District of Elkford:
Climate Change Adaptation Strategy

Report for: District of Elkford, B.C., Canada

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elkford
Wild at heart.

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Executive Summary

For several years, the Columbia Basin Trust (CBT) has been spearheading research on climate impacts in the Columbia Basin, supported by a team of scientists and planners, and in partnership with the Pacific Climate Impacts Consortium (PCIC). The CBT observed that the impacts of climate change, and the vulnerability of communities to change, varied throughout the Basin. In 2008, the CBT recognized the need to support communities in identifying localized climate change projections and vulnerabilities, and in creating adaptation plans that would allow those communities to prepare for a much different future. The District of Elkford was one of two communities chosen to participate in Columbia Basin Trust's *Communities Adapting to Climate Change (CACC)* initiative. For the District of Elkford, this initiative was integrated into an Official Community Plan (OCP) revision, which was to be completed 'through a climate change lens.'

With support from PCIC, the *Communities Adapting to Climate Change* team (comprised of Karen Gorecki, Megan Walsh and Jeff Zukiwsky) developed a process that emphasized community and staff engagement, and the pairing of local knowledge with scientific data and projections to determine areas of priority for further climate impact research. Initial open houses revealed strong community concern for issues such as wildfire, road maintenance, stormwater management and water quality. The CACC research team used the public input and best available science to focus in on three priority areas: Wildfire, Flooding and Water Supply. These three priority areas were determined to be most vulnerable to future climatic changes, and in the context of Elkford, were of most concern to the community in terms of impacts on community safety and wellness.

A workshop with staff, council and the Community Advisory Committee worked through the vulnerability, probability and risks of climatic impacts on each of the three priority areas. The vulnerability of Elkford to climatic impacts, such as the risk of flooding to the sewage lagoon and domestic water supply wellheads, were assessed for the three priority areas. Input was provided during this process from scientists involved in the *Communities Adapting to Climate Change* initiative.

Gorecki, Walsh and Zukiwsky used the valuable input from staff, Council and the Community Advisory Committee to develop climate change adaptation strategies that will foster a resilient and prepared community. The recommendations can be integrated and reflected in existing bylaws and policies, and will be a core theme in the revised Official Community Plan. Implementation of the recommendations into policy, bylaw and District operations will certainly place Elkford on the leading edge of climate change adaptation planning. We are pleased to have been part of the process.

Acknowledgements

First and foremost we could like to thank the funders of this initiative: The Columbia Basin Trust's *Communities Adapting to Climate Change* initiative and the District of Elkford.

This project would not have been possible without the dedicated efforts of numerous individuals:

- We would like to thank the District of Elkford staff, especially the dedicated and tireless efforts of Corien Speaker. Numerous other staff participated in workshops and enthusiastically provided information and knowledge including Curtis Helgesen, Duncan McDonald, Bernie Van Tighem, and Norma Everett.
- Elkford Mayor Dean McKerracher and council have been extremely supportive of this project and their active engagement has made this project a success.
- Kindy Gosal and Michelle Laurie, from the Columbia Basin Trust, have offered much valued advice, coordination, and patience.
- *Communities Adapting to Climate Change* Advisory Committee advice, participation, and presentations have been great motivators in this project. We'd like to especially thank Meredith Hamstead, Cindy Pearce, Mel Reasoner, Hans Schreier, and Stewart Cohen.
- Ingrid Liepa, Local Coordinator for the Kimberley Climate Change Adaptation project, has been extremely supportive and insightful. The sharing of knowledge between communities enhanced this process.
- Thanks to Smart Growth Advisory Services and Thinkbright Environmental Innovations for helping us create a successful team, for sharing knowledge and expertise, and organizing and facilitating community engagements.
- Thank you to Amy Thede, a Simon Fraser University Masters student, for providing volunteer time on this project.
- Forest and wildfire specialists who provided insights into the completion of this document include: Peter Hisch, Matthew Tutsch, Rob Walker, Mark Fercho, and Lauren Phillips.

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List of Acronyms

AC	Advisory Committee
BC	British Columbia
BGC	Biogeoclimatic
CACC	Communities Adapting to Climate Change
CAC	Community Advisory Committee
CBT	Columbia Basin Trust
CCA	Climate Change Adaptation
CWPP	Community Wildfire Protection Plan
ESSF	Engelmann Spruce Subalpine Fir
ESSFdk	Dry Cool Engelmann Spruce Subalpine Fir
GHG	Greenhouse gas emissions
ICH	Interior Cedar Hemlock
IPCC	International Panel on Climate Change
MS	Montane Spruce
MSdk	Dry Cool Montane Spruce biogeoclimatic subzone
MPB	Mountain Pine Beetle
NDT	Natural Disturbance Type
OCP	Official Community Plan
PCIC	Pacific Climate Impacts Consortium
SGAS	Smart Growth Advisory Services
WMS	Wildfire Management Strategy
WUI	Wildland Urban Interface

Project Background

In the spring of 2008, Elkford was chosen as one of two communities to partner with the Columbia Basin Trust (CBT) in a yearlong community learning, engagement and planning process on adapting to local climatic changes. Elkford's interest in the initiative was a result of the District of Elkford's desire to see implications of future climatic changes incorporated into their Official Community Plan (OCP). At the time, no other community in British Columbia had attempted to integrate climate change adaptation in their OCP.

Communities Adapting to Climate Change is a planning and action initiative for local governments in the Columbia Basin. The initiative's aim is to help Basin communities increase their resiliency to climate change at the local level. The CACC initiative provides funding for communities to identify the range of potential impacts, assess local risks, vulnerabilities and sensitivities, and develop adaptation strategies for addressing climate change impacts. As a pilot community Elkford was supported by an advisory committee comprised of scientists, planners, community-based experts, and government representatives, coordinated by the CBT. As one of two communities in the Basin selected to participate in the initiative, the District of Elkford initiated the Climate Change Adaption planning process. As part of the CACC process, the District was to engage their community throughout the project, and to share their learning over the year with the CBT's CCA Learning Network.

Local Elk Valley consultants Jeff Zukiwsky, Megan Walsh, and Karen Gorecki (herein referred to as the climate change adaptation team) responded to the District of Elkford's request for developing a climate change adaptation (CCA) strategy and OCP in partnership with Thinkbright Environmental Innovations and Smart Growth Advisory Services (SGAS). This diverse team had the appropriate skill-set to successfully address all of the objectives of the project. With expertise in climate change adaptation and mitigation, community engagement, and resource management, Zukiwsky, Walsh, and Gorecki led the climate change adaptation strategy development and planning process. Thinkbright Environmental Innovations acted as facilitator and local coordinator for the OCP process. SGAS was program manager for the OCP revision.

There have been other key players in the development of this plan. District of Elkford staff has been integrally involved in this project through workshops and acting as reviewers. In addition, a council-approved Elkford OCP Community Advisory Committee has been involved in the development of and final approval of this CCA strategy.

This paper was written for two audiences:

1) **The District of Elkford staff, mayor, council, and community members** – The contents of this report is intended to be integrated into their policies and operations.

2) **Other communities interested in developing a climate change adaptation strategy** – We have tried to include as much information on our process and 'lessons learned' to help guide future climate change adaptation plans.

Introduction

The need for communities to adapt to climate change is apparent through the science at an international level, and in order to create resilient communities at the local level. Climate change is often quoted as the 21st century's greatest environmental challenge. The Intergovernmental Panel on Climate Change (IPCC)[1] and the Academies of Science[2] for the G8+5 countries have both made strong statements around the certainty of climate change, the need to act, and, most relevant for this project, the need to adapt (see text box below). Through these highly esteemed scientific bodies, and a consensus of the vast majority of scientists, experts and many political decision-makers are acknowledging that climate change is a grave reality for many years to come. There is an immediate need for action to reduce anthropogenic greenhouse gas (GHG) emissions, but given that climate change is a long-term process that impacts all facets of natural and built systems, there is also a need to adapt to, and prepare for the changes that are inevitable.

Adaptation must occur at all levels of government, and it is through the Columbia Basin Trust's project that municipalities have the opportunity to take the lead on action. Although climate change is a global phenomenon, effects will be felt most prominently at the local level. Local governments have the ability to tailor climate change preparedness strategies to their specific context, and to the unique set of climate change impacts that they expect to face. And the impacts may not

The Need to Act – IPCC and the G8 +5 Academies of Science

In 2007, IPCC concluded that:

- Warming of the climate system is unequivocal;
- Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely (at least 90% likelihood) due to the observed increase in anthropogenic (human) greenhouse gas concentrations; and
- The likely amount of temperature and sea level rise varies greatly depending on the fossil intensity of human activity during the next century.

The Academies of Science for the G8+5 countries in 2005 came out with a joint statement declaring:

- The scientific understanding of climate change is now sufficiently clear to justify nations taking prompt action.
- A lack of full scientific certainty about some aspects of climate change is not a reason for delaying an immediate response that will, at a reasonable cost, prevent dangerous anthropogenic interference with the climate system.

[1] Academies of Science of co-ordinates scholarly scientific research activities playing an important organizational role in academic exchanges and collaborations between countries.

[2] The IPCC is a scientific intergovernmental body set up by the World Meteorological Organization (WMO) and by the United Nations Environment Program (UNEP) tasked with acting as an objective source of information on climate change for decision-makers and others.

be entirely negative. There may be new opportunities for communities as the climate shifts, such as the ability to plant new food crops or to save on snow removal costs. Although opportunities do exist, the impacts of climate change will generally require an adjustment in planning, development and capital spending. Investing in proactive planning for climate change may, in the long run, actually create costs savings as compared to a reactive approach.

Planning for climate change now will benefit the health, safety, and welfare of present and future generations. Part of this planning involves anticipating future trends and changes that will impact the environment, the economy and community well-being. It is also important for communities to be proactive their climate change adaptation planning. Being proactive and strategic can create opportunities to modify existing policies and practices and capitalize on some of the benefits of climate change. Climate change preparation planning can help protect community assets and government services and is a form of good governance.

What is Climate Change Adaptation?

Climate Change Adaptation involves making adjustments in our decisions, activities and thinking in response to observed and predicted changes in climate. The goal is limiting harm or reducing costs in the long-term while taking advantage of new opportunities and maximizing benefits. Successful adaptation does not mean that impacts will not occur, only that they will be less severe than would be experienced had no adaptation occurred.[3]

Why is Climate Change Adaptation Important?

Mitigation (reducing GHG concentrations) and adaptation are both necessary responses required to meet the challenges posed by climate change. This is evident by the fact that even after introducing significant measures to reduce GHG emissions; some degree of climate change is inevitable. For example, even if GHG emissions had been stabilized in 2000, scientists predict that we would see increased warming to the end of the 21st century due to the concentration of GHGs in the atmosphere, and the "lag time" it takes for the Earth's oceans and atmosphere to warm.[4] Additionally, the reduction of GHG emissions that is needed to slow climate change is unlikely to happen in the immediate future, due to the dependence of the global economy on fossil fuels and the lack of effective policy implementation. Some changes in climate are inevitable and will have economic, social and environmental impacts on Canadian communities.

Given these realities, managing climate change impacts is not simply a matter of proceeding "business as usual." It is becoming increasingly necessary to take steps to prepare for the regional effects of climate change even as communities work together to stabilize global GHG emissions. Taking steps now can save money, resources, and even

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[3] Natural Resources Canada (NRCAN) (2007) - From Impacts to Adaptation: Canada in a Changing Climate. http://adaptation.nrcan.gc.ca/assess/2007/index_e.php

[4] (IPCC) Intergovernmental Panel on Climate Change (2007). Climate Change 2007: The Physical Basis: Summary for Policy Makers, Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, NY. Available for download at: http://www.ipcc.ch/WG1_SPM_17Apr07.pdf

lives in the future. Action now can also take advantage of potential benefits for a community.

While all levels of government should act, community level adaptation is a natural fit. Local governments are erecting or significantly influencing the vast majority of infrastructure, building or zoning decisions – key areas that should take climatic changes into account. Communities can also, to some degree, influence local economies, and have a big stake in their changes. Adapting at the local level means the actions that are taken can be tailored to the regional context, including regional temperature and precipitation changes.

Unique Communities, Unique Approaches

The City of Kimberley was the other 2008 pilot community chosen by the CBT. Each of these communities has very distinctive economic, infrastructure, and cultural challenges when attempt at becoming more resilient to climate change adaptation. Even with the diversity of challenges, each community found themselves struggling through the same questions and challenges in the process of developing climate vulnerability assessments and adaptation strategies.

Why climate change adaptation and an Official Community Plan?

This plan was completed simultaneously with an update of Elkford's Official Community Plan (OCP). Significant time and cost efficiencies were gained through the coupling of these two processes, particularly with the organization and facilitation of community outreach.

Integrating planning for current and future climatic impacts into an OCP can ensure an adaptation strategy is practical and consistent with what the District is already doing. Planning for climate change has a natural fit with official community planning as another layer of mid to long term planning. The OCP guides future land use planning and management decisions, which are imperative for a community to adapt to climate change. Rewriting or revising an OCP is a good time to examine and integrate other relevant policies such as climate change adaptation.

What is an official community plan?
An Official Community Plan (OCP) is a provincially mandated, legal document that provides the long-term vision for the community. The OCP contains objectives and policies to guide decisions on planning and land use management within the community. It includes areas such as the environment, economic development and transportation, and detailed policies on residential, commercial and industrial development designed to support the plan's larger objectives.

What is a resilient community?

Resiliency refers to the amount of change a system can undergo without changing state, or the degree to which the system is able to rebound or recover from a stressor or driver. The Ontario Healthy Communities Coalition identifies the following characteristics and outcomes of a resilient community:

- When disaster strikes, losses, both financial and human, are reduced;

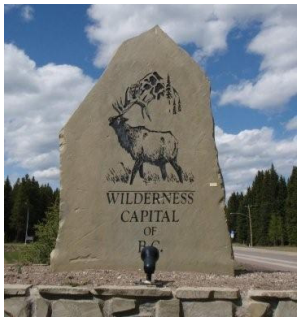
- Resilient communities exhibit a sense of pride and openness to new ideas and alternatives;
- A local economy, aware of its social capital, is more likely to weather economic recession and remain intact afterwards, keeping money in the community.[5]

In the context of Elkford and the CCA initiative, creating a resilient community is the ability to react to, and recover from impacts of climate change without significant loss or damage. The community is creative and effective at implementing new ideas and remains aware of the long-term implications of planning and decision-making. Resilient communities are the result of an engaged and community-centered process, with the support and leadership necessary from the local government.

Communities adapting to Climate Change
Many communities across Canada and the United States are recognizing the need to be proactive and plan for the potential future impacts of climate change. Some examples of municipalities taking action on climate change adaptation are: Keene, New Hampshire; Dawson Creek, BC; Kimberley, BC; and Hall Beach, Nunavut.

About Elkford

Located in the Southern Rocky Mountains, Elkford is the "Wilderness Capital of BC" and is surrounded by stunning mountains, lakes, rivers, and year-round recreation opportunities. Established as a mining town in 1971, Elkford is experiencing growth in the tourism industry and in recreational property investment. These changes will bring new investment and economic opportunities to the District; however challenges related to climate change, affordability, and community character need to be considered. Strategic planning will ensure that development is managed in a way that is compatible with: community values, global trends, and the wilderness that is the 'core' of Elkford.



Population and Census Data

According to the 2006 Census, the population of the District of Elkford is 2,463. The population decreased by 4.9 % from 2001 to 2006. However, historically the population of Elkford has fluctuated between changes of +/- 4%, to as much as +74% from 1976 – 1981. Much of this fluctuation is based on the activity of the Elk Valley Coal Mine, the single main employer for residents in Elkford.

Economy

The economy of Elkford is strongly tied to the resource extraction industry, primarily coal mining. In 2006 1,390 people made up the labour force in Elkford. The resource-based industry, with 705 people, is overwhelmingly the largest employment sector in the community. This dominance is due to Elkford's proximity to the following 4 mining facilities:

[5] Ontario Healthy Communities Coalition. www.ohcc-ccso.en/relient-communities

- Greenhill's Mine (located within the District boundaries 6km northeast of the Elkford town site);
- Fording River (located by satellite within the District boundaries 29 km north of the Elkford town site);
- Line Creek Mine (located between Elkford and Sparwood);
- Elkview Mine (located in Sparwood).

Retail trade, Business and other services are the next most prevalent industries in Elkford. Construction, Manufacturing, Finance and Real Estate, Health Care and Social Services and Education Services only employ a handful of people in each category.[6]

Despite Elkford's reliance on the mining industry and thus its ties to the world economy and global prices of coal, the community has attempted to diversify its economic base. Elkford has branded itself as "Wild at Heart" in a bid to attract recreation-oriented visitors.

To visitors and residents, Elkford is defined in part by its Rocky Mountain location and by extension, its wealth of outdoor recreational opportunities. Activities include:

- Snowmobiling on more than 400 km of trails in the area;
- ATV trail riding in the summer months;
- Skiing at the Wapiti Ski Hill;
- Cross-country skiing;
- Fishing (Elk and Fording rivers provide outstanding Fly fishing opportunities;
- Golfing at Mountain Meadows Golf Course;
- Hiking and Camping. [7]

Elkford's pristine natural wilderness is highlighted by its close proximity to Elk Lakes Provincial Park. The park is located approximately 70 km north of Elkford and offers a wilderness experience characterized by outstanding sub-alpine landscapes, remnant glaciers, rugged peaks and productive lakes. The park supplies visitors with a variety of hiking experiences ranging from some maintained trails appropriate for families to back-country hiking terrain.

Ecosystems in the Elkford Area

The District of Elkford is nestled in the Upper Elk Valley, within the Rocky Mountain range at the Junction of the Elk River and Boivin Creek. The two primary biogeoclimatic (BGC) zones found within the District of Elkford are Montane Spruce (MS) and Engelmann Spruce Subalpine Fir (ESSF). Portions of the valley south of Elkford are in the Interior Cedar Hemlock (ICH) zone. Dominant BGC subzones within the District are:

- Dry Cool Montane Spruce biogeoclimatic subzone (MSdk);

[6] 2006 Census, Community Profiles, District of Elkford, British Columbia, Industry for both sexes, http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92591/details/page_Figure.cfm?Lang=E&Geo1=CSD&Code1=5901003&Geo2=PR&Code2=59&Data=Count&SearchText=Elkford&SearchType=Begins&SearchPR=01&B1=Labour&Custom=&Profile=23000&Sex=Total

[7] Ibid.

- Dry Cool Engelmann Spruce Subalpine Fir (ESSFdk).

Figure 1 illustrates the BGC subzones within and around the District of Elkford.[8] The MSdk subzone occurs in valley bottoms and lower valley slopes of the eastern Purcell and Rocky Mountains. The average temperature is below 0°C for 5 months of the year and above 10°C for 2 to 4 months. Mean annual precipitation ranges from 380 to 660 mm. The growing season is sufficiently warm and dry and moisture deficits can occur, particularly in the drier subzones.

ESSFdk is a higher elevation subzone and is a forested subzone that is widespread across south eastern BC. The ESSF has a relatively cold, moist, and snowy climate. Mean monthly temperatures are below 0°C for 5 to 7 months and only above 10°C for 0 to 2 months. Mean annual precipitation is highly variable ranging from 500 – 2,200 mm annually. Most (50 to 70%) of the precipitation falls as snow and maximum snow pack ranges from about 1 to 4 m.

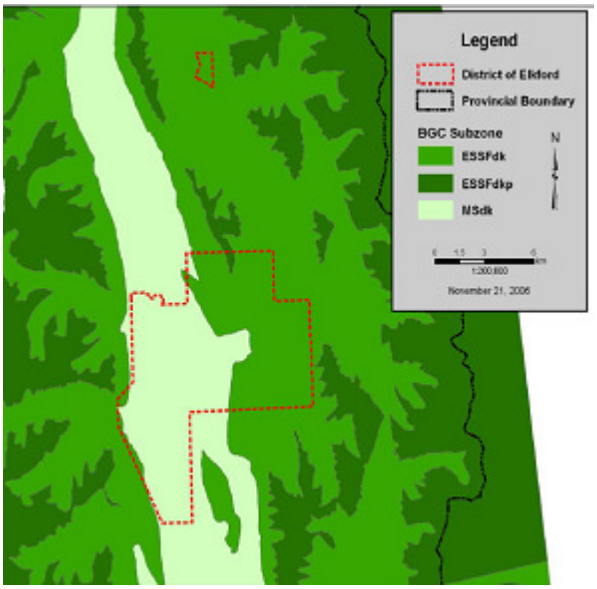


Figure 1: BGC Subzones

Dominant vegetation in the MSdk subzone includes sasakatoon, snowberry, false azalea, soopolallie, twinflower, pinegrass and heart-leaved arnica. In the ESSFdk, dominant vegetation includes false azalea, black huckleberry, black gooseberry, grouseberry and arnica.

Wildlife Species

Animal species thrive in specific niche ecosystems. Wildlife in the Elkford area has adapted to either survive or avoid the deep snows of winter. The extensive stands of lodgepole pine provide summer and fall range for Mule Deer, which prefer the lower elevation mature coniferous forests.

Steep south-facing grassland slopes, though not extensive in this area, are locally significant as foraging areas for California and Rocky Mountain Bighorn Sheep. Avalanche tracks, with their lush forage production are feeding habitats for Grizzly Bear, Black Bear, and Rocky Mountain Elk. Riparian areas and water bodies are very important summer habitats for a variety of mammals, birds and amphibians. Mule Deer often select these habitats in the summer to drop and rear their calves and fawns because of the abundant forage and dense security cover.

A variety of resident and migratory bird species are found in these forests including woodpeckers, flycatchers, jays, crows, chickadees, nuthatch's, thrushes, sparrows,

[8] From: District of Elkford (2006) Wildland/ Urban Interface: Wildfire Management Strategy

hummingbirds and finches. With the combination of forests, fish bearing streams and open agricultural farmland, this area provides good hunting habitat for a number of raptor species including eagles, hawks, vultures, kestrels and owls. [9]

Endangered Species

The BGC zones in the Elkford area contain species listed as threatened or endangered (red listed) and sensitive or vulnerable species (blue listed). Some of the red listed species generally found in the MS and ESSF BGC zones include: Peregrine Falcon (subspecies anatum), Red-tailed Chipmunk (Subspecies simulans & ruficaudus), Northern pocket gopher (subspecies segragatus), Bay-breasted Warbler and the Western Grebe. Blue listed species include: Great blue heron, Bald eagle, Swainson's hawk, Sandhill crane, Red-necked phalarope, Southern red-backed vole (subspecies galei), Wolverine (subspecies luscus), Fisher, Badger, Grizzly bear, Big horn sheep (subspecies canadensis) and Caribou (south-eastern population). [10]

History of Wildfires in Elkford

Most ecosystems are influenced by periodic disturbances that vary in size, severity and occurrence depending on ecosystem characteristics. Wildfires are one of the most prominent natural disturbance patterns in BC. The forest in and around the District of Elkford are classified as natural disturbance type (NDT) 3, meaning that fires are relatively frequent[11]. The average fire return interval for large-scale crown fires in this NDT is 125 years. Smaller spot fires occur more frequently and are influenced by annual temperature and precipitation, with warmer and drier years being more susceptible to fire.

