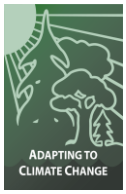
Increasing Adaptive Capacity



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Barriers to adaptation

The ultimate impacts of climate change on society depend on 1) the type and magnitude of changes in biophysical processes and on 2) the adaptive capacity of the coupled social and ecological system affected (based on Johnson and Williamson 2007). Adaptive capacity includes the ability to limit potential damages, to take advantage of opportunities, or to cope with consequences (IPCC 2007a). It is closely tied to resilience. The adaptive capacity of a society depends in part on institutions and networks that support learning, store knowledge, facilitate flexible problem solving and balance power among interest groups (Resilience Alliance[1]).

Although no cohesive theory allows quantification of adaptive capacity (Williamson and Isaac, forthcoming, cited in Pearce 2012), from a practical perspective the short-term adaptive capacity of forest management is signalled by the number and magnitude of barriers to adaptation. Barriers limit the identification and implementation of climate-savvy management strategies and preparations for future disturbances. Some barriers are insurmountable: no feasible, beneficial responses exist.

Below we group barriers identified in case studies into four main classes: lack of concern at the regional scale, lack of knowledge, lack of planning capacity and lack of institutional support for innovation and change. Lack of institutional support appears to be the largest barrier identified and may signal insufficient awareness or concern at the provincial level (Table 1)

Table 1. Subjective rating of the relative importance of barriers across all case studies. Ratings range from nil ("—") to high ("XXX") and tend to be consistent across case studies.

Barrier Category	Sub-category	Importance rating
1. Lack of concern	– regional scale	—
	– provincial scale*	XX
2. Lack of knowledge and expertise	– basic biophysical knowledge	—
	– inventory and monitoring	X
	– operational trials	XX
3. Lack of planning capacity	– existing plans	XX
	– existing planning approach	XX
4. Lack of institutional support for change	– economic disincentives	XX
	– restrictive legislation	X
	– weak governance and limited resources	XXX
	– weak professional guidance	X

[1] http://www.resalliance.org/index.php/adaptive_capacity

Lack of concern (*Note that this is a regional perception of provincial concern)

Lack of concern does not appear to be a barrier to adaptation at the regional scale. In all projects, most participants (e.g., managers, researchers, etc.) felt that climate change posed a serious challenge to successful forest management and showed strong interest in learning more about impacts, particularly those within their region. Many participants had a good intuitive understanding of the climate challenge because they had observed climate-related change first-hand (e.g., increased mortality in regenerating stands). Concern may not be ubiquitous: the West Kootenay case study had poor representation from some forest management organisations.

Other studies support high levels of concern among forest managers. Across the Canadian forest sector, awareness of the importance of climate change is increasing (Pearce 2012). In BC, forest managers believe they have a responsibility to ensure forests are resilient and able to cope with climate change (Perez 2012).

Regional participants perceived a lack of provincial concern about climate change. Participants from all projects noted that lack of provincial support and funding posed a barrier to adaptation. Similarly, participants in the West Kootenay project identified an inability to influence appropriate levels of government as a barrier, and noted that senior managers may be unrealistically optimistic about future conditions under climate change (optimism bias). Lack of support does not necessarily reflect lack of concern, however; it may reflect other barriers. In addition, provincial climate-related initiatives are only now becoming visible to a broader audience (e.g. FLNRO 2012) even though work has been ongoing for over seven years.

Awareness and concern are only some of the prerequisites to action. There are a host of underlying psychological factors that can limit willingness to act and these must be addressed in addition to the structural barriers that prevent adaptation (Gifford 2011). There are also other large issues (e.g., health care for an aging population) that divert focus and support from climate-change adaptation.

Lack of knowledge

Lack of knowledge about biophysical systems is not a major barrier to adaptation, once a vulnerability assessment has been completed. Regionally-relevant information about climate change and ecological responses is voluminous and scattered among disciplines. It can be overwhelming (according to participants in West Kootenay); however, it becomes manageable when synthesized in the context of a vulnerability assessment (observations from all case studies). West Kootenay participants felt scientific, local and traditional knowledge synthesizing in their case study would help support adaptation.

