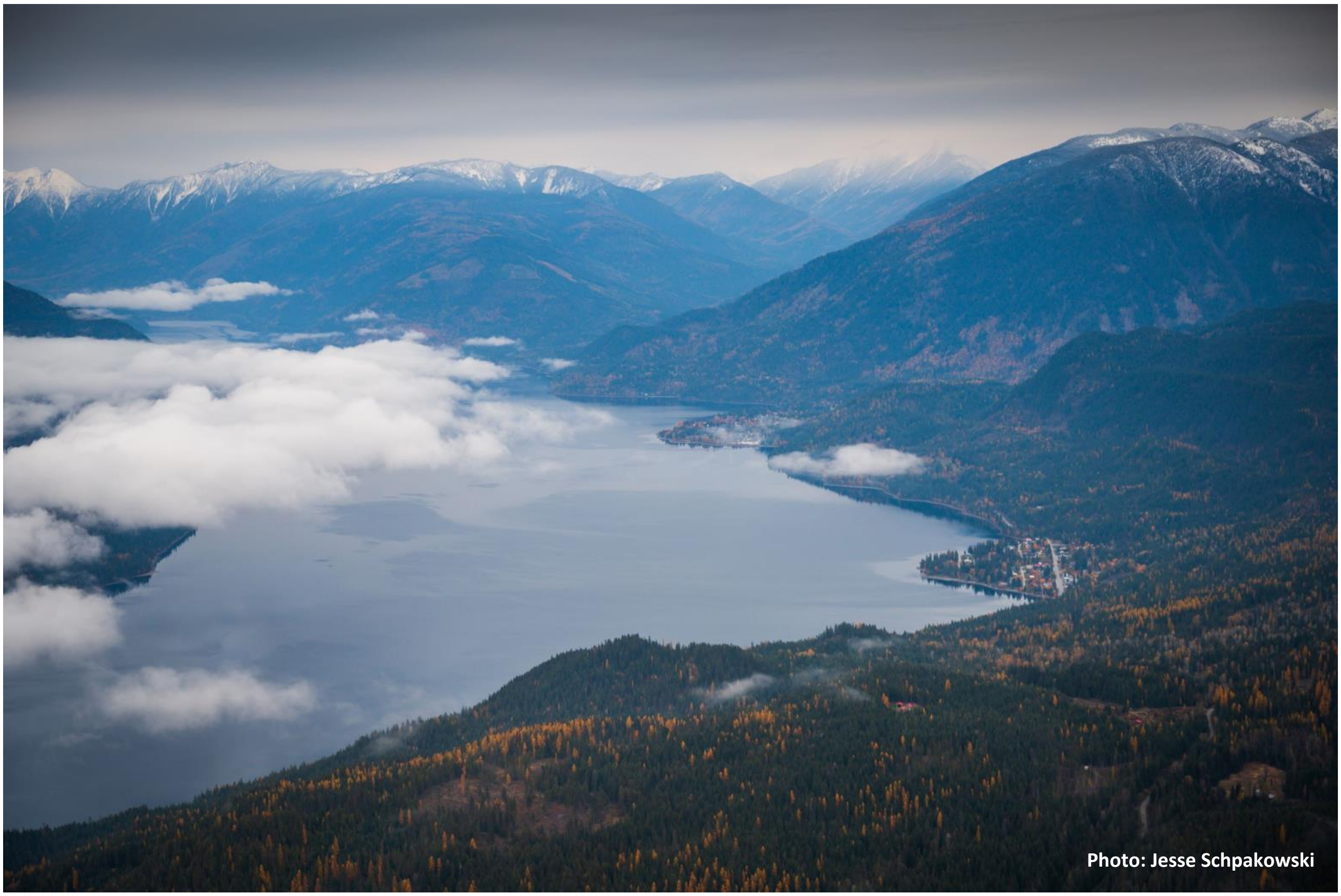
State of Climate Adaptation

Village of Silverton

April 2020



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ACKNOWLEDGEMENTS

The preparation of this report was carried out with assistance from the Government of Canada and the Federation of Canadian Municipalities, with additional funding from Columbia Basin Trust and participating local governments. The project was led by the Columbia Basin Rural Development Institute with contributions from external experts and local governments.

We acknowledge the following individuals for their contributions to this report:

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- Kim Green
- Lauren Rethoret
- Jay Maloney
- Jamiee Remond
- Nerissa Abbott
- Raymond Neto
- Leeza Perehudoff

Climatic Resources Consulting

- Mel Reasoner
- Charles Cuell

Village of Silverton

- Hillary Elliott
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- Leonard Casley

Regional District of Central Kootenay

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- Eileen Senyk
- Meeri Durand

And many thanks to the others who helped us secure the needed data to prepare this report, including BC Hydro, Interior Health, DriveBC, and the Province's Southeast Fire Centre.

ACROYNMS

AHCCD	Adjusted and Homogenized Canadian Climate Data
ALR	Agricultural Land Reserve
BWN	Boil Water Notice
CL	Confidence Level
CMIP5	Coupled Model Intercomparison Project Phase 5
CWPP	Community Wildfire Protection Plan
GCM	Global Climate Model
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
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 Village of Silverton 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.

