State of Climate Adaptation

Regional District of Central Kootenay Area H

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(Revised June 2020)

COLUMBIA BASIN RDI RURAL DEVELOPMENT INSTITUTE Selkirk College

REGIONAL DISTRICT CENTRAL KOOTENAY

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ACROYNMS

ALR	Agricultural Land Reserve
BWN	Boil Water Notice
CL	Confidence Level
GDD	Growing Degree Days
GIS	Geographic Information Systems
EMBC	Emergency Management British Columbia
EOC	Emergency Operations Centre
GCM	Global Climate Model
LiDAR	Light Detection and Ranging
NDMP	Natural Disaster Mitigation Program
NTU	Nephelometric Turbidity Units
$PM_{2.5}$	Fine Particulate Matter
RCP	Representative Concentration Pathways
RDCK	Regional District of Central Kootenay
RDI	Columbia Basin Rural Development Institute
SoCARB	State of Climate Adaptation and Resilience in the Basin
SWE	Snow Water Equivalent
UBCM	Union of British Columbia Municipalities
WQA	Water Quality Advisory
WUI	Wildland Urban Interface

DISCLAIMER

The data for State of Climate Adaptation indicators has been collected and analyzed by a team of qualified researchers. A variety of municipal, regional and provincial data sets informed the indicator findings. In some cases community-specific data is not available. State of Climate Adaptation indicator reporting should not be considered to be a complete analysis, and we make no warranty as to the quality, accuracy or completeness of the data. The Columbia Basin Rural Development Institute and Selkirk College will not be liable for any direct or indirect loss resulting from the use of or reliance on this data.

The preparation of this report was carried out with assistance from the Government of Canada and the Federation of Canadian Municipalities. Notwithstanding this support, the views expressed are the personal views of the authors and the Federation of Canadian Municipalities and the Government of Canada accept no responsibility for them.

INTRODUCTION

Purpose

Welcome to the Regional District of Central Kootenay (RDCK) Area H 2020 baseline report for the State of Climate Adaptation and Resilience in the Basin (SoCARB) indicator suite. SoCARB indicators were designed to provide data and insights relating to climate change, including local environmental impacts and community impacts (e.g., economic impacts), as well as information to help build adaptive capacity and track local actions. Originally developed in 2015, the SoCARB indicator suite measures community progress on climate adaptation across five climate impact pathways: extreme weather and emergency preparedness, water supply, flooding, agriculture, and wildfire.

***Figure 1**: RDCK Electoral Area H*

Climate-related impacts like flooding, drought and high temperatures can be critical events for communities and are examples of events that are projected to occur with greater frequency and/or intensity as the climate gets warmer. Flooding poses a risk to water infrastructure and public safety, and contributes to turbidity in surface sources. Drought has implications for water supply, local food production and increasing wildfire risk. Higher temperatures can impact vulnerable populations, including the elderly, socially isolated, chronically ill and infants.

The information presented in this report is intended to highlight trends and impacts related to the local climate and surrounding environment, and to inform local planning and decision-making. This report includes changes in indicators outside of the RDCK Area H jurisdiction, such as wildfire starts, recognizing that a better understanding of trends associated with these indicators can help the community prepare for current and future changes. Some indicators, such as per capita water consumption, come directly from local governments, as they are best positioned to identify and track where their actions could increase community climate resilience.

The SoCARB suite includes 58 climate adaptation indicators. This report, however, excludes indicators that the RDCK has not identified as a priority or where sufficient data was not available, as well as all indicators from SoCARB’s Community Resilience Index. In addition, the evolution of adaptation practice since 2015 and learnings from pilot implementation in 2016-2017 with four communities within the Columbia Basin resulted in minor updates to the suite in spring 2019.

Report Highlights

- Area H’s climate is changing, with data showing trends toward higher average annual and seasonal temperatures. This upward trend is expected to continue, with an increasing overall rate of warming. There is also a trend toward more hot and extreme heat days, a longer growing season and more growing degree days. Historical total annual precipitation shows an increasing trend, and future projections indicate increasing precipitation in all seasons except summer, as well as an increase in extreme precipitation
- Climate change is becoming evident through changes in environmental conditions. For example, the frequency of heavy snowfalls is declining along with spring snowpack, and the amount of heat energy available for crop growth is on the rise. Several environmental impact indicators lack sufficient data to infer trends and could be focal points for efforts to enhance climate adaptation monitoring, planning and action.
- RDCK is actively taking steps to adapt to changes that have already happened and to prepare for future changes. These actions include flood and geohazard risk assessment, updates to floodplain mapping, development of an All Hazards Regional Plan and a comprehensive FireSmart program. Opportunities exist to further Area H’s readiness to adapt, which include exploration of additional actions on water conservation and quality and promoting community-based efforts to adapt (e.g., through programs aimed at enhancing personal and household emergency preparedness).
- While some datasets are not lengthy or complete enough to evaluate trends in Area H’s adaptation, the analyses conducted for this project provide a valuable baseline assessment against which future progress can be compared.

Methods

The State of Climate Adaptation and Resilience in the Basin indicator suite was released in 2015 by a team of climate change professionals. The full suite separates indicators into two instruments:

1) a set of five thematic pathways (wildfire, water supply, agriculture, flooding, and extreme weather) that, through 50+ indicators, measure climate change, climate change impacts, and climate change adaptation; and
2) a Community Resilience Index that uses an additional 20 indicators to provide insights on socio-economic conditions in the community that contribute to its capacity to adapt.

The Water Supply pathway (Figure 2) illustrates how SoCARB conceptualizes the relationships between categories of indicators. Climate changes have direct and indirect impacts on communities. Indirect impacts are experienced through both environmental and community impacts. Impacts can be addressed through adaptation actions and capacity building, and the results of such efforts improve adaptation outcomes.

For this report, RDCK personnel identified indicators reflecting local priorities. Community Resilience Index indicators were not assessed as part of this report; however, many of these indicators can be found in the Columbia Basin Rural Development Institute's (RDI) State of the Basin reports and Community Profiles. The Community Resilience Index presents an opportunity for further applied research to inform local climate adaptation and resilience efforts.

This report includes an introductory climate section, which presents climate change indicators common to all five pathways, followed by pathway-specific sections following the same structure as Figure 2.

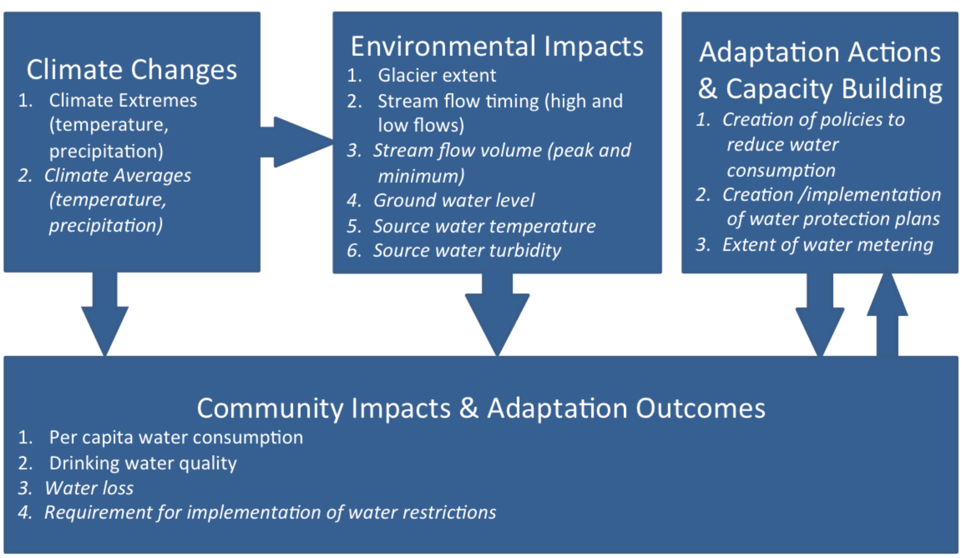

***Figure 2**: Water supply pathway from the SoCARB indicator suite*

Notes to the Reader

The indicators, and their related data sets range from simple to complex. Additional detail on any of the datasets or analytical methods is available from the RDI. Understanding the data and its limitations is important for many reasons. The points below should be considered while reviewing the report.

- **Climate trends are complex**. It is difficult to look at climate trends over the short or medium term because there are other factors beyond climate change that can influence trends. Climate science experts were consulted when analysing and interpreting data for this report.
- **Use of proxy data**. For some indicators, there is no local data source. Where feasible and appropriate, proxy (or stand-in) data sources were used.
- **Confounding factors**. An indicator can be influenced by several factors, making it difficult to distinguish the cause of a change. For example, trends in water consumption may be influenced by water conservation initiatives, but other factors (e.g., anomalous weather) must also be considered.
- **No obvious trend**. Some data may show no obvious trend. However, this data still has value as a trend may eventually emerge, and the information can still help inform decision making.
- **Trend that is not statistically significant**. Due to high variability in the data and / or short time periods, some data trends fall below 95 per cent confidence levels (i.e. not statistically significant). This does not nullify the presence of a trend; it highlights that there is less than 95 per cent confidence that the trend captures the true mean.

About the Climate Data

Climate data for RDCK Area H locations were provided by Climatic Resources Consulting, Inc. and come from two main modeling sources. Technical information is presented below. Climate projections for the 2050s within this report are separated into two scenarios: low carbon and high carbon. Climate projections for the 2050s indicate the average for the 2041-2070 period. The low carbon scenario (RCP4.5) is considered to be optimistic and, although insufficient to maintain global temperatures to below 2°C warming above pre-industrial temperatures, would require significant international cooperation that exceeds current commitments of signatories to the Paris climate agreement.[1] The high carbon scenario (RCP8.5) is also referred to as 'business as usual'. Global emissions are still moving along a trajectory that could lead to 3 to 5°C of global warming by the end of the century.[2] Consequently, it is important to also consider the high global emissions scenario (RCP8.5) in planning for climate change in the Columbia Basin and Boundary regions. Climate trends, i.e. rates of change, are expressed in units per century, meaning the change per 100 years.

Technical Information

Historical climate data was prepared using climate reanalysis ERA5.[3,4] Climate reanalyses combine past observations with models to generate consistent time series of multiple climate variables.[5] They provide a comprehensive description of the observed climate as it has evolved during recent decades, on 3D grids at sub-daily intervals. The estimates are produced for all locations on earth, and they span a long time period that can extend back several decades or more. Adjusted and Homogenized Canadian Climate Data (AHCCD) from Environment Canada provides long-term (since the early 1900s) observed data from a climate station in New Denver, which is used for some indicators in this report.

Climate projections are based on output from an ensemble of 12 statistically downscaled Global Climate Model (GCM) projections[6] from the Coupled Model Intercomparison Project Phase 5 (CMIP5),[7] and downscaled using Bias Correction/Constructed Analogues with Quantile mapping recording[8] to a resolution of 10 km by 10 km. Representative Concentration Pathways (RCPs) are numbered (e.g. RCP8.5 or RCP4.5) according to the radiative forcing in W/m^2 that will result from additional greenhouse gas emissions by the end of the century. Modellers use RCPs to generate scenarios of future climate.

Important note: ERA5 and CMIP5 do not use the same spatial grid for climate analysis, which can cause more variation in mountainous regions as a result of differences in topography and elevation. The result is that climate plots (e.g., **Error! Reference source not found.** and separate Appendix for climate data) for Area H locations show a gap between historical and projected climate trends.

CLIMATE

Four climate change indicators are common to most pathways: climate averages and extremes for both temperature and precipitation. They are presented first since changes in temperature and precipitation are key drivers of both environmental and community impacts. These four indicators encompass both historical trends and future projections for three RDCK Area H locations: Krestova, Silverton, and a high elevation (2000m) location in Valhalla Provincial Park. Figures in this section provide a quick visual analysis and tables are included for more detailed information. Additional climate information for Area H locations can be found in the separate RDCK Area H Appendix.

The Overall Picture

Both annual and seasonal average temperatures are rising in Area H locations and are projected to continue rising through the 2050s. Annual average temperature has been increasing by +3.3 to 4.3°C per century in the 1979-2018 period, depending on location. By the 2050s, this is projected to increase to 3.5 to 3.6°C per century under a low global emissions scenario and 7.1 to 7.5°C per century in a high emissions scenario, depending on location. The frequency of hot days has increased over the last century and is projected to continue increasing. Total annual precipitation has also increased over the last century, but this trend is not consistent across seasons. Total annual precipitation is also projected to increase over the coming decades, with proportionately more precipitation falling in winter and spring. Extreme precipitation showed a downward trend in the 1979-2018 period but is projected to increase by the 2050s.

Average annual temperature increasing

Analyses of estimated average annual temperature data for three locations in Area H show the 1961-1990 baseline temperatures ranging from 1.8°C at the Valhalla Provincial Park high elevation location to 6.8°C in Silverton and 9.7°C in Krestova (Figure 3; Table 1; Table 2; Figure 4). Both annual and seasonal temperatures show an upward trend in the 1979-2018 period. There have been statistically significant warming trends in average annual temperature of +3.3 to +4.3°C per century depending on location, with the highest rate of warming occurring at the high elevation location in Area H – Valhalla Provincial Park at 2000m (Table 2). Summer temperatures have increased at the highest rate, with trends calculated at +5.6°C per century during the 1979-2018 period.

Projections for the 2050s indicate that summers will warm faster than other seasons in both low and high carbon scenarios. Average annual temperatures are projected to increase by 2.5°C and 3.3°C from the 1961-1990 baseline under low and high carbon scenarios, respectively, for Valhalla and Krestova locations. Silverton is projected to increase by 2.6°C and 3.2°C from the 1961-1990 baseline under low and high carbon scenarios, respectively.

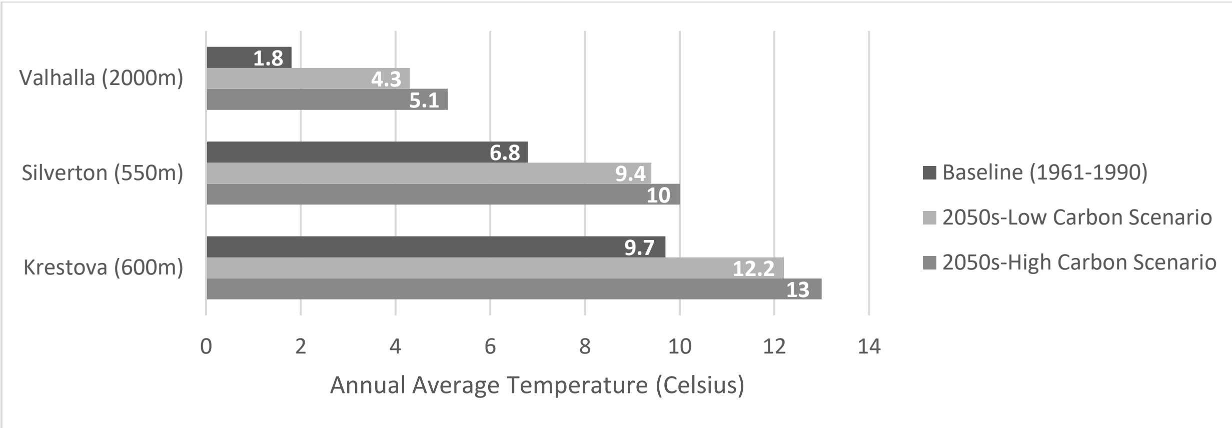

Figure 3: *Historical and projected annual average temperature for Area H locations in degrees Celsius*

Table 1*: Historical and projected average annual and seasonal temperature for Area H locations in degrees Celsius.*

		Annual	Winter	Spring	Summer	Fall
1961-1990 baseline	Krestova (600m)	9.7ºC	-0.2	9.4	19.7	9.5
	Silverton (550m)	6.8	-2.4	5.8	16.5	7.0
	Valhalla (2000m)	1.8	-7.8	1.4	11.6	1.6
2050s – projected temperature – low carbon scenario	Krestova (600m)	12.2	2.5	11.9	22.6	11.8
	Silverton (550m)	9.4	0.2	8.3	19.4	9.3
	Valhalla (2000m)	4.3	-5.1	3.9	14.5	3.9
2050s - projected temperature – high carbon scenario	Krestova (600m)	13.0	3.0	12.4	23.7	12.6
	Silverton (550m)	10.0	0.7	8.8	20.5	10.1
	Valhalla (2000m)	5.1	-4.6	4.4	15.5	4.7

Table 2: *Average annual and seasonal average temperature trends for Area H locations in degrees Celsius per century. Results that are not statistically significant (<95% confidence level) are in italics.*

		Annual	Winter	Spring	Summer	Fall
Historical (1979-2018)	Krestova	+3.3ºC per century	+2.7	*+1.8*	+5.5	+2.8
	Silverton	+3.4	*+3.1*	*+1.8*	+5.6	+2.8
	Valhalla – high elevation	+4.3	*+3.2*	*+2.9*	+5.6	+3.8
2050s – low carbon scenario	Krestova	+3.6	+1.9	+3.1	+4.0	+3.2
	Silverton	+3.6	*+2.1*	+2.9	+4.2	+3.0
	Valhalla – high elevation	+3.5	+2.2	+3.2	+3.8	+2.9
2050s – high carbon scenario	Krestova	+7.1	+7.4	+5.1	+10.5	+6.5
	Silverton	+7.5	+7.5	+5.5	+10.4	+6.9
	Valhalla – high elevation	+7.1	+7.4	+5.5	+10.2	+6.2

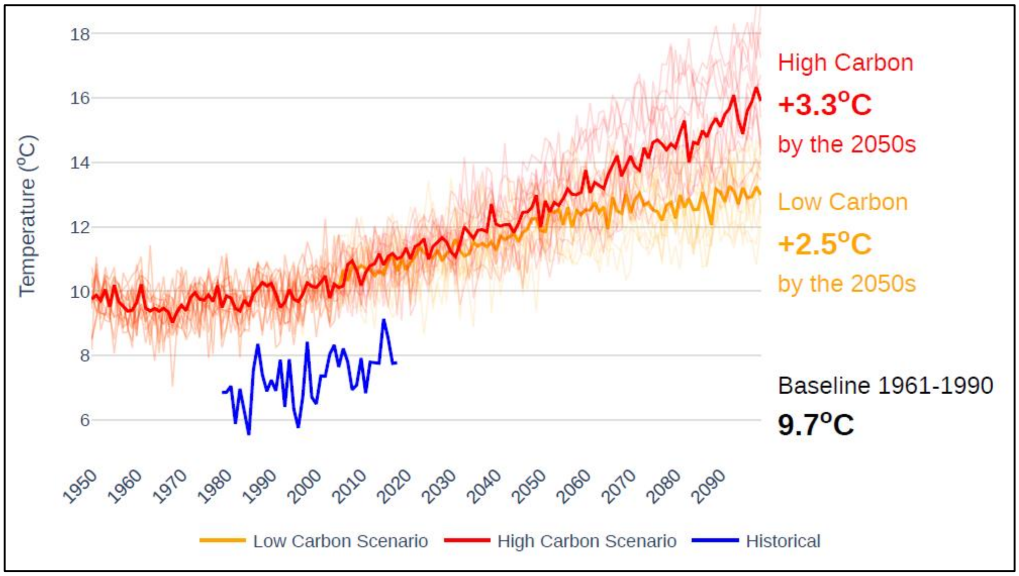

Figure 4: *Historical and projected average annual temperature for Krestova*

Total annual precipitation is increasing while summer precipitation is decreasing

Analyses of estimated average annual precipitation data for Area H locations shows total annual precipitation is increasing (Figure 5), while summer precipitation is decreasing (Figure 6). The 1961-1990 baseline ranges from 760.3 mm in Krestova to 969.9 mm in Silverton (Figure 5;

Table ***3***, Figure 7). Average annual precipitation trends (Table 4) show considerably more variability than those for temperature. As a result, confidence levels for a number of historical trends and projected trends fall below 95 per cent, as noted by italics in Table 4. However, while some trends and projections may fall below the 95 per cent confidence level, they remain useful in showing the overall direction of precipitation trends.

