



HAL
open science

Models for integrating climate objectives in forest policy: Towards adaptation-first?

Guillaume Peterson St-Laurent, Bruno Locatelli, George Hoberg, Veronika Gukova, Shannon Hagerman

► To cite this version:

Guillaume Peterson St-Laurent, Bruno Locatelli, George Hoberg, Veronika Gukova, Shannon Hagerman. Models for integrating climate objectives in forest policy: Towards adaptation-first?. Land Use Policy, 2021, 104, 10.1016/j.landusepol.2021.105357 . cirad-03920178

HAL Id: cirad-03920178

<https://hal.science/cirad-03920178>

Submitted on 3 Jan 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License



Models for integrating climate objectives in forest policy: Towards adaptation-first?

Guillaume Peterson St-Laurent^{a,b,*}, Bruno Locatelli^{c,d}, George Hoberg^e, Veronika Gukova^a, Shannon Hagerman^a

^a Department of Forest Resources Management, Faculty of Forestry, University of British Columbia, 2424 Main Mall, Vancouver, BC V6T 1Z4, Canada

^b Pacific Institute for Climate Solutions (PICS), PO Box 1700 STN CSC, Victoria, BC V8W 2Y2, Canada

^c Forests and Societies, CIRAD, University of Montpellier, Avenue Agropolis, 34398, Montpellier Cedex 5, France

^d Center for International Forestry Research (CIFOR), PO Box 1558, 15024 Lima, Peru

^e School of Public Policy and Global Affairs, University of British Columbia, C.k. Choi Bldg, 1855 West Mall #162, Vancouver, BC V6T 1Z2, Canada

ARTICLE INFO

Keywords:

Climate policy integration
Joint adaptation and mitigation
Forest management
Adaptation-first model
Conceptual framework
British Columbia

ABSTRACT

Recognizing the potential interactions and synergies between adaptation and mitigation in land-use policies in general and forest policies in particular, research on climate change policy has increasingly focused on integrating both objectives simultaneously (hereafter “interaction model”). However, while support exists for the integration of adaptation and mitigation, very few policies have successfully integrated both objectives in practice (hereafter “separation model”). In addition to the interaction and separation models, we introduce the “adaptation-first model”—an approach to climate policy integration that centers adaptation at the core of forest management, with mitigation as one benefit amongst others—and assess whether it more effectively characterizes the practical realities of forest management than the separation or interaction models. Drawing on a review of policy documents, a survey (n = 48) and interviews (n = 22) with government managers in British Columbia (BC), Canada, we analyze which of the three models have been used for integrating climate objectives into BC’s forest policy and explore views of government managers on the relationships and trade-offs between adaptation and mitigation and which model should be prioritized for their integration into forest management. Our analysis of climate-focused forest policy documents indicates that a possible shift from the separation to the interaction model is taking place in BC. However, our results also indicate that while government managers support the interaction model *in principle*, they perceive numerous barriers to policy integration that may prevent the shift towards the interaction model to materialize *in practice*. Because of the fundamental perceived differences in the levels at which adaptation and mitigation intervene in decision-making, government managers in our study were generally more comfortable with the adaptation-first model, which ultimately suggests the need to rethink how we frame climate integration into forest management and policies.

1. Introduction

Land use and land management play essential roles in mitigating and adapting to climate change. In particular, forests offer substantial opportunities to mitigate climate change by reducing greenhouse gas emissions and increasing carbon removals from the atmosphere (FAO, 2016; IPCC, 2014b). Forests are also vulnerable to climate change and its impacts, including shifts in temperatures and increase in the frequency and intensity of extreme weather events (droughts, storms,

windthrows) and natural disturbances (e.g., insect and disease outbreaks, wildfires and flooding) (IPCC, 2019). Thus, climate-adaptive forest management strategies are critical to enhancing forest resilience to climate impacts (Hagerman et al., 2010; Hagerman and Pelai, 2018; IPCC, 2014a).

In most climate change policies across most sectors, adaptation and mitigation tend to be addressed separately (Grafakos et al., 2020; Spencer et al., 2016; Wilbanks et al., 2003). This separation is reflected in how the Intergovernmental Panel on Climate Change (IPCC) has

* Corresponding author at: Department of Forest Resources Management, Faculty of Forestry, University of British Columbia, 2424 Main Mall, Vancouver, BC V6T 1Z4, Canada.

E-mail address: peterston.guil@gmail.com (G. Peterson St-Laurent).

<https://doi.org/10.1016/j.landusepol.2021.105357>

Received 1 September 2020; Received in revised form 10 January 2021; Accepted 16 February 2021

Available online 25 February 2021

0264-8377/© 2021 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

organized its work since the publication of its third report in 2001. Among the three working groups of the IPCC, one is on adaptation (WG2: Impacts, Adaptation, and Vulnerability), another on mitigation (WG3: Mitigation), and there are limited overlaps between the two. Yet the IPCC increasingly acknowledges opportunities for their integration. In 2001, the WG2 Summary for policymakers had only one section about why "adaptation is a necessary strategy at all scales to complement climate change mitigation efforts." A few years later, the Fourth Assessment Report (2007) included one full chapter (Chapter 18) about "Inter-relationships between adaptation and mitigation," and, in 2014, the WG2 report included a chapter on "climate-resilient pathways: adaptation, mitigation, and sustainable development."

Adaptation and mitigation strategies in the forests interact in various ways, each capable of producing positive or negative outcomes for the other (Morecroft et al., 2019). An example of a 'win-win' outcome for mitigation and adaptation is forest conservation, particularly in the tropics, which provides climate change mitigation benefits that also increase forest resilience by enhancing biodiversity and connectivity (Hisano et al., 2017; Pires et al., 2018; Sakschewski et al., 2016). Conversely, 'win-lose' scenarios can arise when adaptation actions negatively affect mitigation, and vice versa. For instance, reducing wildfire risks through thinning and shorter rotation in industrial plantations provides adaptation benefits, but could also, in some contexts, lessen short-term carbon sequestration in the forests (win for adaptation, loss for mitigation; Couture and Reynaud, 2011). Or fast-growing plantations with high carbon sequestration could create forest landscapes vulnerable to storms and pests (loss for adaptation, win for mitigation; D'Amato et al., 2011). The joint implementation of adaptation and mitigation also has the potential to generate synergies, or a 'win-win+' (i.e., when their combined effect can be higher than the sum of their separated effects) that would not have otherwise existed (Locatelli et al., 2015; Thomas et al., 2013), for instance by increasing access to funding (Locatelli et al., 2016) or public acceptance (Ayers and Hug, 2009).

Recognizing the potential interactions and synergies between adaptation and mitigation, research on climate change policy has increasingly focused on integrating both objectives simultaneously (Di Gregorio et al., 2017; IPCC, 2014a; Ravindranath, 2007). A central emphasis of this line of inquiry is to evaluate whether, how and the degree to which climate objectives have been integrated into other policy domains (Dupont, 2016; Hogl et al., 2015), including the forest sector (Locatelli et al., 2015). From this perspective, adaptation and mitigation are conceived as complementary strategies to be integrated, or at least for which trade-offs need to be assessed to allow for prioritization between the two climate objectives. We refer to this approach as the *interaction model*.

Yet, despite the linkages between adaptation and mitigation activities and attention in the research community for their joint consideration, both objectives are usually treated separately in practice, with very few examples of policies that have successfully integrated both. This lack of integration, which we refer to as the *separation model*, is observed for climate policies in general (Grafakos et al., 2020; Spencer et al., 2016; Wilbanks et al., 2003) and for forest policies specifically (Casado-Asensio and Steurer, 2014; Keenan, 2016; Kongsager et al., 2016; Locatelli et al., 2015). Two main difficulties are common. First, the integration of adaptation and mitigation can increase institutional and decision-making complexity. For example, involving a broader range of affected stakeholders can increase the complexity of trade-offs, and make projects difficult to implement and cost-ineffective (Klein et al., 2005; Kok et al., 2008). Second, seeking integration can generate perverse incentives to neglect activities with the potential to deliver only one climate objective, even if that objective is a crucial one (Moser, 2011). In other words, adaptation interventions do not always have a mitigation component (and vice versa). The desire to prioritize win-win situations can disfavor otherwise effective standalone adaptation or mitigation policy.

So while support exists for the integration of adaptation and mitigation *in principle*, evidence also suggests this integration often fails to materialize *in practice* (Di Gregorio et al., 2017; Thuy et al., 2014). In response, we introduce a new approach to climate policy integration—the *adaptation-first* model—and explore whether it more effectively characterizes the practical realities of forest management and policy. Under this model, adaptation is at the core of forest management, and mitigation represents an important benefit that should be considered and pursued when possible.

In this paper, we use the case study of the Canadian province of British Columbia (BC) to assess three research questions:

- 1) How have mitigation and adaptation been considered and what models—separation, interaction and adaptation-first—have been used for integrating climate objectives into BC's forest policy?
- 2) What are the views of government managers on how adaptation and mitigation have been integrated into BC's forest policy?
- 3) How do government managers perceive the relationships and trade-offs between adaptation and mitigation, including views about which of the three models should be prioritized for integrating climate objectives into forest management?

Based on a review of policy documents, a web-based survey (n = 48), and semi-structured interviews with government managers (n = 22), we examine two specific propositions: (1) there has been an evolution in policy instruments from the separation model to the interaction model, and (2) in practice, government managers and policymakers are struggling to work with the interaction model and are more comfortable with the adaptation-first model.

