Regional adaptation strategies: Kootenay & Boundary

BC Agriculture & Food Climate Action Initiative

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CLIMATE CHANGE ADAPTATION PROGRAM

Regional Adaptation Strategies: Kootenay & Boundary

Funding for this project has been provided by the Governments of Canada and British Columbia through the Canadian Agricultural Partnership, a federal-provincial-territorial initiative. The program is delivered by the Investment Agriculture Foundation of BC.

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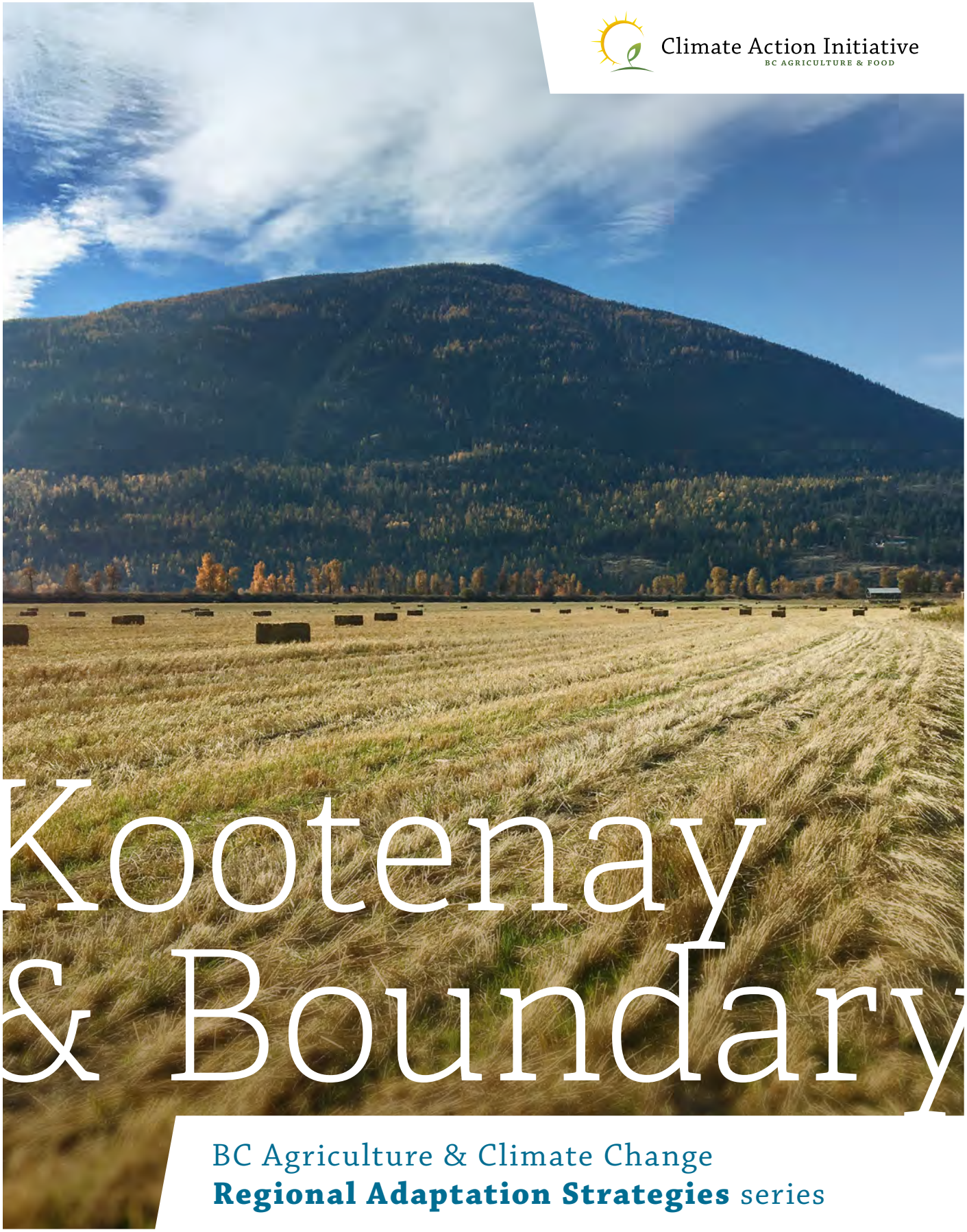

Kootenay & Boundary

BC Agriculture & Climate Change
Regional Adaptation Strategies series

Regional Adaptation Strategies: Kootenay & Boundary

This project is part of the ***Regional Adaptation Program***,
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The BC Agriculture & Food Climate Action Initiative (CAI) develops tools and resources that increase the capacity of agriculture to adapt to climate change. Guided by industry, CAI brings together producers, government and researchers to develop a strategic, proactive and pan-agricultural approach to climate adaptation. The Regional Adaptation Program is part of the BC Ministry of Agriculture's ongoing commitment to climate change adaptation in the agriculture sector while enhancing sustainability, growth and competitiveness.

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Contents

Introduction

In the coming years, climate change will impact the agriculture sector in British Columbia in a range of different ways.

Although agricultural producers are accustomed to adjusting their practices to manage through difficult conditions, the scope and scale of climate change is anticipated to exceed anything previously experienced. Strategies and actions that will enhance agriculture's ability to adapt to climate change are the focus of this plan.

In 2011–2012, a province-wide assessment of climate change-related risks and opportunities evaluated the potential impacts of climate change on agricultural production and the sector's capacity to adapt.[1] The assessment made evident that due to British Columbia's diversity (with respect to agriculture, ecology and climate), a regional approach to climate change adaptation is required. In addition, while some adaptation will occur at the farm level, the context beyond the farm and collaborative approaches, are critical for supporting agricultural adaptation.

Building on these findings, in 2012–2013 a pilot project was initiated with agricultural producers, agricultural organizations and local governments in Delta and the Peace River and Cowichan Valley regions. Each planning process resulted in a distinctive set of local sector impacts and priorities, as well as a series of strategies and actions for adapting and strengthening resilience. The plans are intended to offer clear actions suited to the specifics of the local context, both with respect to anticipated changes and local capacity and assets.

In 2013–2014, following completion of the pilot, the ***Regional Adaptation Program*** was launched. The Program is delivered by the BC Agriculture & Food Climate Action Initiative (CAI). Since the Program's inception, additional adaptation plans have been completed for the Cariboo region (2014), the Fraser Valley region (2015), the Okanagan region (2016), the Bulkley-Nechako & Fraser-Fort George region (2019) and Kootenay & Boundary region (2019). Between 2017 and 2018, five of the plans (Peace, Delta, Cariboo, Fraser Valley and Okanagan) were updated to reflect implementation progress and near-term priorities.

From 2018 through to 2023, the Regional Adaptation Program is funded by the governments of Canada and British Columbia through the Canadian Agricultural Partnership. Once regional adaptation plans are completed, Canadian Agricultural Partnership "seed" funding is available to regional partners (working with the CAI) to develop and implement collaborative priority projects.

Completed plans and details regarding projects (completed and underway) are available at *www.bcagclimateaction.ca*.

Project Delivery

A local Advisory Committee for the Kootenay & Boundary region was formed to provide input throughout the project. This Committee included participants from the three regional districts, the BC Ministry of Agriculture, the Kootenay and Boundary Farm Advisors and five local/regional agricultural organizations.

The agricultural producer participants volunteered their time throughout the project, representing five distinct local production systems. The regional district partners provided staff time and expertise and covered costs associated with the workshops. With funding from the Canadian Agricultural Partnership, the BC Agriculture & Food Climate Action Initiative provided core management and human resources for project delivery. Please see Acknowledgements for more details.

photo by Harmony Bjarnason

Project Methodology

The development of the ***Kootenay & Boundary Adaptation Strategies*** involved three key stages:

Stage 1 – Project Development

A project plan was drafted and background research was conducted through a review of relevant documents and related activities. Eleven preliminary meetings were held with agricultural organization representatives and local and provincial government staff to discuss local issues and priorities. An initial meeting was held with the Advisory Committee to receive input on the project outline and the proposed approach for the first workshop.

Stage 2 – Workshops

Two sets of workshops were held (each set held in both Creston and Greenwood) for a total of four workshops. Due to the size and the diverse geography of the Kootenay & Boundary region, two supplementary focus groups were also held (in Winlaw and in Cranbrook).

The first set of workshops focused on reviewing climate change projections, discussing the associated agricultural impacts and identifying priority areas of risk. Developing strategies and actions for adapting to these priority areas then became the focus of the second set of workshops.

Prior to the second set of workshops, a series of overarching goals, strategies and sample actions was developed and reviewed by the Advisory Committee. These materials provided support for the workshop action planning process (which also incorporated consideration of local priorities, context and resources). One hundred and fifteen individual participants attended one or more of the project workshops, focus groups and/or the final implementation meeting.

Stage 3 – Implementation Meeting

An implementation meeting was held in Creston with participants representing many of the local partner organizations. The meeting involved prioritization of draft actions based on which were most important, which were easiest to implement and which would support enhancement of capacity for additional adaptation. The meeting also included discussion of steps to implement prioritized actions.

Regional Context

Geography, Climate & Production Capacity

The geographic scope of the ***Kootenay & Boundary Adaptation Strategies*** covers 57,721 square kilometres[2] and includes the Regional District of Kootenay Boundary (RDKB), the Regional District of Central Kootenay (RDCK) and the Regional District of East Kootenay (RDEK). The region includes a substantial portion of the Canadian Columbia basin drainage and is located in the southeastern corner of British Columbia, bordered by Alberta to the east and the United States to the south.

Within these three regional districts there are 25 municipalities and 22 electoral areas.[3] The area is home to the Shuswap First Nation and the Ktunaxa Nation and its communities of ʔAkisq̓nuk (Upper Kootenay Tribe), St. Mary's (ʔAq̓am), Tobacco Plains (ʔAkink̓um‡asnuq‡iʔit) and Lower Kootenay (Yaqan Nuykiy).[4]

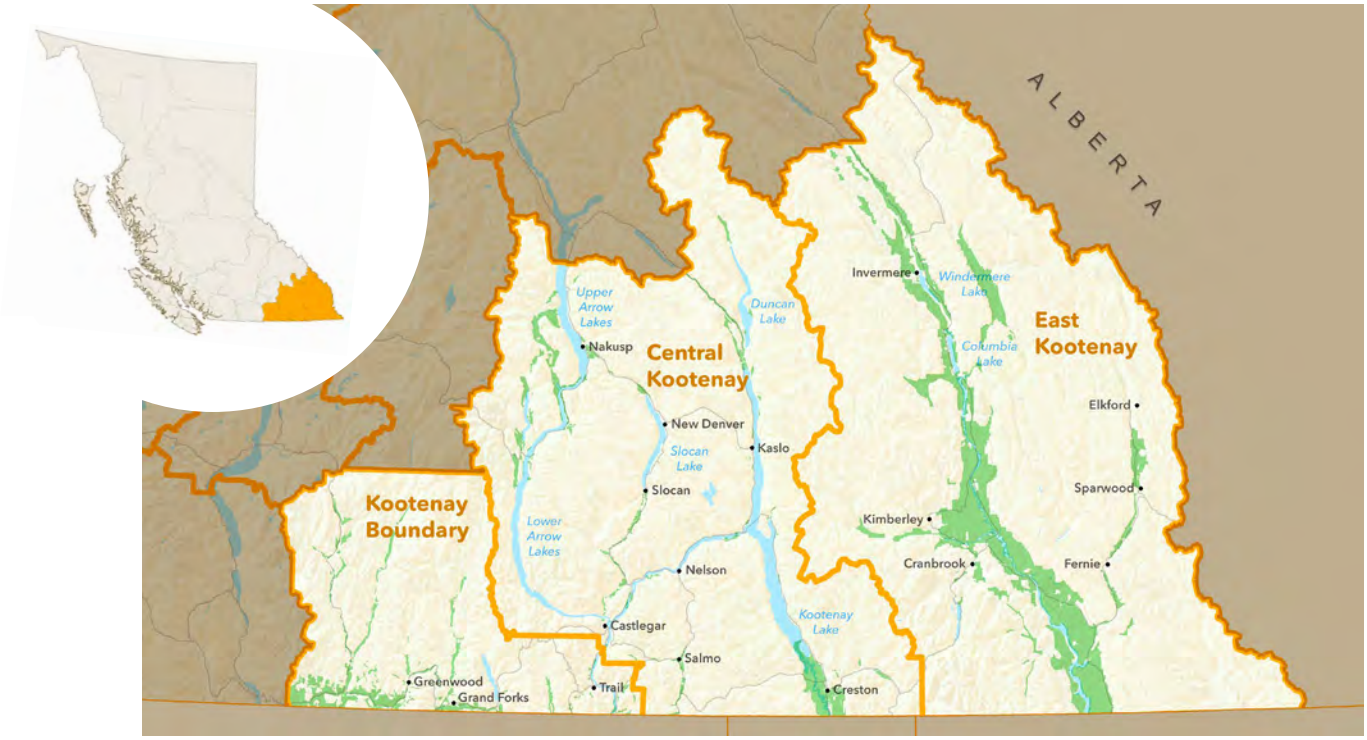


FIGURE 1 Map of the three Kootenay & Boundary region's Regional Districts (with ALR shown in green)

A series of valleys are distributed throughout the Kootenay & Boundary region, nestled between four mountain ranges — the Rocky Mountains, the Purcell Mountains, the Selkirk Mountains and the Monashee Mountains. There are also numerous watersheds in the region, including the Elk River, Kootenay River, Columbia River, Kootenay Lake, Slocan River and Kettle River.[5] Crown land — largely forested and mountainous areas — comprises approximately 91% of the land base in the region.[6] Much of the land in the valleys — where the majority of the agricultural production occurs — is privately owned.

The topography across the region is mountainous and diverse and temperature and precipitation can vary greatly across small distances.[7] The region receives an average of 998 mm of precipitation annually,[8] but this region-wide average does not accurately reflect precipitation along the valley floors, where annual precipitation tends to be much lower (649 mm in Creston, 496 mm in Cranbrook, 531 mm in Grand Forks). Precipitation falls relatively evenly throughout the year, with a slight increase in precipitation in May and June in the eastern and northern portion of the region, and slightly more precipitation during the winter in the central and western portion of the region.[9] The exception is in the north-central Kootenays, through the Slocan Valley, which receives average annual precipitation of 1,298 mm[10] with a higher concentration of precipitation (frequently falling as snow) during December, January and February.[11]

Summers in the Kootenay & Boundary region are generally hot and dry, while winters vary from mild to severe.[12] Winter temperatures are slightly milder in the Boundary area.[13] The average frost-free period is approximately 5 months long, with a slightly longer growing season in the western portion of the region.[14] The Creston area of the Central Kootenays also has warmer average and minimum winter temperatures than the rest of the region.[15] Summer maximum temperatures hover in the mid-to-high 20s along the valley floors.[16]

There are limitations to agricultural production in the region, due primarily to the mountainous topography (a climatic limitation) and to soil type and quality (e.g., moisture deficiency, stoniness, etc.). In the East Kootenays, 24% of Agricultural Land Reserve (ALR) land is Class 2 through 4, with stone free, fine-textured soils found mostly on the terraces of the Rocky Mountain trench and the Elk River Valley.[17] The remaining (76%) of East Kootenay ALR land is rated Class 5 or lower.[18] In the Central Kootenays, cultivated soil types are primarily sand and silt loam, as well as silty clay loam[19] and over 80% of ALR land is Class 4 or higher.[20] The soils in the agricultural valleys of the Boundary area are — in their unimproved state — predominantly marginal (Class 4, 5 or 6), but are often improvable to prime (Class 2 or 3).[21]

Economic & Institutional Context

The Kootenay & Boundary region's economy is reliant on the natural resource sector which includes forestry, mining and hydroelectric power generation.[22] While the forestry sector employs less than 2% of the population,[23] the industry's impact on the agricultural sector is relatively large since forest management practices affect the ecology, land-cover and hydrology of the region. Tourism is also a large economic driver for the region.[24]

The region is experiencing a positive population trend. Between 2011 and 2016, the population of the region increased 3.5%, from 146,264 to 151,403, although this growth is lower than the BC average of 5%.[25] The combined population of the three regional districts is 151,403 (representing 3.3% of British Columbia's population).[26]

Farmland in the Kootenays (at $45,000/acre) is more affordable than in the Okanagan and on the South Coast, but significantly more expensive than in other regions of the province (such Thompson-Nicola and Central/Northern BC).[27] During the past few years, agriculture has trended toward smaller acreages. However, in 2018, the region as a whole saw a very limited number of farmland sales, especially for orchard properties.[28]

There are a number of local initiatives supporting and promoting local food production and/or consumption[29] and the region is home to over 20 farmers' market locations, with some markets operating year-round.[30] Almost 40% of farms report participating in some form of direct marketing.[31]

The Columbia Basin Trust[32] supports the agriculture sector through several high-profile initiatives (e.g., Basin Business Advisors, Grassland and Rangeland Enhancement Program) and through capacity building and research (e.g., the Agricultural Forum on Market Development, Basin Food and Buyers Expo).[33] The Trust also collaborates with the three Regional Districts to fund extension services for producers through the Kootenay and Boundary Farm Advisors (KBFA) program.[34,35]

The Regional District of Kootenay Boundary (2018), Regional District of Central Kootenay (2011), and Regional District of East Kootenay (2014) have all completed Agriculture Area Plans.[36,37,38] RDCK previously had an Agricultural Advisory Commission (AAC) for Electoral Areas A, B and C (Creston Valley) to provide advice to local government on agricultural issues, although they are currently on hiatus. RDEK has an AAC built into their Advisory Planning Commissions and RDKB established the Boundary Area Food and Agriculture Advisory Council to support the development of the Area Agricultural Plan and to advance food security in the region. An Agricultural Land Use Inventory (ALUI) has been completed for the Regional District of Central Kootenay, and for sub-areas of the Regional District of East Kootenay (including the Elk Valley, Columbia Valley and Central Region).[39] Agriculture Water Demand modeling — which models current and future water demand for agriculture — has been completed for the RDCK and the Kettle Watershed (a sub-region of Regional District of Kootenay Boundary).[40]

photo by Harmony Bjarnason, Rock Creek

While the Kootenay & Boundary region is home to two local colleges (Selkirk College, College of the Rockies), there are no formal agriculture education or research programs. The Columbia Basin Rural Development Institute (through Selkirk College) does facilitate agricultural research, including research focused on expanding the regional food system and improving food security.[41]

The region is home to many agriculture organizations including several local chapters of the BC Cattlemen's Association (e.g., the Kootenay Livestock Association, Creston Valley Beef Growers Association, Southern Interior Stockmen's Association), several organic grower groups, the Kootenay Milk Producers Association, the Windermere District Farmers' Institute and the Rock Creek Farmers' Institute. Some cherry growers in the Central Kootenays belong to the BC Cherry Association and, until 2019, BC Tree Fruits maintained field staff in the area, but has recently discontinued this service.