The modelled dataset shows a small increasing trend for historical average annual precipitation (1979-2018); however, it is not statistically significant. All three locations show a statistically significant downward trend in historical summer precipitation of -191 to -297 mm per century. Other seasons show increasing trends, but the confidence levels fall below 95 per cent. Actual historical precipitation data (1968-2018) from six climate stations in the southwest Columbia Basin[i] show average annual precipitation increasing by an average of 152 mm per century in this larger region.

[i] Creston, Warfield, Grand Forks, Castlegar, Kaslo and Fauquier

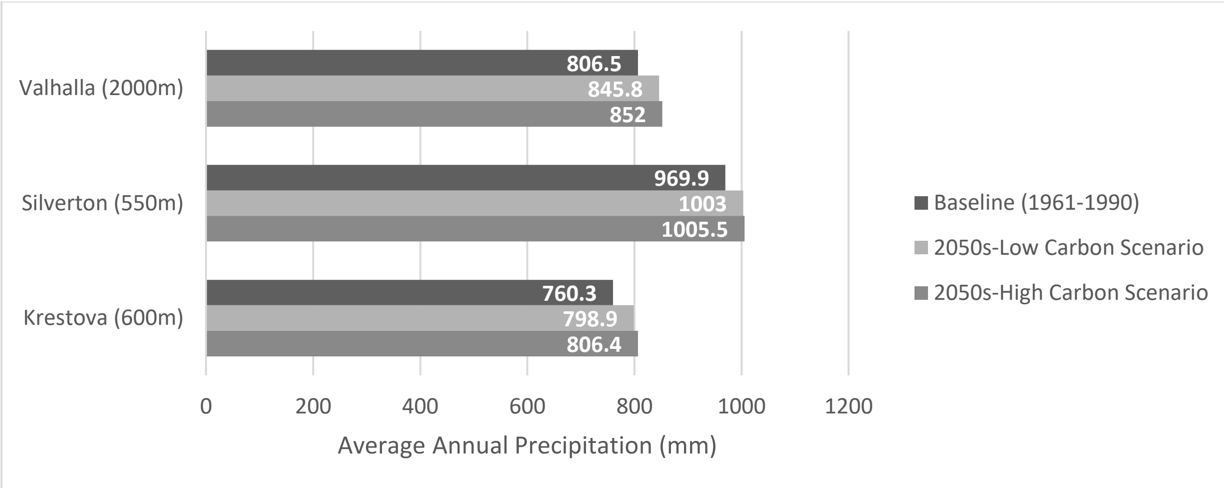

Figure 5*: Average annual precipitation for Area H locations in millimetres*

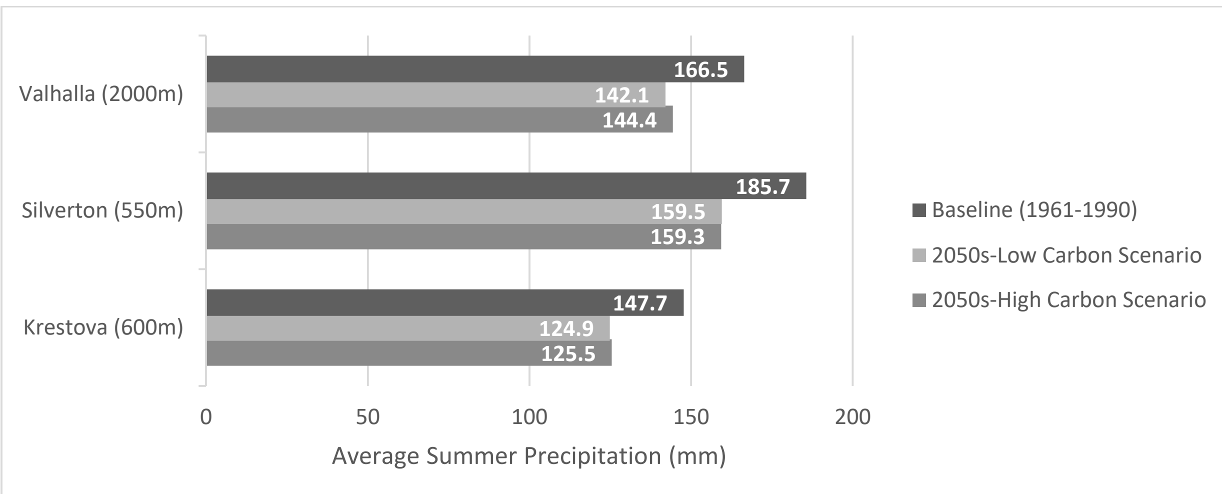

Figure 6: *Average summer precipitation for Area H locations in millimeters*

Table 3: *Average annual and seasonal total precipitation for Area H locations in millimetres*

		Annual	Winter	Spring	Summer	Fall
1961-1990 baseline	Krestova (600m)	760.3 mm	252.7	167.3	147.7	189.4
	Silverton (550m)	969.9	328.9	215.4	185.7	240.1
	Valhalla (2000m)	806.5	267.4	163.0	166.5	206.2
2050s – projected change in precipitation – low carbon scenario	Krestova (600m)	+38.6	+16.2	+25.0	-22.8	+11.1
	Silverton (550m)	+33.1	+16.7	+24.4	-26.2	+8.8
	Valhalla (2000m)	+39.3	+20.0	+25.3	-24.4	+14.4
2050s - projected change in precipitation – high carbon scenario	Krestova (600m)	+46.1	+17.2	+26.8	-22.2	+11.3
	Silverton (550m)	+35.6	+17.8	+25.4	-26.4	+7.7
	Valhalla (2000m)	+45.5	+19.4	+25.1	-22.1	+13.0

Table 4: Annual and seasonal total precipitation trends for Area H locations, in millimetres per century. Results that are not statistically significant (< 95% confidence level) are in italics.

		Annual	Winter	Spring	Summer	Fall
Historic (1979-2018)	Krestova (600m)	*+39.5 mm per century*	*+25.3*	*+94.9*	-297.7	*+124.1*
	Silverton (550m)	*+23.7*	*+21.7*	*+86.6*	-228.2	*+115.0*
	Valhalla (2000m)	*+41.7*	*-3.2*	*+91.1*	-191.6	*+71.2*
2050s – low carbon scenario	Krestova (600m)	*+74.6*	*+31.6*	*+61.7*	*-1.7*	*+17.3*
	Silverton (550m)	*+84.2*	*+29.9*	*+54.1*	*-4.3*	*+26.3*
	Valhalla (2000m)	*+129.0*	*+37.5*	*+44.6*	*-8.4*	*+36.6*
2050s – high carbon scenario	Krestova (600m)	+250.7	*+107.6*	+85.2	*-44.5*	+99.7
	Silverton (550m)	+262.1	*+102.2*	+79.3	*-85.3*	+103.1
	Valhalla (2000m)	+334.0	*+118.9*	+114.6	*-55.7*	+113.6

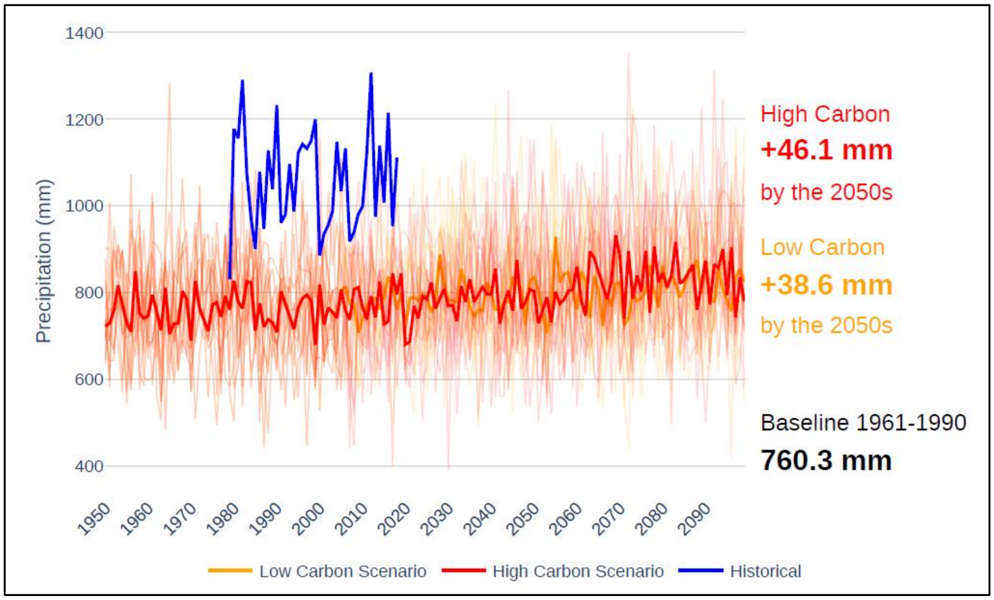

Figure 7: *Historical and projected total annual precipitation for Krestova*

Precipitation projections for the 2050s (Table 3) indicate an increase of approximately 3.5 to 6% in average annual precipitation by the 2050s (depending on location and scenario), with less precipitation falling in summer, and more precipitation falling in the other seasons. Looking to the 2050s, only the high carbon scenario projections for spring, fall, and annual precipitation are statistically significant (Table 4), showing total annual precipitation increasing between 250 to 334 mm per century depending on location.

More hot days

This extreme temperature indicator measures the average annual sum of days when the temperature exceeds the 90th percentile for the baseline period (1961-1990). For Area H locations, this translates into the following baselines and projections for the 2050s:

Table 5: *Baseline 90th percentile temperature threshold for Area H locations*

	Silverton	Krestova	Valhalla
Baseline (1961-1990) 90th percentile threshold for daily temperature	25.1 °C	29.7 °C	21 °C

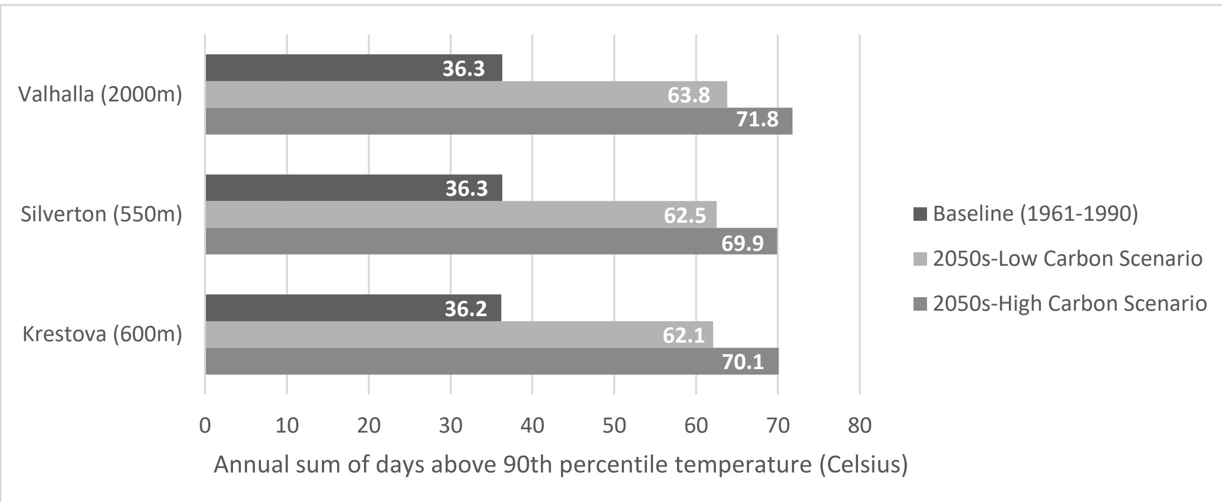

Figure 8: *Baseline and projections for the average number of days annually when temperature exceeds the 90th percentile in Area H location*

All Area H locations have experienced and are projected to continue experiencing an absolute increase in hot days. The magnitude of this upward trend is also projected to increase. The annual number of hot days (i.e. those above the baseline 90th percentile temperature) is projected to increase by 17 to 35 days by the 2050s, depending on location and scenario, and the rate of increase is projected at 100 days per century by the 2050s for Krestova and the Valhalla high elevation location in a high carbon scenario.

More days with heavy rainfall

The extreme precipitation indicator measures the average annual sum of daily precipitation exceeding the 95th percentile for the baseline period (1961-1990) and can be described as the amount of rain that falls during very heavy rainfall days. For Area H locations, this translates into the following baselines and projections for the 2050s:

Table 6: *Baseline 95th percentile daily precipitation threshold for Area H locations*

	Silverton	Krestova	Valhalla
Baseline (1961-1990) 95th percentile threshold for daily precipitation	10.4 mm	9.8 mm	10 mm

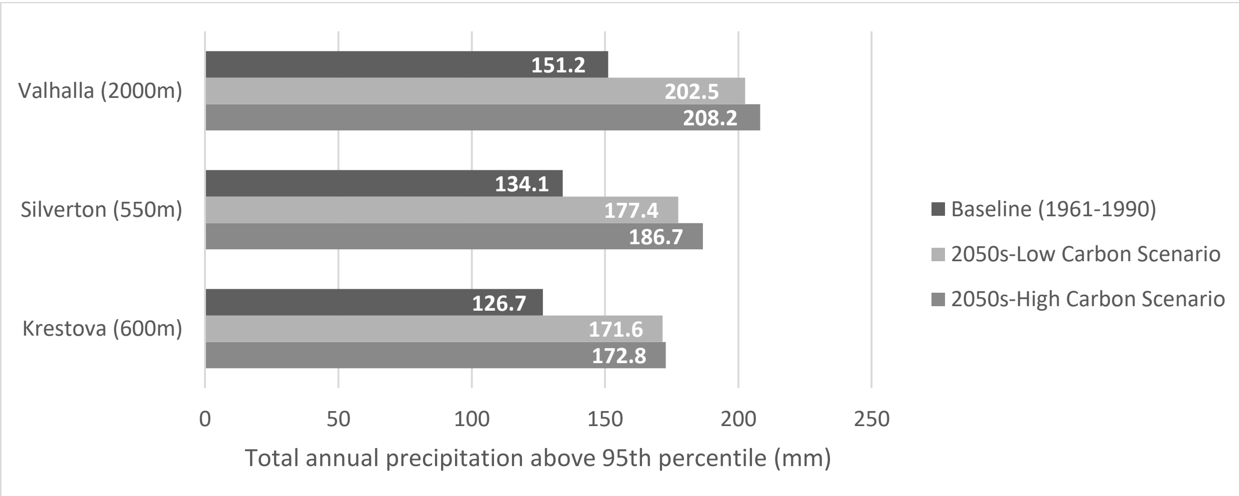

Figure 9: *Baseline and projected change in the average annual sum of daily precipitation above the 95th percentile in millimeters.*

Extreme precipitation has a downward trend from 1979-2018. Similar to the Area H data for total annual precipitation, all historical and low carbon scenario trends fall below 95 per cent confidence levels. However, projections for annual, spring and winter daily precipitation above the 95th percentile in a high carbon scenario are statistically significant, showing increases of 123, 146 and 216 mm per century in this precipitation index for Krestova, Silverton and Valhalla, respectively. This means more heavy rain days above the 1961-1990 95th percentile thresholds in all locations.

EXTREME WEATHER AND EMERGENCY PREPAREDNESS

Extreme weather events, such as extreme precipitation, windstorms, and heat waves, can have significant impacts on communities. This was underscored by an independent review of BC's historic flood and fire events of 2017 commissioned by the BC government, noting, "A range of data from reputable sources points to growing challenges with respect to heat, drought, lightning and intense rains intersecting with snow melt, underlining the imperative for government to respond in new, different or better ways."[9] The review produced over 100 recommendations to improve emergency preparedness and disaster response. Climate projections suggest an increase in some extreme weather events, such as warm days, extreme warm days, and extreme wet days. Communities can prepare for the immediate short-term demands of extreme weather events with adaptations such as all-hazards emergency preparedness plans, backup power sources, and home emergency preparedness kits.

The Overall Picture

RDCK Area H is experiencing a higher number of extreme heat days than in the past. Other indicators of extreme weather in the area, however, are either lacking long-term datasets or not yet showing the trends that have been identified at wider geographic scales. The RDCK's Emergency Preparedness Plan will help mitigate the impacts of extreme weather events on residents and businesses. The number of RDCK Area H residents with emergency preparedness kits is low, suggesting the benefits of supporting information and awareness of personal emergency preparedness.

Climate Changes

As discussed in the Climate section, data for Area H locations show increased average annual and seasonal temperatures, increased average annual precipitation and decreased summer precipitation over the last century. The frequency of hot days has increased and will continue to increase. Extreme precipitation has a downward trend from 1979-2018, but this trend is projected to change in the future. Additional climate indicators related to the Extreme Weather pathway are discussed below.

More extreme heat days

Heat waves and heat extremes have negative health impacts on vulnerable populations including the elderly, socially isolated, chronically ill, and infants. Estimated historic temperature data for Krestova and Silverton show a clear upward trend in the average annual frequency of days over 30^{o}C, with 1961-1990 baselines of 34.8 and 6.7 days, respectively; increasing at a rate of 45 to 60 days per century, respectively. The high elevation location in Valhalla Provincial Park shows an annual average of zero days over 30^{o}C for the baseline period.

By the 2050s, all locations are projected to see an increase in days over 30°C (Figure 10, Figure 11). In a high carbon scenario, the projected rate of increase in the 2050s ranges from 50 days per century for the Valhalla high elevation location to 94 days per century in Silverton.

