



# Adapting Sustainable Forest Management to Climate Change: An Overview of Approaches for Assessing Human Adaptive Capacity



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# Adapting Sustainable Forest Management to Climate Change: An Overview of Approaches for Assessing Human Adaptive Capacity

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# Canadian Council of Forest Ministers

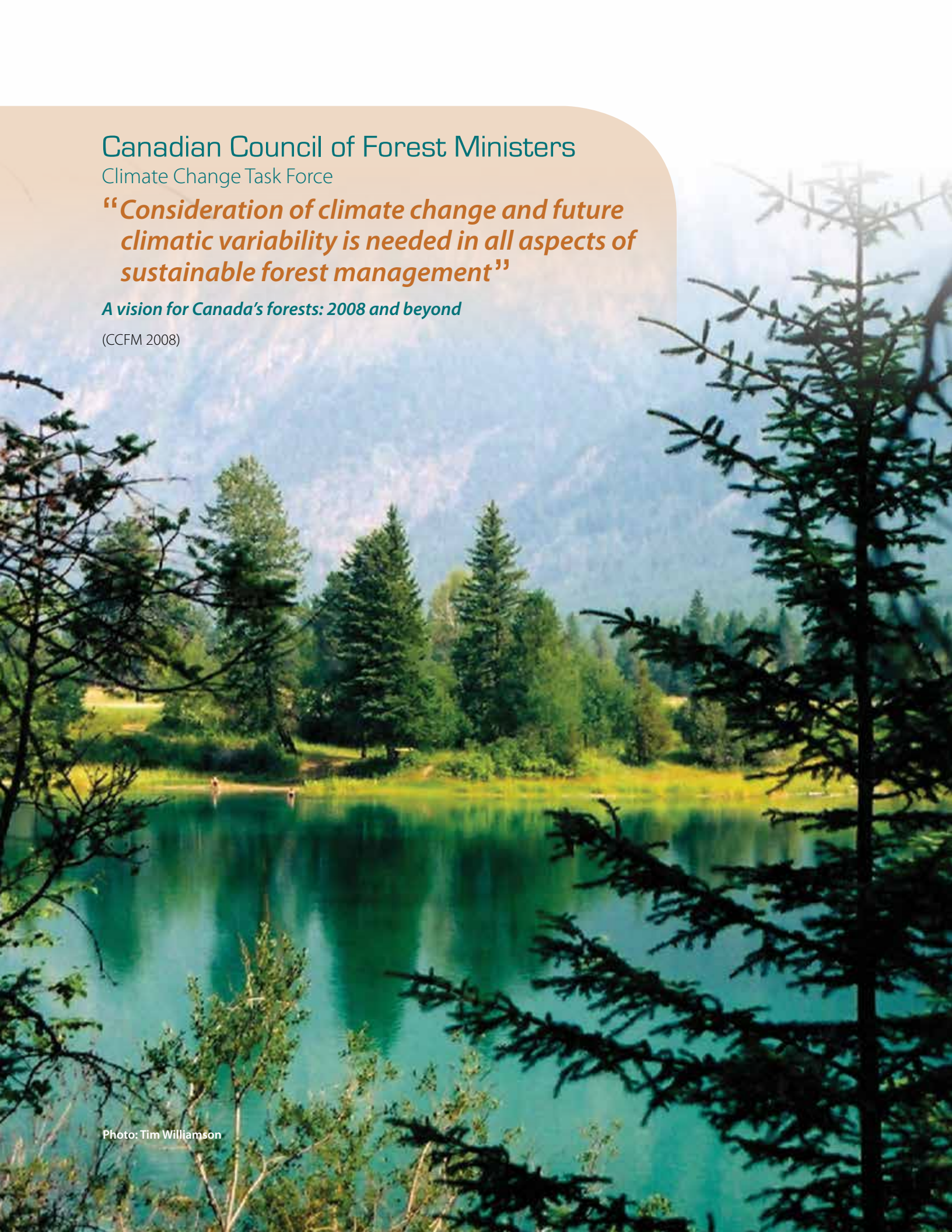
Climate Change Task Force

***“Consideration of climate change and future climatic variability is needed in all aspects of sustainable forest management”***

***A vision for Canada’s forests: 2008 and beyond***

(CCFM 2008)

Photo: Tim Williamson





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Photo: Tim Williamson

## FOREWORD

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Canada has 397 million hectares of forests and other woodlands, representing 10% of the world's forest cover. Our forests constitute a world-class natural treasure providing ecological, economic, social, and cultural benefits to all Canadians, regardless of whether they live in small northern communities or large urban centres. Canada is committed to sustainable forest management, which aims to maintain and enhance the long-term health of forested ecosystems while providing ecological, economic, cultural, and social opportunities for present and future generations.

One of several factors that pose both opportunities and challenges in terms of effectively and efficiently meeting our sustainable forest management goals is climate change and its inherent uncertainties. The Canadian Council of Forest Ministers (CCFM) identified climate change as one of two priority issues for Canada's forest sector. In its *Vision for Canada's Forests: 2008 and Beyond*, the CCFM stated, "Consideration of climate change and future climatic variability is needed in all aspects of sustainable forest management." In addition, to minimize the risks and maximize the benefits associated with a changing climate, Canada's provincial and territorial premiers asked their Ministers responsible for forest management to collaborate with the federal government on adaptation in forestry through the CCFM's Climate Change Task Force. Phase 1 of this work, completed in 2010, involved a comprehensive assessment of the vulnerability of various tree species and identified management options for adaptation. Phase 2 has gone beyond the level of trees to look at climate change adaptation within forest ecosystems and the broader forest sector. The goal of phase 2 was to equip members of the forest sector with a suite of tools and state-of-the-art information to enable them to make better decisions about the need for adaptation and the types of measures that may be most beneficial.

Over a period of two years, nearly one hundred individuals from a wide range of organizations have contributed to achieving this goal. The fruits of their labour have been captured in the CCFM's Climate Change Adaptation series, which comprises several technical reports and review papers. It is our sincere hope that these documents, which will be used in conjunction with workshops, seminars, and presentations, will benefit forest practitioners from coast to coast to coast as they seek innovative ways to adapt sustainable forest management policies and practices for a changing climate.