Large wildfires in the greater Elk Valley region occurred in 1904 and 1908, the years when the town of Fernie was destroyed by wildfires. Wildfires may have also occurred in the Fording Valley in the 1960's[12]. In 2003, the Lamb Creek and Plumbob fires burned significant areas in the East Kootenay.

Planning for Wildfires in Elkford

The District of Elkford has recognized the growing threat of WUI fires in the valley. To respond to these risks and reduce the risk to residents and infrastructure, the District has integrated wildfire planning (to a limited degree) into the Official Community Plan (OCP), and a Community Wildfire Protection Plan has been completed which includes a Wildfire Management Strategy (WMS) and Fuel Reduction Program. This section outlines the Districts efforts to plan for wildfires.

Official Community Plan

Elkford's OCP (1999) identifies 'forest fires' as a development constraint which should be managed to ensure a safe environment and preserve environmentally sensitive areas. Three wildfire policy objectives exist in the OCP:

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[9] Information from: District of Elkford (2006) Wildland/ Urban Interface: Wildfire Management Strategy.
[10] Stevens, V. (1995) Wildlife Diversity in British Columbia: Distribution and Habitat Use of Amphibians, Reptiles, Birds, and Mammals in Biogeoclimatic Zones. BC Ministry of Forests, Research Program.
[11] District of Elkford, 2008: Wildland/ urban interface wildfire management strategy
[12] Information from Community Advisory Committee meeting: May 6, 2009

1. Consider fire prevention and layout of any buildings in high risk areas;
2. All roadways and turnabouts will be capable of accommodating emergency vehicles;
3. Provide rights-of-way where road access is incomplete or indirect for emergency vehicle access.

Wildfire Management Strategy

In 2006, a Wildfire Management Strategy was developed by the District to Elkford to address the threat of wildfires in the WUI in the District. The strategy includes a Fuel hazard ranking and wildfire risk analysis of the WUI in Elkford. The risk analysis is based on an assessment of the forest fuel types and historical weather patterns in the region[13]. Both urban (site specific) and landscape level fire risks were assessed, and recommendations for wildfire mitigation are presented.

At the landscape level, three areas were identified as high or extreme fire risk areas that pose a threat to the District:

- Northwest of North Elkford,
- Northeast of North Elkford, and
- East of South Elkford

Site specific wildfire assessments were conducted in urban areas of the District. High-risk fire areas in the District include:

- North of Boivin Creek
- Alpine Way and Alpine Drive
- North of Balmer Drive
- Cariboo Drive and Cassiar Drive[14]

Numerous wildfire mitigation recommendations were presented in the Wildfire management strategy. Appendix E includes a summary of these recommendations[15].

Wildfire Fuel Reduction Program

As a result of the wildfire risk analysis in the wildfire management strategy, fuel modifications were proposed for the District. The primary goal of the fuel reduction program is to undertake fuel modification work thereby reducing the likelihood and intensity of wildfires in and around the District of Elkford. 41 treatment polygons were identified, with 21 identified as high (12) and very high (9) priority. Fuel management treatments focus on protection of public infrastructure and property, and private homes within the community. Treatment of the polygons follows five objectives:

1. Protection of public safety both within and adjacent to the District of Elkford.

[13] The strategy does not account for potential changes to fuel types and weather patterns from climate change

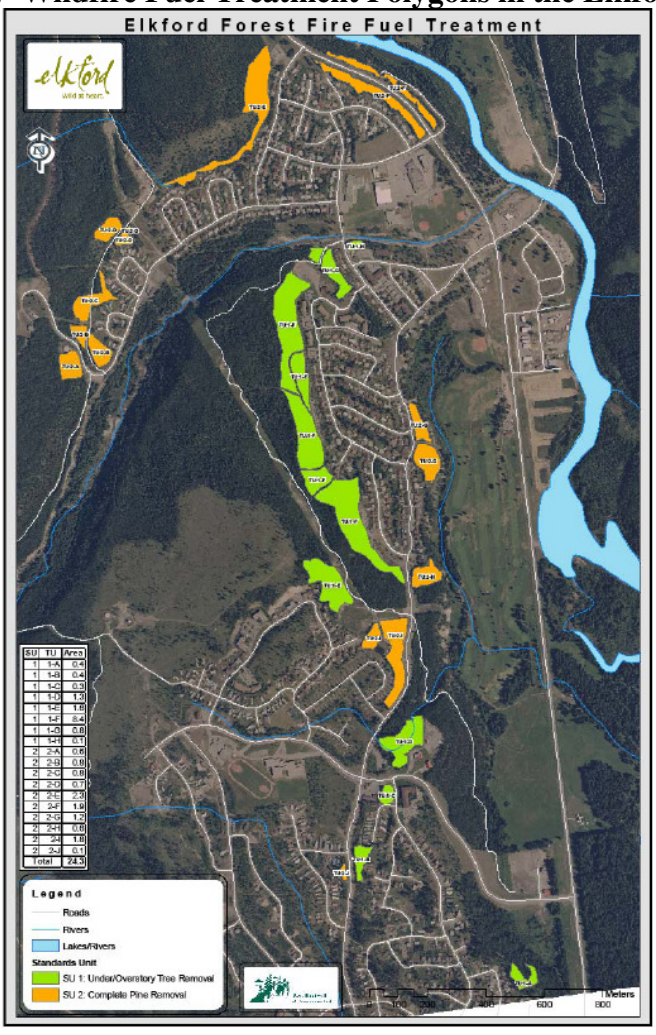
[14] Refer to the District of Elkford Wildland/ Urban Interface Wildfire Management Strategy for more information

[15] Recommendations specific to the fuel hazard reductions, including treatment prescriptions and options are not summarized here.

2. Improvement of the ability of District of Elkford Fire and Emergency Services to protect both life and property values at risk within the boundaries of the District of Elkford.
3. Removal of dead, dying and or susceptible lodgepole pine impacted by the current Mountain Pine Beetle outbreak.
4. Enhancement of natural barriers that reduce the continuity of fuel loads and wildfire risk.
5. Improvement in biodiversity of wildlife habitat through improved understory vegetation development and or the establishment of early seral forests.

Figure 2 shows the areas of Elkford prescribed for understory tree removal (green) and complete pine removal (orange). Fuel modifications are set to begin in the summer of 2009.

Figure 2- Wildfire Fuel Treatment Polygons in the Elkford WUI



Source: B.A. Blackwell & Associates Ltd.: Elkford Presentation- Feb.2, 2009

Flooding and Water Supply

Elkford is located along the Elk River, which flows from the Upper Elk Lake and Lower Elk Lake. Peak flows in the Elk River occur during the spring thaw (freshet) and are maintained through the summer, providing habitat for fish and other aquatic species. In 1989, floodplain mapping was completed for the 200-year floodline. Within this floodline lies the District sewage operations and it is on the boundary of two of the three water wells. One of the most significant floods in recent years occurred in 1995.

The District of Elkford draws water from 3 wells. Throughout the Province, only one-third of aquifers are mapped; Elkford is drawing from an aquifer about which little is known. Water is chlorinated at the source and quality samples are taken from the three wells bi-weekly. A Class II Water Distribution System is currently used for drinking water. Residents are charged a flat rate for water use at an annual rate of $175, as identified in Bylaw No. 689 Schedule A.[16]

There is very little known about the nature of the aquifer and the recharge locations and sources. Efforts have been taken by the District to ensure the integrity of the Boivin Creek Watershed, the watershed believed to feed the aquifer. Existing Policy No. 2001-05 states that: "Without prior authorization from the Public Works Superintendent, vehicle access to the upper Boivin Creek watershed shall be closed to the general public."

Due to the cost of purifying the District's water system, it is in the financial interest of the community to decrease water consumption. The District promotes water conservation by implementing outdoor watering restrictions between April and October each year, where outdoor water use is to occur between the hours of 6 am and 9 am or from 6 pm and 10 pm.[17]

Elkford's Climate Change Adaptation Planning Process

There is no single approach to developing a community adaptation plan. There are a number of frameworks that have been developed to guide the process of adaptation plan development. Ultimately the needs of the community, the priorities identified through community engagement and best available science will determine the most appropriate approach for a community.

The Elkford CCA team took six basic steps to developing a climate change adaptation plan for the District of Elkford. Our process was based on input from two key documents:

- *Preparing for Climate Change – A Guidebook for Local, Regional, and State Governments*[18] and,
- *Adapting to Climate Change – A Risk-based Guide for Ontario Municipalities*. [19]

[16] District of Elkford, Waterworks Bylaw No. 689 Schedule A
[17] District of Elkford, Water Conservation Policy, Policy No. 2004-05).
[18] Climate Impacts Group (CIG), Joint Institute for the Study of the Atmosphere and Ocean University of Washington, & ICLEI – Local Governments for Sustainability (2007) Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments. URL: http://cses.washington.edu/cig/fpt/guidebook.shtml
[19] Bruce, J.P., Egener, I.D.M., & Noble, D. Adapting to Climate Change: A Risk-based Guide for Ontario Municipalities

We adapted their processes based on what we thought would work best for Elkford and the CBT's project and the following objectives:

- Ensure staff and community "buy-in" to increase the likelihood for recommendations;
- Focus on relevance to and integration into the OCP;
- Consult with the CBT Advisory Committee (AC) to sufficiently benefit from their experience and knowledge.

Our process consists of the following steps all of which were completed by our team, except the final step of implementation; this step is led by the District.

1. **Examine potential precipitation and temperature changes -** The Pacific Climate Impacts Consortium (PCIC) provided historical (last 100 years) and regional modeling projections (next ~70 years) for temperature and precipitation changes.

2. **Investigate climate change impacts** – Based on the data provided by PCIC, we researched the scientific literature, and gathered information from experts to explore what other biophysical and anthropogenic impacts may affect Elkford and the surrounding region from projected changes in temperature and precipitation.

3. **Develop risk scenarios (impact pathways)** – Potential climate change impacts were translated into impact pathways (see Appendix C- Elkford's Impact Opportunity Pathways). These visual pathways draw connections between the chain of impacts that may result from changes in temperature and precipitation to how it may impact the environment and the citizens of Elkford.

4. **Identify community adaptation priorities** – Based on steps 1-3, we identified six priority areas for the CCA strategy to address – wildfire, flooding/land slides, snow, water availability, ecosystem change, and disease/pests (i.e. mountain pine beetle). We then presented these priorities to the community to determine whether they reflected their key areas of concern. This was achieved through booths in the mall, a paper and web-based survey, and an open house event. The following question was posed, to determine community priorities: "From the six potential climate change impact areas, what do you [community members] see as priorities for the District to address?" Based on the results we narrowed to three key planning areas – wildfire, flooding/stormwater management, and water supply.

5. **Vulnerability and Risk Assessment** – This step was used to find gaps in the identified planning areas and to help determine what to pay attention to first. Our vulnerability assessment evaluated: a) the degree our planning areas are impacted by climate change; b) to what degree they are exposed; and c) Elkford's adaptive capacity in each of these areas (based on potential adaptive actions and their related barriers). The risk was then assessed by identifying the probability of a

climate change related event occurring within a 20-year period and the vulnerability of the community. This process was undertaken collaboratively with Elkford staff, elected officials, and members of the community advisory committee (CAC). Members of the CBT staff and Learning Network also participated.

6. **Action Planning –** At this point, the intent was to identify what adaptation measures should be taken, and who would lead each task. This was accomplished by formulating goals and objectives for each of Elkford's priority planning areas, and then developing actions to meet these goals and objectives. The final CCA strategies address Elkford's highest sensitivity's, and most feasible adaptive capacities identified during the vulnerability assessment.

7. **Implementation, Monitoring and Adjusting –** At this point, staff and community members will take responsibility for ensuring that actions in the CCA strategy are implemented over time. As the staff has been involved at each step in the CCA process, they have the knowledge and skill set to monitor and adjust this plan over time.

Table 1 below delineates the purpose of the vulnerability assessment, risk assessment and action planning stages in the development of a climate change adaptation strategy to help clarify the role of each step.

Table 1: Purpose of Vulnerability, Risk and Action Planning

Process Step	Shorthand name	Purpose
Vulnerability assessment	Find weak spots	Figure out how sensitive and exposed a community is to certain risks and whether or not they can adapt to these risks with available capacity, and which require actions outside available capacity to reduce
Risk assessment	What to pay attention to first	Figure out the which risks are priorities based on probability of occurrence and vulnerability
Strategic action planning	Who to do what first	Decide on priority actions and responsibilities to reduce the priority risks

Source: Based on a table by Cindy Pearce

The following sections elaborate on each of the seven steps above, including specific data collected, results and outcomes of each step.

Step 1 - Examine Potential Precipitation and Temperature Changes

CBT's partner, The Pacific Climate Impacts Consortium (PCIC) has created a regional overview of the Columbia Basin's historical and predicted future climate trends.[20] Details on the methodology used for PCIC modeling can be found in Appendix A. The data below is an initial analysis of historical changes in hydro-climatology and projections for the future with yearly and seasonal differences provided. The information provides a foundation for discussing potential impacts.

Summary of Historic Changes, 1900-2004

As evident from Table 2 below, based on historic data, Elkford's temperature has increased over the last century. The mean temperature increase has been 1.0°C to 1.5°C. Similar trends exist for the East Kootenay in general (constant and gradual), while the Provincial rate of increase has accelerated faster. Through the 1950 to 2006 period, there were significant increases in spring stream flow, and decreases in summer stream flow. This likely indicates greater runoff in the spring due to a larger snowpack from increased winter precipitation and increased spring precipitation. PCIC found that increases in winter streamflow for the 1970 to 2006 period could be reflective of increases in precipitation falling as rain versus snow.

Table 2: Summary of Temperature and Precipitation Changes in Elkford, 1900-2004

Season	Mean temperature change	Minimum average temperature	Maximum average temperature	Precipitation
Overall	+1.0°C to +1.5°C	+1.0°C to +1.5°C	+0.5°C to +1.0°C	+20% to +40%
Winter	+1.5°C to +2.0°C	n/s	+1.5°C to +2.0°C	n/s
Summer	+1.0°C to +1.5°C	+1.5°C to +2.0°C	+0.5°C to +1.0°C	n/s
Fall	n/s	n/s	n/s	n/s
Spring	+1.0°C to +2.0°C	+1.5°C to +2.0°C	+1.0°C to +1.5°C	10% to 20%

n/s= not significant

Elkford is projected to have a 2°C to 3°C warmer climate with more precipitation in the winter and spring, and less precipitation in the summer (see Table 3 below) by mid-century. Elkford will have a 0% to 5% increase in precipitation overall but up to 20% to +25 more precipitation in the winter by mid-century. As temperatures increase, winter precipitation is more likely to fall as rain, rather than snow.

PCIC models found that future precipitation is projected to increase by 1% to 13% in winter and to decrease by -4% to -10% in summer for the Canadian Columbia Basin as a whole, with local variations as significant as 15% over distances as small as Kimberley to Elkford. Future temperatures are projected to increase more rapidly than was observed in

[20] Werner, A.T., Paterson, B.M., & Harpreet, J.K., 2008. Analytical Summary - Past Trends and Future Projections for the Kimberley and Elkford Region, Pacific Climate Impact Consortium, October 1, 2008, Version 3.

historic trends. Annual average temperature is projected to be 1.9°C to 3.0°C warmer by the 2050s for the Canadian Columbia Basin as a whole, with similar local changes.

Table 3 Historical and Future Projections for Climatology in the Elkford Region

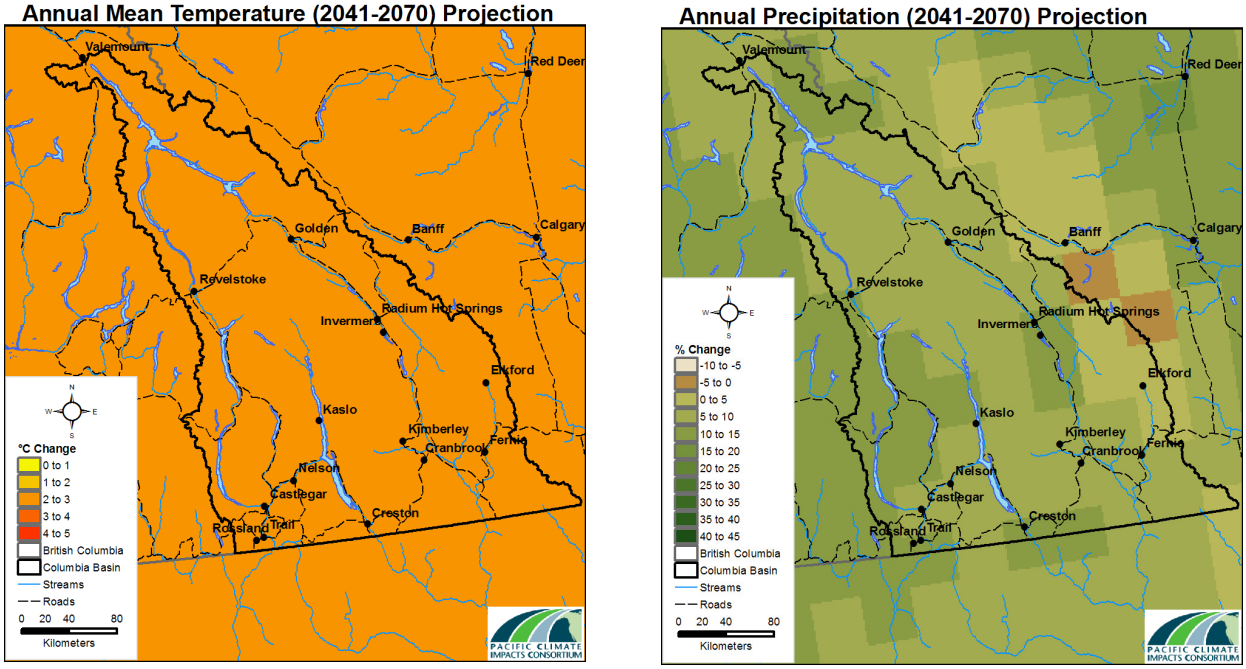
Variable	Historical climatology (1961-1990)[21]	Historical climatology (1980-2002)	Past trend	Future projection (2050s) [22]
Temperature – annual mean	4.1°C	4.5°C	+1.0°C to +1.5°C per century	(+2°C to +3°C warming)
Precipitation – annual total	582 mm	596 mm	+10% to +20% per century	+0% to +5% increase
Precipitation – winter	n/a	n/a	n/a	+20% to +25% increase
Precipitation – summer	n/a	n/a	n/a	-5% to -10% decrease
Snow/Snowpack	n/a	251 cm	n/a	-15% to 0%[23]
Streamflow	n/a	n/a	Shift of peak from May/June to April/May (1950-1995)	

Examples of projected changes in temperature and precipitation to mid-century are below, in Figure 3. Further projections related to past and projected changes in temperature, precipitation, growing degree degree days, frost-free days, and winter mean temperature can be found in Appendix B.

With all future climate change projections, it is important to remember that predicting the future is never completely accurate. Future climatic changes and the impacts associated with those changes will vary drastically between different ecosystems across BC. It is important for Elkford to plan for alternative future scenarios, capitalizing on opportunities while increasing the adaptive capacity and reducing the vulnerability of infrastructure and livelihoods to climatic impacts.

[21] Based on Cranbrook 1961-1990 and difference between Cranbrook and Elkford 1980-2002 climatology's.
[22] Ranges based on 25th and 75th percentiles of projections from 30 GCM results unless otherwise noted.
[23] Range for surrounding area based on single regional model projection.

Figure 3: Projected Changes in Temperature and Precipitation by Mid-Century
Source: Werner, A.T., Paterson, B.M., & Harpreet, J.K., 2008. Analytical Summary - Past Trends and Future Projections for the Kimberley and Elkford Region, Pacific Climate Impact Consortium, October 1, 2008, Version 3.



Step 2 - Investigate Climate Change Impacts

Precipitation and temperature changes must be analyzed further to understand how these changes will impact other forces of disturbance (wildfire, flooding), the soils, flora and fauna, and the eventual impacts on our community infrastructure, economy, recreation, and general well being. The climatology data provided by PCIC is a good start to understanding potential climate change impacts in Elkford, but, this data must be taken a step further to better understand human and ecosystem impacts. In an ideal world, there would be further data on how these changes in temperature and precipitation impact local hydrology, fire regimes, flora and fauna, etc.

This section outlines the results of our research on how the projected climate changes from PCIC are likely to affect Elkford. After a literature search and interviewing community members, staff and scientific experts, we narrowed our potential priority areas to wildfire, flooding/land slides, snow, water availability, ecosystem change, and pests (mountain pine beetle). To share resources and save time, we worked in close collaboration with the Kimberley CCA coordinator. We established a list of 'data needs' that was sought by both CCA teams.

Potential Wildfire Impacts

Wildfires are considered a natural part of many ecosystems across BC. The long-term health of BC's forests relies on large-scale stand-replacing wildfires to rejuvenate and regenerate the ecosystem. Wildfires entering urbanized areas [i.e. the wildland urban interface (WUI)] however, pose significant risks to our communities and livelihoods. This was apparent in 2003 when hot and dry conditions resulted in over 2,500 wildfires

across the Province, destroying 334 homes, forcing the evacuation of over 45,000 people, killing 3 people and resulting in economic losses estimated at $700 million[24]. It's unclear whether the 2003 wildfires were a direct result of climate change; however the *Firestorm 2003: Provincial Review* concluded that:

> "Whether the reason is global climate change, or normal weather cycles, it would be prudent for British Columbians to prepare for the probability of more hot, dry summer weather."