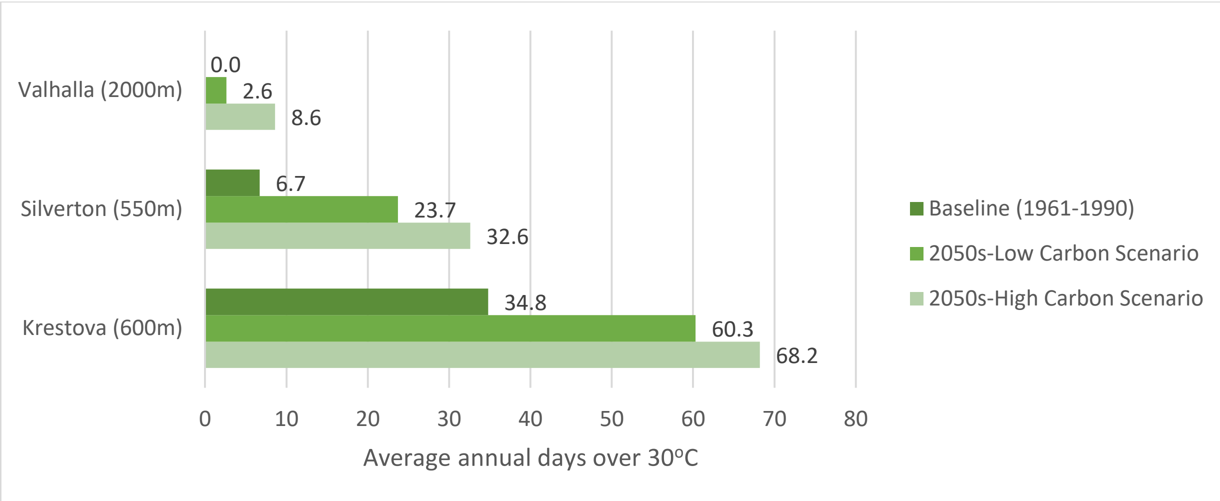

Figure 10: *Baseline and projected change in average annual number of days over 30°C*

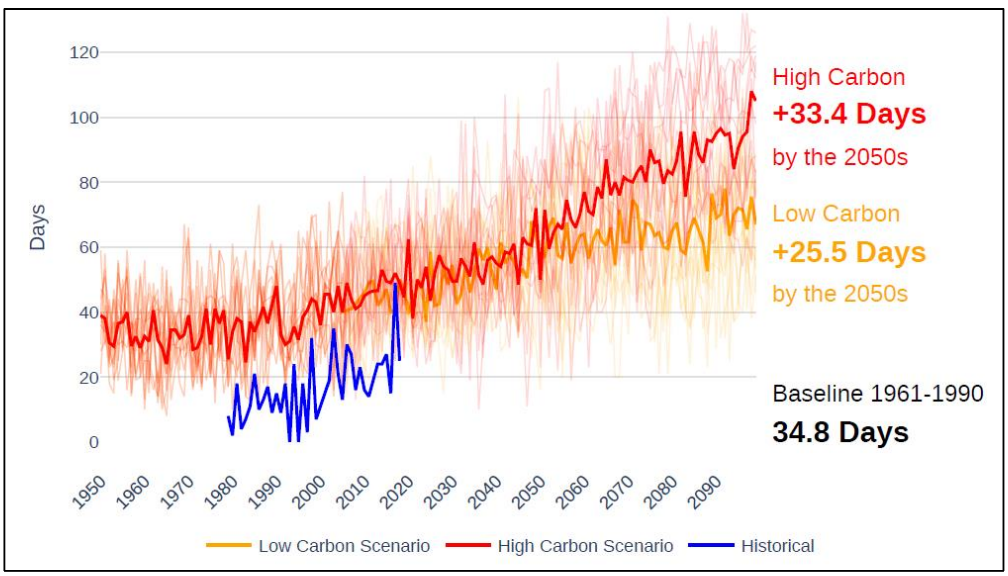

Figure 11: *Annual historical and projected days over 30°C for Krestova*

Fewer heavy snowfalls

Heavy snowfall days are defined as those receiving 15 cm or more over 24 hours. These events can pose challenges to the regular operations of businesses and local governments and may affect the movement of people throughout the region. Snowfall records from Environment and Climate Change Canada's weather station in New Denver show a statistically significant decline in heavy snowfall days from 1924 through to 2019. Data is also available for South Slocan from 1941 to 2007 but does not show any statistically significant trends in heavy snowfall events (Figure 12). New Denver data show a decline in annual heavy snowfall events of approximately 1.8 per century.[10] This means there has been a reduction from 3 to 4 heavy snowfalls per year in the early 1900s to just over one per year in the early 2000s.

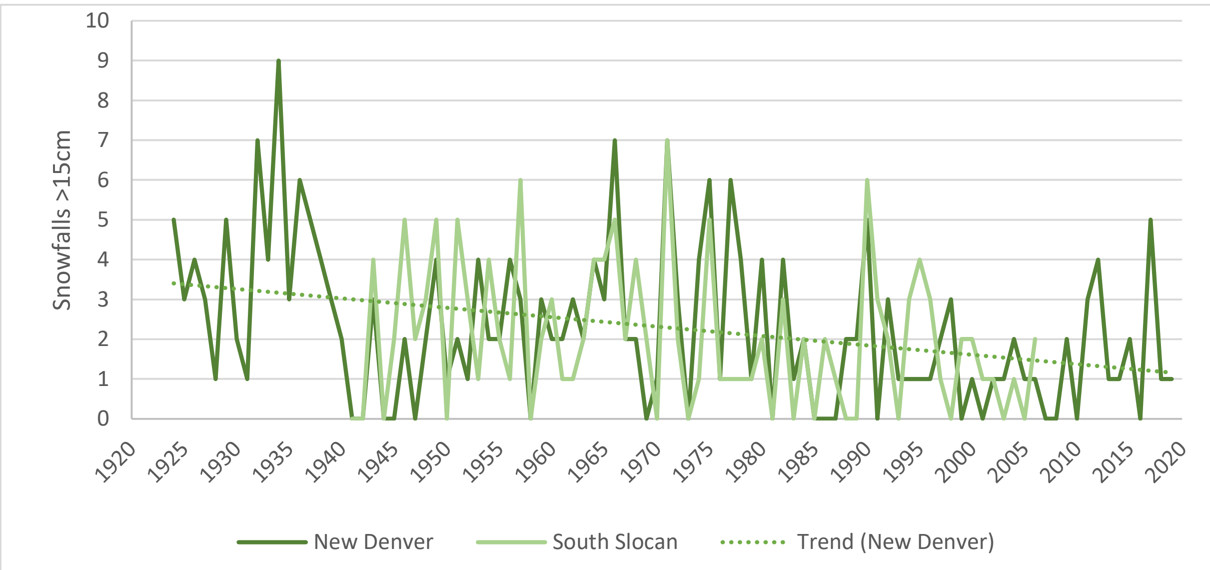

Figure 12: *Annual number of snowfalls exceeding 15 cm in 24 hours*

Strong wind events

Wind storms can damage infrastructure, bring down power lines and cause power outages. A strong wind event is defined as a day with sustained winds of 70 km/h or more and/or gusts to 90 km/h or more. Wind data is not well recorded in the Columbia Basin and the only data available within Area H come from BC Wildfire Service weather stations. These stations provide an hourly reading of sustained wind speed over a ten-minute period.[11] Analysis of the Slocan station, which has data from October 1991 to the present, revealed no records over the 70 km/h threshold.[12]

Maximum 1-day rainfall

Heavy rainfall is a major cause of flooding of creeks and rivers, and can cause stormwater management issues, erosion, and debris slides. A warming climate generally increases the risk of extreme rainfall events because a warmer atmosphere can carry more water vapour, which can fuel more intense precipitation events. The data for Area H indicates 15 to 18 percent increases in average annual maximum 1-day rainfall, with increases in all seasons except summer (Figure

13). Most of the projected trends fall below 95% confidence levels due to the high natural variability of precipitation projected over a relatively short timeframe. Exceptions are Krestova and the high elevation location in Valhalla Provincial Park in the high carbon scenario, which show maximum 1-day precipitation increasing at rates of 15.6 mm and 13.5 mm per century, respectively, by the 2050s.

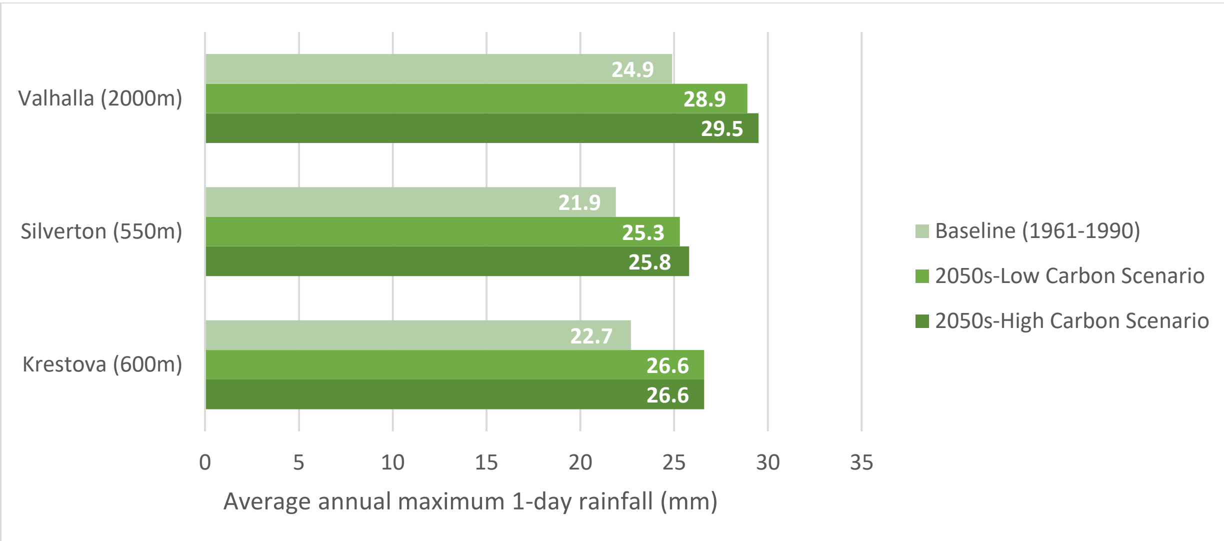

Figure 13: *Baseline and projected changes to average annual maximum 1-day rainfall, in millimetres*

Adaptation Actions and Capacity Building

Emergency Preparedness Plan

As emergency preparedness is managed on a regional scale by the RDCK, the information in this section provides a district-wide perspective, rather than just Area H. The RDCK has an emergency plan that is currently being revised into an "All Hazards Regional Plan", expected to be complete in spring 2020. Of the important plan components included in our survey, all but one – municipal business continuity plan - are in place (Table 7). The RDCK administers a regional emergency management program that includes 7 out of the 9 municipalities that fall within the RDCK boundaries – the exceptions being Castlegar and Nelson. The RDCK has a dedicated Emergency Operations Center (EOC) that is set-up and ready to go at any time. The RDCK also has a recovery plan in place, with revisions in process. There is an RDCK emergency alert system called 'Connect Rocket' that has 14,880 people signed up for emergency alerts region-wide as of December 2019, with 4,369 in Area H.[13]

Table 7: *Emergency preparedness plan components for the Regional District of Central Kootenay*

Component	Included in Emergency Preparedness Plan? Yes	In Progress	No	N/A
Hazard risk assessment	☑	☐	☐	☐
Emergency procedures	☑	☐	☐	☐
Municipal business continuity plan	☐	☐	☑	☐
Community evacuation plan[i]	☑	☐	☐	☐
Public communication plan[ii]	☑	☐	☐	☐
Designated emergency response centre[iii]	☑	☐	☐	☐
Emergency program coordinator[iv]	☑	☐	☐	☐
Designated emergency response team[v]	☑	☐	☐	☐
Identified emergency roles and responsibilities	☑	☐	☐	☐
Action list for each type of hazard	☑	☐	☐	☐
Designated emergency/reception shelter	☑	☐	☐	☐
Plan for shelter stocking[vi]	☑	☐	☐	☐
Training and emergency exercise plan for response personnel	☑	☐	☐	☐
Contact list for all response personnel	☑	☐	☐	☐
Fan-out call list[vii]	☑	☐	☐	☐
Mutual aid agreements with any agencies helping in response (e.g. neighbouring municipalities, school board, local service groups)[viii]	☑	☐	☐	☐

i. This includes use of GIS software that allows fast response time to get addresses of concern to field personnel for quick evacuation for only those impacted.
ii. This includes communications with public and media. Presently finalizing this document.
iii. This is a regional EOC already set-up and ready to go.
iv. There are three Emergency Program Coordinators who cover seven service areas.
v. There is extensive trained EOC staff with the goal to have 3 people trained in each position.
vi. This includes eight stocked trailers spread throughout the region.
vii. This is "Connect Rocket" an online alert system.
viii. Mutual aid agreements are typically created between communities and with regional districts to facilitate response to emergencies. RDCK provides emergency management for 7 of the 9 municipalities within its boundary. The other two municipalities – Castlegar and Nelson – have no formal agreement, but believe they are "in this together" and have strong informal partnerships. RDCK has a level 1 agreement with the Red Cross.

Essential backup power in place

The RDCK has uninterrupted backup power in place for its Emergency Operations Centre and a backup generator at the main RDCK office to keep critical systems alive, such as GIS and finance. For the entire RDCK, only 8 of the 19 water systems run by the RDCK have backup power. However, it is important to note that some of these systems do not need backup power because they are gravity fed with no treatment. The RDCK plans to include backup power in future capital projects as funds allow. Of the three RDCK water systems in Area H, only one has backup power – South Slocan. There are 18 fire halls within the RDCK. These fire halls do not have backup power, but they are able to run off generators if needed. There are multiple evacuation centres around the region. These are usually community halls. Few, if any, have backup power. However, the logistics section of the emergency response team would address this issue as needed.[14]

Few residents have emergency preparedness kits

Having an emergency preparedness kit can help alleviate some of the difficulties caused by an extreme weather event. A voluntary survey of Area H residents conducted in summer 2019 had 49 respondents, of which 28 answered the questions on emergency preparedness. The survey found that only 46% of respondents reported having 72-hour emergency preparedness kits in their home. Over 60% of those with kits did not have the items in one accessible location and most had not reviewed and updated the kit within the last year. The most common items in residents' kits were a first aid kit, flashlight, matches, manual can opener, non-perishable food, and drinking water (Table 8). Many residents could better prepare for extreme weather events by compiling complete kits, storing them in a single accessible location, and reviewing them annually. Future surveys will help the RDCK track personal emergency preparedness over time.

Table 8*: Percentage of respondents from RDCK Area H with emergency kits indicating the presence of important items in their kit*

Item	Yes
Drinking water (2-3 litres of water per person and pets per day, for 3 days)	68%
Foods that will not spoil (minimum 3-day supply)	68%
Manual can opener	73%
Flashlight and batteries	77%
Candles and matches/lighter	73%
Battery-powered or wind-up radio	50%
Cash in smaller bills and change	43%
First aid kit	83%
Special items such as prescription medications, infant formula or equipment for people with disabilities	42%
Extra keys that you might need (e.g. for your car, house, safe deposit box)	36%
A copy of your emergency plan including contact numbers (e.g. for out-of-town family)	24%
Copies of relevant identification papers (e.g. licenses, birth certificates, care cards)	38%
Insurance policy information	38%
Mobile phone charger	43%

Community Impacts and Adaptation Outcomes

No trend in weather-related highway closures

Between 2006 and 2017, there have been 12 weather-related highway closures in Area H with an average closure time of 5.2 hours. These numbers come from Drive BC records, which report closures on major highways only. For Area H, this is Highway 6 from South Slocan to Nakusp and Highway 31A from New Denver to Kaslo. The majority of weather-related highway closures on these roads are due to downed power lines and mudslides. Mudslides are responsible for the longest closures of 13 hours in 2006 and 12 hours in 2012. Both of these mudslides occurred on Highway 31A between New Denver and Kaslo, but mudslides have also closed Highway 6 at Cape Horn north of Slocan. The short length of the dataset precludes trend analysis at this time.[15]

Area H is also impacted by closures on Highway 3 over Kootenay Pass and the Blueberry-Paulson Pass. Avalanche control is the main cause of closures on these passes, though other weather-related events have closed these highways in the past. While the impact of climate change on avalanches in BC's interior remains inconclusive,[16] avalanche professionals are predicting more wet avalanches, reduced avalanche activity at lower elevations and increased avalanche activity at higher elevations.[17] Avalanche-related activities have accounted for an average annual closure time of 93 hours over 37.6 closures at Kootenay pass (2003-2019) and 4.7 hours over 1.5 closures at the Paulson Pass (1989-2019). No trends are evident in the number or duration of avalanche related closures at this time. Highway 31A from Kaslo to New Denver is also an active avalanche area that experiences an average of 14.8 hours of closure time per year over 3.4 events.[18] Interestingly, the number of annual avalanche closures has increased over the years on this highway, but the total closure time has not changed. This is likely due to changes in management strategies and is not thought to be indicative of an increase in avalanche activity related to climate change.[19]

Between 2006 and 2017, Kootenay Pass had five weather-related closures, the longest being a mudslide that closed the road for 13 hours. The Paulson Pass has only two recorded closures from rockslides in 2008 and 2009, stopping traffic for less than 2 hours.[20]

Power Outages

Longer-duration electrical power outages caused by extreme weather events can have significant impacts on local economies, health and quality of life. Power in Area H is serviced by BC Hydro in the north and FortisBC in the south.

BC Hydro data for the New Denver substation feeding the north part of Area H identifies outages caused by adverse weather, including floods, mud/snow slides, lightning, snow, and damage by trees. In available data between April 2014 and March 2019, there were 71 outages that totaled 659 hours. The duration of outages ranged from 1 minute to 56 hours, and the average outage lasted 9.2 hours[21].

FortisBC data for the region feeding the southern portion of Area H is available from 2003 to 2019. The duration of outages ranged from 1 minute to over 11 days, and the average outage lasted 8.7 hours. Starting in 2014, more detailed outage cause descriptions were introduced, including climate change-related subcategories such as wet snow and extreme wind. [22]

Provincial emergency assistance

Monitoring emergency assistance funding issued by the province can provide some measure of the economic impact of disaster and associated recovery over time. Since 2015, the RDCK has received $20,308 from Emergency Management British Columbia (ENBC) for emergency assistance due to extreme weather, including ice jams and weather-related landslides. Of this, none was for Area H.[23]

One evacuation alert

Evacuation records from 2006-2019 showed one evacuation alert in Area H in 2013 for a mudslide that may be attributed to an extreme weather event.[24]

WATER SUPPLY

Projected changes to the climate could influence both the supply of and demand for fresh water for human use. Shifts in temperature and precipitation combined with forest disturbance could change the amount of water stored in the snowpack and the timing of surface water availability in the spring. The water supply pathway focuses on the quality and quantity of water available for consumptive use and adaptation actions that help to conserve and protect the water supply.

The RDCK has a broad range of water supply systems, from large systems with 716 connections to small systems with only 5 connections. The water source of each system also varies significantly – including groundwater or surface water from lakes or small streams. Each system also has varied water treatment, from no treatment at all to highly monitored systems with multiple treatment stages. There are three water systems in Area H run by the RDCK – Rosebery (6 connections presently, serving 20 connections at full capacity), Denver Siding (21 connections), and South Slocan (51 connections). There are over 2300 privately owned water licenses in Area H, of which 13 are privately managed waterworks.[25] Two of these systems are examined in this report. McDermid Creek (5.1 km^2) is one of the smaller catchments in Area H and supplies water for consumptive use to the Krestova Improvement District. Springer Creek is a 50 km^2 watershed that provides source water to the Brandon Water Improvement District. Peak water demand typically occurs in the months of July and August.

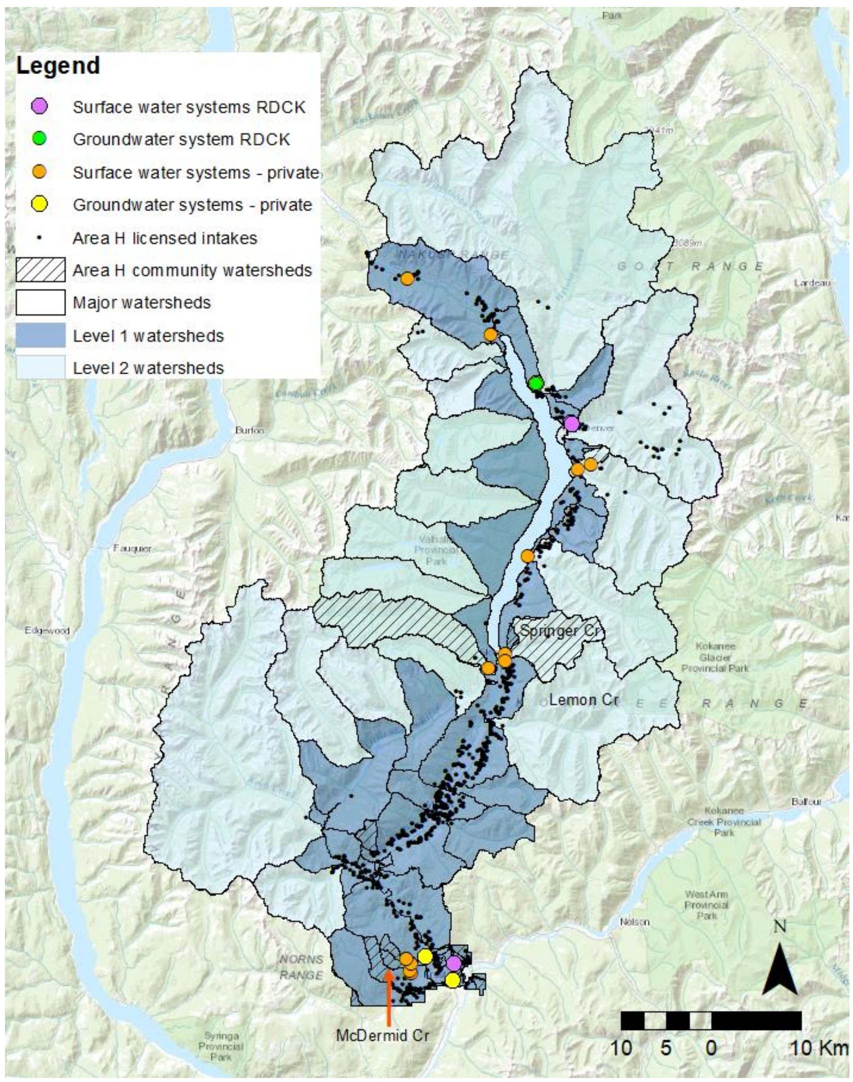

Figure 14: Area H watersheds and water systems

The Overall Picture

The trend toward a wetter, warmer winter and spring is likely to have negative implications for water supplies in small, low elevation watersheds of the West Kootenay. In contrast, many alpine sourced watersheds that flow from the Valhalla and Selkirk Mountains are likely to be more resilient given projected climate changes. A geospatial classification of vulnerable watersheds in Area H is presented in Figure 14. Level 1 watersheds (shaded darker blue) have low elevation source areas that are more likely to experience changes in the timing and volume of streamflow given projected changes in climate to warmer, wetter spring and winter seasons. Level 2 watersheds (shaded light blue) have high elevation source areas that will be less vulnerable to projected climate change in the Kootenay region.

