 2009; Smit & Pilifosova, 2001). Due to this acknowledgement, adaptation has gradually gained momentum over the last two decades (Chisita & Fombad, 2020; Halofsky et al., 2018), and this is reflected with the exponential growth in terms of research and policies (Grüneis et al., 2016; le Dang et al., 2014).

Adaptation can be either autonomous or planned (Andrews-Key, 2018; Grüneis et al., 2016; Sousa-Silva et al., 2018). In unmanaged systems, only autonomous adaptation can take place, which does not include any kind of active intervention and is of reactive nature

(Smit & Pilifosova, 2001; Sousa-Silva et al., 2018; Zareen, 2012). By contrast, planned (or anticipatory) adaptation is a proactive response (Smit & Pilifosova, 2001; Sousa-Silva et al., 2018) described as a complex, multidimensional, and multi–scale process (Abbasi & Nawaz, 2020; H. W. Nelson et al., 2016) that is implemented before climate change impacts are experienced (Zareen, 2012). Relying on autonomous adaptation is not sufficient to offset damages associated with climate change, which will result in substantial ecological, social, and economic costs (Smit & Pilifosova, 2001). By actively considering both vulnerabilities and opportunities, proactive adaptation has the potential to successfully increase resilience to climate change (H. W. Nelson et al., 2016; Smit & Pilifosova, 2001; Zareen, 2012). In order to adapt, Runhaar et al. (2018) and di Giulio et al. (2018) describe two mutually supportive adaptation strategies for planners, which are (i) the development of standing-alone adaptation programmes; (ii) the integration of adaptation considerations into already existing sectoral policies, a process called *mainstreaming*. Mainstreaming presents several advantages that enables the achievement of sustainability, like providing opportunities for synergies, increasing the efficiency of measures and of resources use (di Giulio et al., 2018; Runhaar et al., 2018).

2.2. The implementation gap: adaptive capacity and organizational readiness

As mentioned before, focus on adaptation has substantially grown over the last two decades (Chisita & Fombad, 2020; Ford & King, 2015; Halofsky et al., 2018). However, there is strong evidence that adaptation and mainstreaming are still at their infancy (Halofsky et al., 2018). Lack of implementation is substantial, and only few examples of successful adaptation have been reported, leading to the conclusion the implementation of adaptation is not sufficient to keep pace with the increasing urgency of climate change (Andrews-Key et al., 2021; Barr & Lemieux, 2021; di Giulio et al., 2018; Eisenack et al., 2014; Frick-Trzebitzky & Bruns, 2019; Milhorance et al., 2022; Sousa-Silva et al., 2018; Tilleard & Ford, 2016; Wolf et al., 2021). Research on adaptation is often developed in research environments, thus limited knowledge of examples and research about on-the-ground effective approaches and strategies can be found in the literature (Andrews-Key, 2018; Nagel et al., 2017; Obermaier et al., 2009; Tilleard & Ford, 2016).

Difficulties at the implementation level are present also in countries with high adaptive capacity (Ford & King, 2015), which is described as the potential ability of a system to adjust to climate change (Dumaru, 2010; Ford & King, 2015; Furness & Nelson, 2016). Therefore, it is evident that adaptive capacity is not a synonym of adaptation: the relationship between adaptive capacity and actual adaptation is complex, suggesting that adaptive capacity is hypothetical and does not automatically translate into action (Ford & King, 2015; Furness & Nelson, 2016; Tilleard & Ford, 2016). Scholars like Tilleard & Ford (2016) and Füssel & Klein (2006) argue that adaptive capacity cannot lead to on-the-ground implementation if elements like information on what to adapt and how to do it and resources such as target financial and institutional supports are not present. Taking into account the importance of considering those factors that determine actual adaptation, Ford & King (2015) has proposed the concept of organizational readiness (or preparedness) as a complementary tool to adaptive capacity.

Organizational readiness can be described as the measure of preparedness that human systems possess prior to start adaptation in order to adapt (Ford & King, 2015). It goes beyond adaptive capacity by assessing "whether supportive measures and conditions for adaptation exist" (Tilleard & Ford, 2016, p. 577). For this reason, Ford & King (2015) argues that understanding organizational readiness represents a great opportunity to effectively target policies that will start, implement, and scale-up adaptation. Thereby, combining the concepts of adaptive capacity and organizational readiness in one comprehensive framework can help addressing the directions where resources need to be directed so as to facilitate actual adaptation (Barr & Lemieux, 2021).

2.3.   Vulnerability assessment and climate change

Vulnerability can be defined as "the degree to which a system is susceptible to and is unable to cope with adverse effects of climate change, including variability and extremes" (Füssel & Klein, 2006, p. 306). According to IPCC, system vulnerability can be expressed as a function of 3 parameters (Andrews-Key, 2018): (i) sensitivity, which is "the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli" (Füssel & Klein, 2006, p. 314); (ii) exposure, which entails the "nature and degree to which a system is exposed to significant climatic variations" (Füssel & Klein, 2006, p.

313); and (iii) adaptive capacity of the system. While sensitivity and adaptive capacity are internal dimensions of vulnerability, implying that are dependent on systems characteristics, exposure represents an external dimension (Füssel & Klein, 2006). Climate change is bound to affect exposure rate, thus stressing both systems sensitivity and adaptive capacity and resulting in likely increase of vulnerability (Bissonnette et al., 2017).

Given the relationship between vulnerability and climate change, vulnerability assessment has gradually emerged as a powerful tool to provide information of both science and policy nature. Such multidisciplinary delivery of information is essential in socio-ecological systems, where anthropogenic and ecological dimensions are strongly embedded (Andrews-Key, 2018). Since vulnerability – as defined by IPCC – includes both biophysical and social impacts in its definition, vulnerability assessments are characterized by an interdisciplinary nature and thus can provide integrated information (Andrews-Key, 2018). Therefore, they have the potential to facilitate building flexible adaptation strategies that can be mainstreamed into existing systems (Andrews-Key et al., 2021).
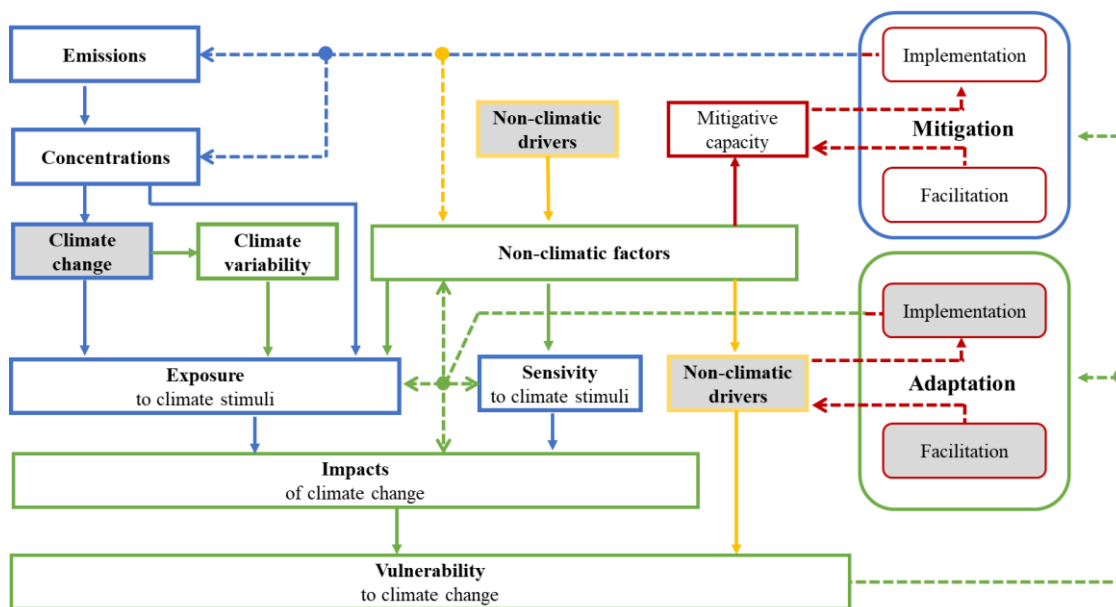
Figure 1. The conceptual framework of an adaptation policy assessment. Source: adapted from Füssel & Klein (2006)

In the context of climate change, Füssel & Klein (2006) distinguishes three types of decisions based on which the discourse of vulnerability assessments has been developed. Vulnerability assessments can be used to provide information (i) to develop long-term strategies for mitigation; (i) to identify vulnerable regions where allocating resources; and (iii) to develop adaptation measures for specific areas. This last category is also called *adaptation policy assessment* by the author because it is aimed at providing policymakers and planners with tailored information to facilitate building adaptive capacity and implementing adaptation. That is because, "decision-makers require very specific types of information in order to design and implement effective adaptive responses" (Füssel & Klein, 2006, p. 321). Adaptation policy assessment (fig. 1) is the one considered in this work.

2.4.   Adaptation discourse within the Canadian Forest Sector

2.4.1. Canadian forestry: SFM and climate change

Forest industry represents an important economic sector for Canada, which holds the first position for trade balance of forest products on a global level (Government of Canada, 2022c). Since the middle 1990s, Canada has been committed to manage forests following the principles of SFM defined by CCFM (Williamson et al., 2012). CCFM is an interjurisdictional body established in 1985 that provides a forum for discussions and directions around forestry on a national level (CCFM, 2022a). Made up of 14 provincial, territorial, and federal ministers, CCFM is responsible for establishing the criteria and indicators to achieve and monitor SFM at a national level (Andrews-Key, 2018; Williamson et al., 2012). Nevertheless, criteria and indicators of SFM were developed under the assumption of stable climate trends (Williamson & Edwards, 2014). Thanks to research carried out on forest ecosystems over the last 40 years, the Canadian forest sector has extensively started to acknowledge the impacts of climate change on forests and the achievement of SFM (Andrews-Key et al., 2021; Williamson et al., 2019). In fact, Canadian forests are experiencing several impacts, which include an increase in magnitude and frequency of wildfire, insects' outbreak, and a rise in the occurrence of extreme weather events (Furness & Nelson, 2016; Gauthier et al., 2014; Picketts et al., 2012; Ste-Marie & Edwards, 2015). Noticing such impacts, importance of proactive adaptation has gradually entered discussions as a necessary response to climate change

(Andrews-Key et al., 2021; Gauthier et al., 2014; Johnston et al., 2010; Spittlehouse, 2005; Williamson et al., 2019), and to guarantee the achievement of SFM in the future (Andrews-Key et al., 2021; Williamson & Edwards, 2014).

2.4.2. National adaptation initiatives

Research on adaptation options in forestry has significantly increased since the early 2000s, when climate change started to gain a higher profile amongst forest managers (Williamson et al., 2019). The emerging concerns within the forest sector led to the recognition of climate change as one of the two major threats by CCFM in 2008, claiming the importance of integrating climate change considerations inside SFM (CCFM, 2022b; Williamson et al., 2019). In the same year, CCFM assembled a climate change task force (CCTF) with the aim of increasing awareness and providing support to forest managers in the ongoing process of adaptation (CCFM, 2022b; Williamson et al., 2019). So far, the work carried out by CCTF can be divided in 3 phases (Williamson et al., 2019). In the first one, two reports have been developed which included a comprehensive review of the vulnerable tree species in Canada and the identification of potential adaptation options (CCFM, 2022b; Johnston & Edwards, 2013; Williamson et al., 2019). The second phase was aimed at providing forest managers with information and tools to use for climate change adaptation (CCFM, 2022b; Johnston & Edwards, 2013; Williamson et al., 2019). Phase three, which has been initiated in 2015, is focused on inter-jurisdictional conversations with the objective of integrating climate change considerations into SFM (CCFM, 2022b; Williamson et al., 2019).

As awareness increased, the presence of research and adaptation planning has grown across the country, with several guidelines and initiatives being developed at a national level (Williamson et al., 2019). In 2011, Canadian Forest Service (CFS) – a federal agency of the Natural Resource Department – initiated *Forest Change* supported by five years of fundings (Ste-Marie & Edwards, 2015). Briefly, some of *Forest Change's* main purposes are to monitor climate change impacts on Canadian forests and develop an adaptation toolkit to assist forest managers in implementing adaptation (Ste-Marie & Edwards, 2015). Furthermore, on a broader level than just the forest sector, the federal government is currently developing a National Adaptation Strategy (NAS) in order to

establish a shared vision across provinces and territories and create a framework for analyzing progress of adaptation at a national level (Government of Canada, 2022b).

In addition to federal directives and research, Williamson et al. (2019) has reported several initiatives undertaken by individual jurisdictions and organizations, including the occurrence of (i) research and assessments – like vulnerability assessments, developing regional climate scenarios, starting applied research programmes; (ii) organizational changes – like developing climate change strategies and adaptation plans and enhancing capacity; (iii) policies, practices and approaches; and (iv) guidance and extension – like the organization of workshops on knowledge exchange. As an example, *SmartForest* Canada is an initiative to monitor climate change impacts on Canadian forests, providing knowledge and integration. This project is carried out through the collaboration of 7 universities (University of Quebec in Montreal, University of New Brunswick, TÉLUQ University, University of Quebec in Abitibi-Témiscamingue, University of Quebec in Outaouais, University of Montreal and University of Alberta) (Smart Forest, 2022).