Agricultural Production

Of the Kootenay & Boundary region's nearly 6 million hectares of land, 381,551 hectares (6.6%) are included in the ALR.[42] The total number of farms in the region has steadily declined over the past decade, from 1,349 farms in 2006 to 1,157 farms in 2016 (a 14% decrease).[43] During this same period, average farm size decreased by approximately 13% in all three regional districts.[44] East Kootenay farms are the largest (at an average of 205 hectares), almost twice the size of the average farm in Kootenay Boundary (at 125 hectares) and over five times the size of the average farm in Central Kootenay (at 40 hectares).[45] Differences in farm sizes

can largely be attributed to differences in production types (due to soil and climatic factors). Ranching is the predominant industry on larger acreages in East Kootenay and Kootenay Boundary, and smaller acreage tree fruit orchards, market gardens and dairies are more prominent in Central Kootenay.

In contrast to the decline in farm number and size, gross farm receipts have been increasing across the region since 2006. Agricultural production generated $90 million in gross farm receipts in 2016, contributing 2.4% to the provincial total.[46] Central Kootenay generated the highest gross farm receipts in 2016 ($46 million)[47] driven by strong dairy and tree fruit sectors. Boundary generated $25 million in farm receipts in 2016[48] and East Kootenay generated $21 million.[49] Between 2011 and 2016, gross farm receipts increased by 28% for the region (the increase was greatest in the Central Kootenay with its concentration of high value production systems such as dairy and cherries). The overall increase represents a significant bump from the 3% increase in the previous 5-year period (2006–2011).[50]

Agriculture in the Kootenay & Boundary region is centred around the ranching industry (predominantly cattle and calf) with 377 ranches and 30,820 head.[51] Ranchers were heavily impacted by the 2003 Bovine spongiform encephalopathy (BSE) crisis and between 2001 and 2016 the number of cattle ranching operations in all three regional districts declined (by over 50% in some areas).[52,53,54] While the industry has recovered somewhat, production has not reached pre-BSE levels.

Forage and pasture accounts for more than 95% of all cultivated land in East Kootenay[55] and are also the predominant crops in Central Kootenay (comprising 76% of all cultivated land)[56] as well as in Boundary.[57] There is some production of barley and oats and limited production of canola across the three regions.[58]

There are almost 200 hectares under vegetable production in Kootenay & Boundary (3% of BC total), as well as small floriculture and greenhouse operations across the region.[59] Forty-seven (4%) of the region's farms are certified organic, and the area is home to 10% of BC's organic farms.[60] Many farms report having a small number of poultry (30% of farms), although the region's overall poultry production is very limited.[61] The region also produces sheep, goats, llamas, turkeys and rabbits and has a large number of bee colonies.[62] East Kootenay also has a sizable Christmas tree industry, accounting for 38% of the BC Christmas tree acreage.[63]

The tree fruit industry in Kootenay & Boundary is primarily located east of Creston and represents 2% of cultivated tree fruit acreage for BC, but is steadily expanding, with acreage being converted from apples to cherries.[64] Favourable climatic conditions — such as warmer winter temperatures and a high number of growing degree days — have led to the establishment of several wineries in the Creston area. Central Kootenay also has a profitable dairy industry that holds 1.4% of the Continuous Dairy Quota for BC (shared by six dairy operations).[65]

photo by Don Low

Regional Climate Science

Accessing the best possible information about climate change is the first step in determining the options for adaptation.

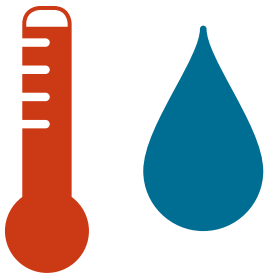
For many years, climate scientists have been improving and refining climate models to produce more accurate future projections.[66] These models have been validated in several ways, including against observed climate records.[67] The resolution of the data and models continues to increase, enabling the kinds of regional projections that follow.

The Pacific Climate Impacts Consortium (PCIC) is a regional climate service centre at the University of Victoria that provides practical information on the physical impacts of climate variability and change, in support of long-term planning.[68] As with the previous (CAI) *Regional Adaptation Strategies*, PCIC has assisted in the production of the agriculturally-relevant regional climate projections for the 2020s to 2080s that are presented in this document.

Additional information about regional climate projections, maps, and related definitions may be found in Appendix B and Appendix C, and in PCIC's *Updated Kootenay and Boundary Climate Summary*.[69]

Climate Projections

Key climate projections for the Kootenay & Boundary region from the 2020s to 2080s are summarized on the following pages.



Projections are derived from PCIC's *Statistically Downscaled Climate Scenarios*[70] at a gridded resolution of 300 arc-seconds (roughly 10 km) for the simulated period of 1950–2100.[71] Numbers provided are the median of all model runs under the Representative Concentration Pathways 8.5 (RCP 8.5) high GHG emissions model (red and blue solid lines in the graphs that follow). The shaded areas on the graphs show the range of projected possible future conditions.[72] RCP 8.5 assumes minor reductions in emissions leading to a + 3.5° Celsius increase in global temperatures. It is standard practice, when planning for future conditions at the local level, to focus planning around the worst-case scenario occurring at the middle of the century (2050s). The climate projections in this report follow this convention.[73]

Temperature

Projections for key temperature variables (see sidebar) show a strong increasing trend with all models projecting warming in all seasons. This trend is significant compared to historical variability, represented by the black line in Figure 2. Average summer temperatures are projected to increase slightly more than average temperatures in other seasons, while average daytime high and nighttime low temperatures are also expected to increase across all seasons.

As shown in Figure 3 (on the following page), the Kootenay & Boundary region's complex topography creates considerable climate variability over short distances with baseline temperatures varying with elevation (warmer in the valleys and cooler in the mountains). Projected warming trends (i.e., the percentage change from the baseline) are consistent across the region's valleys and mountains, even when the baselines vary due to topography (see Appendix B for sub-regional baselines and future projections).

Temperature Projections

- Annual average [74]
  - **+1.6°C** *by 2020s*
  - **+3.2°C** *by 2050s*
  - **+5.3°C** *by 2080s*

  BASELINE of 2.5°C [75]
- Annual frost-free days [76]
  - **+24 days** *by 2020s*
  - **+49 days** *by 2050s*
  - **+82 days** *by 2080s*

  BASELINE of 155
- Growing degree-days [77]
  - **+266 days** *by 2020s*
  - **+580 days** *by 2050s*
  - **+1,019 days** *by 2080s*

  BASELINE of 969

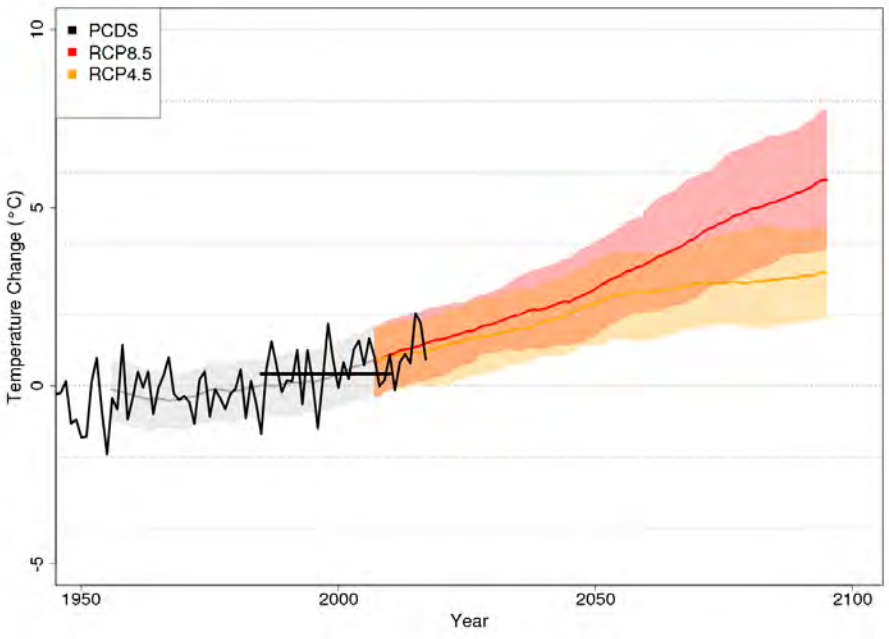


FIGURE 2 Average Annual Temperature change, 1960s to 2080s

RCP (Representative Concentration Pathways) 8.5 is a high GHG emissions scenario. RCP 4.5 is a medium GHG emissions scenario. The bold coloured lines indicate the mid-point of the ensembles of 12 different climate models while shading indicates the projected model range. The black line represents PCDS (Provincial Climate Data Set) and is historic climate data collected from BC.

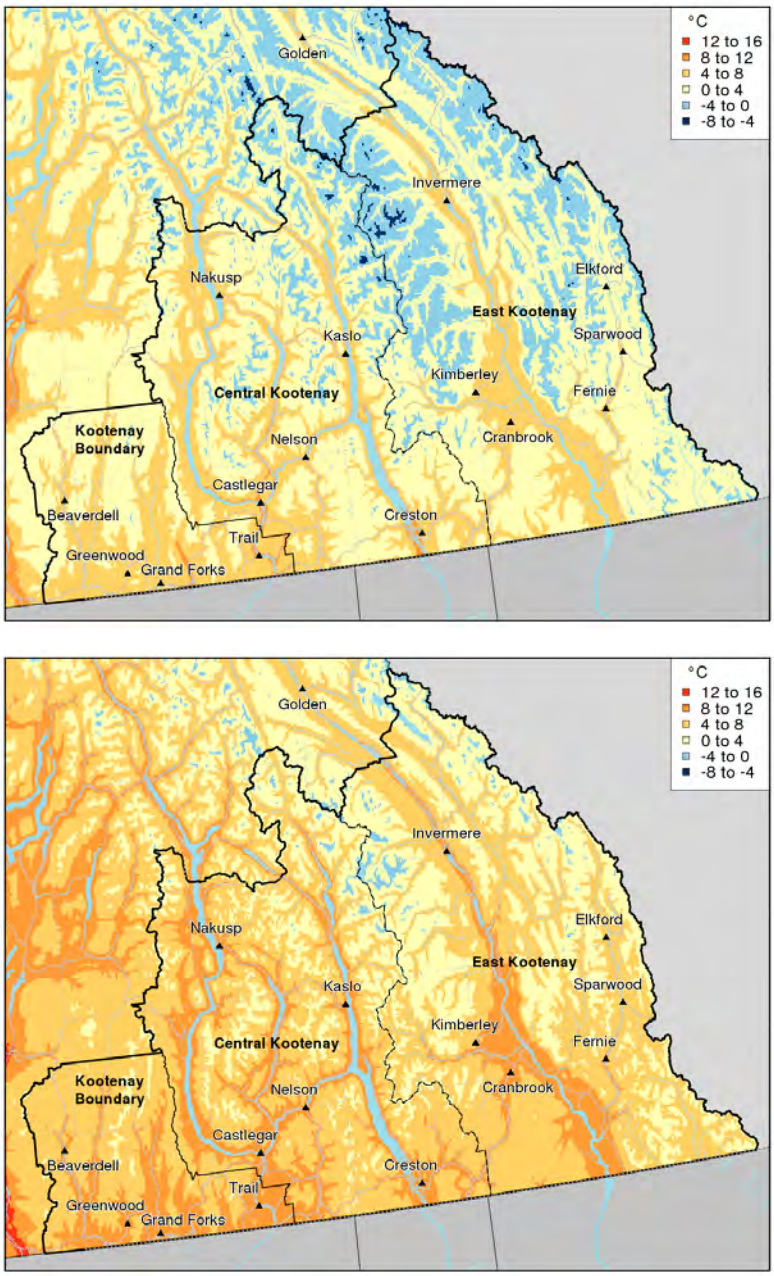


FIGURE 3 Average Annual Temperature
TOP: Historic baseline, 1971–2000
BOTTOM: Projected, 2041–2070

These maps illustrate the spatial distribution of median values for annual temperature.

The baseline map (top) provides a visualization of historic annual temperature, while the 2041–2070 map (bottom) illustrates the projected change in average temperature over a 30-year future period. The global model data has been down-scaled to reflect regional temperature variation, driven largely by topography.

Precipitation

There is considerable variation in average annual precipitation across the region (measured in mm) with the majority of precipitation falling in the Selkirk, Purcell and Monashee mountain ranges. Grand Forks (to the west) receives an average of 531 mm of annual precipitation, Creston (central) receives 649 mm, Cranbrook (east) receives 496 mm. The Slocan Valley, nestled in the Selkirk mountain range, receives 1298 mm of annual precipitation. While models show a range of future average annual precipitation scenarios — including both increasing and decreasing trends — the median trend is an increase of 1% above the regional baseline (998 mm) by the 2020s, and an increase of 4% by the 2050s.

Projections show a decrease in summer precipitation in contrast to the projected increase in precipitation during spring, fall and winter (see sidebar). Projected changes in summer and spring precipitation (see Figure 4) are more pronounced than in winter and fall, which are relatively modest compared to historic variability. While local topography continues to create significant variation in sub-regional precipitation, seasonal relative precipitation projections (i.e., percentage change from the baseline) for the sub-regions closely follow the regional trends.

