

Increasing the Resilience of British Columbia's Rural Communities to Natural Disturbances and Climate Change

Ajit Krishnaswamy, FORREX, Ellen Simmons, FORREX, and Larry Joseph, Consultant

Abstract

It is predicted that climate change has increased the frequency and intensity of natural disturbances and weather related natural disasters. Rural forest-based communities are especially vulnerable to changes in natural disturbance regimes influenced by climate change because their economic, social, and cultural aspects of life are closely linked to the local environment and climate.

In this article, we discuss the impacts of wildfires on communities as an example of how natural disturbances impact humans. The impacts to humans of wildfire is indicative of the type of effects that other natural disturbances such as widespread insect infestation, landslides, floods, drought, storms, avalanches, permafrost melt, forest diseases, erosion, and gradual ecosystem change can have on communities. First Nations communities may be significantly and uniquely impacted by natural disturbances and climate change due to their remote location, strong connection, and heavy reliance on the environment for subsistence and in preserving their culture and their unique and often vulnerable economic situation.

We describe the uncertainty of predicting the frequency and intensity of natural disturbances in a particular location. We suggest that the most effective management response to address this uncertainty is to focus on reducing vulnerability and increasing community resilience. Finally, we list some of the management strategies and tools that communities and those that work with them have been using in British Columbia and elsewhere to increase community resilience to natural disturbances and climate change.

KEYWORDS: natural disturbances; climate change; humans; First Nations; wildfire; risk; vulnerability; adaptive capacity; community resilience; resources

Introduction: From uncertainty to increasing resilience

In recent years, the frequency and intensity of natural disturbance events such as wildfires and floods has increased and this could be related to climate change (Easterling et al. 2000; IPCC 2001, 2007). Climate is becoming increasingly unpredictable, not only in mean and seasonal parameters, but also in increasing variability (IPCC 2007). Climate-ecosystem interactions are also uncertain because, in many cases, the ecological linkages and system response sensitivity to extreme climate parameters are unknown, and the effects of cumulative ecosystem stresses are difficult to predict (Tyler 2010a).

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Currently, climate change can be characterized as follows (IPCC 2007):

- It is not about some future climate scenario, but more about rapidly accelerating change;
- There is greater and more frequent variability in climate patterns;
- Stabilization of the climate at some future climate condition is not yet apparent;
- The probability of extreme weather related events is rising;
- Sudden shifts in climate regimes (especially in the north) are occurring; and
- The effects of cumulative ecosystem stresses are difficult to predict.

To address the uncertainty of predicting the frequency and intensity of natural disturbances caused by climate change, in this article we suggest that management responses to natural disturbances and climate change should focus on increasing the resilience of communities. Resilient human systems are able to handle shocks and stresses without the loss of function and with minimal disruption to crucial services (Joseph & Krishnaswamy 2010). We focus on increasing community resilience to natural disturbances and list some “how-to” strategies and tools that communities and those that work with them have been using to increase community resilience to natural disturbances and climate change.

Impact of natural disturbances and climate change on communities

Natural disturbances, such as wildfires and floods, can affect humans directly through death and injury, or indirectly through the destruction of natural and physical capital on which people rely for their livelihood and quality of life. Climate change plays a role in increasing the frequency and intensity of natural disturbances and weather-related natural disasters (Ibarrarán et al. 2009). Additionally, changes to natural disturbance regimes as a result of climate change may increase community vulnerability by increased flooding, wildfires, threats to health, safety, and livelihood, and destruction of property and infrastructure.

The impacts on humans from natural disturbances and disasters vary significantly across population and economic sectors (Ibarrarán et al. 2009). Rural forest-based communities are particularly susceptible to natural disturbances because their economic, social, and cultural aspects of life are closely linked to the local environment and climate (Pearce & Callihoo 2011). First Nations communities are vulnerable for the same reasons, and for some, their vulnerability is accentuated due to remoteness, poverty, and a lack of adequate infrastructure.

Natural disturbance impacts on First Nations communities will be significant and unique due to their strong connection and heavy reliance on the environment for subsistence and the preservation of their culture, as well as their unique and often vulnerable economic situation (Centre for Indigenous Environmental Resources 2006). First Nation economies are based on both subsistence and income-generating systems and are often dependent on natural resources such as forestry, making them vulnerable to natural disturbances. Cultural sites (e.g., ceremonial burial and spiritual sites, and medicinal plant collection, hunting, fishing, and food-gathering areas) are susceptible to damage due to natural disturbances such as floods and wildfire that may damage, or even permanently destroy coastal and inland cultural sites. Such losses can not be replaced and would have a profound affect on First Nations identity.