2.4.3. Implementation gap

By considering these initiatives together with the high level of awareness, education and health, Canada can potentially be a leader in climate change adaptation (Furness & Nelson, 2016; Picketts et al., 2012). Nevertheless, Canada does not represent an exception to the implementation gap described in section *2.2 The implementation gap: adaptive capacity and organizational readiness*. In fact, scholars claim for the state of adaptation in Canada to be at the early stages (Ford & King, 2015; Halofsky et al., 2018; Picketts et al., 2012; Williamson et al., 2019), with difficulties arising when converting adaptive capacity into action (Andrews-Key et al., 2021; Ford & King, 2015; Furness & Nelson, 2016; Picketts et al., 2012). In their work, Johnston & Edwards (2013) reported 12 cases of vulnerability assessment carried in Canada. However, as stated in their report, at the time of this investigation no adaptation options have been incorporated into forest management. More recently, in *Canada in a changing climate: advancing our knowledge for action* – which is the national assessment of climate change impacts and adaptation going on – 19 adaptation projects for forest management are reported, of which only 3 are under implementation (Canada in a changing climate, 2022). Although, as declared

by the authors, the map does not correspond to a comprehensive list of all adaptation currently taking place in Canada, such information seems to confirm the limited level of implementation undertaken and demonstrates that vulnerability assessments represent still a new field for both jurisdictions and agents (Johnston & Edwards, 2013). For example, in 2012 Furness & Nelson (2012) reported that only one third of the organizations in their sample were already integrating adaption into their planning. This trend seems to be confirmed also more recently: in 2016, a study by Furness & Nelson (2016) showed that less than half of the organizations in the survey carried out adaptive actions. Considering that community level is the scale where climate change will affect most people (Dumaru, 2010), these results show how much work still need to be done.

2.4.4. Barriers to adaptation within Canadian forest sector

The implementation gap for adaptation strongly derives from the high level of uncertainty around climate change, which leads to barriers and action delay (Andrews-Key, 2018). In this subsection, the main barriers to mainstreaming within the Canadian forest sector are described, which are mainly based on Williamson & Nelson (2017) review. Barriers can emerge in every context of natural resource management (Andrews-Key, 2018), so the following barriers may not be necessarily exclusive to forestry (Halofsky et al., 2018). Williamson & Nelson (2017) have classified barriers in three different groups, which are respectively *harmonization barriers*, *enabling barriers*, and *implementation barriers*.

Harmonization barriers derive from considering adaptation and mitigation as two independent responses, thus hindering the possibility of agreeing and developing an integrated approach (Williamson & Nelson, 2017). Presence of *harmonization barriers* stems from individual beliefs and awareness, leading to stronger support for adaptation or mitigation. Since mitigation and adaptation are complementary strategies which cannot be interchanged given their different purposes (Pasimeni et al., 2019), integrative approaches of mitigation and adaptation are necessary. *Harmonization barriers* can contribute to creating difficulties in addressing *enabling* and *implementation* ones (Williamson & Nelson, 2017).

Enabling barriers emerge when there is a lack of those factors that promote the adoption of mainstreaming. This occurs when agents are not empowered or motivated to start adaptation, or when they are actually discouraged through the absence of incentives or even the presence of penalties associated with adaptation measures (Williamson & Nelson, 2017). According to the authors, enabling barriers can be linked to psychological factors, institutions, and leadership.

Psychological factors include, for example, perceptions on climate risk, which can influence the willingness to start adaptation (Furness & Nelson, 2016; Williamson & Nelson, 2017). It is important not to underestimate these factors: in the Furness & Nelson (2016) study, although many adopters did have lack of economic capital, they were still developing adaptive planning with their values and perspectives as a strong driver. Generally, in the Canadian context, it appears that perception of climate change risk does not constitute a barrier – probably thanks to the high level of education in the country (Williamson & Nelson, 2017).

Forest institutions – which correspond to "laws, policies, tenure arrangement, codes of conducts, behavioral norms, rules, penalties, and forest management standards" (Williamson & Nelson, 2017, p. 15) – represent a barrier to mainstreaming when they do not take into account climate change or do not link adaptation and mitigation in their policies, hindering actions by causing inflexibility. According to Williamson & Nelson (2017), forest management institutions in Canada are not incorporating climate change in their regimes to the degree necessary to enable effective climate response. Studies like Andrews-Key (2018) and Fayazi et al. (2020) confirm institutional constraints as one of the major obstacles perceived by the forest managers and communities. More specifically, Fayazi et al. (2020) highlights the current problem of land tenure for indigenous communities: historical disputes over lands generates tension and lack of power for such communities, reducing their adaptive capacity and range of actions.

Leadership is believed to be essential in all the steps of mainstreaming and in different scales thanks to its potential to promote innovation and experimentation (Williamson & Nelson, 2017). Currently, leaders in Canada are facing several challenges that in turn influences the willingness to introduce complex and untested modifications like mainstreaming (Williamson & Nelson, 2017).

Implementation barriers are represented by the absence of all those resources – like knowledge, fundings, and tools – necessary for implementation. In this category Williamson & Nelson (2017) include insufficient fundings, lack of knowledge, governance inadequacies, and deficit in monitoring capacities (Williamson & Nelson, 2017).

Limitation for fundings is a common barrier that impedes adaptation actions and implementation, e.g. getting new technology equipment (Andrews-Key, 2018). Furthermore, financial constraints can force priorities to compete for time and resources, with climate change being only one of priorities (Andrews-Key, 2018; Johnston & Edwards, 2013; Williamson & Nelson, 2017). Fundings are essential for full implementation of adaptation, therefore a commitment for several levels of government is an important requisite (Johnston & Edwards, 2013). Evidence often reports this type of barrier (Andrews-Key, 2018; Johnston & Edwards, 2013; Oulahen et al., 2018), with a trend showing several forest companies and management organizations undergoing a decrease in staff and budget (Williamson & Nelson, 2017).

Lack of knowledge is another frequent issue; climate change requires new knowledge, especially because most of forest management knowledge has been developed with the assumption of no changes occurring in climate (Williamson & Nelson, 2017). Unsurprisingly, knowledge gap is frequently mentioned as an important constraint (Andrews-Key, 2018; Andrews-Key et al., 2021; M. Johnston & Edwards, 2013; Picketts et al., 2012). In Furness & Nelson (2016) and Picketts et al. (2012) research, most of not-adopters did not have a high level of knowledge of climate change risks, suggesting that lack of knowledge prevents action. Production of new knowledge is limited by lack fundings and methodology with which new knowledge is created (Williamson & Nelson, 2017). In fact, "reducing knowledge gaps also requires transforming the ways in which knowledge is created, accessed, and information disseminated" (Williamson & Nelson, 2017, p. 22).

Governance issues are related to either structural problems in governance or policy capacity. For both, Canadian forest governance is currently ill-equipped (Williamson & Nelson, 2017). In fact, top-down and monocentric governance structures typical of forest management governance may not provide the level of flexibility necessary to deal with climate change uncertainty (Furness & Nelson, 2012; Gray, 2012; Williamson & Nelson,

2017). Furthermore, according to Fayazi et al. (2020), the top-down approach is disconnected from communities, which are the first to experience the effects of climate change.

Eventually, monitoring represents a crucial aspect for mainstreaming, since mainstreaming is an on-going process that may need modifications as new knowledge is gained (Williamson & Nelson, 2017). Current state of monitoring appears insufficient (Williamson & Nelson, 2017).

2.5. Provincial strategies for adaptation in BC

Like the rest of Canada, climate warming is affecting BC at a faster pace than the global average, and the consequences of this phenomenon are already visible, e.g. the outbreak of the mountain pine beetle (Furness & Nelson, 2016; Picketts et al., 2012). Political will for adaptation has been officially expressed by the BC government, which in 2008 has established a Pacific Institute for Climate Solutions (PICS), released a climate action plan dedicating an entire section to adaptation, and in 2010 presented an adaptation strategy (Government of British Columbia, 2022; Picketts et al., 2012; PICS, 2022). Such plannings have been renewed over time, and in 2022 BC government has released the last climate preparedness and adaptation strategy, supporting actions with more than five hundred million dollars in the period between 2022 and 2025 (Government of British Columbia, 2022). The strategy is organized in four sections, of which one is about the resiliency of species and ecosystems (Government of British Columbia, 2022). In relation to forestry, the BC government is committed to the realization of an Ecosystem Forecast Center within the Ministry of Forests with the aim of using global modeling to produce forecasts of ecosystem changes inside the province. A key point of this project is to bridge scientific research and action on-the-ground, providing planners and practitioners with tools that they can directly use (Government of British Columbia, 2022).

2.6. CCFM framework

In 2012, CCFM has developed a framework for Canadian forest managers to achieve SFM in a context of climate change (Williamson et al., 2012). Based on the *adaptation policy assessment* from Füssel & Klein (2006)'s work, CCFM has developed a

comprehensive and scalable framework that can be adapted to several contexts. Currently, CCFM mainstreaming approach is referred mainly to adaptation, but it could be expanded to include also mitigation (Williamson & Nelson, 2017).
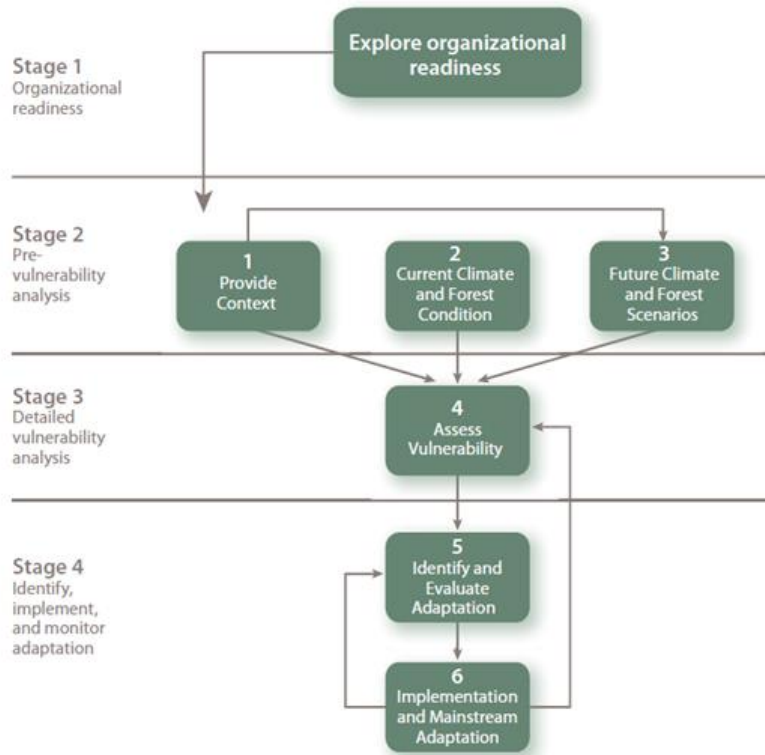
Figure 2. CCFM framework for adaptation. Source: Williamson et al. (2012)

CCFM vulnerability assessment comprises four phases (fig.2): (i) organizational readiness; (ii) pre-vulnerability analysis; (iii) detailed vulnerability analysis; and (iv) identification, implementation, and monitoring of adaptation.

The first phase is the assessment of organizational readiness. Gray (2012) has developed a framework for this phase that will be described more into details in section *3.2.1 Gray's framework*.

The second phase is the pre-vulnerability analysis, and it is made up of three components: provide context, in order to ensure that adaptation goals are consistent with the management system and context, other than confirming that the organization has the necessary capacity.

Describe current climate and forest condition, which aims at understanding the biophysical and human relationships between the organization and the environment. Given the future uncertainty, knowing current conditions can help better assuming what would happen under future changes.

Develop future scenarios for climate and forest conditions – this step is aimed at developing scenarios that can represent future potential conditions and impacts, which in turn have important implications on SFM (Williamson et al., 2012).

The third phase is called detailed vulnerability analysis and has one component. Its objective is to assess the adaptive capacity of the organization (Williamson et al., 2012).

The fourth phase is actual adaptation, where there is identification, implementation, and monitoring of adaptation measures. It is made up of two components. The former is the identification and evaluation of adaptation: based on the vulnerability assessment results, it is evaluated whether adaptation is necessary and which options might be needed. The latter is the implementation and mainstreaming of the adaptation measures decided. This step is a continuous process in which adaptation measures might be modified if necessary (Williamson et al., 2012).

3. MATERIALS AND METHODS

3.1. Case study area: MCF

MCF, or TFL26, lies within the district of Mission, approximately 60 km East to Vancouver, which corresponds to the most populous region of British Columbia (BC) (Nicholls, 2020). This area corresponds to the traditional territory of the following First Nations (FN) and indigenous communities and organizations: Katzie FN, Kwantlen FN, Leq'á:mel FN, Matsqui FN, Musqueam Indian Band, Peter Band, Seabird Island FN, Semiahmoo FN, Shxw'ow'hamel FN, Skawahlook FN, Sto:lo FN, Sto:lo Nation, Sto:lo Tribal Council, and Sumas FN (Nicholls, 2020). Of the total 10935 hectares surface that constitute the licensee, 88% is crown land and 12% is municipal forest (Rhodes, 2021), both distributed in two sectors divided by the lower reservoir of Stave Lake (Nicholls, 2020).

MCF is the oldest community forest still operating in Canada (Rhodes, 2021). In Canada, forest national laws are developed at the federal level, but the provinces are the institutions which have jurisdiction over the majority of Canadian forests (Government of Canada, 2022a). In BC, 95% of forests are public and are managed under the guidelines of Forest Act and Forest and Range Practices Act. In protected areas, there are three additional regulations which are enforced - Protected Areas of British Columbia Act, Park Act, and Ecological Reserve Act (Government of British Columbia, n.d.). Under the Forest Act, the BC government can issue different forms of forest tenure agreements - both short and long – called licenses for several kinds of agents (like companies, FN, communities) (Government of British Columbia, n.d.).