McDermid Creek is classified as a Level 1 watershed. The lack of a long-term discharge dataset for McDermid Creek or similar nearby watersheds preclude an assessment of regional trends. The projected climate trends will likely result in earlier spring freshet and longer periods of low flows in McDermid Creek. Re-establishing discharge gauging on Goose Creek would provide the RDCK with valuable information regarding changes in timing and volume of runoff in the South Slocan area.

Springer Creek is classified as a Level 2 watershed. Long-term discharge gauging on nearby Lemon Creek indicates that there are no obvious trends in the timing or volume of spring flows. A negative trend in the volume of summer low flows appears to relate to a period of higher-than-average low flows that occurred during the 1970's. A longer discharge record is needed to determine if this trend reflects trends other than decadal climate variability.

The RDCK adopted a Drinking Water Conservation Plan in 2019 that includes leak detection and water loss reduction programs, which will increase the climate-resilience of its water systems.

Climate Changes

As discussed in the Climate section, average annual and seasonal temperatures are increasing, and are projected to continue increasing over the coming decades. Precipitation trends have been increasing in all seasons except summer, but the trends fall below the 95 per cent confidence level due to the high natural variability of precipitation. Future projections indicate an increase in total annual precipitation by the 2050s under both low and high carbon scenarios, with less rain falling in the summer.

Environmental Impacts

Stream flow timing

McDermid Creek

Stream flow timing is sensitive to climate change, especially in small, low elevation (<1600m) snowmelt catchments such as McDermid Creek. There has been no long-term flow gauging on

McDermid Creek on which to base an analysis of past trends. Limited gauging during the late 1960s indicates that the freshet peak flow occurs in early May.[26] Given projected trends for warmer springs and the existing downward trends for April 1st snowpack (see Flooding Pathway) it is likely that McDermid Creek will experience earlier peak flows and longer periods of low flows. Low summer stream flows mean less water is available for human use at the time of year when it is typically in highest demand. Low flows also result in higher water temperatures, which presents challenges for both ecosystems and water quality.

Springer Creek

Springer Creek is a moderate sized (50 km^2) watershed with headwaters over 2200 metres in the Selkirk Range. There is no long-term flow gauging on Springer Creek, however Lemon Creek directly to the south, with similar physical characteristics including elevation distribution, can be used as a proxy to evaluate probable trends for Springer Creek.

Using Environment Canada data,[27] no changes in the timing of maximum daily flows or summer low flows are apparent for Lemon Creek given a 43-year continuous record of discharge (See Flooding Pathway for more information on maximum daily flows). A trend may be present for the timing of half-annual flow volume for Lemon Creek. The half-annual flow volume metric can reveal changes in the distribution of flow from the watershed and reflects the cumulative influence of changes in snowmelt volume and changes in annual meteorology. For example, projected climate trends of reduced seasonal snowpack and warmer spring temperatures are likely to result in a shift of the half-annual flow volume to earlier in the year relative to historical runoff timing. In Lemon Creek, the date of occurrence of half the annual flow volume has advanced, on average, 4.6 days compared to when gauging began in 1974 (Figure 15). This trend is not considered statistically significant at the 95% confidence level. A more detailed investigation is needed to determine if this trend is real and what is causing it, given there are no detectable trends in the timing of either maximum or summer minimum flows.

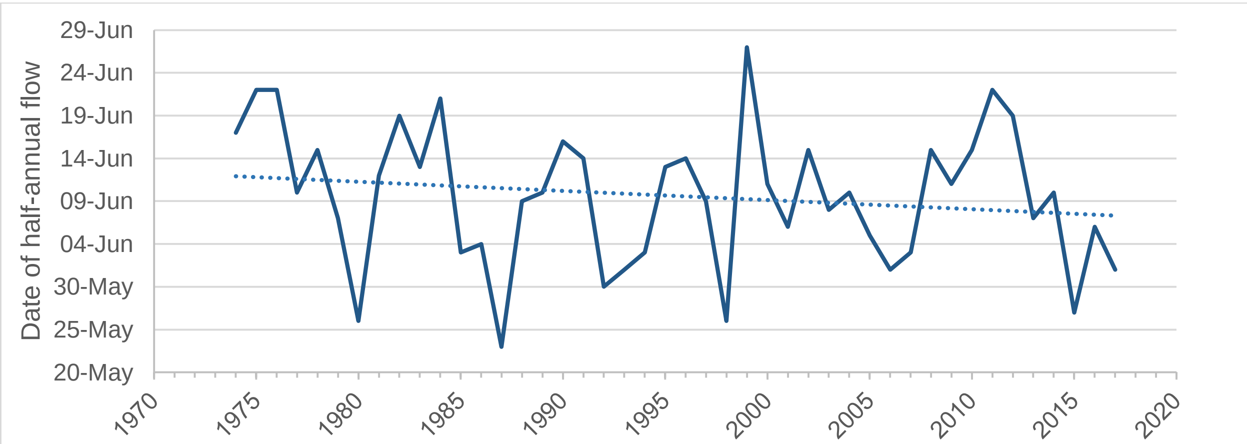

Figure 15: *Date of half-annual flow volume and trend for Lemon Creek. Trend is not statistically significant (<95% confidence level).*

Stream flow volume

McDermid Creek

The lack of long-term gauging on McDermid Creek or near-by, similarly sized watersheds in the South Slocan area limit the investigation of current trends in flow volume. Environment Canada discharge data from the 1960s indicates that peak flows on McDermid Creek were in the order of 0.23 to 0.26 m^3/s and low flows were so low as to not be detectable at the gauging sites (0.0 m^3/s).[28] The lower annual average flow volume in McDermid Creek likely reflects the relatively lower snowpack associated with the low elevation slopes in this watershed. Projections for warmer, wetter winter and spring months could result in further decreases in the late winter to spring snowpack volume in McDermid Creek, leading to decreased spring freshet runoff.

Springer Creek

Using Environment Canada data,[29] there are no trends in annual maximum daily flow volume or the half-annual flow volume for nearby Lemon Creek; however, a statistically significant negative trend was noted in summer low flow volume (Figure 16). The trend indicates low flows have decreased over time since gauging began in 1973. A similar trend in low flow volume is also apparent on the Upper Kaslo River (Env. Can. station #08NH132), which is the closest gauging site with concurrent discharge records. In both cases the negative trend can be related to the influence of high summer low flows that occurred from the mid 1970s to the early 1980s. A longer period of gauging is needed to determine if this trend will persist or if it is a function of decadal climate oscillations.

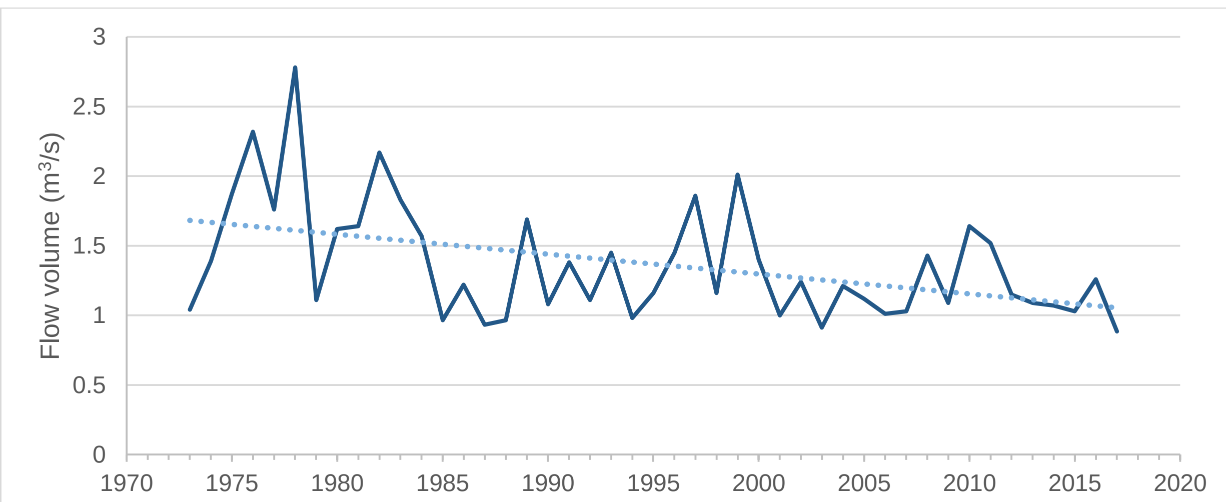

Figure 16: *Minimum daily discharge for Lemon Creek shows a decreasing trend that is likely extenuated by high summer low flow volumes in the mid-1970s and early 1980s.*

Groundwater levels

The RDCK’s Rosebery water system is a groundwater system. There is limited groundwater data available on this system. In March 2018, the static water level was 39.44 meters. In August 2019, the static water level was 40.08 meters.

Source water temperature

Temperature can be an important determinant of water quality. Records of source water temperature are available for the RDCK South Slocan water system starting in February 2011. This record is too short to provide reliable trend analysis but can offer baseline information for future comparison. The average annual water temperature for this system is 9.2°C.[30] However, maximum summer temperatures often near or exceed 15°C—an aesthetic drinking water objective set by Health Canada (Figure 17).[31] The frequency of temperature recording has decreased over the nine-year record from roughly 12 measurements per month near the start of the record to only four per month in recent years.

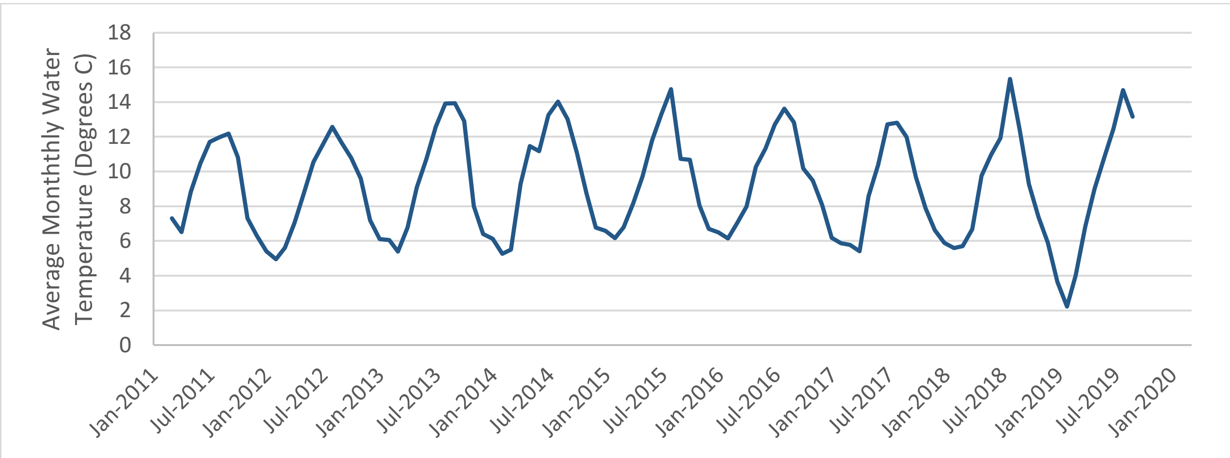

Figure 17: *Average monthly water temperature at the RDCK South Slocan water system*

Source water turbidity

Higher turbidity associated with snowmelt and high stream volumes during spring freshet may result in boil water notices or water quality advisories. A turbidity reading less than one NTU is considered good quality, between one to five NTU is rated as fair quality, and a reading greater than five NTU indicates poor drinking water.[32] Turbidity measurements have been recorded for the South Slocan Water system since August 2010.

From 2010 to 2019, the turbidity values reported were highly variable.[33] Average monthly turbidity ranged from 0.33 NTU to 1.35 NTU and shows peaks during spring snowmelt and early summer rain events, as well as during some fall storms. Over the nine-year record, 82% of measurements indicated good water quality with less than one NTU. 17% of average monthly turbidity readings indicated fair water quality, and 1% of average monthly turbidity indicated poor water quality conditions.

The most recent year with complete records available, 2018, had average monthly NTU values with fair quality from February to April. The rest of the year had NTU values below one NTU, indicating good water quality (Figure 18). This data is useful for setting a baseline against which future measurements of source water turbidity can be compared.

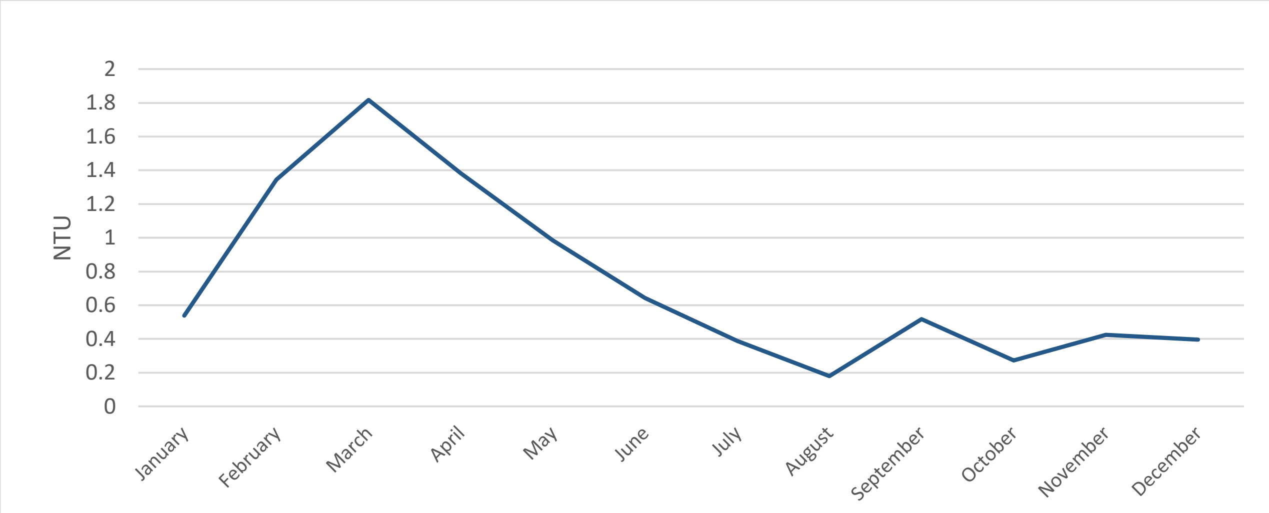

Figure 18: *Average monthly turbidity of South Slocan water system in 2018*

Adaptation Actions and Capacity Building

Policies to reduce water consumption

The RDCK employs a range of water conservation policies and measures for the drinking water systems it owns and operates. For example, 4 out of 19 water systems run by the RDCK have universal water metering. One of these systems – Rosebery – is located in Area H. Only two RDCK systems have volumetric billing in place, neither of which are in Area H. Although Rosebery has universal metering, metered billing has not occurred because the community is only partially developed and water demand is low. The level of implementation for a full suite of actions to address water system leakage for the entire RDCK is included below (

Table 9). Of note, the RDCK Board adopted a *Drinking Water Conservation Plan* in May 2019. In this plan there are many steps proposed to address water consumption and conservation practices, including a Water Loss Control and Leak Reduction Program.

Table 9: *Implementation of policies to reduce water consumption for all of RDCK.*

Policy/Practice	**Level of Implementation**			
	Full	Moderate	Minimal	None
Universal water metering[i]	☐	☐	☑	☐
Public education and outreach on water conservation[ii]	☐	☑	☐	☐
Public education and outreach on water consumption trends	☐	☐	☑	☐
Water meter data analysis	☐	☑	☐	☐
Consumer billing by amount of water used (volumetric)[iii]	☐	☐	☑	☐
Implementation of water utility rates sufficient to cover capital and operating costs of water system[iv]	☐	☐	☑	☐
Water conservation outcome requirements for developers	☐	☐	☐	☑
Water conservation targets[v]	☐	☐	☑	☐
Stage 1 through 4 watering restriction bylaw	☑	☐	☐	☐
Enforcement of watering restriction bylaw[vi]	☐	☑	☐	☐
Drought management plan	☐	☐	☐	☑
Actions to address water system leaks:				
Targeted leak repair[vii]	☐	☐	☑	☐
Water operator training	☑	☐	☐	☐
Replacement of aging mains[viii]	☐	☐	☑	☐
Addressing private service line leakage[ix]	☐	☐	☑	☐
Pressure management solutions	☐	☐	☑	☐

i. Four of 19 systems have universal metering – Rosebery is the only one in Area H. A Water Metering Strategy is in development.
ii. Nine water systems participate in the Water Smart program – South Slocan is the only one in Area H.
iii. Only two systems – Grandview Heights and Lucas Road. Balfour will be added in 2020.
iv. Many systems are underfunded. Asset management planning has brought awareness to the state of "hidden infrastructure" in order to help support increases in parcel taxation to cover infrastructure costs.
v. Establishing water system targets is part of the Drinking Water Conservation Plan. Targets specific to water systems are in process. There is an overall target of 20% reduction.
vi. This bylaw is enforced more in Water Smart communities. Enforcement is limited due to staff capacity.
vii. Repairs occur when leaks are known.
viii. Mains replacement is tied to grants. Progress is made whenever money is available.

ix. Although not responsible to help, will provide homeowners with guidance and direction about what to do.