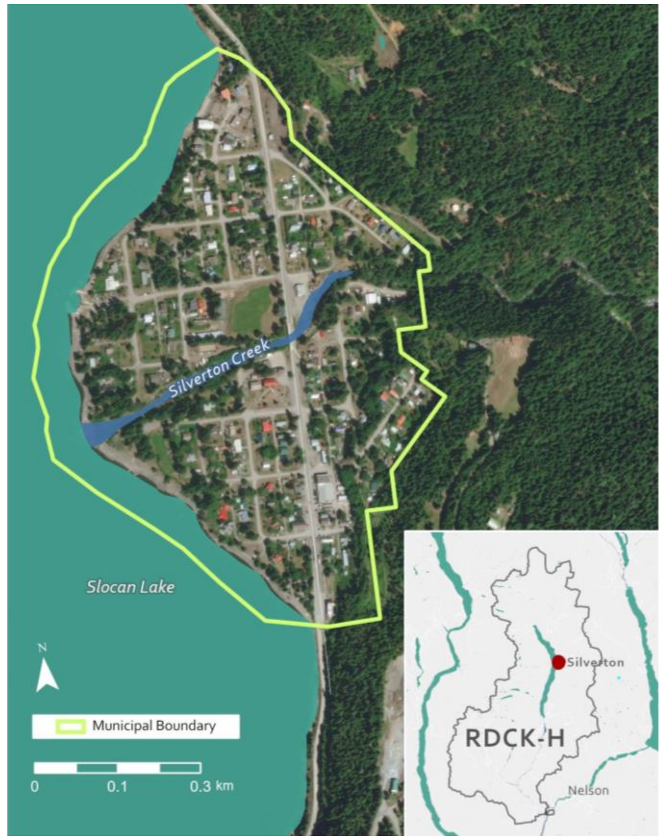

Figure 1*: Village of Silverton and its location with the Regional District of Central Kootenay (RDCK) Area H.*

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 with data from outside of Village of Silverton boundaries, such as wildfire starts within the Regional District of Central Kootenay (RDCK), recognizing that a better understanding of trends associated with these indicators can help the community prepare for current and future changes. The data for some indicators, such as per capita water consumption, come directly from local governments, and can be used to identify and track where actions could increase community climate resilience.

The original published SoCARB suite had 58 climate adaptation indicators. Excluded from this report are indicators that the Village of Silverton has not identified as a priority or where sufficient data was not available. In addition, the evolution of adaptation practice since SoCARB was originally developed and learnings from pilot implementation in 2016-2017 with four communities resulted in minor updates to the suite in spring 2019.

About Silverton

The Village of Silverton is a small community with less than 200 residents. The population fluctuates significantly according to the seasons, with a full population in the summer, and fewer residents in the winter. The Village of Silverton has four part-time staff members whose duties cover a wide scope of activities. For example, the fire chief is also in charge of maintaining all infrastructure and winter snow removal. This information is important to frame the capacity challenges that can be present within a small rural community.

Report Highlights

- Silverton's climate is changing, with data showing trends toward higher average annual and seasonal temperatures. This upward trend is expected to continue. 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.
- 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.
- The Village of Silverton's capacity to address climate adaptation is increased due to important partnerships and agreements with the RDCK. The RDCK supports Silverton by including them in their Emergency Response and Recovery Plan, Area H North Community Wildfire Protection Plan, and comprehensive FireSmart program.
- Opportunities exist to further the Village of Silverton's readiness to adapt, which include exploration of additional actions on water conservation and promoting community-based adaptation efforts (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 the Village of Silverton's status of climate 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, the Village of Silverton 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.

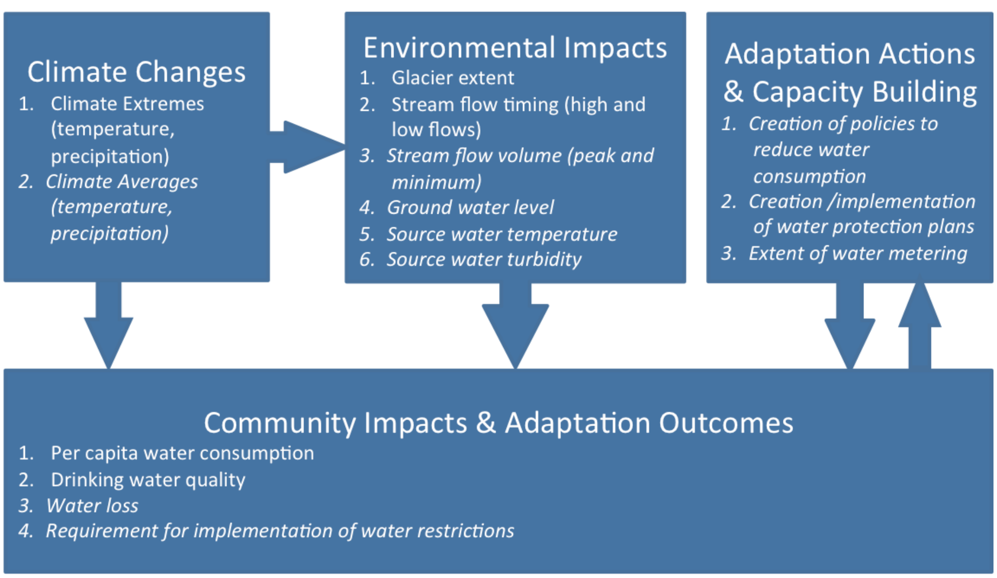

Figure 2 *- Water supply pathway from the SoCARB indicator suite*

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 Silverton was provided by Climatic Resources Consulting, Inc. and comes from two main modeling sources. Technical information is presented below. Climate projections for the 2050s in this report include two scenarios: low carbon and high carbon. 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.