Many rural forest-based and First Nations communities in British Columbia are now experiencing more frequently the impacts of natural disturbances and climate change,



such as the increased frequency and intensity of wildfires and flooding, which cause transportation disruptions, water shortages, and the resulting changes in forestry, tourism, mining, energy, and agriculture sectors (Pearce & Callihoo 2011). Extreme weather events threaten community safety and disrupt the local economy. Rural communities may not have financial, organizational, or personal resources to recover from short-term climate change impacts or to adapt to longer term and slower changes (Pearce & Callihoo 2011). The impacts of natural disturbances and climate change will vary in intensity and frequency, depending on location and vulnerability of communities.

Some of the human impacts are caused by short-term or catastrophic natural disturbances such as wildfire, insects and diseases, storms, and landslides. Long-term and gradual changes to the ecosystem due to climate change also impact humans. Climate change has the potential to greatly influence British Columbia's forest ecosystems by changing, not only the aforementioned disturbance regimes, but also the overall distribution of forest types and the productivity of forest resources. These changes will have important implications for the many economic, social, and cultural values communities associate with forests.

Impacts of wildfire on communities

We present some of the economic, social, health and safety, infrastructure, and cultural impacts of wildfires on communities in Table 1 as an example of how natural disturbances impact humans. The effects on humans from wildfires described in Table 1, are indicative of those that other natural disturbances, such as widespread insect infestation, drought, storms, avalanches, permafrost melt, forest diseases, erosion, and gradual ecosystem change can also have on communities. The impacts from three other natural disturbances (mountain pine beetle infestation, landslides, and floods) are described in Krishnaswamy et al. 2011.

Many rural communities in British Columbia are threatened by the increased frequency, extent, and severity of wildfires as a result of their proximity to forests and their relative isolation. The effects of wildfire on communities in Interior BC have been compounded by buildup of fuel (i.e., dry and dead trees) from the mountain pine beetle (MPB) infestation, which also has affected 103 First Nations communities in the interior of British Columbia (Caverley 2009). In the case of First Nations communities, some of the negative impacts of wildfire described in Table 1 tend to be more severe and longer lasting, as these communities are usually more remote, have a less-developed infrastructure, and have higher rates of poverty than other rural communities (BC First Nations Forestry Council 2011).

The public perception of wildfire tends to be highly negative given the widely held belief that all wildfire is bad and needs to be fought and suppressed (Southern Illinois University Carbondale 2004; Lewis 1979); yet, not all the impacts of wildfire are negative for communities. Fire may be beneficial to a community in many ways: fires can increase community safety with the creation of natural fire breaks, which reduce the possibility of future fires; and wildfires can also enhance species diversity resulting in increased forage for hunting purposes and a healthier production of traditional food and medicinal plants (Martin, Personal Communication 2011; Lewis, 1979). Thus, managers should not ignore the benefits of wildfire, and not all wildfires need be vigorously suppressed. The public should be made aware of the positive impacts of fires in order to garner their support when managers plan to use fires to enhance community safety.