Source water protection plan and climate change

The RDCK has no source water protection plans at this time. However, a larger Regional Watershed Governance Initiative has started for the RDCK. This initiative may inform how to address source water protection plans. The Regional Watershed Governance Initiative scoping study final report is due at the end of January 2020.[34]

Water loss detection practices

Nine RDCK communities participated in the Columbia Basin Water Smart program, with South Slocan as the only one in Area H. Part of this program supports capacity building for water loss detection. For the RDCK, water loss detection is minimal or non-existent. However, the RDCK addresses this in their newly adopted *Drinking Water Conservation Plan*.[35] The RDCK presently conducts water audits and interventions only as time allows or issues arise. Leak detection equipment, such as a noise correlator, is expensive and there are no specific budgets for leak detection work. However, a formal Water Loss Control & Leak Reduction Program will be established to help address water system leaks.[36]

Table 10: *Implementation of water loss detection practices for all of RDCK's 19 water systems*

	Level of Implementation			
	Full	Moderate	Minimal	None
District water meters[i]	☐	☐	☑	☐
Residential water meter[ii]	☐	☐	☑	☐
Night flow analysis	☐	☐	☐	☑
Water loss audits[iii]	☐	☐	☑	☐
Acoustic leak detection[iv]	☐	☐	☑	☐
Leak noise correlation testing	☐	☐	☐	☑

i. *Only for 2 systems – none in Area H*
ii. *Only for 3 systems – Rosebery is only one in Area H*
iii. *Only for 1 system – none in Area H*
iv. *Only for 2 systems – none in Area H*

Community Impacts and Adaptation Outcomes

Per capita water consumption

This indicator measures water use attributable to user demand and system water loss. The RDCK tracks per capita water consumption, but year to year data is limited. As such, the RDCK reports per capita water consumption based on the year with the highest consumption data. See Table 11.[37] The provincial average for total municipal water system use is 494 litres per person per day.[38]

Table 11: *Per capita water consumption for RDCK water systems in Area H*

RDCK Water System	Consumption (L/capita/day)	Year
Denver Siding	1250	2015
Rosebery	945	2017
South Slocan	943	2017

Drinking water quality

Drinking water quality can be adversely affected by source water quality issues caused by the higher air temperatures, more extreme precipitation patterns, or more rapid snowmelts that may accompany climate change.[39] Reviewing water quality data is complex in Area H due to the vast number of systems that serve the area (Figure 14**:** Area H watersheds and water systems). Water utilities are required to notify residents of high turbidity and/or the presence of pathogens in drinking water. The frequency of notices could increase with climate change due to potential changes in surface water quality associated with rising temperatures or more rapid runoff.

Using data from the Interior Health Authority (IHA) between the year 2000 to mid-July 2019, 20 water systems in Area H experienced a total of 32 Water Quality Advisories (WQA) or Boil Water Notices (BWN). Most of these were issued for private systems, with one BWN recorded for the Roseberry Highlands water system for 22 days in the summer of 2015 and a BWN for the South Slocan water system between 1992 and 2010 (prior to the implementation of sufficient water treatment) and again for 9 days in February 2015. Thirteen of the 32 advisories have been short, lasting less than one year, while an additional 13 lasted between one and ten years. The remaining 9 advisories were open for longer than 10 years.[40] No trends in the annual number of water advisories are evident at this time.

The two private water systems of interest in this report – Krestova and Brandon Water Improvement Districts - have both been under boil water notices since 1992 and 2003, respectively.[41]

Unfortunately, the detailed cause of water advisories is not specified in the dataset provided by IHA making it difficult to link water quality issues to weather conditions. Additionally, there are some inconsistencies among the IHA dataset, IHA's drinking water advisory website (www.drinkingwaterforeveryone.ca), and information from local governments about water system names and the status of water advisories. IHA provides a disclaimer with the dataset that accuracy issues may exist within the data. As an example, the RDCK Denver Siding water system is on a permanent boil water advisory due to it being an untreated surface water source that is susceptible to rockslides and sediment intrusion. At the time of writing, this BWN did not appear in IHA's dataset and had no water advisory listed on the IHA website.

To address the water quality issue at Denver Siding, the RDCK is currently reviewing the feasibility of amalgamating this water system with the Village of New Denver water system to improve drinking water quality.[42]

Watering restrictions

Watering restriction bylaws provide a tool for utilities to reduce their vulnerability to water supply challenges. By tracking the need to implement these restrictions, water operators can better understand how climate change may be affecting supply and demand. In the RDCK, stage one water restrictions go into effect every year from June 1st to September 30th regardless of seasonal weather patterns. If conditions require further conservation measures, the RDCK will move through stages two to four as necessary. Each water restriction stage regulates the times water use is allowed or if certain water uses are prohibited.[43] Water restrictions are enforced, with more enforcement occurring in Water Smart communities. More resources for enforcement are desired by the RDCK. Between 2012 and 2019, of the three RDCK water systems within Area H, only South Slocan moved beyond stage one watering restrictions at any point. Over the past six years, the RDCK has implemented an annual average of 31 days of stage two restrictions for the South Slocan system (Figure 19).

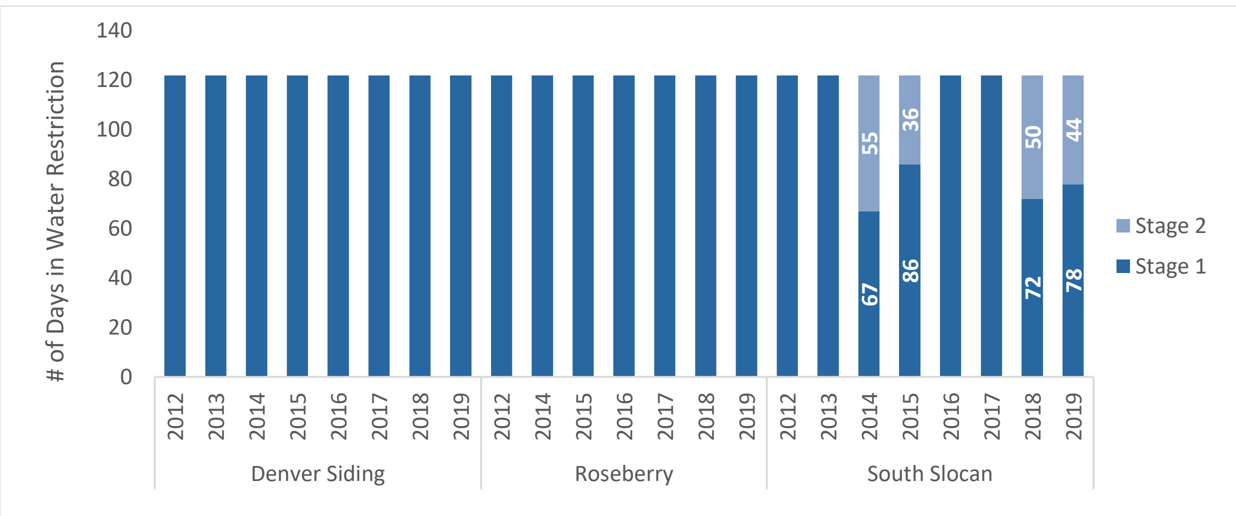

Figure 19: *Number of days under water restrictions for the three RDCK water systems in Area H*

No data on water loss

Accurate water loss records do not exist for Area H due to minimal or no water loss detection practices.

FLOODING

Projected climate changes, including more intense rainstorms, warmer wetter winters, and more precipitation in spring indicate a potential for increased flooding in snowmelt watersheds. Alterations to forest cover through wildfire, disease and logging can alter the processes of snow accumulation and melt rates in snowmelt watersheds, which can also increase the occurrence of flooding. Increased frequency of flooding is a concern for the community of South Slocan, which is situated, in part, on the floodplain of the Slocan River and has historically experienced flooding. The community of Lemon Creek is also vulnerable to flooding. In addition to representing a risk to life and property, increased flooding can impact water quality due to increases in turbidity. Recognizing how the flood regime is changing allows communities to improve infrastructure and establish flood mitigation measures. Indicators for the flooding pathway include the timing and volume of annual maximum daily discharge and half-annual flows as well as changes in the frequency of annual maximum daily discharge for Lemon Creek and Slocan River at Crescent Valley.

The Overall Picture

The Slocan River and Lemon Creek are high elevation watersheds in which extreme floods are a function of rapid snowmelt from areas above approximately 1800 metres elevation. Historical stream flow records indicate there have been no substantial changes to the volume or timing of maximum annual flows or the frequency of floods on the Slocan River or Lemon Creek. The largest flood on record in Lemon Creek occurred June 18th, 1974, which followed a period of high temperatures in mid-June that triggered rapid melt of a higher-than-average snowpack. The highest flood recorded over the past 90 years on the Slocan River occurred on June 7th, 1961; it followed an extended period of high temperatures in late May and early June. The projected trend toward higher average spring temperatures and higher spring precipitation may drive earlier snowmelt in these high elevation watersheds, but the potential for increased flooding may be partially mitigated by a declining trend in spring snowpack at lower elevations. The RDCK is actively addressing flood risk by completing flood and steep creek hazard assessments and updated floodplain mapping.

Climate Changes

As discussed in the Climate and Extreme Weather sections, trends toward more extreme rainfall have not been confirmed for climate data for Area H locations. However, unprecedented precipitation events have made significant impacts on areas in the region in recent years. An analysis of average annual and seasonal precipitation data and future projections shows rising annual, spring, winter and fall precipitation and declining summer precipitation.

Freeze-thaw cycles are declining

The frequency of freeze/thaw cycles is an important parameter for engineering design in cold regions. This climate index is measured by the annual sum of daily fluctuations between -2°C and +2°C. Estimated historical data for Area H locations show the average annual number of freeze-thaw cycles in Krestova and Valhalla has been on the decline, with no apparent trend in Silverton; however, these trends fall below the 95% confidence level. Annual daily freeze/thaw cycles are projected to decrease in all locations through the rest of the century. For Krestova and Silverton, the biggest rate of decline is projected to occur during the winter season, whereas for the Valhalla location this is projected to occur in the spring season. The winter season in the Valhalla location is projected to see an increasing trend in daily freeze-thaw cycles per century under both high and low carbon scenarios.

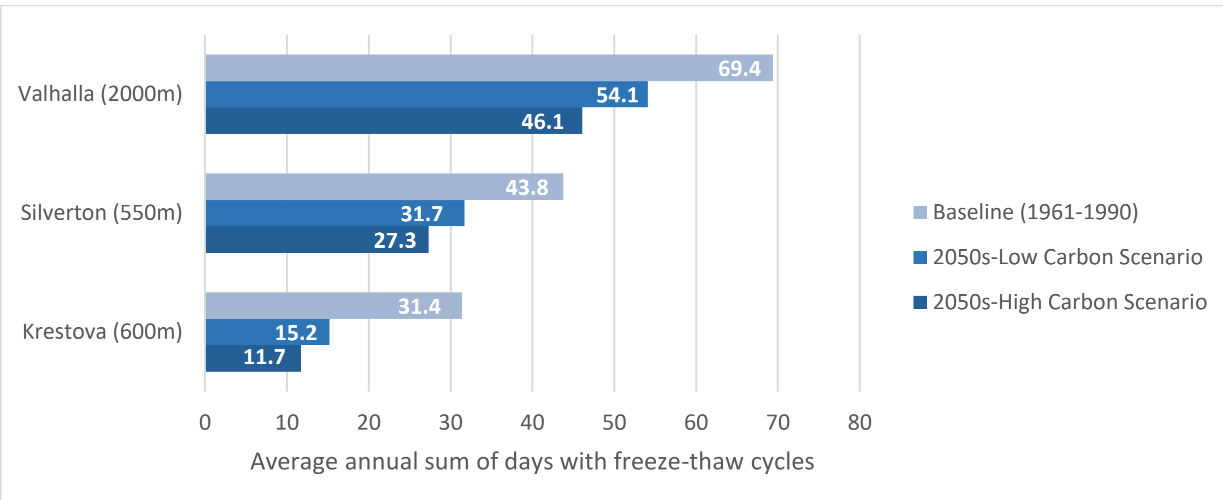

Figure 20: *Baseline and projected changes to average annual sum of days with freeze-thaw cycles, in days*

Environmental Impacts

April 1st snowpack is declining

Springtime snowpack provides some indication of how much meltwater will be available to feed creeks in the early summer months, relevant to both water supply and flooding. The April 1st snowpack data for Area H is available for both low and high elevation sites in the Selkirk Mountains.[44]

The low elevation Sandon site is a manual snow survey site dating back to the late 1930s located at an elevation of 1070 meters. The high elevation site is an automatic snow pillow site located at an elevation of 2100 metres in Redfish Creek that started recording in 2002. A third site, Grano Creek, situated at just over 1800 metres west of Arrow Lake, offers additional information for snowpack trends likely in the drier portions of Area H such as the South Slocan and Krestova areas. The data set for the Grano Creek site reveals a downward trend in April 1st snow water equivalent (SWE) over the last 20 years but the trend is not statistically significant at the 95%

confidence limit (Figure 21). Regardless of the lack of statistical significance the trend at the Grano Creek site suggests that over the past 20 years since gauging began the average April 1st SWE has decreased by approximately 84 mm.

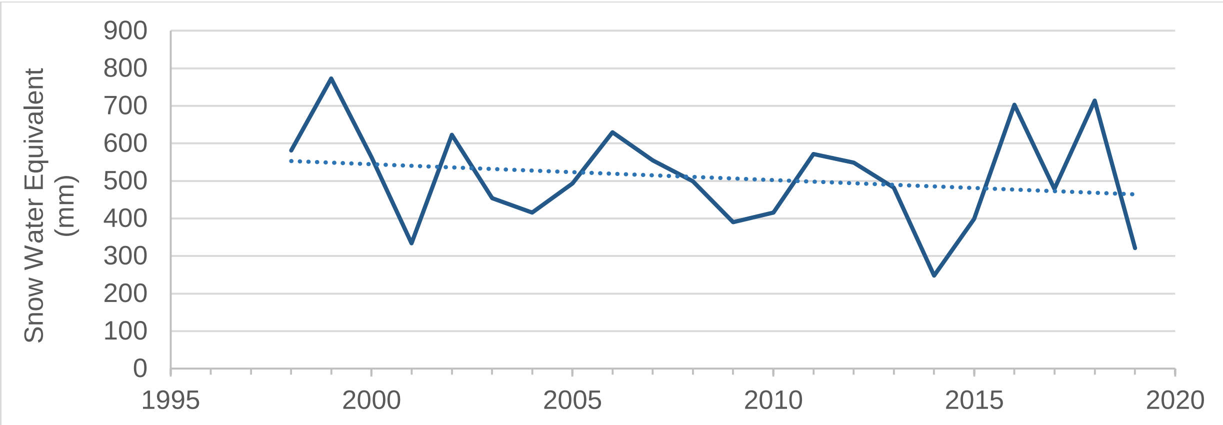

Figure 21: *April 1st snow water equivalent (SWE) and trend line at Grano Creek snow pillow site. Trend is not statistically significant (<95% confidence level).*

The data at the low elevation Sandon site also reveals a downward trend in April 1st SWE, but this trend is also not statistically significant at the 95% confidence level (Figure 22). In contrast, the high elevation Selkirk Mountain Redfish snow pillow site reveals an increasing trend in April 1st SWE, although also not statistically significant (Figure 23). Regardless of statistical significance, the trends are consistent with climate model projections for the West Kootenay region that forecast increases in winter and spring precipitation and spring temperatures that would result in greater snow accumulation above 2000 meters and relatively lower accumulation for areas below this. A longer record of high elevation April 1st SWE is needed to confirm the significance of the increasing trend suggested in the 18-year record for Redfish.

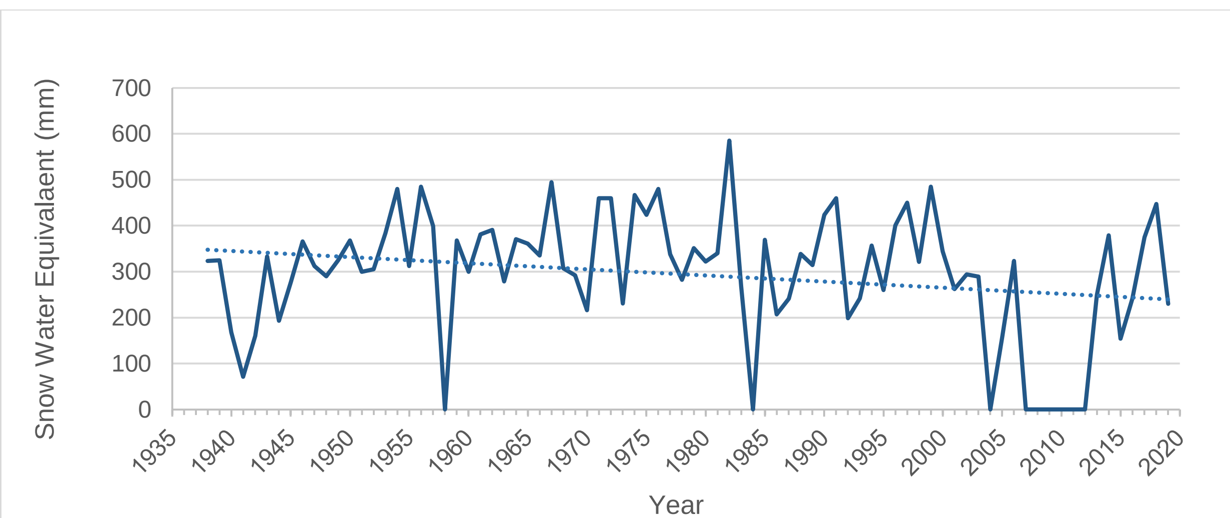

Figure 22*: April 1st snow water equivalent (SWE) and trend line at Sandon manual snow survey site. Trend is not statistically significant (<95% confidence level).*

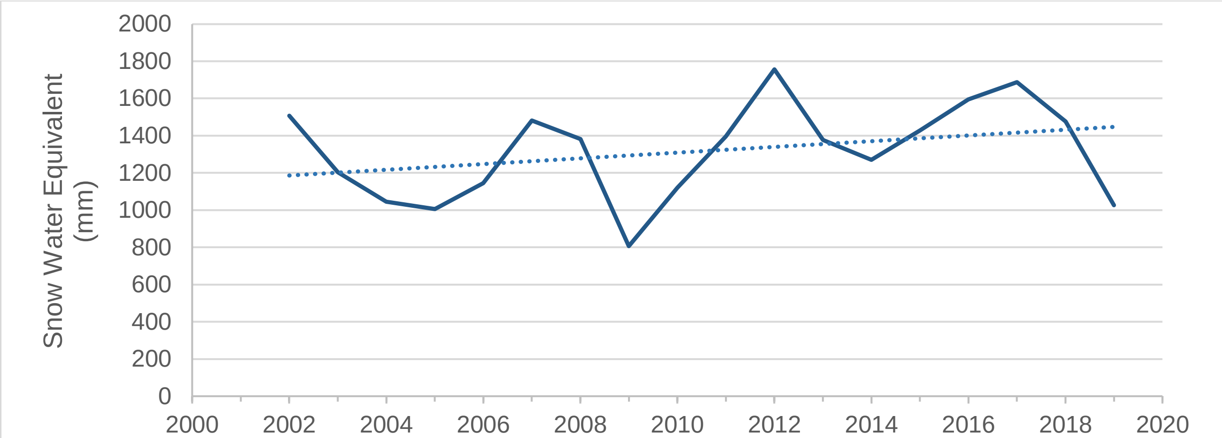

Figure 23: *April 1st snow water equivalent (SWE) and trend line at Redfish snow pillow site. Trend is not statistically significant (<95% confidence level).*

No/minimal trend in stream flow timing

Using data from Environment Canada,[45] trend analyses were completed on Slocan River and Lemon Creek to explore stream flow timing within Area H. In alpine-driven fluvial systems such as the Slocan River and Lemon Creek, projected climate trends are unlikely to affect the timing of spring peak flows, which are controlled primarily by seasonal solar radiation inputs. In contrast, lower elevation watersheds such as Goose Creek could experience shifts in timing of spring flooding in response to more frequent rain-on-snow and/or landcover disturbance. Results of the analysis indicate there is no trend in the timing of flows for the Slocan River at Crescent Valley or Lemon Creek. As previously discussed in the Water Supply Pathway, the half-annual flow volume has advanced, on average, 4.6 days compared to when gauging began in 1974. A more detailed investigation is needed to determine what is causing the trend given there are no detectable trends in the timing of either maximum daily (Figure 24) or summer minimum flows. If it is a longer-term trend associated with climate change, the earlier melt of the high elevation snowpack, suggested by the advance of half-annual flow, could translate to a reduction in the likelihood of extreme flood events, which have historically been caused by the rapid melt in late-spring of high-elevation snow packs.