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Photo: Tim Williamson



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## ABSTRACT

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Enough is now known about climate change to conclude that it will increase the adaptability requirements of the Canadian forest sector. The Intergovernmental Panel on Climate Change has defined adaptive capacity as “The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.” This report presents an overview of assessment techniques, concepts, and approaches for describing and analyzing human adaptive capacity, and some general high-level options for enhancing it. One way of describing adaptive capacity is to identify and describe determinants or assets that contribute to it. In general terms, adaptive capacity determinants include human skills and knowledge about climate change, networks and partnerships, climate change science, and institutional capacity for adapting to the effects of climate change. Characterizing adaptive capacity may also involve describing processes and mechanisms used in mobilizing pertinent resources. There may also be instances where an understanding of the distribution of adaptive capacity among various stakeholders and interested parties is desired. A number of approaches can be used to obtain the information needed to describe adaptive capacity, including structured interviews, workshops, case histories, and the measurement and mapping of indicators. Methods of analyzing adaptive capacity include assessing requirements, assessing the degree to which current mobilization processes are efficient and effective, evaluating and assessing whether the distribution of adaptive capacity is equitable, and identifying barriers and system failures that may be impairing optimal investment in adaptive capacity. Options for enhancing adaptive capacity include investing in particular determinants, reducing barriers and constraints to rational investment in adaptive capacity, facilitating a more equitable distribution of pertinent resources, and modifying institutions and governance to enable adaptation where it is rational, feasible, and justified.

**Key words:** adaptability, adaptive capacity assessment, forest management systems, description, determinants, mobilization, analyzing adaptive capacity, requirements, deficits, enhancing adaptive capacity

## RÉSUMÉ

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On en sait suffisamment sur les changements climatiques pour en déduire qu'ils augmenteront les besoins d'adaptation de la part du secteur forestier canadien. Le Groupe d'experts intergouvernemental sur l'évolution du climat a défini la capacité d'adaptation comme étant « La capacité d'un système à s'adapter aux changements climatiques (y compris la variabilité du climat et les extrêmes) pour en atténuer les effets néfastes, pour tirer avantage des occasions favorables ou pour faire face aux conséquences ». Dans ce rapport, nous présentons un aperçu des concepts, techniques et approches d'évaluation qui servent à définir et à analyser la capacité d'adaptation humaine, ainsi que des stratégies d'amélioration. Une façon de définir la capacité d'adaptation est de déterminer et de définir les ressources ou les actifs qui contribuent à la réaliser. En termes généraux, les facteurs déterminants de la capacité d'adaptation comprennent le savoir-faire humain, les réseaux et les partenariats, les connaissances générales et scientifiques sur les changements climatiques et la capacité des institutions à s'adapter aux effets de ces changements. Caractériser la capacité d'adaptation peut aussi impliquer la description des processus et des mécanismes employés pour mobiliser les ressources pertinentes. Il y a aussi des cas où la compréhension de la répartition de la capacité d'adaptation entre diverses parties prenantes est souhaitable. On peut employer un certain nombre d'approches pour obtenir l'information requise pour définir ce qu'est la capacité d'adaptation, y compris les entrevues structurées, les ateliers de travail, l'étude de cas, le suivi et la représentation cartographique d'indicateurs. Les méthodes d'analyse de la capacité d'adaptation comprennent l'évaluation des besoins en cette matière, du degré d'efficacité des processus actuels de mobilisation, de l'équité dans la répartition de la capacité d'adaptation et des obstacles et des faiblesses du système qui pourraient contraindre l'investissement optimal dans la capacité d'adaptation. Les possibilités d'améliorer la capacité d'adaptation comprennent les actions suivantes : investir dans les ressources, réduire les obstacles et les contraintes à l'investissement rationnel, faciliter une répartition plus équitable des ressources appropriées et apporter des modifications aux institutions et à la gouvernance afin de favoriser l'adaptation là où elle doit se faire, de façon rationnelle, faisable et justifiée.

**Mots clés :** adaptabilité, évaluation de la capacité d'adaptation, systèmes d'aménagement forestier, définition, ressources, mobilisation, analyse de la capacité d'adaptation, besoins, déficits, amélioration de la capacité d'adaptation.



## CONTENTS

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INTRODUCTION	1
OVERVIEW OF ASSESSMENT TECHNIQUES, CONCEPTS, AND APPROACHES	3
DESCRIBING CURRENT ADAPTIVE CAPACITY—WHAT IS IT?	5
Determinants	5
Indicators and mapping	6
Properties	6
Mobilization	6
Case histories and proxies	7
Distribution	7
ANALYZING ADAPTIVE CAPACITY—IS IT ADEQUATE?	9
Requirements	9
Effectiveness and efficiency	10
Equity	10
Deficits	10
MANAGING ADAPTIVE CAPACITY—WHAT CAN BE DONE?	11
Investing	11
Reducing deficits	12
Addressing inequities	12
Governance and institutions	12

ILLUSTRATIVE EXAMPLES	15
A comprehensive assessment of adaptive capacity	15
An approach for assessing organizational adaptive capacity	16
CONCLUSIONS	19
ACKNOWLEDGMENTS	19
LITERATURE CITED	20
GLOSSARY	21



## INTRODUCTION

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The goal of sustainable forest management (SFM) is to maintain healthy forests while providing economic, cultural, and social opportunities for present and future generations (CCFM 2008). Successful implementation of SFM requires balancing these considerations in dynamic settings that are continuously evolving as a result of advances in science and changes in technology, markets, social expectations, and forest conditions. Accordingly, SFM systems and the professional managers, organizations, stakeholders, and institutions within them are inherently adaptable.

Enough is now known about climate change to conclude that it will increase the requirements for adaptability (or adaptive

capacity) of SFM systems (see text boxes “Sustainable forest management systems” and “Climate change and adaptability”). But what does this mean, and what kinds of tools, techniques, concepts, and approaches can be used for describing, analyzing, managing, and enhancing adaptive capacity? This report introduces and defines the concept of adaptive capacity and presents an overview of techniques, concepts, and approaches for assessing

it in the context of the human dimensions of SFM systems (e.g., forest managers, forestry companies, management agencies, and forest-based communities, policies, and institutions). Given that the assessment of adaptive capacity is an important element of vulnerability assessment, this report can be used in conjunction with the Canadian Council of Forest Ministers vulnerability assessment framework described by Williamson et al. (2012a).

There is no single right way to assess adaptive capacity, and therefore it is impossible to set

### **Sustainable forest management systems**

A sustainable forest management (SFM) system is defined as a coupled human–environmental system that works toward the management of forests in a manner consistent with SFM principles and objectives. An SFM system can exist at any scale (including national, provincial, and local scales) and in a variety of contexts (e.g., protected areas, industrial lease areas, community forests, and small private woodlots). SFM systems include individuals, firms, organizations, agencies, and communities (called SFM actors) that have roles in, influence on, or a stake in the sustainable management of forests. The actions, decisions, and choices of SFM actors are affected by their individual goals, by the objectives of the broader SFM system, and by the institutions that are in place to achieve SFM goals and objectives. These institutions include markets for forest-based goods and services, governance of forest resources, and property rights assigned through forest tenure, as well as standards, norms, rules, regulations, and policies.

out a step-by-step procedure for such an assessment. The scope and method for any particular assessment will vary depending on the subject of analysis, the reasons for the assessment, the depth of analysis desired, and the spatial, temporal, and organizational context of the assessment. Some assessments may be strategic and broad in nature, whereas others will be more in-depth.