Mission obtained a tree farm license in 1958, when the district was issued a twenty-five-years renewable one, gaining control over the majority of Crown Forest lands within the municipal boundaries (Rhodes, 2021). It has been the first town in the entire BC to obtain this type of license, and it has taken more than thirty years to be followed by other municipalities in the province (Rhodes, 2021). A unique feature of MCF is that it has been historically managed by a branch of Mission's municipal government (Rhodes, 2021). The initial aim behind this strategy was to support local economic development and take control over the municipal forest, which was increasingly threatened by the large harvesting of powerful companies (Rhodes, 2021). With time,

MCF motives to manage the forest management have evolved from keeping a control over local resources to multiple values (Rhodes, 2021), which encompass recreation and environmental services (Mission Municipal Forest, 2021).
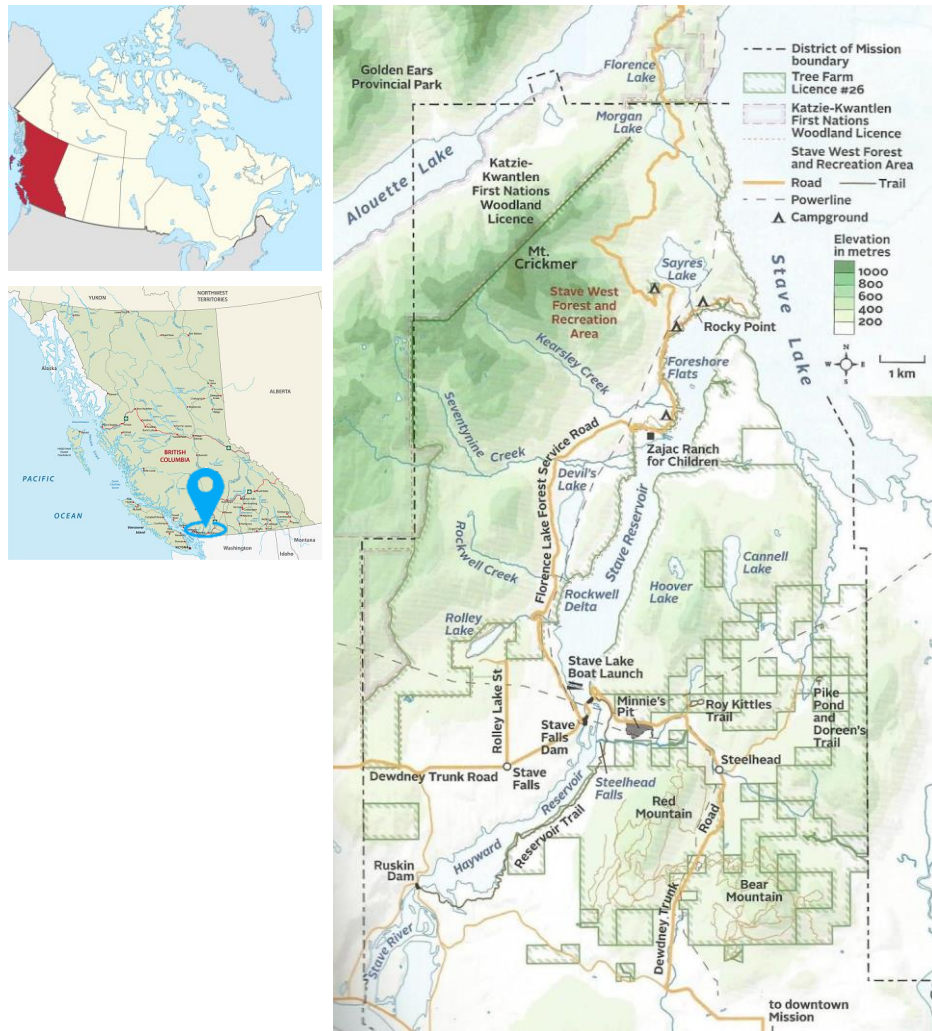
Figure 3. Map of MCF (right), source: Rhodes (2021); its location in BC (left below), source: iStock (2022); and BC location in Canada (upper left), source: Mysteries of Canada (2022).

The highest point corresponds to Mount Crickmer (1356 m), but the majority of TFL26 territory lies between 100 m and 700 m in elevation (Nicholls, 2020). As for the biogeographic ecosystem classification, most of MCF is Coastal Western Hemlock, with small areas of Mountain Hemlock in higher elevation zones. Hemlock and Douglas fir are the most common species, followed by red cedar, deciduous species, amabilis fir, and, in small percentage, yellow cedar (Nicholls, 2020; Rhodes, 2021). In the last determination for average annual cut, 67% of the territory is considered to be available to

be harvested (Nicholls, 2020). Due to historic harvesting, the majority of the stand is younger than 100 years, and only 5% is older than 200 years in the forested land base.

Currently, MCF team is made up of 6 people, which include the director of forestry, one forest technologist, 1 forest operations manager, 2 forest operation crew members, and 1 administration assistant (Gruenwald, 2022, Pers. Comm.). MCF manages the municipal forest on behalf of a community that has grown from a few thousand people in the 1950s to over forty thousand residents (Rhodes, 2021).

3.2. Methods

3.2.1. Gray's Framework

The framework developed by Gray (2012) aims to embrace all the various aspects necessary to assess organizational readiness to climate change. This systematic approach is based on three pillars organized in ten themes that can be adapted to a wide range of contexts (Fig.4). The three pillars are as following: (i) place- and time-based perspectives, which refer to the spatial and time perspectives applied by the organization for their resource management; (ii) community-empowered conditions, which define how the social response is coordinated; (iii) knowledge-driven programs, which assess the state of technical and educational tools for adaptation within the organization. The three pillars, with their respective themes, have been summarized and described in table 1.

Figure 4. The three pillars and the correspondent ten themes as in the approach by Gray to analyze organizational readiness. Source: own elaboration, based on Gray (2012).

Table 1. The 10 themes to explore for analyzing organizational readiness according to Gray's framework (Gray, 2012). Source: own elaboration.

Pillar	Theme	Objective
Place and time-based perspectives	1) Place and time-based perspectives	Assessment of the spatial and time lenses used by the organization for mapping and monitoring ecosystems
Community empowered conditions	2) Principles, Trust, and Values	Assessment of (i) the principles behind the organization's management and how these principles are connected with an adaptive approach; (ii) level of trust among people involved and the level of involvement; (iii) the values towards which the organization is oriented
	3) Institutional culture and function	Assessment of the organization's structure
	4) Leadership	Assessment of the leadership style and traits in the organization
	5) Partnership	Assessment of the level of organizational partnership with forest sector, professional organizations, indigenous communities, environmental communities, and non-traditional partners.
Knowledge driven programs	6) Strategic planning	Assessment of the short-term and long-term strategic and looking-forward planning, if present, adopted by the organization and evaluation of its functionality under climate change
	7) Legislation and policy	Assessment of the policy and legislation in which the organization's planning occurs to operate and evaluation of the extent to which they support climate change adaptation
	8) Knowledge and information management	Assessment of the level of research and knowledge regarding responses of natural assets to climate change and evaluation of the ways through which information is managed and integrated into planning
	9) Communication, education, and knowledge exchange	Assessment of (i) the communication level; (ii) the education training carried out by the organization; (iii) the exchange and consequent incorporation of different types of knowledge
	10) Implement adaptation	Assessment of the use of adaptive management for planning and of the ways these frameworks are integrated into existing management practices.

3.2.2. Methodology

As a first step, Gray's framework has been tailored to the specific case of MCF. For this purpose, themes have been selected by considering MCF context and forest management. After pre-selection from an academic perspective, the chosen themes have been discussed with the director of forestry, who has given their feedback and suggestions. After this step, themes have been validated, resulting in the selection and re-arrangement of eight of Gray's in three areas – which are displayed in table 2 and fig.5.

Table 2. Motivations behind the choice of the three areas for assessment of organizational readiness in MCF. Source: own elaboration.

Area	Motivations	References	Theme by Gray
Climate change knowledge	Knowledge is a recurrent determinant of adaptive capacity in literature, providing an essential help in the decision-making process and facilitating adaptation. Investing in the increase of public knowledge and awareness about climate change is important for framing risk perception, which in turn can influence adaptive behavior.	Armitage (2005); Barr & Lemieux, (2021); Bidwell et al. (2013); Ford & King (2015); Furness & Nelson (2012, 2016); Picketts et al. (2012); Williams et al. (2015)	8, 9
Organizational culture and capacity	Organizational culture is a key element for mobilizing resources to implement adaptation. Values can determine decisions on whether/how to adapt to climate change, while leadership can greatly influence decision-making. Capacity and flexibility are also highly dependent on the amount of power allocated to the organization for decision-making, and community forests need the right balance of autonomy and support from the government. Empowered local-scale system of governance may increase the success at other scales.	Adger et al. (2009); Armitage (2005); Barr & Lemieux (2021); Bixler (2014); Eisenack et al. (2014); Furness & Nelson (2012); Gray (2012); Neef et al. (2018)	2, 3, 4, 6, 7
Social systems	In community forests like MCF, the social tissue is strongly linked to natural resources. Trust building, clear communication, and collaboration enable support in case of unpopular decisions, allowing an active dialogue which in turn increases awareness and influences perceptions. Furthermore, successful community management is facilitated with a great number of participants;	Armitage (2005); Barr & Lemieux (2021); Berkhout (2012); Ford & King (2015); Furness & Nelson (2012); Rhodes (2021); Sheppard et al. (2011)	2, 5, 9

Figure 5. Organizational readiness framework after selection and rearrangement of Gray's themes for TFL26. Source: own elaboration

The areas which have been defined correspond to (i) climate change knowledge and awareness. This aims at investigating the level of knowledge and awareness that MCF have, the sources to access knowledge, their integration, and the exchange of such knowledge; (ii) institutional culture and capacity, with the objective of analyzing MCF values, leadership, the resources available to start adaptation, and the barriers that can hinder adaptation; (iii) the social system that characterize MCF, which include analyzing the level of trust in the organization and perceived support from indigenous and non-indigenous communities, MCF communication strategies and channels, and collaborative decision-making.

Then, a questionnaire has been developed in order to investigate the chosen themes and provide a structural base for the interview. Every section of the questionnaires is made up of 4 questions on average, and the sections have been organized in the following order: (i) knowledge and awareness, (ii) organizational culture and capacity, and (iii) social systems. It has been decided to ask open questions in order to let the interviewees express themselves with the highest level of freedom possible, trying not to constraint their thoughts inside formatted categories or replies.

In the following step, relevant interviewees have been selected in the consultation with MCF director of forestry, resulting in a list of ten participants, three of which belonging to MCF and seven offering a perspective from the outside. Therefore, interviewees can be grouped in two different classes named IMCF – for interviewees inside the organization – and OTO – indicating the participant from outside the organization. The OTO group is made up of individuals from both the indigenous and non-indigenous communities that have been chosen according to their role in the municipality with the aim of avoiding biased opinions. As a result, two questionnaires have been prepared, which present slight differences and that can be found in Annex I and II.

The interviews have been carried out both in person and via zoom. With interviewees' permission, they have been recorded with the aim of avoiding mistakes related to misunderstanding and reducing the chance of information loss. Interviews have been carried out between 20th June 2022 and 18th July 2022 and, in all cases, it was necessary to follow-up with the interviewees in order to complete all the questions contained in the

questionnaires. After having transcribed all the recordings - providing a specific code to each transcript in order to ensure the privacy of every respondent -, the qualitative analysis phase has been initiated using the procedure as described below.

First, the information from each transcript has been summarized in bullet points per each question so as to facilitate the comparison between responses. Then an excel sheet (example in Annex III) has been organized inserting every topic mentioned in each row and the participants' codes at the head of each column. Then, an "x" has been written inside cells according to the respondent(s) that mentioned such information. In this way, it has been possible to check the frequency and compare every element declared by the interviewees. Secondly, results have been integrated with information available in the literature so as to provide an overall picture of MCF organizational readiness. The integration has been functional to qualitatively assess the relevance and contribution of these results to organizational readiness.

4. RESULTS

Initially, 10 interviews have been settled for this research, 3 of which were organized with interviewees working inside the organization (IMCF) and 7 with interviewees outside it (OTO). All the interviews with MCF members have been carried out, while it has not been possible to carry out the interviews with 3 persons from the OTO group. On average, the interviews have lasted 100 minutes each. Generally, the respondents have not met difficulties in replying to the questions proposed in the form. Nevertheless, in some cases the interviewees could not answer due to either limited access to precise information about the topics asked or the inner complex language of the question. To overcome the latter case, questions have been rephrased by also reducing the level of academic language. Furthermore, since two versions of the questionnaire have been developed to specifically target both IMCF and OTO groups, some results have been available mainly from one of the two categories, although in few cases all respondents have managed to answer. The specific cases have been collected and described in table 3.

Table 3. Cases of difficulty/impossibility to reply for the interviewees. Source: own elaboration.

Area	Question	Difficulty/impossibility to answer	Motivation
1	Have you had discussions about climate change impacts with MCF?	IMCF	Question not present in IMCF questionnaire
1	To which extent does MCF have access to different sources of knowledge around climate change?	OTO	Question not present in OTO questionnaire. Limited knowledge of detailed information on the topic
2	How familiar are you with the management resources and tools of MCF?	OTO	Limited knowledge on the topic, especially if out of people's scope
2	Would MCF be open to explore different options [ndlr. resources] to help adapt to the impacts of climate change?	OTO	Question not present in OTO questionnaire
2	Level of flexibility	OTO	Limited knowledge on the topic
3	Could you describe the state of relationship with locals and surrounding First Nations?	OTO	Absence of knowledge on the topic
3	How much do you value trust and public support in your decision-making?	OTO	Question not present in OTO questionnaire.

