

Decision Support Framework: A Mental Model for Integrating the Environmental and Human Dimensions into Decision-Making Related to Changes in Natural Disturbance Events

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Abstract

This discussion paper builds on the synthesis component of the Future Forest Ecosystem Scientific Council (FFESC) project and discusses how current and projected changes in natural disturbance are being linked with existing decision frameworks within government and forest companies in British Columbia. Based on information gathered through an online survey, face-to-face discussion sessions, and a review of the literature, a proposed decision support framework is discussed. This framework is presented in the form of a mental model to provide strategic guidance on one possible way to integrate information related to projected changes in natural disturbance for on-the-ground actions and decisions.

KEYWORDS: changes in natural disturbance; decision support frameworks; risk and opportunities; climate change

Introduction

Almost everything a human being does involves making some form of decision. As the complexity of the decision increases, so does the process involved in making that decision. Decision researchers have divided this decision process into phases or stages (Hansson 1994). For example, Brim et al. (1962) broke the decision process into five steps: 1) identification of the problem; 2) obtaining necessary information; 3) production of possible solutions; 4) evaluation of such solutions; and 5) selection of a strategy for performance. There are many other examples in the problem-solving literature that include various permutations and combinations of these phases, but which retain these core elements (Hansson 1994).

In the forest sector, there are many examples of decision frameworks that people use to support decision-making within their organization. Risk and risk management guidelines (e.g., the International Standards Organization Risk Management 31000 Guidelines) are one example of a decision framework used by many organizations, including the British Columbia (BC) provincial government, to improve their financial planning. The international Standards Organization (ISO) 14000 is a common decision framework used by forest management companies to manage their environmental operating standards. Certification systems such as the Canadian Standards Association (CSA), the Sustainable Forestry Initiative (SFI), and the Forest Stewardship Council (FSC) are also other exam-



ples of decision frameworks that these same forest companies may use to manage their forest management decision-making.

Tools, such as model projections, research and monitoring results, mathematical probability equations, and financial analyses, can provide information in support of these decision frameworks. Typically, information generated from these types of tools flows into one of these structured processes to help users make informed decisions about a specific concern. If the process works effectively, the specific decisions made can be linked back to the information that was used to support them, and the results from these decisions can also be linked back to the original information. If a positive result occurs with the decision process, that same information can be used again. If a negative result occurs, the information used for decision-making can be augmented with new research or data.

So how does this discussion of decision frameworks connect to expected changes in natural disturbance in British Columbia? There has been a surge of new research, provincially, nationally, and internationally, in the area of climate change and the projected changes in regional climate, much of which calls for immediate action and change to ensure the resiliency of ecosystems and human systems. With the immediacy of actions suggested by this new information, will the suggested changes that affect forest and range productivity and human systems become part of the knowledge set that is currently linked to decision frameworks used to manage those systems? Has this information also been included in the strategies or actions that are currently being undertaken to address some of the environmental changes (positive or negative change) as a result of these shifts? This article will build on the synthesis component of the author's Future Forest Ecosystem Scientific Council (FFESC) project and discuss how current and projected changes in natural disturbance are being linked with existing decision frameworks used by the provincial government and forest companies operating in British Columbia. Based on information gathered through an online survey, face-to-face discussion sessions, and a review of how other organizations and agencies from other jurisdictions are addressing this issue, a potential decision support framework is proposed and discussed. The purpose of this framework is to help provide some guidance on one possible way to integrate information related to projected changes in natural disturbance into on-the-ground decisions and actions. The decision framework is presented in the form of a mental model that provides a process to help inform strategies and actions related to addressing shifts in natural disturbance. It focuses on where to go for answers and how to enhance existing tools, rather than being the answer itself.

Materials and methods

Though there are many existing decision frameworks that are currently in use to manage the forests of BC, it is unclear if and how these frameworks are being adjusted to address potential and predicted changes in natural disturbance events. To address this question two different approaches were used. The first involved the application of a survey, which was developed and delivered over a six-week period, beginning the first week of June, 2011. The survey, entitled "Decision making processes with respect to changes in natural disturbance regimes as a result of climate change," was distributed to 150 individuals. These individuals were considered "early adopters," that is, people who actively apply new scientific information into practice early on in the life of that information. These early adopters were from government organizations, nationally owned private forest companies, not-for-profits, universities, communities, First Nations groups, and community forest



corporations. The purpose of the survey was to develop some preliminary baseline information for further discussions and extension activities in this subject area.

The second approach was to invite these early adopters to participate in one of four one-day regional dialogue sessions (Nanaimo, Prince George, Smithers, and Kamloops, during the month of June, 2011), where part of the agenda included discussions on various aspects of current decision-making in the area of changing natural disturbance.