Some assessments may be undertaken for a particular organization, while others will be for an entire SFM

system. The suite of techniques, concepts, and approaches presented here cover a range of options. Examples and hypothetical case studies are included to illustrate the assessment of adaptive capacity.

### **Climate change and adaptability**

Climate change may result in ongoing impacts on forests and forest values. Because the rate and magnitude of climate change over the next 100 years will be unprecedented, sustainable forest management (SFM) actors can expect novel forest conditions and other surprises. More specifically, they can expect changes in the frequency and intensity of drought, extreme wildfire seasons, and insect outbreaks. They can also expect changes in the costs of management, the costs of industrial production, and the global supply of forest products. Climate change contributes complexity to already-complex forest management decision making. In addition, forest managers can no longer assume that the future will be like the past, so there will be increased uncertainty about the future condition of forests. The anticipated overall effect of these changes in management operating environments is that forest management in Canada will need to be more adaptable than it has been in the past.

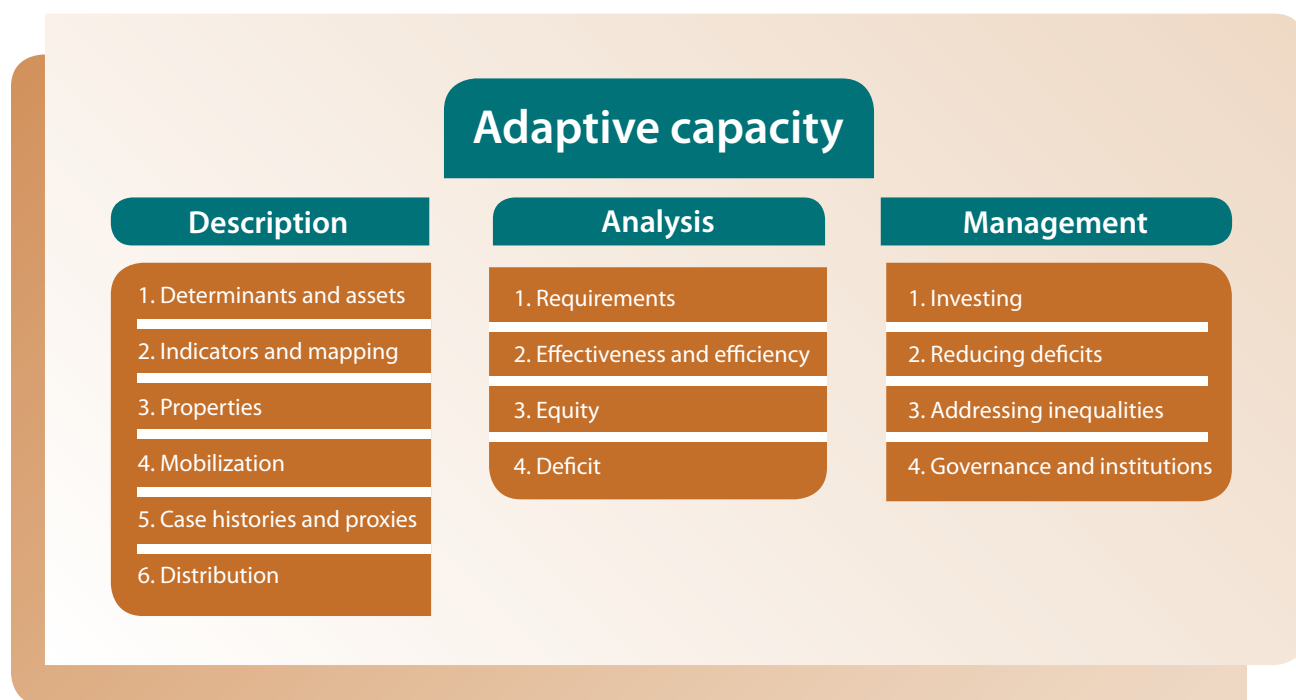


## OVERVIEW OF ASSESSMENT TECHNIQUES, CONCEPTS, AND APPROACHES

The Intergovernmental Panel on Climate Change (IPCC) has defined adaptive capacity as “The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.” Generally, adaptive capacity is a function of assets and resources and the institutions and governance mechanisms that enable (or pose barriers to) their mobilization for the purposes of adaptation.

Although there is some agreement with the above definition of adaptive capacity, there is, as noted in the previous section, no single theoretically correct way to assess adaptive capacity. A number of concepts and approaches have been proposed that can be used to assess adaptive capacity.

In total, 14 techniques or approaches are presented in this report. They are grouped into three broad categories: those suited to describing or characterizing adaptive capacity, those suited to analyzing adaptive capacity in terms of whether it meets the needs of SFM, and high-level options for managing adaptive capacity (see Figure 1). Some of the techniques and approaches are straightforward, with others being more intricate.



**FIGURE 1. Approaches for assessing the adaptive capacity of SFM, showing the three functional reasons for assessment and options or approaches within each function.**



Photo: Tim Williamson

## DESCRIBING CURRENT ADAPTIVE CAPACITY—WHAT IS IT?

Describing and characterizing adaptive capacity constitute the fundamental first step in assessment. What kinds of resources, characteristics, and properties contribute to the ability of SFM participants, organizations, and systems to adapt to climate change, and how do specific aspects of decision making contribute to rendering SFM actors, organizations, and systems more adaptable? Several techniques and approaches for describing adaptive capacity are introduced and described in the remainder of this section.

### Determinants

Determinants of adaptive capacity are resources that make adaptation possible. For example, human capital is the accumulated education, training, and experience of individuals involved in SFM, including their skills, capabilities, aptitudes, and health. Human capital enables the identification and successful implementation of adaptation options. The following two specific questions can aid in assessing the current human capital of SFM actors and systems:

What is the general level of experience, education, training, and skill of forest managers, decision makers, and forestry stakeholders within the SFM system of interest, and what are the key factors that contribute to current education, training, and skills (e.g., presence of education and training institutions, organizational commitment to training, professional standards)?

What is the current level of understanding and awareness of forest managers, decision makers, and forestry stakeholders regarding the potential impacts of climate change on the SFM system of interest and of adaptation options for minimizing negative impacts and maximizing opportunities?