4.1. Climate change awareness and knowledge

4.1.1. Level of awareness and knowledge

All the interviewees have expressed familiarity with climate change – providing either brief or longer definitions to it – and have experienced climate change effects under different forms in their personal life (fig.6). 2 participants have claimed that climate change has also directly impacted their work activities.

Within the climate change effects, fire-related impacts represent the most reported ones (6 respondents): the incidence of wildfire in the BC has been noticed by 3 participants, and 2 respondents have talked about the 18 consecutive days of extreme fire-risk in Summer 2021. Other 2 participants have mentioned the case of Lytton, a city completely burnt to the ground in BC because of a wildfire during the same period. 2 respondents have noticed trees with brown needles in the area. Another frequent impact experienced by the interviewees is the heat dome occurred in Summer 2021 (5 respondents), followed right away by the flooding of Fall 2021 (4 respondents).
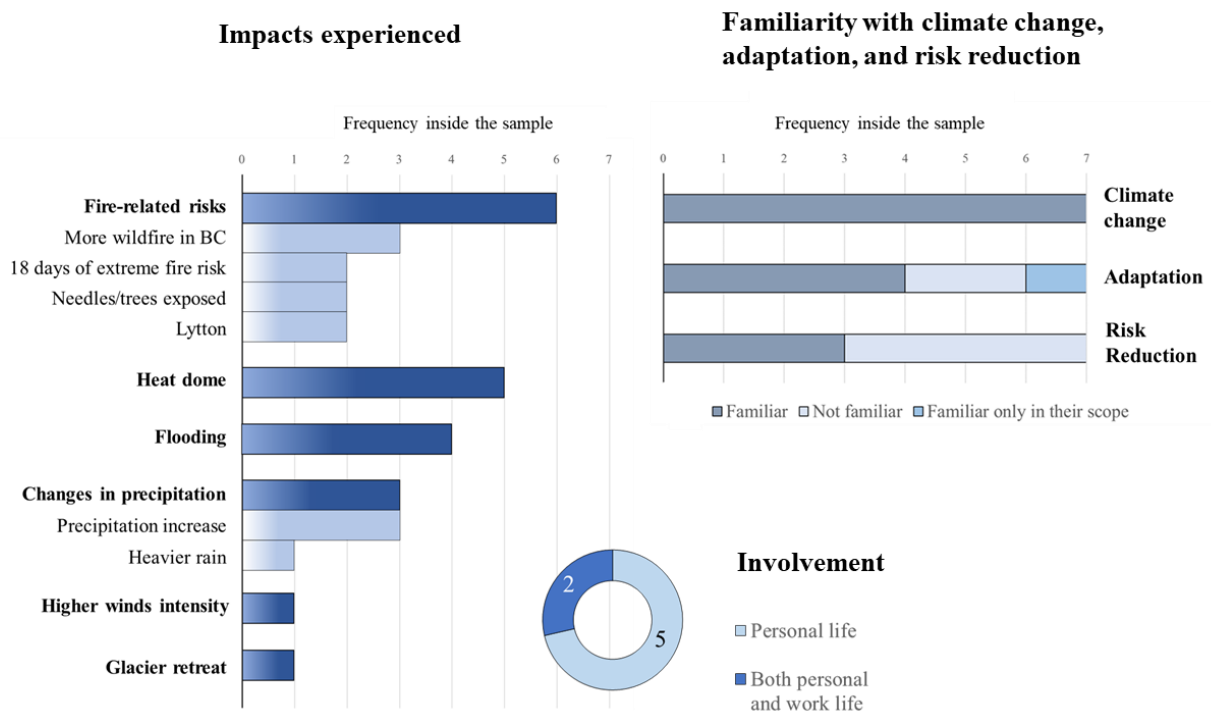
Figure 6. The figure in the upper right provides information on the climate change, adaptation, risk reduction familiarity of the interviewees. On the left results of the main impacts of climate change experienced by the interviewees are displayed. The pie chart shows the extent of involvement experienced by the interviewees. Source: own elaboration.

Precipitation increase over time has been observed by 3 respondents, with change in its magnitude and seasonal distribution noticed by 1 interviewee each. 5 respondents have declared to consider climate change as a major threat or that dealing with its impacts have been stressful.

When it comes to adaptation, the level of familiarity among the interviewees has been lower; 4 respondents have provided a definition and have been also able to distinguish between the concepts of adaptation and mitigation, while 1 respondent has provided a definition only in their scope. The remaining 2 interviewees have not given an answer because of different motivations. In one case, the uncertainty has derived from the personal unfamiliarity with the concept of adaptation. In the second case, the interviewee has claimed that there is no sufficient scientific knowledge to properly define what adaptation is or what requires. Regarding risk reduction, 3 participants have been responsive to it, while the other 4 interviewees either were not sure or provided no answer (fig.5).

4.1.2. Sources of knowledge and integration

7 sources of knowledge around climate change have been mentioned during the interviews, which can be seen in fig.2. The most frequent one among the interviewees is the connection with universities like UBC and BCIT (5 respondents). Other sources discussed have been the directives and information provided by the province; online information and research papers; access to traditional knowledge from FN; web-in-airs and conferences; and workshops – 3 respondents each. Another mentioned source is the network on which MCF can rely on, which includes connections with experts and professional associations (3 and respondents respectively), and environmental groups (1 participant). Silvicultural working groups and personal access to education have been mentioned by 1 respondent each. Eventually, there is a local weather station which provides local meteorological data (1 respondent). Yet, according to 4 interviewees, it is difficult to obtain precise information about how climate change is going to impact the region, and 4 respondents have highlighted the necessity of having access to more localized information. As will be seen in section *4.2.4 Barriers*, this knowledge gap is perceived as an important constraint in order to start adaptation by most of the interviewees. Integration of these sources is carried out by the organization but appears

to be limited, or not at the level it should be, for 3 respondents because of motivations like limited human resources (2 interviewees) and uncertainty around climate change (1 respondent).

6 respondents have declared to be favorable to seeing MCF as a source of knowledge and research around climate change at a local level. At the moment, no research on monitoring climate change effects on local ecosystems and communities has been reported, and 3 interviewees have highlighted the necessity to start monitoring these aspects (fig.7). However, such initiatives could imply a high cost for Mission's municipality according to 2 respondents. 3 interviewees share the idea that higher levels of governments already have either the resources or the structure to carry out these investigations and integration at a local level, potentially being able to regularly provide and update guidelines based on the knowledge acquired.

Regarding the amount of climate change knowledge shared with the public, interviewees have replied with mixed opinions. In fact, 3 interviewees have declared that the knowledge acquired by MCF is usually shared with the community.
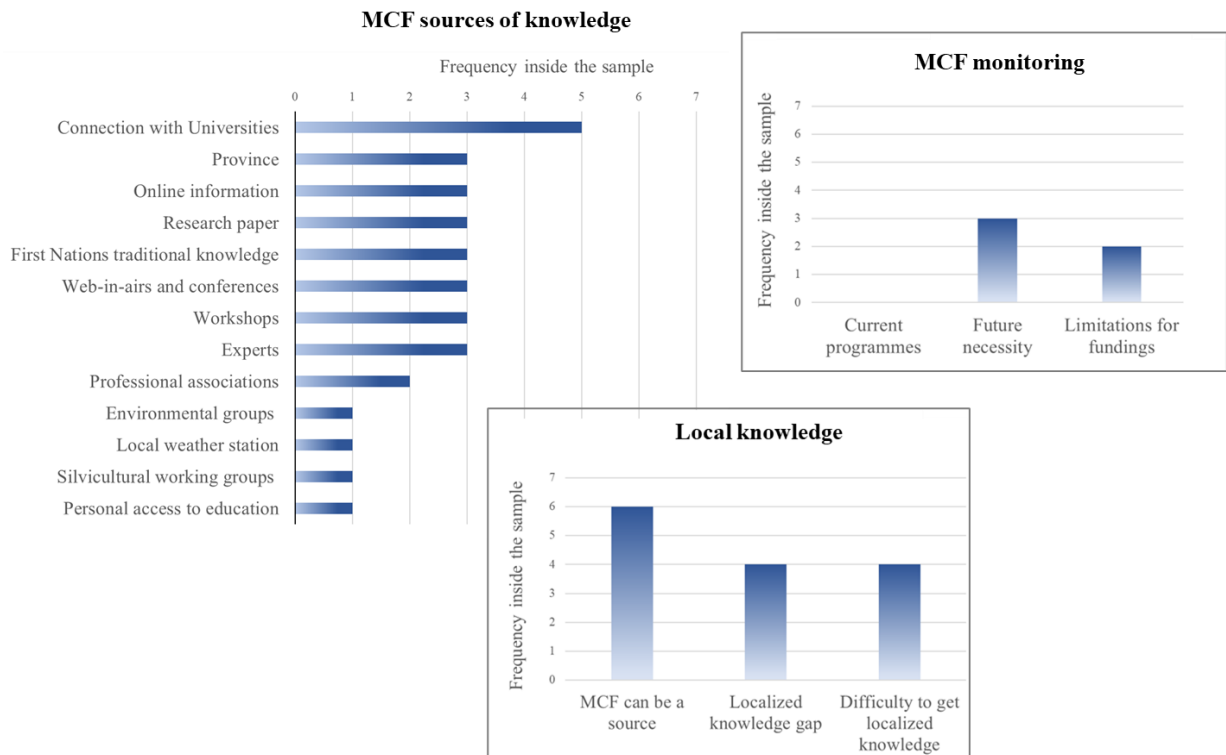
Figure 7. On the left the sources of knowledge that MCF have access to are displayed. The right boxes summarize interviewees' perspective around localized knowledge (bottom box) and level of MFC local monitoring (upper box). Source: own elaboration.

However, the same respondents have also recognized that the information is either poorly advertised or not present. The same information has also been reported by another participant, with thus 4 respondents declaring that the sharing of knowledge needs to be improved. Discussions about climate change have been carried out according to 4 interviewees. However, 1 respondent has specified that these conversations have been mainly focused on fire prevention and have been started recently. 1 respondent has affirmed that it would be useful to have a forum with the province and other licensees to provide inputs around climate change.

4.2. Institutional culture and capacity

4.2.1. Values

When asked about MCF values and objectives in terms of forest management, the majority of respondents have declared that sustainability is a key factor for MCF. 6 respondents have sustained that MCF forest management is oriented toward the valorization and preservation of the multiple benefits that forests provide to Mission, which include economic, social, and environmental services according to respectively 6, 6, and 4 respondents. However, 1 interviewee believes that the organization's management prioritizes the economic revenue over the other values (fig.3). 4 interviewees have sustained that climate change is currently not affecting MCF management, while 1 respondent sees impacts already nowadays.
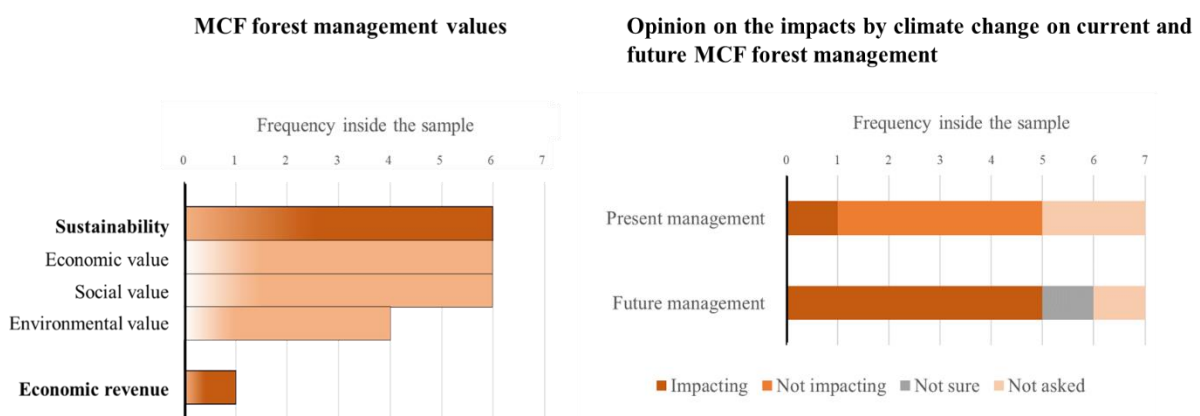
Figure 8. Result of interviewees' perspective on MCF values in terms of forest management (left graph); and on the impacts by climate change on present and future management. Source: own elaboration.

When asked about the future, climate change is going to impact the achievement of these objectives according to 5 participants, while 1 interviewee is not sure about it. For this interviewee, the reason behind this uncertain reply is that multiple factors – and not only climate change – are likely going to impact MCF operations, thus making it difficult to clearly establish which specific effects climate change will bring (fig.8). 4 respondents have claimed that adaptation is considered necessary in order to continue achieving the objectives and values of the current forest management.