Lack of basic inventory and monitoring information hinders adaptation. A recent report by the Auditor General confirms that existing forest monitoring and reporting are inadequate (Auditor General of BC 2012) even without considering climate change. Post-free-growing stands are largely ignored. All three case studies identified new monitoring as a necessary component of adaptation for several management issues. Knowledge synthesized in vulnerability assessments is sufficient to develop hypotheses about appropriate adaptation strategies but the costs and benefits of adaptation remain uncertain. Reducing uncertainty and improving adaptation require a better understanding of underlying

conditions (e.g., watershed assessments and inventories) that help predict ecological responses to climate and increased monitoring to determine which of several potential climate-related changes is occurring (e.g., tree disease surveys).

Lack of operational research and/or cost-benefit analysis hinders adaptation. West Kootenay participants identified lack of investment in research and innovation as a barrier. Further operational research and analysis is needed to clarify implementation costs, risks to non-target values and the magnitude of benefits related to adaptation. Essentially, substantial operational trials are needed to test adaptation hypotheses. There is a critical need to "operationalize" adaptation measures for reforestation (Perez 2012).

Lack of adequate knowledge should not be used as an excuse for inaction. Not acting is a decision that should be made consciously and that should be supported by best available information. Approaches exist for coping with uncertain knowledge, such as using the precautionary principle (Gollier and Treich 2003) or risk assessment (Burgman 2005).

Lack of planning capacity

Although inventory, monitoring and operational research are considered as knowledge in the section above, they can also be considered as an integral part of the planning process.

Existing plans are inadequate. All projects indicated that existing plans do not account for climate change and will need to be revised. All scales of plans need attention, however broad-scale strategic plans (e.g., strategic land use plans, timber supply analyses, wildfire plans, and watershed assessments) are a top priority because of their longer time frame and hence greater exposure to climate change.

Existing planning approaches hinder adaptation. The Kamloops project specifically identified the lack of a comprehensive, strategic and persistent planning process as a barrier that prevents 1) sharing information (e.g., fire management strategies developed without available ecological information), 2) evaluating consequences of management across all forest values, and 3) developing a coherent management approach across scales (e.g., linking wildlife tree patches and old growth management areas to form a connected network). West Kootenay participants also identified the need to link plans addressing stand and landscape scales. In addition to addressing these challenges, planning must evolve to account for cumulative effects (e.g., development plus climate change) and uncertainty (e.g., alternative climate futures) and to foster learning to reduce uncertainty (Ludwig 1993). Planning must become an ongoing process that can respond to change (all case studies). Sustainability is a journey, not a destination[2] (based on Plato's concept of perfection). Continual improvement of plans, however, is challenging when budgets are tight: for example Land and Resource Management Plans created in the 1990s have not been updated despite both initial intentions and increasing pressure (Special Committee on Timber Supply 2012) to do so. It will be important to find cost-effective ways to revise plans.

[2] http://www.guardian.co.uk/sustainability/blog/sustainability-journey-destination and other sources.

Lack of institutional support for innovation and change

"Lack of institutional support for innovation and change" may best summarize the suite of barriers that hinder the actual implementation of adaptation strategies. Despite considerable research addressing adaptation, action is lacking (Hallegate 2009). Disincentives include lack of profit and restrictive legislation (mainly affecting licensees), lack of mandate (mainly affecting government), and lack of professional support.

Lack of economic benefit hinders adaptation. Licensees perceive that the costs and risks of adaptation likely exceed benefits to the company. Company forest managers expressed an unwillingness to take steps that increase costs (e.g., expensive planting stock, higher costs of harvesting disturbance-susceptible stands first) or risks (e.g., failure to reach free growing) without short-term benefit (discussion from all studies). Under a corporate model, benefits related to adaptation that occur in the mid- to long-term are subject to substantial discounting. Also, under volume-based tenures, future benefits are not secure: they may accrue to a competing company or to the public. Overall, the economic motivation for companies to undertake proactive adaptation seems limited. Government may need to share in costs and risks.