BC represents an ideal jurisdiction to explore these enquiries because it has a highly-developed and active forest sector that recognizes forests' mitigation potential (Peterson St-Laurent et al., 2017b, 2018). At the same time, the forest sector also increasingly acknowledges the urgent necessity to identify and implement strategies to adapt to the impacts of the rapid and unprecedented changes in climate that are increasingly impacting BC's 55 million hectares of forests (Pelai, 2019; Peterson St-Laurent et al., *In press*). Recent severe natural disasters (e.g., insect outbreaks, wildfires), which are considered "the new normal" in BC (Abbott and Chapman, 2018), have resulted in a shift from a carbon sink to source in 2003, and the forests have emitted more greenhouse gases than they sequestered ever since (BC MOE, 2019).

2. Conceptual background

2.1. Climate policy integration for forest policy

Scholarly attention to climate policy integration has multiplied in recent years (Adelle and Russel, 2013; Hogl et al., 2015). While recent studies have delved into integrating adaptation and mitigation objectives when developing policies (e.g., Casado-Asensio and Steurer, 2014; Thuy et al., 2014), most research on climate policy integration has focused on mainstreaming either climate change adaptation or mitigation objectives into and across sectoral policies (De Roeck et al., 2018; Dupont, 2016; Urwin and Jordan, 2008). In response to this research gap, Di Gregorio et al. (2017) proposed a conceptual framework for analyzing climate policy integration that explicitly considers the interactions between mitigation and adaptation. In their framework, they define climate policy integration as "the integration of multiple policy objectives, governance arrangements and policy processes related to climate change mitigation, adaptation and other policy domains" (p 36). Di Gregorio et al. (2017) describe climate policy integration as the combination of two concepts: (1) policy coherence and (2) policy integration.

Policy coherence refers to the "policy outputs and outcomes, or the consistency of multiple policy objectives and associated implementation arrangements." Internal policy coherence comprises integrating climate

change mitigation and adaptation into climate policy, whereas external policy coherence refers to mainstreaming climate change mitigation or adaptation efforts into broader non-climate policies. Policy integration is defined as “the governance arrangements (administrative and organizational structures) and policy-making processes.” Vertical policy integration focuses on the adoption of measures enabling the adoption and implementation of climate change objectives across multiple levels of government within a given sector or policy regime—in this case forest management. Evidence of vertical policy integration includes sectoral climate change plans with targets, timetables, and reporting requirements. In contrast, horizontal policy integration focuses on the institutional interactions between sectors and the extent to which policy objectives are incorporated across multiple sectoral domains. An example of horizontal policy integration includes the development by a central authority of cross-sectoral climate strategies establishing overarching goals, sectoral responsibilities and reporting requirements.

In this paper, we focus on internal policy coherence within the forest sector (i.e., vertical policy integration; highlighted in blue in Fig. 1). While not the main focus of this paper, we occasionally discuss other quadrants of the Climate Policy Integration framework.

2.2. Three models for considering adaptation and mitigation in the forest policy sector

This study assesses how three models for integrating climate objectives into forest climate policy have been used in BC, and how these models are perceived and discussed by government managers (Fig. 2). First, arguably the most widespread model of climate change in forest management and policy is the consideration of mitigation and adaptation as two independent objectives that are treated separately (Kok et al., 2008; Locatelli et al., 2011). The separation model reflects how the IPCC has divided its scientific assessments and reports into adaptation and mitigation. There are two variations to the separation model. A mitigation-only focus emphasizes how to manage forests to increase their role as carbon sinks and reduce greenhouse gases emissions (Canadell and Raupach, 2008; Dugan et al., 2018; Griscom et al., 2017). In contrast, an adaptation-only focus emphasizes how to manage forests to reduce their vulnerability and increase their resilience, to allow them to adapt to the current and projected impacts of climate change and to ensure the continued provision of goods and services to society (Hagerman and Pelai, 2018; Millar et al., 2007). Initiatives focused on forest carbon offsets and projects aimed at reducing deforestation and forest degradation in developing countries (or REDD+) are good examples of mitigation-only separation model (Buizer et al., 2014; Pistorius, 2012), whereas wildfire management (Miller et al., 2020) or seed sourcing programs (Aubin et al., 2016; Conroy et al., 2019; Park and Talbot, 2018) exemplify the adaptation-only separation model.

1. “Separation” model



2. “Interaction” model

Tradeoffs, synergies, prioritization



3. “Adaptation-first” model



Fig. 2. Three models for considering climate change in forest policy.

Second, under the interaction model, both climate objectives are considered simultaneously during the design and implementation of forest management strategies. There are two versions of the interaction model. First, the focus can be placed on complementarity and how forests can be managed to reduce trade-offs between adaptation and mitigation and increase synergies (Locatelli et al., 2011, 2016). The main objective of such an approach is to reduce vulnerability and store carbon simultaneously, or create a desirable mix of the two outcomes. Second, when trade-offs are unavoidable, the interaction model can lead to “prioritization,” meaning that the most important objective(s) (i.e. adaptation or mitigation) should be identified and prioritized. This means that adaptation is prioritized in some areas and mitigation in others depending on opportunities (e.g., REDD in humid tropical forests

Policy integration

		Vertical (within the forest sector)	Horizontal (across sectors)
Policy coherence	Internal (climate policy)	Integrating mitigation and adaptation objectives into climate policy within the forest sector	Integrating mitigation and adaptation objectives into climate policy across sectors
	External (non-climate policy)	Mainstreaming mitigation and adaptation into broader non-climate policy within the forest sector	Mainstreaming mitigation and adaptation into broader non-climate policy across sectors

Fig. 1. Summary of Climate Policy Integration. The blue section highlights the focus of this paper. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.) Adapted from Di Gregorio et al. (2017).

under deforestation threats) and challenges (e.g., climate-related risks with fires or pests) (Laukkonen et al., 2009; Thuy et al., 2014).

Third, under the adaptation-first model, adaptation is placed at the core of forest management to ensure forest persistence or transformation and the delivery of ecosystem services and nature's contributions to people, including mitigation as well as other benefits such as timber production, aesthetic, cultural recreational and spiritual values and watershed protection. The main distinction with the separation (i.e., either adaptation or mitigation) and interaction (i.e., trade-offs, synergies and prioritization) models is that adaptation is considered an intrinsic and crucial component of forest management that ultimately allows for mitigation. It is different from the adaptation-only separation model because adaptation is not treated separately from mitigation; on the contrary, it is perceived as a necessary means to accomplish mitigation. And it is different from the interaction model because there is no need to consider the trade-offs between both climate objectives as adaptation is perceived as inherent to any forest management decision. Both models encourage the joint consideration of adaptation and mitigation, but the adaptation-first model places adaptation at the core of management because it is perceived to be needed to ensure the delivery of ecosystem services, including mitigation. In this model, the trade-offs and synergies occur more between the multiple benefits provided by forests (e.g., mitigation vs water regulation) rather than between adaptation and mitigation.

3. Methods

3.1. Data collection

We used a mixed-methods approach that included qualitative and quantitative data collection, specifically (1) document review, (2) an online survey and (3) semi-structured interviews of government managers. The survey and interviews elucidate the views of government managers' perceptions so as to better understand the dominant model for considering adaptation and mitigation in the main government agencies involved with forests and their management. This decision means that our results are not representative of the broader forest sector, which includes other influential actors such as private forest companies, Indigenous Peoples and non-governmental organizations.

Data collection focused on the two leading BC government agencies responsible for climate policy in the context of forest management: (1) Ministry of Forests, Lands, Natural Resource Operations and Rural Development (hereafter referred to as "Ministry of Forests" for simplicity) and (2) the Ministry of Environment and Climate Change Strategy. The provincial government owns approximately 95% of forested lands and has near-exclusive jurisdiction over forest management (Luckert et al., 2011). The Ministry of Forests is responsible for most matters related to land management, forests and their management. Second, the Ministry of Environment and Climate Change Strategy is responsible for environmental and climate policy. The Climate Action Secretariat, within the Ministry of Environment and Climate Change Strategy, is responsible for leading and coordinating research on and the analysis, development and implementation of programs, policies and legislation on climate change in the province. Before data collection, we requested authorization from the BC government to distribute our survey and conduct interviews with government managers. We were assigned a government liaison to help us identify potential participants.

We carried out a detailed review of key publicly available climate-focused policy documents related to forests and their management (e.g., legislation, programs, standards and strategies). The content analysis focused on analysing how adaptation and mitigation are considered and integrated (or not) into the main objective(s) presented in the policy documents. We selected the policy documents based on results from the interviews (see below) and in consultation with our government liaison.

The objective of the online survey was to quantitatively assess overall trends in the views of government managers on whether and how

adaptation and mitigation are considered in forest policies in BC. The questionnaire was comprised of 35 questions, including multiple-choice, rating scales and open-ended questions. For survey inclusion criteria, we defined government managers broadly as individuals who have some authority over forest policy, scientific research (i.e., government scientists) or on-the-ground decision-making about forest management (provincially or regionally). We created a list of potential respondents using a publicly available government online directory (<https://dir.gov.bc.ca>). We attempted to identify all government managers who directly or indirectly work towards the development or implementation of climate change mitigation or adaptation policies or programs in BC's forests. We distributed the online survey link (Qualtrics; <https://www.qualtrics.com>) by email to 198 government managers between January 15th and February 28th, 2019. We collected 48 completed surveys (24% completion rate). Most respondents completed multiple choice and rating questions, whereas open-ended questions received a lower completion rate.

Definitions for all key terms were provided at the beginning of the survey. We defined climate change mitigation as changing human activities to reduce further climate change impacts by reducing greenhouse gas emissions to the atmosphere (i.e., carbon sources) or increasing carbon removals from the atmosphere (i.e., carbon sinks). In contrast, we defined climate change adaptation as actions to help forests and society adjust and prepare for the actual or expected change in climate and its impacts. Respondents then answered questions about (i) the importance and consequences of considering adaptation and mitigation objectives together when developing forest management policies, (ii) existing adaptation and mitigation forest management policies in BC (identified during interviews and with government liaison), (iii) how well these policies consider adaptation and mitigation objectives together, (iv) barriers to considering adaptation and mitigation objectives together into climate and broader non-climate forest management policies, and (v) potential outcomes of forest management interventions for adaptation and mitigation if they were implemented in BC's forests.