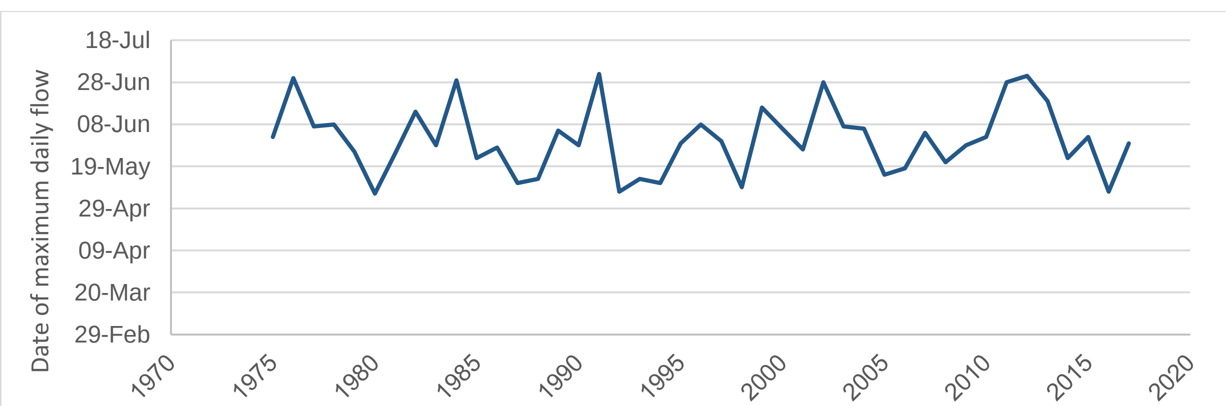

Figure 24: *Date of maximum daily flow for Lemon Creek*

No/weak trend in peak stream flow volume

Using data from Environment Canada,[46] trend analyses were completed on peak stream flow volume for both Slocan River and Lemon Creek. Trends in the time-series of annual daily maximum flow volume (peak flow volume) could indicate changes in the meteorological factors generating the peak flows (i.e. solar radiation vs rain-on-snow). There is no trend in the volume of flow for the Slocan River at Crescent Valley (Figure 25). The 43-year record of stream flow gauging on Lemon Creek is not sufficiently long to discern long-term climate change effects from decadal climate oscillations, but it can provide an indication of the susceptibility of the watershed to climate and/or land cover disturbances. The Lemon Creek trend analysis of annual maximum daily discharge reveals a weak positive trend in annual maximum daily flow volume that is not significant at the 95% confidence level (Figure 26).

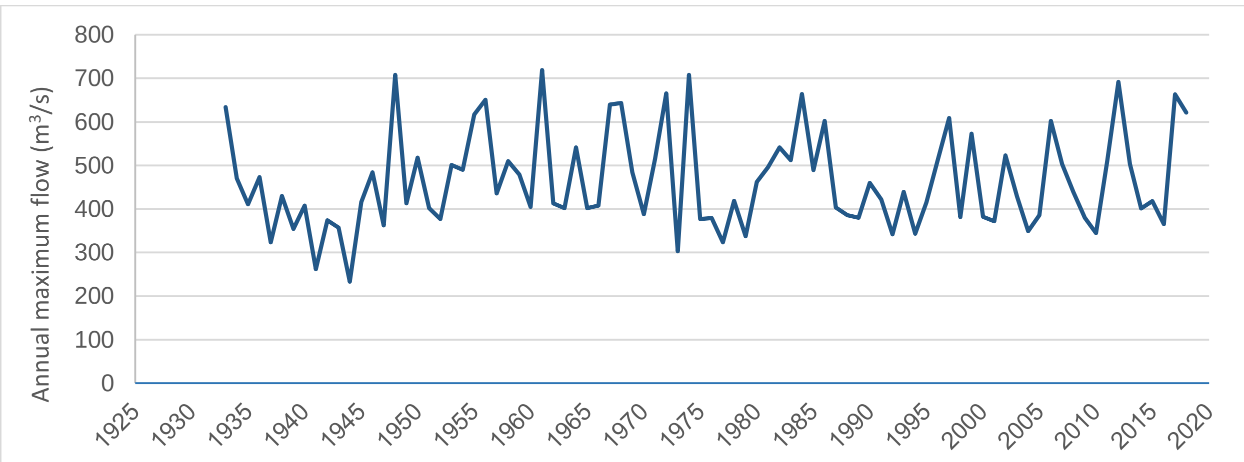

Figure 25: *Annual maximum flow for the Slocan River at Crescent Valley*

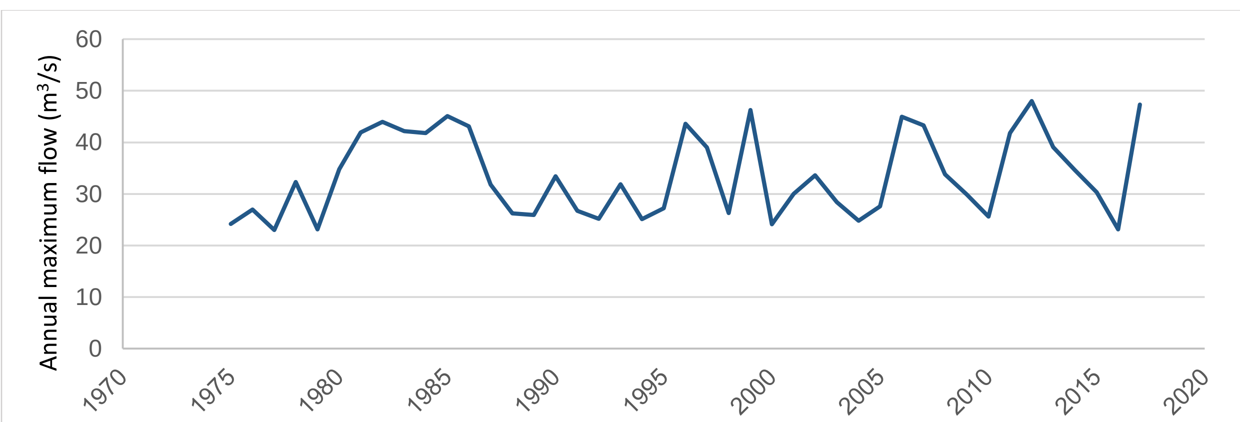

Figure 26: *Annual maximum flow for Lemon Creek*

No changes in flood frequency

To investigate if there have been changes in the frequency of flooding over the years with available data on both the Slocan River and Lemon Creek[47], flood records are divided into subsets and compared (Figure 27, Figure 28). This analysis reveals no changes in the frequency of floods on either Slocan River or Lemon Creek given magnitude between the subsets. For

Lemon Creek, the slight elevation in the more recent flood distribution above the 1973–1997 sub-set, which represents an increase of 7% in the average of the distribution, is not statistically significant and lies within the 95% confidence intervals. A longer record of discharge is required to determine if this upward shift is related to decadal oscillations or to longer-term climate impacts.

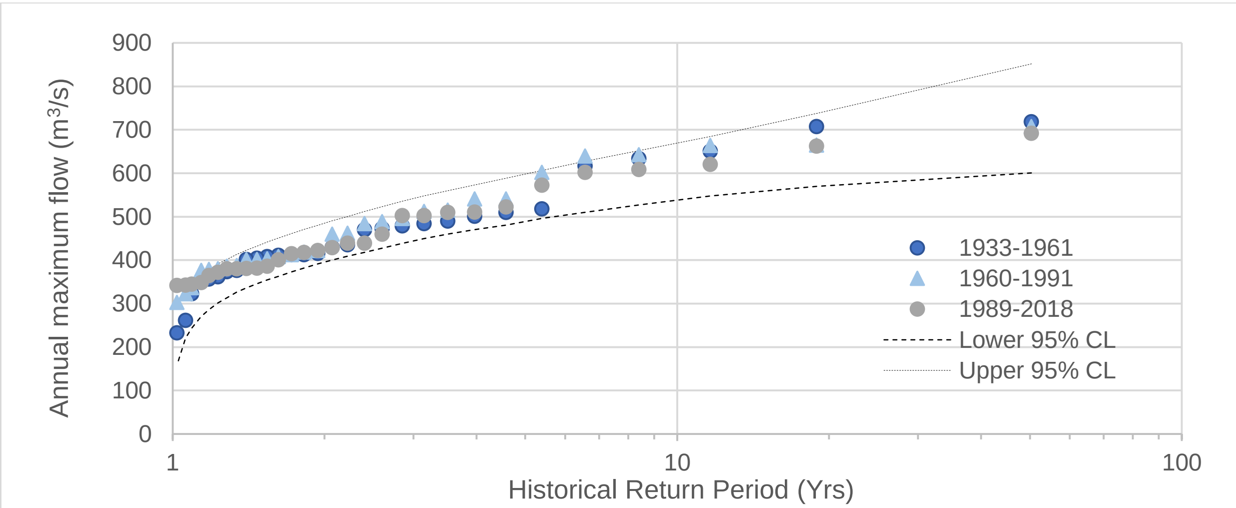

Figure 27: *Flood frequency analysis for three 30-year sub-sets of peak discharge on Slocan River at Crescent Valley using the 95% confidence level (CL).*

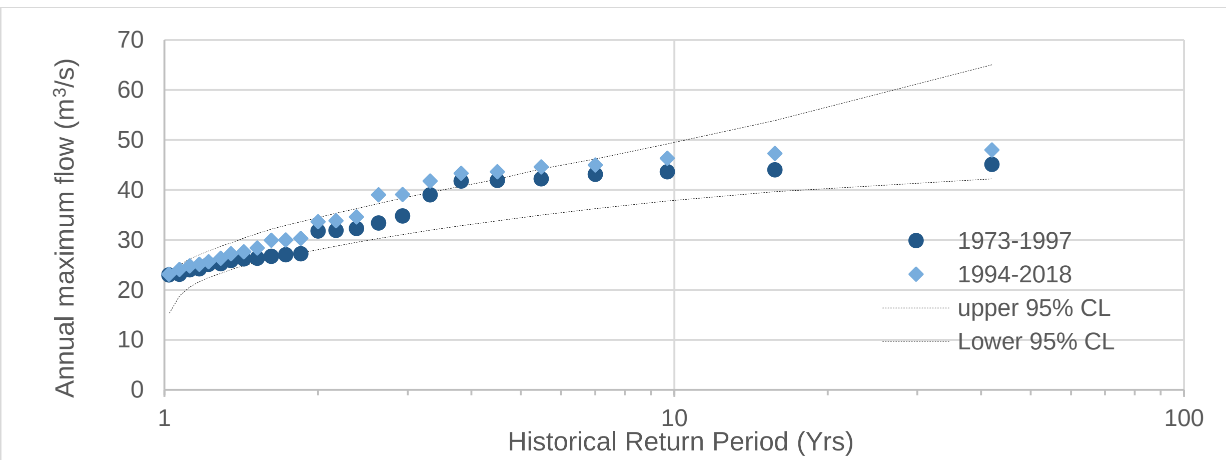

Figure 28: *Flood frequency analysis for two 25-year sub-sets of peak discharge on Lemon Creek using the 95% confidence level (CL)*

Adaptation Actions and Capacity Building

As discussed in the Extreme Weather section, the RDCK has an Emergency Preparedness Plan in place.

Floodplain mapping

The RDCK has started the process of updating its floodplain mapping. A flood and steep creek risk prioritization study was completed by BGC Engineering Inc. in spring 2019. Detailed assessments of ten alluvial fans and six floodplains is taking place across the entire RDCK. Two areas in Area H are being assessed – Slocan River and Wilson Creek. This project is funded by Emergency Management BC and Public Safety Canada under Stream 2 of the Natural Disaster Mitigation Program. Data was collected in the summer of 2019. It is expected that the final maps and reports will be finalized in June 2020.[48]

Flood protection expenditures

Information on spending related to flood protection provides some measure of a local government's efforts to improve their resilience to climate change. Within the RDCK, flood expenditures have been project-based. A $3 million project to better understand flood and steep creek hazard throughout the regional district is presently underway. This is funded through the Natural Disaster Mitigation Program (NDMP). The RDCK previously received $1.4 million from NDMP for earlier phases of this work (2017 to spring 2019). An additional $200,000 was received by the Union of British Columbia Municipalities (UBCM) Community Emergency Preparedness Fund for floodplain mapping in 2019. This totals $4.6 million in projects related to flood protection since 2017.[49]

Community Impacts and Adaptation Outcomes

Provincial emergency assistance data

As discussed in the Extreme Weather section, monitoring emergency assistance funding issued by the province can provide some measure of the economic impact of disaster and associated recovery over time. Since 2015, the RDCK has received $575,810 in provincial emergency assistance from EMBC for flooding events. Of this, $564,183 accounted for flooding events throughout the RDCK region that may include flooding events in Area H. The largest payment from EMBC was for the "2018 freshet" valued at $348,777.[50]

Dwellings in the floodplain

Understanding how many dwellings are within the floodplain will permit a more accurate assessment of flood risk and help planners understand whether new development policies are needed to support community resilience to flooding. According to current RDCK floodplain mapping, there are 160 properties in Area H that fall within the floodplain.[51] This figure should be reassessed upon completion of the updated floodplain maps discussed above.

Flood-related highway closures

There are no records of flood related highway closures in Area H since the launch of the Drive BC monitoring program in 2006. Closures related to mudslides are reported in the Extreme Weather Pathway.[52]

Multiple evacuation notices

Evacuation records from 2006 to 2019 show multiple evacuation notices attributed to flooding in Area H. There were five evacuation orders, five evacuation alerts, and eight declared states of local emergency. Many of these events occurred for flooding along the Slocan River in 2006, 2012, 2017 and 2018. [53]

AGRICULTURE

Climate has a significant, but complex, impact on food growing activities, with some projected climate changes expected to increase productivity and others reducing it. Climate change also has the potential to negatively affect food production in other parts of the world, which means that locally produced food and local food self-sufficiency could become important climate adaptations in coming years. The Agriculture Pathway tracks the climate-related viability of food production and the impacts of climate change on food production by farmers and backyard growers. Area H has a number of small and commercially viable farms. The area has seen a 30% increase in agricultural sales receipts from 2011-2016.[54]

The Overall Picture

A trend toward higher temperatures is influencing the growing climate in the region, with Area H experiencing more growing degree days than in the past and a weak trend toward a longer growing season. Continued monitoring of drought levels will help planners understand how a trend to lower levels of summer precipitation is affecting agricultural viability, local food production, and local water demand. Survey results indicate an enthusiasm for food self-sufficiency, with 70% of respondents cultivating 100 square feet or more for food production.

Climate Changes

As discussed in the Climate and Extreme Weather sections, average annual and seasonal temperatures are increasing, as is annual precipitation. While Area H locations have not yet seen a statistically significant trend in extreme precipitation, projections show it to be increasing, along with more precipitation in winter, spring and fall. Summer precipitation has decreased and is projected to continue decreasing, and both the number and frequency of hot and extreme heat days is on the rise.

Environmental Impacts

Drought index available since 2015

The BC Drought Index is comprised of four core indicators: basin snow indices; seasonal volume runoff forecast; 30-day percent of average precipitation; and 7-day average streamflow. While this data set is too short to infer any trends, initial years will contribute to creating a baseline against which future conditions can be assessed. Area H is contained within the ‘West Kootenay Basin’ of the index. Since 2015, there has been an average of 59 ‘dry’ and 31 ‘very dry’ days in the West Kootenay Basin. The number of days under drought conditions varies greatly from year to year. For example, 2018 was a particularly dry year with 98 days drier than normal conditions, while 2016 was a wetter year with only 70 dry days and no very dry days.[55]

Length of the growing season

A longer growing season[ii] allows for greater diversity of crops (especially crops requiring longer days to maturity), greater flexibility in early planting avoiding late summer drought, and more time for plant growth. Some communities in the Columbia Basin are already experiencing a longer growing season. Estimated historic data for Area H locations (1979-2018) shows a small increasing trend in growing season length of 11.4 and 13.7 days per century for Silverton and Krestova, respectively, but these trends are not statistically significant. During the 1961 to 1990 baseline period, average annual growing season length ranged from 140 days in the Valhalla location to 236 days in Krestova (Figure 29).

By the 2050s, all three locations are projected to have a longer growing season under both low and high carbon scenarios (Figure 29), extending the season by approximately one month. The projected rate of change in the 2050s in a high carbon scenario ranges from +50 days per century in Krestova to +79 days per century at the high elevation location in Valhalla.

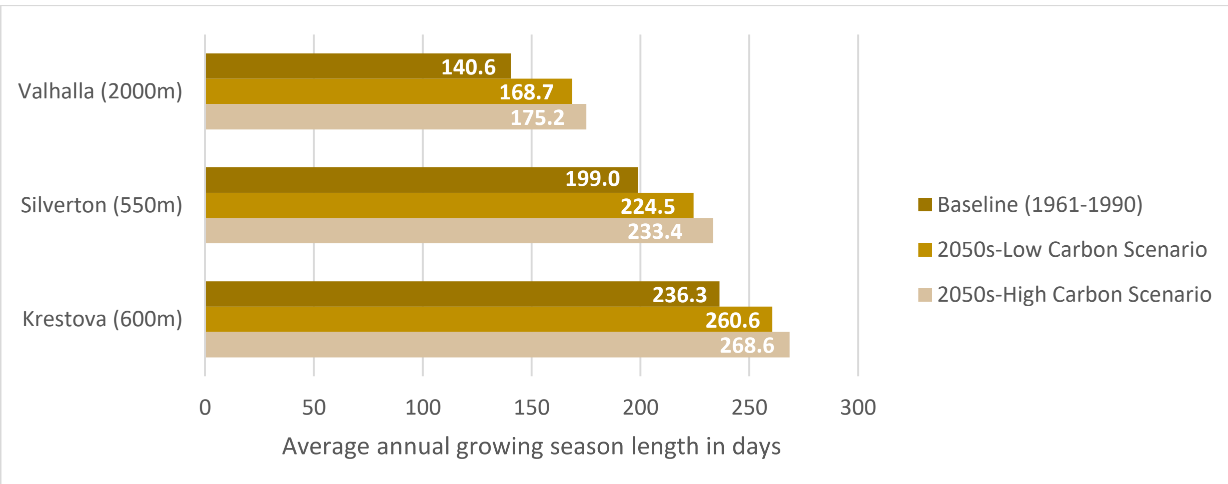

Figure 29: *Baseline and projected changes to average annual growing season length, in days*

Growing degree days

Growing degree days[iii] (GDD) describe the amount of heat energy available for plant growth and provide better insight on how plants are affected by temperatures than straight temperature data. Average annual GDD in the 1961-1990 baseline period (Figure 30) range from 761 GDD for the high elevation location in Valhalla to 2285 GDD for Krestova (Figure 31). The relative projected change in annual growing degree days varies considerably among the three locations, with the

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[ii] For the purposes of this report, growing season is defined as the number of days annually between the first and last five consecutive days with an average temperature of 5°C.

[iii] For the purposes of this report, growing degree days was calculated by multiplying the number of days that the average daily temperature exceeds 5°C (average base temperature at which plant growth starts) by the number of degrees above that threshold. Studies often use different definitions of growing degree days; therefore, caution should be exercised when comparing these results to other research.

Valhalla high elevation location projected to have a 75% increase in growing degree days in the 2050s under a high carbon scenario, and Krestova having a 38% increase.

Growing degree days for Area H locations (1979-2018) are increasing by 620, 817 and 850 GDD per century for Valhalla, Krestova and Silverton, respectively. This rate of increase is projected to rise to 1347, 1974 and 1778 GDD per century, respectively, by the 2050s under a high carbon scenario.