Table 1 - Anticipated impacts of wildfire on communities

Type of human impacts	Some possible impacts of wildfire on communities	
	Short-term (during the wildfire and immediately following it)	Long-term (about 6 months after the wildfire)
Economic	<ul style="list-style-type: none"> • Loss of tourism • Cost for site rehabilitation and reforestation • Cost of firefighting • Increase in jobs due to salvage logging • First Nations communities unable to collect plants for food or medicine, or hunt for food; as a result, they would need to buy these necessities. • Volunteer and work opportunities during the fire event for local people 	<ul style="list-style-type: none"> • Loss of logging and other forestry based livelihoods • Mid- and long-term timber supply may be negatively impacted. • Increased growth of pioneer species may increase availability of medicinal plants and traditional food sources in the long-term. • Mushroom growth following a fire can provide a source of income . • An increase in large mammals feeding on new growth will result in more favourable hunting.
Social	<ul style="list-style-type: none"> • Disruption of life – work and school • Evacuation – displacement from home • Resettlement • Anxieties related to fire and evacuations • Loss of recreation opportunities • Public and stakeholder collaboration to improve response to wildfires • Increased community networks through volunteering 	<ul style="list-style-type: none"> • Community resilience could increase after having faced a crisis. • Possible increase in recreation opportunities (e.g., due to improved access)
Health and Safety	<ul style="list-style-type: none"> • Deteriorating air quality • Food safety (Northern Health 2011) • Burn injuries or injuries from fighting fire • Human casualties • Post-fire treatments, such as danger from fire-damaged or beetle-killed trees • Increased landslides (Red Cross 2007) 	<ul style="list-style-type: none"> • Negative impact on mental health, e.g., reports that Kelowna residents emotions are still negatively affected by the 2003 firestorm (Pruden 2011) • Fire is a natural cleanser and will burn old and diseased timber and plants, returning nutrients to the soil. • Natural fire breaks are created, thus protecting communities and increasing the success of future fire containment.
Infrastructure	<ul style="list-style-type: none"> • Loss of residential and business property • Strain on emergency services • Damage to communications infrastructure • Possible loss of utilities 	<ul style="list-style-type: none"> • Creates natural fire breaks for future fire starts in the area that ultimately protects utilities.
Cultural	<ul style="list-style-type: none"> • Loss of traditional food harvesting sites (e.g., for berry picking) • Loss of medicinal plants • Destruction of cultural heritage resources • Loss of culturally modified trees • Cumulative losses may limit the ability of First Nations communities to exercise resource rights and practices. • The practice of traditional ecological knowledge by First Nations may be challenged by catastrophic fire. 	<ul style="list-style-type: none"> • Increase in traditional food harvesting sites • Possible increase in medicinal plants • Creation of browse for traditional sustenance hunting, e.g., moose, deer, etc • Creation of more “hunnable” areas due to increase in visibility and access • Closer, easier access to firewood for cooking, heating



Management response to impacts of natural disturbances on humans: Reducing vulnerability and increasing resilience

Managing for impacts on humans due to changes to natural disturbance regimes resulting from climate change involves recognizing that the nature of the human impacts depends on three factors (Tyler 2010a):

1. the scale or intensity of the climate-induced hazard;
2. the likelihood of the hazard; and
3. the vulnerability of the community.

The first two factors have typically been based on historical records, but the assumption that future natural disturbances and hazards will occur based on historical patterns no longer holds (Milly et al. 2008), making both these factors more unpredictable. In the face of this uncertainty, decision-makers may become paralyzed, but a positive management response can focus on the third factor, that is, reducing the vulnerability of communities.

In conditions of high uncertainty about risks to communities from natural disturbances, it will be difficult to justify or identify specific management actions that are effective in addressing hazards emanating from climate change. Management strategies should focus on reducing the vulnerability of communities to natural disturbances, instead of addressing highly uncertain impacts of these on communities, ecosystems, and livelihoods (Tyler 2010a).

Risk and vulnerability

By reducing vulnerability, we reduce the impacts of hazards from natural disturbances, regardless of their probability or nature. Risk is a product of the magnitude of the natural hazard or disturbance, its probability, and the vulnerability of the people or systems involved (Twigg 2009).

$$\text{Risk} = [\text{Disturbance Magnitude} \times \text{Likelihood}] \times \text{Vulnerability} \text{ (Tyler 2010a)}$$

This relationship is explained below in the context of what is currently occurring:

- the variable natural disturbance magnitude or intensity is **increasing**;
- the variable likelihood of a disturbance happening is **increasing** in frequency; thus
- the risk to the community can be lowered by **reducing** the vulnerability of humans and communities to natural disturbances.

Reducing vulnerability

Vulnerability can be described through the following definitional relationship (Tyler 2010a):

$$\text{Vulnerability} = \text{Exposure} / \text{Adaptive capacity}$$

Exposure to hazards from natural disturbances is mainly a function of site and geographical conditions, as well as prevailing climate conditions. Exposure addresses questions such as “Are people close to the disturbance and directly impacted?” and “Are key systems and infrastructure that support people directly impacted by the disturbance?” A theoretical management response to reduce exposure to risk is the relocation of communities or supportive infrastructure; however, in most cases that may not be a practical option (e.g., relocating an entire community or a cultural heritage resource may not be possible). Yet, in some cases, the risk of exposure to natural disturbance impacts can be reduced (e.g., community relocation, removing trees in the urban interface, and not building infrastructure in high risk areas).



Adaptive capacity describes the ability of human systems and agents to respond constructively to change and stress. This includes responses by individuals, households, communities, and organizations, such as private sector businesses, civil society, and local and provincial governments. Adaptive capacity encompasses the capacity to reduce exposure to risks associated with climate change, recover from losses emanating from climate change impacts, and exploit new opportunities through the process of adaptation (Adger and Vincent 2005).