Climate projections for the 2050s indicate the average for the 2041-2070 period. Seasons are defined as follows:

- Spring = March, April, May

- Summer = June, July, August
- Fall = September, October, November
- Winter = December, January, February

Historical data for Silverton comes from the nearby weather station in New Denver, which has daily temperature data from 1968-2018 and precipitation data from 1924-2018. It is import to note limitations using the New Denver station as a proxy for Silverton, as anecdotal information indicates that weather can vary significantly between the two communities.

Technical Information on Climate Models

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. Climate projections are based on output from an ensemble of 12 statistically downscaled Global Climate Model (GCM) projections[3] from the Coupled Model Intercomparison Project Phase 5 (CMIP5),[4] and downscaled using Bias Correction/Constructed Analogues with Quantile mapping recording[5] 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.

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 Silverton. Additional climate information for Silverton can be found in the separate Appendix document.

The Overall Picture

Both annual and seasonal average temperatures are rising in the Silverton area and are projected to continue rising through the 2050s. Annual average temperature increased at a rate of by 3.9°C per century over the 1968-2018 period. By the 2050s, this rate is projected to shift to 3.7°C per century under a low global emissions scenario and 7.0°C per century under a high emissions scenario. Hot days have increased over the last century and are projected to continue increasing. Total annual precipitation has also increased over the last century, but this trend is not consistent across seasons. Precipitation projections indicate the potential for an increase in total annual precipitation and less summer precipitation over the coming decades. Extreme precipitation trends are uncertain.

Average annual and seasonal temperatures are increasing

Analysis of climate data for Silverton shows increasing temperatures since the late 1960s. There has been a statistically significant warming trend of +3.9°C per century in Silverton's average annual temperature (Table 1). The 1961-1990 baseline temperature is 7.7°C (Figure 3). Average seasonal temperatures have also increased. Summer temperatures have been increasing at the highest rate, with the warming trend calculated at +3.6°C per century (Table 1).

Projections for the 2050s indicate that summers will be warming faster than other seasons in both low and high carbon scenarios. Average annual temperature is projected to increase by 2.6°C to 3.2°C from the 1961-1990 baseline to 10.3°C and 10.9°C, respectively, under low and high carbon scenarios.

Table 1: *Annual and seasonal temperature trends (rate of change) for Silverton in degrees Celsius per century.*

	Annual	Winter	Spring	Summer	Fall
Historic (1968-2018)	+3.9°C per century	*2.8*	3.1	3.6	2.8
2050s (low carbon)	3.7	*2.0*	2.7	4.0	2.9
2050s (high carbon)	7.0	8.0	5.5	10.3	6.7

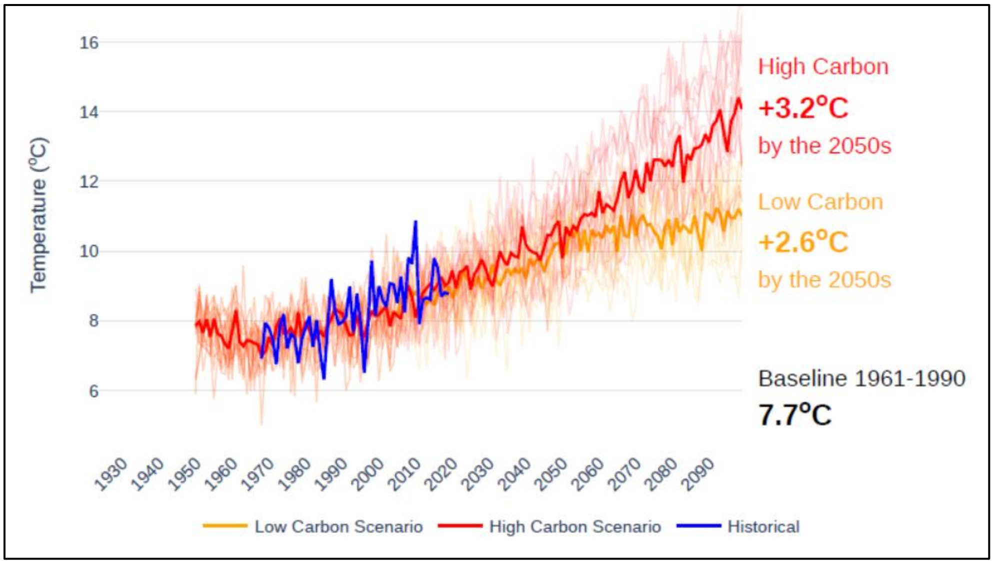

Figure 3: *Historical and projected average annual temperature for Silverton*

Average annual precipitation is increasing

Average annual precipitation trends are not as clear cut as those for average annual temperature (Table 2, Figure 4). Silverton's average annual precipitation for the 1961-1990 baseline period is 847.4 mm. The dataset shows an increasing trend for historic average annual precipitation of +171 mm per century. Spring and summer precipitation have also been on the rise. Trends for the winter and fall seasons are not statistically significant.