The third part of this project was to review what types of decision frameworks other organizations, both nationally and internationally, are using to support changes in management of natural disturbance events. Part of the objective of conducting this review was to also determine what elements might be useful for inclusion in our decision framework for British Columbia, which will provide support for both the ecological and the human systems being managed. A second objective of this review was to determine additional components that could compliment the existing policy review process currently under way by the Chief Forester of BC (see Snetsinger 2012).

Results

Survey results

The decision-making process survey was developed in early June, 2011, and distributed to 150 people in the province of British Columbia who were considered to be “early adopters.” The response rate was 20% (30 responses); the majority of responses came from the provincial government (67%), 17% from nationally owned private forest companies, and 16% from sources classified as “other.” What follows is a brief synopsis of some of the key information messages from the survey that were used in support of the development of the decision support framework.

The results of the survey suggest that decision-making that includes information related to changes in natural disturbance regimes is still relatively new and not yet integrated into existing systems. For example, the survey indicates that many (80%) of the participating organizations had already developed, or were considering developing, a policy or objective related to potential climate change induced changes to natural disturbance regimes; however, most (56%) did not know how this policy or objective would fit into their existing policy framework. There appears, however, to be a strong link with integration into the organizations’ sustainable forest management objectives (24%), risk management framework (16%), and/or part of another policy objective within the current decision-making framework (4%). When asked what basic values/beliefs/attitudes within their organization had led them to consider this policy or objective, 54% of survey participants indicated that reducing liabilities and risks was the driving force, while wildfire protection was also an important consideration (48%), as were carbon emissions reductions (44%) and community safety and resilience (40%).

Tools

Part of the survey was designed to assess what tools various organizations use to support their decision-making around shifts in natural disturbance and which ones are most effective. When asked whether all levels of their organization/institution understand or have the tools to contribute to achieving their climate change objective, 93% of respondents answered “no” to this question; however respondents did provide information on some of the analysis work that they, or their organization, had done, as well as the tools that they had used or found useful. For example, when asked if their organization had



done any analysis on how climate induced changes to natural disturbance regimes may impact management decisions, 50% of respondents answered “yes” and 50% answered “no.” When asked to identify all tools that were used to conduct this analysis, participants named the following tools: climate modelling tools (100%), inventory data (67%), scenario analysis techniques (50%), growth and yield models (50%), risk assessment procedures (42%), vulnerability assessment procedures (for natural systems) (42%), hydrologic models (33%), carbon accounting systems (25%), climate change adaptation and resiliency actions for communities (25%), cost-benefit analysis (17%), vulnerability assessment procedures (for human systems) (17%), and trade-off analysis tools (8%). Some of the tools that survey participants found most useful included provenance data; ClimateWNA; GIS Random Forests Projections of BEC climate envelopes; Chief Foresters guidance on seed use and assisted migration research by investment branch; models such as FORECAST, CLIMATE (FORWADY), TACA, SORTIE-BC, SELES; landscape level analysis; and, climate shifts affecting species and site productivity.

Information needs

Decision-making around projected shifts in natural disturbance appears to be a relatively new area; therefore, identifying information needs during this early stage of development of any decision support framework is key to help move the process forward. To gather this information, specific questions related to the organizations’ information needs were posed. For example, participants were asked their information needs with respect to the impact of potential changes to natural disturbance regimes as a result of climate change that were different from the list provided under the tools question. Specific needs included (in order of priority by respondents):

- What expected changes may be coming, where, and how extreme (88%)?
- Mitigation or adaption strategies to address these projected changes for natural systems (88%).
- Climate change adaptation and resiliency strategies (79%).
- What impact those expected climate changes might have on human and natural systems (65%)?
- Who is currently working on various tools and strategies, and how to access that information (65%)?
- What is at risk and to what extent (59%)?
- Cost-benefit analysis tools (35%).
- Mitigation or adaption strategies to address the projected changes for human systems (24%).

Other additional concerns noted by participants:

- Increase the availability of local information.
- Enhance the ClimateWNA to include information on historic climates.
- Conduct scenario analysis for changes in disturbance regimes.
- Estimate climate change and natural disturbance impacts on all aspects of forest operations, from harvesting to reforestation.

Barriers to using information

When developing any type of decision support framework, it is important to identify barriers that could hamper the implementation of information supporting the process. Included in the survey were a series of questions designed to identify and assess some of the



key barriers that may need to be overcome to support decision-making in the area of managing for shifts in natural disturbance.