Future climatic changes will likely result in an increase in the frequency and severity of wildfires across BC.[25] Drier forests, warming temperatures and shifting precipitation regimes resulting from climate change have also increased the climatically suitable range of the mountain pine beetle (MPB) in BC.[26] North America is currently experiencing the largest known outbreak of MPB, with an estimated 80% of lodgepole pine being killed by 2013.[27] In general, MPB infested forests are more susceptible to fire risk.[28] The PCIC's climate projections for the Elkford area do not specifically look at fire risk, however studies from across Canada have shown that future climatic changes will likely increase:

- The total area burned by wildfires[29],
- The total length of the fire season[30], and
- The proportion of critical fire weather days.[31]

Changes in wildfire regimes may increase risks to the District of Elkford, but also provide some opportunities. Potential opportunities of increased fires, and burned landscapes include:

- Economic benefits from wood salvage and harvesting of burned and pine beetle impacted forests
- Harvesting of non-timber forest products (e.g. berries, mushrooms)
- Increased hunting opportunities

Water Availability and Flooding

Warming temperatures in the mountains of Western North America are very likely to result in increased glacial melt, earlier spring snow melt, more winter rain events and increased peak winter flows and spring flooding events by the mid-21st century[32]. Timing

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[24] Filmon, 2004: Firestorm 2003- Provincial Review

[25] NRCAN, 2007: From Impacts to Adaptation: Canada in a Changing Climate.

[26] Gayton, 2008: Impacts of Climate Change on British Columbia's Biodiversity: A Literature Review.

[27] District of Elkford, 2008: Wildland/ urban interface wildfire management strategy.

[28] BC Ministry of Forests and Range, 2006: Preparing for climate change: Adapting to impacts on British Columbia's forest and range resources.

[29] Flannigan et al., 2005: Future area burned in Canada

[30] Benton, 2003: Potential changes in forest cover and fire danger in the Columbia Basin

[31] Williamson et al., 2008: Assessing potential biophysical and socioeconomic impacts of climate change on forest-based communities

[32] Werner, A.T., Paterson, B.M., & Harpreet, J.K., 2008. Analytical Summary - Past Trends and Future Projections for the Kimberley and Elkford Region, Pacific Climate Impact Consortium, October 1, 2008, Version 3.

of the spring runoff will likely shift earlier in the spring, as historical streamflow data for the Elk River indicates a trend towards earlier peak flow. Watershed changes as a result of mountain pine beetle kill, wildfires, and increased winter rain events are likely to increase the frequency and severity of flooding events due to decreased capacity for water retention within the ecosystem.

In the short term, peak-melting events may cause late summer/early fall flooding until the glaciers contributing to this runoff diminish, at which point a significant reduction in glacial-fed stream flow will occur[33]. These impacts have already started to play out in the Columbia Basin region. Between 1986 and 2000, there was an 8.6% loss of glacial cover in the Elk River drainage, and 16% loss in the Columbia Basin as a whole. Smaller glaciers, declining snowpack, shifts in timing and amount of precipitation and prolonged drought will increasingly limit water supply during periods of peak demand.[34]

Climate changes will affect not only surface water, but also groundwater aquifers. It is expected that future reductions in streamflow will have negative effects on both groundwater recharge and discharge rates.[35] The implications of these climatic changes on water availability and flooding could place a stress on water use in Elkford. Although there will be impacts on water supply, some water-related opportunities may be observed with projected climatic changes in Elkford. These include:

- Reduced winter snow removal costs;
- Prolonged summer tourism and recreation; and
- Reduced snow shoveling for residents.

Ecosystem and Species

Scientists project that there will be significant ecosystem and species shifts (predominately northwards and to higher elevations) as climate change shifts temperature and precipitation regimes. While adjustments, adaptations and impacts from climate change will likely happen on a species-specific level, [36] the rate of warming expected during this century will likely exceed the ability of many species to migrate and adapt. Extensive species loss is expected, particularly for lower mobility species.[37]

Ecosystems in mountainous regions appear to be particularly vulnerable and in many cases will have limited migration options (i.e. these ecosystems will decline and/or disappear).[38] Human impacts on the landscape are likely to affect the migration abilities of many species. Climatic migrations will be impacted by habitat degradation and loss,

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[33] Pacific Climate Impacts Consortium (PCIC) (2006)- Preliminary Analysis of Climate Variability and Change in the Canadian Columbia River Basin: Focus on Water Resources. http://www.cbt.org/uploads/pdf/Preliminary_Analysis_of_Climate_Variability.pdf

[34] Natural Resources Canada (NRCAN) (2007) - From Impacts to Adaptation: Canada in a Changing Climate. http://adaptation.nrcan.gc.ca/assess/2007/index_e.php

[35] Ibíd.

[36] Gayton (2008) - Impacts of Climate Change on British Columbia's Biodiversity: A Literature Review. URL: http://www.forrex.org/JEM/ISS48/vol9_no2_art4.pdf

[37] Compass Resources Management. (2007). Major Impacts: Climate Change. Prepared for: The biodiversity BC technical subcommittee for the report on the status of biodiversity in BC.

[38] Ibid.

natural disturbances (fires), and human impacts.[39] It is expected that with the shift of biogeoclimatic zones, genetic diversity may be affected, as climate change will select those individuals with greater genetic ability to adapt.[40] Table 4 outlines potential changes in the ecological zones in the Elkford region.

Table 4: Potential Ecosystem Shifts resulting from Climate Change

Ecological Zone	By year	Elevation Shift (meters)	Northward Shift (kilometers)	Area Change (%)
Engelmann Spruce-Subalpine Fir	2025	+86 m	+ 154 km	6 %
	2055	+ 143 m	+ 224 km	3 %
Montane Spruce	2025	- 28 m	+ 149 km	- 19%
	2055	- 22 m	+ 302 km	- 40%
Alpine Tundra	2025	+ 168 m	- 5 km	- 60%
	2055	+ 303 m	- 67 km	- 85%

Source: Adapted from: Hamman, A. & Wang, T. (2006). Potential effects of climate change on ecosystem and tree species distribution in British Columbia.

Step 3 - Develop Risk Scenarios (impact pathways)

The next step was to take the information we'd gathered on potential climate change impacts for Elkford and put them into a visual form to help people better understand climate change. Impact pathways are designed as a web of connected impacts, opportunities, and consequences that stem from temperature and precipitation changes as a result of climate change. These figures build understanding not only of how climate change impacts our communities and ecosystems, but also of the many connections between communities, ecosystems and climatic connections. Impact pathways can also illustrate the linkages between different planning priorities such as the connection between mountain pine beetle and wildfires.

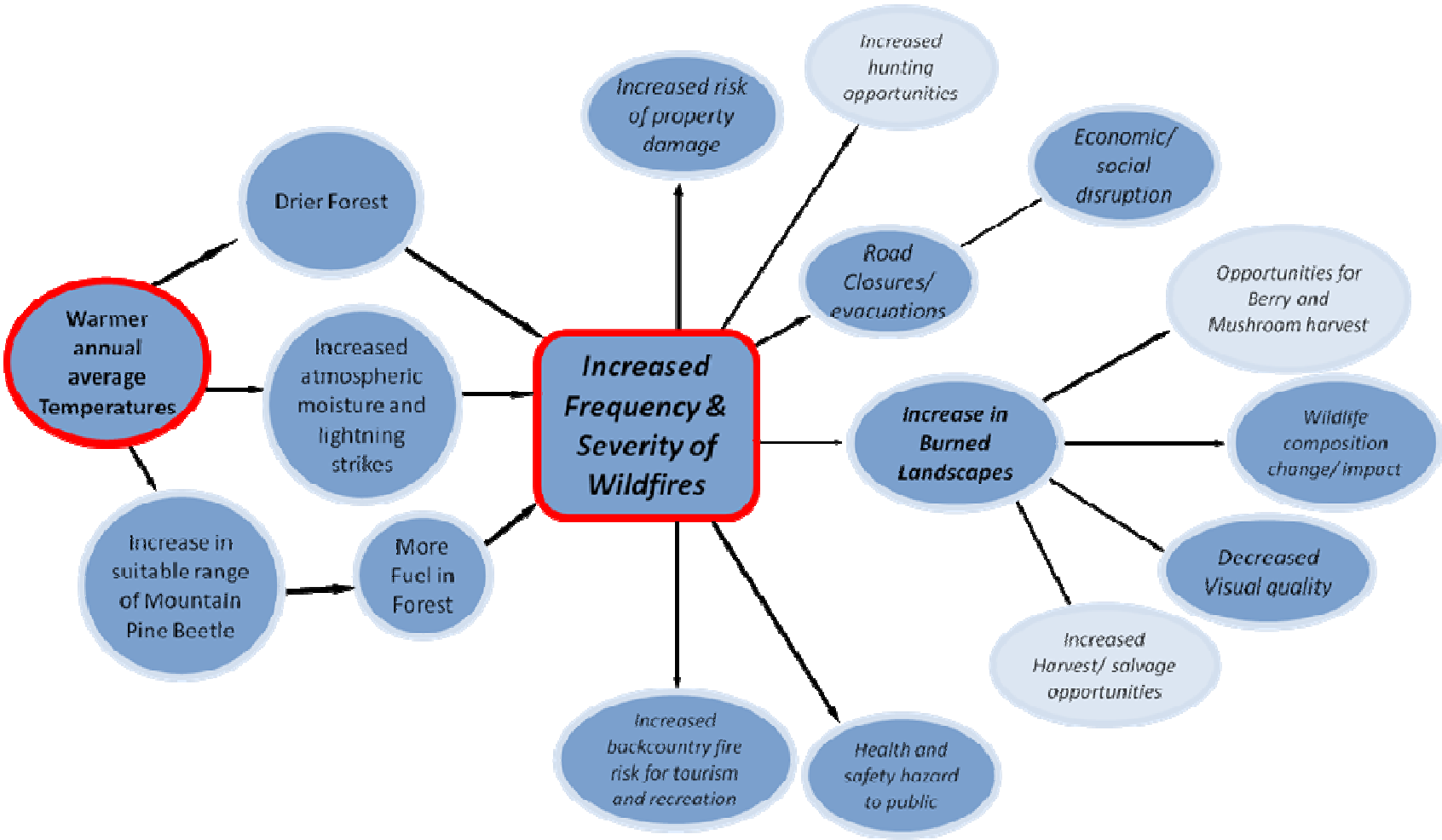
Each impact pathway begins with a **climate change projection**. Figure 4 begins with the climate projection of *Warmer Annual Average Temperatures.* The **ecological changes** expected from this climate projection are then identified. In this Figure, these changes include drier forests, increased suitable mountain pine beetle range, etc. The **impact** of the ecological changes is summarized

[39] Gayton (2008) - Impacts of Climate Change on British Columbia's Biodiversity: A Literature Review. URL: http://www.forrex.org/JEM/ISS48/vol9_no2_art4.pdf

[40] Compass Resources Management. (2007). Major Impacts: Climate Change. Prepared for: The biodiversity BC technical subcommittee for the report on the status of biodiversity in BC.

(*Increased Frequency and Severity of Wildfires)*, and the associated impacts and opportunities for the community are identified. An impact pathway was developed for each of the initial priority areas, and displayed at an open house in Elkford. The remaining impact pathways can be found in Appendix C.

Figure 4 Wildfire Potential Impact Pathways for Elkford



Step 4 - Identify community adaptation priorities

This step of the process provides significant opportunity for community engagement. Initial community outreach had been initiated at the start of the project to inform residents of the OCP and the climate change adaptation planning initiative. An initial search for a Community Advisory Committee (CAC) had begun through outreach at a community registration evening, door to door discussions, newsletters, and 'fire starter' contact cards. Now, the CCA team used further OCP related outreach to help narrow down the number of Elkford's CCA planning priorities and gauge support for adapting and mitigating to climate change in Elkford.

Outreach

Some of the outreach tactics used included: displays at the mall, a paper and web-based survey, and kitchen table meetings to gauge community sentiment. A climate change adaptation fact sheet was used at kitchen table meetings to provide the facilitator with some quick facts and questions to gather community observations, perspectives, and knowledge (summarized in Appendix D). The mall display consisted of three easels each with a different survey question. The approach for this survey was intended to be non-confrontational and participatory of nature. The 'Dot Survey' invites participants to simply place a 'dot' under the answer to a simple question that best suits their opinion. Sixty people participated in the survey over two days.

Dot Survey at the Mall

Survey Results

Based on the survey and the mall display, a majority of responding Elkford residents believe anthropogenic climate change is happening and that Elkford should take leadership in acting on climate change. A majority of Elkford residents (58%) feel human activity is contributing to climate change, but a significant number (34% of total) do not see humans having a significant contribution (see Figure 5 below). At the same time, the majority (63%) feels that climate change affects everything we do, and that it is better to adapt to scenarios now than to wait (Figure 6 below). Participants were split almost 50/50 on whether climate change has become more of an issue for them over the past year (Figure 7) and whether or not the District of Elkford should take the lead on climate change (Figure 8).

Figure 5 Do you think human activity is contributing to climate change.[41]

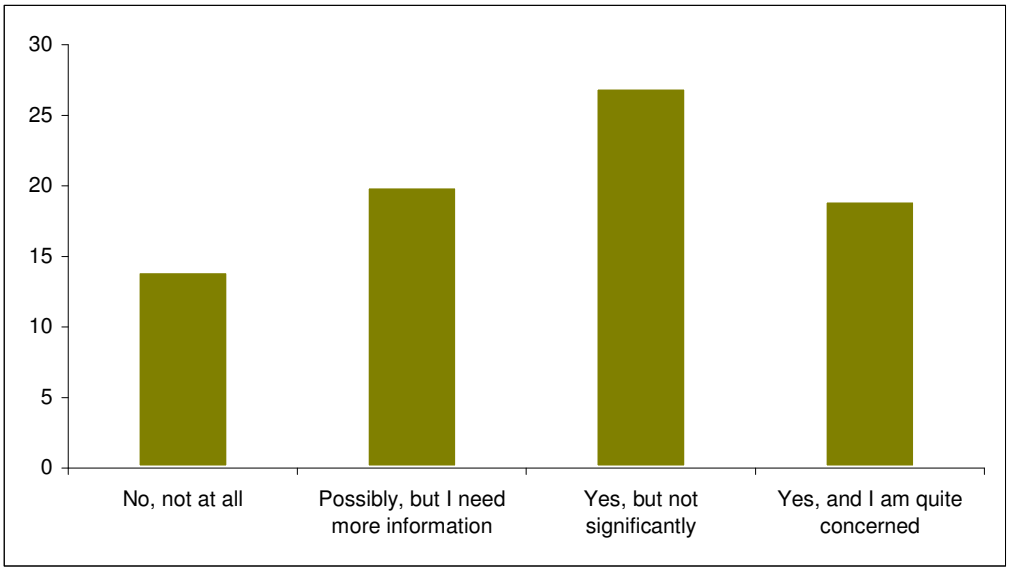
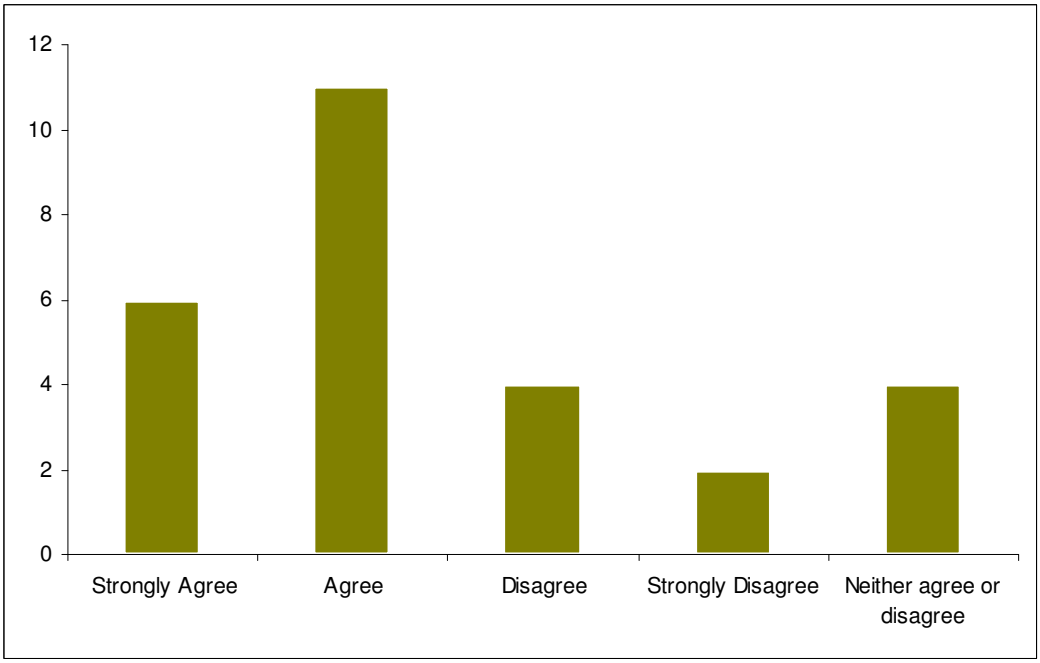


Figure 6: Climate Change will affect everything we do in the future. It is best to adapt to potential scenarios now than to wait and try to do it later.



[41] One of the mall and survey questions.

Figure 7: Climate change has become more of an issue for me in this last year

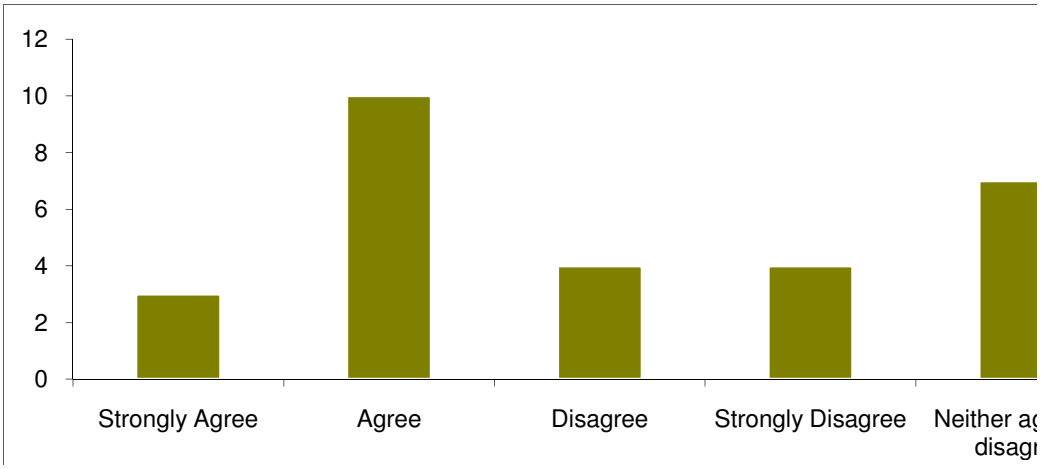
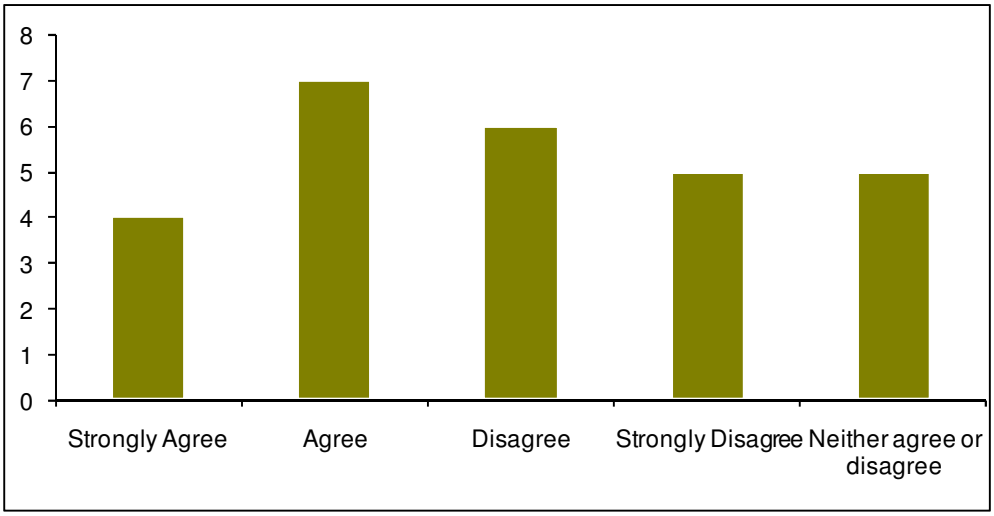


Figure 8: The District of Elkford should take the lead in tackling climate change



The mail-out survey and the dot survey provided the list of CCA planning priorities. Water supply (18%) and availability (18%), wildfire management (22%), and road maintenance and snow removal (19%) were considered the top four priorities based on survey responses (see Figure 9 and 10 below). There is only one access road in and out of Elkford, and so the residents concerns regarding snow removal and road maintenance may relate to concerns around emergency response. Wildfire is also a natural concern given Elkford is surrounded by forest, much of which has been impacted by the mountain pine beetle, and fire could restrict an evacuation of Elkford residents.