Precipitation Projections

- Summer
  - **– 8%** *by 2020s*
  - **– 12%** *by 2050s*
  - **– 20%** *by 2080s*
  - *baseline of 213 mm*
- Fall
  - **+ 2%** *by 2020s*
  - **+ 7%** *by 2050s*
  - **+ 14%** *by 2080s*
  - *baseline of 268 mm*
- Winter
  - **+4%** *by 2020s*
  - **+7%** *by 2050s*
  - **+14%** *by 2080s*
  - *baseline of 286 mm*
- Spring
  - **+ 5%** *by 2020s*
  - **+ 12%** *by 2050s*
  - **+ 18%** *by 2080s*
  - *baseline of 231 mm*

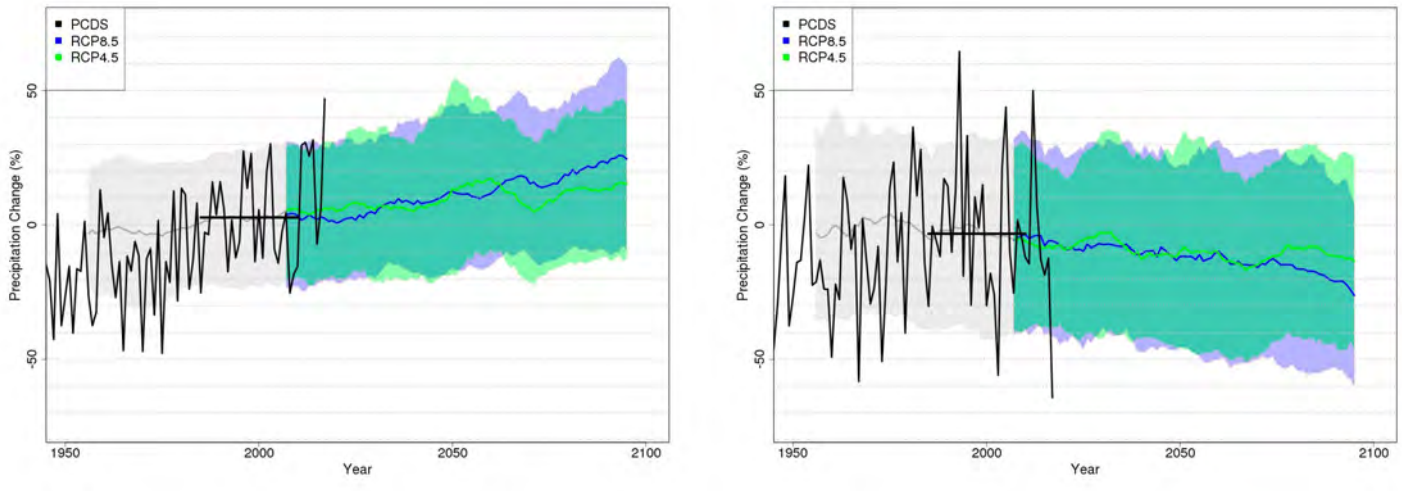


FIGURE 4 Average (Seasonal) Precipitation Change, 1960s to 2080s
LEFT: Spring
RIGHT: Summer

Related Effects

The magnitude and frequency of extreme events, related to both temperature and rainfall, are forecast to increase with climate change. Unusually warm temperatures are very likely to occur more often, and unusually cold temperatures less frequently. Projections are for twice the number of days per year over 25°C and three times the number of days per year over 30°C by the 2050s. Extremely hot days (defined as the hottest day in the past 20 years) previously reached 31°C. By the 2050s these extreme highs are expected to reach 36°C, and 39°C by the 2080s. The frequency and magnitude of extreme rainfall events are also projected to increase. Detailed projections for the 2050s extremes are provided in the sidebar.[78]

Winter and spring warming will reduce snowpack throughout much of the region, particularly at low elevations,[79] although most basins will continue to be snow dominated watersheds.[80]

Future projections indicate that both the Columbia River and Kootenay River will have increased streamflow during the winter and spring. Summer and autumn stream flows in the Kootenay River are projected to decrease, while the summer flows in the Columbia River are expected to remain relatively consistent with past trends.[81] Summer flows on the Kettle River in Boundary have been steadily decreasing over the last 50 years,[82] and are expected to continue to decrease in the summer as temperatures warm and precipitation decreases.

Winter and spring flows on smaller tributaries will also be affected by more rapid snowmelt in the spring and increased spring precipitation, while summer flows will be affected by warming summer temperatures and decreased summer precipitation.

The projected changes outlined in this section will affect the Kootenay & Boundary region's agricultural sector. The ecological effects and resulting agricultural impacts of these changes are summarized in the next section.

Extremes

- Days per year over 25°C are expected to occur more than twice as often by 2050.
  BASELINE of 19 days per year
- 17% increase in "1-in-20 hottest day" temperature by 2050.[83]
  BASELINE of 31°C
- Days with heavy rain[84] are expected to occur up to 25% more often.
- 30% more of the rain falling will fall in heavy rain events.

Agricultural Impacts

The changes in climate projected for the Kootenay & Boundary region will have a range of impacts on the agriculture sector. These impacts are summarized in the table immediately below.

TABLE 1 Potential impacts of climate change on agricultural production in the Kootenay & Boundary region

Projected Climate Changes	Projected Effects	Potential Agricultural Impacts
▪ Increase in average temperatures ▪ Increase in summer average and maximum temperatures ▪ Increase in number of days above 25°C and 30°C ▪ Decrease in summer precipitation	***Warmer & drier summers*** *(changing hydrological regime):* ▪ Lower summer stream flows ▪ More frequent and extended dry periods in summer	▪ Increase in agricultural water demand ▪ Reduction in water supply availability ▪ Increase in need for new/improved water storage and irrigation infrastructure ▪ Reduction in water flows and water pressure in purveyed water systems (due to increased water demand) ▪ Negative impacts to crop yields and quality (particularly non-irrigated crops) ▪ Changes to timing and use of rangelands for grazing cattle ▪ Forage crop losses and increase in livestock feed costs during dry years ▪ Increase in pest pressure
▪ Increase in summer temperatures, reduction in summer rainfall and periods of extreme heat (longer, warmer and drier summers) ▪ Increase in winter and spring temperatures (more rapid snowmelt, drier conditions)	***Increasing wildfire risk:*** ▪ More frequent and intensive wildfire events	▪ Damage and losses to agricultural assets and infrastructure ▪ Increase in costs associated with preparing for, managing and responding to wildfire ▪ Stress and psychological challenges for producers ▪ Lost production during active wildfire and recovery period ▪ Negative impacts to animal and crop health and productivity/ yield from smoke ▪ Reduced human capacity and worker productivity (respiratory and cardiac illnesses) from smoke ▪ Changes to pollinator behaviour ▪ Long-term impacts to soil, hydrology and forest ecosystems ▪ Increase in invasive species pressure in burned areas

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Projected Climate Changes	Projected Effects	Potential Agricultural Impacts
▪ Increase in variability of conditions (including temperatures, precipitation and extremes)	***Increasing variability:*** ▪ Fluctuating and unpredictable seasonal conditions (temperature/ moisture) ▪ Increased uncertainty over frost timing (spring/fall)	▪ Damage to crops from extreme temperature fluctuations in late winter and early spring ▪ Reduction in crop productivity and quality ▪ Increased costs to adopt new farm practices/install infrastructure to mitigate risk ▪ Shifting/unpredictable schedule for farm activities ▪ Changes to pollinator behaviour
▪ Warmer winter and spring temperatures ▪ Increase in winter and spring precipitation ▪ Increase in extreme precipitation events	***Potential for increased flooding*** *(changing hydrological regime):* ▪ Increasing river flows in winter and spring ▪ Earlier peak stream flows/freshet	▪ Risk of catastrophic flooding and damage to farm buildings and equipment ▪ Impact to farm profitability due to crop or livestock losses ▪ Increase in need for farm and community flood-readiness (and associated costs) ▪ Disrupted access to local services/supply chains/transportation networks ▪ Increase in pressure on flood-protection infrastructure
▪ Increase in average precipitation in winter ▪ Increase in intensity/ frequency of extreme rainfall events	***Extreme precipitation*** *(changing hydrological regime):* ▪ Potential for more rain-driven flood events ▪ Increase in excess moisture ▪ Increase in run-off	▪ Increase in site-specific flooding (and associated crop/ infrastructure losses) ▪ Damage to riparian areas (erosion, washouts, silting) ▪ Reduced access to fields and risk of soil compaction ▪ Increase in pressure on farm drainage systems ▪ Increase in risk of soil erosion and landslides ▪ Reduced windows for crop development and seasonal tasks (pollination, planting, harvesting) ▪ Increased disease pressure (from excess moisture)
▪ Increase in average and maximum summer temperatures	***Increase in extreme heat events:*** ▪ Increasing number of days per year over 25°C and 30°C	▪ Increase in evapotranspiration and crop water demand ▪ Risk of crop damage and loss (especially for crops without irrigation) ▪ Negative impacts to livestock health and productivity ▪ Increase in need for livestock and poultry cooling infrastructure
▪ Increase in average temperatures ▪ Increase in growing degree days ▪ Increase in frost free days ▪ Increase in winter minimum temperatures ▪ Shift in precipitation patterns	***Changing crop suitability ranges:*** ▪ Changing seasonal conditions ▪ Changing production windows	▪ Increase in management complexity and cost (e.g., with season extension) ▪ Inconsistent yield and quality of previously suitable crops ▪ Difficulty in identifying suitable crops for changing conditions ***Potential Opportunities:*** ▪ Increase in suitability for new varieties and new crops ▪ Less winter kill of perennial crops (e.g., peach trees) ▪ Opportunity for season extension and additional harvest of certain crops

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Projected Climate Changes	Projected Effects	Potential Agricultural Impacts
▪ Increase in annual temperatures ▪ Increase in winter minimum temperatures ▪ Increase in spring precipitation and extreme rain events ▪ Drier summer conditions	***Changes in pests, diseases, invasive plants:*** ▪ Increasing winter survival rates ▪ Increasing number of cycles in a year ▪ Introduction of new pests and diseases ▪ Changing range/ distribution of pests, diseases and invasive species	▪ Reduction in efficacy of previous pest management schedules and practices ▪ Increase in management costs and complexity ▪ More frequent and increased damage to crops ▪ Impacts to livestock health (poisonous weeds/ poor pasture) ▪ Reduction in forage and pasture quality/yield

photo by Harmony Bjarnason

This set of "impact areas" (groupings of projected climate changes and their associated effects and agricultural impacts) formed the basis for discussions at the first set of workshops and the first focus group.

These impact areas were explored in detail with participants and ranked in order of importance for both the individual farm and at the regional level. Based on this input, the highest priorities were identified and some impact areas in the table above were excluded from consideration at the second workshops. Those impacts that were excluded may prove to be problematic or advantageous in the Kootenay & Boundary region in the future, and should continue to be monitored. Adaptation strategies will still be needed for agriculture to address all impact areas.

Priority Impact Areas, Strategies & Actions

The following four impact areas were identified as the highest priorities with respect to agricultural adaptation in the Kootenay & Boundary region:

- **Impact Area 1**
  Warmer & drier summer conditions
- **Impact Area 2**
  Increasing wildfire risk
- **Impact Area 3**
  Increasing variability
- **Impact Area 4**
  Increasing risk of spring flooding

In the sections that follow, a background description and adaptation goals are provided for each of the Impact Areas. Following the impact description, a series of strategies and actions to support the Kootenay & Boundary region agriculture sector with adapting to climate change are outlined.

The selected strategies and actions presented are intended to:

- Address the highest priority impact areas
- Reduce vulnerability to these impacts, and/or build capacity to adapt and respond to these impacts; and
- Define practical steps forward that address gaps and build on existing assets in the Kootenay & Boundary region context.

Following the strategies and actions, the final section highlights those actions identified for near-term implementation. Implementation details, key participants, timeframes and cost ranges are provided for these near-term priority actions.

Impact Area 1: *Warmer & drier summer conditions*

The Kootenay & Boundary region's (historical average) summer conditions are typically dry and irrigation is required to maintain healthy agricultural production. The amount of land under agricultural production that relies on irrigation varies, from approximately 50% of actively farmed land in the East Kootenays, to 35% in the Central Kootenays to 10% in Kootenay Boundary.[85] Some areas, such as the Creston Flats, are naturally sub-irrigated by high water tables from adjacent waterways (e.g., Kootenay and Goat Rivers). There is extensive dryland farming in the region primarily encompassing forage, pasture, cereals and oilseeds; while tree fruits, vegetables, and nursery production are typically irrigated. Demand for irrigation is expected to increase with drier conditions.

With climate change, increasing winter temperatures are expected to result in a decrease in snowpack and earlier peak stream flows. More frequent and extended hot and dry periods are also anticipated during the growing season, along with changes in hydrology that will reduce surface water flows in some major rivers and tributaries in summer. This combination of changes will result in reduced water supply during the periods of greatest water demand.[86] Over time, the impact of glacial retreat on the region's water resources and supply will be significant.[87]

Across the region there are a number of water systems that are already insufficient to meet peak demand.[88] In August 2015 the Central and East Kootenay regions both reached a Level 3 drought,[89] and in September of 2017 the Boundary region reached a Level 4 drought.[90] The BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) Water Stewardship division monitors 15 creeks and rivers in the Kootenay & Boundary region during drought conditions[91] and the Regional Districts have flagged additional creeks with supply concerns.

The combined effect of warmer and drier summer conditions, and higher rates of evapotranspiration, will increase agricultural water demand. The *Agriculture Water Demand Model: Kettle Valley Report* projects a 25% increase in future annual water demand (over demand during baseline hot, dry years). Agriculture Water Demand modelling has also been completed for the RDCK and an Agricultural Water Demand Review is underway for Erickson (within RDCK). Water demand in the Creston area could be further impacted by changes in production type (e.g., anticipated increase of cherry acreage of up to 50% over the next five years).[92]

In addition to changes in water supply and demand, the regulatory context for agricultural water is also shifting. The Water Sustainability Act includes a number of regulations of concern for agriculture (including those related to groundwater protection, dam safety and livestock watering).[93,94] Producers require a clearer understanding of how the new and upcoming regulations will affect them, as well as information about how water supply and demand will change over time.

The strategies and actions in this section address the following ***adaptation goals***:

- ***Increasing adoption of water conservation best practices***
- ***Ensuring availability of a sustainable water supply for agricultural production***

Relevant Climate Change Effects

- Increasing average summer temperature
- Increasing number of days per year above 25°C and days per year above 30°C
- Increasing winter minimum temperatures
- Decreasing precipitation in the summer

Improve tools and resources for irrigation efficiency and water management best practices

As noted previously, many producers in the Kootenay & Boundary region utilize irrigation to maintain crop productivity. Use of best practices to optimize water use (suited to farm conditions and production type) will contribute towards ensuring producers have the water they need throughout the growing season.

Resources for irrigation efficiency and water management already exist in BC (e.g., Irrigation Management Guides, Irrigation Scheduling Calculators) and there is an opportunity to improve water use efficiency through irrigation management.[95] Developing new resources — or adapting and improving existing resources – with locally relevant and/or commodity-specific water management options and opportunities would also be beneficial.

Measuring water use is an important component of water management, in order to track use and know where improvements can be made. At present many producers can estimate their water usage based on irrigation sets (i.e., a function of type of irrigation equipment utilized, length of time spent irrigating, flow rate, etc.), but a more precise (metered or non-metered) tracking tool may be helpful. A tracking tool piloted with grape growers in the Okanagan could inform development of a similar tool for the Kootenay & Boundary region.[96] The RDCK is drafting a metering implementation plan for the Erickson area and subsequently for all RDCK water systems.[97] Lessons learned from these initiatives could inform water measurement elsewhere in the Kootenay & Boundary region.

There may be opportunities to increase uptake of cost-shared irrigation management plans and water saving technologies (such as weather stations, soil moisture sensors and moisture meters) through the Environmental Farm Plan and Beneficial Management Practices programs.[98]

There is substantial interest from producers in obtaining new information regarding practices for improving soil moisture-holding capacity which are of benefit to both irrigated and dryland farms. For many producers optimizing soil moisture-holding capacity and preventing evaporation are the only options for dealing with warmer and drier conditions because water storage and irrigation are not feasible. Improving resources on this topic is a high priority — including better data regarding microclimates and soils, along with local demonstration. The Kootenay and Boundary Farm Advisors program provides a strong foundation for these types of knowledge transfer activities.

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ACTION 1.1A **Develop resources to improve water use efficiency and communicate benefits of water conservation**	ACTION 1.1B **Develop tools(s) to measure, track and optimize water use**	ACTION 1.1C **Provide knowledge transfer for practices to maintain/ enhance soil moisture**
▪ Conduct a baseline assessment (by commodity) to document current irrigation practices/technologies and identify opportunities for improvement ▪ Document the benefits of water conservation and costs/ impacts of overwatering (e.g., nutrient leaching and increased susceptibility to disease) ▪ Identify opportunities for cost-shares/incentives to support adoption of improved technologies and practices ▪ Summarize findings in a resource (organized by commodity type or by farm practice/irrigation type) ▪ Conduct knowledge transfer through field-days, fact-sheets, webinars, etc.	▪ Develop tool(s) to track (or accurately estimate) farm water consumption ▪ Use data from water tracking tool to generate a baseline 'report card' for producers to evaluate and compare their year-to-year water use ▪ Promote uptake of water measurement tools through local extension (e.g., Ministry of Agriculture staff, Environmental Farm Plan Advisors, Kootenay and Boundary Farm Advisors).	▪ Synthesize and adapt existing informational resources ▪ As required, develop new resources specific to Kootenay & Boundary region ▪ Determine the preferred mechanisms to share resources (e.g., field days, workshops, demonstration sites, fact-sheets) ▪ Conduct knowledge transfer through preferred channels

Support the enhancement of existing, and development of new, water storage capacity

Producers in the Kootenay & Boundary region rely on many different water sources (e.g., dams, dugouts, points of diversion) for irrigation and livestock water. With water supply being adversely affected by climate change and peak agricultural water demand coinciding with periods of reduced water supply — enhancement of water storage and delivery infrastructure will be increasingly necessary to ensure adequate water availability. Climate change may make the cost/benefit of water storage investments more favourable, both at the farm-level and more broadly.

A high-level assessment to identify agricultural sub-regions that are (or may become) vulnerable to water shortages could be followed by a more in-depth assessment of optimal sites for shared water storage. The process would identify delivery infrastructure requirements and estimated installation costs, along with (agricultural and environmental/social) benefits, and would set the stage for collaboration on supplemental water storage development. Collaborative development and distribution of a shared water source may help to keep costs down for small farms, and thus be the best mechanism to increase water storage capacity.

Producers wishing to enhance or expand farm-level water storage face many barriers including the need for costly technical assistance and navigation of a complex regulatory context. These barriers, along with the financial cost (from lost production) of giving up sizable areas of land for water storage infrastructure, can prove particularly daunting to small-scale farms. Providing improved information (on technical considerations and requirements) that is tailored to farm and production type, could help to overcome some barriers. For example, market gardeners may be able to install small-scale water storage infrastructure for drip systems on private land.