When participants were asked what barriers they have experienced with acquiring new information, they noted the following: time required to find and filter the information (68%), awareness of where to find information (55%), its cost (55%), and access to it (32%). When asked for other barriers, participants identified:

- lack of local information
- reduced journal access within government organizations along with limited technical assistance
- academics refusing to share unpublished information
- out-of-date information
- workload
- lack of over-arching organization

When participants were asked to identify barriers that they have experienced with respect to using new information, respondents listed: cost (65%); time (65%); lack or uncertainty of acceptance of new information (48%); conflicting policies (48%); lack of organizational flexibility to use new information (39%); and, doubts regarding the value of the information (39%). Other barriers included by participants were:

- no limits observed
- government standards

When participants were asked to identify barriers that they had experienced with respect to applying innovative practices, respondents noted: costs (64%); policy (50%); regulations (50%); organizational culture (50%); regulatory agency approval (36%); lack of sufficient information (18%); and, lack of incentives (18%). Time was also identified as another barrier.

Workshop dialogue discussions

The discussion from the four regional workshop dialogue sessions provided additional information not identified in the survey. There was significant discussion in these sessions regarding the need for the sharing of risk between the landlord (the province) and those who are tasked with managing the assets of the landlord (various licensees). There was also discussion on the need for some form of cost recognition or incentive/benefits for the use or development of innovative practices, if the license holder was to be motivated to use new information. Other important elements of discussion included

- The need to use the best information available that is relevant to the decision-maker.
- The need to integrate across disciplines.
- The need for clear objectives as well as a transparency and accountability in the decision-making processes around this issue.
- Monitoring for both social benchmarks as well as ecological triggers.
- The need to build in opportunities to learn and make mistakes.
- The need for more local research to support local decision-makers.

Review of decision frameworks used by other organizations

There is a significant body of work available from other organizations that looks at how each organization has refined various decision and policy frameworks to address projected environmental changes (see Resources). For example, at the global scale, the United Nations



Development Program has released the Adaptation Policy Framework for Climate Change (2012) (see http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/5501.php). The International Union of Forest Research Organizations has also released a report that outlines various frameworks for forests and people to adapt to climate change (Seppala et al. 2009). At the regional or local level, countries such as the United Kingdom, Australia, New Zealand, and Scotland, among others, have developed more general frameworks that rely on change to be lead at the local level. This reliance on local leadership is also true for the frameworks developed for Canada at the national scale.¹ At the provincial scale, most provinces in Canada have some form of plan to address climate change, but the government of Alberta has developed a specific decision support framework focused on their own provincial government (see <http://www.srd.alberta.ca/MapsPhotosPublications/Publications/ClimateChangeAdaptationFramework.aspx>). At the very local scale, there are also many examples of cities (New York City, US; London, UK; and in Canada, Whitehorse, NWT, and St. John's, NL) that are developing their own strategies and decision-making processes to address the potential consequences that changes to their local environment may have.

There are a few common threads that exist within all of the decision and policy frameworks reviewed. The first is that some form of analysis or projection is undertaken to identify what the future environment might look like. The second is to examine this future through the lens of a standardized risk management approach to address the significance of these issues. Once there is a picture of the potential future changes, and the potential risks, the third common element is to review existing plans, policies, and regulations so that local learning and adaptation can occur where needed. In addition, there are a number of other common elements, including

- Broader collaboration and integration between all organizations that may be involved with, or affected by, the changes that may occur (especially at the local level). This integration is primarily focused at the local level since much of the expected effects that climate change may have are at this scale. But, there are some potential shifts in natural disturbance that may also affect the broader provincial/national scales. Integration at this broader level will also be important so that decision-making to address these issues is not done in isolation of where the consequences may be experienced.
- Some form of incentive to support those involved in the change process. Many groups have identified additional funding as one of the mechanisms through which this incentive could be provided, since supporting any type of adaption process often requires additional resources.
- Organizational leadership from above and below. It is important to note that leadership from above provides strategic direction, and leadership from below identifies the operational realities of implementing the outcomes of the decision-making process. There is also a need for clear and consistent communication between these different levels to ensure that all aspects of the organization are working together to address the changes that may be taking place.
- Projected changes in natural disturbance are full of uncertainties for decision-making; therefore, creating opportunities to learn and adapt to these uncertainties is an important part of the change process. A continual learning and adapting culture will be required to address the level of uncertainty that is inherent in projected changes.

Decision support frameworks

Based on the work of other jurisdictions and some of the challenges being faced in British Columbia (as identified through an online survey and follow-up dialogue sessions), the



author has proposed a draft framework (Figure 1) to provide a process on how best to address projected changes to natural disturbance events. As identified in this framework, addressing the projected changes and support to the development of resistant ecosystems and communities at the local level will involve the implementation of three aspects of decision-making. These aspects include providing the exposure/effects of the potential change, building adaptive capacity to address that change, and addressing or considering the competing pressures that may arise because of that change. Under each of these aspects is a pillar explaining how the specific issue can be addressed and allow for actions to take place at the local scale. Actions are focused at the regional or sub-regional level since changes to natural disturbance will be experienced differently across regions, thus allowing policy responses to be tailored to individual needs and issues.