In addition, the primary author conducted 22 semi-structured interviews (17 in-person, five over the phone) between January and April 2019 with key informants from the two key government agencies. The purpose of the semi-structured interviews was to gain an in-depth and more nuanced understanding of the views of managers regarding climate change and how it is integrated within BC's government agencies and forest policy. Interview topics include climate change adaptation and mitigation policies in BC's forests, the extent to which the two objectives are considered and implemented within forest policy and the challenges and opportunities associated with different models of climate change. In contrast to the broad selection criteria used for the survey, we only selected interviewees who had been directly involved in the design and/or implementation of climate change adaptation or mitigation policies. We purposefully selected potential interviewees using a list provided by our government liaison and identified additional participants through iterative sampling (i.e., our participants helped us recruit other government managers playing critical roles in forest climate policy). Because the survey was anonymous, we do not know how many interviewees also completed the survey. Interviews were audio-recorded and transcribed verbatim.

3.2. Data analysis

We used descriptive statistics (i.e., means and frequencies) to summarize the results from the multiple-choice and rating survey questions. We coded policy documents, answers to open-ended survey questions and verbatim transcripts from interviews using the qualitative analysis software NVIVO (version 12). We used a deductive content analysis approach to categorize recurrent themes and subthemes (Elo and Kyngas, 2008) based on the three models of climate integration introduced above and the propositions being explored. Thus, coding categories included how climate change objectives are considered in forest

policy, the extent to which climate change adaptation and mitigation are considered and integrated into current BC forest policy, and the primary model used by interviewees when discussing mitigation and adaptation. We present quotes to illustrate central themes and, when appropriate, use proportions to show how many respondents discussed specific themes. To preserve confidentiality, we identify interview respondents with numbers (R1-R22).

4. Results

4.1. How is climate integration represented in BC's forest policy documents?

Our document analysis indicates that older climate-focused forest policy instruments (pre-2015) are best described by the separation model, focusing on either mitigation or adaptation (Fig. 3, Table 1). However, four out of the five latest policy documents considered adaptation and mitigation together, indicating a possible shift towards the interaction model.

4.2. Views of government managers on how adaptation and mitigation have been integrated into BC's forest policy

A majority of survey respondents (57%) disagreed or strongly disagreed that current BC climate forest management policies adequately consider climate change adaptation and mitigation objectives together (i.e., interaction or adaptation-first models). A minority (18%) agreed or strongly agreed with the statement (Supplementary Material 1). Even fewer survey respondents (8%) agreed or strongly agreed that the BC government has developed a comprehensive cross-sectoral strategy to consider both mitigation and adaptation objectives in forests, whereas more than half (58%) disagreed or strongly disagreed. Survey respondents were also asked to indicate what climate objectives are pursued by specific publicly available government legislation, programs, standards or strategies (Table 1). The results suggest discrepancies between respondents' opinions and the content of older instruments (as highlighted by our document analysis), whereas most recent policy instruments (since 2015) were more accurately assessed (Table 1). Survey results also indicate that government managers believe that many policy instruments that adopt a separation model still pursue both climate objectives. For instance, 42% of respondents indicated that the Climate

Based Seed Transfer pursue both adaptation and mitigation even though the program was developed based on the adaptation-only separation model.

During the interviews, approximately half of respondents highlighted efforts and improvements made towards better integration. Many praised the creation and recent outcomes of new climate programs/projects. For instance, a respondent closely involved with the Forest Carbon Initiative—a program focused predominantly on mitigation—indicated that adaptation is being integrated into most projects:

We are constantly looking for ways to combine adaption and mitigation. My gold-star theory is that actions that mitigate and adapt at the same time are the top priority actions. Even though they might be more expensive, we have to make sure we're doing both at the same time if we can (R19).

In contrast, the other half of interviewees was very critical, indicating that not enough efforts were made towards climate actions, let alone considering the interactions between adaptation and mitigation:

We have not figured out how to do the adaptation or mitigation pieces independently. So how do you integrate them if they are not fully being implemented separately (R8)?

Results from the survey and interviews highlighted four key barriers believed to prevent the effective integration of adaptation and mitigation into forest policy—and thus the adoption of the interaction or adaptation-first models. First, most respondents discussed deficiencies in the provision of high-level guidance on climate change, particularly by criticizing the absence of a comprehensive climate plan with targets, timetables and measuring and reporting requirements. Respondents did note that departments and regional offices often compensate this shortcoming by having their own programs and climate committees, but that the outputs of these initiatives (e.g., internal reports and plans) are rarely made public:

To my knowledge, documents have not been published publicly, because nobody wants to give the impression of making commitments. When you're not willing to make things publicly available, they are not really all that meaningful (R6).

Many respondents also indicated that neither adaptation nor mitigation is integrated into BC's most influential forest-related legislation

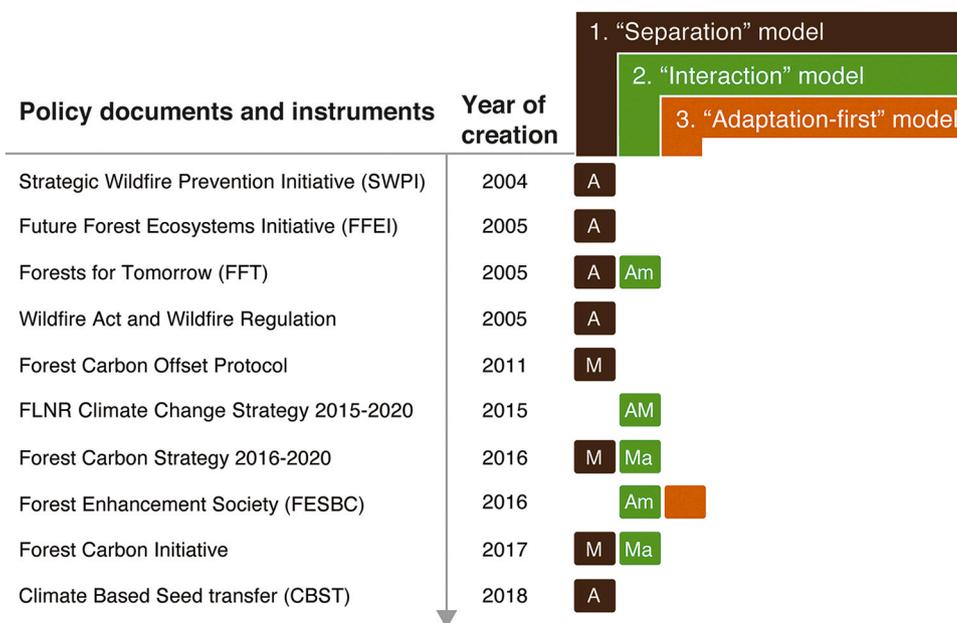


Fig. 3. Trends in the use of the three models for considering adaptation and mitigation in forest policy. The letters “A” and “M” refer to the adaptation-only or mitigation-only versions of the separation model, respectively; “Am” and “Ma” refer to the versions of the interaction model that prioritize adaptation or mitigation, respectively; AM refers to the version of the interaction model that considers the complementarity between adaptation and mitigation (see Fig. 2 and corresponding text).

Table 1

Summary of the main objective and model(s) that have been used for integrating climate objectives into BC's climate-focused forest policy documents since 2004. The last column shows the percent of survey respondents (n = 39) who classified each government legislation, program, standard or strategy based on whether they pursue (1) mitigation, (2) adaptation, (3) mitigation and adaptation, or (4) neither objectives.