4.2.2. Leadership

4 participants have sustained that leadership provides a crucial contribution to achieve an organization's goal. When asked about the essential traits a leader must have to properly climate change, the most frequent factor amongst the interviews is represented by communication-related skills, which has been considered fundamental by all the 7 respondents. Within the forms of communication mentioned, seeking for advice and listening to others are highly relevant aspects for all the interviewees. Another form of communication which has been discussed (3 interviewees) is the ability to convey the information about climate change in a successful way so as to obtain support – especially in case of an unpopular decision to make.
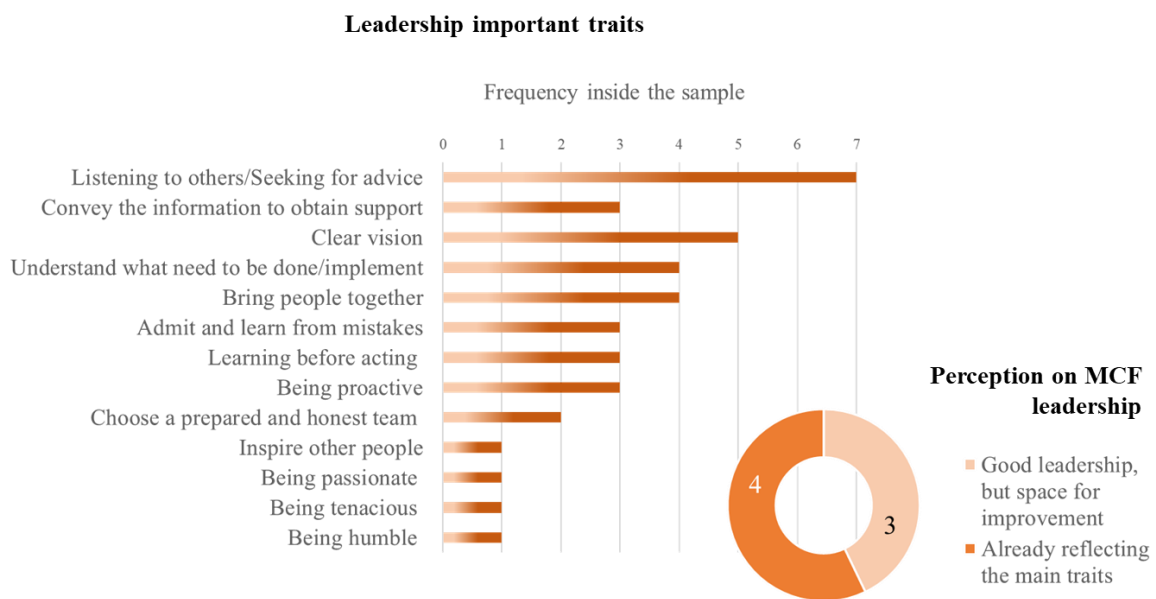
Figure 9. In the left graph the interviewees' perspectives on the relevant leadership traits are displayed. In the pie chart, perception on current leadership is shown. Source: own elaboration.

Other frequent traits that have emerged during the interviews include having a clear and defined vision (5 interviewees); understanding what needs to be done and transform it into actions (4 interviewees); creating a sense of ownership and bringing people together (4 interviewees); admit and learn from mistakes (3 interviewees); learning before acting (3 interviewees); and being proactive (3 interviewees). Less frequently mentioned characteristics have been surrounding themselves with a prepared and honest team (2 interviewees); inspire other people, being passionate and tenacious, and humility (1 interviewee per each). 4 participants consider MCF leadership to be already characterized by these traits, while 3 interviewees sustain there is space for further improvements (fig.4). This feedback comes from both groups, showing a similarity within IMCF and OTO opinions. The suggestions proposed in order to further improve MCF leadership have been the following: to equally consider both interpersonal team and workload management to guarantee the development of an effective team; to scale back some of the workload off the leader's shoulders; to increase the emphasis and effort towards the climate change crisis into forest management.

4.2.3. Resources

According to respondents, MCF has several resources available at their disposal, which will be described in this section (fig.10). According to 5 participants, the council is generally supportive of MCF in terms of fundings –, with 2 respondents claiming that the support is usually high on the condition of providing a business case and/or the details of any proposal. Also, the community is supportive according to 4 interviewees. It has emerged that MCF can have access to provincial support in different manners. Province and Ministry of Forests can help MCF by providing guidelines on climate change, as in the case of climate seed transfer directives mentioned by 2 respondents. In terms of fundings, there is the possibility of accessing fundings through provincial programs according to 3 respondents. An example of use of this kind of resource is the Mission's recent participation in the *FireSmart* program, a provincial wide plan aimed at fire prevention which has been mentioned by 4 respondents. Nevertheless, 1 respondent has claimed that obtaining economic resources from the province can present obstacles that have been further explored in *section 4.2.4 Barriers*. Access to new knowledge and education around climate change represents another acknowledged resource amongst the interviews. In this field, new partnerships with local universities have been developed

recently according to 2 interviewees. In terms of human resources, 2 interviews have affirmed that MCF is able to cover a fair part of the workload internally thanks to high capacity of the staff, while the rest is contracted out of the organization. When asked about the level of MCF flexibility to start adaptation, the replies have been mixed. On one hand, all the 3 respondents from MCF have assessed the current level of flexibility as sufficient. 1 interviewee has justified this reply by considering the small size of the organization, which limits the emergence of conflicting opinions inside the team and allows MCF to adapt without seeking approval from higher outside sources. On the other hand, 2 interviewees have claimed that inflexibility can emerge when there are regulations in place.

In order to start adaptation, all the 3 IMCF participants are open to explore new resources or implement the already existing ones. Resource suggestions which have been mentioned in the interviews include increasing partnership with universities (2 participants); enhancing education with children and information available for the public around climate change (2 participants); increasing collaborative working with local experts and FN (1 participant); and establishing learning structures close to the municipal forest aimed at increasing public awareness about climate change and MCF forest management (1 participant).
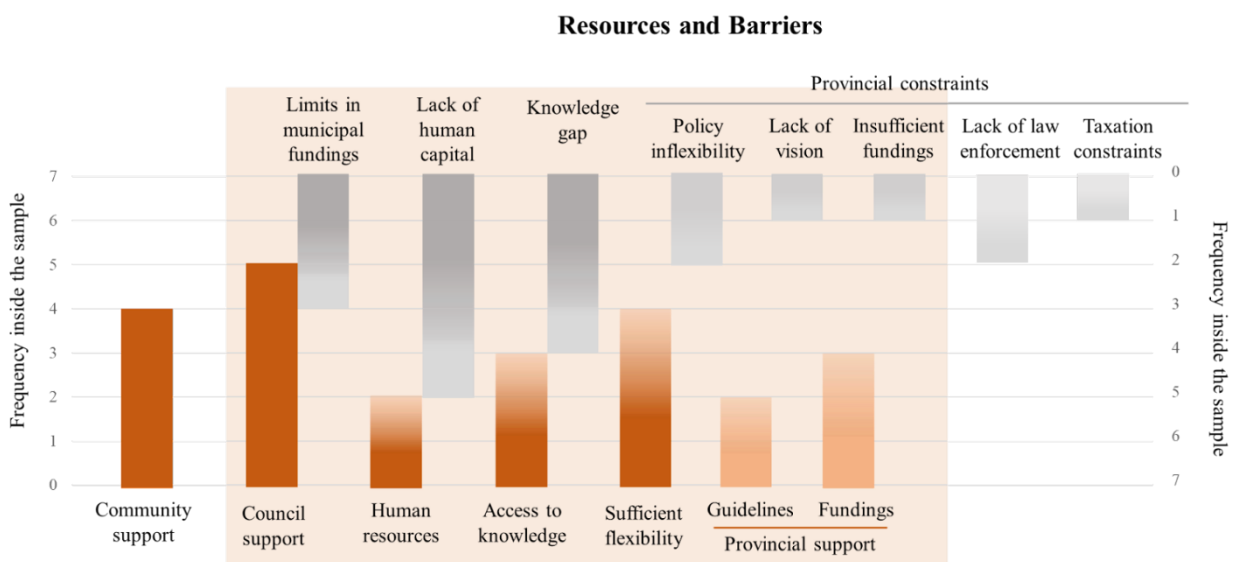
Figure 10. Resources (orange) and barriers (gray) of MCF for starting an adaptation plan. The orange box contains those barriers that are related to a lack of the resources below. Source: own elaboration.

For 2 respondents it has been difficult to give answers about resources questions. They have claimed that the uncertainty around climate change makes it challenging to assess whether the current level of resources is adequate or which resources will be needed in the future. More specifically, 1 of these 2 respondents has declared that adaptation is not a "destination" – thereby the resources needed can change over time –, while the second argues that an assessment of resources is only possible after having developed an adaptation plan, which is currently missing.

4.2.4. Barriers

When asked about potential barriers to adaptation for MCF, 5 main obstacles have emerged which will be described in this section (fig.10). Some of them are also a lack of specific resources that have been mentioned in the previous subchapter.

4 interviewees have highlighted the knowledge gaps about current climate change impacts at a local level. According to them, this uncertainty would hinder MCF from the possibility to develop an appropriate adaptation strategy.

Another frequent barrier (4 interviewees) amongst the interviews is the economic constraints that may emerge when planning and implementing adaptation. More specifically, 3 participants have described economic limitations at a municipal level, claiming that higher government levels have major financial capacity and thus should be the one providing resources. Furthermore, 1 interviewee has reported that the provincial taxation system and market trends can cause a fluctuation of MCF financial revenue, making it difficult for MCF to have stable incomes through which funding projects over time.

Although 2 interviewees have sustained that MCF is able to cover efficiently the workload internally – with 1 of these respondents also claiming that there is a good balance between workload managed internally and the one that is contracted out –, 5 interviewees believe that MCF human resource is currently low and one person more might be needed. In fact, 2 respondents have highlighted that the current workload makes it challenging to have the time for staying up to date on climate change information.

Several obstacles emerged during the interviews regard the contribution of the provincial government to facilitating adaptation. 2 participants have talked about how

provincial law can be inflexible in some matters; for instance, planting hardwood species is subject to limitation because of provincial policies enforcing conifer plantation. According to 1 respondent, the province is lacking vision on climate change, which in turn hinders the possibility to have and implement long-term strategies. Furthermore, during an 80-years rotation 20 different governments are elected, each one with their own vision and approach. According to the same respondent, most political decisions are made with the aim of being re-elected, which is another element that can increase the modifications to planning. Another interview has also highlighted how often the same provincial funding is available for applications by multiple departments, forcing entities to choose which initiative to give priority to once the fundings are available – likely selecting options with an immediate outcome rather than decision characterized by long-term ones. Finally, 2 interviewees have expressed doubts on the level of enforcement of laws and policies, which may be either enforced too strictly or not enough.

Although MCF flexibility has been described as sufficient by all the participants from IMCF group, 2 respondents have highlighted that problems of inflexibility may emerge with provincial policies and regulations in place – e.g. plantation of hardwood species.

4.3. Social systems

4.3.1. Trust and public support

All the members inside IMCF group highly value trust. When asked about their idea on the level of trust from the public, members of IMCF perceive it as good from both local and indigenous communities. However, 1 of IMCF interviewees has specified that these replies correspond just to their perspective and may not reflect what is the trust actually given from the public. Respondents from the OTO have generally assessed trust and public support towards MCF as high (2 participants), although 1 participant has sustained that few "loud voices" in the public may interfere with decisions around climate change. Moreover, for 1 respondent the city support towards adaptation would be highly dependent on the cost and on the money available.

In order to keep and/or increase the level of trust and public support, 4 participants have highlighted the crucial role of education, especially when institutions face complex issues such as climate change.

4.3.2. Communication

Communication has been evaluated as remarkably important by all the interviewees. When asked why, 2 interviewees have replied that effective communication plays a relevant role in obtaining public support. As emerged from the interviews, MCF communicates with the public through several channels (fig.11), which include open houses and community events (4 interviewees), guided walks in the forest (4 interviewees), education with kids in school (3 interviewees), direct forms of communication – which include mail, email, phone calls – (3 interviewees), through council meeting (3 interviewees) and videos (2 interviewees). According to 3 interviewees, the frequency of communication by the organisation is adequate to meet MCF obligations towards the public, with MCF always informing in all those cases where MCF operations have direct impacts on citizens.

MCF channels of communication
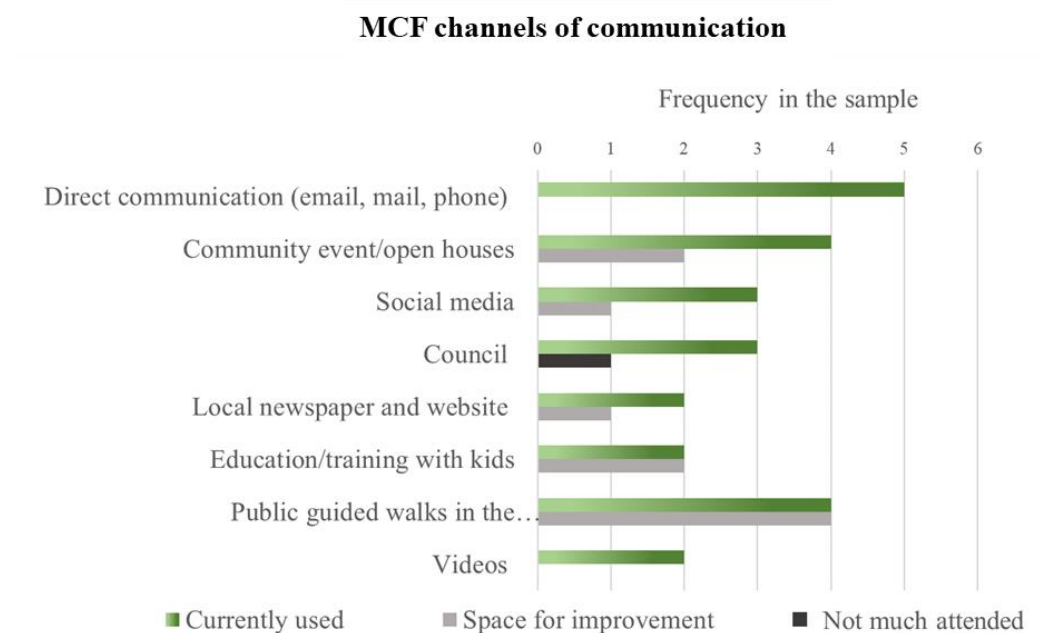
Figure 11. MCF channels of communications as declared by the interviewees. Source: own elaboration.