Knowledge transfer activities could include developing and sharing new resources for farm-level water storage, establishing demonstration sites and/or piloting a 'water management advisor' to visit farms/ranches to provide guidance on suitable storage options and assistance with permit and cost-share applications. Collaborating with existing organizations and programs (e.g., RDKB's Kettle River Watershed Management Plan implementation team, the Grassland and Rangeland Enhancement Program and the Kootenay Boundary Farm Advisors, as well as with the Ministry of FLNRORD) would reduce costs and improve success of this Strategy.

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ACTION 1.2A **Identify and evaluate options for shared (sub-regional) water storage**	ACTION 1.2B **Strengthen availability of technical, regulatory and economic information on development/ enhancement of on-farm/ranch water storage**
▪ Building on local knowledge and existing research, identify sub-regions experiencing (or likely to experience) water supply shortages but with opportunities for diversion/storage ▪ Undertake in depth analysis in selected (pilot project) area/s including: - Assessment of water delivery infrastructure and opportunities for improvement - Storage options and criteria for suitability - Cost-benefit analysis (development costs, agricultural benefits) - Potential co-benefits (flood mitigation, fire protection, wildlife enhancement) - Impacts of climate change on water availability/flows - Possible partners ▪ Convene stakeholders to discuss and prioritize options	▪ Inventory existing informational and technical resources and develop new resources that fill information gaps for various farm types/scales regarding: - Regulatory considerations - Suitability of different infrastructure - Cost-benefit analysis and pay-back period - Cost-share supports/co-funding - Climate change considerations - Technical or "how-to" information ▪ Establish demonstration sites to showcase a variety of storage types and sizes; provide knowledge transfer via (for example) case studies, field days, fact-sheets and videos ▪ Pilot a 'water management advisor' program to provide farm/ranch specific guidance on suitable water storage options and to assist with permit and cost-share applications. (Note: This step may come first, as one or more years of this position could inform all previous steps identified)

Enhance representation of agricultural interests in landscape level water management and planning

Increasing temperatures, rapid spring snow melt and changing precipitation patterns are altering forest ecosystems in the Kootenay & Boundary region and affecting aquifer recharge rates and dynamics. Producers are concerned that forest management practices are also having an impact on aquifer health and increasing pressure on water resources.

Identifying informational gaps related to water management and aquifer health (of greatest importance to agriculture) would support suitably focused research and monitoring. There is an opportunity for the agriculture sector to work collaboratively on priority issues, and potential for the sector to become involved with improving baseline information/filling data gaps through on the ground activities such as well monitoring and citizen science.[99]

A number of specific topics of interest have been identified, ranging from improving knowledge about how climate change affects aquifer recharge, to sharing information with producers about how forest management practices affect the availability and quality of water resources. Aquifer and water mapping/monitoring is taking place in parts of the region and consolidating and sharing this information — as well as the results of the Ministry of FLNRORD's cumulative effects[100] assessment — would be a positive step in strengthening producer knowledge of aquifer health.

At present the Regional Districts have varying levels of activity associated with watershed planning (e.g., RDKB Watershed Coordinator position and the RDCK Watershed Governance Initiative project). Identifying opportunities for on-going, efficient and integrated engagement of the agriculture sector in watershed management, planning and initiatives would help to ensure that agricultural interests are represented and enable the sector to start addressing key areas of concern. There are a number of active water advocacy/water management groups in the Kootenay & Boundary region (e.g., the Columbia Basin Watershed Network, Kettle River Watershed Management Plan implementation team) that the agriculture sector could collaborate with.

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ACTION 1.3A **Identify and fill information and data gaps relating to water resources in the region**	ACTION 1.3B **Strengthen regional capacity for a coordinated, cross-sector approach to water management and planning**
▪ Inventory current research/knowledge/data and identify gaps of greatest importance to the agriculture sector ▪ Support the initiation of new research/data gathering of greatest importance to the agriculture sector (as identified above) ▪ Improve monitoring on small streams and wells and develop a resource/tool to provide real-time information about aquifer recharge/levels (use data collected on streams and wells to estimate aquifer recharge/health) ▪ Develop resources to improve baseline knowledge relating to aquifer dynamics/water resource management	▪ Document active water stewardship groups in the region and assess their mandates, activities and current links with the agriculture sector ▪ Assess options for: - Strengthening integration of agricultural representation/concerns with existing water stewardship groups - Creating an agricultural water advisory committee to interface with all/select groups - Creating a regional water board (similar to Okanagan Basin Water Board) ▪ Engage with agricultural stakeholders (e.g., through a forum) to: - Discuss options and identify the preferred engagement mechanism - Identify key priorities (water management topics of most importance to agriculture) - Develop a feedback mechanism to share water management updates/progress on key priorities with producers

Impact Area 2: *Increasing wildfire risk*

Earlier snowmelt due to warmer winter and spring temperatures, combined with prolonged hot and dry summers, is increasing the likelihood of more severe and frequent wildfires in the Kootenay & Boundary region. Forest die-off due to mountain pine beetle, a long history of fire suppression activities and logging practices that leave fuel behind, are also increasing wildfire risk.

Although the Kootenays have not experienced the extensive destructive wildfires that have impacted other agricultural regions of the province (i.e. the Cariboo in 2017 and Bulkley-Nechako in 2018),[101] wildfire activity has been increasing in the region over the past decade.[102] Boundary, which is more arid than Central and East Kootenay, experienced a significant wildfire season in 2015 with severe agricultural impacts. This fire burned 4400 hectares of land between Westridge and Rock Creek, destroyed structures on more than 50 properties (including 30 homes and 20 outbuildings), burned kilometres of livestock fencing and hundreds of hectares of ranchland.[103]

Wildfires jeopardize crop production and quality, livestock health, farm workers' health and agricultural infrastructure. Producers are keenly aware of the increasing risk of wildfire and require support in mitigating risks to their operations and in planning for wildfire emergencies. Strategies to support and promote individual producer preparedness are required, as well as actions that will strengthen implementation of fuel management at the farm level and on the agriculture/wildland interface.

As in other areas of BC, producers in the region have concerns about effective communication with key agencies during wildfire response. A consistent and collaborative approach to communication and information sharing, before the wildfire season and during wildfire emergencies, is needed. A pilot project in the Regional District of Okanagan Similkameen to develop and test a "communication protocol"[104] may provide a model for a similar project in the Kootenay & Boundary region.

Relevant Climate Change Effects

- Increasing average and maximum summer temperature
- Increasing average winter and spring temperature
- Increasing number of days above 25°C and 30°C
- Decreasing precipitation in the summer

Wildfire smoke impacts extend well beyond the areas in immediate jeopardy. The 2017 and 2018 growing seasons were notable for extensive and prolonged smoky conditions. In 2018, most of the region experienced more than 20 days of Air Quality Health Index[105] above 7 (high health risk) due to significant smoke cover. These conditions negatively impacted crops and animal health across the region, and relevant adaptation actions are included in Impact 3, Strategy 3.2.

The strategies and actions in this section address the following ***adaptation goal:***

- ***Supporting comprehensive wildfire preparedness planning to minimize impacts from wildfire***

Promote wildfire preparedness planning at the farm and regional levels

As is the case across much of British Columbia, climate change is increasing the risk of wildfires on the agricultural interface in the Kootenay & Boundary region. Mitigating damage associated with wildfire requires preparedness planning at both the farm and community levels.

In 2018, the BC Agriculture & Food Climate Action Initiative released a farm-level *Agriculture Wildfire Preparedness and Mitigation Workbook & Guide*[106] to assist producers with planning for a wildfire emergency and reducing impacts to their operations. The wildfire preparedness materials were promoted through workshops held across the province in 2018 and 2019.[107]

Demand remains high within the producer community for continued support with preparing for, and mitigating, risks associated with wildfire. There is particular interest in on-farm assessments to assist with preparedness/mitigation planning, but also in additional workshops and/or instructional videos. The Kootenay Livestock Association has been collecting relevant information from producers (e.g., equipment available for mobilization during an emergency) to coordinate producer preparedness/response, and this type of leadership from the agricultural sector will enhance the actions below.

When wildfire risk is present (i.e., when wildfire is in the area and during alerts/orders) producers require timely information to help them react quickly and effectively and to inform farm-level decisions (e.g., livestock relocation, harvest timing). Effective information exchange and communication – before and during wildfire events – is an important contributor to wildfire impact reduction.[108] Producers rely on outside agencies for information during the wildfire season, and ensuring that communication mechanisms, key contacts and roles and responsibilities are shared and understood is critical.

As noted previously, a pilot project is underway in the Okanagan-Similkameen region to establish a protocol to guide communication between the Regional District of Okanagan Similkameen, response agencies and agricultural residents. The pilot approach could be adapted/replicated in the Kootenay & Boundary region.

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ACTION 2.1A **Encourage adoption of farm-level wildfire planning preparedness tools and resources**	ACTION 2.1B **Develop a wildfire communication protocol to guide communication between response agencies and producers**
▪ Identify and implement preferred mechanism(s) for completion of farm-level preparedness and mitigation planning (e.g., *Agriculture Wildfire Preparedness and Mitigation Guide/Workbook*). This may include: - Development of how-to-videos and/or webinars - Farm assessments - Workshops (and follow-up sessions) - Distribution of resources through partner agencies ▪ Provide additional planning support (e.g., through targeted workshops) to livestock sector to develop and coordinate livestock relocation plans ▪ Ensure relevant information from individual plans (e.g., contact information, maps, equipment lists) is being effectively shared with response agencies	▪ Bring producers and response agencies together to develop a communication protocol (utilizing/adapting Regional District of Okanagan Similkameen Wildfire Communication Protocol materials). This protocol may include: - Roles and responsibilities during a wildfire - Local contact information - Permitting and re-entry guidelines - How and what to communicate at what times - Where to post/find information - Incorporating an "agricultural liaison" into Emergency Operations Centres ▪ Pilot implementation of Wildfire Communication Protocol ▪ Evaluate outcomes and revising protocol as needed

Pilot and demonstrate fuel management practices for private and Crown range land

Fuel management is a critical element of wildfire mitigation and refers primarily to reducing the fuel load (vegetation and woody debris). Producers with large acreages and private woodlot licensees[109] — who hold exclusive rights to manage and harvest Crown timber within the woodlot licence area — have access to very few resources to assist them with reducing fire risk on their property or tenure.

FireSmart principles can be effectively utilized to reduce the risk of fire damage to agricultural buildings and structures, but fuel management on larger acreages necessitates the development and execution of larger-scale — and more costly and complex — fuel management plans. Developing new resources to support small-scale fuel management activities is an important component of farm-level wildfire preparedness. Producers are also interested in fuel management options that allow them to better manage (for profit) their private timber supply (private land/woodlot).

An initial assessment/consultation to define local priorities would be the first step, followed by a pilot to test and demonstrate practices. Producers would also benefit from identification and/or development of cost-share supports and incentives to support private fuel management practices. For example, the newly created provincial Community Resiliency Investment (CRI) program (replacing the Strategic Wildfire Prevention Initiative) has expanded its mandate to include funding for FireSmart activities on private land.[110]

High fuel loads on Crown land pose significant wildfire risk to adjacent private lands and farmers and ranchers cannot mitigate impacts to their operations (through actions identified in Strategy 2.1, and treatments on private land) without collaboration and partnerships with Crown land managers. Ember showers from Crown land can ignite fuels from up to two km away.[111] Agricultural producers have very few opportunities for fuel management on Crown land, and even where opportunities exist, these activities tend to be complex, time consuming and expensive to carry out.

To fill gaps in current fuel management activities, there is a need to support collaborative fuel management at the agricultural/wildland interface by piloting different approaches for removal and disposal of fuel and exploring alternative options — such as range management practices — for fuel reduction.

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ACTION 2.2A **Identify and address barriers to fuel management on private land**	ACTION 2.2B **Develop and pilot collaborative fuel management approaches to reduce fuel on high-risk Crown land***
▪ Building on work completed in the Cariboo (Opportunities and Barriers to Wildfire Risk Mitigation), conduct an analysis to identify local priorities for fuel management on private land (e.g. addressing access to equipment and expertise, costs of treatment, disposal challenges) ▪ Develop pilot project(s)/program to reduce identified barriers (e.g., providing technical expertise to private landowners to develop prescriptions for reducing fuel load, identifying how land-owners can manage land to reduce wildfire risk and maximize profit from harvesting timber) ▪ Develop resource materials and sharing results with producers ▪ Identify and/or develop cost-share supports and incentives to support farm-level fuel management practices	▪ Compile research on options for management of forest fuels near agricultural operations such as: - creating fire breaks - fuel thinning/fuel chipping - prescribed burning - silvopasture/agroforestry to remove understory ▪ Document range management practices that can be used to reduce fuel loads and assess suitability for region ▪ Convene partners to prioritize locally suitable fuel management practices for pilot/demonstration and identify pilot area(s) and collaborators ▪ Establish one or more pilot sites to demonstrate practices identified above ▪ Assess opportunities to increase the duration of range tenure as an incentive to employ management practices to reduce the fuel load in long-term

* **Developing and testing collaborative fuel management approaches has been prioritized in other regions of the province and opportunities to build on existing/ongoing research and demonstration should be explored before undertaking a project.**

Impact Area 3: *Increasing variability*

The combination of changes in climate (including shifting and unpredictable temperature and precipitation patterns, increasing growing degree days and increasing frequency and intensity of extreme events) is resulting in more variable seasonal conditions and changing pest cycles — both of which increase the complexity of farm management decisions and associated costs. Adapting to variable conditions requires that producers increase their overall resilience and their ability to respond to a broad range of projected changes.

Critical windows in the production season (such as planting and harvesting) are becoming less predictable. Variable temperatures and abrupt temperature swings can result in increased risk of frost or heat damage to crops, and winter storm events are of particular concern for livestock and forage producers (e.g., impact of freeze-thaw cycles on crops, livestock mortality due to extreme cold). Parameters for crop suitability may shift in some areas, reducing the viability of current crops/varieties and increasing the potential of others. However, harnessing the potential of new crops and varieties requires trials, market research and transition support.

Limited access to reliable local weather information is a gap for most producers which impacts their ability to manage (proactively or in response to) variable conditions. Increasing the availability of weather data and forecasts would support producers with decisions regarding soil management, irrigation scheduling and pest treatments, and would support more accurate assessments around the suitability of new crops.

A critical strategy for adaptation is conducting local research to trial new crops or varieties and to evaluate how differing practices and technologies may strengthen resilience. Some producers are already undertaking applied research, but would benefit from additional research support and expertise, as well as improved communication channels for sharing results and/or exchanging information with other producers.

Relevant Climate Change Impacts

- Shifting precipitation patterns
- Increasing number of growing degree days
- Increasing frequency and intensity of extreme events

Variability is also anticipated to increase pest pressure in the region. As average annual temperatures increase, the ranges and prevalence of insect pests, diseases and invasive species are anticipated to shift. Climate change may result in an increase in the number and distribution of existing problem species, and may also result in new species becoming established in the region.[112] Improving locally relevant pest identification and management resources is a priority for producers in the region.

The strategies and actions in this section address the following ***adaptation goals:***

- ***Enhancing availability of data-driven resources to support adaptation***
- ***Supporting collaborative research on crop selection and farm practices***
- ***Strengthening knowledge transfer to limit the impacts of pests and invasive species***

Enhance weather data collection/analysis and availability of decision support tools

Access to real-time weather data (such as growing degree day accumulation) would enable farm planning and decision-making that are more responsive to local microclimates and actual conditions (rather than timing activities based on historical averages). Access to more precise weather data would also allow producers to better track how variable conditions are affecting their operations year over year (e.g., frequency of late spring frosts and hot summer temperatures).

At present the Farmwest website (www.farmwest.com) provides access to 5-day forecasts for 17 weather stations across the Kootenay & Boundary region. Not all of these stations measure variables of value to the agriculture sector (e.g., humidity, precipitation). In addition, there remain significant geographic gaps in coverage which are exacerbated by the microclimatic variability across the region. For example, there are four microclimate zones for tree fruits in Creston alone, and there is only one weather station in Creston.[113]

Improving the weather monitoring network also creates the potential to develop locally relevant decision support tools[114] which link to real-time weather station data. Some decision support tools can be found on the Farmwest website, but producers are interested in a greater diversity of these resources. Other relevant decision support tools already exist in BC and beyond but may require adaptation for the local context (e.g., the Okanagan BC Tree Fruit Decision Aid System, AgWeather Quebec).[115,116] There may also be opportunities to test/demonstrate tools that link to private (on-farm) weather stations (i.e., that would not require the establishment of a network of weather stations).