According to the above-mentioned definitional relationship describing the factors of vulnerability, if adaptive capacity increases, then vulnerability decreases, even if exposure to risk remains unchanged.

Resilience

Walker et al. (2004) define resilience as the capacity of a system to absorb disturbance and reorganize so as to still retain essentially the same function and structure. While the variety of academic definitions and concepts about resilience can be confusing, Twigg (2009) suggests that for operational purposes it is more useful to work with commonly understood characteristics of resilience. Twigg posits that community resilience can be understood as the capacity to:

- anticipate, minimize, and absorb potential stresses or destructive forces through adaptation or resistance;
- manage or maintain certain basic functions and structures during disastrous events; and
- recover or bounce back after an event.

Resilience has the following two dimensions (Tyler 2010a):

1. The resilience of agents or actors (people and social organizations: individuals, households, community organizations, government organizations, etc.); and
2. The resilience of systems that support human communities (ecosystems, infrastructure, institutions, and knowledge).

We can identify the characteristics of resilient agents and systems, and activities that would increase the resilience of both agents and systems. Community resilience can be measured by the adaptive capacity of communities to respond to change. The resilience of individuals, communities, and organizations increases if their adaptive capacity also increases. Thus, resilient communities have low vulnerability to natural disturbance impacts.

A focus on resilience leads to greater emphasis on what communities can do for themselves and how to strengthen their own capacities, rather than simply concentrating on their vulnerability to natural disturbances (Twigg 2009). The terms resilience and vulnerability can be seen as opposite sides of the same coin; however, both concepts are relative to what individuals, communities, and systems are vulnerable or resilient to, and to what extent. Different features or layers of resilience are needed to deal with different kinds and severities of risk, shock, stress, or environmental change (Twigg 2009).

Walker et al. (2004) argue that three attributes of social-ecological systems determine their future trajectories: resilience, adaptive capacity, and transformability. A social-ecological system is a system of people and nature, for example, the basin of a river (Carpenter 2011). In social-ecological systems, adaptive capacity is the capacity of actors in the system to increase resilience, without fundamentally changing it (Walker et al. 2004). Transformability, on the other hand, is the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable (Walker et al. 2004).



Resilience of forest-based communities

Williamson et al. (2007) define vulnerability in the context of forest-based communities as a “function of *sensitivity* and degree of *exposure* of social, ecological and economic systems to climate hazards (both present and in the future), and *adaptive capacity*” (p. 3, emphasis in original). They state that sensitivity is high where the ability to adapt is severely constrained, and that a highly vulnerable community is one whose economic, social, and ecological systems are sensitive to climate hazards. Williamson et al. (2007) explain that

[forest-based] communities that face relatively high levels of exposure to climate change and that are highly sensitive to changes in the composition and productivity of forests and to changes in forest disturbances (e.g., wildfire), or that have relatively low adaptive capacity (because of factors such as individual immobility, low economic diversity, remoteness, or lack of autonomy) will be vulnerable to climate change.” (p. iii)

Joseph and Krishnaswamy (2010) further elaborate these concepts by identifying 15 factors that contribute to community resilience in order to establish why some forest-based communities do better than others in reducing vulnerability. Many of the factors they identified related to resources in the community (e.g., financial and natural resources, human and social capital), and the role of the community (e.g., local control over enterprise and policy). Some factors may require development (e.g., economic diversity, and high-quality planning), while others may require creative and innovative solutions (e.g., new markets, and new products from natural resources). Joseph and Krishnaswamy (2010) have also provided examples of indicators to measure vulnerability and resilience.

Vulnerability assessments for forest-based communities

As vulnerability is a function of exposure and adaptive capacity, vulnerability assessments should address both these elements (MacKendrick and Parkins 2005). Williamson et al. (2007) present a vulnerability assessment framework as a tool that forest-based communities can use to help them identify where they are most vulnerable to climate change. They outline step-by-step activities in three phases that either researchers or communities can use to systematically identify sources of vulnerability to climate change.

The first phase is to engage the community, including obtaining data on past and current climate and future climate scenarios. The second phase is to interpret what the anticipated climate changes may mean in terms of the surrounding forests, and to determine the resulting social, economic, and cultural impacts, including changes in local timber supply; employment and income effects; increases in the risk of wildfire; changes in the economic viability of local industries; impacts to the local economy, and changes to the traditional economy and culture. The third phase involves measuring the local capacity for adaptation through assessment of the factors that affect adaptive capacity, including revenue, mobility, education, social networks, trust, institutions, risk perceptions, and availability of natural resources (Williamson et al. 2007).