In addition to human capital, other types of determinants and assets include

- climate change knowledge (scientific, local, Aboriginal, traditional, and operational) and knowledge mobilization (e.g., education, awareness raising, knowledge exchange);
- technological options for adaptation and the ability to develop such options;
- leadership (e.g., leaders' views about climate change and their influence on adaptation decisions);
- social capital (i.e., relationships and networks among individuals, groups, and organizations);
- institutional capital (i.e., the laws, norms, rules, and customs that guide behavior);
- political capital (i.e., access to and influence on policy, legislation, and political decisions);
- infrastructure (e.g., buildings, equipment, roadways);
- economic and financial resources;
- cultural capital (e.g., values, beliefs, and world views that acknowledge climate change and support adaptation);
- natural capital (i.e., forests, water, soil, minerals).

These kinds of determinants contribute to or influence (sometimes positively, sometimes negatively) an SFM system's ability to adapt to climate change. As such, describing adaptive capacity determinants and assets can help organizations understand and assess their adaptive capacity.

One example of an adaptive capacity assessment of forest management based on determinants was provided by Johnston et al. (2010). Their study involved discussions and interviews with practitioners carried out during almost 60 meetings across Canada. Forest managers were asked about measures that could be or were already being taken to adapt to the impacts of climate change, as well as about the factors affecting their own adaptive

capacity. The study considered the importance and sufficiency of eight specific determinants of adaptive capacity: (1) the state of awareness and understanding of climate change, (2) perceptions of urgency, (3) the range of technological options available for adaptation, (4) the economic resources available, (5) the institutional factors affecting adaptability, (6) the state of human and social capital, (7) access to information and information management, and (8) risk management. The authors also described existing and potential processes for mobilizing these determinants of capacity and highlighted important barriers to adaptation.

Johnston et al. (2010) reported that high levels of education and experience among professional forest managers in Canada and strong institutions contributed to a relatively high general capacity to adapt. However, they found that technical and scientific capacity related specifically to climate change varied widely and in an overall sense was low. Forest managers typically felt as though they were ill-equipped to evaluate, plan, or implement actions to effect climate change adaptation. One major constraint that the managers identified was a lack of appropriate information about climate change at scales relevant to decision making and planning. In addition, existing policies, rules, and standards (i.e., institutions) were identified as constraining adaptation. For example, current forest policy typically assumes that the future climate and physical environment will remain as they were in the past. Under climate change, this assumption is no longer valid. Forest managers indicated that Canada's forest policies would need to evolve in ways that would help the sector deal more effectively with uncertainty, surprise, and novel conditions. An adaptive capacity issue of growing importance will be the extent to which managers are able to adapt to localized impacts. The interviews indicated that current policy and practice often impair the ability of forest managers to develop and implement new approaches for reducing localized impacts.

### Indicators and mapping

Adaptive capacity indicators are measures that can be reported either spatially (as cross-sectional data) or temporally (as time-series data). Relevant indicators may be based on determinants or assets that are known to contribute to adaptive capacity, such as number of forest managers or forest management expenditures per

hectare of managed land and average education and experience of forest managers. Data can be gathered through studies or surveys or can be obtained from existing sources (such as Statistics Canada census data). For example, census data on average income can be used as an indicator of the financial resources available to individuals in forest-based communities. Similarly, census data on education attainment can be used as an indicator of human capital.

### Properties

Properties are features, characteristics, attributes, qualities, or traits belonging to SFM actors and systems that in some way contribute to their adaptability. Examples of such properties include economic and social diversity, diversity of management options, flexibility in policy making and decision making, responsiveness, size or scale, remoteness, and isolation. The degree of integration among SFM systems is another property-related factor that affects adaptive capacity. The adaptive capacity of a specific SFM system may be affected by its relationships to large and smaller systems. These relationships can affect the flow of information, knowledge, people, finances, and other assets into and out of the SFM system. For example, local SFM systems that are strongly integrated with provincial, national, or international institutions may have greater access to scientific information about the effects of climate change or to climate change experts who can help them understand adaptation challenges and options. However, integration with a higher-order system can also reduce local autonomy or the ability to adapt locally because of the presence of centralized decision-making processes.

### Mobilization

Another approach to assessing adaptive capacity pertains to how SFM systems mobilize adaptive capacity resources once a decision to adapt has been made. That is, if a need for adaptation arises because of changing climatic or environmental conditions, or even in anticipation of future changes, how would resources be mobilized to actually implement adaptation measures? More specifically, what are the institutions and governance processes through which SFM actors and organizations assemble and use resources for adaptation? What kinds of processes, structures, and mechanisms are in place for accessing, combining, and using adaptive capacity resources? The mobilization of adaptive capacity



resources is affected by many factors, including markets, bureaucracies, networks, informal relationships, and public institutions, to name a few. These factors can either support or hinder efforts to mobilize resources.

### Case histories and proxies

A fifth approach to describing adaptive capacity involves the use of proxy measures. Overall adaptive capacity is a condition or state of being that is intangible and difficult to quantify. A proxy measure of adaptive capacity is a quantifiable measure that is related to adaptive capacity, for example, the value of forestry production per hectare of managed land. This measure is potentially valid as a proxy if it can be assumed that investment in adaptive capacity within the SFM system of interest is related to the value of the forests being managed. Other proxies of adaptive capacity include the profitability of the forest industry, rates of unemployment, percentage of allowable annual cut utilized within the managed forests, rates of growth in regional incomes, and the current condition of forests and the general environment.

Case histories can also provide insight into a system's capacity to cope with and adapt to climate change. For example, a case history describing how well a particular SFM system has coped with and adapted to a previous event, such as a significant drought, insect outbreak, or forest fire, can help in identifying strengths and weaknesses in the adaptability of the current management system and associated decision-making processes. An example of the case study approach is provided by Keskitalo et al. (2011), who examined and contrasted disturbance preparedness and response to multiple stresses in the forest sectors of Sweden and Canada (specifically the province of Ontario). These researchers used a comparative case history approach to sketch adaptations in response to economic change and abiotic and biotic disturbances, including globalization of markets, storms, and pest outbreaks. They also described the influence of policy development on the ability to deal with future stress. Their assessment approach employed several case histories of disturbance events to understand and evaluate preparedness, planning, and management. The researchers also conducted a literature review, interviews, secondary document analysis, and surveys to understand policy responses to events that are anticipated to become more frequent under climate change (specifically, storm and pest disturbances). They

then compared and contrasted the policy responses to understand how they contributed to adaptive capacity. The research team concluded that access to economic assets was central for adaptation to economic stress, whereas institutional structure and governance were vital for the mobilization and deployment of information and skills related to biotic and abiotic disturbance. The study indicated that institutional capacity in forest management can be improved through enhanced planning and through information and skill development. Integrating proactive policies and adaptation measures was considered an option to better position forest managers to deal with climate-related stress.

### Distribution

Descriptions of adaptive capacity might also include assessments of how adaptive capacity differs among individuals, groups, or communities within an SFM system, a property referred to as the distribution of adaptive capacity.