The BC Ministry of Agriculture, in partnership with the British Columbia Agricultural Climate Adaptation Research Network (ACARN), has completed a *Gap Analysis and Overview of Weather Station Data in British Columbia Agricultural Regions*, which includes an analysis of the Kootenay & Boundary region.[117] This research could inform a more in-depth assessment of the weather network coverage in the Kootenay & Boundary region. The BC Ministry of Agriculture has allocated funding to establish new weather stations across the province of BC and has approved a new station in Grand Forks that will link to Farmwest. Additional stations may be installed in the Kootenay & Boundary region through this initiative, although funding is limited.

Establishing and maintaining a weather station network is a significant undertaking that would require long-term collaboration, investment and effort, and partnering with existing initiatives will be vital to success. It will also be important to provide training and knowledge transfer about how to use the data and associated tools. Supporting education and training for existing extension agents, as well as sharing information through sector groups, would enable efficient transmission of information about new tools and resources.

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ACTION 3.1A **Expand weather station coverage and improve producer access to station data**	ACTION 3.1B **Develop decision support tools and resources linked to weather data**
▪ Complete an analysis of weather station coverage (identify existing station locations and utility to the agriculture sector) and identify monitoring gaps ▪ Evaluate options for linking with existing networks and/or establishing and maintaining a new network (e.g., administration, funding and maintenance) ▪ Share findings with agricultural organizations and regional partners and develop implementation plan ▪ Install new stations to fill critical gaps and make data available to producers	▪ Determine options for developing decision support tools that are relevant to agricultural needs (linked to expanded weather data network in ACTION 3.1A) and document costs of tool development and projected producer benefits. Tools may include: - Expanding the BC Tree Fruits Decision Aid System (BC DAS) Tool - Adapting/developing new tools for forage, hay and range management - Providing improved (localized) weather forecasting information ▪ Evaluate options (costs/benefits) for network/shared tools versus tools linked to private (on-farm) weather stations ▪ Develop prioritized tool(s) and resources and share them with producers

Support local research and demonstration for crop trials and farm management practices

Producers are adept at managing through challenging conditions and are constantly experimenting with new crops and farm practices. Local research is a valuable contributor to testing and evaluating practices, technologies and/or crops for the local context. There has been no formal long-term agricultural research in the region since AAFC closed their regional station 30 years ago. Results from farm-level research may prove valuable in assisting other producers in the region to adapt to increasing variability.

Many producers are eager to undertake research but require assistance and support to design and conduct trials and analyze results. The recently developed *Guide to On-Farm Demonstration Research* provides a structured approach for producers to develop a research question, gather data and analyze results.[118] Taking this work a step further, a project is underway (from 2019 to 2022) in the Kootenay & Boundary region to develop research templates (with accompanying Case Studies) for a range of commodities/research questions.[119]

The Kootenay & Boundary region is very diverse with respect to growing conditions and production types and research and demonstration interests/needs vary by location. Some examples of research interests include trialing new drought tolerant varieties, conducting season extension trials with high tunnels,[120] management intensive grazing and keyline design.

Sharing the results from producer-led (and other locally relevant) research could be facilitated through the development of a digital knowledge hub which could be hosted on an existing website. The hub could offer a forum for questions/answers to be shared, and for local research priorities to be established. Creating a digital knowledge hub could be relatively low-cost, but long-term success requires ongoing funding and administrative support, as well as collaboration and engagement from producer partners.

The Kootenay and Boundary Farm Advisors would be a strong local partner for all of the actions within this strategy. Other partners could include university researchers and students (e.g., University of British Columbia, Thompson Rivers University, Kwantlen Polytechnic University). College of the Rockies and Selkirk College also have some interest in agricultural research.

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ACTION 3.2A **Create a producer-led research network**	ACTION 3.2B **Develop an online producer knowledge hub**	ACTION 3.2C **Identify and undertake applied research to support innovative farm practices to mitigate risk from climate change impacts**
▪ Create an inventory of producer-led research currently underway ▪ Survey producers to identify research priorities ▪ Secure partnerships and develop a program or support system to assist producers with their farm research. Support may include: - providing in-person technical input in advance of and during trials - assisting with trouble shooting, data collection and analysis - hosting a 'farm-research bootcamp' - sharing the *Guide to On-Farm Demonstration Research* ▪ Coordinate knowledge transfer activities for producers to share their research/results	▪ Outline objectives and functional requirements of an online producer knowledge hub and identify possible partners. Objectives may include: - Sharing of research results - Linking producers wanting to do research with land - Seed sharing - Producer-to-producer knowledge exchange ▪ Establish, pilot and evaluate the knowledge hub ▪ Collaborate with partners and funders to develop a long-term administration and management plan	▪ Consult with the agriculture sector to prioritize research topics and/or create a regional producer research advisory body (link to producer-led research network in ACTION 3.2A if action completed) ▪ Conduct a scan of innovative management practices to assist producers in reducing impact of variable/extreme conditions such as: - Extended periods of wildfire smoke (e.g., impacts to light levels, air quality and temperature) - Protection from late spring/early fall frost - Worker and animal health during extreme heat ▪ Share scan results and assess local applicability including piloting and demonstrating practices (as needed) ▪ Conduct knowledge transfer (e.g., field days, fact sheets etc.)

Improve education and awareness for effective management of pests

(pests include insects, diseases, weeds and invasive species)

Climate change will shift the distribution and life cycles of insects, diseases, weeds and invasive species already present in the region (such as spotted wing drosophila and aster yellows) and may create conditions favourable for the establishment of new pests (such as brown marmorated stink bug which is currently found in the Okanagan).

Identifying the pests of greatest concern to agriculture and developing and/or disseminating resources for identification and effective management would minimize negative impacts to the sector and assist producers with making timely management decisions. Early detection of, and rapid response to, emerging pests can help to prevent establishment. A project completed in the Cariboo provides a methodology that could be applied to identification of priority pests, critical information gaps, and resource requirements for producers in the Kootenay & Boundary region.[121]

Knowledge transfer activities might include the development and delivery of fact-sheets, presentations, workshops and field days. There are also opportunities to develop new outreach mechanisms — such as a "pest-of-the-week" newsletter, enhanced pest-alerts[122] and/or expanding the coverage of weed/pest reporting apps[123] to cover the region.

There is demand from producers for Integrated Pest Management (IPM)[124] and improved information regarding biological and mechanical controls for pests and invasive species. Currently IPM adoption is most common among organic growers, growers selling for export (e.g., cherry producers) and producers selling into the retail market.[125] Generally, IPM information is difficult to access, or does not exist for the local context. Specific IPM topics of interest include:

- → providing/creating habitat for beneficial insects being introduced to farm;
- → managing soil health to reduce pest and invasive species pressure; and
- → understanding how the prevalence of certain weeds relates to soil health.

Invasive species are monitored and managed by each Regional District's invasive species organization. The Boundary Invasive Species Society, Central Kootenay Invasive Species Society and East Kootenay Invasive Species Council have robust education, training and outreach programs, although to date the agriculturally focused resources have been primarily for the forage sector.

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ACTION 3.3A **Determine economically significant pests/ emerging pests of concern to the agricultural sector**	ACTION 3.3B **Enhance producer knowledge of, and access to, pest and invasive species management information**	ACTION 3.3C **Provide knowledge transfer about biological/mechanical treatments for pests and invasive species**
▪ Utilize the methodology from *Priority Pests of the Cariboo-Chilcotin*; consult with agricultural organizations, regional invasive species groups and government agencies to: - Identify pests and invasive species of greatest concern to the agricultural sector - Assess existing programs and resources to determine transferability and identify gaps ▪ Adapt existing resources and (if needed) develop new resources to address knowledge gaps (as identified above)	▪ Share information about programs and cost-share supports (e.g., RDEK has a cost-share support program for invasive species management) ▪ Utilize resources (from ACTION 3.3A) to deliver knowledge transfer activities which may include: - Distributing fact sheets and other informational resources - Hosting presentations/ workshops/field days on pest and invasive species identification and management - Developing targeted promotional campaigns/ outreach (such as Pest Alerts, or Insect Week – where one pest is highlighted each week) - Working though existing channels (such as local agricultural newsletters and local agricultural meetings) to distribute information and resources	▪ Consult with producers to determine which pests and invasive species to focus on (build on results of ACTION 3.3A if completed) ▪ Identify biological and mechanical controls for priority pests and develop and share supporting resources with producers (may build on existing resources) ▪ Develop resources to enhance producer knowledge of the relationship between soil health (e.g., soil pH, nutrient deficiency) and pests

Impact Area 4: *Increasing risk of spring flooding*

Warming winter and spring temperatures are changing precipitation patterns (with less precipitation falling as snow and more falling as rain) and are causing earlier and more rapid snowmelt.[126] These factors, combined with projected increases in spring precipitation, are heightening the risk of flooding on land adjacent to large and small watercourses.

Flood risk in the Kootenay & Boundary region is most pronounced in the spring (although flooding can occur any time of year) and is most frequently caused by rapid melting of a thick snow pack, heavy rainfall and/or ice or debris jams.[127]

Areas that are deemed highly susceptible to flooding are designated as floodplains, and the region has the largest number of individual floodplains in British Columbia.[128] Much of the agricultural land in the region follows the valley floors and rivers, and is therefore vulnerable to flood events.

Producers need to be prepared for a range of flood scenarios from large-scale floods (as experienced on the Kettle and Granby Rivers in 2018), to site-specific floods along smaller watercourses. Addressing flood risk on agricultural land requires both farm-level and landscape-level planning and mitigation approaches. The Regional Districts have been proactive in undertaking research to better understand regional flood risk and risk mitigation (such as LIDAR floodplain mapping, debris flow management planning, evacuation route mapping) and in developing programs to support flood recovery (such as Boundary Flood Recovery).

Landscape-level flood mitigation is increasingly examining how to restore and enhance the role of natural green infrastructure (such as forests, riparian areas, floodplains and wetlands) to reduce/manage flood risk. Following the 2018 flood season, the City of Grand Forks (as part of their 2018 flood recovery efforts) has been particularly proactive in identifying areas that would benefit from natural green infrastructure installation or enhancement, including the restoration of floodplains and riparian areas.[129] There are opportunities to connect agricultural areas prone to flooding with existing regional initiatives, to implement green infrastructure projects and/or demonstration sites.

Relevant Climate Change Impacts

- Increasing winter and spring precipitation
- Increasing average temperatures (particularly in spring)
- Increasing frequency and intensity of precipitation events

At the farm level, riparian rehabilitation and the creation of riparian buffers can reduce the potential for inundation, washouts and erosion, as well as minimize the loss of productive land to flooding.[130] There are both local and provincial level resources and expertise available to provide support to producers with planning and undertaking riparian projects on private land.[131] However, even with these supports, agricultural landowners still face significant obstacles when planning and undertaking riparian projects including difficulty navigating the regulatory and permitting process and the financial burden of establishing and maintaining these areas.

The highly productive Creston Flats agricultural area is a former floodplain that is now protected by dikes on the Kootenay and Goat rivers.[132] However, this area is still at risk of flooding if dikes are overtopped or breached. The dikes are managed by several independent diking districts, and the agricultural sector would benefit from improved communication regarding planned maintenance and upgrades.

The strategies and actions in this section address the following ***adaptation goals:***

- ***Enhancing natural flood management infrastructure to mitigate flood risk***
- ***Reducing the impacts of flooding on agricultural lands and operations***

Slow and capture runoff through enhancement of small-scale green infrastructure

Green infrastructure refers to ecological systems, both natural and engineered, that act as living infrastructure. Natural green infrastructure (including forests, grasslands, wetlands, creeks and other waterways) supply valuable environmental services such as providing habitat for fish and wildlife, filtering of air and water pollutants and reducing run-off and associated flooding.[133]

As in many areas, the function and health of natural green infrastructure in the Kootenay & Boundary region has been compromised by human activities – particularly forestry – over the last century.[134] Restoration and rehabilitation of existing green infrastructure and installation of new green infrastructure (such as the establishment of small woody dams, rehabilitation and/or improvements to riparian zones and rehabilitation of floodplains) can slow and spread run-off while reducing flood risk.

Various research projects (led by the Regional Districts) are currently underway to help to improve baseline understanding of regional flood risk. RDCK is undertaking a regional flood risk assessment, including a gap analysis and a prioritized inventory of hazards across the region.[135] RDKB and the City of Grand Forks have completed flood risk assessments and flood recovery planning and identified sites in need of natural (and constructed) flood infrastructure improvements.[136] Opportunities exist to partner with these (and other) initiatives to incorporate an agricultural lens into current research and projects.

A scan of best practices for small-scale green infrastructure enhancements and an assessment of which options are best suited to the region (e.g., small woody dams, floodplain restoration, riparian zone rehabilitation) would be an important first step. Building on this work, identification of suitable small-scale pilot/demonstration locations could be followed by an assessment of feasibility, costs and potential for water storage (a valuable co-benefit for agriculture). Moving from the assessment phase into demonstration would require partnerships and strong local champions. It would also be important to collect baseline information at any new demonstration sites to enable evaluation of cost of installation/maintenance versus the extent of various anticipated benefits.

ACTION 4.1A **Identify suitable green infrastructure options and priority pilot areas**	ACTION 4.1B **Establish pilot site(s) and evaluate benefits**
▪ Complete a scan of best practices for small-scale green infrastructure enhancements and assess which options are best suited to region ▪ Conduct a vulnerability assessment to identify suitable pilot area(s) (with agricultural relevance) with potential for green infrastructure improvements/installations ▪ Quantify costs of infrastructure and benefits of proposed project(s) ▪ Convene relevant government agencies and agricultural partners to discuss pilot project options and to seek co-funding	▪ Building on ACTION 4.1A, work with local partners and government agencies to plan pilot projects, obtain necessary permits and authorizations ▪ Develop a monitoring and evaluation plan and collect baseline data before infrastructure installation ▪ Work with partners to install and maintain green infrastructure ▪ Evaluate project(s) and share the results with stakeholders (e.g., field tours, case studies)

Support knowledge transfer for effective management and enhancement of on-farm riparian areas

Healthy wetlands and riparian areas provide valuable flood-mitigation services to adjacent farmland and lessen the impacts of floods when they do occur. There are many initiatives and groups across the region that provide support to producers with riparian and wetland restoration/enhancement such as the Slocan River Streamkeepers, Salmo Watershed Streamkeepers Society, Granby Wilderness Society and the Farmland-Riparian Interface Stewardship Program (FRISP).

Even with these existing supports, undertaking improvements in riparian zones is labour and cost-intensive and any work completed, requires ongoing maintenance. The benefits to the private land-owner are not always clear. Often the value of riparian health is connected to providing habitat or environmental services, rather than to reducing flood risk to private land. It is important to fill this information gap by documenting/sharing the role of riparian and wetland restoration in flood protection.

Existing resources on riparian restoration could be synthesized and tailored for an agricultural audience and could integrate case studies, outline suitability of enhancements/practices for particular sites and provide practical information on permitting requirements. Utilizing demonstration sites to showcase how riparian projects are designed and installed could also support adoption. There are existing projects on farms in the area that may be candidates for demonstration. Opportunities to develop new demonstration sites (with strong local partnerships) may also exist.

Cost is frequently identified by producers as the biggest barrier to riparian and wetland enhancement and restoration (followed closely by legislative and/or permitting barriers). Addressing this barrier is critical to broader adoption and may include enhancing availability/accessibility of cost-benefit information and improving linkages to financial supports (e.g., Environmental Farm Plan and Beneficial Management Practices Program)[137]. Farmland Advantage (based in East Kootenay) has partnered with the Environmental Farm Plan Program on a five-year pilot project (in three regions including the Kootenays) to establish and monitor riparian demonstration sites to inform the development of a payment for ecosystem services model which could be more broadly implemented in the future.[138]

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ACTION 4.2A **Consolidate, create and share information on riparian management and enhancement**	ACTION 4.2B **Establish demonstration sites to facilitate knowledge transfer**	ACTION 4.2C **Develop/improve financial supports available for riparian enhancement**
▪ Undertake a scan to document existing resources (informational, technical, financial, local experts) and to identify resource gaps ▪ Tailor existing materials and/or develop new materials to communicate: - Climate change impacts to watercourses and potential for riparian areas to reduce flood impacts/mitigate risk - Costs and benefits of riparian enhancement - Different types of riparian projects (suitability, case studies, how-to) - Permitting requirements - Available cost-share supports and expertise - Farm management practices for riparian health ▪ Share resources broadly through local agricultural/community groups (e.g., at monthly meetings and AGMs, through workshops, webinars)	▪ Identify existing sites that could be used for demonstration and develop a shortlist of sites for new demonstration (may tie into ACTION 4.4B) ▪ Develop criteria and select suitable new sites for demonstration (if existing sites are not sufficient) ▪ Establish demonstration sites (documenting process/costs for knowledge transfer materials) and/or provide access to existing sites ▪ Evaluate impact of project(s) and quantify benefits ▪ Host field days and develop knowledge transfer materials (e.g., signage for sites, fact-sheets)	▪ Assess existing financial supports and identify gaps/challenges with obtaining financial support/cost-shares ▪ Identify opportunities to reduce cost-share barriers and enhance cost-share opportunities. Options may include: - Establishing a per-plant/tree cost share program (similar to Municipal Neighbourwoods[139] programs) - Incorporating planning for riparian enhancement/flood mitigation into farm business planning services - Improving access to education programs (e.g., subsidies for courses offered by the Wetlands Institute) ▪ Pilot a program – with local funders – to improve financial support for producers (based on results above)

Improve tools and resources for farm-level flood readiness

Various resources are distributed by the Regional Districts to encourage flood-readiness and emergency preparedness, as well as to provide seasonal updates on snowpack/flood conditions.[140] However, there are few informational materials that are specifically designed for agriculture. New agriculture and flood-focused resources are under development through CAI and will be available in 2020. There are also all hazard emergency planning guides available for some agricultural commodities in BC (e.g., dairy, cattle, pork).[141]

Reviewing and adapting existing farm-level preparedness resources (as needed) to suit the various local contexts within the region (e.g., Creston Flats, Boundary) is a first step. This process may focus primarily on how best to disseminate existing preparedness information, but may also incorporate locally specific considerations and support the development of supplemental (sub-regional) resources.