Table 2: *Average annual and seasonal total precipitation trends (rate of change) for Silverton, in millimetres per century. Results that are not statistically significant (< 95% confidence level) are in italics.*

	Annual	Winter	Spring	Summer	Fall
Historic (1924-2018)	+171 mm per century	*-21*	72	59	*41*
2050s (Low carbon)	*106*	*26*	*30*	*-17*	*19*
2050s (High carbon)	250	*110*	56	*-102*	102

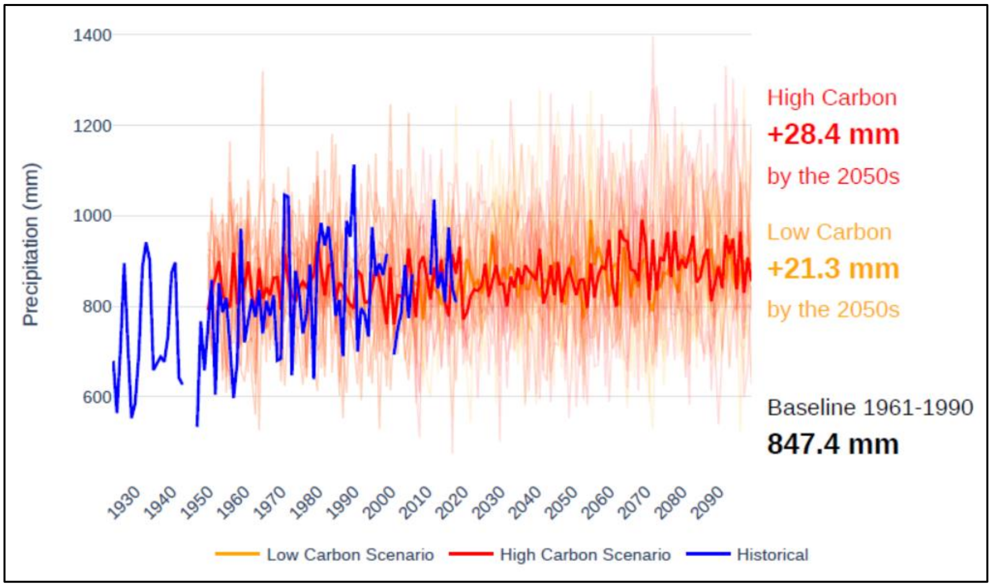

Figure 4: *Total annual precipitation for Silverton*

Precipitation projections indicate that precipitation will likely increase across all seasons except for summer. Precipitation has considerably more variability than temperature, thus confidence levels for most projections fall below 95 per cent (Table 2).

More hot days

This extreme temperature indicator measures the number of days when the maximum temperature exceeds the 90th percentile for the baseline period (1961-1990). For Silverton, this translates into a baseline of 36 days above 27°C. Historic data show a statistically significant rate of increase in hot days of 39 days per century. Annual hot days (i.e. those above 27°C) are projected to increase by 27 to 35 days by the 2050s, under low and high carbon scenarios, respectively, and the rate of increase could go as high as 100 days per century by the 2050s in a high carbon scenario.

Amount of precipitation falling during heavy rainfalls

The extreme precipitation indicator measures the 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 Silverton's baseline period, the 95th percentile threshold for precipitation is 9.2 mm, with an average total of 126.9 mm falling annually on days when precipitation exceeds 9.2 mm. Records show the highest annual sum of 95th percentile precipitation at 340 mm. Historic data for Silverton do not show clear trends in the amount of rain falling on very heavy rainfall days. Projections for the 2050s suggest that that the amount of rain falling during very heavy rainfall days is likely to increase across all seasons except the summer; however trends are generally only statistically significant under the high carbon scenario. Under this scenario, models project a 157 mm/century upward trend by the 2050s, which translates to an additional 45 mm above the 1961-1990 baseline of 9.2 mm.

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." [6] 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

Silverton is experiencing a higher number of extreme heat days and fewer heavy snow days than in the past. Other indicators of extreme weather in the area are either lacking long-term datasets or not yet showing the trends identified at larger geographic scales. The Village has an outdated Emergency Plan and an agreement with the RDCK to include the Village of Silverton in their emergency planning and response. There is an opportunity for the Village of Silverton and the RDCK to work together to further clarify the Village's role in emergency planning and response. The number of Silverton 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, the New Denver climate station (proxy for Silverton) shows increases in annual and seasonal average temperatures and increased annual precipitation over the last century. The frequency of hot days has increased and will continue to increase. The amount of rain falling on very heavy rainfalls days may be increasing, but trends are not certain 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. Historic temperature data for Silverton shows an upward trend in the average annual frequency of days over 30ºC, increasing at a rate of 20 days per century. During the 1961-1990 baseline period, Silverton experienced an average of 15.6 days per year above 30ºC. By the 2050s this is projected to increase by 22 days in a low carbon scenario and by 31 days in a high carbon scenario, which translates to 37-47 days per year above 30ºC (Figure 5).