An example of an assessment of the distribution of adaptive capacity was the 2007 national climate change assessment (Lemmen et al. 2008). For that project, researchers from various government agencies and universities across Canada contributed to a national assessment of regional vulnerabilities and opportunities presented by climate change. The assessment focused on human and managed systems of all types, and it characterized specific factors influencing adaptive capacity in different regions and sectors. The sources of information were the published scientific and technical literature and expert knowledge. The assessment approach involved describing several determinants of adaptive capacity using either qualitative data descriptions or proxy indicators and reaching general conclusions about the status and distribution of adaptive capacity. On the basis of their assessment, the researchers concluded that overall national adaptive capacity was high, thanks to Canada's relative wealth, high levels of education, substantial access to technology, and strong and effective institutions. However, adaptive capacity was found to be unevenly distributed among and within regions, sectors, and communities. For instance, communities reliant on renewable natural resource sectors (agriculture, fisheries, forestry, tourism, recreation, etc.) for employment, as well as Aboriginal communities strongly dependent on natural resources

both economically and culturally, were identified as being highly sensitive to ecosystem change. For many of these communities, the ability to adapt was constrained by limited economic resources, poorly diversified economies, isolation from services, and limited access to education. Conversely, strong social networks, attachment to community, high levels of local and traditional knowledge, and high rates of volunteerism were found

to strengthen communities' adaptive capacity. In the far north (e.g., the Arctic), where climate change impacts are expected to be much greater than in more southern regions of Canada, adaptive capacity was thought to be especially limited because of the small and widespread population, changing governance and institutions, a substantial subsistence economy, and inadequate infrastructure.

## ANALYZING ADAPTIVE CAPACITY—IS IT ADEQUATE?

The second category of approaches to assessing adaptive capacity is based on analysis, with the aim of answering the question, Does climate change have implications for adaptability, and if so, what are they?

This second category of approaches encompasses methods that support analysis to better understand

- adaptive capacity requirements;
- efficiency or effectiveness in mobilizing adaptive capacity resources;
- equity of distribution;
- system failures that are preventing appropriate investment in adaptive capacity, thus creating adaptive capacity deficits.

### Requirements

One way to evaluate adaptive capacity requirements at a general level is to consider the social and economic values that are at risk. For example, one of the values at risk is timber supply and the employment income and revenues gained from harvesting, transporting, and processing the timber. The value of the ecosystem services that the forest provides, including biodiversity and carbon sequestration, can also be very important. The greater the value that the forest provides, the more important it may be for the SFM system to have adequate adaptive capacity and thus the greater the investment in adaptive capacity that may be justified.

General requirements for adaptive capacity may also be based on the magnitude of impacts (or variability) facing or expected for the SFM system. For example, greater adaptive capacity may be needed in SFM systems that deal more frequently with large disturbance events or mill

shutdowns. In addition, adaptive capacity requirements may change over time. For example, requirements for adaptive capacity in a particular SFM system might increase in the future, as the magnitude, incidence, and frequency of social, economic, and environmental impacts increase because of a continuously changing climate. To understand how requirements may change in the future, forward-looking scenarios of climate, forest, economic, and social conditions may be useful. For more information on developing and using scenarios for SFM, see *Adapting Sustainable Forest Management to Climate Change: Scenarios for Vulnerability Assessment* (Price and Isaac 2012).

Analysis of adaptive capacity requirements might also involve considering the adaptive capacity outcomes and properties that are desired. Decision makers could be asked, for example, if the SFM system (or some element of it) is sufficiently responsive, prepared, proactive, flexible, diverse, or adaptable in an overall sense. If it is determined that the existing adaptive capacity cannot achieve desired outcomes or does not possess desired properties, then management actions to correct the deficiencies may be warranted.

Analysis of adaptive capacity requirements may also be based on an assessment of the adequacy of individual determinants of adaptive capacity. Given a particular context for decision making, such an assessment might consider whether the requirements for particular determinants of adaptive capacity, such as human capital, social capital, knowledge capital, institutional capital, or governance, are sufficient or must be adjusted or enhanced. For example, the following two questions pertain to the need or requirement to modify human capital under a changing climate:

Does climate change necessitate that forest managers, decision makers, and stakeholders increase their knowledge and understanding of the science of climate change, of the current

and future impacts of climate change, and of available adaptation options?

Does climate change necessitate higher levels of knowledge and understanding to enable the development of innovative solutions to climate change–related challenges?

## Effectiveness and efficiency

Some individuals, organizations, and groups will be more effective and efficient than others at mobilizing resources for adaptation. Greater effectiveness means a better ability to achieve desired objectives. Greater efficiency means an ability to do so at a lower cost-to-benefit ratio (i.e., for two organizations that can achieve the same objective, the one that does so at a lower cost is more efficient). Effectiveness and efficiency may be difficult to measure. However, case histories from the first component can be used to learn how effectively and efficiently resources have been used to deal with stress caused by past natural disasters, economic downturns, or other stressors. This type of analysis involves assessing how the resources were used to adapt, as well as the relative success of the adaptation. Another approach would be to examine the system's effectiveness and efficiency in reaching its current goals, such as overall sustainability objectives.

## Equity

SFM decision makers may be interested in the distribution of adaptive capacity and relevant resources among different SFM actors and stakeholders, both for the current generation and for future generations (i.e., intergenerational equity). As such, one approach to analyzing adaptive capacity is to determine whether the distribution of adaptive capacity resources (i.e., who has what) is equitable, fair, and just. It is important to note, however, that redistribution to address inequities requires taking resources from one group in society and giving them to another group. Decisions about redistribution are typically made collectively and democratically within a society and are therefore often outside the scope of forest management decision making. However, forest managers could have a potential role in identifying and advocating for particular SFM actors and stakeholders with low adaptive capacity.

## Deficits

Another approach to analyzing adaptive capacity is to assess whether gaps exist between desired (or ideal) and actual adaptive capacity. Such gaps are referred to as adaptive capacity deficits (Williamson et al. 2012b). It is not possible to identify such deficits by comparing existing adaptive capacity against some optimal but unknown adaptive capacity standard. It can be logically assumed, however, that if individuals are rational and if institutions are functioning efficiently and effectively, then adaptive capacity will likely be at its socially and economically desired (ideal or optimal) level. If, on the other hand, available information is not being used, or the choices of decision makers are biased or irrational, or aspects of the system are out of date, inefficient, or skewing (biasing) decisions about investment in adaptive capacity, then an adaptive capacity deficit may exist. Thus, a pragmatic approach to identifying adaptive capacity deficits is to identify potential causes (e.g., market failure, social system failure, governance failure, irrational or biased decision making) and to show how they might result in too little adaptive capacity.