There are several flood related emergency planning activities taking place at the regional and municipal level and facilitating the agriculture sector's participation in existing initiatives would help to ensure that emergency response needs for the sector are identified and addressed. However, much of the responsibility for emergency preparedness falls to producers and it may be beneficial to support an agriculture-led initiative that encourages preparedness planning and identifies sector specific concerns related to flood-readiness planning, flood response and flood recovery (e.g., carcass disposal, obtaining feed for animals after damage to cropped land, supporting non-commercial / hobby producers with post-disaster assistance).

ACTION 4.3A Develop and/or distribute farm-level flood readiness resources

- Assess applicability of existing resources and adapt and/or develop new resources as needed
- If required, develop new resources to address links between flood risk and land and soils management decisions. Topics may include:
  - How climate change will impact flood risk
  - Examples of the positive benefits of flooding in restoring soil health
  - Riparian enhancement as flood mitigation practice (ties into Strategy 4.2)
- Provide active support for farm-level flood-readiness planning (e.g., workshops, webinars/videos, farm visits)
- Share flood readiness resources with producers (e.g., at agricultural organization AGMs and monthly meetings, workshops)

ACTION 4.3B Enhance integration of agriculture-specific issues into community-level emergency planning

- Identify key challenges/areas of concern for the agriculture sector relating to flood readiness, response and recovery
- Facilitate the agriculture sector's participation in community preparedness initiatives (municipal or regional district level) and/or develop an agriculture-led initiative including identification of agriculture specific concerns

Support a cooperative and consistent approach to dike management in the Creston Valley

Diking infrastructure along the Kootenay and Goat Rivers (comprised of dikes, control structures and pumps) has transformed the landscape of the Creston Flats and made farming possible on the former floodplain. The dikes are managed and maintained by several independently operated diking districts.[142] Producers with operations located on the Creston Flats are interested in ensuring that the dikes are being managed and maintained to withstand additional pressures from climate change, but do not have easy access to information about planned maintenance and improvements.

To support information sharing, a first step could be collecting and collating information on planned maintenance and improvements, and documenting diking district processes and procedures (highlighting similarities, differences and best practices). Recent work completed by the Lower Kootenay Band (Yaqan Nukiy) assessing the state of the dikes[143] could serve as a building block for this activity and reduce the necessary up front research. The results of this research could be shared through a collaborative forum with key stakeholders (producers, diking district representatives, Lower Kootenay Band, government agencies) to discuss research findings and to determine how to strengthen communication between producers and the diking districts. The forum could also serve as a venue to discuss the potential for increasing cooperation between the diking districts.

Improving riparian management practices along dike banks and set-backs could enhance the function of the dikes and reduce flood risk (from overtopping and breach), while the establishment of sediment ponds could help to reduce the need for dredging.[144] There is potential to strengthen riparian management practices along dikes, but this would require partnerships with land-owners and technical guidance regarding practices. Identifying the best riparian practices for dike banks and set-backs and undertaking an analysis to document the costs (e.g., cost of establishment, loss of productive land from larger dike set-back) and benefits (e.g., erosion control, sediment control, flood mitigation, environmental values) of practices would be an important first step in supporting improved practices.

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ACTION 4.4A **Support improved communication among diking districts and between diking districts and the agricultural sector**	ACTION 4.4B **Establish demonstration sites to encourage adoption of riparian management practices that enhance flood mitigation on dike banks and set-backs**
▪ Synthesize and compile existing information on the current condition of dikes and planned dike upgrades and maintenance ▪ Undertake an assessment of processes and procedures for dike management across the diking districts in the Creston region – documenting differences, similarities and best practices ▪ Convene key stakeholders to share results of the assessment and facilitate dialogue about: - Opportunities to improve communication with the agriculture sector - Development of a common approach for dike management - Creation of a joint body (with one representative per diking district) to facilitate collaborative dike management and fundraising	▪ Undertake a scan of riparian practices to improve marginal land along dikes and to prevent dike erosion (e.g., riparian plantings, sediment ponds, larger set-backs) ▪ Conduct an analysis to calculate the costs and benefits of potential riparian management practices ▪ Identify and establish demonstration site(s) and conduct evaluation of project(s) ▪ Provide knowledge transfer to support adoption of improved riparian practices along dikes (e.g., signage, tours, fact-sheets, how-to workshops)

Implementation & Monitoring

While all of the actions contained in this plan are important for the Kootenay & Boundary region agriculture sector to adapt to climate change, the actions on the following pages are identified as "next steps." This is due to their importance and may also reflect their relative ease of implementation or their potential to build capacity for further adaptation actions (see text box on this page). Building momentum and capacity for collective action, and addressing the most important issues, will help to ensure implementation of all of the identified actions.

As the final stage in plan development, an implementation meeting was held with key partners (25 individuals) to prioritize actions and determine how to move them forward. The input received at this meeting informs the content below.

In some cases, multiple actions have been merged into single projects because this is the most effective and efficient way to accomplish them. Implementation considerations, such as potential partners and cost range, are identified for each of the next steps.

In order to move forward with project implementation, members of the Advisory Committee that supported the development of this plan will transition into a local working group to oversee implementation and monitor progress. This group will continue to include agricultural organizations, local government and provincial government representatives. The Climate Action Initiative will function as the overall coordinator for this group and will also lead project development and assist with monitoring progress and reporting.

For each Action in the Next Steps below, potential partners are identified. Potential partners were determined through workshops and subsequent draft development, but no formal commitments have been made regarding roles in various strategies and actions. Development of partnerships will be a preliminary activity in project development.

- ***Important*** actions are those that address the highest priority impacts or critical gaps for building resilience.
- ***Ease of implementation*** refers to actions that can be initiated without delay because there is a window of opportunity, there are clear co-benefits with other actors or programs, or there are minimal barriers to address. These actions can also create momentum to help move more difficult or longer-term actions forward.
- ***Capacity building*** actions support the sector by strengthening the ability of producers and producer organizations to take effective action. This may include filling knowledge gaps or developing resources that strengthen the ability to act collectively or individually.

Next Steps for ACTIONS 1.1A & 1.1C

Actions

→ ***Develop resources to improve water use efficiency and communicate benefits of water conservation.***

→ ***Provide knowledge transfer for practices to maintain/enhance soil moisture.***

Implementation details

- Initial phase will involve a scan to identify types of irrigation/water management practices being employed and opportunities for improvement
- Resources will need to be tailored for different agricultural production systems and the local context
- Knowledge transfer should include multiple channels (e.g., demonstration, field days, videos, fact-sheets)
- Identify opportunities to support producers (through knowledge transfer/collaboration) with acquisition of necessary equipment/infrastructure and/or inputs (e.g., sharing woodchips and compost)
- Topics of interest include:
  - Organic practices for soil moisture preservation: cover crops, green manures, row mulch and supplements
  - Impact of weeds on water availability for crops
  - Tools to capture, slow and sink water
  - Irrigation design
  - Optimizing water use for crop type
  - Costs of overwatering

Potential partners

- Agricultural organizations
- BC Ministry of Agriculture
- Kootenay and Boundary Farm Advisors
- Post-secondary institutions (e.g., Selkirk College, College of the Rockies, UBC, Kwantlen)
- BC Institute of Agrologists

Timeframe

- First project (scan and initial knowledge transfer resources/ activities) = Short term (LESS THAN 2 YEARS)
- Multiple projects = Medium-term (2–4 YEARS)

Cost

- First project = Medium ($50,000–$100,000)
- Multiple projects = High ($100,000+)

Next Steps for ACTION 1.2B

Actions

→ ***Strengthen availability of technical, regulatory and economic information on development/ enhancement of on-farm/ranch water storage.***

Implementation details

- First step is to identify and document water storage needs (e.g., types of storage, vulnerable production systems, areas with greatest need, producer interest, costs and benefits)
- Explore opportunities to partner with existing resource people/ groups to pilot water storage field support (e.g., Kootenay and Boundary Farm Advisors)
- Knowledge gathered by 'water management advisor ' after first year can inform development of resources.
- Can link knowledge transfer with ACTIONS 1.1A and 1.1C

Potential partners

- Agricultural organizations
- BC Ministry of Agriculture
- BC Ministry of Environment
- Regional Districts and local governments
- First Nations
- Kootenay and Boundary Farm Advisors
- Kettle River Watershed Planning team

Timeframe

- Medium-term (2–4 YEARS)

Cost

- Medium ($50,000–$100,000)

Next Steps for ACTIONS 2.1A & 2.1B

Actions

→ ***Encourage adoption of farm-level wildfire planning preparedness tools and resources.***

→ ***Develop a wildfire communication protocol to guide communication between response agencies and producers.***

Implementation details

- Explore options for linking preparedness support/information into existing events (e.g., Columbia Basin Agricultural Forum, South-East PREOC Emergency Preparedness Workshops)
- Provide additional resources (beyond workshops) for farm-level preparedness planning (e.g., farm visits, videos)
- Ongoing follow-up/support for farm-level planning would result in completion of more plans
- Communication protocol priorities include: Incorporating an agricultural liaison into the Emergency Operation Centres (EOCs), streamlining the permitting and re-entry process for producers and developing a mechanism for producers to share their farm-level preparedness plans back with the Regional Districts

Potential partners

- Agricultural organizations
- BC Ministry of Agriculture
- BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (Range staff and BC Wildfire Services)
- First Nations
- Partners in Protection Canada (FireSmart Program)
- Kootenay and Boundary Farm Advisors
- Columbia Basin Trust
- Regional Districts and local governments
- Emergency Management BC

Timeframe

- Farm-level preparedness planning = Short-term (LESS THAN 2 YEARS)
- Developing and piloting a communication protocol = Short-term (LESS THAN 2 YEARS)

Cost

- Farm-level preparedness planning = Low (LESS THAN $50,000)
- Developing and piloting a communication protocol = Medium ($50,000–$100,000)

Next Steps for ACTION 3.1A

Action

→ ***Expand weather station coverage and improve producer access to station data.***

Implementation details

- Two phases are required – first phase is coverage and gap assessment/feasibility analysis, second phase is securing partnerships and establishing weather network
- Phase 1 (assessment) can build on recent provincial weather network assessment by Agriculture Climate Adaptation Research Network (ACARN) and Environment and Climate Change Canada/Canadian Centre for Climate Services
- This project could link into Farmwest and the BC Ministry of Agriculture's weather network expansion initiative, and could partner with technical colleges to hire students to check and maintain stations.
- Phase 2 (establishing a network) will be dependent on securing strong partnerships and funding. The strength of these partnerships (and geographic concentration of agricultural operations) may necessitate the establishment of sub-regional networks (e.g., Creston area).

Potential partners

- Agricultural organizations
- BC Ministry of Agriculture
- Other government agencies (which maintain weather stations)
- Regional Districts and local governments
- First Nations
- Farmwest
- Growers' Supply
- Post-secondary institutions

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Timeframe

- Assessment = Short-term (LESS THAN 2 YEARS)
- Establishing network = Medium-term (2–4 YEARS)

Cost

- Assessment = Low (LESS THAN $50,000)
- Establishing network = Medium ($50,000–$100,000; will require partner funding)

NEXT STEPS FOR ACTION 3.2C

Action

→ ***Identify and undertake applied research to support innovative farm practices to mitigate risk from climate change impacts.***

Implementation details

- Begin with identifying commodities at greatest risk of negative impacts, impacts of greatest concern (e.g., wildfire smoke, pollinator populations, extreme heat, farm activity timing), along with suitable technologies/practices
- Develop case studies and pilots to demonstrate and evaluate technologies and practices (including cost-benefit analysis) directed at highest risk commodities identified above
- Knowledge transfer will be vital to success; work through local channels/champions (producers, Kootenay and Boundary Farm Advisors) to share findings

Potential partners

- Agricultural organizations
- Producers
- BC Ministry of Agriculture
- BC Agricultural Climate Adaptation Research Network
- Kootenay and Boundary Farm Advisors
- Post-secondary institutions
- Kootenay Permaculture Institute
- Agricultural supply/seed companies

Timeframe

- Assessment = Short-term (LESS THAN 2 YEARS)
- Piloting and demonstration = Medium-term (2–4 YEARS)

Cost

- Assessment = Low (LESS THAN $50,000)
- Piloting and demonstration = Medium ($50,000–$100,000)

Next Steps for ACTIONS 4.1A

Action

→ ***Identify suitable green infrastructure options and priority pilot areas.***

Implementation details

- It will be important to tie-into existing initiatives (e.g. green infrastructure planning/projects with Regional Districts) to keep costs down and to build partnerships for projects
- Metric of success would be improving consideration for/ understanding of agricultural values when planning green infrastructure projects
- Moving from the assessment phase (identifying suitable green infrastructure options for the region) into establishing green infrastructure projects is dependent on strong local partnerships and co-funding

Potential partners

- Agricultural organizations
- Producers
- BC Ministry of Agriculture
- BC Ministry of Environment
- Regional Districts and local governments
- First Nations
- Selkirk College Rural Development Institute and GIS department
- Local streamkeeper societies
- BC Wildlife Federation
- Ducks Unlimited
- Creston Valley Wildlife Authority
- Creston Wildsight Society

Timeframe

- Assessment = Short-term (LESS THAN 2 YEARS)
- Piloting and demonstration = Medium-term (2–4 YEARS)

Cost

- Assessment = Low (LESS THAN $50,000)
- Piloting = Low (LESS THAN $50,000; will require partner funding)

Next Steps for ACTION 4.2C

Action

→ ***Develop and improve financial cost-share supports for riparian enhancement.***

Implementation details

- In-kind support (for project design, implementation) can serve as an important cost-share support and should be included in analysis
- There are many strong local riparian enhancement groups who can provide support and expertise
- Look to reduce permitting burden by building strong relationships with government agencies

Potential partners

- BC Ministry of Agriculture
- BC Ministry of Environment
- Regional Districts and local governments
- First Nations
- Local streamkeeper societies
- BC Wildlife Federation
- Ducks Unlimited
- Credit unions
- Columbia Basin Trust

Timeframe

- Medium-term (2–4 YEARS)

Cost

- Medium ($50,000–$100,000)

Appendix A: Weather, Climate & Variability

Weather is what happens on a particular day at a particular location. Farmers are continually required to adapt to weather conditions to effectively plan and manage their businesses. In contrast, climate refers to long-term trends, patterns and averages over time. These are more difficult to notice through day-to-day or year-to-year experiences, or short-term records of weather. However, over a period of decades, recorded observations can characterize the climate and identify trends.

Anyone who pays close attention to weather forecasts appreciates that predictions of weather are often limited in their accuracy. This is partly because of the many factors that impact weather. Turning to longer, climate-related timescales, in BC we are familiar with the 3–7 year cycles of El Niño and La Niña ("ENSO"), which dramatically impact the climate of individual seasons and years (see Figure 5). Compared to La Niña years, conditions in BC during El Niño years are typically warmer and drier in winter and spring, and less stormy in southern BC.

Adding to the complexity, the Pacific Decadal Oscillation (PDO) is a known pattern that shifts over longer time periods (20 to 30 years) and this is associated with different temperature and precipitation conditions here in BC. It also has a warm and cool phase, and so it can either enhance or dampen the impacts of El Niño and La Niña conditions in a given year.

Figure 5 shows the difference between climate variability, oscillations, and climate change. The many factors that impact the weather create significant variation in what we experience from year to year. However, we are still able to chart averages over long periods of time.

For additional resources see *BC Agriculture Climate Change Adaptation Risk & Opportunity Assessment Series* (*https://bcagclimateaction.ca/regional/risks-opportunities/*) and Pacific Climate Impacts Consortium video *Climate Insights 101: BC Climate Impacts and Adaptation: The Climate of British Columbia* (*https://pics.uvic.ca/insights/bc-regional-climate-impacts-adaptation/M2L1_SEPT23_2014/player.html*).