Legislation and policy that do not consider climate change hinder adaptation directly, by prohibiting certain actions, and indirectly, by increasing costs and risks faced by licensees who undertake adaptation (see lack of economic benefit above). For example, case studies suggest that legislation and profit-oriented objectives act together to hinder novel stocking prescriptions (i.e., different tree species and/or density):

- regulations discourage use of species that have no commercial value[3];
- company foresters must invest time and effort to prepare rationales for novel stocking;
- novel stocking standards increases the risk of delayed approval or rejection of forest stewardship plans;
- novel stock may cost more to procure;
- novel stock may fail on some sites, requiring licensees to replant.

Uncertainty about success no doubt contributes to an unwillingness to propose novel stocking. At the present time, forestry practitioners have mixed feelings about whether climate change projections are sufficiently reliable to support implementation of non-standard reforestation strategies (West Kootenay).

Free-growing policy motivates short-term thinking and promotes the use of fast growing conifer species (Pearce 2012). Licensees are responsible for the first ten to fifteen years of a regenerating stand, until free growing status is reached, thus, logically their main priority is to establish a stand that is most likely to reach free-growing, not one that is most likely to be resilient to climate change over a rotation.

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[3] Forest Planning and Practices Regulation, S26. Accessed August 6, 2013 from http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/14_2004

Relaxing legislation will not necessarily support adaptation. In general licensees do not try to achieve non-legal objectives that are costly, for obvious economic reasons. Rather, legislation and policy that promotes adaptation should be developed.

Lack of effective governance and resources hinder adaptation. Government has responsibility for establishing the legal framework for forest management; determining broad patterns of land use; and managing Parks, Protected Areas and post-free growing stands. The declining staff and financial resources available to natural resource ministries have reduced its adaptive capacity, impeding forestry practitioners from undertaking "non-essential" tasks (West Kootenay), such as adaptation. Previously, government staff were told to consider climate change in their decisions (MOE 2010), however to the extent that an adaptation mandate exists, its implementation has appeared fragmented and uncoordinated. The legal framework and planning mechanisms that would support adaptation do not yet exist; and district-level forest managers do not have a clearly defined mandate to implement adaptation in their District. As well, West Kootenay specifically identified an inability to influence appropriate levels of government as a barrier. The current management system makes collaborating with provincial managers (e.g., to change landscape targets) and with other branches (e.g., for water management) challenging.

Lack of clear adaptation objectives further undermines the mandate of government managers to undertake adaptation. Under the Forest and Range Practices Act (FRPA), government forest managers are not directly responsible for developing and implementing management strategies; rather their main role is to ensure that company-developed strategies are not inconsistent with publically defined management objectives. Without clear objectives and enforceable requirements for adaptation, government cannot apply pressure on licensees to adapt; and existing higher level plans do not take the impacts of climate change into account. Currently, FRPA objectives are designed to avoid unduly constraining timber supply and thus are at odds with several adaptation measures.

Since the time of the case studies, the provincial government has developed a series of initiatives to address adaptation shortcomings, including FLNRO's *Forest Stewardship Action Plan for Climate Change Adaptation* (FLNRO 2012), which identifies a set of goals (and objectives) for climate change adaptation in the forestry sector: foster resilient forests; maintain future options and benefits; build adaptive capacity. As well, FLNRO is seeking to introduce vulnerability assessment for high-risk values and areas and is reviewing methods to conduct assessments. These initiatives would signal emerging leadership, however a broad suite of training and resources necessary to enable adaptation have not been identified and secured.

Lack of professional leadership also hinders adaptation. BC's results-based forest management model is implemented through professional reliance—professionals are required to protect the public interest and the environment in the conduct of their duties based either upon sound stewardship principles (e.g., Association of BC Forest Professionals) or guidelines for sustainability (e.g., Association of Professional Engineers and Geoscientists of BC). Stewardship principles related to climate change are just emerging and need to be disseminated and clarified. Unlike engineering and planning professions, the Association of BC Forest Professionals has not provided guidance or training on how to consider and

incorporate climate-change in professional decisions (Gage 2011), thus, creating uncertainty about the appropriateness of novel strategies and tension between those foresters that propose and those that approve strategies (Pearce 2012). As well, professional reliance functions best when objectives for a management unit are known and agreed to by stakeholders. Once climate-savvy objectives are developed, company professionals can incorporate planning for climate change that addresses both company needs and societal values.