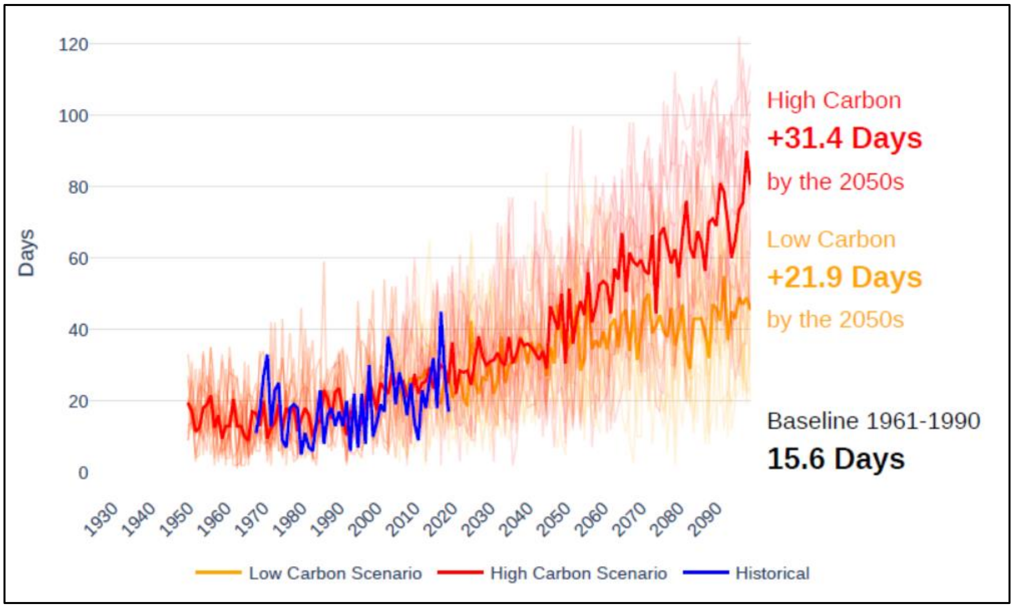

***Figure 5**: Extreme heat days (above 30ºC) in Silverton*

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 (Figure 6). This data shows a decline in average annual heavy snowfall events of approximately 1.8 per century.[7] This means a reduction from three to four heavy snowfalls per year in the early 1900s to just over one per year in the early 2000s.

The same data were used to assess annual maximum one-day snowfall; however, there is no significant trend for this indicator. The average maximum one-day snowfall in New Denver is 23.3 cm.

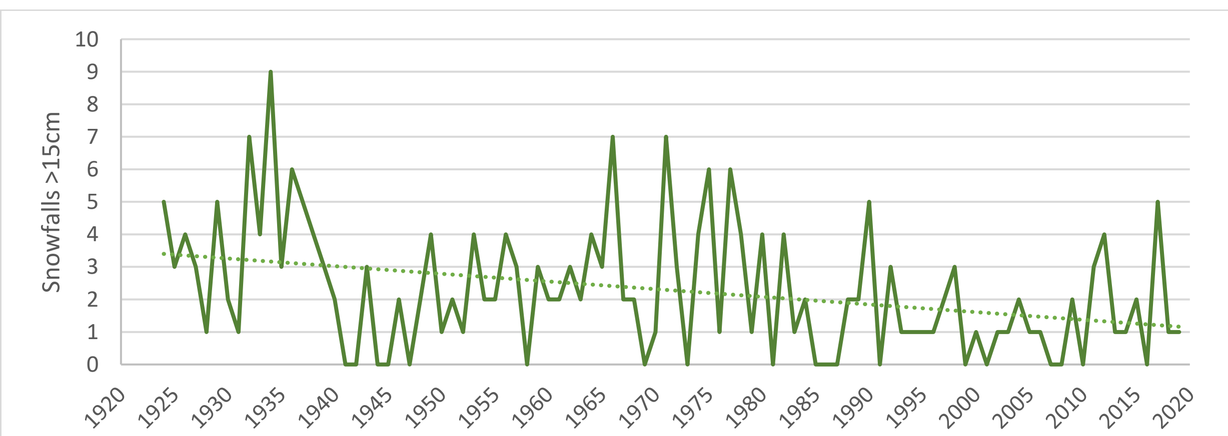

***Figure 6:** Annual number of snowfalls at New Denver Station weather station exceeding 15 cm in 24 hours*

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 near Silverton comes from BC Wildfire Service weather stations. These stations provide an hourly reading of sustained wind speed over a ten-minute period, which means 83% of wind behaviour is unrecorded.[8] Analysis of the Slocan station, which has data from October 1991 to the present, revealed no records over the 70 km/h threshold.[9]

Maximum 1-day rainfall has declined but is projected to increase

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. Historic data for Silverton indicates 20.3 mm as the 1961-1990 baseline for maximum 1-day rainfall, with a peak 1-day rainfall as high as 70 mm in 2013. There is no clear trend in the historic data. Projections for the future indicate the possibility of a small increase in annual maximum 1-day rainfall, but again, trends are generally not significant.