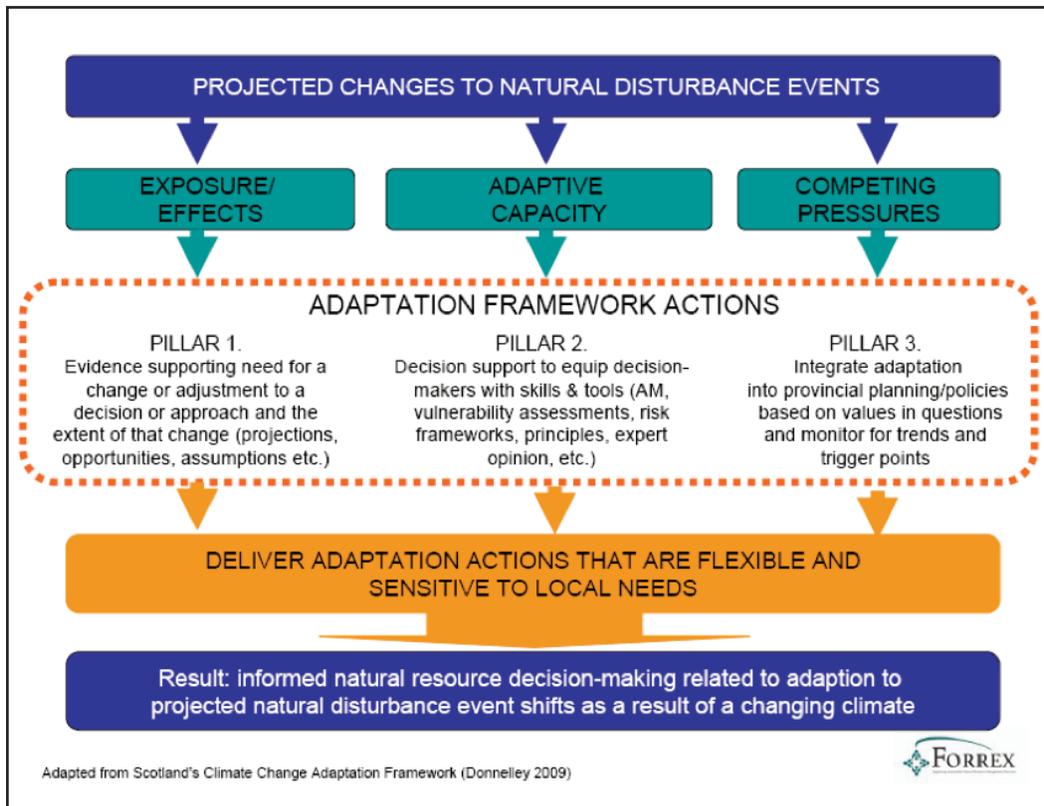


Figure 1: Decision Support Framework to address shifts in natural disturbance events

What follows is a brief description of each section of the framework.

Pillar 1: Evidence/effects

This first component looks at the extent to which a decision can be changed or adjusted by natural resource decision-makers. This process helps inform existing organizational or agency decision frameworks by looking at the evidence as well as the projected effects that changes to natural disturbances may have on their organization or community. It involves, but is not limited to:

- Scoping out and defining the problems related to projected environmental, social, and economic changes that may occur as a result of shifts in natural disturbance events.
- Building up the knowledge base related to the consequences of a changing environment, and both the challenges and opportunities this presents.



- Providing the evidence-based knowledge of those changes via projections, expert opinion, current research data and statistics, current assumptions, etc. In doing so, it is important to recognize that there will be a dynamic tension between the complexity of some scientific information and the need of decision-makers for simplicity and tractability (Meyer 2012).
- Determining the potential choices available to address those problems, and assessing the level of information related to those choices, as well as the level of confidence and expectations with respect to the degree of risk, uncertainty, and costs associated with those choices. This includes determining the various values that are involved in the decision-making process currently underway.
- Determining the timeframe within which a decision has to be made or adjusted and the scale of that decision. What is the lifetime of that decision? Over what period are the benefits of the decision expected to be realized?
- Determining if any adjustments need to be made to existing plans and policies, the extent of that adjustment, and what, if any, learning is needed.
- Identifying some of the possible indicators/stressors/descriptors/triggers for effectively managing the expected change, as well as the potential tradeoffs that may have to take place related to the various values to be managed (keeping in mind scale).
- Determining what steps need to be taken to implement any decision (their sequence and timeframe), what information may be needed at each step, and the availability of resources for implementation.