Figure 9: Climate change impacts the environment in many ways. Please rank the importance of the following issues in the District of Elkford

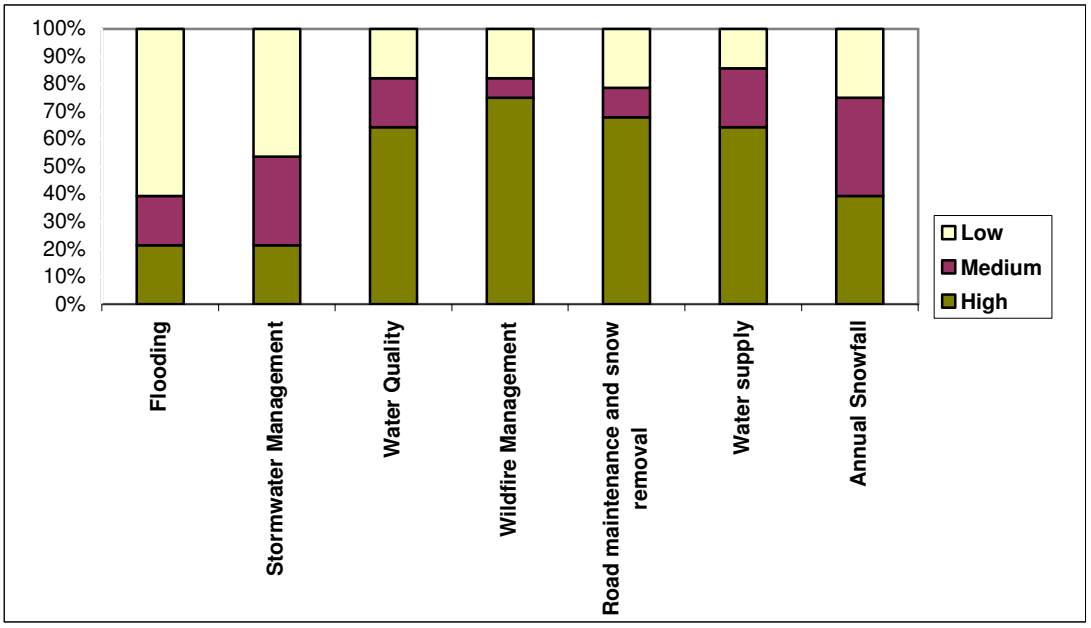
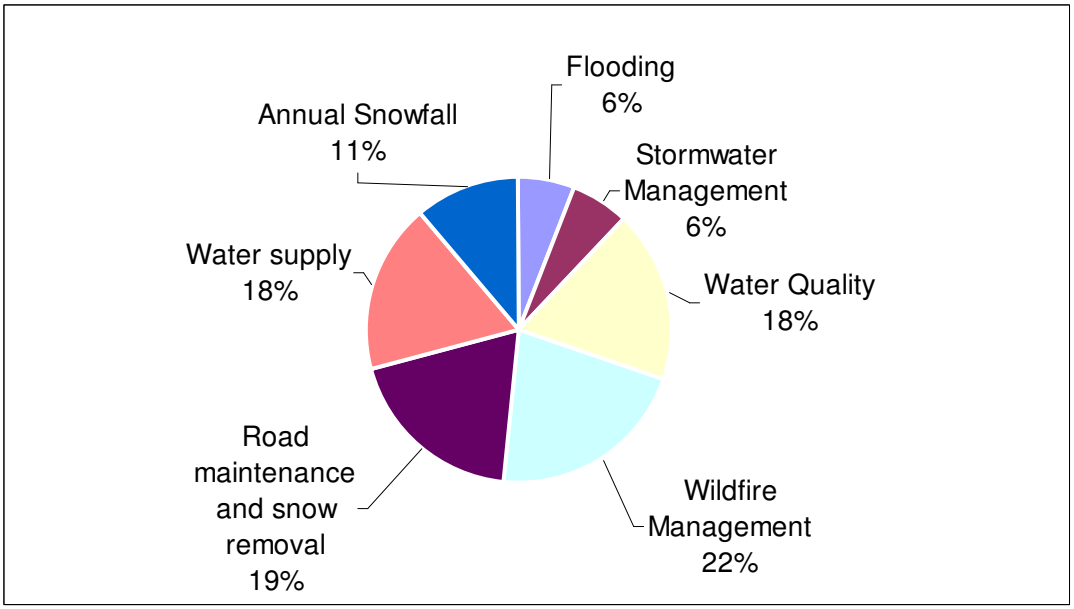
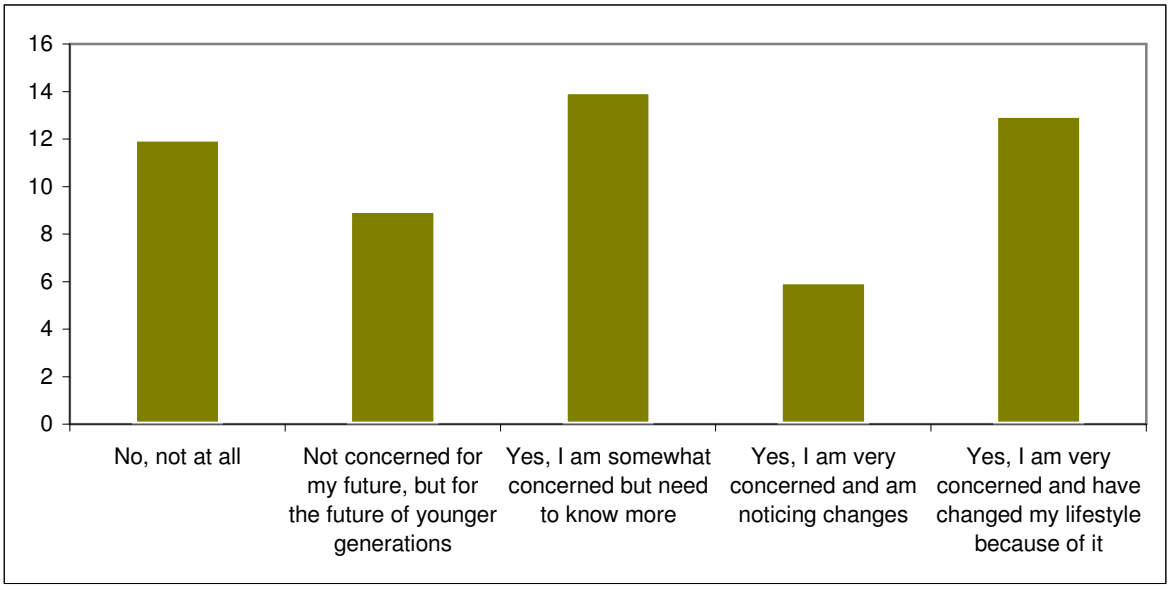


Figure 10: Elkford High Concern Climate Change Hazards from Survey



Finally, Elkford residents were asked about their concern for current and future climatic impacts. This question was only asked at the mall booths and not in the paper survey. Sixty one percent of respondents stated they were concerned – 24% have changed their lifestyle because of their concern and 26% were only somewhat concerned but wanted to know more (see Figure 11 below). Of the 39% who were not concerned 43% were concerned for future generations.

Figure 11: Are you concerned about the current and/or future impacts of climate change on our communities?



Open House

The survey results were presented at an open house where we also gathered more detailed information from Elkford residents on climate change adaptation. Almost 50 people attended, perhaps enticed by the meal of barbecue ribs. Given the open house was close to municipal election time, many current and potential councillor and mayoral candidates attended. General information on climate change, the PCIC climatic impact data, information on further impacts based on temperature and precipitation changes, and the six planning area impact pathways were presented. Stewart Cohen, a CBT advisory committee member, gave a presentation on climate change impacts and the need for adaptation in long-term community planning. The community was asked for feedback on their local observations on potential climatic changes, input on what the climate change adaptation priority areas should be, and potential solutions for climate change adaptation and mitigation. Input on the CCA priorities were taken into consideration when determining the planning priorities. The adaptation solutions were incorporated into our vulnerability assessment process (see page 32).

Meeting with Staff

The final step in determining Elkford's climate change adaptation planning priorities was to meet the District staff to affirm whether our draft planning areas were appropriate and reflective of the District's priorities. At this meeting we also discussed findings to date including: PCIC modeling results and additional information on potential CCA impacts for Elkford. Staff affirmed that climatic changes on wildfire, water availability/quality, and flooding were chief concerns for the District. Snowpack was also deemed to be of interest if there was time in the contract for us to address the issue.[43] Staff also outlined further Elkford relevant information on each of these areas such as District buildings potentially at risk in the floodplain, any information they had on their aquifer, and background to the development of their wildfire strategy.

Local Climate Observations from Elkford[42]

- Winter is warmer
- Established snowfall arrival seems delayed
- Noticed an increased intensity to snowfalls, later in the year
- More spring precipitation
- Warmer summers
- Longer gardening season – can grow vegetation couldn't grow before
- Change in prevailing wind direction
- More warm autumn days
- The water level at horse pasture south of town has dramatically decreased in 29 years
- Pests are more frequent (mountain pine beetle) and survive longer (grasshoppers)
- Chinook seem to come into the valley (as opposed to over the valley) more often
- Birds and bugs have changed
  - Clark's nutcrackers in large groups and at different times of year than before
  - Pine Gros Beak and Pine Siskin are more common and at lower elevations
  - Magpies were not in the valley before the last ten years

Step 5 - Vulnerability and Risk Assessment [44]

What is a Vulnerability and Risk Assessment?

A vulnerability and risk assessment can be the most challenging and rewarding part of the climate change adaptation planning process. The vulnerability and risk assessment process used in Elkford was adapted from the Climate Impacts Group's *Preparing for Climate Change* document. Vulnerability assessment involves estimating how sensitive or susceptible a system (e.g. a community) is to climatic changes, and how easily the changes can be adapted to. A risk assessment adds a probability to each risk in order to determine priority planning strategies (see Figure 12 below).

[42] These are anecdotal observations and may not be scientific evidence for climate change
[43] Time and resources did not allow a focus on investigating specific snowpack impacts.
[44] Cindy Pearce acted as a guide throughout the vulnerability and risk assessment process, as such many of her ideas are incorporated into this section.

Definitions

Exposure – exposure to a climate related hazard

Sensitivity - the degree a planning area is affected by changes in climate conditions or impacts

Sensitivity - the degree a planning area is affected by changes in climate conditions (e.g., temperature and precipitation) or impacts (e.g., wildfires, floods, storms, etc.):

- **Low**- Affects from climate change unlikely
- **Medium**- Affects from climate change possible
- **High**- Affects from climate change very likely

Adaptive Capacity - the ability to accommodate changes in climate with minimum disruption or minimum additional cost ($, technology, information):

- **Low-** Adjustments difficult and costly
- **Medium-** Adjustments possible with some disruptions and/or costs
- **High** – Adjustments possible with minimal disruptions and cost

Vulnerability – the degree to which a planning area is susceptible to, and unable to cope with, adverse effects of climate change based on exposure, sensitivity, and adaptive capacity

Vulnerability Assessment- estimate the vulnerability of certain planning areas to climate change considering the potential of feasible adaptations to reduce adverse impacts

Risk Assessment – process to rank climate change risks to identify high and low priority adaptation strategies

Probability – The likelihood that an impact will occur (20 year time frame)

Figure 12: Risk and Vulnerability 'Equations'

Vulnerability = Exposure x sensitivity x adaptive capacity

Risk = Vulnerability x Probability

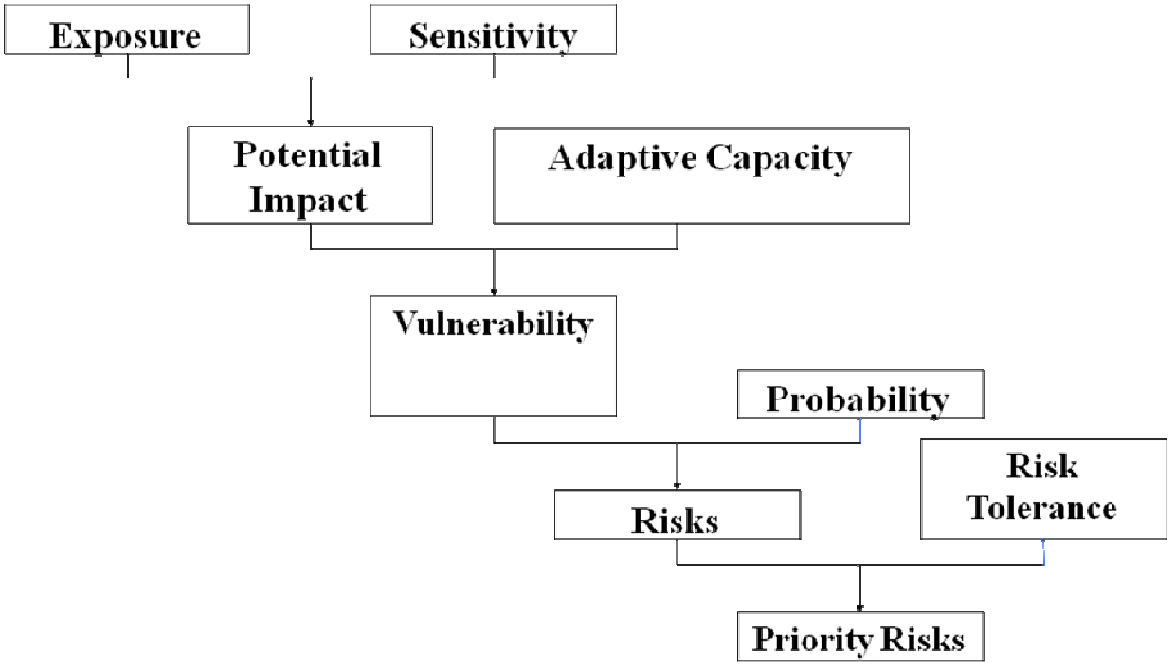
How to conduct a vulnerability and risk assessment

Vulnerability and risk assessment is a complex process which we have attempted to simplify for Elkford's adaptation process. The first step is to determine the potential impact of climate changes. Impacts are determined by exposure (whether an impact is possible) and sensitivity (the degree to which the impact will be felt). The next step is to couple the impact with the adaptive capacity of the system to determine vulnerability. Tables 8.1 and 8.2 in the CIG Guide were used internally to consider how climate changes relate to sensitivities and adaptive capacities in Elkford[45].

[45] Climate Impacts Group (CIG), Joint Institute for the Study of the Atmosphere and Ocean University of Washington, & ICLEI – Local Governments for Sustainability (2007) Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments. URL: http://cses.washington.edu/cig/fpt/guidebook.shtml

To determine the total climate-related risk of a potential impact, the next step is to determine the probability of occurrence for each impact occurring over a certain time period (e.g. 20 years)[46]. Once a risk level has been established the community also must determine what level of risk they are willing to accept (risk tolerance). The outcome is priority risk areas for which to focus climate change adaptation actions and strategies. Figure 13 graphically depicts the vulnerability and risk assessment process.

Figure 13: Vulnerability and Risk Assessment Process



The Elkford Process

In determining the vulnerability of each priority area, Elkford staff, council members, community advisory committee members, the Mayor, and members of the CBT Learning Network were engaged in a full-day workshop. Participants first addressed the following questions:

- What are Elkford's weak spots (vulnerabilities) in each priority planning area?
- What should we pay attention to in order of priority?
- What further information do we need?

The process of the vulnerability and risk assessment aims to answer these questions:

- What are the potential impacts of wildfire, flooding and water availability 'incidents' in Elkford?
- What is the likelihood that some of these impacts will be seen in Elkford?
- Where has Elkford already acted to mitigate these impacts?
- What are potential responses for mitigating risks with minimal disruption and cost (now and in the future)?

[46] We chose 20 years as it is the long term vision period in the OCP

- What actions might be expensive or difficult, but crucial to avoid major impacts to the District?

Essentially the vulnerability and risk assessment processes try to identify high frequency and high consequence climate related impacts and the actions that could be pursued to adapt to them.

Elkford Vulnerability Assessment

The aim of the full-day workshop was to make climate change adaptation vulnerability and risk assessments practical and useful for the District of Elkford. The objectives were:

- To get feedback from staff, mayor and council, community members, CBT, and the Learning Network;
- To help the District staff, council, and community to learn about vulnerability and risk assessment process so they can be used in future planning; and
- To build understanding on why vulnerability assessments are important for planning.

Elkford Vulnerability Assessment

In order to fit a vulnerability assessment on three planning areas into a one-day (6.5 hour) workshop, significant preparation was required. Sensitivity and adaptive capacity charts had been filled out (Tables 8.1 and 8.2 in the CIG Guide) with information based on our research and preliminary ratings.

For water and flooding risk topics, we walked the participants through the research in our sensitivity and adaptive capacity tables to ensure we had sufficient understanding and loose consensus on their contents. Tables 5 and 6 below provide examples of sensitivity and adaptive capacity tables used in Elkford's vulnerability assessment process.

Table 5- Determining Sensitivity- Sample Evacuation Risk Table

Determining Sensitivity			
Wildfire Risk Topic	**Current and expected Risk**	**Expected Climatic and Non-climatic changes**	**Degree of Sensitivity** (L,M,H)
Evacuation of whole or part of community	Evacuations limited by single access road into Elkford (Hwy. 43) No firesafe staging area or evacuation plan Are there other current and expected risks associated with this topic?	Warmer climate, more precipitation in the winter and spring, less precipitation in the summer Warmer temperatures will lead to drier forests and an increased frequency and severity of wildfires The length of the fire season in the Columbia Basin is projected to increase by 38 to 52 days by 2080 Are there other climatic and non-climatic changes that should be considered?	Is Elkford's sensitivity- low, medium, or high?

Table 6- Determining Adaptive Capacity- Sample Flooding Risk Table

Determining Adaptive Capacity			
Flood Risk	**Potential Adaptation Actions**	**Barriers**	**Adaptive Capacity** (L, M, H)
Flooding of buildings or lands in Elkford	• Maintain existing areas of marshland, forests and parks along the river. • Implement a flood warning protocol to alert residents of projected flood events • Identify 'no-development' zones in floodplain • Update 200-yr flood line. • Direct road runoff into 'swales' built with sand filters • Allow infiltration to retention ponds or wetlands • Require new developments to use pervious materials in construction of driveways, parking lots, etc. What other potential adaptive actions are there?	What are the barriers to implementing these actions?	Is Elkford's adaptive capacity low, medium, or high?

We then used the sensitivity and adaptive capacity ratings to come up with the vulnerability assessment rating. It flowed well to subsequently have Hans Schreier, a

University of British Columbia Institute for Resources, Environment and Sustainability professor, who also gave a presentation on potential impacts of flooding and stormwater and related low impact management techniques. For wildfire, the participants broke into smaller groups of four or five workshop participants to come up with sensitivity and adaptive capacity ratings.

Once vulnerabilities were determined, the next step was to estimate a probability for each risk. Due to time constraints we did not finish the probability assessment, however we did verify (based on one example) that estimating the probability of a risk (e.g. a wildfire entering the District boundary) is a subjective process with initial estimates ranging from very low (unlikely to occur) to high (likely to occur several times). The risk assessment was completed through online collaboration software - *Google Docs*.

Probabilities used in the risk assessment would ideally be based on information such as historical records, climate trends, more detailed modelling data, insurance company records (fire/ flood), input from scientific and engineering experts, staff, council and community perceptions. It was beyond the scope of our project to expand beyond a qualitative assessment based on input from CBT and advisory committee experts, staff, council, and community members due to time, data availability and budget.

Tables 8-13 summarize the vulnerability assessment findings for Elkford. Table 7 summarizes the risk assessment planning guide. The colours correspond to appropriate actions in the risk assessment table (Tables 9, 11, and 13)[47].

Table 7- Risk Assessment Planning Guide

	Negligible- No action required
	Low- Some actions (public education) may be desirable
	Moderate- Some controls required to reduce risk to lower levels
	High - high priority control measures required
	Extreme - immediate controls required

[47] From: Bruce, J.P., Egener, I.D.M., & Noble, D. Adapting to Climate Change: A Risk-based Guide for Ontario Municipalities

Table 8: Wildfire Vulnerability Summary

Wildfire Risks	Sensitivity (L, M, H)	Adaptive Capacity (L, M, H)	Vulnerability (VL,L,M,H,VH)
Wildfire enters District boundary	High	Low	Very High
Smoke alert from nearby wildfires	Moderate	Low	High
Evacuation of whole or part of community	Moderate-high	Moderate	Moderate- High
Road and highway closure (Hwy 43)	Moderate-high	Moderate	Moderate-High
Backcountry/ forest closures due to high fire risk	Moderate	Low	High
Damage to Infrastructure and Homes	High	Moderate	High
Loss of life from wildfires	High	High	Moderate
Closure of Mine due to fire risk (for at least one day)	Moderate	Low	High
Lawsuit against District for fire damage	Moderate	Moderate	Moderate

Table 9: Wildfire Risk Assessment Summary

Vulnerability	**Very high** *(High sensitivity, low adaptive capacity AC)*	• Wildfire enters district			Wildfire Enters		
	High (*High sensitivity, moderate AC or Moderate sensitivity low AC)*	• Smoke alert • Evacuation Road and highway closures • Damage to infrastructure and homes • Mine closure		Evacuation Mine closure	Damage to Infrastructure Road highway closure	Smoke alert	
	Moderate *(Moderate sensitivity and adaptive capacity)*	• Lawsuit • Loss of life		Lawsuit Loss of life			
	Low *(low sensitivity moderate AC) or (moderate sensitivity high AC)*	• Backcountry/ forest closure				Backcountry forest closure	
	Very Low *(Low sensitivity, high adaptive capacity)*						
			Unlikely to occur	**May occur once**	**Likely to occur at least once**	**Likely to occur several times**	**Occurs frequently**
	Probability in 20 year planning period						

Table 10: Flooding Vulnerability Summary

Flooding Risks	Sensitivity (L, M, H)	Adaptive Capacity (L, M, H)	Vulnerability (VL,L,M,H,VH)
Flooding of buildings or lands	High	Low	Very High
Damage to bridge integrity	High	Low	Very High
Storm water management stress	Moderate	High	Low
Death/ injury to river recreation users	Low	Moderate	Low
Pumphouse floods and compromises water supply	High	Moderate	High

Table 11: Flooding Risk Assessment Summary

Vulnerability	**Very high** *(High sensitivity, low adaptive capacity AC)*	• Flooding of buildings and land • Damage to bridge		Damage to bridge	Flooding of buildings and land		
	High (High sensitivity, moderate AC or Moderate sensitivity low AC)	• Pumphouse floods and compromises water supply		Pumphouse flooding			
	Moderate *(Moderate sensitivity and adaptive capacity)*						
	Low *(low sensitivity moderate AC or moderate sensitivity high AC)*	•Stormwater management stress •Death/ injury to river users		Death/injury to river users	Stormwater management stress		
	Very Low *(Low sensitivity, high adaptive capacity)*						
			Unlikely to occur	**May occur once**	**Likely to occur at least once**	**Likely to occur several times**	**Occurs frequently**

	Probability in 20 year planning period

Table 12: Water Quality & Availability Vulnerability Summary

Water Quality & Availability	Sensitivity (L, M, H)	Adaptive Capacity (L, M, H)	Vulnerability (VL,L,M,H,VH)
Decreased water quality	Low	Low	Moderate
Decreased water Availability	Moderate	Low	Moderate-High
Decreased aquifer recharge rate	Moderate	Low	Moderate-High
Decreased watershed health and integrity	Moderate	Moderate	Moderate
Increased turbidity of river water	High	Low	Very High
Increased cost of water treatment due to health regulation	Moderate	Moderate	Moderate

Table 13: Water Quality and Availability Risk Assessment Summary

Vulnerability							
	Very high *(High sensitivity, low adaptive capacity AC)*	•Turbidity				Turbidity in river (impacting fish)	
	High (High sensitivity, moderate AC or Moderate sensitivity low AC)	• Water Availability (Unknown probability) •Aquifer recharge – (Unknown probability)					
	Moderate *(Moderate sensitivity and adaptive capacity)*	• Water quality • Watershed health and integrity • Increased cost of water treatment due to health regulation		Water quality	• Watershed health and integrity • Increased cost of H_2O treatment		
	Low *(low sensitivity moderate AC) or (moderate sensitivity high AC)*						
	Very Low *(Low sensitivity, high adaptive capacity)*						
			Unlikely to occur	**May occur once**	**Likely to occur at least once**	**Likely to occur several times**	**Occurs frequently**
			Probability in 20 year planning period				

Step 6 - Action Planning

This step involves coming up with viable climate change adaptation actions for the District of Elkford. Climate change adaptation goals, objectives, and strategies were developed by the consulting team based on the results of the risk and vulnerability assessment, background science, and community and staff engagements. Draft CCA strategies, including the objective of each strategy, and overall climate change preparedness goals were presented to District of Elkford staff and CAC on May 6, 2009.