Policy documents/ instruments	Year of creation	Main objective(s)	Models(s) for considering climate objectives (primary model bolded)	Survey respondents' (n=39) views on pursued objective(s)
Program: Strategic Wildfire Prevention Initiative (SWPI)	2004	It provides a suite of funding programs to "support communities to mitigate risk from wildfire in the wildland urban interface" (UBCM, 2012)	Separation model (Adaptation only)	M: 32% A: 24% M&A: 18% Neither: 3% Don't know: 24%
Program: Future Forest Ecosystems Initiative (FFEI)	2005	"To adapt B.C.'s forest and range management framework to a changing climate" (MFR, 2008).	Separation model (Adaptation only)	NA
Program: Forests for Tomorrow (FFT)	2005	Reforestation program "to respond to the catastrophic wildfires that occurred in the southern and central interior, and to the mountain pine beetle epidemic" and to "improve future timber supply, and addressing risks to other forest values" (MFLNRORD, 2020)	Separation model (Adaptation only) Interaction model* * Over time, the FFT has been increasingly framed as providing both adaptation and mitigation benefits.	M: 21% A: 26% M&A: 45% Neither: 5% Don't know: 3%
Legislation: Wildfire Act and Wildfire Regulation	2005	"Specify responsibilities and obligations on fire use, wildfire prevention, wildfire control and rehabilitation" (Government of BC, 2020)	Separation model (Adaptation only)	M: 24% A: 16% M&A: 5% Neither: 27% Don't know: 27%
Standard: Forest Carbon Offset Protocol	2011	Outlines the rules regulating forest carbon offsets to "guide the design, development, quantification and verification of B.C forest carbon offsets from a broad range of forest activities on private and public land in B.C." (BC MOE, 2015)	Separation model (Mitigation only)	M: 55% A: 5% M&A: 3% Neither: 5% Don't know: 32%
Strategy: FLNR Climate Change Strategy 2015-2020	2015	"Adapting to, and mitigating climate change in the natural resource and heritage sectors requires an understanding of the potential long-term impacts of climate change, variability and the significance of the actions we take or forego today" (MFLNR, 2015)	Interaction model	M: 5% A: 5% M&A: 74% Neither: 3% Don't know: 13%
Strategy: Forest Carbon Strategy 2016-2020	2016	"Outlines current and planned initiatives by the Ministry of Forests, Lands and Natural Resource Operations (FLNRO) to manage forest carbon and improve the sustainability of B.C. forests, communities and industry while mitigating the effects of climate change" (BC MRLNRO, 2016)	Separation model (Mitigation only) Interaction model* * The strategy mainly focuses on mitigation, but it also acknowledges the importance of, and the synergies with, adaptation. For instance, one of the main categories of mitigation strategies include: "Create forests that are more resilient to changes in climate suitability, pathogens, invasive species, drought, and wildfire"	M: 40% A: 5% M&A: 37% Neither: 3% Don't know: 16%
Program: Forest Enhancement Society (FESBC)	2016	Fund projects to "enhance forest resilience to wildfire and climate change for the lasting benefit of British Columbia's environment, wildlife, forest health, and communities" (FESBC, 2018). Types of projects include "forest carbon, stand rehabilitation, fiber recovery, habitat enhancement and wildfire risk reductions.	Interaction model Adaptation-first model* * Adaptation is required for all types of projects, with some types of projects having mitigation as a co-benefit. However, one project type, referred to as "carbon project" on the program's website, focuses mainly on mitigation (e.g., using uneconomic residual fiber to avoid pile burning emissions).	M: 29% A: 13% M&A: 50% None: 5% Don't know: 3%
Program: Forest Carbon Initiative	2017	Take a "portfolio approach to enable a range of forest carbon projects and activities across the province, including reforestation, fertilization, increased fiber utilization and tree improvement projects" (Government of BC, 2019).	Separation model (Mitigation only) Interaction model * Mitigation is the main focus of the program, but the "tree improvement" type of projects has both mitigation and adaptation components: "plantations established with improved seed grow faster, are better matched to the future climate and in some cases are more resistant to pests."	M: 42% A: 3% M&A: 42% None: 3% Don't know: 11%
Standard: Climate Based Seed Transfer (CBST)	2018	"Promotes healthy, resilient and productive forests and ecosystems through the matching of seed sources (seedlots) to climatically suitable planting sites.	Separation model (Adaptation only)	M: 3% A: 50% M&A: 42% None: 3% Don't know: 3%

(i.e., Forest Act and Forest Range and Practices Act):

We have not pulled the policy levers on neither adaptation nor mitigation, and they are not being translated into ground-level operations. We are still stuck in an old paradigm that has not sufficiently shifted to align with these objectives as they have not become legislation yet (survey respondent).

Respondents generally agreed that including climate into forest

legislation would compel forest tenure holders to manage forests for climate objectives:

To create that objective, you'd need to prescribe it in a regulation and the act [...] My experience is that unless you prescribe something and require people to do it, you're not going to consistent results (R8).

Second, many respondents pointed out the lack of effective coordination on climate actions between branches and divisions within the

same ministry and between ministries. Respondents notably drew attention to “disciplinary silos”—groups working in isolation on very narrow areas of forest management and climate change—which were blamed for hindering learning, collaboration and coordination. The case of harvest residue utilization and wildfire prevention exemplifies the challenges associated with inadequate coordination. Certain government divisions are attracted by the mitigation opportunities of increasing utilization of harvest residues to produce wood products or bioenergy instead of burning them on-site. Yet others fear the potential fire hazard associated with this practice, particularly since the piles of harvest residues are often left on site for extended periods before they are collected and used. In particular, the agency responsible for managing wildfire (the BC Wildfire Service) has been reportedly intransigent in ensuring its mandate of slash burning residues after harvest. Respondents explained that this divergence in opinion leads to tension, conflict, lack of communication and an inability to collaborate and explore synergies between adaptation and mitigation.

Third, respondents stressed the importance of prioritizing climate change objectives at every level of government, an aspect that many believe was overlooked in recent years. The lesser priority allocated to climate change in recent governments was identified as leading to lower funding and resources allocated for climate adaptation and fewer high-level directives on climate actions:

There has not been any direction or clarity in using those categories [adaptation and mitigation] with the latest governments. I would say that climate change is not a priority (R5).

Respondents also discussed the diverging priority given to adaptation and mitigation objectives, generally agreeing that the government’s priority—at least in terms of funding—has recently shifted from adaptation to mitigation, particularly with the creation of the Forest Carbon Initiative. This discrepancy ostensibly generates “internal competition between the mitigation and adaptation ‘people’, with more money in mitigation and adaptation being ignored” (R6). Many respondents also criticized the timber-centric orientation of BC’s forest sector and the prioritization of timber production over other values, including climate change adaptation and mitigation:

It’s time that we focus on values of importance in addition to economic timber in the province. If we want to manage sustainably over the long-term, we have to take climate change into account. It’s all about policy and what we are managing for. As that changes, it will drive us to change practices (R7).

Fourth, a majority of respondents believe that economic circumstances—both in terms of funding availability and cost of implementation—also prevent the adoption of the interaction model for the integration of adaptation and mitigation. The recent shift in focus from adaptation to mitigation made it particularly challenging to secure funding for activities with adaptation components:

We got funding cut back for adaptation. It’s kind of a pendulum. When adaptation was all the focus, and climate action plans were being developed, my branch made sure that mitigation was in there as well. And now the carbon is the focus, it’s getting all the money, so we’re making sure adaptation is in there as well” (R18).

The expected costs and economic returns generated by climate interventions—mitigation, adaptation, or both—also influence their uptake. Options that increase the costs of doing business are expected to receive objections from the forest industry, whereas interventions with no or positive economic impacts will be supported. Respondents indicated that mitigation activities generally have the potential to generate economic benefits (e.g., through the sale of carbon credits from offset projects).

The tendency is always to look at things and say, ‘How can we make money out of this? How can we look at things as an opportunity rather than a challenge?’ Given that there are significant funding pots for mitigation, and people can make money, adaptation is being ignored. Our bias towards cost-recovery gets in the way of looking at useful things (R6).

In contrast, while respondents stressed the economic importance of adaptation (e.g., avoided loss), they explained that the upfront costs of implementing such approaches represent an issue in a sector where cost-recovery is fundamental. Views on the relationship and trade-offs between adaptation and mitigation and which model should be prioritized for their integration.

A vast majority of survey respondents indicated that the effect of considering adaptation and mitigation objectives together when developing forest management interventions in BC’s forests is positive (38%) or very positive (43%), with very few respondents saying that it is neutral (11%), negative (6%) or very negative (2%). Most indicated that adaptation and mitigation objectives should always (40%) or most of the time (43%) be considered together when developing forest management interventions against a minority for never (4%) or sometimes (13%). Similarly, 21 out of 22 interviewees emphasized the importance of integrating adaptation and mitigation, some even mentioning that the two objectives “go hand in hand” (R7) and are “fundamentally linked” (R9). However, some respondents also acknowledged that while it is theoretically necessary to integrate both objectives, it is also “potentially too complex in most areas of BC” (R12). A few interviewees drew attention to the common trade-offs associated with any climate-focused interventions in the forests:

Some [projects] might be 90% adaptation and 10% mitigation; others will be the other way around. Everything is a trade-off. Probably every action can be characterized as covering both objectives (R14).

Even though respondents emphasized the importance of integrating adaptation and mitigation, the vast majority of examples of possible benefits and risks of doing so focused predominantly on the impacts of adaptation actions (or the lack thereof) on mitigation; for example, how enhancing resilience to natural disturbances like wildfire and insect outbreaks also increases carbon sequestration. Apart from a few examples (e.g., increased possibilities for funding or increasing public support), respondents rarely highlighted the positive effects of mitigation on adaptation. They did, however, discuss ways in which mitigation actions can negatively affect adaptation, for instance, how carbon plantations can reduce resilience to natural disturbance or how different harvesting strategies can generate wildfire risks. Very few examples focused on the synergies or competition of implementing both objectives together.

Figure 4 shows what survey respondents expect would be the outcomes of 14 different forest management interventions on (1) adaptation and (2) mitigation if they were implemented in BC’s forests.¹ On average, survey respondents attributed positive outcomes for adaptation and mitigation objectives to 11 forest management interventions. Interventions such as climate-based seed transfer, enhancing forest landscape diversity and connectivity, increasing afforestation and rehabilitating forests after natural disturbances all received high scores for both climate objectives. In contrast, three interventions—using harvest residues to produce bioenergy, reduce the area available for harvesting, and suppress wildfires—were thought to generate substantial positive mitigation, but adverse adaptation outcomes.

We identified three recurring principles that interviewees conveyed in support of the adaptation-first model (Table 2). First, all but four

¹ This question’s results should be considered with caution due to the small sample and because the possible outcomes of the forest management interventions are case-specific and depend on different circumstances (e.g., forest types, climate, geography).