MacKendrick and Parkins (2005) carried out vulnerability assessments in eleven communities in British Columbia and two communities in Alberta, located near forests experiencing various levels of mountain pine beetle (MPB) infestation. Their vulnerability assessments considered the physical exposure to the MPB infestation, along with the social, economic, political, and institutional conditions that are associated with community capacity. The authors found that community vulnerability is not solely a function of the level of



exposure to the MPB infestation. In fact, some communities with higher levels of exposure were found to be less vulnerable than other communities with lower levels of exposure to the MPB infestation. They state that community vulnerability, in addition to exposure, is also a function of various social, economic, and political factors, often inherent in the community (MacKendrick & Parkins 2005). So by inference, for some communities, reducing vulnerability will also involve changing social, economic, and governance conditions.

Similarly, a study of two resource-based communities in northern British Columbia, Tumbler Ridge and Smithers, found that inherent characteristics, such as place, people, territorially-based community governance, and social capital networks, have promoted more sustainable forms of local development and increased community resilience (Jackson et al. 2008).

Resources for increasing community resilience

Resources for increasing community resilience to natural disturbances include plans, tools, guidebooks, and case studies that have been prepared either by governments (federal and provincial), non-profits, universities, and research organizations; or through partnerships between these institutions (see Table 2). Some of the resources listed in the table reflect real lessons learned from trying to implement plans to increase community resilience.

We have listed separately resources prepared for communities in British Columbia, Canada, and internationally. We have also listed separately resources that have been prepared specifically for First Nations communities. The list is by no means exhaustive, but indicative of the types of actions taken or suggested to increase community resilience in various geographical regions. The use of these resources would need to be tailored to local conditions.

Table 2 - Resources for increasing community resilience

Strategies and Tools Web Link	Resilience focus
British Columbia resources	
Climate Change Adaptation Resource Kit – Columbia Basin Trust (CBT) http://cbtadaptation.squarespace.com	The website provides tools for communities of the CBT to increase their climate change resilience, including case studies from several CBT communities, factsheets, and videos on climate change adaptation.
Five year diversification and implementation Plan (2009) – Omineca Beetle Action Coalition (OBAC) http://www.ominecacoalition.ca/Strategies/DandIPlan/pdf/OBAC_Diversification_ImplementationPlan_Aug28Summary.pdf	The OBAC's mandate is to plan for increasing community resilience after the mountain pine beetle epidemic that threatens to devastate the region's forest industry. The OBAC region covers more than 18 million hectares in Northeast BC. Two regional districts, 12 municipalities, and more than 20 First Nations communities are members of the coalition. A broad range of stakeholders collaborated to produce a five-year diversification and implementation plan with nine sector strategies. These strategies are the foundation for action on increasing the resilience of communities in the OBAC region.
BC Regional Adaptation Collaborative – Fraser Basin Council (FBC) http://www.fraserbasin.BC.ca/programs/BC.rac/climate_change_scenarios_site.html	The BC Regional Adaptation Collaborative (BC RAC) is a FBC partnership initiative with Natural Resources Canada and the BC Ministry of Environment – Climate Action Secretariat to help BC communities adapt to climate change and its impacts. BC RAC consists of 21 collaborative projects across the province to support decision-making on water allocation and use, forest and watershed management, flood protection, and community planning. The emphasis is on building regionally relevant tools and information, and on integrating climate change adaptation into planning and decision-making.

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Table 2 - (continued) Resources for increasing community resilience