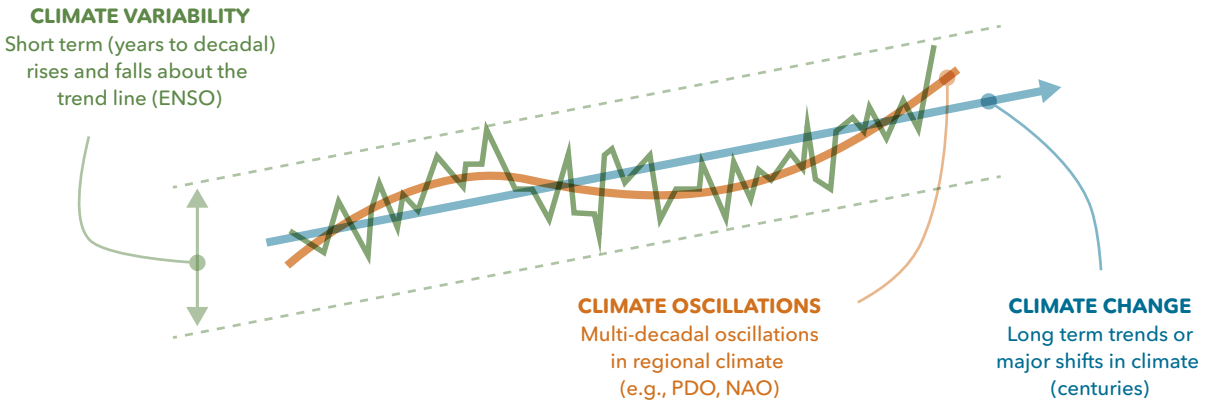

FIGURE 5 Climate Variability, Oscillations & Change

Diagram showing difference between climate variability, oscillations, and climate change. Adapted from original, courtesy of Pacific Climate Impacts Consortium, www.pacificclimate.org

Appendix B: Future Projections: Climate Maps & PCIC Tables

Table 2 Kootenay & Boundary Region Climate Projections — 2020s
(Source: Pacific Climate Impacts Consortium, *www.pacificclimate.org*)

Climate Variable	Time of Year	Projected Change from 1971–2000 Baseline to 2020s			Kootenay and Boundary (Baseline)
		Kootenay and Boundary (Range)	Kootenay and Boundary (Average)	BC (Average)	
Mean Temperature (°C)	Annual	+1.0 °C to +2.1 °C	+1.6 °C	+1.0 °C	2.5 °C
Precipitation (%)	Winter	–3% to +14%	+4.4%	+8%	286 mm
	Spring	–2% to +11%	+4.6%	+6%	231 mm
	Summer	–16% to –1%	-7.6%	+2%	213 mm
	Fall	–6% to +7%	+1.6%	+6%	268 mm
Growing Degree Days (degree days)	Annual	+147 to +365	+266	+153	969
Frost Free Days (days)	Annual	+15 to +34	+24	+10	155
Growing Season Length (days)	Annual	+12 to +26	+19	n/a	148

Table 3 Kootenay & Boundary Region Climate Projections — 2050s
(Source: Pacific Climate Impacts Consortium, *www.pacificclimate.org*)

Climate Variable	Time of Year	Projected Change from 1971–2000 Baseline to 2050s			Kootenay and Boundary (Baseline)
		Kootenay and Boundary (Range)	Kootenay and Boundary (Average)	BC (Average)	
Mean Temperature (°C)	Annual	+1.9 °C to +4.4 °C	+3.2 °C	+1.8 °C	2.5 °C
Precipitation (%)	Winter	–1% to +13%	+7%	+9%	286 mm
	Spring	0 to +19%	+12%	+15%	231 mm
	Summer	–33% to +2%	-12%	–1%	213 mm
	Fall	–1% to +15%	+7%	+17%	268 mm
Growing Degree Days (degree days)	Annual	+323 to +824	+580	+283	969
Frost Free Days (days)	Annual	+39 to +63	+49	+20	155
Growing Season Length (days)	Annual	+24 to +53	+39	n/a	148

TABLE 4 Kootenay & Boundary Region Sub-Regional Baseline
(SOURCE: Pacific Climate Impacts Consortium, *www.pacificclimate.org*)

Climate Variable	Time of Year	Invermere	Cranbrook	Creston	Slocan Valley	Grand Forks
Mean Temperature (°C)	Annual	5.2 °C	5.3 °C	7.3 °C	3.1 °C	7.5 °C
Precipitation (mm)	Winter	79 mm	119 mm	192 mm	394 mm	150 mm
	Spring	83 mm	111 mm	156 mm	302 mm	139 mm
	Summer	144 mm	146 mm	133 mm	234 mm	125 mm
	Fall	89 mm	120 mm	169 mm	368 mm	117 mm
Growing Degree Days (degree days)	Annual	1,547	1,493	1,773	1,015	1,910
Frost Free Days (days)	Annual	182	184	220	169	214
Growing Season Length (days)	Annual	194	191	210	153	212

TABLE 5 Kootenay & Boundary Region Sub-Regional Climate Projections — 2050s
(SOURCE: Pacific Climate Impacts Consortium, *www.pacificclimate.org*)

Climate Variable	Time of Year	Invermere	Cranbrook	Creston	Slocan Valley	Grand Forks
Mean Temperature (°C)	Annual	+3.2 °C	+3 °C	+3.1 °C	+2.9 °C	+3.2 °C
Precipitation (mm)	Winter	+8%	+6%	+6%	+6%	+11%
	Spring	+13%	+12%	+11%	+11%	+16%
	Summer	–9%	–11%	–13%	–14%	–19%
	Fall	+7%	+4%	+6%	+8%	+9%
Growing Degree Days (degree days)	Annual	+688	+694	+753	+595	+756
Frost Free Days (days)	Annual	+47	+51	+61	+49	+56
Growing Season Length (days)	Annual	+32	+36	+40	+37	+34

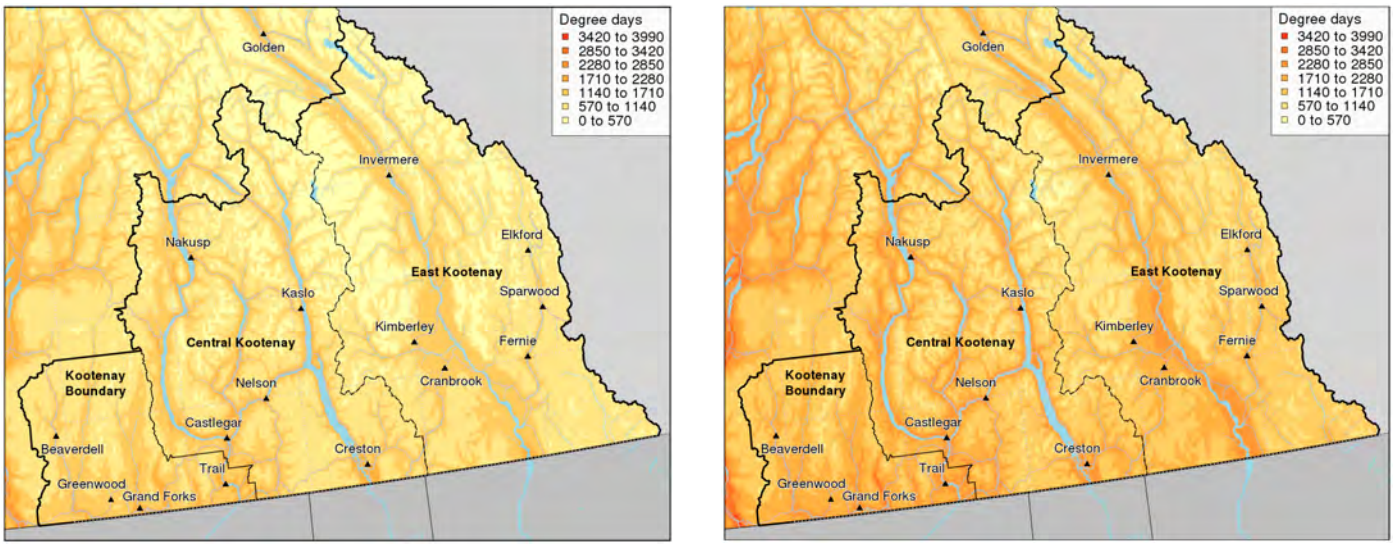

FIGURE 6 Growing Degree Days,
Baseline 1971–2000 (left) and Projections 2041–2070 (right)

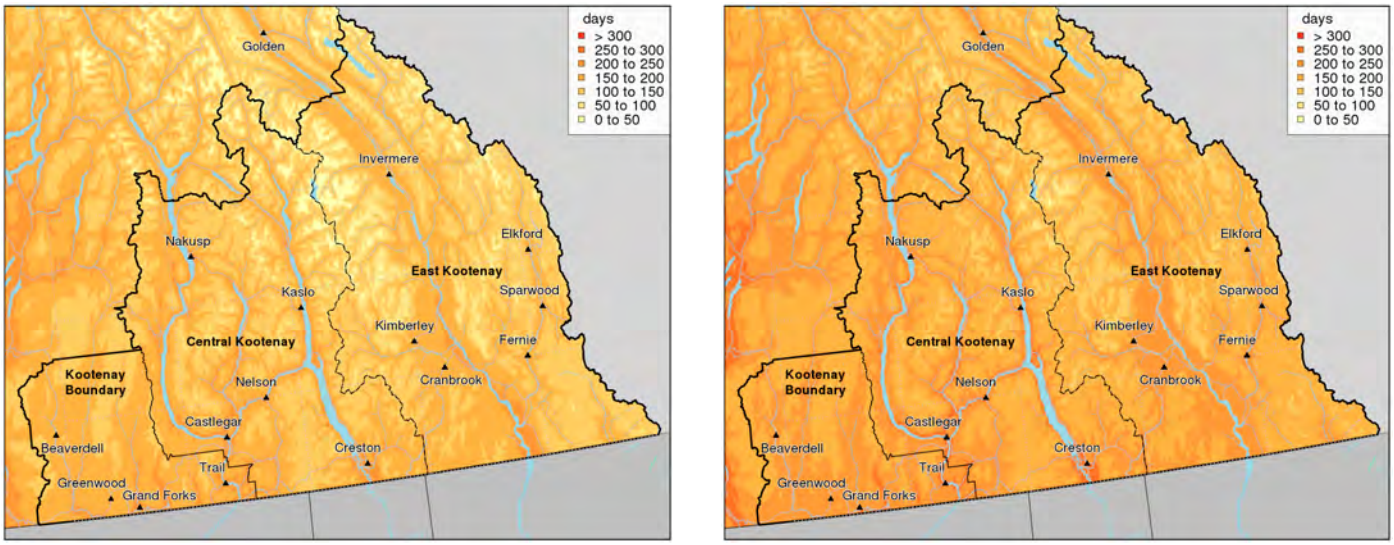

FIGURE 7 Growing Season Length,
Baseline 1971–2000 (left) and Projections 2041–2070 (right)

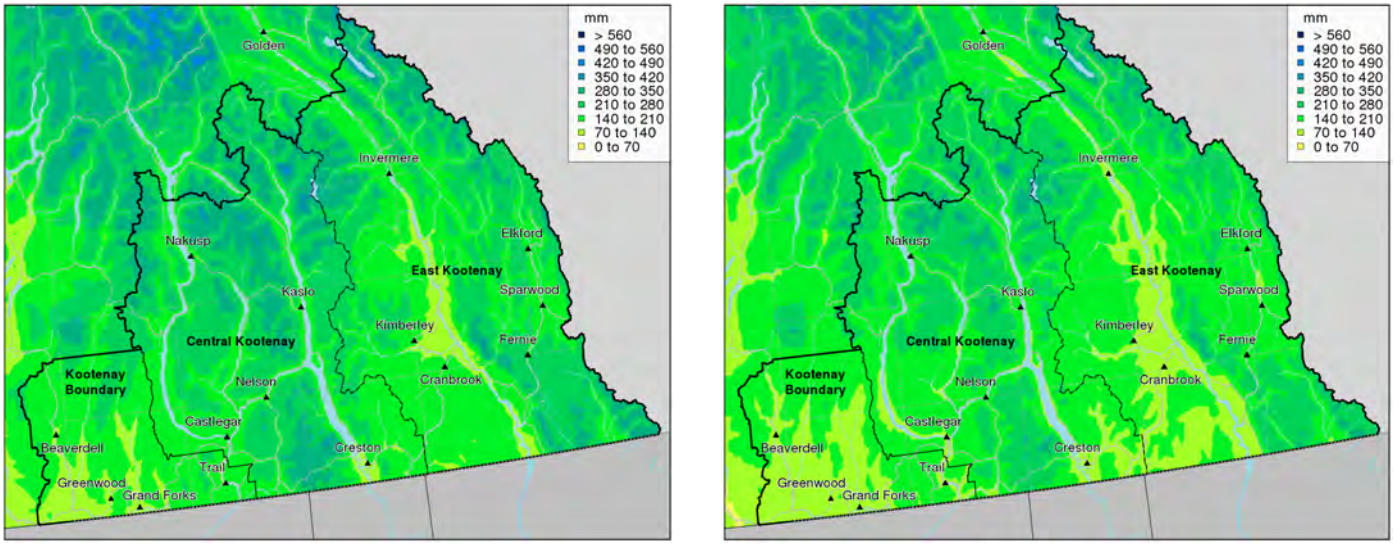

FIGURE 8 Summer Precipitation (mm), Baseline 1971–2000 (left) and Projections 2041–2070 (right)

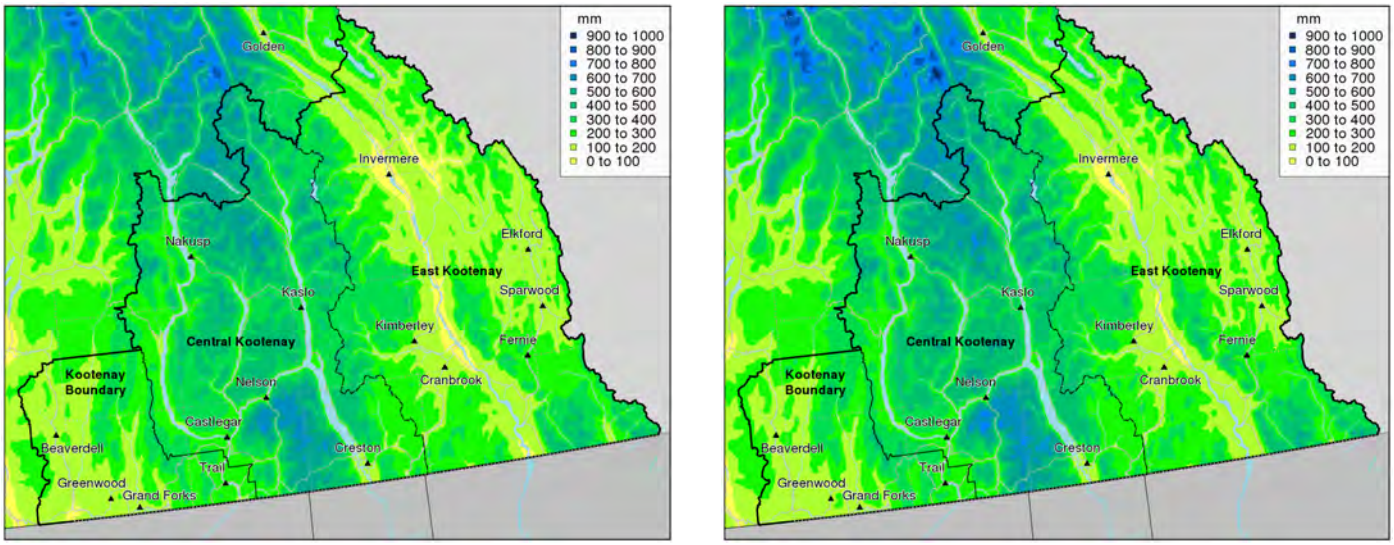

FIGURE 9 Winter Precipitation (mm), Baseline 1971–2000 (left) and Projections 2041–2070 (right)

Note that for legibility, winter and summer use different legends and so cannot be directly compared.

Appendix C: Definitions

- ***Annual Average Temperature***
  refers to the average of the nighttime low (minimum temperature) and the daytime high (maximum temperature) over a calendar year.

- ***Frost-Free Days (FFD)***
  refers to the number of days (in a calendar year) that the minimum daily temperature stayed above 0°C.

- ***Growing Degree Days (GDD)***
  are a measure of heat accumulation and represent the cumulative number of degrees that the average daily temperature is above a base temperature of 5°C, for all days of the year.

- ***Growing Season Length (GSL)***
  represents the number of days between the first span of six consecutive days with a daily mean temperature above 6°C and the last day with a daily mean temperature above 6°C.

- ***Heavy rain days (i.e., the 95th percentile wettest days)***
  represents the total amount of rain that falls on the wettest days of the year, specifically on days when precipitation exceeds a threshold set by the annual 95th percentile of wet days during the baseline period (1971–2000).

- ***Historic Baseline***
  is the average of the variable from 1971 to 2000 (variables are averaged over this 30-year period to smooth out annual variability).

- ***1-in-20 hottest day***
  refers to a day so hot that it has only a one-in-twenty chance of occurring in a given year. That is, there is a 5% chance in any year that temperatures could reach this magnitude.