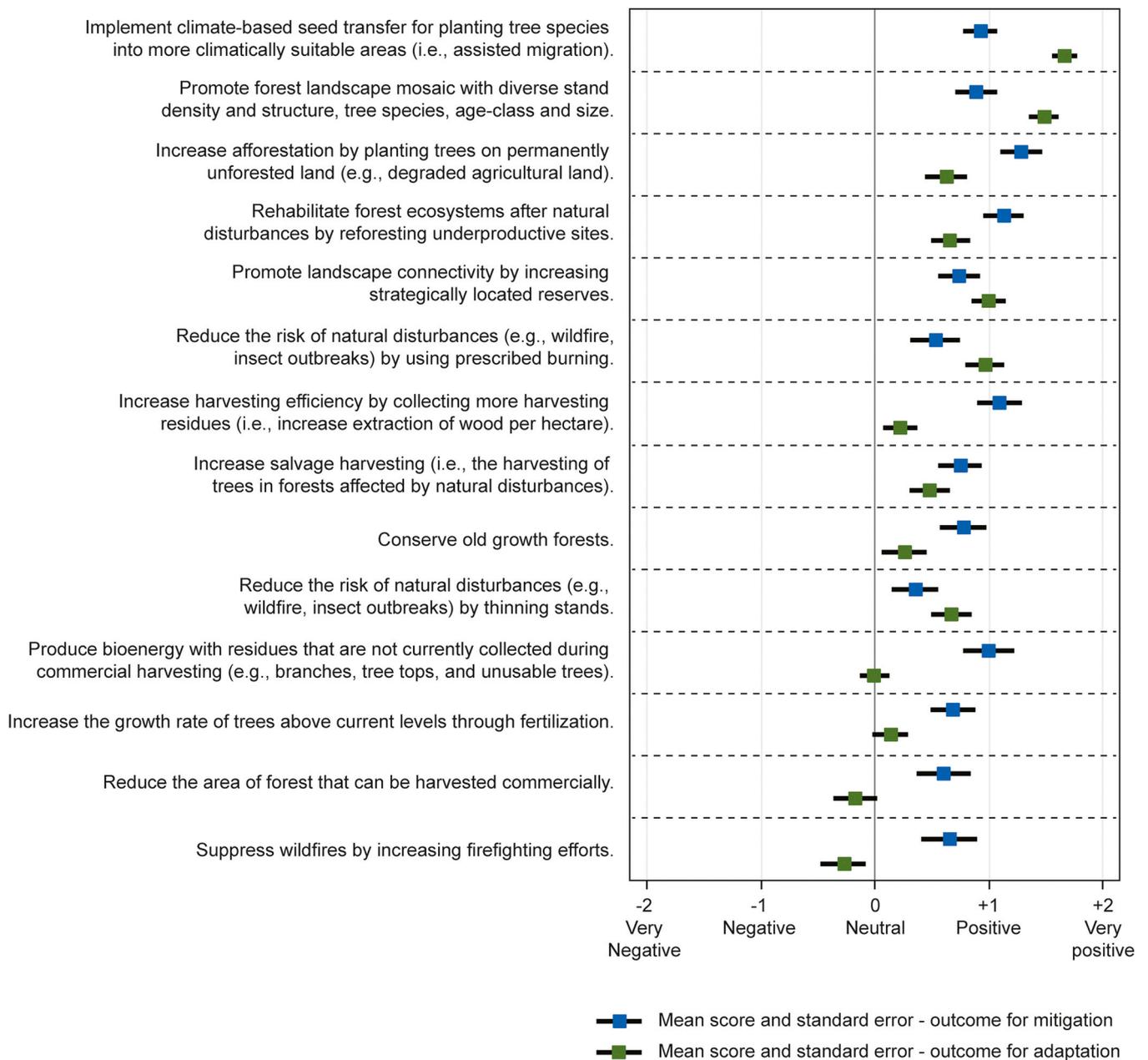


Fig. 4. Forest plots showing mean scores and standard errors of survey respondents' views on the outcomes that would have 14 forest management interventions on adaptation and mitigation objectives if they were to be implemented in BC's forests, using a scale from -2 = very negative to 2 = very positive. Each respondent evaluated half of the forest management interventions (randomly assigned; n = 24 for each intervention).

interviewees identified adaptation as a prerequisite to mitigation. This *prerequisite principle* encapsulates the assumption that mitigation cannot happen without adaptation. Second, about three-fourths of respondents indicated that climate change is increasingly impacting BC's forests and that it is becoming imperative and *urgent to consider adaptation*. Third, 55% of interviewees presented *mitigation* as a vital *co-benefit of adaptation*. As co-benefit, mitigation is perceived as an essential benefit of adaptation that should be pursued whenever possible, with the condition that it does not negatively impact adaptation.

5. Discussion

5.1. From a separation to an interaction model in forest policy?

In contrast to studies in other regions of the world (Berry et al., 2015; Di Gregorio et al., 2017; Suckall et al., 2014; Thuy et al., 2014), our

analysis of forest policy documents suggests that a shift from the separation model towards the interaction model and the joint consideration of adaptation and mitigation objectives is progressively taking place in BC's forest policy, thereby confirming our first proposition (Table 1, Fig. 2). Since 2015, all climate policy instruments except for the Climate-Based Seed Transfer have adopted an interaction model to an extent. Even the Ministry of Forests' Forest Carbon Strategy 2016–2020, which by nature focuses on mitigation, acknowledges the importance of, and the synergies with, adaptation.

However, despite the increasing number of climate-focused forest policy instruments that adopt the interaction model, few government managers believe that both climate objectives are effectively integrated into forest policy. A recent review of Canadian forest management identified three categories of barriers—harmonization, enabling and implementation—to integrated consideration of adaptation and mitigation (Williamson and Nelson, 2017). In our study, government

Table 2

Quotes from the interviews (n = 22) illustrating the three dominant principles in support of the adaptation-first model. Numbers in parentheses refer to counts of interviewees that used each principle.

Principle 1: Mitigation cannot happen without adaptation (n = 18)	Principle 2: We urgently need adaptation (n = 16)	Principle 3: Mitigation is a co-benefit of adaptation (n = 12)
“I don’t think adaptation is a value that’s equal to carbon. I think adaptation is what ensures that you get the stream of benefits from forests. And if you don’t adapt, you’re not getting any of them (R11).”	“The risk factor is probably the biggest thing that we’re dealing with right now. I can’t even think of a single project or program that’s not being affected by ecosystem changes. [...] We have to assess risk and consider adaptation in order to avoid that (R1).”	“Every adaptation measure is mitigation: For example, seed transfer, by changing the trees, you can actually affect how this tree sequester carbon in the long term. More adapted forests are better for the climate (R5)”
“There’s such heightened attention on forest carbon. If you’re only focusing on that and optimizing that value, you end up creating choices; you could choose things that are counter-productive for other values. I think we need to consider adaptation first. And then- carbon is a co-benefit of different adaptation choices that people have (R10).”	“With adaptation, we are trying to look at forest health and see what diseases are increasing. For example, it’s predicted that <i>Armillaria</i> [a forest pathogen] in the south will increase. We have to say “how do we adapt to that?” The forest health is an important factor as well. And also fires. What species do we use, preserve? Which ones are more fire resistant than others? That’s all part of how we should look at forestry, using a holistic vision with adaptation at its core (R3).”	“The Climate Based Seed Transfer improves forest health, and with this you generate mitigation. Mitigation is a direct benefit of adaptation, but mitigation is not always necessarily good for adaptation and can lead to some issues (R8)”
“If you don’t consider adaptation, your forest carbon management strategy might fail. In my view, adaptation is the best mitigation strategy to pursue. If we’re not planting the right species densifying forests so that they are more susceptible to fire, we’re increasing exposure. I think it is essential that they [adaptation and mitigation] be considered together. Even to the point where you might say, “Prioritize the adaptation benefits (R13).”	“The reality of forestry is that you can invest in forest management, but you can’t guarantee that you’re going to realize a return on that investment because of insects, fires, and diseases. And we saw that quite evidently with the mountain pine beetle outbreak. A lot of the stands were killed (R8).”	“If we keep our trees healthy and growing well through adaptation, we will sequester carbon faster. And those actions that we take to adapt, to keep tree species healthy, to ensure that they’re growing in suitable places, to protect against insect and disease and wildfire, all of those things are helpful in regards to keeping more carbon on the land base (R7)”
“If we’re doing mitigation, let’s say we plant a bunch of trees in the Cariboo region to recover from the 2017 and 2018 wildfires, those trees are going to a) have to survive the short-term to become established, and b), in the long-term, the growth and yield and risk of disturbances, say pathogens and insects, will depend on what is planted. Adaptation and mitigation are fundamentally linked, but adaptation is at the core (R9).”	“We have rapidly changing conditions and adaptation is needed. Fire occurrences are becoming more common and bigger. (R12).”	“Working on reducing wildfire risk is actually helpful in terms of carbon because you’re potentially lowering emissions by making it easier to put out fires when it’s July and its 35 degrees and its droughty. We don’t have the modeling that can show the absolute benefit in terms of GHG benefits, but it’s clear that the numbers are substantial (R19).”
“Let’s take seedlings, for example. We plant seedlings, which sequester carbon and thus part of mitigation. If we plant the wrong seedlings because they are not adapted to climate change, they will die. So, if the two [adaptation and mitigation] aren’t hand-in-hand, it simply won’t work (R3).”	“I think there’s a feeling among BC’s foresters that they’d like to do something about climate change if they can to help keep forests healthy as the climate changes. So there was no fighting about the Climate Based Seed Transfer. People see the urgency and want to help (R10).”	

managers discussed similar barriers that explain the persistence of the separation model in BC’s forest policy.

One recurrent reason is the lack of clear high-level guidance and integration of climate change into legislation. For instance, including climate into the main forest legislation (Forest Act and Forest Range and Practices Act) or adopting more comprehensive rules for accounting of forest-related emissions (both options are discussed in details by [Hoberg et al. \(2016\)](#)) would send clear signals and incentives to manage forests for both mitigation and adaptation.

While our study highlights effective collaborations between different divisions and programs, it also identifies an organizational culture that is siloed and compartmentalized, another barrier that is often associated with ineffective climate policy integration ([Casado-Asensio and Steurer, 2014](#); [Williamson and Nelson, 2017](#)). Insights from the literature indicate that translating high-level climate objectives into actions requires effective cross-organizational collaboration and planning at different levels of government (e.g., local, regional and national; [Nunan et al., 2012](#); [Reid et al., 2018](#); [Somorin et al., 2016](#)).