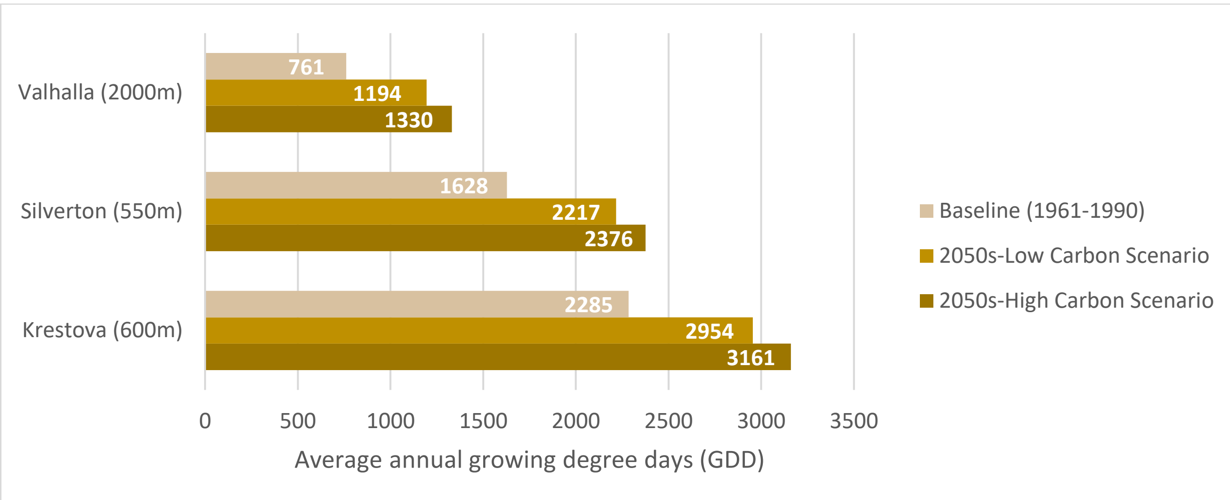

Figure 30: *Baseline and projected changes to average annual growing degree days*

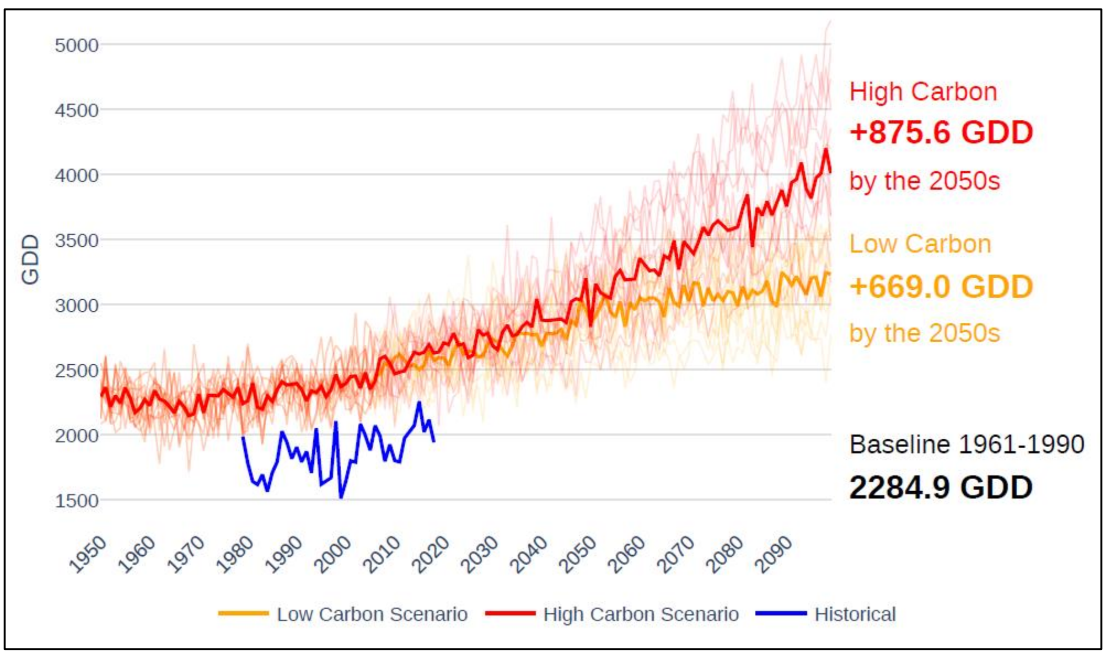

Figure 31: *Historical and projected growing degree days for Krestova*

Consecutive dry days

The average annual maximum number of consecutive dry days for Area H locations show small increasing trends since 1979, however, none of these trends are statistically significant. During the 1961 to 1990 period, the annual maximum number of consecutive dry days ranged from 15.2 days for Silverton to 18.2 days for Krestova (Figure 32). This is projected to increase by the 2050s under low and high carbon scenarios with Krestova seeing the most increase (3.3 days) and Silverton the least (0.8 days), respectively. Projected rates of change in the 2050s indicate statistically significant increasing trends for Krestova and the Valhalla high elevation location of +25 and +10.7 days per century, respectively, in a high carbon scenario.

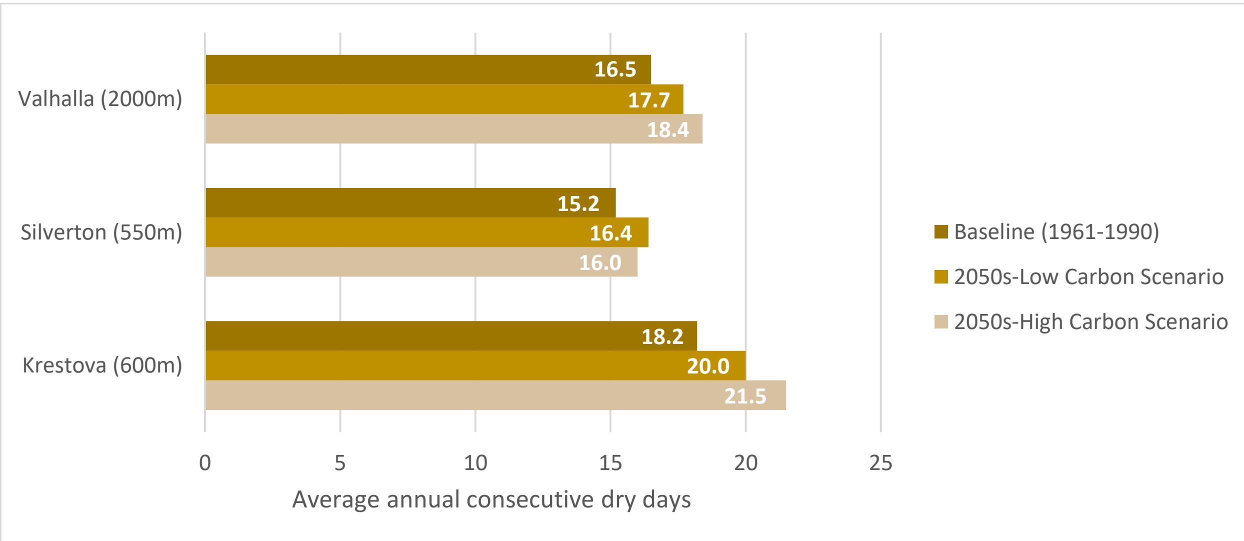

Figure 32: *Baseline and projected changes to average annual consecutive dry days for Area H locations*

Adaptation Actions and Capacity Building

Many residents grow some of their own food

Backyard gardening of edible crops is an indicator of local self-sufficiency and food security. A voluntary survey of Area H residents conducted in the summer of 2019 was completed by 48 respondents and found that home food production is very popular locally, with 97% of respondents growing or raising some of their own food. Garden size (not including fruit trees or berry patches) ranged from less than 5 square feet to over 300 square feet, with 70% of respondents cultivating 100 square feet or more (

Table ***12***). Most gardeners reported growing vegetables (93%), 74% grew fruit, 48% grew herbs, and 11% grew nuts. The most popular items grown were tomatoes, squash, carrots, herbs, peas, raspberries and strawberries. Composting is very common among residents with 96% composting food scraps and 92% using compost in their food gardens. Additionally, 29% of respondents reported keeping livestock, including chickens, quail, ducks and goats.

__Table 12:__ Area under cultivation (excluding orchards and berry patches) by growers in Area H

Area	% of respondents	# of respondents
Less than 5 square feet	3.7	1
5-15 square feet	7.4	2
15-30 square feet	0	0
30-50 square feet	7.4	2
50-100 square feet	11.1	3
100-200 square feet	18.5	5
200-300 square feet	7.4	2
More than 300 square feet	44.4	12

Amount of area being farmed

There are multiple sources of data that can help determine the area being farmed or the potential area to be farmed. The 2016 Agricultural Census through Statistics Canada reports 342 hectares of land used as crops in Area H. This census report only includes farms that sell at least one type of farm-related product.[56] BC Assessment records 1570 hectares of land used for farming.[57] The farming potential within Area H can be estimated by the amount of land in the Agricultural Land Reserve (ALR). In Area H, the ALR accounts for 4580 hectares.[58] Figure 33 shows how this data is related to each other, and clearly shows the limited area available to be farmed, which rests within the valley bottoms, mostly in the southern portion of Area H.

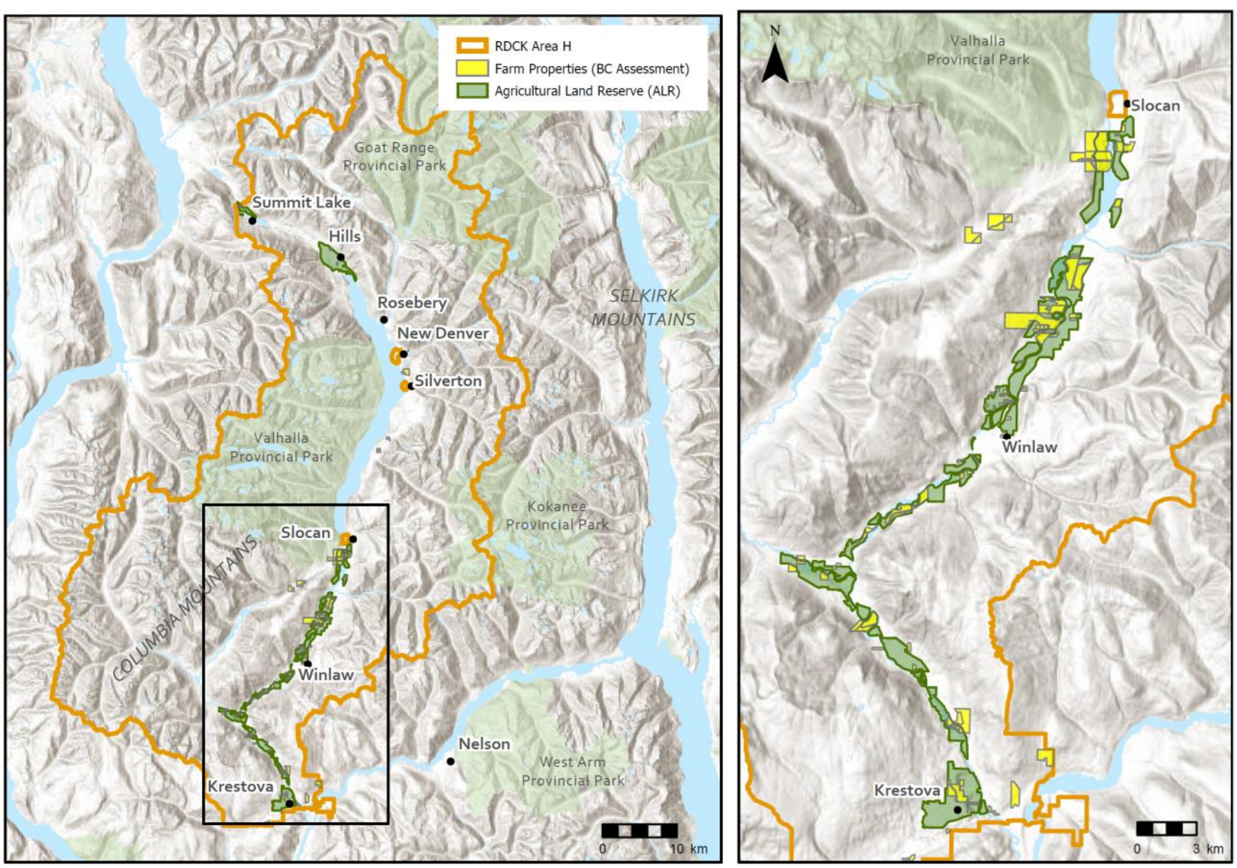

Figure 33: *BC Assessment farm properties and ALR lands within Area H.*

WILDFIRE

Wildfire can cause serious damage to community infrastructure, water supplies and human health, as well as the evacuations of residents and communities. It is projected that climate change may increase the length of the wildfire season and the annual area burned by wildfire due to warmer, drier summers. The Wildfire Pathway tracks fire risks and impacts on communities as well as adaptation actions being undertaken by communities. RDCK Area H is situated in the Arrow Fire Zone, which falls within the boundaries of BC’s Southeast Fire Centre.

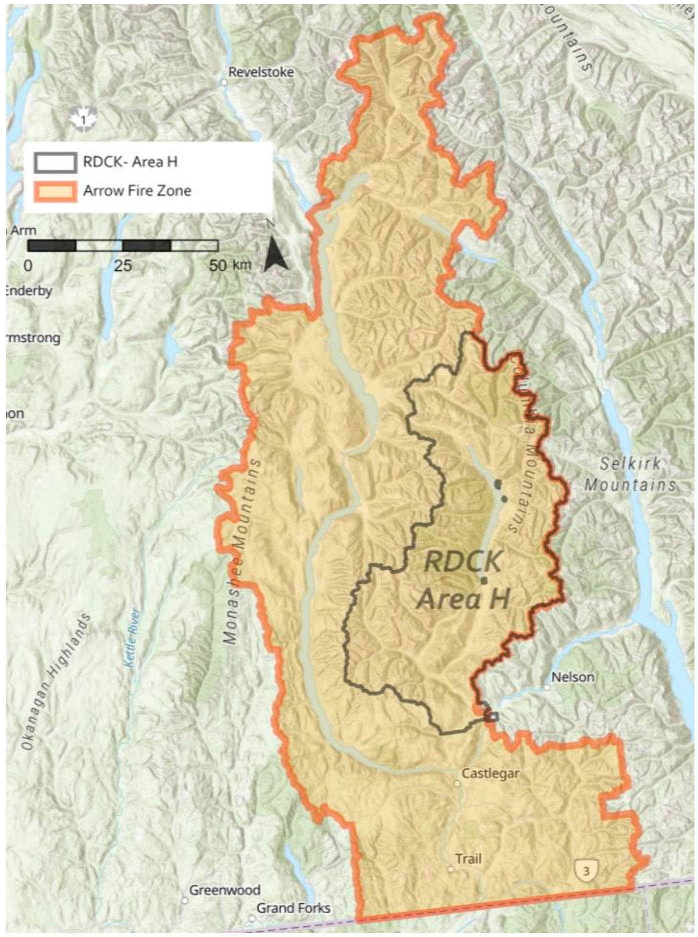

Figure 34*: Area H and Arrow Fire Zone*

The Overall Picture

Wildfires are becoming more frequent at regional and national scales and studies generally suggest that this trend, along with a trend to more area burned, will continue. The active wildfire seasons experienced in 2017 and 2018 highlight the social and economic impacts of fire due to fire bans, evacuation notices and alerts, and road closures. Area H has seen increases in lightning caused wildfires and the number of wildfire starts greater than one hectare. With a history of interface fires in Area H, fire prevention education and fuel management remain important as most human-caused fires occur near communities. The strong commitment to FireSmart programs and the recent release of two Community Wildfire Protection Plans for Area H (north and south) mark another important step in addressing wildfire risk.

Climate Changes

High fire danger

The BC Wildfire Service establishes wildfire danger ratings using the Canadian Forest Fire Danger Rating System. The number of days in the high and extreme danger classes provides an indication of how weather and water availability are influencing fire risk. From 1992 to 2019, the Slocan fire weather station averaged 24.2 days per year with a danger rating of high or above. The greatest number of days above a high danger rating was in 1994 at 65 days, followed by 2017 at 58 days and 2007 at 52 days (Figure 35). The short record for these data and the large annual variability obscure any significant trends at this point. However, other nearby stations with longer records do show significant increases in the number of days above a high danger rating. Stations at Castlegar and Smallwood (near Nelson) both show trends of roughly 0.6 more days of high fire danger each year.[59] These stations emphasize differences in sub-regional climates and are more representative of southern portions of Area H.

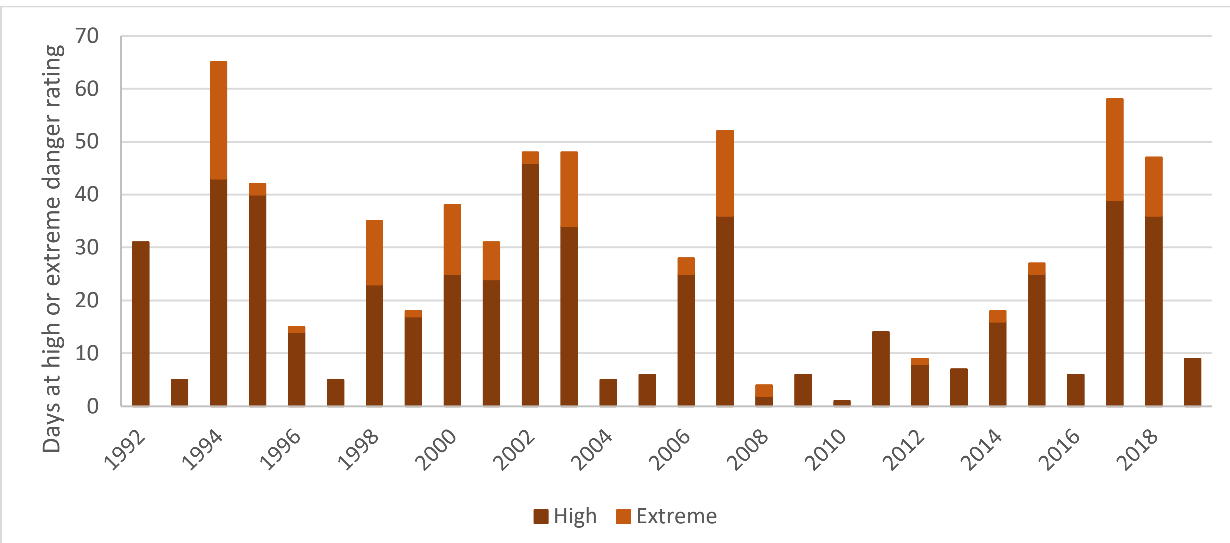

***Figure 35**: Days with high or extreme fire danger rating at the Slocan fire weather station*

Environmental Impacts

Air quality

The air quality indicator reports daily concentrations of fine particulate matter ($PM_{2.5}$) in the air, which can be strongly influenced by wildfire events. High $PM_{2.5}$ concentrations can have significant impacts on human health.[60] There are no air quality monitoring stations in Area H; however, the nearest station in Castlegar can provide some insight on air quality in the region. The worst air quality on record occurred in 2018, with 30 days of $PM_{2.5}$ concentrations above the 24-hour $PM_{2.5}$ air quality objective for British Columbia of 25 ug/m^3.[61,62]

A comparison of Castlegar data from 2016 (a year with minimal wildfire activity) to 2018 (a year with exceptionally high wildfire activity) shows how air quality in our mountainous region is influenced by smoke from wildfires (Figure 36).[63]