A specific example of an adaptive capacity deficit might be a situation in which the institutions that govern decision making in climate-sensitive sectors have not yet incorporated climate change considerations where it is appropriate to do so (given the spectrum of other factors that influence decision making). Sector capacities to support justifiable adaptation, therefore, are likely lower than what might be considered optimal or justified given the challenges posed by climate change and variability. Such institutions may, in fact, be creating barriers to adaptation. Another example of an adaptive capacity deficit is insufficient investment by an organization or agency in the knowledge and specialized human resource skills needed to understand and prepare for climate change, where such investments are feasible and justified.



## MANAGING ADAPTIVE CAPACITY—WHAT CAN BE DONE?

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The final group of approaches and techniques in assessing adaptive capacity pertains to higher-level options or actions that can be taken to manage (i.e., enhance or modify) the adaptive capacity of SFM actors and organizations. A good place to start in determining management actions is to describe the kinds of adaptive capacity outcomes desired. Some of the reasons for investing in adaptive capacity include desires to enhance responsiveness, resilience, preparedness, and flexibility. Enhancing knowledge of when and where to adapt and enhancing the ability to successfully implement adaptation measures that reduce impacts in an efficient, effective, and feasible manner might also be desired goals of management. Managers may also wish to enhance diversity or flexibility or both.

If the analysis described in the second component, above, shows or suggests that an SFM system is sufficiently responsive, prepared, proactive, flexible, diverse, or adaptable in an overall sense, then actions to manage or modify adaptive capacity may not be required. In this situation, periodic reassessment will be helpful to ensure that adaptive capacity remains at an appropriate (or desired or optimal) level. However, if the analysis shows that the system's adaptive capacity cannot achieve desired outcomes or does not possess desired properties, then management actions may be warranted.

A number of options and approaches are available for managing adaptive capacity. The choice of specific actions will depend on the extent to which results from the analysis component identify or point to needs and requirements. Assessing the feasibility of various management options is also important. Some options for enhancing adaptive capacity may be more “doable” than others because SFM actors have more direct influence

or control. For instance, a forest manager may have significant input into forest management planning for his or her SFM system; as a result, changes can be made quickly and effectively. Yet the same forest manager may have less influence on the development and direction of SFM policy in his or her jurisdiction, with some adaptive capacity actions being taken at higher levels or over longer time frames. Although certain SFM actors have less direct control over broader time frames and larger geographic scales, knowing that adaptive capacity management actions are warranted is valuable to allow communication of the requirements to those with influence on such decisions.

Broad approaches for managing adaptive capacity include investing in adaptive capacity determinants, reducing adaptive capacity deficits, addressing inequities in distribution, and modifying governance and institutions to reduce barriers and enable justifiable adaptations.

### Investing

Enhancing adaptive capacity can involve investing in, building, or increasing determinants or assets (described in the first component, above). The analysis undertaken in the second component should aid in identifying priority determinants or assets that are limiting or constraining adaptation. Some examples of enhancing adaptive capacity assets include

- increasing scientific knowledge of impacts and adaptation;
- developing adaptation tools to support forest management decision making at multiple levels;
- embedding climate change experts into resource management organizations;
- including training about climate change impacts and adaptation in university curricula;
- advancing climate change knowledge through professional education and training;

- increasing awareness about risks and vulnerabilities related to climate change;
- establishing and maintaining communities of practice and networking opportunities related to climate change.

The following question is an example of what might be asked in considering the management of human capital:

If it is determined (through an assessment of requirements) that human capital should be enhanced in preparation for climate change, what are the feasible options for new or increased investment to increase the levels of knowledge and understanding of climate change impacts and adaptation among forest managers, decision makers, and forestry stakeholders for the SFM system of interest?

## Reducing deficits

The approach of reducing adaptive capacity deficits involves taking action to address the issues (i.e., social, economic, behavioral, and institutional failures) that are preventing actors from achieving what might otherwise be considered an appropriate (or optimal) level of adaptive capacity. Achieving this goal is not necessarily easy or straightforward. However, it may be the most important and effective way of reducing the vulnerability of an SFM system to climate change. As noted in the analysis section above, adaptive capacity deficits arise when decisions are made without full information, when decisions are biased or based on irrational judgments, or when institutions and decision-making processes have not been updated to reflect changed circumstances in the decision-making environments. The factors contributing to adaptive capacity deficits include (1) forest management policies, objectives, and practices that do not account for climate change; (2) planning approaches that do not account for expected changes in climate and in forests; (3) organizations and managers within organizations that are insufficiently informed about climate change impacts and adaptation options; (4) barriers in accessing available science and knowledge; and (5) knowledge gaps related to impacts and adaptation. Corresponding examples of management actions to address these issues would be (1) modifying objectives to account for future climate change (e.g., modifying the criteria and indicators of

SFM to include climate change), (2) including scenarios of future climate change and future forest conditions into long-term forest management planning processes, (3) increasing awareness about climate change and supporting professional education about the effects of climate change on SFM systems, (4) ensuring that science and knowledge about climate change impacts and adaptation are relevant and accessible, and (5) supporting scientific research and knowledge exchange efforts to address information gaps that represent barriers to adaptation.

## Addressing inequities

One possible approach for managing adaptive capacity is to redistribute adaptive capacity resources. For instance, some resource-based communities and communities located in forested areas may be vulnerable to climate change impacts because they have relatively low adaptive capacity. They may, for example, have less access to economic and information resources for adaptation than other types of communities. A potential role for forest managers is to engage with, and provide a voice for, groups or communities that are vulnerable to climate change because of potentially high impacts and relatively low adaptive capacity. Forest-based communities may have both a stake and a role in the management of forests under a changing climate. These are areas where, in turn, forest managers have both interest and influence.

## Governance and institutions

Investing in determinants, reducing deficits, addressing inequalities, and removing barriers to adaptation may involve developing new institutions and approaches to governance or modifying existing ones. For example, decentralization of power and authority and creation of more polycentric systems of governance may be options for empowering and enabling more effective local adaptation and providing local flexibility. However, if there is insufficient capacity for implementing adaptation measures at local scales, there is a risk of failure or other unintended consequences (i.e., maladaptation).

Institutional change could also involve establishing new mechanisms for cooperation, collaboration, development of climate change science, sharing of knowledge, and creation of partnerships. Inclusive policy development and implementation that encourage innovation, learning,

and adaptive management may also contribute to adaptive capacity. New or modified governance and management institutions or arrangements that include a diversity of measures and instruments and are sufficiently flexible to deal with a range of possible future impacts can also support adaptation. Conducting climate change assessments, developing and implementing adaptation strategies (including allowance for climate change effects in forest management planning), and mainstreaming adaptation into policy and decision making are other options for institutional change that may enhance adaptive capacity and facilitate adaptation.