Initially, seven climate change adaptation preparedness goals were presented to District staff and the CAC. These goals were later downsized (some goals were more appropriate as objectives) resulting in four climate change adaptation preparedness goals for the District of Elkford:

1. Elkford is a resilient FireSmart community
2. Elkford prepares for and mitigates flood risk
3. Elkford understands the status of water supply and manages the resource effectively
4. Climate change adaptation is considered in future planning decisions

Goals, Objectives and Strategies:

- Most communities generate **Goals** that are broadly stated and represent the community vision
- **Objectives** are more specific guiding statements that detail what will be done to meet the Goals
- Good **strategies** detail how, who, and when each objective will be accomplished

The goals are meant to help direct the implementation of Elkford's CCA strategies. Each CCA strategy is linked to an objective which identifies the overarching purpose of the strategy. Elkford's CCA strategies fall both within the OCP and outside the OCP. For strategies that fall within the OCP, the consultants worked simultaneously with Smart Growth Advisory Services in the creation of an OCP background report. The Background report included a *Climate Change Adaptation Issues Paper* which was a primer for the types of strategies to be included within the finalized OCP.

Climate change adaptation strategy recommendations and actions have been developed for the District of Elkford in the three priority areas: wildfires, flooding, and water supply. Each strategy falls under one of the four goals.

Goal 1: Elkford is a resilient FireSmart community

To date, the District of Elkford has taken significant steps to ensure the community is prepared for the risk of wildfires penetrating the District boundaries. The recommendations below are implementation recommendations which reflect the risks and vulnerabilities identified in Elkford, and suggest strategies for integrating many of the Wildfire Management Strategy recommendations into Elkford's plans and policies.

Objective: Reduce the likelihood of wildfires penetrating the WUI

1. Implementation of Wildfire Fuel Reduction Program

To protect livelihoods and infrastructure in Elkford, it is recommended that the District continue to implement the fuel hazard reduction and remediation recommendations laid out in the Wildfire Management Strategy. Fuel reductions are likely the most effective means of reducing fire hazard and creating defensible spaces around the District.

Note: It is important that high and extreme fire risk maps are updated once the wildfire fuel reductions have been completed.

Throughout the fuel reduction process, the District should ensure:

- The maintenance of Elkford's natural landscape, wilderness character and community values;
- That information about the forest modifications (including location, and the necessity for the modifications) and remediation plan are effectively communicated to community members;
- The forest remediation plan accounts for potential species and biogeoclimatic changes to the forest with expected future climatic conditions. Tree species for re-planting should be chosen based on their resistance to pests and fires given expected ecosystem conditions.

2. Park and trail development for firebreaks and access

The District should strategically site parks, trails and road developments to create fire breaks and provide access for firefighting. Road, trail and park developments should focus first on high and extreme risk fire areas. This strategy should be implemented through a Parks and Trails Master Plan for the District of Elkford.

Objective: Increase resiliency of new developments to wildfires

3. Fire Hazard Development Permit Area

Local governments can designate a development permit area (DPA) for the purpose of reducing wildfire risks. The DPA can include requirements relating to: landscaping; the siting, form, exterior design and finish of buildings and other structures; and the placement of trees and other vegetation[48]. To ensure new developments are firesafe, a fire hazard development permit area should be created in high and extreme fire risk areas within Elkford's Official Community Plan. The permit should include developer requirements, including:

- A pre-development fire hazard and fire risk assessment;
- FireSmart building materials and construction standards;

[48] Local Government Act: s.920

- Vegetation management according to FireSmart Guidelines;
- Requirements for underground power lines and utilities;
- The supply of water for firefighting;
- The development of roads and trails to act fire breaks;
- A restrictive covenant attached to high fire risk properties to ensure FireSmart guidelines are maintained in perpetuity;
- Verification of low/reduced fire hazard by a qualified individual.

4. Update Subdivision and Servicing Bylaw

Subdivision and/or servicing bylaws can contain specific requirements to address wildfire risk. Sidewalks, boulevards and highways can be located to act as firebreaks and evacuation routes. Requirements can also include underground wiring and the provision of fire hydrants[49]. Elkford's subdivision and servicing bylaw should be updated to reflect the FireSmart development guidelines. Specifically, the provision of fire breaks, evacuation routes, underground wiring and adequate fire suppression in all new developments.

> The District of Langford's *Interface Fire Hazard Planning Model* includes numerous examples of local governments across BC using legal tools to mitigate interface fires including: Development permits, subdivision and servicing bylaws, zoning bylaws, building bylaws and land title covenants.
> http://www.cityoflangford.ca/documents/brochures/FireInterface_Doc.pdf

5. Update Zoning Bylaw

Local government's can use zoning bylaws to regulate: the use of lands, buildings and structures, density, and locations of uses within its boundaries[50]. Based on the fire hazard assessments from Elkford's Wildfire Management Strategy, Elkford's zoning bylaw should be updated to reflect fire hazard objectives, including:

- Strategic siting of parks and open spaces to act as fire breaks;
- Limited or no development in high and extreme fire risk zones; and
- Clustering of residential, commercial, and industrial development in low risk fire zones,

[49] Local Government Act: s.938
[50] Local Government Act: s.903

Objective: Fire resiliency for existing homes and buildings

6. Update Building Bylaw

Elkford's building bylaw, through the provision of building permits, can require FireSmart development standards for renovations and additions to existing homes and buildings[51]. To reduce the probability of wildfires destroying homes and buildings in Elkford, it is recommended that the building bylaw be updated to require either fire resistant building materials or adequate sprinkler systems for renovations and additions to existing homes and buildings in high and extreme fire risk areas. To enhance the political feasibility of this strategy for council, and the economic feasibility of it for Elkford residents, this strategy should be implemented with an effective rebate program (see strategy 8)[52].

> Bill 10 includes new provisions for municipalities to enhance their building codes. The code remains an area of concurrent influence, meaning that any municipal regulations that exceed the code would need to be approved by the Province.

7. FireSmart Education Program

The District should enhance its FireSmart education program to ensure Elkford residents are aware of basic FireSmart information, including:

- The hazards associated with wildfires;
- How to reduce the chance of human ignitions;
- How to FireSmart a property;
- How to convert and/or retrofit homes and structures with FireSmart materials;
- The benefits of FireSmarting (reduced insurance rates, increased quality of life, reduced worries about wildfire risk, etc.); and
- How to obtain financial support for FireSmarting properties, homes and structures.

> The City of Prince George has an informative website where residents can get information on fire hazard management, fuel treatments, tree planting, and many other resources. http://www.city.pg.bc.ca/rec_culture/parks/urbanforestry/

To implement the education program, the District should implement the education recommendations laid out in the Wildfire management strategy. This includes:

- An educational brochure distributed to local residents with the above information;
- Having FireSmart manuals readily available for residents, or distributed with the annual property tax assessments;

> BC Ministry of Forest and Range: Wildfire Management Brach- Protecting your Property http://bcwildfire.ca/Prevention/property/

[51] See District of Langford: An Interface Fire Hazard Planning Model
[52] Provisions for FireSmart development standards for renovations and additions is also included in the Fire Hazard Development Permit Area

- An easily navigable web page on the District's website with a Wildfire link with pertinent wildfire information;
- Annual FireSmart public presentations and/or workshops;
- FireSmart education programs and field trips at local schools;
- Fire awareness signs indicating the current Ministry of Forest fire hazard rating and the number to call when a fire is detected;
- FireSmart education and awareness coupled with large events in the District.

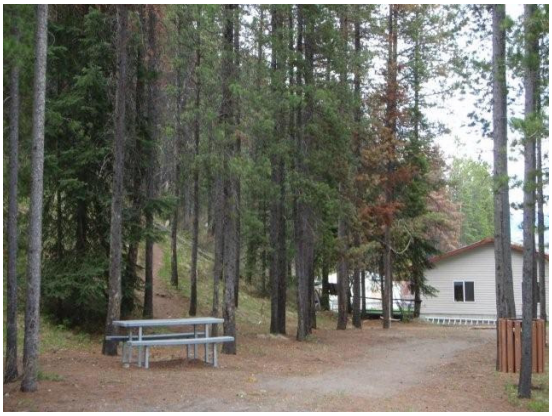
The Homeowners Firesmart Manual: http://www.pssg.gov.bc.ca/firecom/pdf/homeowner-firesmart.pdf

To enhance the effectiveness of the FireSmart education program, the District could create an 'ideal' FireSmart building as an example for the community. The Fire Hall may be the best site for this.

8. FireSmart Rebate program

To encourage FireSmart development and conversions on existing homes, the District should establish a FireSmart rebate program. The program may include rebates as an incentive for FireSmart:

- Roof constructions and building materials;
- Deck construction;
- Tree removals; and
- Vegetation management.



The amount of the rebate would need to be high enough to encourage home retrofits and conversions, and included as part of the FireSmart education program (Strategy 7).

Objective: Elkford is prepared for wildfire emergencies and evacuations

9. Elkford Community Evacuation Plan

The District of Elkford should have a community evacuation plan. The plan should primarily address fire risk, but would also be applicable to flood risks, and other large hazards. The evacuation plan should follow the BC Operational Guidelines for Evacuations and should:

1. Designate an emergency public warning system which alerts the entire community when wildfires or flooding threaten homes and/or lives. A siren exists on the roof of City Hall, however in the event of an emergency the siren should be augmented with an emergency radio broadcast and/or phone diallers.

The BC Provincial Emergency Program (PEP) has a Community Emergency Program Review which allows communities to assess the preparedness of your community for emergencies. http://www.pep.gov.bc.ca/cepr/review.html

2. Identify pre-designated primary and secondary evacuation routes which lead community residents away from an advancing wildfire to safety zones, including an alternative access road to the North of Elkford in the case that the highway is not accessible as an egress route
3. Designate a marshalling point where evacuated community members can assemble. The marshalling point should be: safely away from any hazards of fire or smoke, large enough to accommodate the entire community, accessible by primary and secondary evacuation routes, equipped with emergency supplies, and known to all members of the community
4. Create an evacuation process and procedures including roles and responsibilities of emergency and volunteer personnel

The evacuation plan should be tested regularly, and be accessible to all community members. The plan should be integrated with the community FireSmart education program (strategy 7). The Evacuation plan should also incorporated into Elkford's Emergency Management Plan.

10. Improve Local Firefighting Capacity

It was noted at the vulnerability assessment workshop that Elkford's firefighting capacity is about 1-2 homes. After this point, resources would be exhausted. Where possible, and at the discretion of Elkford Fire Rescue Services, the District should take steps to enhance their capacity to fight wildfires entering the wildland urban interface in Elkford. Options to enhance local capacity include:

- Additional fire fighters,
- Additional trucks equipped with sprinkler equipment,
- Water storage tanks in unprotected areas,
- Backup power supply (generator) in the event that electricity pumps are unavailable (power off) during a fire,
- Identify and designate easily accessible water sources (such as lakes) in the District that could be used for fire fighting from the air.

Objective: Enhance regional forest management and wildfire planning

11. Strengthen Partnerships outside the District

Elkford's wildfire Management Strategy identifies various high risk fire areas outside the District of Elkford boundaries. One of the biggest risks facing the District is the risk of wildfires penetrating the WUI from outside the District boundaries. Collaboration with adjacent landowners is a priority for reducing Elkford's vulnerability to wildfires. The District should engage and work with adjacent land owners to share in the management of forested areas in the valley. Adjacent land owners include:

- First Nations
- Elk Valley Coal
- BC Transmission Corporation (BCTC)
- Provincial forest license holders
- Regional District of East Kootenay

- BC Provincial Government
- Alberta Provincial Government
- Private landowners

Collaboration should include sharing of information regarding intended future land uses, road and trail development (to serve as fire breaks and evacuation routes), and timber harvesting plans. Opportunities should be sought to create and modify fire breaks in the region.

12. Elkford Community Forest

Many communities in BC are obtaining community forest licenses to manage the crown land near their boundaries. The BC Community Forest Association (BCCFA) has 44 member communities who have created or are in the process of creating a community forest. A community forest, administered by the District of Elkford would help achieve numerous climate change adaptation objectives, including:

- Diversification of the local economy
- Creating firebreaks that protect Elkford from wildfires
- Maintaining the health and integrity of Elkford's watershed and drinking water supply

With the assistance of an experienced community forest manager, the District should seriously consider the establishment of a community forest to achieve regional forest management and wildfire planning objectives.

Goal 2: Elkford prepares for and mitigates flood risk

Objective: Reduce the vulnerability of infrastructure to flooding

13. Protect key infrastructure located within or near the floodplain from flooding

Elkford's Sewage Lagoons

It is recommended that the floodplain designation be updated, after which the District of Elkford should take steps to increase the resiliency of buildings and infrastructure located within the newly designated floodplain. Of current concern are the pumphouse, sewage treatment facility and lagoon, located within the floodplain as it is designated. Of particular risk is the potential for the flooding of sewage lagoons, leading to the contamination of the Elk River downstream to Sparwood and Fernie. An assessment of the infrastructure, and potential upgrade to the flood protection and mitigation may be appropriate.

14. Update the Elk River and Boivin Creek Development Permit Area bylaws

The current Elk River and Boivin Creek Development Permit Area bylaw was written due to 'the potential for flooding and to protect their [the rivers] qualities as a natural

water course.' The guidelines require a development permit for the DPA, except where lands have been zoned for single or two family use. Furthermore, development is discouraged where natural vegetation would be removed. It is recommended that the DPA apply to all developments (including single or two family use), due to the potentially increased risk of more frequent or greater intensity spring runoff. A requirement that natural vegetation is absolutely maintained (if not enhanced) may be an addition to the DPA, so as to enhance the capabilities of the riparian area to mitigate floods.

Flood protection at Elkford's sewage lagoons

15. Re-designate floodplain

The most recent update of the floodplain occurred in the 1980's. It is highly recommended that the floodplain be re-designated to incorporate new climate science and projections and potential geomorphological changes that have occurred since the 1980's.

16. Update Road Design Standards: Require water retention or on-site stormwater management techniques

Adapting roads to facilitate infiltration will decrease runoff, and allow for water to be dealt with on-site. Swales and/or French drains can be used instead of standard curb and gutter construction. The swales would be located along each side of the road, and would be connected to a constructed wetland or pond for further filtering. This recommendation will ensure that the subsurface drainage is not connected to the aquifer to which drinking water is drawn. Revisions to Subdivision Servicing Bylaws can be made to require on-site water retention and minimized runoff design.

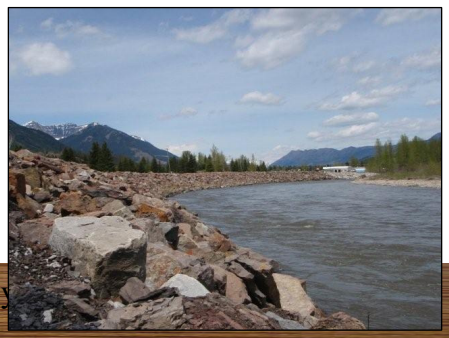
District of Ucluelet, BC
The OCP promotes "Alternative Development Standards," which includes the use of French Drains as an alternative to traditional curb and gutter road design.
www.ucluelet.ca/UserFiles/File/Bylaws/OCP/OCP%20Jan%2011%202007.pdf

Objective: Manage the land to enhance water retention

17. Maximize buffer zones, and allocate flood areas along streams and rivers

The following actions can be taken to reduce the impacts of a major flood event, and to maintain the health and integrity of riparian areas.

- Identify zones along the Elk River or significant tributaries that can be designated for flooding during an extreme flood event or major storm event (natural depressions, wetlands, fields, etc.)



- Maintain a significant buffer zone along streams and rivers, ensuring natural vegetation is present for maximum absorption.
- Designate stormwater storage areas in the headwaters of the watershed, and determine where wetland and floodplain storage expansion are possible upstream of town.

Diking along the Elk River in Elkford

18. Adapt Development Cost Charges for development of greenspace in flood prone zones

Development Costs Charges can be assigned to the improved development of parks, trails and greenspace where flooding is likely to occur, or where it is deemed appropriate to allow flooding so as to prevent flooding of infrastructure. A well-designed and maintained riparian zone will help retain water during high levels, and can be an opportunity to create parks, trails and other recreational zones.

19. Work with regional stakeholders to identify watershed-level management opportunities

Maintaining the health and integrity of the headwaters of the Elk River and the tributaries which flow into it is an inexpensive yet very valuable method of ensuring water quality. The District of Elkford should collaborate with adjacent landowners and jurisdictions to:

- Develop guidelines for development in the headwaters of the tributaries and rivers in the region.
- To ensure generous buffer zones and limited development in proximity to streams and rivers, particularly those which may feed into the aquifer.

Goal 3: Understand and effectively manage the water supply

Objective: Encourage water conservation and demand reduction

20. Implement water conservation education and awareness programs.

Town of Gibson's, BC
Implementing a water-metering program, as well as water efficient fixtures and hot water tank replacements. They have a very comprehensive and information website dedicated to water issues: http://www.gibsonswater.ca

In British Columbia, we consume almost three times the amount of water used in an average European home. It is important that we recognize the value of water, and take actions to ensure we are managing the resource effectively. Water education programs can be very successful in encouraging individuals to consider their personal water use. Implementing water conservation and education measures incrementally will increase the acceptance of the initiatives by the public, and will allow individuals to become educated and aware of the water challenges the region is likely to face in the future. The Province of British Columbia has developed a homeowners water conservation program. As part of a District education program, homeowners may be encouraged to participate in the Province's "Water Smart Home Assessment." Consider providing incentive for homeowners that participate, such as provision of a low-flow fixture.

21. Implement water metering for all residential homes.

Water metering has been implemented in several British Columbia communities as a means of education, as well as to encourage self-monitoring of water-use. It is recommended that the implementation be incremental, and that it be established initially as a means of conservation awareness. Assigning rates may be an option in the future, once all residential homes have been outfitted. Some communities establish a policy that water meters must be installed before a home is sold. In others, the local government provides or subsidizes the installation.

> Many communities in the Okanagan have installed end-use water meters, which have reduced water use by up to 20%. Okanagan Sustainable Water Strategy, Action Plan: http://www.obwb.ca/water_strategy/

22. Adapt municipal building bylaw to require low-flow plumbing fixtures for all new buildings

The Province of British Columbia recently amended the Building Code to require the installation of low flow fixtures in all new homes (maximum 9 litres per minute). It is recommended that the local government adopt these amendments, and implement a fixture incentive program to encourage existing homes to replace inefficient fixtures.

23. Update Subdivision Servicing Bylaws: Implement low impact development standards for new developments

Consider the integration of Low Impact Development standards for new developments. Potential low impact developments should incorporate one or more of the following water retention methods to their properties:

- Reduce paved areas or construct permeable driveways.
- Maintain natural features on the landscape particularly if the landscape contains wetlands, floodplain or natural depressions.
- Design greenspace (yards, etc.) using absorbent landscaping techniques (i.e. at least 300mm of BC Landscape Standard soils, with thick, matted vegetation planted on top).

Low Impact Development standards can be incorporated into the Official Community Plan, as well as being written into the relevant Bylaws and Policies.

Objective: Understand the nature and characteristics of Elkford's water supply

24. Map aquifer to understand characteristics

Given the importance of groundwater as the sole drinking water supply for the District, it is recommended that aquifer mapping be completed to determine the nature and characteristics of Elkford's aquifer. The Ministry of Environment is currently undertaking an initiative to map and delineate aquifers throughout the Province; however

this has not taken place in this region. Ground water and aquifer mapping will allow the District to make long term water management strategies and provide a better indication as to the storage capacity of the aquifer.

Goal 4: Climate change adaptation is considered in future planning and development

25. Future land use planning, and development decisions consider climate change adaptation

Where possible, planning and development (including: bids, tenders, and contracts) undertaken within the District of Elkford should consider and make reference to:

- The climate change adaptation goals, objectives, and strategies outlined in this plan, and
- The implications of the PCIC's climate change projections for the Elkford area.

26. The goals and objectives of this climate change adaptation plan should be adapted and integrated throughout Elkford's OCP

- The goals are:
    1. A resilient FireSmart community
    2. Prepare for and mitigates flood risk
    3. Understand and effectively manage water supply
    4. Consider climate change in future planning and development

- The Objectives are:
    1. Reduce the likelihood of wildfires penetrating the WUI
    2. Increase resiliency of new development to wildfires
    3. Fire resiliency for existing home and buildings
    4. Prepare for wildfire emergencies and evacuations
    5. Enhance regional forest management and wildfire planning
    6. Reduce the vulnerability of existing infrastructure to flooding
    7. Manage the land to enhance water retention
    8. Encourage water conservation and demand reduction
    9. Understand the nature and characteristics of Elkford's water supply

Step 7 – Implementation, Monitoring and Adjusting

The ultimate success of a climate adaptation plan is dependent on the willingness of the community to implement and act upon the recommendations. The District of Elkford has demonstrated significant dedication to ensure the community moves towards increased resiliency. The District has taken the appropriate first steps of integrating long-term planning processes with climate projections to ensure decisions are being made with the future in mind.

Table 13 outlines the results of a final workshop that was held with District staff and the community advisory committee to determine the priorities for implementation. The staff

were asked to rank each recommendation, and determine whether the recommendation was to be implemented immediately (High, 0-2 years), in the near future (Medium, 3-10) or in the more distant future (Low, more than 10 years). Additionally, the staff identified the individuals within the District whom are responsible for the implementation of recommendations. Success can be measured by the implementation of the strategies within the allocated timeframe.

It is recommended that the individuals responsible for each action review the strategies on a regular basis to gauge progress on implementation. Our team acknowledges the challenges of funding and capital expenditure that exists at the local government level. The District of Elkford should adjust the timeframes if necessary based on unexpected events and/or changing community priorities.