Pillar 2: Adaptive capacity

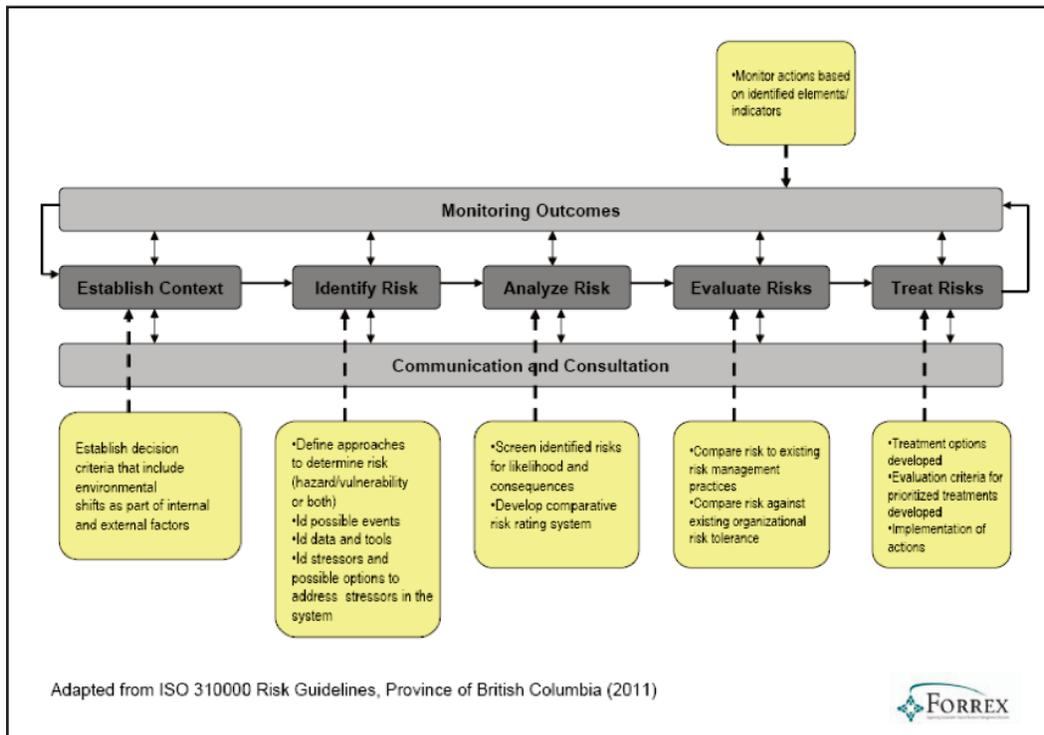
This second component involved providing evidence-based tools to support the specific and deliberate choices needed to enable the change or action targeted at the vulnerable system(s) in response to the evidence/effects provided in Pillar 1. Learning to adapt current tools or developing new ones targeted as specific decisions can help increase the adaptive capacity of the decision-maker, thus leading to innovative solutions. These changes or actions can also be set within the context of the adaptive management framework to facilitate the learning experience. This process involves:

- Providing access to the various types of decision support tools that can help clarify decisions and needs (models, checklists, factsheets, processes such as multi-criteria analysis, scenario planning, risk analysis, vulnerability, and hazard assessments, etc.)
- Recognizing which tool(s) can help with which decision, as well as the probabilities, risks, and scientific uncertainties associated with that tool. Remember that some tools may be more culturally acceptable than others.
- Providing linkages to the experts associated with those various tools, or facilitating learning to ensure that the tools are used appropriately and effectively.
- Creating a learning environment that can foster innovation and innovative approaches, where failure is part of learning.
- Identifying incentives that can support the implementation of the learning environment.
- Identifying obstacles that may limit this learning environment, and implementing effective measures and options to overcome them.

One example of a tool that could be modified to fit within this Pillar 2 environment is presented in Figure 2. This figure provides an example of how a standardized decision support tool, such as a risk management framework (in this case ISO 31000), can be modified to include potential changes to natural disturbance. Innes et al. (2010) also present a framework for adaptation and adaptive management that can be used as a tool to im-



prove local forest management policies and practices. These are just two examples of products that are available or could be developed to improve the skills of those who may wish to modify some of their existing decision support tools in light of projected environmental changes or shifts in natural disturbance events.



Adapted from ISO 31000 Risk Guidelines, Province of British Columbia (2011)



Figure 2: Example of how a standardized risk management framework such as ISO 31000 Risk Management Framework can be adjusted (yellow boxes) to include projected changes in natural disturbance events.