Adaptation Actions and Capacity Building

Emergency Preparedness Plan

The majority of responsibility for emergency response in Silverton was transferred to the RDCK in 2005 and is now covered under the RDCK's 2016 Emergency Response and Recovery Plan.[10] This Plan is currently being revised into an "All Hazards Regional Plan". 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 RDCK Area H.[11]

The Village of Silverton's Emergency Plan was updated in 2017; however, some sections remain outdated and/or incomplete and much of the emergency planning is held within the knowledge base of key community members. The Village would benefit from a better understanding of RDCK's emergency planning and response processes for the Village and identification of areas the Village needs to address.[12]

Table 3: Emergency preparedness plan components for the Village of Silverton

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

i. This is covered under the RDCK, but the Silverton Fire Chief fills this role if needed.
ii. Silverton Fire Hall
iii. There is a stocked trailer within the Village of Silverton
iv. Outdated
v. Outdated within Village of Silverton plan, but small size of community and community networks fill this gap. RDCK has an emergency alert system (Connect Rocket) that includes Silverton.
vi. Have agreements with RDCK for emergency response and New Denver for fire protection

Essential backup power in place

The Village of Silverton has backup power in place for its drinking water system. The fire hall, city hall and public works yard are all situated next to each other. During an emergency, a small generator is available to power a portion of these as needed.[13]

The RDCK has uninterrupted backup power in place for its Emergency Operations Centre (EOC) and a backup generator at the main RDCK office in Nelson to keep critical systems alive, such as GIS and finance.[14] The EOC would serve the Village of Silverton, as needed, in an emergency response.

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 completed by 38 Silverton residents conducted in summer of 2019 found that only 25% of respondents have emergency preparedness kits in their homes. Of those, 44% reported having their kits consolidated in an easy to access location and 55% reported having updated their kits within the past year. See Table 4 to review the percentage of respondents who had the presence of important items in their kits. Many residents could better prepare for extreme weather events by compiling complete kits and storing them in a single accessible location.

Table 4*: Village of Silverton survey respondents with emergency kits indicate the presence of important items in their kits*

Item	Yes
Drinking water (2-3 litres of water per person and pets per day, for 3 days)	67%
Foods that will not spoil (minimum 3-day supply)	89%
Manual can opener	100%
Flashlight and batteries	100%
Candles and matches/lighter	100%
Battery-powered or wind-up radio	44%
Cash in smaller bills and change	89%
First aid kit	100%
Special items such as prescription medications, infant formula or equipment for people with disabilities	22%
Extra keys that you might need (e.g. for your car, house, safe deposit box)	89%
A copy of your emergency plan including contact numbers (e.g. for out-of-town family)	44%
Copies of relevant identification papers (e.g. licenses, birth certificates, care cards)	56%
Insurance policy information	63%
Mobile phone charger	89%

Community Impacts and Adaptation Outcomes

Extreme weather-related highway closures average less than two per year

Between 2006 and 2017, there have been 12 weather-related highway closures in Area H with an average closure time of 4.5 hours. These numbers come from Drive BC records, which report closures on major highways only. The highways that were analysed for Silverton are 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 dataset is too short for trend analysis at this time. [15]

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.[16] 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.[17]

Silverton is also affected 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,[18] avalanche professionals are predicting more wet avalanches, reduced avalanche activity at lower elevations and increased avalanche activity at higher elevations.[19] 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.

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. The Village of Silverton is serviced by BC Hydro. Available data for the New Denver substation feeding Silverton was analyzed for outages caused by adverse weather, including floods, mud/snow slides, lightning, snow, and damage by trees between April 2014 and March 2019. There were 38 outages over this time-period that totaled 318 hours. The duration of outages ranged from 1 minute to 51 hours, and the average outage lasted 8.4 hours.[21] Anecdotal information on power outages is also available based on the hours of use of the Village of Silverton generator. The generator was used for 525 hours since 2006, with most of that being for weather related power outages.

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. There have been no provincial emergency assistance payments made to the Village of Silverton.[22]

Evacuation alerts

There are no records of evacuation alerts in the Village of Silverton due to extreme weather.

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. Two groundwater wells on the fan of Silverton Creek provide water for the Village of Silverton. A high level of connectivity between surface flows and the Silverton aquifer means that climate change impacts on Silverton Creek can impact the supply of drinking water to Silverton.[23] A back-up water licence is maintained on Bartlett Creek. Silverton Creek only has discharge data for the years 1914 to 1919, which is too short for an analysis of trends over time. More short-term data for Silverton Creek is available through the Slocan Lake Stewardship Society, although this data is presently limited and was not used in this report. Nearby Lemon Creek is used as a proxy for Silverton Creek to investigate trends in flow volume and timing.

The Overall Picture

With very little discharge data available for Silverton Creek, inferences for the trends in flow volume and timing in Silverton Creek are based on nearby Lemon Creek. Assuming the two streams are well correlated, there are few discernible trends in the volume or timing of flows. Decreases in low elevation April 1st snowpack and increases in high elevation April 1st snowpack are not statistically significant but do reflect regional trends consistent with climate projections. A decreasing trend in minimum flow volume over the period of record more likely reflects decadal variability in climate associated with high low-flow volumes in the late 1970's and early 1980's than long-term trends due to climate change. A longer period of discharge gauging is needed to evaluate the presence of any climate-related trends.