Strategies and Tools Web Link	Resilience focus
British Columbia resources	
Retooling for Climate Change website – Fraser Basin Council (FBC) http://www.retooling.ca	The website is designed to be a first stop for elected officials and staff of local governments, First Nations, and others interested in learning about climate change adaptation. It has the latest information on climate change, local impacts, and adaptation planning, tools, and resources. The idea behind the Retooling website is to help communities prepare for climate change, and to integrate adaptation into local planning and decision-making.
Urban Forests: A Climate Adaptation Guide – Fraser Basin Council (FBC) http://www.retooling.ca/_Library/docs/Urban_Forests_Guide.pdf	This website is a guide that has been prepared to help communities in British Columbia identify and prepare for some of the impacts of climate change. It provides information on how you can use urban forests to manage some of the impacts of changing climates, and how to adapt these urban forests so that they survive and thrive in future climates. This is a high-level overview that can be used by staff and elected officials in BC's communities—small and large, rural and urban.
Plan2Adapt website – Pacific Climate Impact Consortium (PCIC) http://pacificclimate.org/tools-and-data/plan2adapt	Plan2Adapt is a tool designed help those involved in local/regional community planning to assess climate change in their region through the generation of high-resolution maps, graphs, and data tables, based on a standard set of climate model projections. After identifying the projected climate changes in their region using this website, planners and decision-makers are encouraged to use the Retooling for Climate change website (described earlier) to examining climate change impacts and prepare for adaptation.
Adapting to Climate Change: A Risk-based Guide for Local Governments in British Columbia – Volume 1 and 2 – James P. Bruce, I.D. Mark Egener, and Robert A. Black. 2010 http://adaptation.nrcan.gc.ca/projdb/pdf/212_e.pdf (Volume 1) http://adaptation.nrcan.gc.ca/projdb/pdf/213_e.pdf (Volume 2)	This Guide takes a risk-management approach to assist local and regional governments in understanding the risks of predicted climate impacts and how to manage them. Volume 2 of the guide is a case study and workbook section with templates for recording information.
B.C. Climate Action Toolkit – Province of BC, Union of BC Municipalities (UBCM), Fraser Basin Council (FBC) http://www.toolkit.BC.ca	The Toolkit is provided by a three-way partnership between the Province, UBCM, and FBC. The Toolkit provides BC communities guidance and resources to support local governments in taking a more integrated approach to planning that will lead to more resilient, complete, compact and livable communities.
Canada resources	
Pathways to Climate change Resilience – Guidebook for Canadian Forest-based Communities. Draft for community pilots – Model Forest Network. 2011 http://www.modelforest.net/pubs/Pathways_to_Climate_Change_Resilience_FINAL_Feb_2011.pdf http://www.modelforest.net/pubs/Pathways_to_Climate_Change_Resilience_Community_Resource_Collection_Final_Feb_2011.pdf	This Guidebook provides a “Climate Resilience Trail” identifying strategies, tools and resources for mainstreaming climate change adaptation in everyday decisions in small rural Canadian communities.
A framework for assessing vulnerability of forest-based communities to climate change – NRCan. 2007 http://www.resourcesnorth.org/downloads/NOR-X-414_web.pdf	This vulnerability assessment framework helps forest-based communities identify where they are most vulnerable to climate change. The document outlines step-by-step activities in three phases that researchers or communities can undertake to systematically identify sources of vulnerability to climate change.

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Table 2 - (continued) Resources for increasing community resilience

Strategies and Tools, Web Links	Resilience focus
Canada resources	
<p>Adapting to climate change: An introduction for Canadian municipalities – NRCan. 2010</p> <p>http://adaptation.nrcan.gc.ca/mun/index_e.php</p>	<p>This is an information tool for municipal decision-makers with information on how to put climate change adaptation measures in place.</p>
<p>Regional Risk-based Guides for Canadian Local Governments – NRCan. 2010</p> <p>http://adaptation.nrcan.gc.ca/tools/abosuj_e.php#risk</p>	<p>This series of guides uses the Canadian Standards Association (CSA) risk evaluation processes in climate change adaptation for the regions of Canada.</p>
<p>Prioritizing Climate change Risks and Actions on Adaptation: A review of selected Institutions, Tools and Approaches. Government of Canada. Policy Research Initiative. 2009</p> <p>http://publications.gc.ca/collections/collection_2009/policyresearch/PH4-49-2009E.pdf</p>	<p>This publication reviews tools and institutional approaches used in Canada and other jurisdictions to help prioritize climate change risks and adaptation options.</p>
<p>Canadian Communities' Guidebook for Adaptation to Climate change – Environment Canada and UBC. 2008</p> <p>http://www.forestry.ubc.ca/LinkClick.aspx?fileticket=xsexCSatHjo%3D&tabid=2455&mid=5415&language=en-US</p>	<p>This resource guides users through a decision-making process that combines a Sustainable development, Adaptation, and Mitigation (SAM) approach with Canadian case studies.</p>
<p>Municipal Resources for Adapting to Climate change – Federation of Canadian Municipalities. 2009.</p> <p>http://fmv.fcm.ca/files/Capacity_Building_-_PCP/PCP_Resources/Mun-Re-_Adapting-Climate-change-e.pdf</p>	<p>This resource tool for municipal officials, who wish to undertake adaptation planning, features examples from other municipalities.</p>
<p>Ontario Centre for Climate Change Impacts and Adaptation Resources: Tools and Frameworks (OCCIAR)</p> <p>http://www.climateontario.ca/tools.php</p>	<p>OCCIAR is a university-based resource hub for researchers and stakeholders that communicates the latest research on climate change impacts and adaptation and aids in the development of tools to assist with municipal adaptation plans. This page has several tools relevant to Canadian municipalities and communities.</p>
<p>Changing Climate, Changing Communities: Guide & Workbook for Municipal Climate Adaptation – ICLEI Canada 2010</p> <p>http://www.iclei.org/index.php?id=11710</p>	<p>Addresses the issue of climate change adaptation from a local government perspective with examples from various municipalities in Canada.</p>
<p>Managing the Risks of Climate Change: A Guide for Arctic and Northern Communities – Centre for Indigenous Environmental Resources (CIER) 2010</p> <p>http://ccrm.cier.ca/start_here.php</p>	<p>This online risk management guide helps identify climate change priorities and ways to deal with them. The guide includes worksheets for recording information.</p>
<p>Northern Climate ExChange (NCE)</p> <p>http://taiga.net/nce</p>	<p>The NCE is a clearinghouse of climate change information for northern Canada. NCE hosts community adaptation planning projects.</p>