Brown (2009) described an adaptive capacity assessment that examined governance and institutions in terms of implications for adaptive capacity. This investigator examined the collective response to climate change of governments, industry, civil organizations, First Nations, and communities involved in the forest sector of Ontario. The assessment approach focused on the specific processes of creating networks and sharing information to highlight their influence on the overall institutional

adaptive capacity of the Ontario forest sector. The approach was primarily descriptive, and the institutional networks and responses were not assessed against any particular standard. However, Brown (2009) used insights from the published literature to draw conclusions about the effects on adaptive capacity. She also described inter-institutional networks that have arisen in response to climate change, their composition, and the opportunities they present for exchanging knowledge. She found that some innovative networks had emerged at the provincial level, including an expert panel of diverse players that was advising the government on how to address climate change. She also found that expanding the networks connecting provincial governments and local institutions would enhance the adaptive capacity of vulnerable groups such as First Nations and forest-dependent communities. To improve policy learning and the transfer, receipt, and integration of knowledge, she also suggested a “network broker” or “collaborative capacity builder” to help enhance these capacities in Ontario’s forest sector institutions.





Photo: Tim Williamson



## ILLUSTRATIVE EXAMPLES

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Two examples of assessment approaches are provided below. The first hypothetical example illustrates a comprehensive assessment that links aspects of description, analysis, and management. The second example presents a tool for assessing the readiness (or capacity) to adapt to climate change at an organizational level.

### **A comprehensive assessment of adaptive capacity**

As noted earlier, there is no single correct way to assess adaptive capacity. Various approaches have been presented in this report, organized into three groups: those suited to description, those suited to analysis, and those suited to identification of management options. Ideally, an assessment of adaptive capacity of SFM systems (or elements of SFM systems) will be based on one or more approaches from each of these broad categories to support decisions about whether there is a need to adjust adaptive capacity and if so, how?

One method for assessing the adaptive capacity of an SFM system is to collect qualitative data through interviews with forest managers, decision makers, and stakeholders. The questions about human capital presented in earlier sections of this report demonstrate the kinds of qualitative data that support description, analysis, and the identification of management options as part of adaptive capacity assessment. These questions are compatible, consistent, and closely linked (i.e., they consider description, analysis, and management of a

particular aspect of adaptive capacity sequentially). Although these questions focus on the human capital of an SFM system, it is important to note that human capital is only one aspect of overall adaptive capacity. The questions pertaining to description, analysis, and management of human capital are repeated below to demonstrate and illustrate the linkages between description, analysis, and the identification of management options within a comprehensive assessment of adaptive capacity.

#### ***Description using a determinants approach focusing on human capital:***

Question 1: What is the general level of experience, education, training, and skill of forest managers, decision makers, and forestry stakeholders within the SFM system of interest, and what are the key factors that contribute to current education, training, and skills?

Question 2: What is the current level of understanding and awareness of forest managers, decision makers, and forestry stakeholders regarding the potential impacts of climate change on the SFM system of interest and of adaptation options for minimizing negative impacts and maximizing opportunities?

#### ***Analysis using a requirement-based approach focusing on human capital:***

Question 3: Does climate change necessitate that forest managers, decision makers, and stakeholders increase their knowledge and understanding of the science of climate change, of the current and future impacts of climate change, and of available adaptation options?

Question 4: Does climate change necessitate higher levels of knowledge and understanding to enable the development of innovative solutions to climate change-related challenges?

### **Identification of management options using an investment approach focusing on human capital:**

Question 5: If it is determined (through an assessment of requirements) that human capital should be enhanced in preparation for climate change, what are the feasible options for new or increased investment to increase the levels of knowledge and understanding of climate change impacts and adaptation among forest managers, decision makers, and forestry stakeholders for the SFM system of interest?

### **An approach for assessing organizational adaptive capacity**

Forest management organizations and the individuals they employ are at the core of SFM systems. The readiness of an organization to adapt to climate change reflects its adaptive capacity. Gray (2012) has developed and described a tool for assessing the readiness of organizations to adapt to climate change. This assessment tool is tailored for organizations that already practice or participate in SFM. The approach involves assessing readiness for adaptation to climate change by identifying functions and tasks that enable organizations to make such adaptations. The framework consists of 10 themes, organized under three broad groupings. The themes are presented as organizational tasks, principles, or functions that, if achieved, would contribute to the readiness of the SFM organization to deal with climate change. The themes are related to the determinants of adaptive capacity identified in the section on describing current adaptive capacity (above), but they are much more specific to SFM organizations. Sample questions for each theme are provided here to illustrate the kind of information that would support an assessment of organizational readiness (see Gray [2012] for a more complete list of questions).

#### **1. Place- and time-based perspectives: providing contextual scale**

Theme 1: Describe forested ecosystems and other types of planning areas in space and time.

What scales of ecosystem mapping and monitoring are available, and how do mapping and monitoring programs support a transdisciplinary approach to adaptation in a rapidly changing climate?

What time frames are needed to monitor the known and potential impacts of climate change on economic, cultural, and social values?

#### **2. Community-empowered conditions: enabling a coordinated societal response**

Theme 2: Use SFM principles, establish and maintain trusting relationships, engage people, and account for the spectrum of values of natural assets.

How do the guiding principles used by the organization support its commitment to adaptive SFM?

Theme 3: Ensure that institutional culture and function can foster an adaptive approach to decision making.

How does the management process sponsored by the organization provide for ongoing assessment of allocation decisions and for modification of those decisions as the climate changes?

Theme 4: Promote informed leadership.

How does the organization inform staff about the tools and techniques of an adaptive approach to management in a changing climate?

Theme 5: Create and support the partnerships needed for adaptive decision making and program management.

How does the organization work with other organizations to facilitate better decision making at the ecosystem level of natural asset allocation and management?

#### **3. Knowledge-driven programs: developing and implementing the best mix of tools and techniques**

Theme 6: Embrace an ecologically oriented approach to adaptive management by thinking and planning strategically for the long term.

How does the organization's strategic plan support ecologically meaningful management in a rapidly changing climate?

Theme 7: Implement “climate-ready” policy, legislation, and regulation to achieve and maintain SFM objectives.

How do current policies sponsored by the organization provide for an adaptive approach to decision making in a rapidly changing climate, and how do they inform adaptive SFM?

Theme 8: Gather knowledge through research, inventory, monitoring, and assessment, and manage this knowledge to support decisions that will reduce the negative effects of climate change and unanticipated outcomes.