Pillar 3: Competing pressures

This final component puts the decision-making process within the context of the wider public policy and regulation framework, so that the change outcome supports, rather than hinders, actions that can take place at the local scale. This part of the process involves:

- Recognizing that any decision that needs to be made, related to addressing environmental change, should be informed by the best information available.
- Recognizing that the better the knowledge about future changes in natural disturbance risks, the more specific the action that can be taken now will be (Fussel 2007).
- Identifying the available options (realistic and feasible) and determining how to implement those options to protect or enhance the values in question, now and into the future. Recognizing that, the less experience in managing a specific risk associated with a projected change in natural disturbance, the greater the need for new and additional actions (Fussel 2007).
- Identifying barriers that may exist in the policy and/or regulatory environment and mechanisms that could be used to address them.
- Analyzing the associated effects, the probabilities of success/failure of the choices that need to be made, the risks, the benefits, the tradeoffs, the consequences, and the scientific uncertainties. If information gaps exist, mechanisms will need to be determined to address them.
- Developing methods to integrate change into future planning so that consideration can be given towards the extent that changes to natural disturbance will influence that area or jurisdiction.



- Determining criteria and elements to be monitored for trends so that strategies and actions can be implemented successfully. Consider elements that have sufficient information, integrity, or thresholds, such that change to that element has the potential to trigger some form of response or plan adjustment.

As part of the collaboration developed for this FFESC project, the author worked with members of the Williams Lake Timber Supply Area (TSA) Silviculture Sub-Committee to develop a localized decision support framework (Figure 3). In order to develop actions that would work for the TSA, the focus of the decision-making process was narrowed to identifying opportunities to change existing stocking standards or to present new ones to increase in drought hazard. This is reflected in Figure 3 under Pillar 3 by making reference to the Forest and Range Practices Act (Forest Planning and Practices Regulation 26/5), which discusses how to develop alternative stocking standards in the Forest Stewardship Plan where certain approval tests cannot be met “having regard to the future timber supply for the area” (BC Reg. 2004/14:n.p.). Work continues in this TSA to use this framework as a mechanism to address some of the drought and regeneration challenges being faced as a result of the recent Mountain Pine Beetle infestation and wildfires. Further reporting on this work will occur in later published papers as the process and tools are refined.

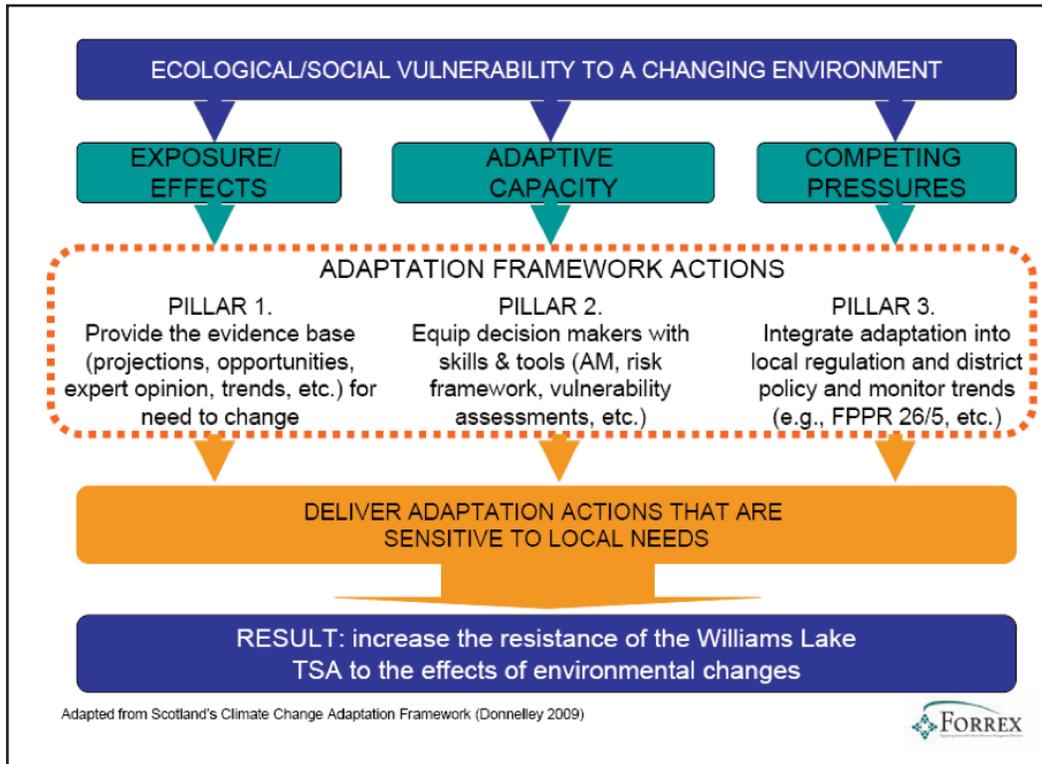


Figure 3: Decision Support Framework adapted to localized needs of the Williams Lake TSA.

Conclusions/observations

This component of the Future Forest Ecosystem Science Council project was to determine what existing decision systems were being used in the province of British Columbia to address potential shifts in natural disturbance. From this knowledge, a decision support framework was derived that would help support these systems as they tried to address these potential shifts. Based on an initial analysis, the various organizations sampled within BC (including the provincial government—Ministry of Forests, Lands and Natural



Resource Operations—and the forest industry) have only just begun to include information related to shifting natural disturbance into any of their decision-making processes.