Table 13: Elkford Climate Change Adaptation Prioritization Table

CCA Strategy Prioritization Table			
Climate Change Adaptation Goal	**High urgency Initiate in 0-2 years**	**Moderate urgency Initiate in 3-10 years**	**Low urgency Initiate in 10+ years**
1. Elkford is a Resilient FireSmart Community	• Fire Hazard development permit area in OCP • Update subdivision and servicing bylaw • Update building bylaw • Update zoning Bylaw • Elkford Community evacuation plan • Implement Fuel reduction program • Road, trail and park development to maximize fire breaks	• FireSmart Education Program: • FireSmart rebate program • Strengthen partnerships outside the District	• Improve local firefighting capacity • Elkford community forest
2. Elkford prepares for and mitigates flood risk	• Update Subdivision and Servicing Bylaw to reflect floodplain development permits • Update Development Cost Charges for trail, park development along river • Extend diking north and south of the District • New developments to have flood-protection design	• Determine watershed-level water storage capacity • Identify appropriate 'flood zones' along Elk River • Identify wetland for floodland expansion upstream of town	• Redesignate the floodplain • Update Development Permit Areas
3. Elkford Understands and effectively manages water supply	• Integrate Low Impact Development (LID) objectives into bylaws and policies • Integrate LID objectives into OCP	• Reduce demand, increase efficiency of domestic water use • Develop water-use education programs • Consider water metering • Water-use bylaw update	• Map the District's aquifer and groundwater networks
4. Consider climate change adaptation in future planning decisions	• Climate change adaptation objectives and strategies are integrated into Elkford's Official Community Plan		

Summary Action Plan

The following table summarizes the goals, objectives and strategies of Elkford's climate change adaptation plan.

Goal	Objective	Strategy Recommendation
Elkford is a Resilient FireSmart Community	Reduce the likelihood of wildfires penetrating the WUI	1. Implement Wildfire fuel reduction program 2. Park and trail development
	Reduce the vulnerability of new developments to wildfire	3. Fire hazard development permit area 4. Update subdivision and servicing bylaw 5. Update zoning bylaw
	Fire resilient homes and buildings	6. Update building bylaw 7. FireSmart education program 8. FireSmart rebate program
	Prepared for wildfire emergencies and evacuations	9. Community evacuation plan 10. Improve firefighting capacity
	Enhance regional forest management and wildfire planning	11. Strengthen partnerships outside the District 12. Community forest
Elkford prepares for and mitigates flood risk	Reduce the vulnerability of infrastructure to flooding	13. Protect key infrastructure located within or near the floodplain from flooding 14. Update the Elk River and Boivin Creek Development Permit Area bylaws 15. Re-designate floodplain 16. Update Road Design Standards: Require water retention or on-site stormwater management techniques
	Manage the land to enhance water retention	17. Maximize buffer zones, and allocate flood areas along streams and rivers 18. Adapt Development Cost Charges for development of greenspace in flood prone zones 19. Work with regional stakeholders to identify watershed-level management opportunities
Understand and manage water supply	Encourage water conservation and demand reduction	20. Implement water conservation education and awareness programs. 21. Implement water metering for all residential homes.

		22. Adapt municipal building bylaw to require low-flow plumbing fixtures for all new buildings 23. Update Subdivision Servicing Bylaws: Implement low impact development standards for new developments
	Understand the nature and characteristics of Elkford's water supply	24. Map aquifer to understand characteristics
Climate change adaptation is considered in future planning decisions	Future land use planning, and development decisions consider climate change adaptation	25. Integrate strategies throughout the Official Community Plan

Moving Forward: A Resilient Elkford

The process of developing a Climate Change Adaptation Strategy for Elkford has resulted in a document that is locally relevant, scientifically supported and reflective of the priorities identified by the community. The process of CCA strategy development is driven only partially by frameworks and protocols: the dedication of the community and local government for a sustainable and resilient future determines the ultimate success of the project.

The approach taken by the CCA team was rooted in the integration of sound science, community input and realistic policy options. The result is a Plan that addresses: the key priority areas identified by community, staff and Council; the vulnerabilities and risks associated with climate change; the opportunities for adaptation and increased resiliency; and the tools and knowledge necessary to move forward and implement effective adaptation strategies. The recommendations in this document address future vulnerabilities, but are written to improve the sustainability and resiliency of the community today. Many of our recommendations have co-benefits of facilitating reduced energy consumption (i.e. water use-reduction), increased safety and well-being (i.e. emergency preparedness), and overall awareness of climatic pressures on the surrounding ecosystem. The concept of planning for a future much different from the past is increasingly recognized as a wise and proactive approach. As we see the impacts of climate change play out in our communities and wild areas, it becomes increasingly important to consider a future with many different and unexpected challenges and opportunities.

In participating in the Columbia Basin Trust *Communities Adapting to Climate Change* initiative, the District of Elkford has demonstrated great leadership in integrating climate adaptation strategies into the core planning documents for the community. As a new leader in climate change adaptation planning, the District of Elkford has an opportunity to inspire communities across the Columbia Basin, the Province, and the Globe into action.

Appendix A- Description of PCIC Modeling Methodology

These sections are taken from Pacific Climate Impact Consortium's report: Analytical Summary - Past Trends and Future Projections for the Kimberley and Elkford Region, October 1, 2008, Version 3.

Regional Climatology

Annual mean temperature and precipitation (1961-1990) climatology is provided with data from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). PRISM interpolates station-based measurements of monthly and annual temperature and precipitation to regularly spaced grid cells (Daly et al., 1994). Orographic effects are modeled by employing a digital elevation model (DEM) and regression techniques (Daly et al., 1994). Stations are weighted to account for local spatial variation in the climate resulting from elevation, orientation of terrain (and whether the terrain is interrupting flow), proximity to the coast, moisture availability, a two-layer atmosphere (to handle inversions), and topography (valley, mid-slope, ridge) (Daly, 2006). Complex climatic extremes, such as rain shadows, coastal effects, and temperature inversions, were modeled with the assistance of expert knowledge[53]. Station data used to create PRISM in BC and the Yukon was provided by Environment Canada and the global historic climatology network (GHCN).

Climate Projections

Projections of future climate are provided from the Canadian Regional Climate Model (CRCM4) at a resolution of 45 km. Results are presented as a difference from the 1961-1990 baseline for the 2050s (2041-2070). Projections are from the latest version of the CRCM4, which is forced (through boundary conditions at the edges of its domain – North America) by the ~350km resolution projection form the Canadian Global Climate Model (CGCM3) following the A2 emissions scenario (run 4). The A2 and B1 emission scenarios are commonly explored. A2 is considered to be a "business as usual" scenario and B1 reflects green house gas levels that result when we use more "alternative" energy sources.

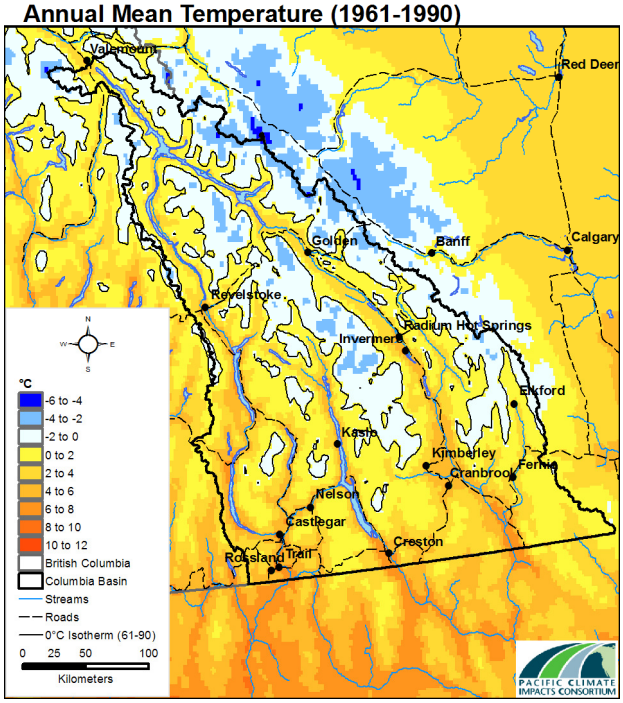
Both the regional and global models are numerical representations of the climate system based on the physical, chemical, and biological properties of its components, their interactions and feedback processes. Currently, atmosphere, ocean, and sea ice interactions are coupled with those occurring on land in GCMs, which provides a comprehensive representation of the climate system.

Because the CRCM is at a higher resolution it represents elevation, physical and dynamical processes as well as land surface characteristics in more detail than the GCM. However, RCMs are less economical to run than GCM. Thus, there are less runs of RCMs than there are of GCMs and the projections shown here are from only one model, run with only one emission scenario A2. From studies of GCM results, we know that for the 2050s more uncertainty is contributed by the various models than by different emission scenarios. By the 2080s, or the 2071-2090 period, emission scenarios have a stronger influence on the strength of the change in temperature and precipitation.

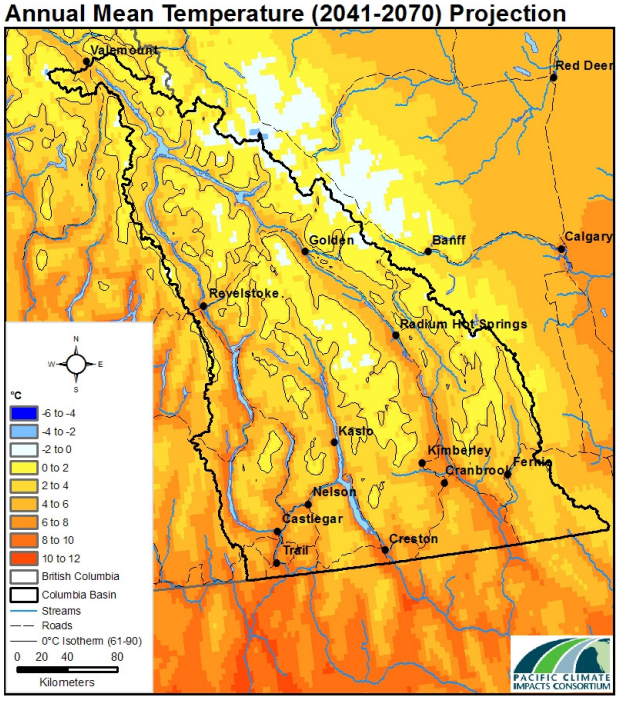
[53] http://www.prism.oregonstate.edu/

Appendix B- Maps of Past and Projected Changes in Temperature, Precipitation, Growing Degree Days, Frost-free Days, and Winter Mean Temperature

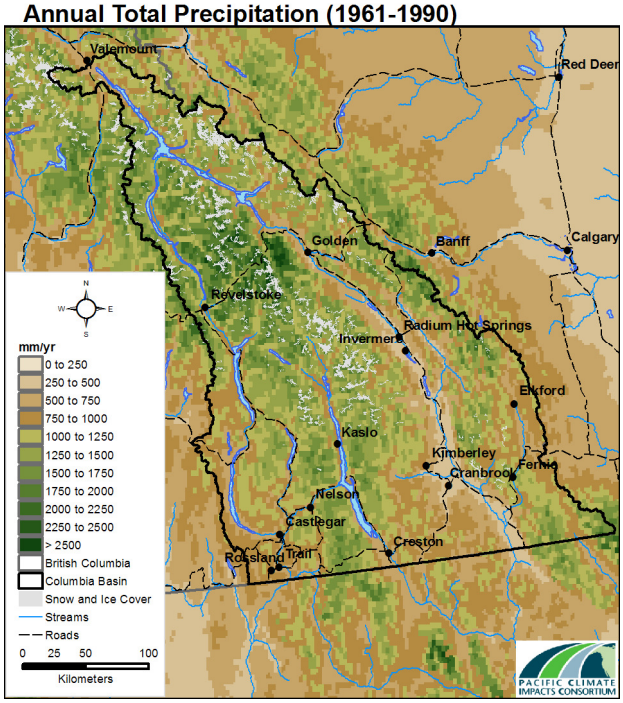
Annual Mean Temperature (1961-1990)



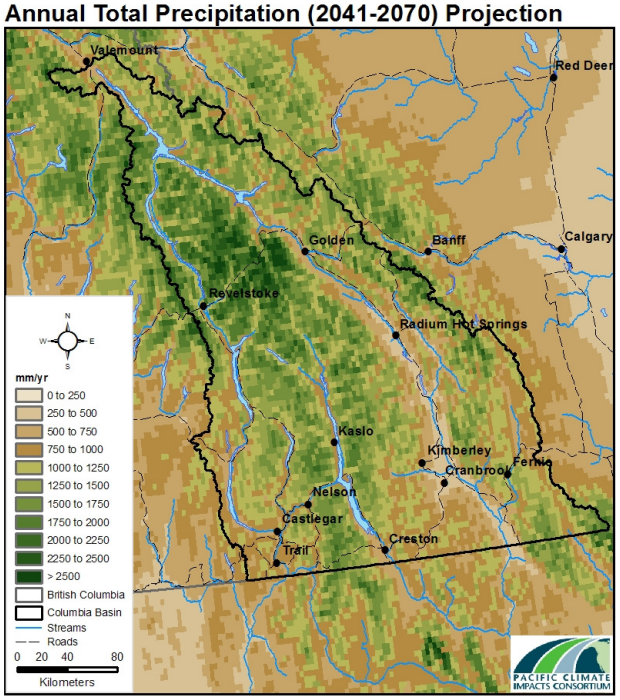
Annual Mean Temperature (2041-2070) Projection



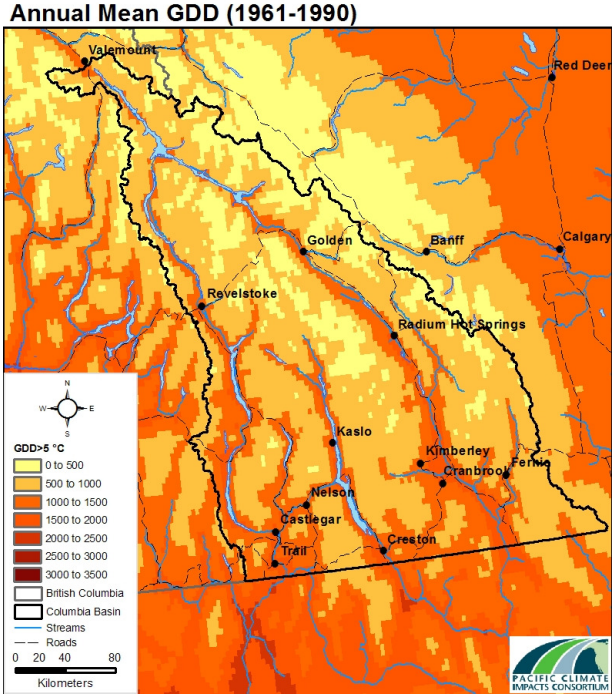
Annual Total Precipitation (1961-1990)



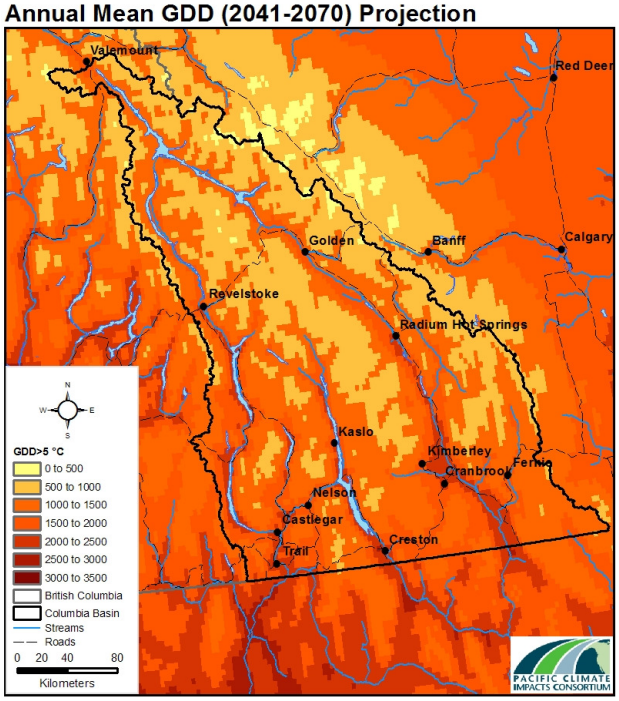
Annual Total Precipitation (2041-2070) Projection



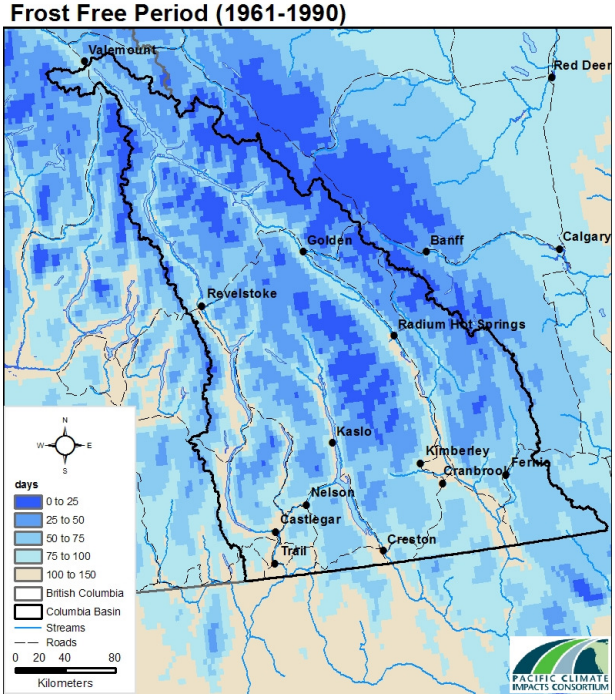
Annual Mean GDD (1961-1990)



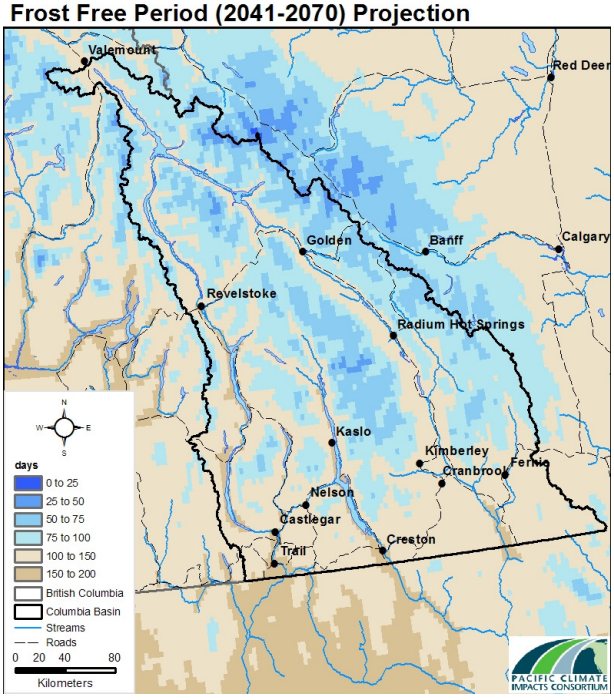
Annual Mean GDD (2041-2070) Projection



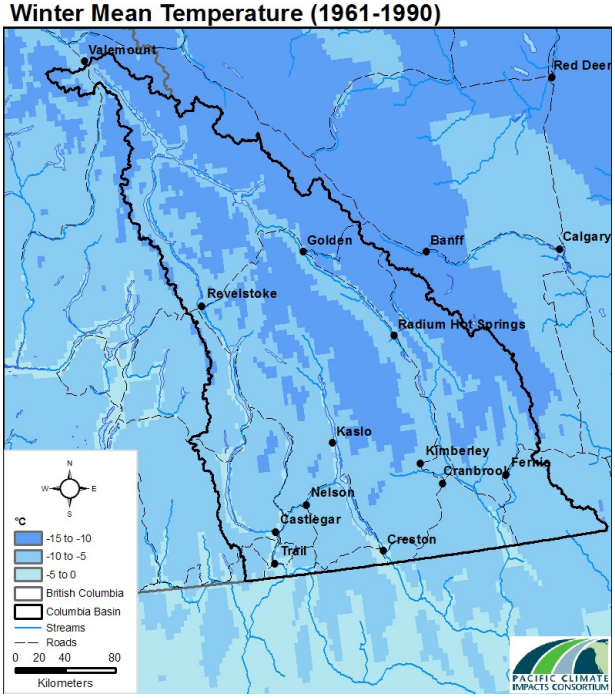
Frost Free Period (1961-1990)



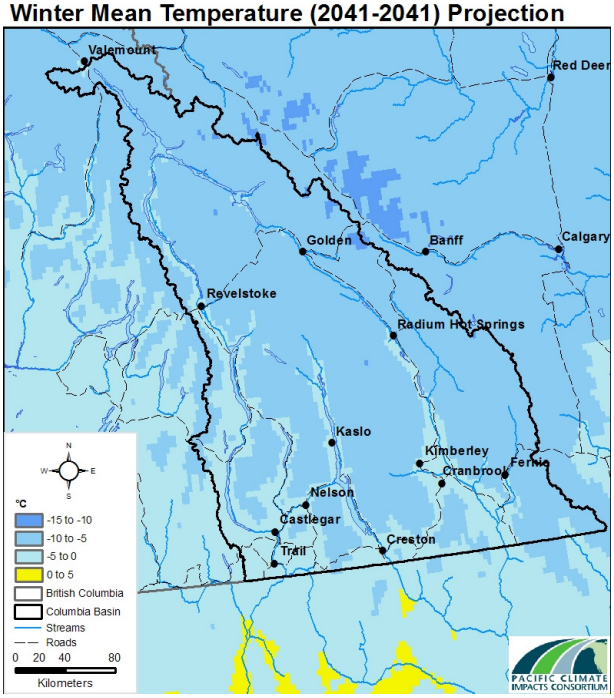
Frost Free Period (2041-2070) Projection



Winter Mean Temperature (1961-1990)