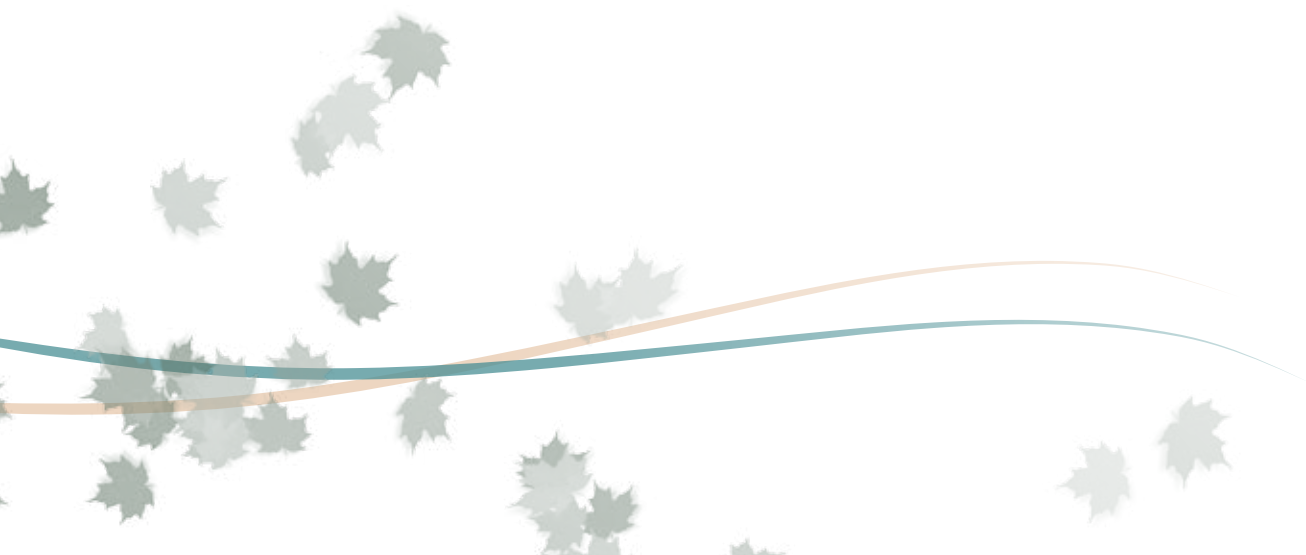
How does the organization’s knowledge management system support climate-related data and information for use in adaptive SFM (e.g., to answer questions about how ecosystems are responding to the short- and long-term impacts of climate change and what monitoring programs need to be implemented to detect these changes)?

Theme 9: Communicate and share knowledge through education and extension.

How do the organization’s communication tools and techniques address adaptive SFM in a rapidly changing climate?

Theme 10: Implement adaptations into operational practice.

How does the organization use an adaptive framework to evaluate and respond to the known and potential impacts of climate change?





## CONCLUSIONS

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An important consequence of climate change is that the adaptability requirements of Canada's SFM system will increase. This report has outlined a variety of approaches

and options for describing, analyzing, and managing the adaptive capacity of the human management component of SFM systems. The range of approaches and options for assessing adaptive capacity presented here offers flexibility and permits tailoring of the assessment to generate desired results, given the resources available. Hypothetical examples of assessment methodologies are also provided.

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## GLOSSARY

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**Actors** | Sustainable forest management actors include individuals, firms, organizations, agencies, and communities that have a role in, influence on, or stake in the sustainable management of forests.

**Adaptation** | “Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (Parry et al. 2007).

**Adaptation options** | Potential actions or activities to address or reduce the vulnerabilities identified in a vulnerability assessment.

**Adaptive capacity** | “The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences” (Parry et al. 2007). In this report, adaptive capacity refers to the human (as opposed to the biological) components of the sustainable forest management system.

**Adaptive capacity assessment** | Assessment of (1) the human and institutional resources and capacities available to identify adaptation requirements and to implement adaptation actions (e.g., human capital social capital); (2) the structural attributes, properties, and characteristics that affect the ability of a system to adapt (e.g., flexibility, rigidity, diversity, liquidity, substitutability); and (3) the factors that impair optimal choices related to adaptation and adaptive capacity requirements (e.g., inefficient institutions, critical knowledge gaps, lack of awareness, biased perceptions of risk).

**Climate** | “Climate in a narrow sense is usually defined as the ‘average weather’, or more rigorously, as the statistical description in terms of the mean and variability

of relevant quantities over a period of time ranging from months to thousands or millions of years. These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. The classical period of time is 30 years, as defined by the World Meteorological Organization (WMO)” (Parry et al. 2007).

**Climate change** | “Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), which defines ‘climate change’ as: ‘a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods” (Parry et al. 2007).

**Climate variability** | “Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. The term is often used to denote deviations of climatic statistics over a given period of time (e.g. a month, season or year) from the long-term statistics relating to the corresponding calendar period. In this sense, climate variability is measured by those deviations, which are usually termed anomalies. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability)” (WMO n.d.).

**Coupled human–environmental system** | A concept commonly used in the resiliency and vulnerability literatures to refer to a group of actors (e.g., government agencies, firms, communities, citizens) with strong linkages to a natural ecosystem (e.g., a forest ecosystem), where the linkages between the human and natural systems are regulated and controlled by institutions.

**Ecosystem** | “The interactive system formed from all living organisms and their abiotic (physical and chemical) environment within a given area. Ecosystems cover a hierarchy of spatial scales and can comprise the entire globe, biomes at the continental scale or small, well-circumscribed systems such as a small pond” (Parry et al. 2007).

**Ecosystem services** | “Ecological services or functions having monetary or non-monetary value to individuals or society at large. There are (i) supporting services such as productivity or biodiversity maintenance, (ii) provisioning services such as food, fibre, or fish, (iii) regulating services such as climate regulation or carbon sequestration, and (iv) cultural services such as tourism or spiritual and aesthetic appreciation” (Parry et al. 2007).

**Mainstreaming adaptation** | Inclusion of climate change considerations in day-to-day decision making and management on a continuous and ongoing basis.

**Resilience** | “The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change” (Parry et al. 2007).

**Scenario** | “A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections, but are often based on additional information from other sources, sometimes combined within a ‘narrative storyline’” (Parry et al. 2007). Scenarios are not predictions, and they typically do not include prediction errors or likelihoods.

**Sustainable forest management** | “Management that maintains and enhances the long-term health of forest ecosystems for the benefit of all living things while providing environmental, economic, social, and cultural opportunities for present and future generations” (CCFM 2008).

**Sustainable forest management system** | A coupled human–environmental system that obtains goods and services from forests and works toward the management of forests in a manner consistent with sustainable forest management (SFM) principles and objectives. SFM systems vary with spatial, operational, and organizational contexts. An SFM system can exist at any scale, including provincial forests, community forests, protected areas, industrial lease areas, and small private woodlots.

**Vulnerability** | “The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity” (Parry et al. 2007).

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