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Table 2 - (continued) Resources for increasing community resilience

Strategies and Tools, Web Links	Resilience focus
International resources	
Community-based Risk Screening Tool – Adaptation and Livelihoods (CRISTAL) http://www.iisd.org/cristaltool	The CRISTAL tool is designed to help project planners and managers integrate climate change adaptation and risk reduction into community-level projects.
Preparing for Climate change: A Guidebook for Local, Regional, and State Governments – Washington State 2007 http://cses.washington.edu/cig/fpt/guidebook.shtml	Helping local, regional, and state governments prepare for climate change resilience based on the use of familiar resources and tools.
Vulnerability Assessment Wizard – UKCIP http://www.ukcip.org.uk/wizard	A 5-step web-based tool that guides users in assessing vulnerability to current climate and future climate change.
Local Government Climate Change Adaptation Toolkit. 2008. ICLEI. Oceania http://www.iclei.org/fileadmin/user_upload/documents/ANZ/CCP/CCP-AU/Projects/AI/AdaptationToolkit/Toolkit_CCPAdaptation_Final.pdf	This toolkit is organized according to the adaptive management process for Australian local governments. It outlines how and when to use each of the included tools as a complement to the adaptive management process.
Climate Change Impacts and Risk Management – A Guide for Business and Government – Australian Government http://www.climatechange.gov.au/what-you-can-do/community/~media/publications/local-govt/risk-management.ashx	A guide to integrating climate change impacts into risk management and other strategic planning activities in public and private sector organizations.
Forests and Society – Responding to Global Drivers of Change - IUFRO http://www.iufro.org/science/special/wfse/forests-society-global-drivers	This publication discusses the challenges, threats, and opportunities facing the forest sector due to global drivers such as climate change.
Catalyzing Urban Climate Resilience http://www.i-s-e-t.org/images/pdfs/ISET_CatalyzingUrbanResilience_allchapters.pdf	The publication represents a practical way of systematically translating the growing body of natural and social scientific knowledge regarding resilience into applied planning practice.
Characteristics of a disaster-resilient community: A guidance note – John Twigg. 2009 http://www.abuhrc.org/Publications/CDRC%20v2%20final.pdf	At the core of this publication is a set of tables that gives a comprehensive picture of a resilient community. The tables are divided into 5 main areas: governance, risk assessment, knowledge and education, risk management and vulnerability reduction, and disaster preparedness and response.
Adaptation Policy Frameworks for Climate change – UNDP http://www.undp.org/climatechange/adapt/apf.html	Provides a structured approach to formulating and implementing adaptation strategies, policies and measures to ensure human development in the face of climate variability and change.