This could perhaps be at least partly explained by a perception among Canadians, particularly among British Columbians, of being relatively “safe” from some of the dramatic changes that are being experienced in other parts of the world. This lack of a direct, tangible experience of environmental changes can lead to a more reactive, rather than proactive, approach to decision-making when addressing problems that do arise. One example is the reactive approach taken in British Columbia to address the Mountain Pine Beetle infestation versus the more pro-active approach taken in the province of Alberta. Much of the social science research around the changing environment suggests that if people do not experience this change as part of their reality, they are reluctant to plan for it. In some cases, even when they are aware of the changes that are taking place, and that their choices may be causing future consequences, there remains a reluctance to change current behaviour (comments from participants attending workshop dialogue session in June, 2011).

Although there appears to be a slow response to integrating information related to projected environmental shifts in natural disturbance into current decision-making here in BC, the research effort continues to try to increase knowledge and change attitudes. For example, there has been significant work attempting to document the economic and social effects of environmental changes for Canada, particularly for British Columbia. According to a recent report by the National Round Table on The Environment and the Economy (2011), estimates related to climate change costs for Canada could escalate from roughly \$5 billion per year in 2020 to between \$21 and \$43 billion per year by the 2050s. The timber supply in British Columbia is expected to decline due to fire, pests, and changes in forest productivity, with a conservative projected loss of timber volume of 5 to 8% by 2050 (National Round Table on the Environment and the Economy 2011). This loss of productivity, combined with other losses due to the impact of climate change, is projected to cost to the province of British Columbia between \$5 and \$32 billion by 2080.

Although the report by the National Round Table appears to provide a significant incentive to change decision-making around projected environmental shifts in natural disturbance, part of the hesitance in responding to the impacts of climate change may be due to a number of barriers that exist within the province of British Columbia. These barriers may be hindering changes to decision-making, especially with respect to forest management practices. Based on the information from the discussion groups, many of these barriers seem to be connected to how risk is perceived and how risk will be managed by the various parties involved in forest management on the publically owned landbase. Work continues to take place within the province’s Future Forest Ecosystems Initiative group to address some of these policy and legislative challenges. It is through the development and implementation of the decision support framework outlined in Figure 1 that these types of conversations will continue to take place or be expanded to speed up the process of integrating projected changes (whether they be positive or negative) into our existing decision-making processes.

Recommendations

Based on the survey, dialogue discussion, and a review of the frameworks from other jurisdictions, the following recommendations are suggested to help in building a culture that can adapt to the projected shifts in natural disturbance:

- Discussions need to continue around how environmental changes in natural disturbance may affect the shifts that take place at all scales within the province of British Columbia.



- Localized research and extension of results is important so that there is an increase in awareness and dialogue of these localized effects and the potential solutions developed to address them.
- Improved communication and participation by all parties involved in the management activities on the landbase is needed when developing and implementing the potential actions developed to address these shifts. Without understanding what each organization is doing or has the capacity to do, there is the potential for duplication of efforts or for the development of action plans that cannot be implemented due to jurisdictional barriers.
- The impact of the projected environmental changes will likely be felt by all levels of society, not just by specific individuals. To support people in adapting to these potential changes, organizations will need to encourage a culture of learning through the use of a variety of mechanism rather than limiting or discouraging them.
- Evaluation of the risk and opportunities that shifts in natural disturbance may bring to our ecological and human systems at all scales is an important step in helping to plan actions. Conducting this evaluation will ensure that future plans can adapt or mitigate these potential risks and take advantage of the opportunities that may present themselves.

There are significant challenges ahead, but numerous possibilities exist to meet them. In forest management, these include engaging in activities that reduce the effects of the potential impacts of climate change, as well as developing new management practices and strategies to take advantage of opportunities that may arise. Our ability to adjust and adapt to the projected shifts will be very much influenced by the adaptive capacity of the forest ecosystem, the socio-economic status of communities, and the political climate around forestry (Innes et al. 2010). The decision support framework provided in this article will provide at least one small step in meeting this challenge.

Notes

1. It is important to note that in Canada two approaches are provided to address climate change. The first approach is a risk management framework provided to guide communities in addressing environmental changes. The second approach, lead by the Canadian Council of Forest Ministers (CCFM) Climate Change Task Force, is specifically related to forest management. It uses the CCFM Sustainable Forest Management framework of Criteria and Indicators as a way for various parts of the country to adjust their forest management strategies to accommodate the projected environmental changes (Williamson and Johnson 2010). Information on this system will be available for broader distribution in the near future.