5 participants have affirmed that communication either can or needs to be improved. 1 interviewee has motivated this by claiming that there is a low level of engagement between MCF and the public, claiming that most people in Mission do not know a lot about the forestry department. All the 3 interviewees from MCF are open to changes and to new forms of communication. The suggestions given in the interviews include writing news on the local

newspaper (1 respondent), more education and training with kids (2 respondents), interpretative forest, greater use of social media (1 respondent), the construction of learning centers close to the forest, town hall meetings about forestry or events about it, more public guided tour and operations in the forest. However, 1 respondent has expressed that it should be better to ask the public what are the forms of communication that they prefer for MCF to use.

4.3.3. State of relationship

The state of relationship with non-indigenous community and the other municipal departments is perceived as good from all the interviewees. 1 interviewee has highlighted how there is a mutual respect between MCF and the public, declaring that the community generally appreciates and values MCF work. When asked about the state of relationship with FN, the 3 interviewees in MCF perceive that the relations have been improving over the last 20 years. These results are not conclusive since a proper investigation with the FN and the public is necessary to confirm these perspectives.

All the 3 interviewees from MCF have expressed interest in keeping a good relationship with both the public and FN. When asked about the elements necessary to keep good relations, the most recurrent ones have been inclusivity (6 interviewees) and communication (5 interviewees) followed by collaboration (3 interviewees) and responsiveness (3 interviewees). Other factors which have emerged less frequently are trust (2 participants) and co-management (2 participants). However, 1 respondent has expressed doubts about the feasibility of co-management in decisions where a high number of stakeholders is involved.

4.3.4. Collaborative decision-making

Collaborative decision-making is considered highly important by all the interviewees. When asked what the crucial aspects for an efficient collaborative decision-making, communication and honesty represent the most frequent reply (5 participants). However, effective collaborative decision-making is the one where the inputs and the number of stakeholders to include in the collaboration are correctly filtered according to 2 interviewees. In the case of starting adaptation, 1 respondent has declared that collaborative decision-making can help to create the support necessary to make decisions

that can be unpopular for those few loud voices which would not represent an entire community.

In the case of MCF, the collaborative decision-making that has taken place so far has been described as mostly consultative by 4 interviewees, meaning that the organization collects different inputs and suggestions, ultimately taking their own conclusive decision. As explained by the respondents, collaborative decision-making is usually carried through direct communication with council and the stakeholders involved – either one-to-one or MCF-to-community via mail, emails, calls, and review of documents. 3 participants have also reported a form of collaborative decision-making which is not consultative. The biggest and most recent case of such a method is the Stave West Recreational Area, which is a collaboration between the 3 local FN, the district of Mission, the provincial government, and few recreational user groups. According to 1 participant, this kind of collaborative decision-making would be needed in case of complex and crucial matters like the establishment of an adaptation plan.

5. Discussion

5.1. Climate change awareness and knowledge

5.1.1 MCF awareness and climate perspectives

From the results, all the interviewees acknowledge the existence of climate change and, by their reply, seem to have knowledge of what it is and at least some of its implications. Climate change awareness represents an important element upon which to build dialogues around adaptation: in fact, as highlighted by Nzeadibe et al. (2011), different actors can consider adaptation only by recognizing that climate is changing. Similarly, Adger et al. (2009) claims that it is important to be fully aware of climate change risks because it represents a motivation to justify action. This statement is echoed by other research (Abbasi & Nawaz, 2020; Dhaka et al., 2010; Eisenack et al., 2014; Idrisa et al., 2012; Thi Lan Huong et al., 2017; Zareen, 2012), which supported a correlation between climate change awareness and adaptation. Therefore, based on these studies, it can be argued that the awareness might be one of the main drivers for MCF to consider the initiation of a vulnerability assessment.

The majority of the respondents have either declared that climate change is a huge threat for human's being or have experienced a high degree of stress when dealing with climate change impacts – which, for them, has mainly been related to the high fire-risk experienced during Summer 2021. Personal emotion and concern can play a role in building adaptation will. In fact, several studies either do consider awareness alone not a sufficient element to incentivize the establishment of adaptation measures or focus more on the relationship between climate perspectives and adaptive behavior, often analyzing awareness as a dimension of perspective (Adger et al., 2009; Furness & Nelson, 2012; le Dang et al., 2014; Leao & Samuel, 2014). As an example of the former, Furness & Nelson (2012), by analyzing the state of adaptation amongst BC community-forest organizations, reported that the level of climate change awareness was not remarkably different between adaptors and non-adopters, suggesting that awareness may need to be coupled with a certain degree of concern in order to trigger adaptive measures. Also Eriksson et al. (2018) suggest that, in order to stimulate prevention, the awareness should be associated with the negative emotions related to adverse risks. Studies like le Dang et al. (2014) and Leao & Samuel (2014) focus their investigation on the influence of climate perspectives

towards adaptation. In fact, climate perspectives are believed to be fundamental in inducing adaptation as a means to offset negative impacts of climate change (Abbasi & Nawaz, 2020). In both le Dang et al. (2014) and Leao & Samuel (2014)'s framework, awareness represents one dimension of climate-related perspectives, which is also influenced by other factors such as experience with climate change, level of concern, social constructs, and individual cognition. In particular, experience may significantly contribute to shaping risk perspectives. In MCF context, during the interviews it has been mentioned that Mission has recently joined *FireSmart*, a provincial program aimed at improving wildfire preparedness and mitigation (FireSmart, 2022). Considering that BC was hit by a heat dome and dramatic wildfire occurrence in Summer 2021, it might be that the extremely high fire-risk experience has driven the municipality to participate in such a program as a reactive response. In fact, fire-related risks and heat dome correspond to the most common impacts experienced within the sample. However, the relationship between experience of climate change impacts and the perception of such impacts with adaptive behavior is not linear (le Dang et al., 2014), which makes it impossible to confirm this hypothesis without a targeted investigation. As an example, in a study in the UK Whitmarsh (2008) found out people who were affected by flooding were not linking this impact with climate change, showing no behavioral learning. This, in turn, can hinder from taking action even in cases where adaptation information is provided (Adger et al., 2009). On the other hand, in the Canadian context it seems that, given the high level of education, do not correspond to a significant barrier to adaptation (Williamson & Nelson, 2017).

Based on this analysis, it is my opinion that the combined level of awareness, knowledge and concern around climate change emerged from the interviews suggest that MCF perspectives on climate change can facilitate dialogue around adaptation, being a positive contribution to MCF organizational readiness.

5.1.2. Sources of knowledge and integration

As emerged from the results, MCF can access a wide range of knowledge sources at different scales, from the province to local experts. According to Olazabal et al. (2018), this corresponds to a fundamental asset for decision-making in socio-ecological context,

especially when it is necessary to address complexity and uncertainty. In the case of MCF, knowledge on climate change impacts at a local level needs to be built. In fact, few respondents have highlighted that it is not difficult to obtain knowledge about climate change – which in many cases is of scientific nature and thereby difficult to understand for local users (Sheppard et al., 2011) – but rather gather localized information that can be useful in their decision-making. As highlighted by Adger et al. (2005), this lack of information is often cited as a motivation behind the delay of adaptation actions (Andrews-Key, 2018; Johnston & Edwards, 2013; Oulahen et al., 2018). Furthermore, no local initiative on monitoring impacts has emerged from the interviews, and monitoring data are necessary to make local climate predictions on the long term (Kaspar et al., 2013). Monitoring capacity is an element mentioned by Olsson et al. (2004) to build resilience in socio-ecological systems. Williamson & Nelson (2017) highlights that acquiring new knowledge through monitoring is essential for providing modifications to adaptive planning. In Mission's context, although consciousness of the importance of monitoring is present amongst respondents, there is also a concern that Mission's municipality might not have enough financial resources to carry out such monitoring programs on their own. In fact, transitioning from broad climate information to tailored one that can be utilized for a specific context is a resource-intensive process (Kalafatis et al., 2015). Furthermore, integration of different sources of integration is not perceived as sufficient, which is another motivation behind the knowledge gap. Currently, integration is carried out at the organization level, which appears to be limited in human resources. Therefore, as for monitoring, some participants believe that the municipality might not have the resources necessary to integrate the information around climate change, and thus this integration should be provided by the province because of the higher level of resources. As highlighted by Sheppard et al. (2011), it is necessary to organize and make sense of emerging information on climate change so as to help agencies and communities.

For all these reasons, MCF seems to have a mismatch between information demand and supply: on one hand, the organization can access to updated knowledge on climate change by several sources; on the other hand, this knowledge might not be useful in a local context, given its possible broader scope or the insufficient level of integration between multisectoral sources. Such mismatch, according to Kalafatis et al. (2015) is a frequently mentioned issue in the literature. A valuable solution might be the development of joint

knowledge production (Williamson & Nelson, 2017) and polycentric knowledge network, which incentivizes the mobilization and development of knowledge across scales and actors (Kalafatis et al., 2015; Krätke & Brandt, 2009). In their research, Kalafatis et al. (2015) described polycentric knowledge networks as "a knowledge system of organizations, actors, and objects linking knowledge and know-how with action" (p.31). With the aim of empirically demonstrating their considerable potential, Kalafatis et al. (2015) found out that specialized and regional knowledge networks in the Great Lakes produced usable information for the agents in the region. Given the numerous and various connections that MCF have, it appears feasible to develop or enhance a similar type of network, producing useful information which would embrace both social and environmental fields. In fact, according to Bidwell et al. (2013), knowledge networks stimulate social learning that encompass both physic-ecological knowledge and governance. This is particularly relevant in adaptation of forest systems, where social and physical systems are tightly connected and therefore several social actors (scientists, managers, policy makers, the public) all contribute to provide knowledge (Meijerink & Stiller, 2013; M. P. Nelson et al., 2017). Such cross-sectoral knowledge can lead to a better understanding of climate change, and thus to a solid support for decision-making (Bidwell et al., 2013; Olazabal et al., 2018). Furthermore, as highlighted by Halofsky et al. (2018), sharing information about successful adaptation implementation will be critical. As a demonstration, one of the elements of success to overcome knowledge and training gap in Andrews-Key et al. (2021) study has been the collaboration with experienced researchers, which has bridged scientists and practitioners.

Knowledge exchange with the public seems limited, although MCF carries out activities aimed at increasing awareness and knowledge of the citizens. Interviewees are favorable in seeing MCF as a source of knowledge, expressing positive opinions about practical initiatives (e.g. MCF tours in the forest and education with the kids). This suggests that increasing such kinds of activities is feasible and could be successful to keep/enhance interest and awareness within the public. According to Chisita & Fombad (2020), literature widely claims that knowledge flow – across different actors, including the public – is a crucial element for adaptive response, being an essential tool to empower citizens and thus increasing public support. For this reason, it is highly recommended for MCF to enhance public engagement and education by sharing the information gained

through network and research. Furthermore, considering the importance of local forest for Mission's citizens, increasing their education would facilitate the adoption of climate smart attitudes (Oluwatayo & Ojo, 2016).

5.2. Institutional culture and capacity

5.2.1. Values

The picture that emerges from the result is that MCF management is oriented towards sustainability, and the importance of municipal forest for the organization goes beyond the economic revenue, although it represents for sure a crucial aspect. Social and economic values of the forest seem more shared within the sample, but this does not automatically imply that MCF consider environmental values less important.

Analysis of values are important in terms of organizational readiness: according to Adger et al. (2009), "underlying values determine decisions about whether and how to adapt to climate change" (p.344). Such values place MCF in a favorable condition to start adaptation. In fact, values are central in shaping human behavior, which most often is, at least partially, at the center of environmental problems (Steg et al., 2014). As also highlighted by Adger et al. (2009), values and risk perception are the major factors determining the formation of subjective and mutable limits to adaptation that currently hinder society's ability to act. For this reason, it can be argued that values which have sustainability at their core may shape an adaptive behavior aimed at the perpetuation of that sustainability over the long run.

As will be further analyzed in the section *trust and public support* of this discussion, the community has so far approved MCF operations, implying that they share the organization's values in terms of forest management. Although a tailored survey should be necessary to confirm this assumption, sharing and committing to the same values is one of the keys for developing what is called *identified-based trust*, which is a deeper form of trust that can give a great contribution to improving public support (Lewicky, 2006).

Due to these motivations, current MCF values seem to facilitate adaptive behavior from the organization. Since MCF manages the forest for the public, it can be hypothesized that MCF values might reflect the ones of Mission's citizens. A dedicated investigation would confirm these assumptions: if they are ascertained, then values shared would represent a common commitment and an increased public support, further representing a positive contribution in terms of organizational readiness.