Winter Mean Temperature (2041-2041) Projection

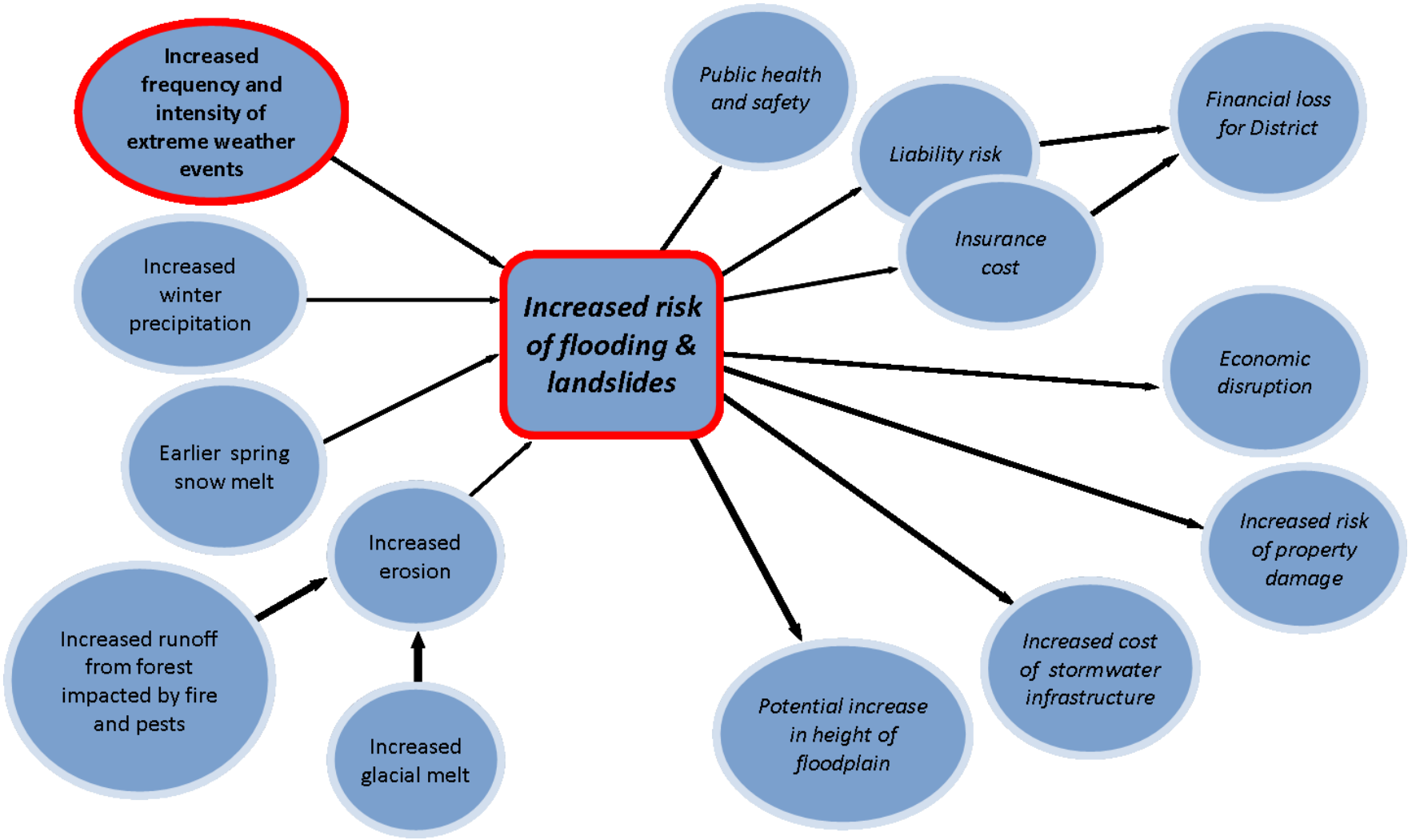


Source: [54]

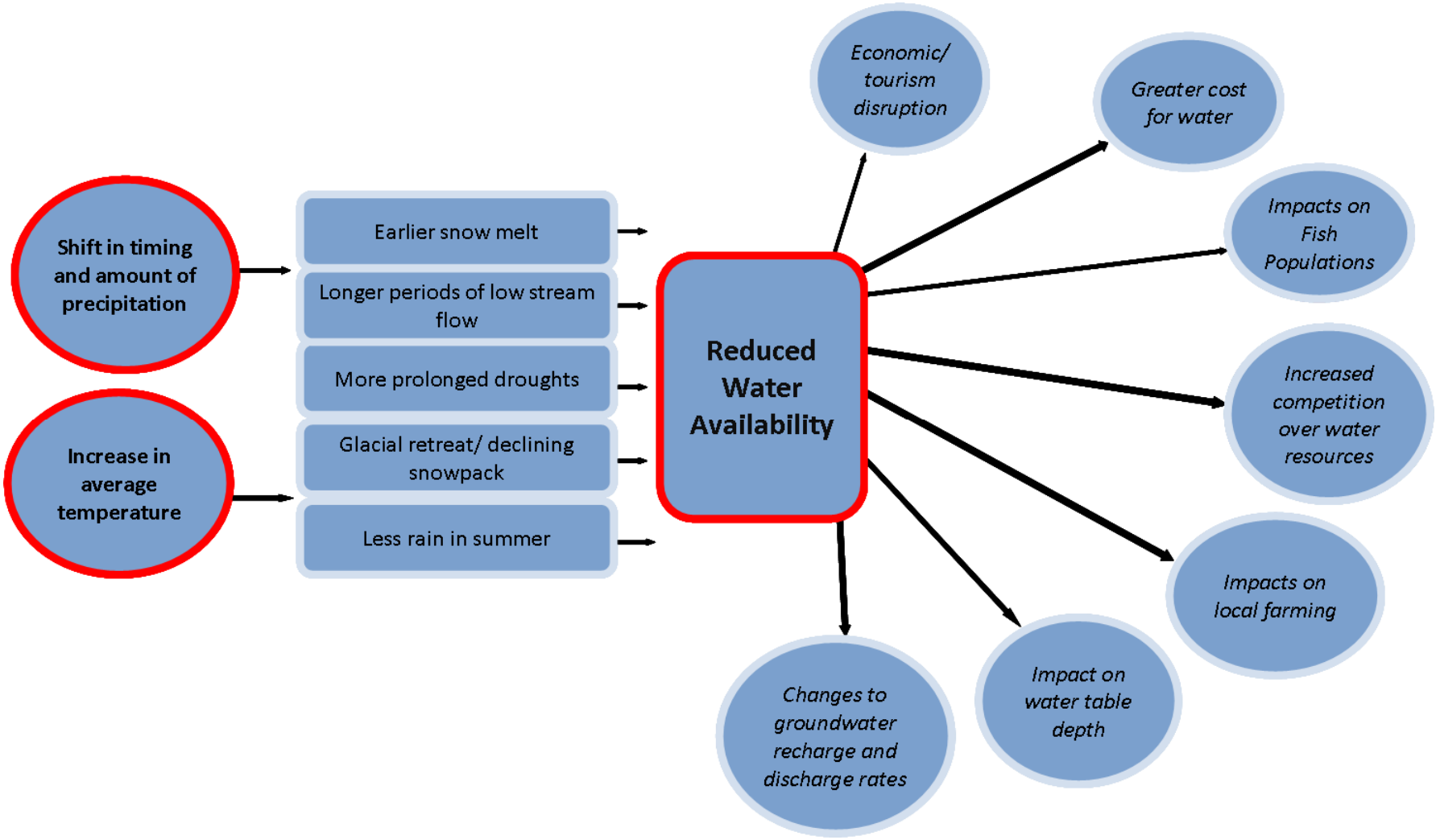
[54] All maps from *Werner, A.T., Paterson, B.M., & Harpreet, J.K., 2008. Analytical Summary - Past Trends and Future Projections for the Kimberley and Elkford Region, Pacific Climate Impact Consortium, October 1, 2008, Version 3.*

Appendix C- Elkford's Impact Opportunity Pathways

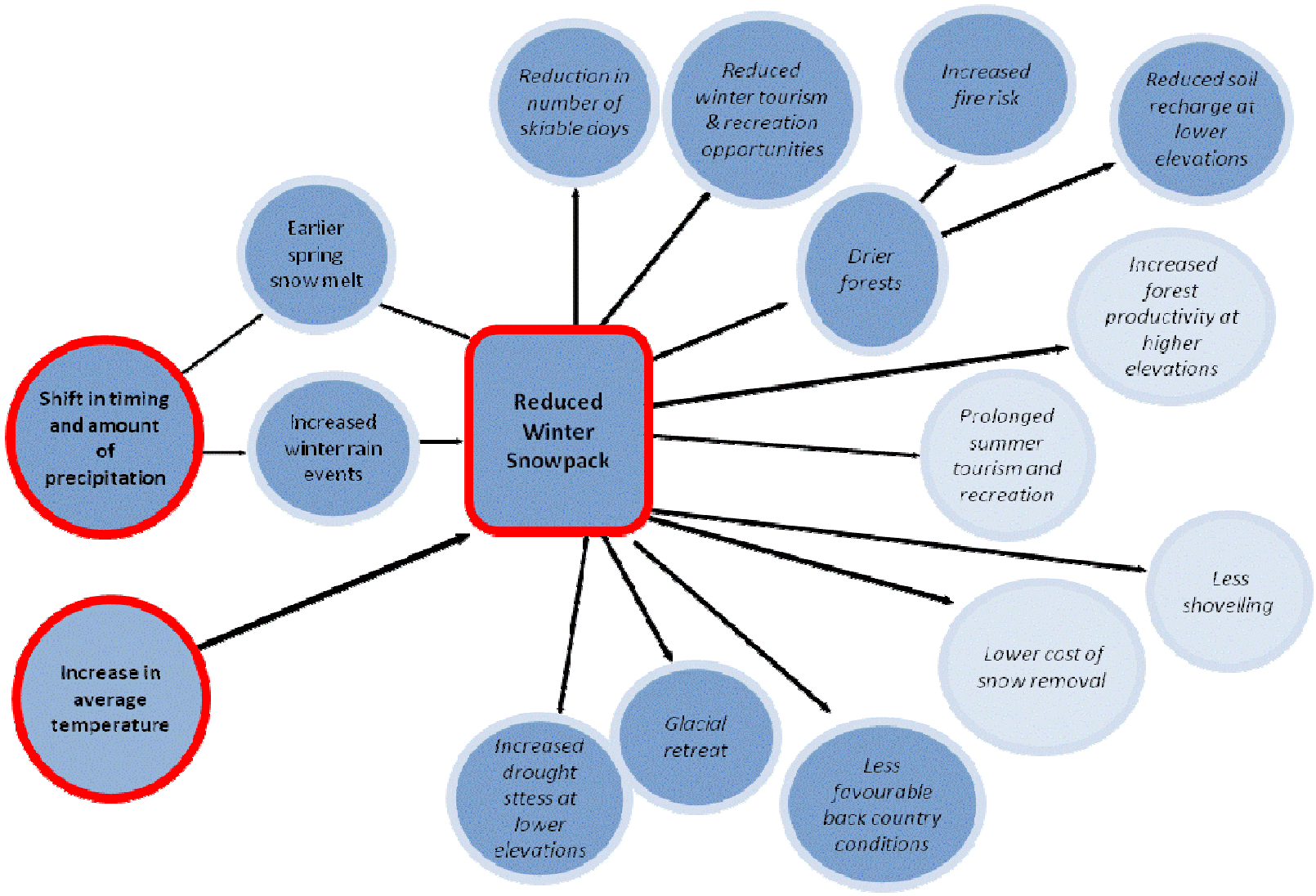
Flooding: Potential Impact Pathway for Elkford



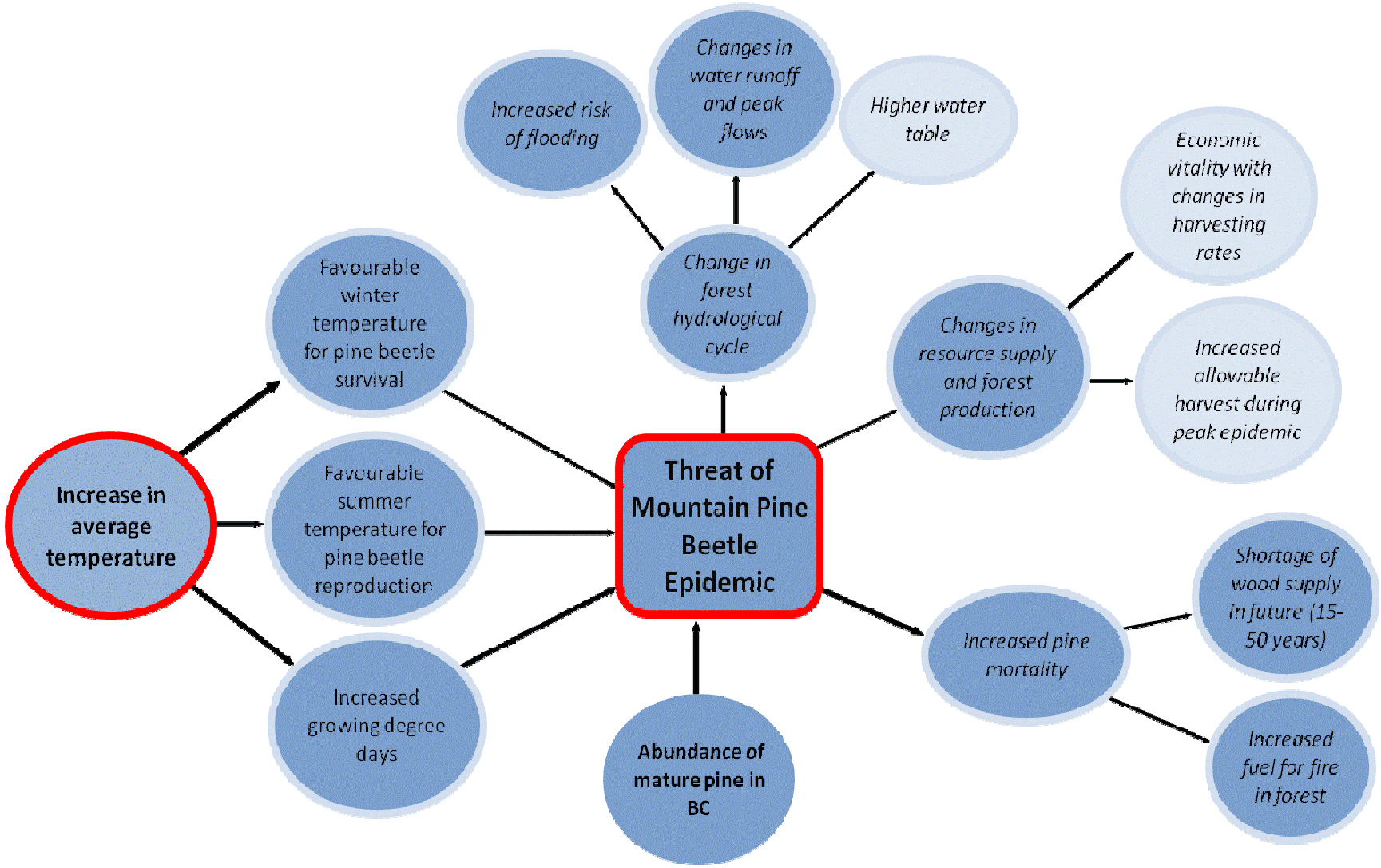
Water Availability: Potential Impact Pathway for Elkford



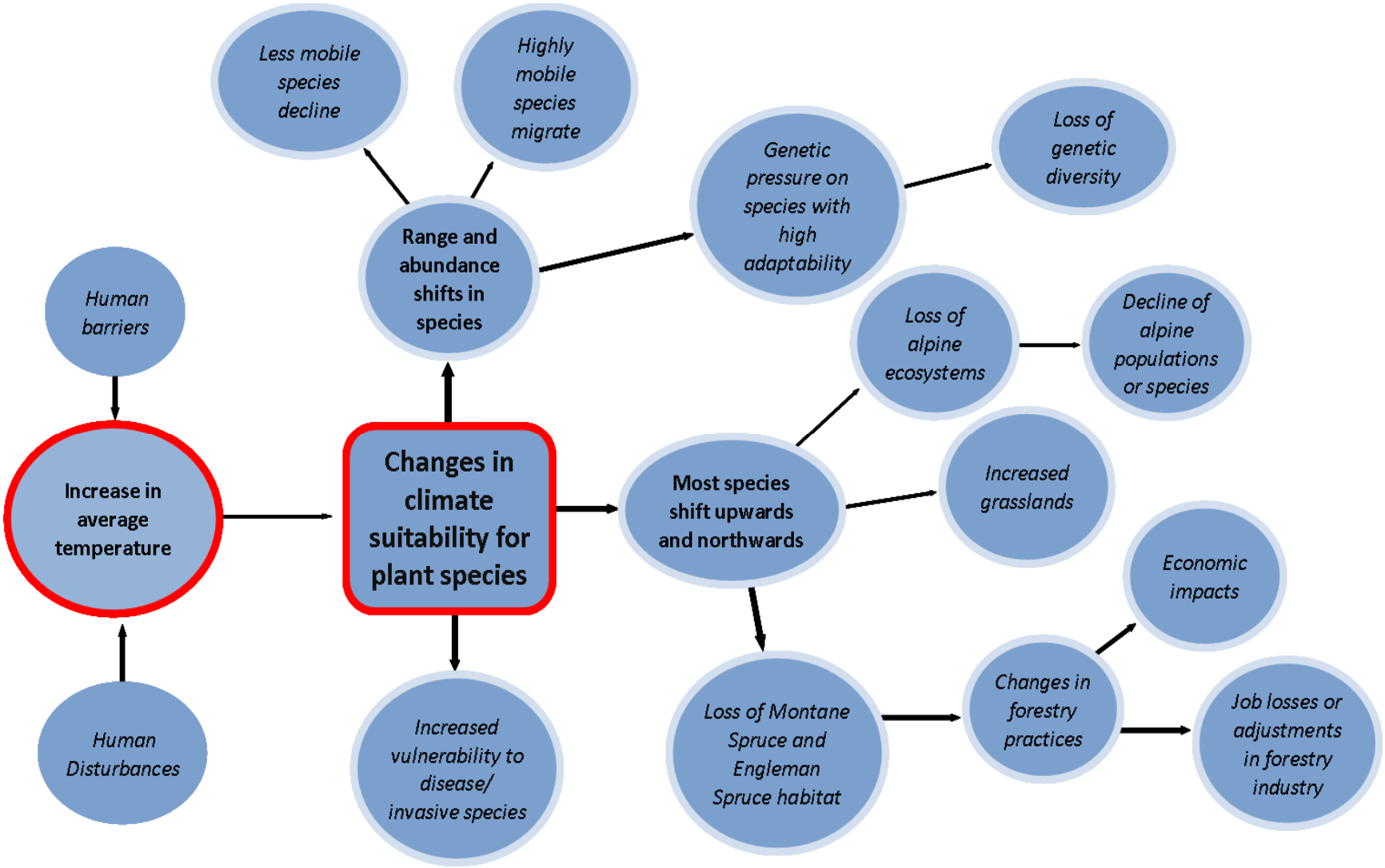
Snowpack: Potential Impact Pathway for Elkford



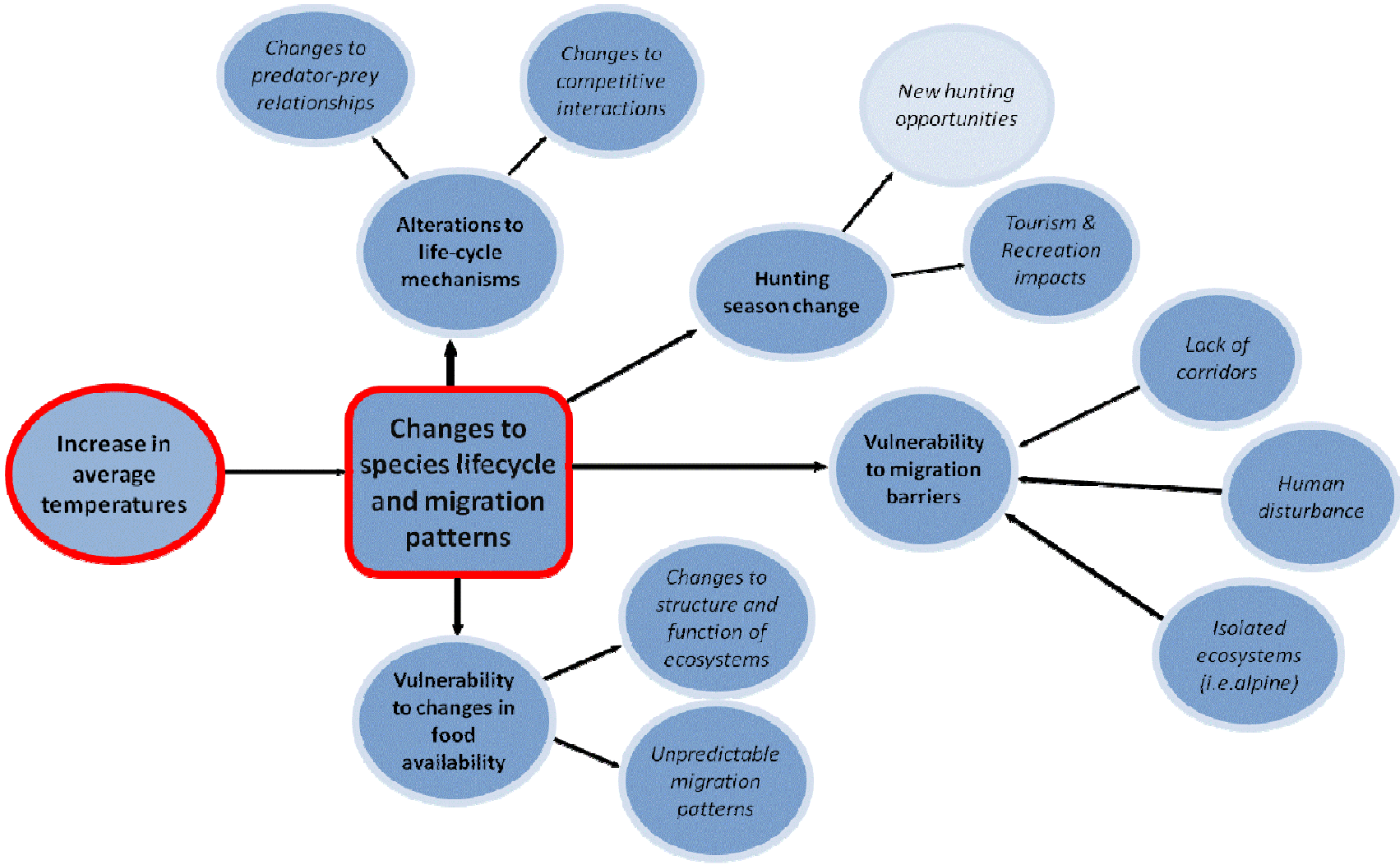
Mountain Pine Beetle: Potential Impact Pathway for Elkford