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Table 2 - (continued) Resources for increasing community resilience

Strategies and Tools, Web Links	Resilience focus
Resources for First Nations communities	
Climate change Planning Tools for First Nations Guidebooks – Centre for Indigenous Environmental Resources (CIER) http://www.cier.ca/information-and-resources/publications-and-products.aspx?id=412	Six guidebooks that “walk and talk” First Nation communities through vulnerability assessments, climate change adaptation, and community resilience planning.
First Nations action plans (including MPB action plan – First Nations Forestry Council) http://www.fnforestrycouncil.ca	The action plans address First Nations community priorities in areas affected by the MPB epidemic, fuel management to reduce fire risk, economic diversification, and cultural sustainability.
First Nations Emergency Services Society (FNESS) http://fness.bc.ca	FNESS develops strategies, plans, and training to make First Nations communities in British Columbia more resilient to emergency situations due to natural or human causes.
First Nations Comprehensive Community Planning (CCP) – Indian and Northern Affairs of Canada (INAC) http://www.aadnc-aandc.gc.ca/eng/1100100021972	CCP is a tool to build healthy and sustainable First Nations communities. INAC BC Region has been working in partnership with five First Nations on CCP pilot projects since 2004.
The Indigenous Peoples' Climate change Initiative http://www.ipcca.net	International group that has included some of British Columbia's First Nations in their research.
Indigenous Climate Portal http://www.indigenousclimate.org	Climate change knowledge-exchange portal focused on research, training, policy, and negotiations relevant to indigenous people.

Vulnerability assessments: A start to increasing resilience

Vulnerability assessments reveal opportunities to intervene to strengthen the resilience of communities and human systems to the impacts of climate change. Management interventions will vary from place to place, depending on the vulnerability assessment. Diagnosis of local conditions will be essential in determining vulnerability in any particular situation.

The reduction of vulnerability requires a local approach because specific vulnerabilities vary from place to place, depending on exposure and the adaptive capacities of agents and systems; but, methods and tools for assessing vulnerabilities and for building local resilience, such as those listed in Table 2, can be developed and replicated (Tyler 2010b). Diagnosis of vulnerabilities must involve the agents themselves so that they can share their knowledge and experience of local conditions in partnership with external expertise (Salinger et al. 2005).

The first time a community assesses climate change adaptation should clearly be marked as the beginning of an ongoing, evolving journey instead of a one-time event (Pearce & Callihoo 2011). Increasing resilience to natural disturbances will be an ongoing activity needing constant attention as communities experience natural disturbance impacts, as new projections of future climate conditions become available, and as new adaptation options are tested and implemented (Pearce & Callihoo 2011).

One of the biggest challenges that communities face is a lack of financial or human resources. If there are no resources, then little action can be taken to build resilience to natural disturbances. Community leaders, all levels of government, industry, and other involved



organizations and individuals need to collaborate on an ongoing basis to address this challenge before embarking on the journey to build community resilience

No community can ever be completely safe from natural disturbances and hazards. It may be helpful to think of a resilient community as a community that can minimize its vulnerability and adapt to and function effectively when it faces hazards from natural disturbances (Twigg 2009).

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Author information

Ajit Krishnaswamy, FORREX Socio-economics Extension Specialist, c/o Simon Fraser University School of Resource and Environmental Management, 8888 University Drive, Burnaby, BC V5A 1S6. Email: ajit.krishnaswamy@forrex.org

Ellen Simmons, FORREX Aboriginal Forestry and Indigenous Knowledge Extension Specialist, c/o En'owkin Centre RR 2, Site 50, Comp 8, BC V2A 6J7. Email: ellen.simmons@forrex.org

Larry Joseph, Member, Board of Directors, Forest Stewardship Council, RR 1, S-0 C-15, Hazelton, BC V0J 1Y0. Email: larry.joseph@me.com

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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.

Increasing the Resilience of British Columbia's Rural Communities to Natural Disturbances and Climate Change

INCREASING THE
RESILIENCE OF
BRITISH COLUMBIA'S
RURAL
COMMUNITIES
TO NATURAL
DISTURBANCES AND
CLIMATE CHANGE

Krishnaswamy,
Simmons,
& Joseph

1. Which of these is not a characteristic of climate change according to the Intergovernmental Panel on Climate Change (IPCC)?
 - a) greater and more frequent variability in climate patterns
 - b) probability of extreme weather-related events increasing
 - c) stabilization of the climate at some future climate condition
2. Identify which of the three choices is not correct. Risk to a community from natural disturbances increases if the:
 - a) vulnerability of the community to natural disturbances decreases
 - b) magnitude or intensity of natural disturbances increases
 - c) likelihood of a natural disturbance happening increases
3. Which of these is not a characteristic of resilience?
 - a) the capacity of a system to absorb disturbances and reorganize through adaptation or resistance
 - b) the capacity to create a fundamentally new system
 - c) the capacity to manage or maintain certain basic functions and structures during disastrous events
 - d) the capacity to retain essentially the same function and structure after disastrous events