Appendix D: Adaptive Management of Climate Change Impacts

Climate change adaptation decision-making is an inherently complex task that requires ongoing learning and reflection to adjust to changing information, events and conditions. As learning progresses, new solutions as well as new challenges will be identified. The following questions are provided as tools for navigating this evolving landscape and determining priorities for action.

Additional considerations when determining how to implement priority actions would include:

- Barriers (e.g., legislation, lack of working relationships)
- Assets/Enablers (e.g., leadership, integrating into existing plans/programs)
- Implementation costs
- Operation and maintenance costs
- Financing and resources
- Timeframe

Table 6 Developing & Prioritizing Adaptation Actions

Effectiveness	To what degree does this action reduce risk/vulnerability, and/or enhance resilience?
Adaptability	Can this action (and resources dedicated to it) be changed or redirected as conditions change?
Urgency	When does action need to be taken on this issue, in order to be effective by the time an impact is projected to occur?
Gaps & Assets	How does this action address identified gaps or barriers? How can it build on existing assets and resources?
Co-benefits ("no-regrets")	What other benefits would this action have, even if climate change impacts do not occur as projected?
Consequences	What could be the unintended and/or undesirable effects of taking this action? Can these be avoided or mitigated?
Extent	Do the benefits apply broadly in the region, or to specific individuals?
Relevance	Does this action have the support of the agricultural community?

Endnotes

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Regional District of East Kootenay. *https://rdek.bc.ca/about/board_of_directors/*

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7 See Table 4 in Appendix B for baseline information on sub-regional variability.

8 Climate projections for the Kootenay & Boundary region provided by Trevor Murdock and Steve Sobie at the Pacific Climate Impacts Consortium.

9 Based on review of historic seasonal precipitation patterns for Invermere, Cranbrook, Creston, Slocan Valley and Grand Forks. Data provided by the Pacific Climate Impacts Consortium and additional information and links to data available in Appendix B.

10 Climate projections for the Kootenay & Boundary region provided by Trevor Murdock and Steve Sobie at the Pacific Climate Impacts Consortium.

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27 Farm Credit Canada (2018) *FCC Farmland and Values Report.* *https://fcc-fac.ca/fcc/about-fcc/reports/2018-farmland-values-report-e.pdf*

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29 Some of these local food initiatives include the Central Kootenay Food Policy Council, Cranbrook Food Action Committee, Fields Forward, Wildsight, as well as numerous food co-ops (Kootenay Co-op, Kettle Valley Food Co-op)

30 *https://bcfarmersmarkettrail.com/markets/?region=kootenay-rockies*

31 32% have farm gates sales/u-picks, 12% use farmer's markets and 2% participate in Community Supported Agriculture. More information can be found in the 2016 *Agriculture In Brief: Kootenays*. *https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/statistics/census/census-2016/aginbrief_2016_kootenay_region.pdf*

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35 The Kootenay and Boundary Farm Advisors (KBFA) provides producers with free, technical production support and information from a network of specialized resources, including independent consultants and academics. KBFA supports producers to improve agricultural production and efficiency by helping find solutions to farm-specific production issues, coordinating educational events and connecting producers to information. Visit *https://kbfa.ca* for more information.

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73 For a detailed explanation, see the presentation by Trevor Murdoch from the Pacific Climate Impacts Consortium at *https://youtu.be/EqV9-jgFFeg* (21 minute mark).

74 Annual average temperature refers to the average of the nighttime low (minimum temperature) and the daytime high (maximum temperature) over a calendar year.

75 The historic baseline (used for all climate variables) is the average of the variables from 1971 to 2000. Variables are averaged over this 30-year period to smooth out annual variability.

76 Frost-free days is a derived variable referring to the number of days that the minimum daily temperature stayed above 0°C, useful for determining the suitability of growing certain crops in a given area. The method used to compute this on a monthly basis is from (Wang et al, 2006).

77 Growing Degree-Days (GDDs) is a derived variable that indicates the amount of heat energy available for plant growth, useful for determining the growth potential of crops in a given area. It is calculated by multiplying the number of days that the mean daily temperature exceeded 5°C by the number of degrees above that threshold. For example, if a given day saw an average temperature of 8°C (3°C above the 5°C threshold), that day contributed 3 GDDs to the total. If a month had 15 such days, and the rest of the days had mean temperatures below the 5°C threshold, that month would result in 45 GDDs.

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85 Statistics for irrigated areas can be found in the Agricultural Land Use Inventories for the Central Kootenays and East Kootenays (Elk Valley, Columbia Valley and Central Region), and in the 2016 Agriculture in Brief profile for Kootenay and Boundary.

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94 Government of British Columbia. (2019). Blog Post #24 — *Proposed Livestock Watering Regulations.* *https://engage.gov.bc.ca/watersustainabilityact/2018/01/12/blog-post-24-proposed-livestock-watering-regulations-what-do-you-think/*

95 van der Gulik, T., Neilsen, D., Fretwell, R. (2013). *Agriculture Water Demand Model: Report for the Kettle Watershed* and van der Gulik, T., Tam, S. (2017). *Agriculture Water Demand Model: Report for Regional District of Central Kootenay*.

96 BC Agriculture & Food Climate Action Initiative. (2018). *Okanagan – Vineyard Water Metric Toolkit* (excel). *https://www.bcagclimateaction.ca/project/ok04/*

97 Jason McDiarmid, Utility Services Manager, Regional District of Central Kootenay, email communication, April 10, 2019.

98 Environmental Farm Plan. (2019). *Canadian Agricultural Partnership Beneficial Management Practices List 2019/20*. *http://ardcorp.ca/wp-content/uploads/2019/04/2019-2020-BMP-List-Final.pdf*

99 Citizen science is defined as scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions. Examples of Canadian Citizen Science projects can be found at *http://science.gc.ca/eic/site/063.nsf/eng/h_97169.html*

100 The cumulative effects framework is a set of policies, procedures and decision-support tools that helps identify and manage cumulative effects consistently and transparently across British Columbia's natural resource sector. The framework incorporates the combined effects of all activities and natural processes into decision-making to help avoid unintended consequences to identified economic, social and environmental values (such as impacts to aquatic ecosystems, which includes water quality and quantity). Government of BC. (2019). *Cumulative effects framework*. *https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/cumulative-effects-framework* and Provincial Aquatic Ecosystems Technical Working Group – Ministries of Environment and Forests, Lands and Natural Resource Operations. (2017). *Interim Assessment Protocol for Aquatic Ecosystems in British Columbia*. *https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/cumulative-effects/interim_aquatic_ecosystems_protocol_dec2017_v11_final.pdf*

101 Wildfire Season Summaries (dating back 10 years) are available on the BC Wildfire Services website. *https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-history/wildfire-season-summary*

102 Based on review of Wildfire Season Summaries for the Kootenay region on the BC Wildfire Services website.

103 Lee, J. (June 26, 2016). Rock Creek slow to rebuild after last summer's devastating wildfire. *Vancouver Sun*. *https://vancouversun.com/news/local-news/rock-creek-slow-to-rebuild-after-last-summers-devastating-wildfire*

104 Information on the pilot project Wildfire Pre-Season Communications and Information Exchange Pilot Project can be found at *https://bcagclimateaction.ca/project/ok09/*.

105 The Air Quality Health Index (AQHI) provides hourly air quality readings and related health messages to report on the health risks posed by a mixture of pollutants, including smoke. For more information visit *https://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-quality/aqhi*. Data analyzed for Castlegar and Cranbrook stations from the *Air Quality Monitoring: Verified Hourly Data* data catalogue.

106 The BC Agriculture & Food Climate Action Initiative's *Agriculture Wildfire Preparedness and Mitigation Workbook & Guide* leads producers through a series of modules that focus on actions producers can take before, during, and after a wildfire to protect their operations and business and helps them to develop an Agriculture Wildfire Plan. The workbook and guide can be downloaded at *https://bcagclimateaction.ca/wildfire*

107 In winter 2019, the BC Agriculture & Food Climate Action Initiative hosted ten provincial workshops focused on farm-level wildfire preparedness and planning (including workshops in Cranbrook, Creston and Greenwood). The BC Cattlemen's Association, in conjunction with AgSafe BC, also hosted a series of farm-level preparedness workshops across BC in winter 2018.

108 Blackwell, B. (2018). *Discussion Document: Planning and Information Exchange for Wildfire Impact Reduction*. BC Agriculture & Food Climate Action Initiative.

109 A list of woodlot licencees for the province of British Columbia can be found at *https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/timber-tenufes/woodlots/issued_woodlot_licences.pdf*. More information about the woodlot licence program is available at *https://www2.gov.bc.ca/gov/content/industry/forestry/forest-tenures/timber-harvesting-rights/woodlot-licence*.

110 The Community Resiliency Investment (CRI) program was introduced by the government of British Columbia in 2018. It is intended to reduce wildfire risks and wildfire impacts in communities by providing funding and support to complete FireSmart initiatives, including priority fuel management activities on provincial Crown land and on private land. Information about the Community Resilience Investment Program can be found at *https://www2.gov.bc.ca/gov/content/safety/wildfire-status/prevention/crip*.

111 Burning embers or other flaming material from a wildfire can be carried by the wind to start new spot fires in areas of unburned fuel. It's quite common for burning embers that are thrown ahead of the leading edge of the fire (the "flame front") to allow wildfires to "jump" fuel-free barriers such as highways or bodies of water. FireSmart BC. *https://firesmartcanada.ca/resources-library/manuals/*

112 Xiang, Tao., and Chaya, Mona. (2019). *Climate change exacerbates the challenge of plant pests*. Foodtank: the Think Tank for Food. *https://foodtank.com/news/2019/03/climate-change-exacerbates-the-challenge-of-plant-pests/*

113 Duane Holder, horticulture consultant, personal communication, April 9, 2019.

114 Decision support tools (DSTs) are information technology resources designed to help farmers tackle complex problems in crop production, inputting the best available data combined with knowledge about best practices.

115 The BC Decision Aid System (BC DAS) is an example of a transferable tool that links data from 27 weather stations in the Okanagan, along with weather forecast data and pest models, to predict pest emergence timing for fruit crops. The tool has a clear, simple interface and links to conventional and organic management recommendations. *https://www.oksir.org/bcdas/*

116 AgWeather Quebec (AQ) provides dozens of bioclimatic models that help producers determine the best time to apply inputs to their fields (pesticides, fungicides, etc.), depending on the specific climate conditions in their area. AQ also provides a management tool for to hay producers to help them determine the best time for the first cut of hay to ensure optimal forage quantity and yield. *http://www.agrometeo.org/indices/category/plantes_fourrageres*

117 Tam, S., Anslow, F. (2018). *Gap Analysis and Overview of Weather Station Data in British Columbia Agricultural Regions*. British Columbia Agricultural Climate Adaptation Research Network. *https://www.bcacarn.com/weather-station-project/*

118 *A Guide to On-Farm Demonstration Research* includes step-by-step instructions on developing research objectives and formulating a research question, deciding what to measure and how to measure it, scouting for relevant research, collecting data and analyzing results. While developed for forage producers, the methodology can be applied to any production system. *https://bcagclimateaction.ca/documents/FI03-On-Farm-Demonstration-Research-Guide.pdf*

119 Information on the project Enabling Climate Change Adaptation through Grab & Go On-Farm Research Templates can be accessed at *https://bcagclimateaction.ca/project/fi19/* .

120 Information on the Farm Adaptation Innovator project Adapting to Low Light Growing Conditions Using High Tunnel Structures can be found at *https://bcagclimateaction.ca/project/fi14/* .

121 This CAI supported project, based in the Cariboo and completed in 2018, combined input from producers on their major pests of concern, statistics on the acreage and value of crops affected by certain pests, information on future biogeoclimatic (BEC) zone modeling to predict shifts to pests, and other criteria to prioritize and rank pests. *https://bcagclimateaction.ca/project/cb13/*

122 Pest alerts are distributed from Canadian Food Inspection Agency (CFIA), but these are reactive once a pest outbreak has occurred. The BC Ministry of Agriculture issues pest alerts and assists with production guides that include information about commodity specific pest management options.

123 In the Cariboo, the Invasive Species Council of BC is consolidating multiple weed reporting apps into one comprehensive app, and other species of pest (in addition to weeds), will be included in the app. If successful, this could be broadened to other regions as a tool.

124 IPM remains the most integrated way to address the increasing severity of pests resulting from climate change. T. Xiang, and M. Chaya. *Climate change exacerbates the challenge of plant pests.* Foodtank: the think tank for food. *https://foodtank.com/news/2019/03/climate-change-exacerbates-the-challenge-of-plant-pests/*

125 Kevin Murphy, Regional Agrologist, BC Ministry of Agriculture, personal communication, April 10, 2019.

126 Pacific Climate Impacts Consortium. (no 70)

127 Regional District Central Kootenays website. *https://rdck.ca/EN/main/services/emergency-management/emergency-preparedness/floods.html*

128 Floodplain maps identify areas that experience periodic flooding from nearby rivers, lakes, streams and the sea and provide information on the spatial distribution of flood construction levels. A comprehensive list of British Columbia floodplains (and associated floodplain maps) can be found at *https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/drought-flooding-dikes-dams/integrated-flood-hazard-management/flood-hazard-land-use-management/floodplain-mapping/floodplain-maps-by-region* . Kootenay floodplain maps can be found under Region 4 – Kootenay, Boundary floodplain maps can be found under Region 3 – Southern Interior.

129 Graham Watt, Recovery Manager, City of Grand Forks and Regional District of Kootenay Boundary, personal communication, May 17, 2019.

130 Cohen, R. (2014). *Fact Sheet #1: Functions of Riparian Areas for Flood Control*. Division of Ecological Restoration, Massachusetts Department of Fish and Game.

131 See Strategy 4.2 for examples of local supports. Financial cost-shared incentives may also be available to eligible producers who develop and have completed a current EFP through the Canadian Agricultural Partnership Beneficial Management Practices (BMP) Program to implement actions identified in their on-farm

environmental actions plan. BMP categories and practices can be found at *http://ardcorp.ca/wp-content/uploads/2018/06/2018-19-BMP-List-Version-3.0-June-21-FINAL.pdf*

132 *Lower Kootenay Band — Creston Floodplain Management Plan: Baseline Study Stage 1*. (2014). (Not public). Provided by Lower Kootenay Indian Band.

133 For more information see resources: Rutherford, S., (2007). *The Green Infrastructure Guide: Issues, implementation strategies and success stories*. West Coast Environmental Law Research Foundation and Fraser Basin Council. (2017). *Rethinking our Waterways: A Guide to Water and Watershed Planning For BC Communities In The Face Of Climate Change And Other Challenges*.

134 Ibid.

135 Information on the RDCK Flood and Geohazard Risk Review can be found on the RDCK website. *https://rdck.ca/EN/meta/news/news-archives/2018-news-archive/regional-flood-and-geohazard-risk-assessment-will-help-reduce-the-impact-of-disasters.html*

136 For more information see Regional District of Kootenay Boundary. (2018). *Community Recovery Options for Areas Damaged by May 2018 Flooding in the Kettle River Watershed. https://bfre.ca/wp-content/uploads/Kettle-River-Flood-Recovery-Report-v-web.pdf*

137 Producers who develop and have completed a current Environmental Farm Plan may be eligible to apply for cost-shared incentives through the Beneficial Management Practices (BMP) Program to implement actions identified in their on-farm environmental actions plan. BMP categories and practices can be found at *http://ardcorp.ca/wp-content/uploads/2018/06/2018-19-BMP-List-Version-3.0-June-21-FINAL.pdf*.

138 For more information on Farmland Advantage's Payment For Ecosystem Services pilot project visit *http://farmlandadvantage.com/about*.

139 The City of Kelowna's NeighbourWoods Program is a residential planting initiative developed to encourage citizens to help grow and preserve Kelowna's healthy neighbourhoods' urban forest. The program provides residents with opportunities to purchase discounted trees (subsidized by the City) on a set date during the year. *https://kelowna.ca/parks-recreation/urban-trees-wildlife/neighbourwoods*

140 An example of a strong resource is the Regional District of East Kootenay Seasonal Flooding Newsletter is available on the Emergency Services page of the RDEK website. *https://rdek.bc.ca/departments/emergencyservices/emergencyinfo/*

141 The BC Ministry of Agriculture has partnered with industry associations to develop all-hazard planning guides for beef, dairy, poultry and pork producers and for mixed farms. Government of British Columbia. (2016). *https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/business-market-development/emergency-preparedness*

142 The six diking districts in the Creston area are the Goat River Residence Association, The Duck Lake Diking District, the Creston Diking District, the Creston Valley Wildlife Management Area, the Reclamation Diking District. Details on each dike can be accessed at *https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/integrated-flood-hazard-mgmt/dikes_listed_by_ownerauthority.pdf*.

143 Lower Kootenay Indian Band. (no 135)

144 Fraser Basin Council. (2010). *Environmental Protection in Flood Hazard Management: A guide for practitioners*. *https://www.fraserbasin.bc.ca/_Library/Water/report_flood_and_environmental_protection_2010.pdf*

Urls in these Endnotes were current as of June 2019.