Government managers also identified the lack of government climate leadership and current economic model of the forest sector as other barriers to climate integration. Forest policy in BC, as in many other jurisdictions, has historically developed as a fairly independent sector with distinctive institutions, ideas and actors ([Luckert et al., 2011](#)). This relative independence can translate into resistance to change and prevent integration with other policy sectors or new agendas—in this case climate change ([Hogl et al., 2015](#)). Despite a recent shift towards management paradigms integrating multiple objectives, actors and values ([Cullen et al., 2010](#); [Mabee and Hoberg, 2006](#)), BC’s forest sector—where forestry represents the historical mainstay of the provincial

economy—still remains powerfully influenced by a traditional timber-centric mindset ([Luckert et al., 2011](#)). The prevailing economic interests in preserving the status quo and the low-cost opportunities for land managers (forest licensees in BC) to adopt climate-informed interventions—particularly for adaptation ([Hotte et al., 2016](#)), but also mitigation ([Hoberg et al., 2016](#); [Peterson St-Laurent et al., 2017a](#))—represent other barriers to the effective integration of adaptation and mitigation into forest management.

The call for overarching climate leadership does not preclude encouraging and facilitating bottom-up policy initiatives, programs and innovation. The fact that some of the most successful climate initiatives in BC have originated from bottom-up, government-led processes reinforces the importance of policy innovations, exchanges of experience, and research at different government levels, including local and regional staff and managers ([Gray, 2013](#)). Such experimentations have the potential to trigger and support the development of effective climate initiatives and to foster cumulative social learning that could lead to fundamental and transformative changes in the forest policy sector ([Pahl-Wostl, 2009](#)). As an example, the broad voluntary adoption of the Climate Based Seed Transfer (61% of all seedling requests in 2019 in the province; [BC MFLNRORD, 2019](#)), which primarily originated from the bottom-up leadership of government scientists and policy managers, represents a transformative policy initiative with the potential to drastically change forest management in BC and other jurisdictions ([Klenk, 2015](#); [Wellstead and Howlett, 2016](#)). The rapid and successful implementation of the program and its widespread adoption by the industry confirms the importance of local champions who can effectively link different government levels, researchers, and the industry ([Johnston and Edwards, 2013](#)).

5.2. Preference for the adaptation-first model in practice

Calls for the consideration of adaptation and mitigation as two complementary objectives are increasingly common (Di Gregorio et al., 2017; Morecroft et al., 2019; Ravindranath, 2007). Our results indicate that government managers agree with the complementarities and synergies between adaptation and mitigation objectives (i.e., the integration model). They also perceive the benefits generated by many forest management interventions for both adaptation and mitigation, even the ones that are originally framed using the separation model (e.g., climate-based seed transfer). However, although policy integration appeals to government managers *in principle*, our results suggest that it does not *in practice*. As observed elsewhere (Berry et al., 2015; Di Gregorio et al., 2017), government managers in this study rarely identified or acknowledged the synergies and conflicts associated with implementing adaptation and mitigation objectives together. Instead, respondents most often discussed the possible positive effects of adaptation on mitigation (and sometimes the possible adverse effects of mitigation on adaptation). Respondents also highlight the prevalence of a generally expected list of barriers to the effective implementation of the interaction model in practice, including limited funding, lack of collaboration, diverging agendas, and limited economic incentives.

Yet perhaps more importantly, our results invite consideration of how the problem of policy integration is framed in the forest policy sector. The three dominant principles—adaptation as a prerequisite for mitigation, adaptation as an urgent necessity, and mitigation as a co-benefit of adaptation—confirms our second proposition that government managers and policymakers are more comfortable with the adaptation-first model. In particular, government managers in our study often indicated how the different levels and temporal and geographic scales at which adaptation and mitigation are considered and operate in the decision-making process about forest management pose challenges to integration (Locatelli et al., 2011; Preston et al., 2015; Tol, 2005). Mitigation has global and longer-term implications, while adaptation is mostly local/regional and can be both short and long-term oriented (Locatelli et al., 2016). These conceptual differences between adaptation and mitigation make sense at a macro level and justify considering them as two complementary objectives with similar stakes (Kongsager et al., 2016). Nevertheless, at a meso- or micro-level, the distinction between both objectives is fundamental: managers perceive that adaptation should become embedded in the practice of forest, whereas they see mitigation as just one (albeit substantial) of many management outcomes.

Many government managers also indicated that adaptation should be prioritized in every forest management decision because forests are increasingly vulnerable to the impacts of climate change (e.g., droughts, wildfires, diseases and pests) and carbon stocks are more vulnerable to reversal and non-permanence. There are arguably some mitigation strategies in the forest sector that do not require adaptation. For instance, incentivizing the production of a commodity mix shifted towards a greater proportion of long-lived products (e.g., sawnwood, other solid wood and panels) at the expense of pulp and paper products or bioenergy, or the use of salvaged wood instead of green harvest (i.e., harvesting of trees in forests affected by natural disturbances such as fire and insects) are two mitigation strategies (Xu et al., 2018) that do not necessarily have or require a strong adaptation component. However, one could also argue that these strategies, as well as any other mitigation strategies, ultimately rely on maintaining healthy and resilient forests at the landscape level. And it is becoming widely accepted that maintaining healthy forests and ecosystems will not be possible without substantial adaptation efforts (Guariguata et al., 2008; Hagerman and Pelai, 2018; IPCC, 2014a; Kareiva and Fuller, 2016; Prober et al., 2019).

The fact that government managers may prefer the adaptation-first model does not mean that it is happening in practice, or at least not sufficiently. If it were happening, adaptation would be integrated into every forest management decision, but our results suggest that this is not

the case. For instance, we only found one policy document that had adaptation-first as a secondary model (Table 1), and respondents often discussed a lack of funding for adaptation. Like many other jurisdictions around the world, the BC government has the opportunity to revisit its forest policy framework and better integrate climate objectives into forest policy and legislation. Whether this reframing will involve the interaction or adaptation-first model (or a combination of both) remains to be seen.

5.3. Study limitations and future research

This study focused exclusively on understanding how and why government forest managers select the climate forest management policy options and alternatives they do, a topic that has recently been highlighted as a priority for research (Capano and Howlett, 2020). However, this study does not cover the views of other important actors in BC's forest sector—including industry, environmental organizations, and local and Indigenous communities—and is therefore not representative of BC's broader forest policy-making network. For instance, the forest industry has considerable leverage and influence on how forests are being managed; it could support policies that provide financial benefits without additional cost (e.g., the Climate Based Seed Transfer) while also potentially dampen the overall climate change ambitions of government forest managers, particularly with policy or alternatives that involve upfront investments. Therefore, further research is needed to better understand other actors' views on climate forest management policies and how these views contrast with the ones of government managers. It is also important to stress that this study was conducted in a single Canadian jurisdiction with a majority of publicly owned forests and a distinctive forest governance system of Crown forest tenure. As such, the results are not necessarily generalizable to other jurisdictions, particularly where forests are governed under private ownership models.

Another methodological limitation is associated with the use of an online survey. In particular, survey findings may have been influenced by self-selection bias, meaning that the government managers who completed the survey are not representative of the target population (Lavrakas, 2008; Rea and Parker, 2014). For instance, it is possible that respondents who were already dissatisfied with BC's climate forest management policies were more likely to complete the survey. Finally, some survey respondents appeared to be unclear about the difference between adaptation and mitigation. In effect, a high proportion of respondents incorrectly identified or did not know the pursued objective (s) of the different policy documents (Table 1). For instance, many respondents indicated that the Climate Based Seed Transfer—a standard that is centrally focused on adaptation (i.e., Adaptation only Separation model)—pursued both adaptation and mitigation objectives. Similarly, multiple respondents indicated that the Strategic Wildfire Prevention Initiative or the Wildfire Act and Wildfire Regulation focused on mitigation, whereas both policy documents emphasize adaptation. This lack of clarity on the concepts of adaptation and mitigation may have affected the study results. It may also indicate that not all government managers have the necessary awareness and expertise to effectively implement climate forest management policy, let alone integrating adaptation and mitigation. Further research could explore how familiar government managers are with climate forest management and policy.

6. Conclusion

This study indicates that a possible paradigm shift from the separation (i.e., adaptation-only or mitigation-only forest policy) to the interaction model (i.e., consideration of trade-offs and prioritization between adaptation and mitigation) is taking place in BC's forest policy. However, government managers identified numerous barriers to climate policy integration and generally perceive that adaptation and mitigation are not effectively integrated into BC's forest policy, thereby suggesting

that a shift towards the interaction model may not always be materializing in practice—at least according to government managers.

Evidence further reveals that government managers are more inclined to prefer the adaptation-first model, which considers adaptation at the core of forest management, and mitigation as one of the benefits. BC government managers are not arguing that we should stop efforts to mitigate climate change in the forest sector or that such strategies are not necessary. On the opposite, they firmly acknowledged the importance of the forests in mitigating climate change and their essential role in accomplishing net negative emission, a required objective to meet the targets set in the Paris agreement (Fawcett et al., 2015). Ultimately, our capacity to build resilient forests depends on our success at mitigating climate change—failure to do so may seriously prevent our capacity to adapt to climate change (IPCC, 2014a). Nonetheless, our results suggest that, because of the fundamental perceived differences in the levels at which adaptation and mitigation intervene in decision-making on forest management, there is a need to rethink how we frame their integration into forest management in practice.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This research was funded by the Pacific Institute for Climate Solutions (PICS) Forest Carbon Management Project. We are grateful to Tony Lemprière and an anonymous reviewer from the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development for reviewing previous versions of this manuscript. We would also like to thank the BC government managers who participated and shared their insights.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.landusepol.2021.105357.