Recommendations for removing barriers to adaptation

Many of the barriers to adaptation described above arise from the current structure of the forest management system in BC. Overcoming these barriers will require a greater investment in research, monitoring and planning and changes to legislation, policy and to government mandates.

Increase knowledge

Develop regional learning programs to improve knowledge and support decision-making. Box 1 outlines different types of knowledge gaps related to climate change. A substantial number of papers addressing climate change call for adaptive management as a means of dealing with the uncertainty created by climate change (e.g., Glick et al. 2009, CCSP 2008). Here we use the term "regional learning program" to avoid pre-conceived notions of adaptive management. Learning is intended to be broad in scope and methodology and can take a variety of forms:

- synthesize existing knowledge;
- improve inventories needed for planning;
- monitor climate trends, ecological responses and responses to adaptation;
- conduct research to understand mechanisms linking climate and ecology
- test adaptation options (e.g., which provenance reduces disease and grows fastest?).

Steps to create a learning program include:

- build on existing regional strengths (e.g., government research staff);
- create a regional climate-change adaptation research/extension position;
- create a framework for recording and disseminating knowledge and for identifying knowledge gaps that can survive staff turnover and institutional restructuring (e.g., Babine Watershed Monitoring Trust[4], Price and Daust 2009);
- create formal and informal channels for sharing information among external researchers, regional researchers, regional and provincial forest managers and interested community members (e.g., articles, conferences, collaborative projects).

[4] www.babinetrust.ca

In addition to providing data and knowledge, a learning program can also cultivate collaboration, partnerships and human capital (recommended for the U.S. Forest Service in Joyce et al. 2008). It could also contribute to the awareness and education of provincial leaders.

The regional scale (e.g., one or more Forest Districts) seems the most appropriate scale for focused learning because adaptation varies by region, and because regional investments can build adaptive capacity (Walker and Sydneysmith 2008). Steps to build adaptive capacity should be locally relevant and build on existing programs and community attributes. In the Nadina area, the core of a learning program already exists: a strong research community (e.g., Bulkley Valley Research Centre[5] and regional FLNRO research staff) and a functioning example of a framework for managing knowledge (e.g., Babine Watershed Monitoring Trust).

Box 1. Knowledge gaps

Improving our ability to manage forests under a changing climate requires undertaking several types of inventory, research and monitoring (example questions shown for each type):

1. **Clarify climate trends in a region (i.e., monitoring).**
   - What are trends in air temperature, rainfall, snowfall, snowpack, runoff, wind, drought, frost-free period, moisture deficits, etc.? (Changes in climate variables drive ecological change.)

2. **Clarify ecological sensitivities to climate change (monitoring, research and adaptive management).**
   - How are hydrological regimes (e.g., timing of peak and low flows and sediment input) responding in different types of watersheds (e.g., glacier versus lake headed)?
   - How are disturbance regimes changing?
   - Which insect and disease agents will benefit most from climate change?
   - How well are post-free growing, immature stands surviving and growing?
   - How does landscape connectivity influence migration and survival of multiple taxa under climate change?
   - How fast is forest encroaching on alpine and what mechanisms limit encroachment?
   - How well do invasive species survive after canopy closure?

3. **Identify high risk areas (watersheds, sites, species; inventory and analysis).**
   - Which watersheds have the potential for high water temperature?
   - Which watersheds have a flashy hydrological regime and might be most susceptible to increased peak flows?
   - Which watersheds have low aquifer volumes and are likely to be more influenced by precipitation events?
   - What sites are susceptible to drought?
   - What sites are susceptible to high shrub competition?
   - Which roads have invasive species?
   - Which species are likely to be at risk in the future?
   - Which recovery plans for species currently at risk need to be revised to account for climate

[5] www.bvcentre.ca

change?

4. **Experiment with a wide variety of new practices (examining benefits and costs using research and adaptive management).**
   - How much does upstream riparian cover influence stream temperature?
   - How does retaining deciduous trees and shrubs influence regeneration success and growth of harvested sites?
   - How much does reforestation with multiple conifer species reduce the risk of plantation failure relative to a monoculture?
   - Do climatically-suitable provenances and species improve regeneration success and growth?
   - How important is downed wood and shade (e.g., due to partial overstory) at retaining moisture on dry sites?
   - What are the costs and benefits of partial-cut salvage harvesting (e.g., harvesting costs, safety, tree growth, forest structure and biodiversity)?
   - How effective is partial-cutting at supporting reforestation of dry sites?
   - How effective are gates at limiting traffic and hunting?