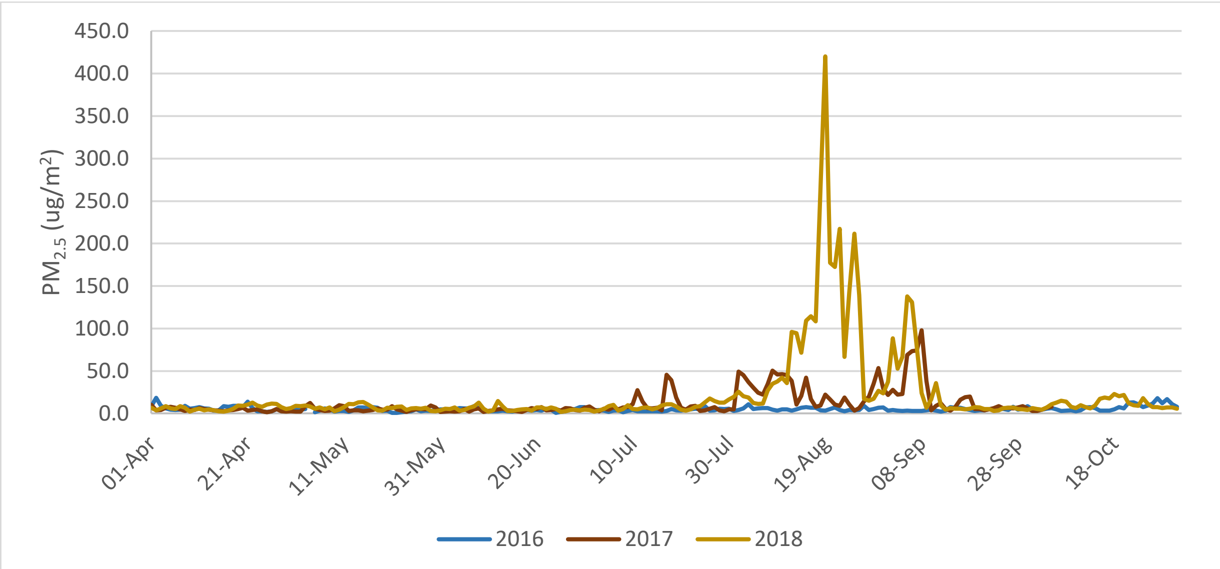

Figure 36*: Daily average $PM_{2.5}$ readings at Castlegar Zinio Park in 2016, 2017 and 2018*

In 2017, the BC Ministry of Environment implemented a Smokey Skies Advisory service to advise communities when they are likely to be affected by wildfire smoke. This smoke modeling initiative does not serve as a substitute for a $PM_{2.5}$ monitoring station but can provide some indication of smoke prevalence. In 2017 and 2018, the Arrow Lakes and Slocan region was under a Smokey Skies Advisory for 43 and 37 days, respectively.[64]

Number of wildfires starts

This indicator tracks the total number of human-caused and lightning-caused wildfire starts per year. Since the mid-1900s, there has been no statistically significant trend in the number of wildfires started annually in the Southeast Fire Centre region. All fire zones in the Southeast Fire Centre and the RDCK show significant decreases in human-caused fires since 1950. Area H shows a significant increase in lightning-caused fires by approximately 10 per year in the 1950s to nearly 20 per year in the 2010s. Area H is the only region in the Southeast Fire Centre showing this trend.[65]

A significant upward trend is present in the number of fires in the Southeast Fire Centre region that grew larger than 1 ha in size (Figure 37). This aligns with recent reports that BC’s fire seasons are becoming more extreme as a result of climate change.[66]

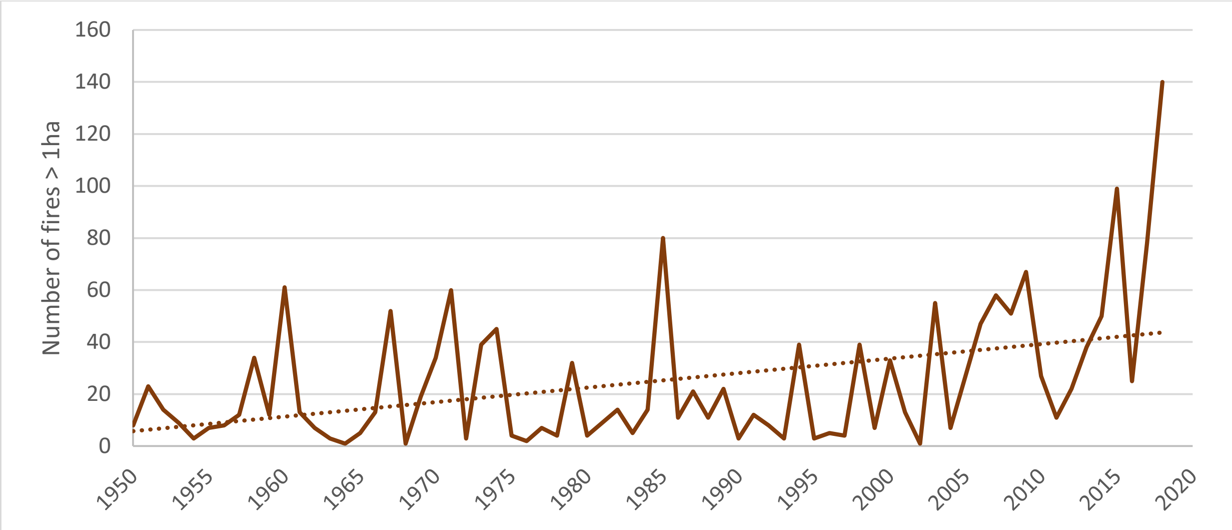

Figure 37*: Fires >1 ha in the Southeast Fire Centre region, 1950-2018*

Two factors may be affecting the identification of trends in the analysis. One is the small geographic scale of the datasets, which may not represent changes in weather patterns that take place over a large geographic area. The second is an issue with data reporting standards, which changed in the late 1990s to exclude suspected fires and smoke traces. This may overinflate estimates of fire starts in earlier years.[67]

The ratio of fires caused by humans vs. lightning can be influenced by both climate and human activities. For Area H, the ratio is consistent with that of the Southeast Fire Centre where, historically, about two-thirds are lightning-caused. On average, there are 19 wildfires starts per year in Area H.

No trend in area burned, but extremes are increasing

This indicator provides a direct measure of how much fire is occurring on a specific landscape over time. The Arrow Fire Zone, which includes most of Area H, experienced severe wildfire seasons in 1985, 2003, 2007 and 2018. In the Arrow Fire Zone and Area H, 2018 was the worst fire season since 1950 in terms of area burned, with over 19,000 hectares of forest burned. Area H has experienced an average of 261 hectares burned annually. Since the onset of provincial wildfire suppression efforts in the mid-1900s, no statistically significant trend can be observed in the annual area burned in Area H, the RDCK, or the Southeast Fire Centre region.

The annual area burned is highly variable and appears to follows a pattern of severe fire seasons occurring roughly every 10 to 20 years.[68] The area burned during severe fire seasons shows an apparent increase at the regional scale, but this is not detected by statistical trend analysis (Figure 38)

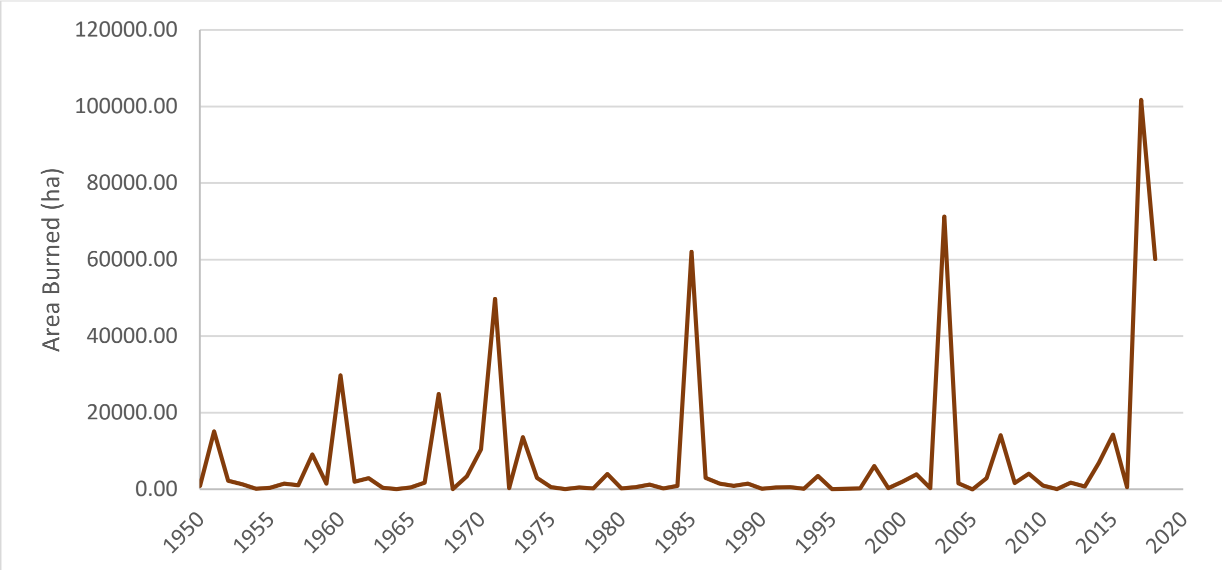

***Figure 38**: Annual area burned in the Southeast Fire Region*

Changes in the size of wildfires may reflect changes in forest management practices as well as changing climate conditions. The value of fire as a natural disturbance regime has been more recognized in recent years, and in some cases, forest managers may be allowing wildfires to grow larger now than in the past.[69] Improved data quality and fire mapping in later years may also be influencing this trend.

Adaptation Actions and Capacity Building

Interface fire fuel treatments

Interface wildfire risk reduction involves assessing and treating high-risk areas to reduce wildfire risk. Community Wildfire Protections Plans have just been completed for Area H. This includes two plans: one for the north and one for the south. Within these plans, just over 14,000 hectares of Area H (21% of the total area of Area H) is classified as high to extreme wildfire threat through the Provincial Strategic Threat Analysis. This analysis evaluates the conditions necessary for a wildfire to threaten a community. Since 2009, 644 hectares of Area H has had fuel treatment. Assuming this treatment takes place in the high to extreme risk areas, this equates to fuel treatment of 5% of high to extreme risk areas.[70,71]

FireSmart recognition

This indicator reports on the number of neighbourhoods and households recognized through Fire Smart Canada's Community Recognition Program and Home Partners Program, providing a measure of citizen involvement in reducing the risk of wildfire to their homes. The RDCK has a comprehensive FireSmart program. In 2018, the RDCK had eight full-time, seasonal Wildfire Mitigation Specialists who conducted education and outreach, collected data, and provided free FireSmart assessments. Through the entire RDCK region, 14 communities are in some stage of the FireSmart Community Recognition Program. There are currently no communities (neighbourhoods) within Area H with FireSmart recognition; however, there are several neighborhoods working towards recognition. In 2018, 79 FireSmart assessments were completed in Area H under the Home Partners Program. There were an additional 24 homes assessed in 2019. Of those, only two have been certified as FireSmart.[72, 73] The RDCK has no Wildfire Hazard Development Permit Areas within Area H.[74]

Community Impacts and Adaptation Outcomes

Frequency of interface fires

This indicator measures the annual number of wildfires that come within two kilometres of address points (Figure 39). Since 1950, Area H has experienced 19 interface fires, with four occurring in 2007 and three in 2017. On average, this equates to less than one interface fire per year and there is no trend evident.[75] Figure 39 also includes the historical fire perimeters in two separate time categories – fires within the last 5 years and fires within the last 6 to 40 years. Past fires within these different time categories will have different impacts on public safety, such as hazards around slope stability and water quality. The greatest hazards come from recent fires and the hazard declines each subsequent year as vegetation re-establishes.[76]

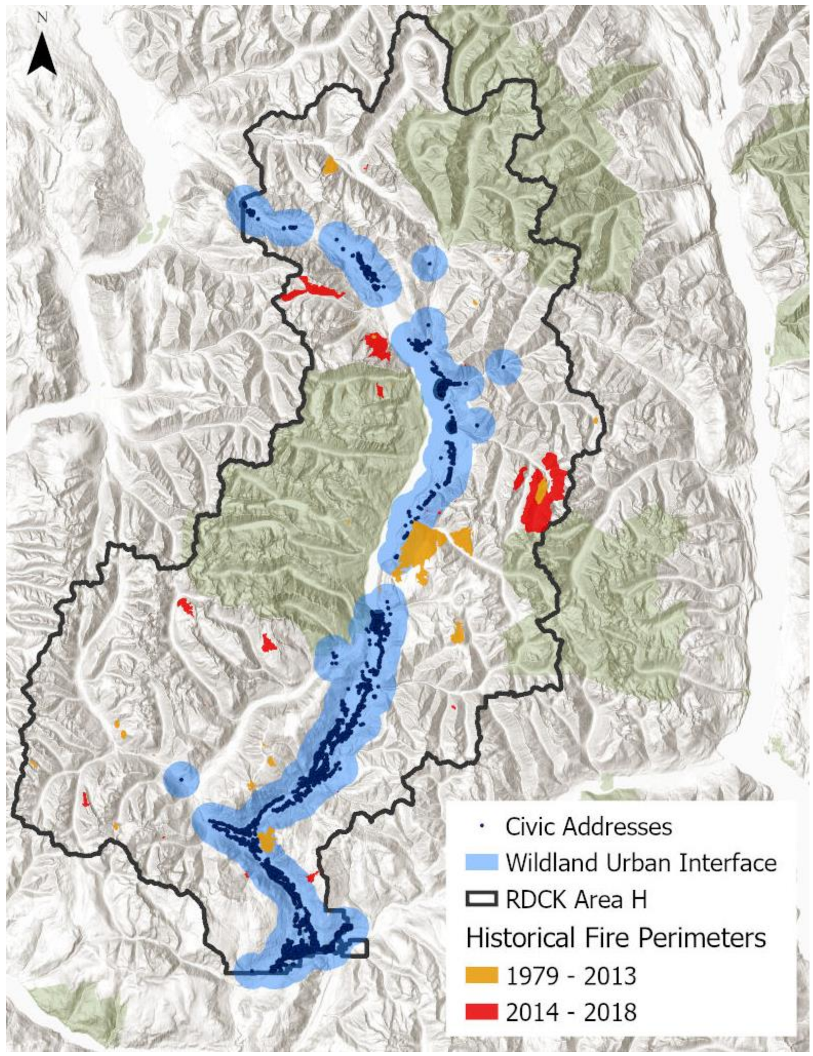

Figure 39*: 2 km wildland urban interface zone around civic addresses in Area H and historical fire perimeters.*

Cost of fire suppression

The average annual cost of fire suppression in the Arrow Fire Zone from 1970-2019 was $2.68 million, peaking at $22.38 million in 2007 and falling as low as $144 in 1976.[77] The cost of fire suppression will vary from year to year and is influenced significantly by prevailing weather conditions. The dataset shows an upward trend over the period of record (Figure 40); however, given that reported values are not corrected for inflation, the true direction and magnitude of this trend cannot be assessed.

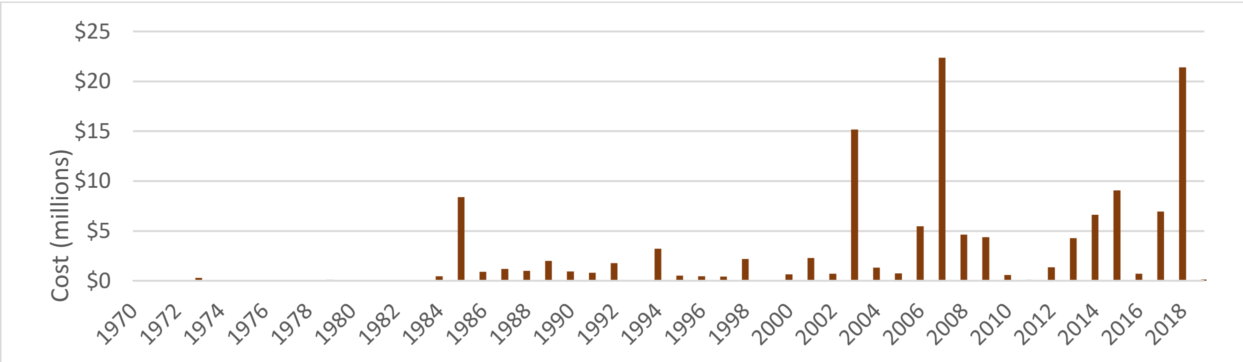

Figure 40: *Annual cost of fire suppression in the Arrow Fire Zone. (Data values from the 1970s are generally too small to show on the scale needed to show data from recent years.)*

Fire-related highway events

In August 2007, a wildfire in the Enterprise Creek area between Slocan and Silverton caused a closure of Highway 6 in both directions for nearly five days. This was one of the worst fire seasons recorded in Area H and is the only wildfire-caused highway closure on record by Drive BC, which has records beginning in 2006.[78]

Provincial emergency assistance

As discussed in both the Extreme Weather and Flooding sections, monitoring emergency assistance funding issued by the province can provide some measure of the economic impact of disaster and associated recovery over time. Since 2015, the RDCK has received $311,823 in provincial emergency assistance from EMBC for wildfire events. Of this, $294,123 was attributed to wildfire events that happened throughout the RDCK region that may include wildfire events in Area H. The largest payment from EMBC for wildfires was for the "2018 wildfires" valued at $228,370.[79]

Annual days under campfire ban

This indicator tracks the number of days annually for which the BC Wildfire Service has issued a campfire ban for the Southeast Fire Centre. It provides a measure of the social cost of the increasing wildfire risk that is projected to accompany climate change. Since 2000, there have been eight years with campfire bans. The longest fire ban occurred in 2017, at 77 days.[80] Long term tracking of this indicator is necessary to establish a trend.

Multiple evacuation notices

Reviewing evacuation records from 2006 to 2019, there are multiple evacuation notices attributed to wildfire in Area H. There were three evacuation orders, six evacuation alerts, and one declared state of local emergency. These events happened in 2007, 2014, 2015, and 2018, with six of the events taking place in 2007.[81]

NEXT STEPS

Action Areas

Assessment results indicate that the RDCK has initiated important steps to adapt to climate change. Areas for further consideration are evident in the data:

- **Wildfire risk reduction**. The recently adopted Community Wildfire Protection Plans for Area H identify priority fuel treatment areas and measures to reduce interface fire risk, which is critical given that 95% of high priority areas are currently untreated. The RDCK's commitment to FireSmart public engagement and education will help Area H residents and neighbourhoods advance their own contributions to wildfire risk reduction in the wildland urban interface.
- **Personal and household emergency preparedness**. Continued encouragement of personal and household emergency preparedness among residents would help foster resilience to the types of extreme weather that are expected to increase with climate change. Local governments have an important role to play in personal emergency preparedness as they are often the 'front line' for residents when disaster strikes.
- **Local food production.** Support local food self-sufficiency, as it can be an important contributor to the resilience of a community, and the enthusiasm for farming and backyard food growing in Area H is evident. At the same time, growing agricultural water demand and climate impacts on water supply and demand during the growing season could result in water use conflicts and shortages in the future, especially in the drier south Slocan region.
- **Water conservation.** Source water monitoring and protection, water conservation targets and education, and leak detection and repair represent significant opportunities to increase the efficient use and resilience of Area H water supplies.
- **Vulnerable populations**. The elderly, chronically ill and the very young are more vulnerable to poor air quality events and extreme heat events. Publicly accessible buildings or refuges are a relatively new idea in most jurisdictions and rural communities may have few locations if any that would be suitable to act as a heat refuge or clean air shelter. While this is not a lead responsibility for local governments, they can play a supportive role in establishing these facilities.
- **Air quality**. Area H does not have air quality monitoring. In the absence of a continuous monitoring station with rigorous data quality control, other communities have considered operation of cost-effective air quality monitoring equipment to gather data on select variables on a seasonal basis. By exploring this opportunity with relevant government agencies, the RDCK may be able to better understand the potential impact of wildfires on human health.

Future Assessments

Though some SoCARB indicators will be monitored on an annual basis, it is recommended that the next full assessment be conducted in five years (2025). In the interim, the RDCK may wish to track certain priority indicators on a more frequent basis to inform planning and decision making on policy, operations and capital expenditures. Many SoCARB indicators are also tracked as part of the State of the Basin initiative, which means substantial data may be available through the RDI.

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