References

- Abbott, G., Chapman, C.M., 2018. A report for the Government and British Columbians. Addressing the New Normal: 21st Century Disaster Management in British Columbia. Adelle, C., Russel, D., 2013. Climate policy integration: a case of Déjà Vu? *Environ. Policy Gov.* 23, 1–12.
- Aubin, I., Munson, A.D., Cardou, F., Burton, P.J., Isabel, N., Pedlar, J.H., Paquette, A., Taylor, A.R., Delagrangé, S., Kebli, H., Messier, C., Shipley, B., Valladares, F., Kattge, J., Boisvert-Marsh, L., McKenney, D., 2016. Traits to stay, traits to move: a review of functional traits to assess sensitivity and adaptive capacity of temperate and boreal trees to climate change. *Environ. Rev.* 24, 164–186.
- Ayers, J.M., Huq, S., 2009. The value of linking mitigation and adaptation: a case study of Bangladesh. *Environ. Manag.* 43, 753–764.
- BC MFLNRORD, 2019. 2019 Year in Review-Forest Improvement and Research Management Branch Retrieved from (https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/tree-seed/firm/firm_2019_year_in_review-updated3.pdf).
- BC MOE, 2015. Designated and Established Protocols. Retrieved March 20, 2015, from (<http://www2.gov.bc.ca/gov/topic.page?id=04464B036DC14656B0C1F16E8E642423>).
- BC MOE, 2019. 2017 British Columbia Greenhouse Gas Inventory. Retrieved October 31, 2019, from (<https://www2.gov.bc.ca/gov/content/environment/climate-change/e/data/provincial-inventory>).
- BC MRLNRO, 2016. Forest Carbon Strategy 2016–2020 Retrieved from (https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nrs-climate-change/bc_forest_carbon_strategy_09092016_sept_21.pdf).
- Berry, P.M., Brown, S., Chen, M., Kontogianni, A., Rowlands, O., Simpson, G., Skourtos, M., 2015. Cross-sectoral interactions of adaptation and mitigation measures. *Clim. Change* 128, 381–393.
- Buizer, M., Humphreys, D., de Jong, W., 2014. Climate change and deforestation: the evolution of an intersecting policy domain. *Environ. Sci. Policy* 35, 1–11.
- Canadell, J.G., Raupach, M.R., 2008. Managing Forests for Climate Change Mitigation. 320, 1456–1457.
- Capano, G., Howlett, M., 2020. The knowns and unknowns of policy instrument analysis: policy tools and the current research agenda on policy mixes. *SAGE Open* 10, 2158244019900568.
- Casado-Asensio, J., Steurer, R., 2014. Integrated strategies on sustainable development, climate change mitigation and adaptation in Western Europe: communication rather than coordination. *J. Public Policy* 34, 437–473.
- Conroy, G.C., Shimizu-Kimura, Y., Lamont, R.W., Ogbourne, S.M., 2019. A multidisciplinary approach to inform assisted migration of the restricted rainforest tree, *Fontainea rostrata*. *PLoS One* 14, e0210560–0210521.
- Couture, S., Reynaud, A., 2011. Forest management under fire risk when forest carbon sequestration has value. *Ecol. Econ.* 70, 2002–2011.
- Cullen, D., McGee, G.J.A., Gunton, T.I., Day, J.C., 2010. Collaborative planning in complex stakeholder environments: an evaluation of a two-tiered collaborative planning model. *Soc. Nat. Resour.* 23, 332–350.
- D'Amato, A.W., Bradford, J.B., Fraver, S., Palik, B.J., 2011. Forest management for mitigation and adaptation to climate change: insights from long-term silviculture experiments. *For. Ecol. Manag.* 262, 803–816.
- De Roeck, F., Orbie, J., Delputte, S., 2018. Mainstreaming climate change adaptation into the European Union's development assistance. *Environ. Sci. Policy* 81, 36–45.
- Di Gregorio, M., Nurrochmat, D.R., Paavola, J., Sari, I.M., Fatorelli, L., Pramova, E., Locatelli, B., Brockhaus, M., Kusumadewi, S.D., 2017. Climate policy integration in the land use sector: mitigation, adaptation and sustainable development linkages. *Environ. Sci. Policy* 67, 35–43.
- Dugan, A.J., Birdsey, R., Mascorro, V.S., Magnan, M., Smyth, C.E., Olguin, M., Kurz, W. A., 2018. A systems approach to assess climate change mitigation options in landscapes of the United States forest sector. *Carbon Balance Manag.* 13, 13.
- Dupont, C., 2016. Climate Policy Integration Into EU Energy Policy, 1st ed. Routledge.
- Elo, S., Kyngas, H., 2008. The qualitative content analysis process. *J. Adv. Nurs.* 62, 107–115.
- FAO, 2016. Forestry for a low-carbon future: integrating forests and wood products in climate change strategies. FAO Forestry Paper 117 Retrieved from (www.fao.org/3/a-i5857e.pdf).
- Fawcett, A.A., Iyer, G.C., Clarke, L.E., Edmonds, J.A., Hultman, N.E., McJeon, H.C., Rogelj, J., Schuler, R., Alsalam, J., Asrar, G.R., Creason, J., Jeong, M., McFarland, J., Mundra, A., Shi, W., 2015. Can Paris pledges avert severe climate change? *Science* 350, aad5761–1169.
- FESBC, 2018. About the Forest Enhancement Society of British Columbia. Retrieved April 9, 2018, from (<http://www.fesbc.ca/about-the-fesbc.html>).
- Government of BC, 2019. Forest Carbon Initiative Project Portal. governmentofbc.maps.arcgis.com. from (<https://governmentofbc.maps.arcgis.com/apps/MapSeries/index.html?appid=f881660f14d438f92f8112289a2e8f9>).
- Government of BC, 2020. Wildfire Legislation and Regulations.
- Grafakos, S., Viero, G., Reckien, D., Trigg, K., Viguie, V., Sudmant, A., Graves, C., Foley, A., Heidrich, O., Mirailles, J.M., Carter, J., Chang, L.H., Nador, C., Liseri, M., Chelleri, L., Orru, H., Orru, K., Aelenei, R., Bilka, A., Pfeiffer, B., Lepetit, Q., Church, J.M., Landauer, M., Gouldson, A., Dawson, R., 2020. Integration of mitigation and adaptation in urban climate change action plans in Europe: a systematic assessment. *Renew. Sustain. Energy Rev.* 121, 109623.
- Gray, P.A., 2013. Adapting Sustainable Forest Management to Climate Change: A Systematic Approach for Exporing Organizational Readiness. Climate Change Task Force of the Canadian Council of Forest Ministers, Ottawa, p. 48.
- Griscom, B.W., Adams, J., Ellis, P.W., Houghton, R.A., Lomax, G., Miteva, D.A., Schlesinger, W.H., Shoch, D., Siikamäki, J.V., Smith, P., Woodbury, P., Zganjar, C., Blackman, A., Campari, J., Conant, R.T., Delgado, C., Elias, P., Gopalakrishna, T., Hamsik, M.R., Herrero, M., Kiesecker, J., Landis, E., Laestadius, L., Leavitt, S.M., Minnemeyer, S., Polasky, S., Potapov, P., Putz, F.E., Sanderman, J., Silvius, M., Wollenberg, E., Fargione, J., 2017. Natural climate solutions. *Proc. Natl. Acad. Sci. USA* 114, 11645–11650.
- Guariguata, M.R., Cornelius, J.P., Locatelli, B., Forner, C., Sánchez-Azofeifa, G.A., 2008. Mitigation needs adaptation: tropical forestry and climate change. *Mitig. Adapt. Strateg. Glob. Change* 13, 793–808.
- Hagerman, S., Dowlatabadi, H., Satterfield, T., 2010. Observations on drivers and dynamics of environmental policy change: insights from 150 years of forest management in British Columbia. *Ecol. Soc.* 15, art2.
- Hagerman, S.M., Pelai, R., 2018. Responding to climate change in forest management: two decades of recommendations. *Front. Ecol. Environ.* 16, 579–587.
- Hisano, M., Searle, E.B., Chen, H.Y.H., 2017. Biodiversity as a solution to mitigate climate change impacts on the functioning of forest ecosystems. *Biol. Rev.* 93, 439–456.
- Hoberg, G., Peterson St-Laurent, G., Schittcatte, G., Dymond, C.C., 2016. Forest carbon mitigation policy: a policy gap analysis for British Columbia. *For. Policy Econ.* 69, 73–82.
- Hogl, K., Kleinschmit, D., Rayner, J., 2015. Achieving policy integration across fragmented policy domains: forests, agriculture, climate and energy. *Environ. Plan. C Gov. Policy* 34, 399–414.
- Hotte, N., Mahony, C., Nelson, H., 2016. The principal-agent problem and climate change adaptation on public lands. *Glob. Environ. Change* 36, 163–174.
- IPCC, 2014a. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Cambridge University Press, Cambridge, UK. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.
- IPCC, 2014b. Climate Change 2014: Mitigation of Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