Improve planning capacity

a) **Adjust plans and planning processes: review and revise forest management objectives and strategies to address climate change impacts.** Long-term forest management plans are the vehicle for considering and addressing the effects of climate change (Williamson 2007). The approach to planning must evolve from a "demolition-reconstruction" approach that fails to capitalize on past work and fails to respond in a timely manner. We recommend a "continuous improvement" approach to planning, based on a cycle with five elements (e.g., Rempel et al. 2004): 1) establishing values and goals, 2) planning actions that are most likely to meet those goals, 3) implementing those actions, 4) monitoring and evaluating outcomes, and 5) adjusting plans and management accordingly. Values and goals (step 1) and knowledge (steps 2, 4 and 5) are the backbone of planning. Ultimately step 1 should **create a desired vision for the landscape**, defined by target ranges of structure (e.g., old forest, road density) and function (e.g., water flow regimes), that reflects the management for all values (Baskerville 2002, 1986).

Existing goals for land and resource management (e.g., Land and Resource Management Plans and FRPA) were developed largely without consideration of climate change; they should be updated. For example, the role of forests in climate change mitigation and in supporting autonomous ecological adaptation should be included. Goals for biodiversity will need to be reframed to recognize that climate change brings increased extinction risk and to incorporate concepts such as ecosystem function (Bunnell et al. 2011) and resilience (Campbell et al. 2009). Goals for timber supply may need to be modified to account for increased variability in mortality and disturbance rates, as well as for maintaining ecosystem resilience.

Revising such broad policy requires the collaboration of provincial and First Nations governments and meaningful public involvement. Existing Land and Resource Management Plans provide a starting place. They are based on considerable public involvement and expert input and in most cases still constitute some of the best available information on public values.

Implementing new goals for mitigation and resilience will require a provincial-scale land management strategy (e.g., Pojar 2011), in addition to regional planning.

Much of the information and expertise needed for the learning program can be leveraged to support plan revision. In addition, new planning approaches, discussed below, are needed to address climate change (see also recommendations in Williamson et al 2009).

b) **Use a structured decision-making approach** (e.g., Ohlson et al. 2005) that separates knowledge from values (e.g., Price and Daust 2009). Isolating knowledge allows planners to cope better with the continuously evolving knowledge about climate impacts and the effectiveness of management.

c) **Develop a regional cumulative effects assessment approach** that ensures that all resource development decisions consider climate change and uncertainty (see discussion in Duinker and Greig 2006). To manage sustainably, policies must account for uncertainty. Principles of decision-making under uncertainty are mainly common sense (Ludwig et al. 1993):

- consider a variety of plausible hypotheses about future conditions
- consider a variety of possible strategies
    - favour actions that are robust to uncertainties
    - favour actions that are reversible
    - favour a variety of actions (hedge)
    - favour actions that are informative (probe and experiment; monitor)
- update assessments and modify policies

Similarly, the precautionary principle—err on the side of caution when uncertainty exists—provides a foundation for decision-making, provided that uncertainty can be resolved over time (Gollier and Treich 2001).

d) **Develop a triage approach** (Joyce et al. 2008) to deal with the expected increase in species-at-risk due to climate change (Thomas et al 2004). The current rating system (e.g., rare, threatened, endangered; COSEWIC) and management response treats species as likely to recover if threats are removed. Climate change may invalidate this assumption. A triage approach must be developed with care so that triage does not become an excuse for less conservation effort.