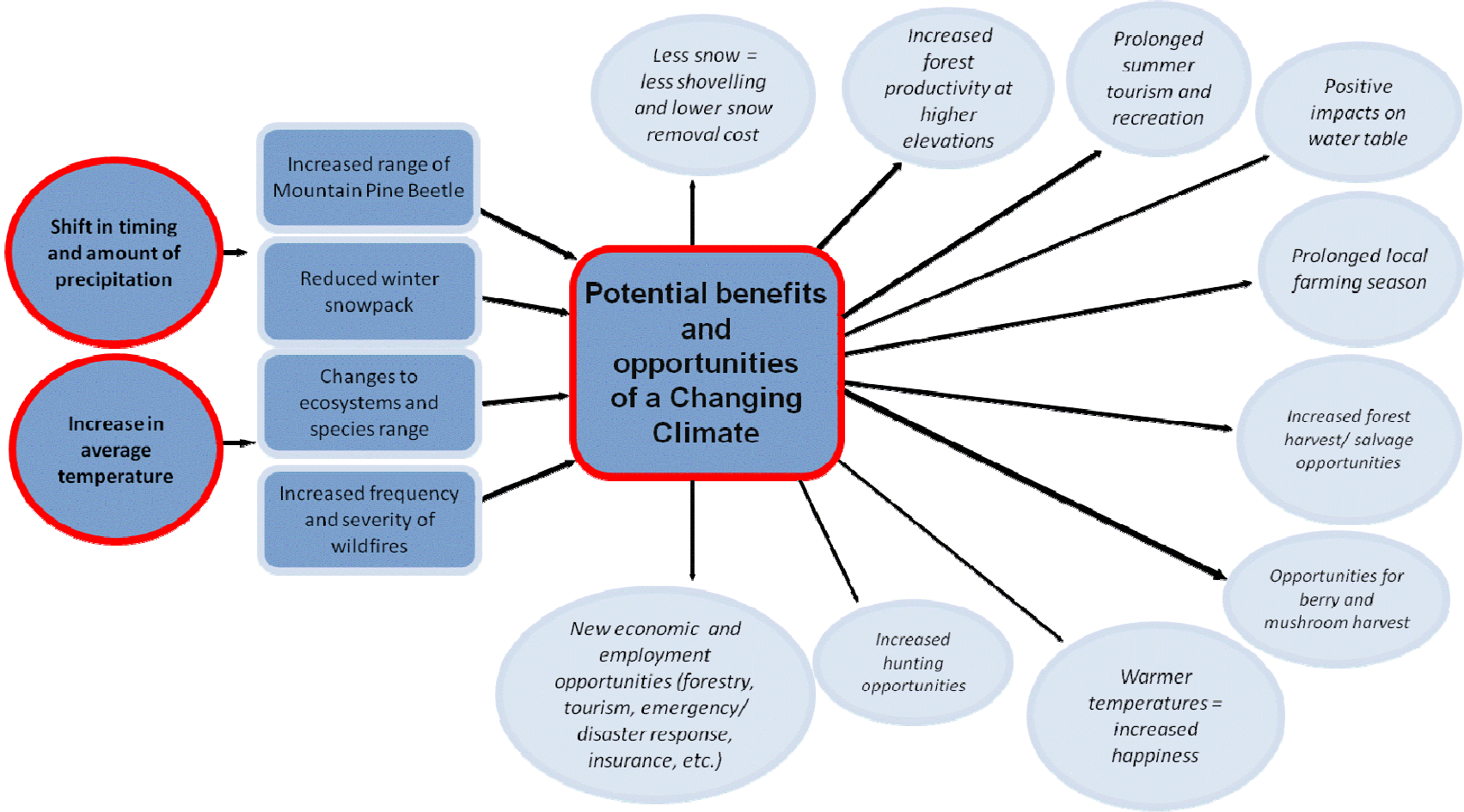
Ecosystem Shift: Potential Impact Pathway for Elkford



Species Change: Potential Impact Pathway for Elkford



Summary: Benefit and Opportunity Pathways



Appendix D- Climate Change: Overview and Potential Topics for Kitchen Table Meetings

Issue: Fire and Pest Management

*Warmer climate will likely result in more favorable conditions for insect and disease outbreaks.

*Climate and change in forest composition will also likely increase length of fire season in the Columbia Basin from between 38-52 days. The magnitude of fires is predicted to be larger.

*Invasive species are expected to establish themselves as ecosystems shift, before the next Ecological Zone populates the area.

- Have you noticed in increase in invasive plant species?
- Have pine beetle infestations been of major concern to people in Elkford? Do you feel your forests are threatened by a potential pine beetle outbreak or other climate sensitive pests?
- Has there been effective forest fire management? Do you have concerns for future forest fire events?

Issue: Water Availability and Management

*Initial research demonstrates that streamflow in the winter has been higher since 1970, potentially due to increased precipitation falling as rain as opposed to snow in the winter.

*Potential for earlier peak spring run-off, and lower streamflow during the summer. Summer precipitation expected to decrease by 5-10% by mid-century. Increase precipitation expected in winter, however increased temperatures (2-3 degrees C by mid-century during the winter) may cause precipitation to fall as rain.

- Has Elkford experienced water shortages, decreased water quality (i.e. high turbidity earlier in the spring), or other related water issues in the past?
- Have you noticed changes in spring run-off? Has this impacted your life in any way? (i.e. land/building flooding, strain on the storm water management system, limited access to backcountry locations, etc.)
- How might you deal with challenges with water availability in the future – are you willing to implement conservation measures (i.e. low-flow toilets, showerheads, etc.)?

Issue: Land Use and Development

*Certain areas of land around Elkford may be identified as sensitive or inappropriate for development due to future land changes as a result of climate change

- Are there areas around Elkford that you feel are particularly sensitive and should be protected from development or significant disturbance?

Issue: Ecosystem Shift

*The Ecological Zones that make up Elkford's surrounding ecosystem are Montane Spruce and Engelmann Spruce-Subalpine Fir. Projections estimate that by mid-century, these ecosystems will shift north by 302 km and 224 km, respectively.
*By 2085, the Ecological Zone will be dominantly Interior Douglas Fir and Sub-Boreal Spruce.

- Have you noticed changes over the past decades of what species of plants and animals exist around Elkford – has there been a change in the populations?
- Would a change in forest composition and species impact your lifestyle (i.e. backcountry recreation, hunting, etc.)?

Issue: Biodiversity
*Migration is the dominant response to ecosystem changes (proven historically with previous climatic change).
*Ability to migrate and disperse depends on the ability of species to move through natural ecosystems that are connected and relatively undisturbed.
*Rate of warming over this century will exceed the dispersal capacity of many species.

- Do you see value in maintaining large corridors for the movement of species?
- What importance would you place on conserving land for the purpose of maintaining corridors and facilitating species migration?
- How might a shift in the species that exist in the region impact your lifestyle?

Appendix E- Summary of Recommendations from Elkford's Wildfire Management Strategy

Landscape level strategies:

- Fuel mitigation should be addressed in co-operation with adjacent landowners and stakeholders;
- Fire fighting access, fire breaks and fire control lines should be improved through the development of road and recreation trails;
- Where hydrant coverage is limited, potential sites for helicopter bucketing or pumping should be located, assessed and mapped;
- Ongoing public education should be used to prevent human caused ignitions;
- The District should consider partnering with First Nations to acquire a forest license for harvesting crown timber.

Wildfire Suppression Planning

- All District staff who work in the WUI should receive basic level fire suppression training;
- Increased cooperation between the municipal fire department and the Ministry of Forest for interagency training and better fire protection;
- The District should be aware of all special populations living in the town that may require assistance in the event of an evacuation;
- At least one firesafe staging area should be designated in the event that Highway 43 is inaccessible;
- The District should have FireSmart manuals readily available for residents, or distributed with the annual property tax assessments;
- The web page of the District should be updated to include a Wildfire link with pertinent wildfire information;
- Annual FireSmart public presentations or workshops should occur prior to each fire season;
- FireSmart education programs and field trips should be used for education at local schools;
- Fire awareness signs should indicate the current MOF fire hazard rating and the number to call when a fire is detected;
- An educational brochure should be prepared and distributed to local residents that outlines the hazards associated with wildfire, how to reduce the chances of ignition and how to protect their homes;
- FireSmart education and awareness should be coupled with large events;
- The District should have restrictions during high/ extreme fire conditions (e.g. no smoking, open stoves or campfires in forested areas)

FireSmart community planning:

- All new areas that are proposed for development should comply with FireSmart guidelines and fuel management recommendations of this report;
- A pre-development 'Fuels Hazard and Fire Risk Assessment' report should be completed for all new developments;

- All homes and buildings in Elkford should meet FireSmart vegetation management guidelines in priority zones 1,2, and 3;
- The District should enhance existing or build new fireguards around high-density residential neighbourhoods.
- New road and trail development should be located and designed to provide adequate access for suppression resources;
- When planning new developments, the supply of water for firefighting should be considered (e.g. man-made water storage tanks, underground cisterns or sprinklers);
- Underground power lines should be considered for all new developments;
- Propane tanks around the District should have surrounding vegetation cleared for at least 3 m in all directions and be located at least 10 m from any building;
- Underground sprinkler systems should be considered in all new developments.

Appendix F- Sensitivity and Adaptive Capacity Wall Charts

Water Availability and Quality - Sensitivity

Water Availability and Quality Risk Topic	Current and Expected Risks	Expected Climate and Non-Climatic Changes	Degree of Sensitivity (L,M,H)
Water Quality	Groundwater quality has not been as big of a concern as surface water. Concerns heard from community on quality of water from mine sites.	The glaciers in Glacier National Park, Montana, area likely to be gone by 2030 [55] Smaller glaciers, declining snowpack, shifts in timing and amount of precipitation, and prolonged drought will increasingly limit water supply during periods of peak demand[56] Decreasing snowpack and glacial melt will limit the quantity and alter the timing of water availability[57] Changes in temperature and precipitation may alter water table depths[58] Reductions in stream flow will have negative effects on both groundwater recharge and discharge rates[59] Lower summer flows will affect the viability of salmon populations. Potential for hydroelectric generation will also be affected[60] Increased temperatures will cause increased glacial melt. In the Elk River Basin, between 1986 and 2000, there was an 8.6% loss of glacial cover. In the short term, peak-melting events may cause late summer/early fall flooding until the glacier diminishes, at which point a significant reduction in glacial-fed stream flow will occur[61] Non-climatic considerations: Population stressors on water use; increased industrial activity (i.e. coal mining and coal-bed methane), changing development patterns, backcountry recreation.	
Water Availability	Currently snowpack and glacial melt feed the watershed throughout the summer. Lower snow pack and glacial retreat will impact flow and recharge rates. 2003 was an example of a low-water availability year: snowpack was 75-80% of normal April 1st records. A hot, dry summer led to low water availability across the region.		
Aquifer Recharge	Subsurface aquifers, channels and recharge points are not mapped, and very poorly understood. Changes in snowpack and glacial capacity will have an impact on aquifer recharge, but the extent is highly unknown.		
Watershed Health and Integrity	Reduced tree coverage due to fire and mountain pine beetle impacting the ability of the land to absorb water. Lower water flows throughout summer change water temperatures, threatening cold-water fish species.		
Increased turbidity of river water	Peak flood conditions result in increased turbidity of the water, posing risk to certain fish species if exposed to turbid water for long periods of time. Water quality for consumption compromised, however dependence of the community on the aquifer reduces this risk to residents.		

Things to think about:

- How often do water quality advisories occur?
- Mapping of subsurface groundwater: where are there deep aquifers; where are the recharge channels from the Elk and other creeks?
- Glaciers in Elk River watershed have not been mapped or monitored.
- Streamflow gauge at Weary Creek has been out of commission for years. Closest monitoring with full data is Elk River at Fernie.
- How much reliance is on the fishing industry for summer tourism?

[55] Hall and Fagre (2003) Modeled Climate-Induced Glacier Change in Glacier National Park, 1850–2100. *Bioscience*. 53(2).
[56] Natural Resources Canada (NRCAN) (2007) - From Impacts to Adaptation: Canada in a Changing Climate.http://adaptation.nrcan.gc.ca/assess/2007/index_e.php
[57] Ibíd.
[58] Ibid.
[59] Ibid.
[60] Ibid.
[61] Pacific Climate Impacts Consortium (2006) - Preliminary Analysis of Climate Variability and Change in the Canadian Columbia River Basin: Focus on Water Resources.

Water Availability and Quality – Adaptive Capacity

Risk Topic	Potential Adaptation Actions	Barriers	Adaptive Capacity (L, M, H)
Water Quality	Implement water conservation education program to reduce water use, particularly during later summer/early fall seasons. Encourage home retrofits for water conserving showerheads, toilets, and other appliances. Require these as a minimum standard in new home constructions. Implement residential water-metering to monitor and charge for excessive water usage. Develop a protocol for emergency water conservation measures. Work in partnership with Ministry of Environment to monitor snowpack and precipitation in order to forecast potential drought conditions. Implement a streamflow monitoring program to track daily and monthly streamflows. Record peak flows annually and monitor for long term changes. Include records of temperature and turbidity. Conduct groundwater mapping to fully understand aquifer size and recharge from main channels. Maintain and monitor wells. Maintain wide buffer zones along rivers and creek to reduce turbidity, and to maintain fish and wildlife habitat.		
Water Availability			
Aquifer Recharge			
Watershed Health and Integrity			

Things to Think about:

- Responsibility of residents, District and industry to balance water needs.
- Requirements for change in policy and bylaws for implementation of several adaptation strategies.
- What's missing from the adaptive capacity list above?
- Is it in the correct order? (easy to difficult to implement)

Flooding – Sensitivity

Flooding Risk Topic	Current and Expected Risks	Expected Climate and Non-Climatic Changes	Degree of Sensitivity (L, M, H)
Flood Frequency and Severity	Increased frequency of rain events during the winter, and earlier snow/glacial melt may result in flooding of greater intensity than historically. Reduction of tree cover due to wildfires or pine beetle kill may result in greater runoff, contributing to more severe flooding.	Projected warming in the western mountains by the mid-21st century is very likely to cause glacial melt, earlier spring snow melt, more winter rain events, and increased peak winter flows which could lead to increases in spring flooding events[62] Overall temperatures by mid-century are expected to be 2-3 degrees above average. Precipitation in the winter is expected to increase 20-25%, but decrease slightly in the summer. Higher temperatures in winter will likely result in precipitation falling as rain, which will be immediately conducted through the watershed[63] Frequency and severity of flooding could be affected by: an increase in winter precipitation, a reduction in the extent and duration of snow cover, an earlier spring melt, and increased runoff from watersheds killed by MPB[64] Winter runoff will increase due to: increasing winter temperatures and precipitation changes (snow to rain)[65] Historical streamflow data for the Elk River indicates a trend towards earlier peak flow[66] Non-climatic Considerations: increasing development in flood-vulnerable areas; increased impermeable surfaces; changes to permitting agent from MOE to District.	
Flooding of buildings or land	Current 200-year floodplain designation has not been updated since 1989. Development exists within the flood line. Currently, permits are required to develop within the floodplain as originally determined. Several District operational facilities exist within the 200-yr floodline, and are at risk to flooding in an extreme event. Designated flooding zones are not identified in floodline mapping. Buffer areas should be established to allow for overflow, reducing cost of building structures or flood protection mechanisms.		
Damage to bridge integrity	Alternative access routes should be determined in the case of bridge damage during a flood event		
Storm water management	There will be an increase in rain events during the winter as temperatures warm. No policy exists to encourage reduction of runoff at residential and District properties. Current OCP requires the developer of new development areas to determine methods for handling storm water management. The District should establish standards.		
Safety of river users	Potential for more frequent high river levels with increased rain events, and earlier spring run-off		

Things to think about:

- The 200-year floodplain has not been reviewed since late 1980's. New information about climate impacts should be considered in the future mapping of the floodplain.
- Development and land management adjacent to river must be planned according to revised floodplain designation
- Construction of additional roads/bridges over the Elk River must be built in a manner that prevents channelization of the river.
- Standards for storm water management at new developments should be developed to encourage basic runoff minimization techniques.
- Are there areas of land designated for flood overflow?
- Is there a method of warning citizens of potential flood conditions during spring melt, etc? Are there signs or posting warning of potentially dangerous river conditions?

[62] Pacific Climate Impacts Consortium (PCIC) - (2008) Analytical Summary- Past Trends and Future Projections for the Kimberley and Elkford Region
[63] Ibid.
[64] David Suzuki Foundation, 2007: Hot Properties: How global warming could transform BC's real estate sector.
[65] Natural Resources Canada (NRCAN) (2007) - From Impacts to Adaptation: Canada in a Changing Climate. http://adaptation.nrcan.gc.ca/assess/2007/index_e.php
[66] Environment Canada, Water Survey of Canada

Flooding- Adaptive Capacity

Risk Topic	Potential Adaptation Actions	Barriers	Adaptive Capacity (L, M, H)
Flood Frequency and Severity	Maintain existing areas of marshland, forests and parks along the river. Encourage use of rain barrels and maintain trees and vegetation on properties. Implement a flood warning protocol to alert residents of projected flood events (working with Ministry of Environment weather forecasting and snowpack analysis) Identify 'no-development' zones where temporary water storage may be possible during a flood event (i.e. depressions in land adjacent to the river, large marsh or grassland areas). Work with Ministry of Environment to update 200-yr flood line. Regulate land use, including: development; designated buffer zones and flood areas; recreational areas and parks based on the new floodplain line. In development of future infrastructure over the Elk River, ensure that all designs maintain the natural flow of the river so as to prevent channelization of the river. Build roads without curbs and gutters; direct road runoff into 'swales' built with sand filters. Allow infiltration to retention ponds or wetlands Require new developments, or retrofits to use pervious materials or porous asphalt in construction of driveways, parking lots, etc.		
Flooding of buildings or lands			
Damage to bridge integrity			
Storm water management			
Increased turbidity of river water			
Safety of River users			

Things to Think about:

- Can any of these things happen before a new floodplain is determined?
- Are the resources available to implement residential-scoped storm water management techniques?
- What's missing from the adaptive capacity list above?
- Is it in the correct order? (easy to difficult to implement)

Wildfires - Sensitivity

Wildfire Risk Topic	Current and Expected Risks	Expected Climatic and Non-climatic changes	Degree of Sensitivity (L, M, H)
Wildfire enters District boundary	Pine beetle infested trees in and around Elkford are creating a high risk of interface fires Elkford OCP- Wildfire risk will be 'considered' in town planning and design. No specific policies or requirements.	Warmer climate, more precipitation in the winter and spring, less precipitation in the summer[67] (PCIC, 2008) Warmer temperatures will lead to drier forests and an increased frequency and severity of wildfires[68] The length of the fire season in the Columbia Basin is projected to increase by 38 to 52 days by 2080[69] Warmer temperatures will increase the climatically suitable range of the MPB[70] Forests damaged by MPB are more susceptible to fire. Full effects of MPB expected to hit Elkford region in 2011[71] Non-climatic Considerations: increasing development in high risk fire areas, community resistance to fuel reduction program, population growth, tourism and migration, etc.	
Smoke from wildfires	Smoke from nearby fires limits visibility and causes health hazards Increased frequency of fires may lead to increased smoke alerts		
Evacuation of whole or part of community	Evacuations limited by single access road into Elkford (Hwy. 43) No firesafe staging area or evacuation plan		
Road and highway closures	Evacuation limited by single access road into Elkford (Hwy. 43) Potential tourism and economic impacts		
Damage to Infrastructure and homes	Some homes in Elkford are developed in the urban/forest interface near high risk fire areas. Elkford OCP- Wildfire risk will be 'considered' in town planning and design. No policies to limit/ restrict development.		
Backcountry/ forest closure	Tourism and economic impacts when forest is closed		

Things to think about:

- Are there other current and expected risks associated with these risk topics?
- How often do smoke alerts occur in Elkford? (ask and add to flip chart)
- Have wildfires occurred in the Elkford District in the past?
- Has there ever been an evacuation notice due to wildfires near Elkford?
- Have homes in Elkford been damaged by wildfires in the past?
- How often are forested areas near Elkford closed due to high fire risk?

[67] Pacific Climate Impacts Consortium (PCIC) - (2008) Analytical Summary- Past Trends and Future Projections for the Kimberley and Elkford Region

[68] Natural Resources Canada (NRCAN) (2007) - From Impacts to Adaptation: Canada in a Changing Climate. http://adaptation.nrcan.gc.ca/assess/2007/index_e.php

[69] Benton (2003)- Climate change in the Columbia Basin. Potential Changes in Forest Cover and Fire Danger in the Columbia Basin. Pages 35-41. http://www.cmiae.org/pdf/ClimateChange2003.pdf

[70] Gayton (2008) - Impacts of Climate Change on British Columbia's Biodiversity: A Literature Review. http://www.forrex.org/JEM/ISS48/vol9_no2_art4.pdf

[71] BC Ministry of Forests and Range (2006) Preparing for climate change: Adapting to impacts on British Columbia's forest and range resources. Victoria, BC. Available at: www.for.gov.bc.ca/mof/Climate_Change/Preparing_for_Climate_Change.pdf.

Wildfires –Adaptive Capacity

Wildfire Risk Topic	Potential Adaptation Actions	Barriers	Adaptive Capacity (L, M, H)
Wildfire enters District boundary	Continue with public education program outlining the benefits and objectives of fuel treatment and remediation program Complete fuel treatments in high risk fire areas near the Wildland/ urban interface Assist in removal of MPB infested trees on private land Collaborate with adjacent landowners on wildfire protection planning (Ministry of Forests, BCTC, forest tenure holders, Sparwood, Teck, Ktunaxa) Obtain a community forest license to manage crown land adjacent the District of Elkford.		
Smoke from wildfires	Collaborate with adjacent landowners to reduce risk of smoke from wildfires outside District		
Evacuation of whole or part of community	Designate a community staging area (mine site) in the event that highway 43 is not a possible evacuation option Develop emergency response and evacuation planning for the event that wildfires penetrate the Elkford interface. Firesmart emergency measure guidelines recommend: an emergency warning system (bells, whistlers, car horns, etc.), planned evacuation routes, marshalling point(s), and evacuation process and procedures. Integrate emergency response and evacuation planning into Bylaw 687, OCP, or other policy.		
Road and highway closures	Designate a community staging area (mine site?) in the event that highway 43 is not a possible evacuation option Construct alternative egress route out of Elkford in the event that highway 43 is not a possible evacuation option		
Damage to Infrastructure and homes	Integrate high risk fire areas from WMS into hazardous and environmentally sensitive areas of OCP Implement permit requirements and policies for development in high risk fire areas according to Firesmart guidelines (Materials, building techniques and maintenance).		
Backcountry/ forest closure	Create alternative tourism and recreation options in non-forested areas		

Things to think about:

- Some Elkford residents are very resistant to tree removal near their properties
- What are the barriers (legal, regulatory, jurisdiction, funding, time, resources, etc)?
- Are there other potential adaptation actions?
- Likely not politically feasible to mandate fireproofing of all homes in Elkford.
- Some Elkford residents are very resistant to tree removal near their homes