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. Annual precipitation has also increased over the period of record, but the trend is not consistent across seasons. Future projections indicate the potential for an increase in total annual precipitation by the 2050s under both low and high carbon scenarios, and a trend toward less summer precipitation than in the past.

Environmental Impacts

Stream flow timing

Silverton Creek above the fan has a drainage area of 116 km^2 and ranges in elevation from 885 to 2,502 metres with a mean elevation of 1678 meters.[24] Lemon Creek is 28 kilometres south of Silverton Creek and, like Silverton Creek, drains westward from the upper elevations of the Selkirk Range. Lemon Creek above the discharge gauge has a drainage area of 181 km^2 and ranges in elevation from 750 metres to over 2550 metres at the headwaters with a mean elevation of 1678 meters. [25] Continuous gauging on Lemon Creek began in 1973 and is ongoing.

No changes in the timing of maximum daily flows or summer low flows are apparent for Lemon Creek in the 43-year record of Environment Canada data.[26] The date of occurrence of half the annual flow volume has advanced, on average, 4.6 days compared to when gauging began in 1973 (Figure 7); however, this trend is not considered statistically significant at the 95% confidence level. The half-annual flow volume provides a mechanism to investigate changes in the annual distribution of flow from the watershed. 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.

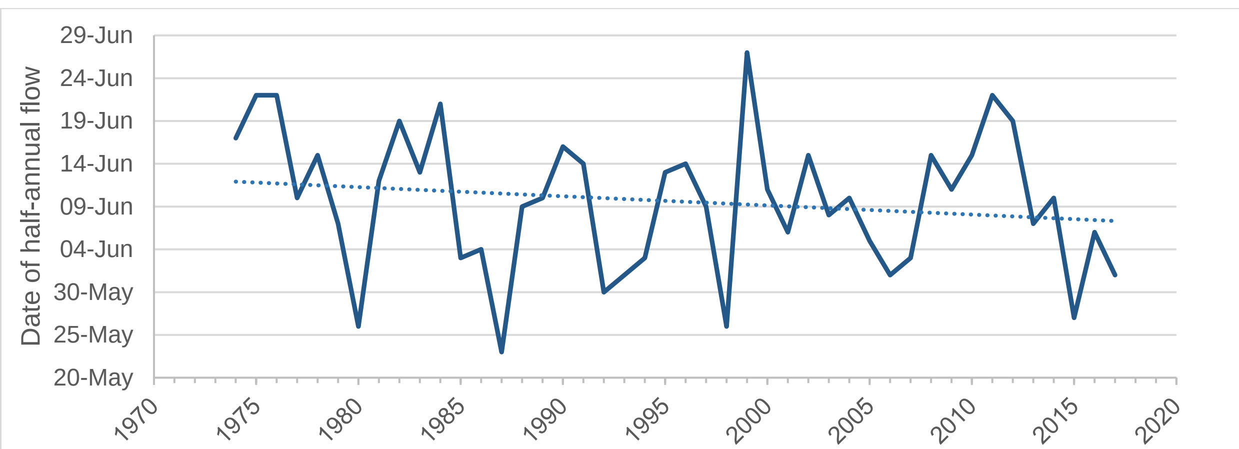

Figure 7: *Date of half-annual flow volume and trend for Lemon Creek. (Trend is not statistically significant).*

Stream flow volume

There are no trends in annual maximum daily flow or the half-annual flow volume for Lemon Creek; however, a statistically significant negative trend was noted in summer low flow volume (Figure 8). 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, which is the closest gauging site with concurrent discharge records.[27] In both cases, the negative trend can be related to the influence of high summer low flows that occurred from the mid 1970’s to the early 1980’s. A longer period of gauging is needed to determine if this trend will persist or if it is a function of decadal climate oscillations.

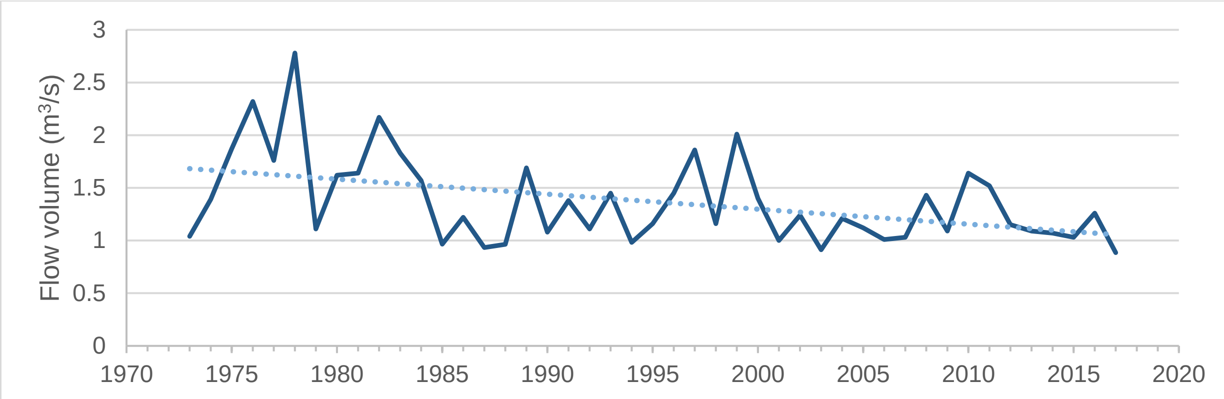

Figure 8: *Minimum daily discharge for Lemon Creek shows a decreasing trend that is likely caused by high summer low flow volumes in the mid-1970s and early 1980s.*