5.2.2. Leadership

The majority of the respondents believe that leadership has a fundamental relevance for achieving the organizations' outcomes. This information is echoed in the adaptation literature, with different studies claiming that leadership is an essential element to build and implement adaptive strategies (Berkhout, 2012; Eisenack et al., 2014; Gupta et al., 2010; Measham et al., 2011; Meijerink & Stiller, 2013; Olsson et al., 2004) and to build resilience of socio-ecological systems (Olsson et al., 2004). Eisenack et al. (2014) claims "that leadership (regardless of position or authority) can be crucial in the early stages of adaptation" (p 869) and that inspired leadership can lead to new governance mechanisms, generating profound changes to the contexts where decision-making happens. As an example, Berkhout (2012) reports a Swedish case in which the mayor of Skedsmo was significantly relevant as a coordinator of local political and business interests, which in turn greatly contributed to the realization of a flood defense wall.

In adaptation circumstances, the role of leadership is multiple and diversified: some authors like Vignola et al. (2017) propose that leadership style should be tailored to the task in the adaptation process. In their work, Meijerink & Stiller (2013) has collected several leadership theories that are particularly relevant for adaptation. By integrating them, they created a framework in which five leadership functions are believed to be essential, which are: (i) *political-administrative*, which includes making decisions on a shared vision for adaptation, communicate it and monitoring its implementation, and deals with the generation and allocation of resources; (ii) *adaptive*, which entails the management of innovative ideas and strategies that unpredictably emerge from the interaction within networks; (iii) *enabling*, which promote new ideas, keep up the schedules by inserting deadlines, and foster interaction; (iv) *dissemination*, which propose newly developed to positional leaders and get them accepted; (v) *connective*, which

allows to promote problems and searching for solution, bring people together or agree on and stimulate collaborative strategies, to push for agreements and implement action. In this framework, all the functions can be carried out by either positional leaders or key individuals, except for political-administrative, that belongs only to positional leaders. As a consequence, one major implication is that inside a team leadership should be shared between different organization's members. This does not correspond to a negative element, as shared leadership is encouraged for dealing with the complex issues facing the modern world (Allen et al., 1998). Most of the leadership traits defined as essential by the interviewees are reflected in one (or more) of Meijerink & Stiller (2013) functions (table 4).

Table 4. Alignment between leadership functions in Meijerink & Stiller (2013) framework and the leadership necessary traits for the respondents in this study. Source: own elaboration.

Leadership functions (Meijerink & Stiller, 2013)	Leadership traits (Mission's respondents)
Political-administrative	Convey the information Clear vision Understanding what needs to be done
Adaptive	Admit and learn from mistakes
Enabling	Listening to others/seeking for advice Choose a prepared and honest team
Dissemination	Convey the information
Connective	Listening to others/seeking for advice Bring people together Choose a prepared and honest team Implement action

The majority of the interviewees have claimed that MCF leadership currently reflects the important traits. Particularly shared in the sample is the communication ability of a leader, both in terms of listening and framing messages. The importance of correctly framed communication is echoed in the literature (Gilley et al., 2009; Meijerink & Stiller, 2013). As an example, Meijerink & Stiller (2013) claim that it is important for a leader to promote problems rather than solutions so as to trigger problem solving through collaborative learning. It is therefore encouraging that MCF leadership is reflecting the majority of these features.

Nevertheless, few areas of improvement have emerged according to the interviewees. Aligned with the lack of human resources explained in section *resources and barriers*, it has been highlighted how MCF leadership is full of workload. Considering that a disproportionality between time dedicated to work management and time spent for team members has been declared in the interviews, it seems that the current amount of workload hinders the enhancements of relations inside the team. This aspect is important to improve for two main motivations; firstly, improvement of internal communication and importance given to personal relations is a function of building capacity (Eisenack et al., 2014); secondly, emphasizing with the others is at the base of further increase trust (Lewicky, 2006) inside the team, creating a good work environment.

For these reasons, MCF leadership appears on the whole as a positive contribution in terms of organizational readiness, especially when addressing and actively improving the emerging suggestions. Following such indications would further increase the state of leadership, contributing to enhancing an adaptive environment.

5.2.3. Resources and barriers

Barriers to adaptation, as adaptation itself, are highly specific on the context (Eisenack et al., 2014). Due to this specificity, it is impossible to develop one general solution to overcome constraints (Eisenack et al., 2014). Nevertheless, cases of successful adaptation projects can help to build understanding and knowledge (Andrews-Key et al., 2021), thus can help in the search for a context-based strategy.

As already mentioned in the results, most of what has been declared as a resource for MCF is also perceived as a barrier. This happens when the level of some resources is lacking or presents significant limitations. Thus, reallocation or improvement of these kinds of resources could be the solution to overcome such barriers. For this reason, both barriers and resources have been discussed in this section.

As already noted, one of the most perceived barriers is the knowledge gap for localized effects of climate change, which highly contributes to the high level of uncertainty in decision-making at a local level (Measham et al., 2011; Nagel et al., 2017). Generating useful knowledge is therefore an important aspect to overcome this issue. As described

in section *Sources of knowledge and integration*, this useful information could be produced by enhancing MCF knowledge network and collaborative partnership. Specifically, increasing partnership may lead to benefits not only in terms of new climate change knowledge. As an example, Barr & Lemieux (2021) claims that stronger and more numerous partnerships "with local and regional conservation organizations would increase resources […] available for adaptation and assist with overcoming political barriers and deficiencies in the political system (e.g., changing priorities every four years) (p.34). MCF is currently working on partnership with education institutions like UBC. Furthermore, respondents have declared to be open to new opportunities, further promoting the idea that the development of a valuable regional network is possible – especially considering that MCF has connections with different organizations across scales, like other licensees, experts, and the province.

Another frequently reported barrier by the interviewees, both directly and indirectly, is the lack of human capital. MCF is made up of a small team which efficiently manages to cover the internal workload. However, during the interviews, it has emerged that, because of the consistent amount of workload, there is not a lot of time to dedicate to other activities e.g. integration of sources of knowledge. MCF is not an isolated case since studies like Halofsky et al. (2018) and Nagel et al. (2017) also report the same type of constraint. Hiring another employee would help to reduce the workload for MCF, giving the possibility for MCF team to spend time carrying out other activities that would benefit adaptation, such effort in increasing citizens awareness and integration of knowledge sources. This solution appears feasible in terms of both will and economic resources given the perceived high support from Mission's council towards MCF initiatives. Nevertheless, when it comes to more cost-demanding options – such as local monitoring – participants have reported that lack of fundings can emerge. This affects both the municipal and provincial level, most likely for different motivations. In fact, municipalities have a lower financial capacity than the provincial level, as also echoed in Measham et al. (2011) and Oulahen et al., (2018). On the contrary, higher levels of government, although gradually mobilizing resources to tackle climate change, seems to be at an early stage in doing so. As an example, Halofsky et al. (2018) affirms that, yet no mandate or guidelines have been provided for prioritizing incorporation of climate change considerations inside sustainable forest management, and there are no dedicated

resources by the provincial agencies to provide assistance. Lack of finances is often cited as a constraint for adaptation (Abbasi & Nawaz, 2020; Barr & Lemieux, 2021; Eisenack et al., 2014; Nagel et al., 2017; Williamson & Nelson, 2017). Also in this case, network and connection can improve the chance of guaranteeing fundings for adaptation initiatives (Barr & Lemieux, 2021). Other than that, also the development of a business case might be an effective strategy to obtain fundings. In fact, it has emerged that municipalities are supportive, especially when MCF supports their plan with a business case. The same reasoning could be applied on the provincial level: in the Andrews-Key et al. (2021) study case, one of the elements of success for a successful implementation of adaptation was the access to fundings from Natural Resource Canada thanks to the provision of a business case.

A consistent number of constraints perceived for MCF come from the province. Apart from providing insufficient fundings, provinces can exhibit policy inflexibility. As an example, few respondents have highlighted the difficulty to increase biodiversity by planting hardwood species because of the provincial directives. Also in this case, Mission's case is echoed by studies like Measham et al. (2011), who argued that the policy framework where local governments operate is widely imposed by higher governance levels. According to Williamson & Nelson (2017), as soon as Canadian institutions do not incorporate climate change considerations inside their policies, they represent a barrier to adaptation. Conversely, institutions should (i) be proactive and promote collaborative adaptive management; (ii) stimulate flexible approaches and learning and (iii) allow diversity in the approach used so as to tailor them to different local contexts (Williamson & Nelson, 2017). Otherwise, since local governments are usually the ones that implement directives generated at higher scales (Measham et al., 2011), lack of mainstreaming in national/provincial policies or too rigid guidelines can easily translate into strong impediments to adaptation. Overcoming these institutional barriers will be challenging (Measham et al., 2011; Williamson & Nelson, 2017) and will require the collaborative efforts of all involved actors at different scales – from citizens to higher levels of government (Sheppard et al., 2011). Although it may be difficult to push the higher spheres governments to changes in policies, in Measham et al. (2011) study case it became feasible when limitations by higher institutional arrangements were clearly identified, moving then adaptation science to the political level. Therefore, Measham et

al. (2011) concluded that "scientifically sound research combined with local political lobbying can lead to policy change at higher scales" (p.905). For these reasons, it is my opinion that MCF could – also in cooperation with other similar agents – identify and collect similar constraints, which could be used to push the BC government to change areas of inflexibility.

Apart from governmental constraints, MCF is perceived to be characterized by a sufficient level of flexibility and a perceived high community support. Flexibility is greatly important in the context of adaptation, as adaptive strategies need to be updated once new significant knowledge is acquired (Williamson & Nelson, 2017). Eventually, one resource on which it has been difficult for participants to provide an assessment is the technological availability for MCF. This has been challenging because of the uncertainty around climate change, which hinders participants from understanding which technology is needed. A vulnerability assessment can provide useful related information.

5.3. Social systems

5.3.1. Trust and public support

Public trust represents an important element in terms of support to forest management (Peterson St-Laurent et al., 2019), with studies demonstrating that trust is positively related to public support and therefore successful forest management of public forestlands (Eriksson et al., 2018; M. P. Nelson et al., 2017; Paul et al., 2016). According to Eriksson et al. (2018), "closed ties with the responsible actors, reflected in high trust and satisfaction with processes, may lead to higher public acceptance of more pervasive traditional management strategies" (p. 179) From what emerged during the interviews, MCF is well-placed in terms of both trust and public support, and relationships appear to be in a good state and characterized by mutual respect. Furthermore, the opinions collected suggest that the public and MCF seem to share the same values, given also that MCF's forest management is aimed at providing Mission's residents with benefits. Based on this assumption, it can be argued that MCF and the public may be linked by, or might be developing, identified-based trust by sharing the same values in terms of forest management. According to Lewicky (2006), identified-based is a deeper level of trust in which the parties can understand and appreciate one another's wants, making it beneficial

both inside the team and towards the organization. Differently from other management agents, MCF, as a municipal department, manages the forests with the main goal of guaranteeing their benefits for the community. For this reason, it is reasonable that this type of trust corresponds to a positive contribution in terms of organizational readiness. However, it is important to highlight that these results just give a partial indication of the state of relationship and the level of trust. A tailored investigation would be necessary to provide a precise and thorough picture.

Digging more specifically into the FN' state of relationship with MCF, Mission, as the rest of Canada, is undergoing the process of reconciliation with the local indigenous population. At a national level, this process started in 1998, when the Canadian Government issued a statement of reconciliation with Indigenous people (Blackburn, 2007) with the intention of addressing past harms and promoting self-determination and health of indigenous communities over the country (Government of Canada, 2022d). In Mission's context, reconciliation has also taken the form of shared governance in the case of Stave West Forest and Recreation Area. In 2015, Stave West planning team was made of more than 30 people coming from 3 FN, educational institutions, the Province, and other associations, and this partnership has generated concrete and positive results, including an improvement of relationship with at least 3 of the local FN (Rhodes, 2021). The results obtained seem to confirm this trend, expressing a perceived improvement with local FN over the last 20 years. However, also in this case, information is unilateral and therefore partial: no opinions from the FN have been obtained in this work, and a complete assessment requires a specific investigation analyzing a consistent sample from both indigenous and non-indigenous communities.

Eventually, MCF may be in the suitable position as an organization to receive trust from the public. In fact, Peterson St-Laurent et al. (2019) described how different studies' results show that the trust from the public is well-placed toward experts who work on the ground (like foresters and scientists), whilst there is generally a lower level of trust towards the governments, which work on the policy level. This supports the idea that MCF is well-positioned with the public. Since the organization is working on the ground, it could also potentially be a local "bridge" between the public and the policymakers and, in the long run, contribute to increasing the level of trust in the government.

5.3.2. Communication and engagement

Communication represents a critical aspect for adaptation success and can highly influence its adoption and outcomes (Agrawal et al., 2008; Allen et al., 1998; Barr & Lemieux, 2021; Nagel et al., 2017; Sterman, 2011). In fact, there is a widely high consensus about the current occurrence of climate change and its anthropogenic origin, this consciousness has not been transmitted to policymakers and the public, representing a great bottleneck since in democracies public awareness is highly influential on political decisions (Sterman, 2011). For this reason, analyzing MCF strategies for communication represents a crucial element that can play a great role in shaping public support towards MCF adaptation strategies.