- IPCC, 2019. Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems.
- Johnston, M., Edwards, J., 2013. Adapting sustainable forest management to climate change: an analysis of Canadian case studies (pp. 1–52). Retrieved from (<http://www.ccfm.org/english/coreproducts-cc.asp>).
- Kareiva, P., Fuller, E., 2016. Beyond resilience: how to better prepare for the profound disruption of the anthropocene. *Glob. Policy* 7, 107–118.
- Keenan, R.J., 2016. Forests and Climate Change: Introduction to a special section. *Adaptation of Forests and Forest Management to Changing Climate* 360, 353–356.
- Klein, R.J.T., Schipper, E.L.F., Dessai, S., 2005. Integrating mitigation and adaptation into climate and development policy: three research questions. *Environ. Sci. Policy* 8, 579–588.
- Klenk, N.L., 2015. The development of assisted migration policy in Canada: an analysis of the politics of composing future forests. *Land Use Policy* 44, 101–109.
- Kok, M., Metz, B., Verhagen, J., van Rooijen, S., 2008. Integrating development and climate policies: national and international benefits. *Clim. Policy* 8, 103–118.
- Kongsager, R., Locatelli, B., Chazarin, F., 2016. Addressing climate change mitigation and adaptation together: a global assessment of agriculture and forestry projects. *Environ. Manag.* 57, 271–282.
- Laukkonen, J., Blanco, P.K., Lenhart, J., Keiner, M., Cavric, B., Kinuthia-Njenga, C., 2009. Combining climate change adaptation and mitigation measures at the local level. *Climate Change and Human Settlements* 33, 287–292.
- Lavrakas, P.J., 2008. *Encyclopedia of Survey Research Methods*. Thousand Oaks, California.
- Locatelli, B., Evans, V., Wardell, A., Andrade, A., Vignola, R., 2011. Forests and climate change in Latin America: linking adaptation and mitigation. *Forests* 2, 431–450.
- Locatelli, B., Fedele, G., Fayolle, V., Baglee, A., 2016. Synergies between adaptation and mitigation in climate change finance. *Int. J. Clim. Change Strateg. Manag.* 8, 112–128.
- Locatelli, B., Pavageau, C., Pramova, E., Di Gregorio, M., 2015. Integrating climate change mitigation and adaptation in agriculture and forestry: opportunities and trade-offs. *Wiley Interdiscip. Rev. Clim. Change* 6, 585–598.
- Luckert, M.K., Haley, D., Hoberg, G., 2011. Policies for Sustainably Managing Canada's Forests. *Tenure, Stumpage Fees, and Forest Practices*. UBC Press, Vancouver.
- Mabee, H.S., Hoberg, G., 2006. Equal partners? Assessing comanagement of forest resources in Clayoquot sound. *Soc. Nat. Resour.* 19, 875–888.
- MFLNR, B., 2015. *FLNR Climate Change Strategy 2015–2020 Setting the Stage*. 1–4.
- MFLNRORD, B., 2020. *Forests for Tomorrow*. from (<https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/land-based-investment/forests-for-tomorrow>).
- MFR (Ministry of Forests and Range), 2008. *Jan. Future Forest Ecosystems Initiative: Frequently Asked Questions*. [for.gov.bc.ca](https://www.for.gov.bc.ca/ftp/hfp/external/publish/web/ffeif/project/FFEI_FAQs.pdf). from (https://www.for.gov.bc.ca/ftp/hfp/external/publish/web/ffeif/project/FFEI_FAQs.pdf).
- Millar, C.I., Stephenson, N.L., Stephens, S.L., 2007. Climate change and forests of the future: managing in the face of uncertainty. *Ecol. Appl.* 17, 2145–2151.
- Miller, R.K., Field, C.B., Mach, K.J., 2020. Barriers and enablers for prescribed burns for wildfire management in California. *Nat. Sustain.* 1–9.
- Morecroft, M.D., Duffield, S., Harley, M., Pearce-Higgins, J.W., Stevens, N., Watts, O., Whitaker, J., 2019. Measuring the success of climate change adaptation and mitigation in terrestrial ecosystems. *Science* 366, eaaw9256.
- Moser, S.C., 2011. Adaptation, mitigation, and their disharmonious discontents. *Clim. Change* 33, 717.
- Nunan, F., Campbell, A., Foster, E., 2012. Environmental mainstreaming: the organisational challenges of policy integration. *Public Adm. Dev.* 32, 262–277.
- Pahl-Wostl, C., 2009. A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Glob. Environ. Change* 19, 354–365.
- Park, A., Talbot, C., 2018. Information underload: ecological complexity, incomplete knowledge, and data deficits create challenges for the assisted migration of forest trees. *Bioscience* 68, 251–263.
- Pelai, R., 2019. Whose expertise counts? Assisted migration and the politics of knowledge, in: Hagerman, S. (Ed.). *The University of British Columbia*, Vancouver, BC.
- Peterson St-Laurent, G., Hagerman, S., Hoberg, G., 2017a. Barriers to the development of forest carbon offsetting: lessons from British Columbia, Canada. *J. Environ. Econ. Manag.* 203, 208–217.
- Peterson St-Laurent, G., Hagerman, S., Hoberg, G., 2017b. Emergence and influence of a new policy regime: the case of forest carbon offsets in British Columbia. *Land Use Policy* 60, 169–180.
- Peterson St-Laurent, G., Kozak, R., Hagerman, S., 2021. Cross-jurisdictional insights from forest practitioners on novel climate-adaptive options for Canada's forests. *Reg. Environ. Change* 21 (4). <https://doi.org/10.1007/s10113-020-01733-3>.
- Peterson St-Laurent, G., Hoberg, G., Sheppard, S.R.J., 2018. A participatory approach to evaluating strategies for forest carbon mitigation in British Columbia. *Forests* 9, 225.
- Pires, A.P.F., Srivastava, D.S., Farjalla, V.F., 2018. Is biodiversity able to buffer ecosystems from climate change? What we know and what we don't. *Bioscience* 68, 273–280.
- Pistorius, T., 2012. From RED to RED+: the evolution of a forest-based mitigation approach for developing countries. *Curr. Opin. Environ. Sustain.* 4, 638–645.
- Preston, B.L., Mustelin, J., Maloney, M.C., 2015. Climate adaptation heuristics and the science/policy divide. *Mitig. Adapt. Strateg. Glob. Change* 20, 467–497.
- Prober, S.M., Doerr, V.A.J., Broadhurst, L.M., Williams, K.J., Dickson, F., 2019. Shifting the conservation paradigm: a synthesis of options for renovating nature under climate change. *Ecol. Monogr.* 89, e01333–01323.
- Ravindranath, N.H., 2007. Mitigation and adaptation synergy in forest sector. *Mitig. Adapt. Strateg. Glob. Change* 12, 843–853.
- Rea, L.M., Parker, R.A., 2014. *Designing and Conducting Survey Research: A Comprehensive Guide*.
- Reid, H., Bourne, A., Muller, H., Podvin, K., Scorgie, S., Orindi, V., 2018. Chapter 16. A Framework for Assessing the Effectiveness of Ecosystem-Based Approaches to Adaptation, in: Zommers, Z., Alverson, K. (Eds.). Elsevier Inc., pp. 207–216.
- Sakschewski, B., von Bloh, W., Boit, A., Poorter, L., Peña-Claros, M., Heinke, J., Joshi, J., Thonicke, K., 2016. Resilience of Amazon forests emerges from plant trait diversity. *Nat. Clim. Change* 6, 1032–1036.
- Somarin, O.A., Visseren-Hamakers, I.J., Arts, B., Tiani, A.-M., Sonwa, D.J., 2016. Integration through interaction? Synergy between adaptation and mitigation (REDD+) in Cameroon. *Environ. Plan. C Gov. Policy* 34, 415–432.
- Spencer, B., Lawler, J., Lowe, C., Thompson, L., Hincley, T., Kim, S.-H., Bolton, S., Meschke, S., Olden, J.D., Voss, J., 2016. Case studies in co-benefits approaches to climate change mitigation and adaptation. *J. Environ. Plan. Manag.* 60, 647–667.
- Suckall, N., Tompkins, E., Stringer, L., 2014. Identifying trade-offs between adaptation, mitigation and development in community responses to climate and socio-economic stresses: evidence from Zanzibar, Tanzania. *Appl. Geogr.* 46, 111–121.
- Thomas, C.D., Anderson, B.J., Moilanen, A., Eigenbrod, F., Heinemeyer, A., Quaipe, T., Roy, D.B., Gillings, S., Armsworth, P.R., Gaston, K.J., 2013. Reconciling biodiversity and carbon conservation. *Ecol. Lett.* 16, 39–47.
- Thuy, P., Moeliono, M., Locatelli, B., Brockhaus, M., Gregorio, M., Mardiah, S., 2014. Integration of adaptation and mitigation in climate change and forest policies in Indonesia and Vietnam. *Forests* 5, 2016–2036.
- Tol, R.S.J., 2005. Adaptation and mitigation: trade-offs in substance and methods. *Environ. Sci. Policy* 8, 572–578.
- UBCM (Union of BC Municipalities), 2012. *Strategic Wildfire Prevention*. from (<https://www.ubcm.ca/EN/main/funding/lgpps/strategic-wildfire-prevention.html>).
- Urwin, K., Jordan, A., 2008. Does public policy support or undermine climate change adaptation? Exploring policy interplay across different scales of governance. *Glob. Environ. Change* 18, 180–191.
- Wellstead, A., Howlett, M., 2016. Assisted tree migration in North America: policy legacies, enhanced forest policy integration and climate change adaptation. *Scand. J. For. Res.* 32, 535–543.
- Wilbanks, T.J., Kane, S.M., Leiby, P.N., Perlack, R.D., Settle, C., Shogren, J.F., Smith, J. B., 2003. Possible responses to global climate change: integrating mitigation and adaptation. *Environ. Sci. Policy Sustain. Dev.* 45, 28–38.
- Williamson, T.B., Nelson, H.W., 2017. Barriers to enhanced and integrated climate change adaptation and mitigation in Canadian forest management. *Can. J. For. Res.* 47, 1567–1576.
- Xu, Z., Smyth, C.E., Lemprière, T.C., Rampley, G.J., Kurz, W.A., 2018. Climate change mitigation strategies in the forest sector: biophysical impacts and economic implications in British Columbia, Canada. *Mitig. Adapt. Strateg. Glob. Change* 23, 257–290.