Resources

Examples of available resources and tools for decision-making frameworks related to climate change

- Adaptation policy framework for climate change – United Nations Development Program. <http://www.undp.org/climatechange/adapt/apf.html>
- Alberta Climate Change Adaption Framework. <http://www.srd.alberta.ca/MapsPhotosPublications/Publications/documents/ClimateChangeAdaptationFrameworkManual-April%202010.pdf>
- Australia – Climate Change Frameworks. <http://www.climatechange.gov.au/what-you-can-do/community/~media/publications/local-govt/risk-management.ashx> & <http://www.climatechange.gov.au/what-you-can-do/community/local-government/risk-management.aspx>
- City of London, England – Thames Flooding – Climate change process. <http://www.environment-agency.gov.uk/research/library/consultations/106100.aspx>
- City of New York, NY – Climate change process. <http://onlinelibrary.wiley.com/doi/10.1111/nyas.2010.1196.issue-1/issuetoc>
- Human Health in a Changing Environment. <http://www.climateneeds.umd.edu/pdf/humanhealth.pdf> & http://cbtadaptation.squarespace.com/storage/_Synthesis_english_low.pdf



Handbook for Small Canadian Communities. http://www.ccadaptation.ca/documents/adaptation_toolsplans/communityadaptationguidebooks/climate-change-adaptation-planning-a-handbook-for-new-zealand-climate-change-framework

OCCLAR (Ontario Centre for Climate Change Impacts and Adaptation Resources: Tools and Frameworks) <http://www.climateontario.ca/tools.php>

Example frameworks include

Adapting to Climate Change: A Risk-based Guide for Local Governments in British Columbia - Volume 1. 2010. James P. Bruce, I. D. Mark Egner, and Robert A. Black. http://www.nrcan.gc.ca/earth-sciences/projdb/pdf/212_e.pdf

Adapting to Climate Change: A Risk-based Guide for Local Governments in British Columbia - Volume 2. 2010. James P. Bruce, I. D. Mark Egner, and Robert A. Black. http://adaptation.nrcan.gc.ca/projdb/pdf/213_e.pdf

Changing Climate, Changing Communities. Guide and Workbook for Municipal Climate Adaptation. 2010. ICLEI - Canada. <http://www.iclei.org/index.php?id=11710>

Climate Change Planning Tools for First Nations Guidebooks. 2006. Centre for Indigenous Environmental Resources (CIER). <http://www.cier.ca/information-and-resources/publications-and-products.aspx?id=412>

Managing the Risks of Climate Change: A Guide for Arctic and Northern Communities. 2010. Centre for Indigenous Environmental Resources (CIER). http://ccrm.cier.ca/start_here.php

Getting to Carbon Neutral: a Guide for Canadian Municipalities. 2010. Toronto and Region Conservation Authority. <http://trca.on.ca/dotAsset/81361.pdf>

Prioritizing Climate Change Risks and Actions on Adaptation: A review of selected Institutions, Tools and Approaches. 2009. Government of Canada. Policy Research Initiative. http://www.policyresearch.gc.ca/page.asp?pagenm=2009-0007_toc

Canadian Communities' Guidebook for Adaptation to Climate Change. 2008. Environment Canada. <http://www.forestry.ubc.ca/LinkClick.aspx?fileticket=xsexCSatHjo%3D&tabid=2455&mid=5415&language=en-US>

Integrating Climate Change into Invasive Species Risk Assessment/ Risk Management. 2008. Government of Canada. Policy Research Initiative. http://www.policyresearch.gc.ca/doclib/WR_SDRP_InvasiveSpecies-v3_200811_e.pdf

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Test Your Knowledge

How well can you recall the main messages in the preceding article?
Test your knowledge by answering the following questions.

Decision Support Framework: A Mental Model for Integrating the Environmental and Human Dimensions into Decision-Making Related to Changes in Natural Disturbance Events

1. The decision support framework presented in this discussion paper is:
 - a) A climate change projection model
 - b) A computer simulation model
 - c) A decision tree
 - d) A mind model that provides a process that can be followed to help inform strategies and actions
2. The decision support framework includes three pillars. Pillar One is associated with:
 - a) integrating adaption into provincial plans/policies
 - b) providing the evidence to support changes or adjustments to decisions
 - c) developing decision support tools
 - d) delivering adaptation actions
3. The article is an example of how to adjust an existing standard decision framework to projected changes in natural disturbance events. Which standard decision framework example did it use?
 - a) risk management framework
 - b) sustainable forest management framework
 - c) CSA certification
 - d) Balanced Scorecard

DECISION SUPPORT
FRAMEWORK:
A MENTAL
MODEL FOR
INTEGRATING THE
ENVIRONMENTAL
AND HUMAN
DIMENSIONS INTO
DECISION-MAKING
RELATED TO
CHANGES IN
NATURAL
DISTURBANCE
EVENTS

Swift