As declared during the interviews, MCF communicates with a wide range of channels, and it is considered highly efficient in terms of both frequency and timing when it is related to MCF operations. Communication is mainly carried out with stakeholders involved in operations, the council, and other forestry departments. On the other hand, communication appears to need improvement when it comes to spread information aimed at increasing awareness of MCF or climate change. As claimed by Wu & Lee (2015), increasing civic awareness may actively help make progress on climate change. Some channels that have been suggested by the interviewees to be enhanced include education with kids, interactive activities (like forest tours), and a greater use of social media with the objective of getting MCF closer to the public. Cutter-Mackenzie & Rousell (2019) highlights the urgency of teaching children about climate change because they will be forced to live with its uncertainties, so they need to develop pro-environmental behaviors in order to support a sustainable planet (Ginsburg & Audley, 2020). MCF seems well-suited to educate children on local forests by collaborating with local schools, as the organization has history with such activities. Also the suggestion on an improvement of social media finds support in research: as claimed by Mavrodieva et al. (2019), a consistent number of studies highlight the power of social media as tools, with an existing link between social media use and changes in opinions of climate change – both in positive and negative ways. For the establishment of interactive activities and learning for the community, it could be a remarkable way of solving the likely lack of knowledge about MCF from the public. In fact, during the interviews it has been declared that it is

likely that most of Mission's citizens might not be fully aware of MCF vision and work with the municipal forest. In such a case, two hypotheses can be valid and could also co-exist; the first one is a tacit approval of MCF management from the public, implying that the citizens do not inform themselves about MCF mandate because they trust the forestry department. In the second one, citizens do not have much information about MCF importance at a local level or do have personal reasons (e.g. lack of time) for not getting informed, reasons for which they would not have a relationship with MCF. Building interactive experience may help to overcome this gap, as "there is an intimate and necessary relation between the processes of actual experience and education" (Dewey, 1938, p.7). As suggested during the interviews, public walks in the forests and similar activities may provide such experiences. Another advice given is the construction of a learning center close to the forest, like a museum, if the municipality has or can access sufficient fundings. In such a structure it would be possible to develop simulations related to climate or games about climate change for kids, which are considered two valuable tools by respectively Sterman (2011) and Wu & Lee (2015).

Based on this analysis, MCF seems to possess a good base structure and attitude towards communication, but improvements are needed to increase public awareness about MCF activities and intentions for adaptation. A final recommendation is, as suggested during the interviews, to investigate which channels the public find most accessible so as to increase the chances of efficiently and widely delivering the messages.

5.3.3. Collaboration and collaborative decision-making

Engagement and collaborative decision-making can lead to several advantages, which include (i) producing context-based knowledge (Davis et al., 2021; Olazabal et al., 2018); (ii) facilitate decision-making by increasing the level of trust between the stakeholders and develop commitment and ownership (Halofsky et al., 2018; Peterson St-Laurent et al., 2019). At the same time, collaboration is considered as a necessary process to overcome barriers like the overwhelming scale of climate change, its great uncertainty, and the scientific abstraction (Eisenack et al., 2014; Sheppard et al., 2011). Nevertheless, it is a difficult process that, according to Measham et al. (2011), is rare to achieve, given that different kinds of knowledge are challenging to integrate.

When it comes to MCF context, it has emerged that, although opinions are highly important and welcomed for MCF, collaboration is usually in the form of consultation. This is not perceived as a negative element from the interviewees, especially in relation to MCF forestry operations. However, as explained before, adaptation requires collaboration across scales and organization (Sheppard et al., 2011), the reason for which collaborative decision-making is encouraged. MCF is open to collaborative decision-making and has recently had experience with it through the Stave West Recreational Area. According to Rhodes (2021), this project has required 7 years and has been characterized by complexity. By bringing to the same table different organizations and stakeholders, Stave West Recreational area has resulted in an increase of relationship and trust. Most of all, it has demonstrated the feasibility and the advantages of collaborative decision-making.

For these reasons, MCF seems to be characterized by a good attitude and performance towards collaborative decision-making, which can give a great contribution in terms of organizational readiness.

6. CONCLUSION

The empirical assessment of organizational readiness represents the first step in CCFM framework for adaptation, given its functionality to provide an overview of potential management problems at their root (Barr & Lemieux, 2021; Williamson et al., 2012). Nevertheless, empirical evaluation of this parameter appears as an unexplored field in the literature, and only one study with application of Gray's framework has been found in the Canadian context (Barr & Lemieux, 2021). Therefore, more examples of utilization of this comprehensive methodology are needed to build knowledge and facilitate its future application in different adaptation context.

This work has helped to identify the potential constraints that might hinder MCF from a successful adaptation process. Interestingly, several barriers that have emerged from the interviews revolve around the socio-political level. On the other hand, this assessment has also highlighted those resources that can potentially facilitate MCF to overcome such obstacles. In fact, most of the potential barriers are represented by an insufficient level of certain factors which are already available to the organization, suggesting that MCF can take advantage of the already existing structure and/or elements, either improving them or changing the way they use them. As an example, MCF has been recently increasing its partnership with universities, further expanding its network which is already made up of several types of organizations. This network can be actively used for joint production and integration of localized knowledge, filling the knowledge gap that often hinders adaptation (Kalafatis et al., 2015). Therefore, main recommendations for MCF are summarized in table 5.

In addition to available resources, MCF can rely on several positive elements, which include: (i) MCF perspectives on climate change, which express a willingness to approach adaptation; (ii) MCF values of forest management, which imply the importance for the organization to maintain a good state of the municipal forest for multiple motives (iii) an adaptation-oriented leadership; (iv) a perceived good/improving level of public support from both the council and the indigenous and non-indigenous community, (v) a good flexibility of the organization; (vi) a collaborative-oriented willingness, which has been already implemented in on-the-ground collaboration (e.g. Stave West Recreation Area).

Table 5. Recommendations for MCF emerged from this study assessment. Source: own elaboration.

Specific barrier	Recommendations
Knowledge gap	• Increase collaborative research within MCF network and take advantage of partnership with universities to start monitoring programmes. Developing a polycentric knowledge network seems feasible.
Lack of monitoring	• Access to municipal and/or provincial fundings • Increase collaborative research with network
Low exchange of knowledge about climate change	• Increase/improve communication and public engagement with MCF activities and values. • Interpretative forest • Learning center close to the forest • Guided tours • Increase communication forms or improve current ones
High workload for MCF	• Hiring another person inside MCF
Lack of fundings	• Access funding through already existing network connections or new partnership • Access to provincial fundings through the provision of a business case
Policy inflexibility	• After precisely identifying the policy constraints, combine scientific research with local political lobbying to push the higher level of government for change. This might be challenging, but it has already occurred (Measham et al., 2011).
Low interaction with the community	• Investigate which channels the public prefer for communication • Increase activities with the kids • Increase guided tour and practical activities

However, some result in this work should be treated with caution. In fact, when it comes to assess the level of trust, public support, state of relationship, and engagement, a thorough evaluation is possible only by carrying out a deeper investigation within the public sector in Mission. Therefore, these results can be used as an initial indication of the current state but should be confirmed with a tailored survey. Another limitation to this study is that, due to a limitation in time, some themes that Gray has included in his framework for organizational readiness have not been assessed. Although the study aims to embrace the key elements for the MCF context, the themes that have not been included would potentially offer additional insights and elements of organizational readiness for this system. On the other hand, the open structure of questions has incentivized the interviews to free dialogue, reason for which they have partially managed to provide such insights. This aspect demonstrates how different themes are strongly interconnected.

Eventually, as highlighted in section *4. RESULTS*, few questions have been considered difficult to reply according to the respondents, mainly because of the use of complex language. This emphasizes the importance of plain vocabulary when carrying out this kind of survey, especially with respondents who are not familiar with the topic.

In conclusion, Gray's framework has been a considerably functional base upon which building a tailored assessment of organizational readiness in MCF case, demonstrating its adaptability in a context of community forest. Although more empirical studies are needed, this research contributes to increase our understanding on the application of Gray's framework through the use of open interviews.

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ANNEX

1. **What is the state of knowledge and awareness about climate change and adaptation, and how is this information achieved and managed in Mission Community Forest?**

- What is climate change to you? Have you experienced any impacts of climate change or extreme weather?

- Are you familiar with the concepts of climate change adaptation and risk reduction? Do you consider adaptation necessary to achieve sustainability in future management?

- To which extent does the MCF have access to different sources of knowledge around climate change (e.g. updated scientific knowledge by university, traditional knowledge by First Nations, etc.)? Are the different sources integrated?

- Is MCF carrying out any research (e.g. climate projections, monitoring, etc.) regarding climate change impacts on its ecosystems and community? Is the knowledge gained by research around climate change shared with the community to increase public awareness?

2. **What is the organizational culture and its capacity to address current climate change impacts within Mission Community Forest?**

- What would you identify as the main values and objectives for the MCF in the decision-making and management process? Do you think climate change impacts or increasing weather variabilities are having an effect on achieving current management objectives?

- What is leadership for you? How important do you consider the contribution of leadership to achieve the organization's outcomes? Which elements would you consider for leadership to be essential under climate change uncertainty? Do you perceive that the MCF leadership is characterized by such elements?

- Which tools and resources do you currently have to adapt your management to climate change? Would you consider these resources sufficient for achieving adaptation? If not, would you be open to exploring different options to help adapt to the impacts of climate change?

- Do you perceive any challenges or barriers that may prevent MCF from applying adaptation to management practices?
- How do you perceive the role of the municipal/provincial government regarding climate change? To which extent are they supporting adaptation in your management? Are there any constraints to your decisions due to municipal/provincial government regulations?

3. **How would Mission Community Forest describe the grade of support, trust, and communication at local level?**

- How much do you value trust and public support in your decision-making? What is, in your perspective, the level of trust placed by locals and indigenous communities in the organization?
- Could you describe the state of relationship with locals and surrounding First Nations? What are the key elements, in your perspective, to guarantee a good relationship with the public?
- How much do you value communication with local and indigenous people? To which extent is the organization informing and involving – through the use of channels such as forums – local and indigenous people during the decision-making process?
- Is collaborative decision-making an important aspect for MCF? Is it already practiced? (if yes, how?)

Annex II: OTO questionnaire

1. **What is the state of knowledge and awareness about climate change and adaptation, and how is this information achieved and managed in Mission Community Forest?**

-   What is climate change to you? Have you experienced any impacts of climate change or extreme weather?
-   Are you familiar with the concepts of climate change adaptation and risk reduction? Do you consider adaptation necessary to achieve sustainability in future management?
-   Have you had discussions about climate change impacts with MCF? If so, do you feel that MCF is valuing and integrating different sources of knowledge around climate change - including yours - into their planning?
-   Are you aware of any research (e.g. climate projections, monitoring, etc.) being carried out by MCF regarding climate change impacts on local ecosystems and communities? Is this knowledge shared with you and if so, how has it been shared? Do you feel that MCF is or could be a source of climate change knowledge?

2. **What is the organizational culture and its capacity to address current climate change impacts within Mission Community Forest?**

-   Which are your main values and objectives in terms of forest management? Are you aware of the values and objectives of the MCF? (To which extent do you share them?) Do you think climate change impacts or increasing weather variability are having an effect on management of the MCF?
-   What is leadership for you? How important do you consider the role of leadership to achieve the organization's outcomes? Which elements, in your opinion, should characterize leadership under climate change uncertainty? Do you perceive that the MCF leadership is characterized by such elements?
-   How familiar are you with the management resources and tools of the MCF? Do you consider such management tools and resources sufficient? If not, which actions and resources would you recommend to take in order to facilitate adaptation to climate change?

- Do you perceive any challenges or barriers that may prevent MCF from applying adaptation to management practices?
- To which extent are you supporting adaptation in MCF management? Do you feel that your regulations or consultation are posing constraints to their decision-making?

3. **How would local stakeholders describe the communication and collaborative decision-making of Mission Community Forest at local level?**

- How much do you value communication with MCF? To which extent is the organization informing and involving stakeholders - e.g. through the use of channels such as forums – during the decision-making process? How is your input utilized?
- How would you describe the state of the relationship with MCF? What are the key elements, in your perspective, to guarantee a good relationship with MCF?
- Do you perceive collaborative decision-making as an important aspect for MCF? Is it already practiced with you? (if yes, how?)

		Elements	IMFC102	IMFC401	IMFC061	OTO071	OTO329	OTO105	OTO704
Impacts by climate change		More rain	x	x	x				
		Heavier rain	x						
		Heat dome	x	x	x		x	x	
		Extremely high fire risk/wildfire	x	x	x	x	x	x	
		Trees exposed and needle brown				x		x	
		Lytton					x	x	
		Several days of fire risk	x	x					
		A lot of fire in BC	x						
		Flooding		x			x	x	x
		Loss of roads in other licensees		x					
		Changes are noticeable	x	x					
		No seasonality			x				
		Both personal life and work experience					x	x	
		Danger for workers outside (heat)						x	
		Health							x
Adaptation knowledge and role		Familiarity	x	x	-	x	x	-	x
		Distinction between mitig. and adapt.		x	-	x	x		x
		Example of climate based seed-transfer	x						
		Clear directives from the Province	-						x
		Importance of adaptation for future SFM	x	x	-	x	x		
		Risk reduction familiarity and importance		x	-	x	x	-	-
		Proactive way of thinking		x					
Sources of knowledge for MCF		Province	x		x	x			
		Experts	x	x			x		
		Own weather station	x						
		Online	x	x	x				
		Research papers	x	x	x				
		Web-in-airs, workshops and conferences	x		x	x			
		Universities connections	x	x	x	x	x		
		Traditional knowledge (FN)	x	x		x			
		Environmental groups				x			
		Network and professional associations		x	x				
Research and integration level/needed		Localized information needed	x	x		x	x		
		Need to know more about what's happening	x	x	x		x		
		MCF as a source of input/knowledge and research	x		x	x	x	x	x
		Provincial role for the integration	x	x	o		x	x	
		Level of integration	-						
		Research by MCF around cc		x/-	-	-			x
		Necessity of doing more/starting monitoring		x	x	x			
Discussions around cc and sharing		Knowledge sharing		x/-	-	x		x/-	-
		Discussions around CC				x	x	x	x