Build institutional support

a) Increase awareness of provincial, regional and local forest managers of the need for climate change adaptation. This step is similar to one recommended for the US Forest Service—providing appropriate climate change information to the multiple actors that influence forestry decision-making (Joyce et al. 2008)—but focuses on provincial decision-makers. This first step is critical because the remaining recommendations require a mandate and resources from provincial leaders. Forest managers and researchers who are already aware of risks posed by climate change are ultimately responsible for spreading information. Ideally, the Association of BC Forest Professionals should develop a stance and

guidance on climate change adaptation. Professional associations can influence members to pay greater attention to climate change and can raise the awareness of provincial leaders (Gage 2011).

b) Provide government support for ongoing learning and planning (as described above). It is difficult for governments to act without public support, however, a recent poll suggests that the Canadian public believes climate change is happening and is a serious concern that is worthy of government action (Borick et al. 2011).

c) Remove legislative and policy barriers. Removal of legislative and policy barriers requires careful consideration. Legislation and policy can constrain adaptation, but also protect forest values by providing minimum performance standards. The costs and benefits of each change need to be weighed. Increasing flexibility in legislation for the purposes of research trials provides one means of advancing climate change adaptation without substantially increasing risk. Increasing flexibility to better address variability in sensitivity provides another means. For example, setting high environmental protection standards that can be relaxed based on professional judgement (e.g., increasing equivalent clearcut area in less sensitive watersheds) provides an economic incentive to engage professional judgement.

d) Create incentives for companies to adapt. The benefits and costs of adaptation to climate change depend on perspective. Companies representing shareholders have different goals and time-frames than governments representing the public. Private enterprise can be encouraged to undertake adaptation that benefits the broader public with legal and economic incentives (e.g., taxes, pricing structures, regulations) and extension (e.g., technology transfer, education), depending on the situation (Figure 6). In the early stages of adaptation, collaborative projects involving forest managers and researchers from various organizations may be useful for developing and testing climate-savvy management strategies.

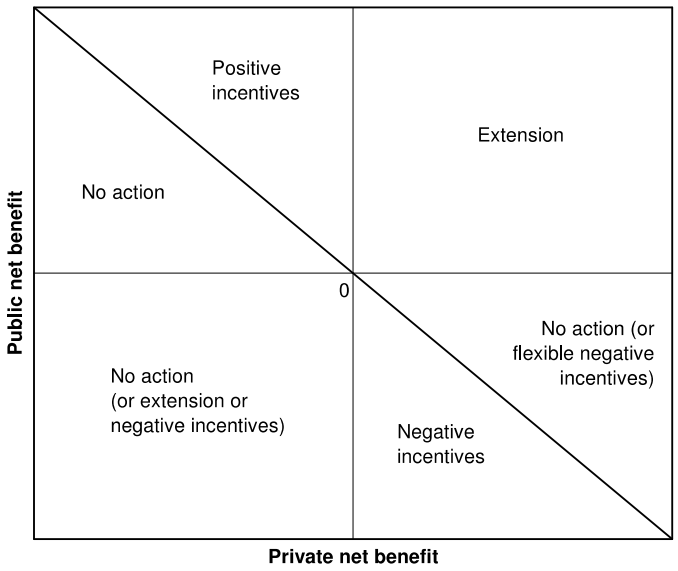

Figure 1. Suggested classes of policy tools for different levels of public and private benefits (from Pannell 2009).

Towards implementing recommendations

Given the magnitude and importance of the recommendations presented above, we believe that the provincial government should use a provincial advisory committee to guide adaptation investment. This work should build upon current knowledge of climate related risks and of barriers to adaptation (e.g., this report; Haeussler and Hamilton 2012). Potential committee tasks follow:

- quantify economic risks and benefits of failure to adapt, and costs and benefits of adaptation;
- identify synergies with mitigation policy;
- secure an appropriate budget to support adaptation (a long-term stable funding mechanism is needed);
- guide implementation of adaptation recommendations;
- strengthen partnerships:
    - collaborate with the federal government, municipalities and First Nations;
    - consult ministries, industry and academia;
    - survey public opinion about the need to adapt to climate change;
    - develop an information-sharing strategy with the public.

Although Canadians are concerned about climate change (Borick et al. 2011), the provincial government will face a major challenge convincing the public to support adaptation with tax dollars because benefits will occur in the future and may be difficult to quantify. A non-partisan committee may be best able to develop a long-term adaptation program. To support the committee's work, the Association of BC Forest Professionals should develop a stance and guidance on climate change adaptation. Professional associations can influence members to pay greater attention to climate change and can raise the awareness of provincial leaders (Gage 2011).

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