Groundwater levels

The Village of Silverton gets its water from two 48-meter deep wells that draw water from an unconfined aquifer in the fan of Silverton Creek. The aquifer occurs in a thick section of highly permeable fluvial gravels deposited by Silverton Creek. Water percolates into the Silverton aquifer at the upstream apex of the fan and is recharged continually by water that percolates downwards to the water table. The flows of Silverton Creek on the fan do not interact with the aquifer. Water levels in the wells vary seasonally with water levels in Silverton Creek and the high level of hydraulic conductivity in the permeable gravels results in high recharge rates in these wells.[28]

Source water temperature

Temperature can be an important determinant of water quality. As Silverton's water source is from groundwater, seasonal temperature fluctuations will be minimal as compared to surface water sources and water temperature should be well below 15^{o}C - an aesthetic drinking water objective set by Health Canada.[29] If the backup water system, Bartlett Creek, is ever used, then temperature data would be important to collect and analyze.

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. Turbidity becomes a concern when it rises above one Nephelometric Turbidity Units (NTU). A turbidity reading between one to five NTU is considered fair quality, while a reading greater than five NTU indicates poor drinking water.[30] As Silverton's water source is from a groundwater well, surface water turbidity is not relevant. If the backup water system, Bartlett Creek, is ever used, then turbidity data would be important to collect and analyze.

Adaptation Actions and Capacity Building

Policies to reduce water consumption

The Village of Silverton has several policies in place to help reduce water consumption. As a participant in the Columbia Basin Water Smart Initiative, the Village of Silverton successfully reduced their community wide water demand by 32% between 2012 and 2015.[31] The Village does not currently have a water conservation target. Village staff noted that water conservation education had the opposite effect on some Silverton residents, sharing that water use increased in certain instances during conservation efforts due to residents hiding water use by using open hoses instead of sprinklers.[32]

Table 5: *Implementation of policies to reduce water consumption for the Village of Silverton.*

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

i. Done in the past through the Water Smart initiative
ii. Have water data at source wells.
iii. Did a review of utilities and adjusted rates to have a reserve for emergencies, although still would need additional external funding
iv. Do not have a bylaw officer
v. Identified all the leaks they can find
vi. Have an asset management plan
vii. Anytime a main line is replaced, nearby service lines are also replaced
viii. Do not have a pressure problem

Source water protection plan and climate change

The Village of Silverton does not have a source water protection plan. However, they endeavor to further understand and protect their watershed as opportunities arise and funding allows. As an example, they have a watershed policy related to logging.[33] The Village is currently working with Simon Fraser University's Adapting to Climate Change Team on an Integrated Climate Action for BC Communities Initiative that will explore opportunities for natural asset management through a low carbon resilience lens.[34]

Water loss detection practices

The Village of Silverton participated in the Columbia Basin Water Smart initiative, which helped build the Village's capacity to identify and address leaks.[35] The Village of Silverton has a water meter at their source water intake, which includes night flow analysis. This data is reviewed for any anomalies or changes that may indicate leaks.[36]

Table 6: *Implementation of water loss detection practices for the Village of Silverton*

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

Community Impacts and Adaptation Outcomes

Per capita water consumption

This indicator measures water use attributable to user demand and system water loss. The Village of Silverton does not track per capita water consumption. It is important to note that water consumption changes dramatically between winter and summer due to population fluctuations. Silverton uses a larger pump in the summer to accommodate the water demand of a larger population.[37] Previous work through the Water Smart Initiative calculated water consumption at 1758 litres/person/day in 2012 and 1472 litres/person/day in 2015.[38] This consumption is well above the provincial average for total municipal water system use of 494 litres/person/day.[39] Updated per capita water consumption data is not available.

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.[40] Since 2000, Silverton's water system has only had one Boil Water Notice. This occurred in 2010 and lasted 56 days.[41] Unfortunately, the cause of water advisories is not specified in the dataset provided by Interior Health Authority making it difficult to link water quality issues to weather conditions.

Watering restrictions

Watering restriction bylaws provide a tool for utilities to reduce their vulnerability to water supply challenges. The Village of Silverton has a *Water Restrictions and Sprinklering Policy* that limits using a sprinkler to two hours twice a day May 1st through September 30th.[42] This policy is shared with residents each year, but it is not enforced.

Minimal data on water loss

The Village of Silverton's Water Smart Action Plan estimated water loss at 26 percent of the total demand in 2012.[43] Village staff indicate that many leaks were fixed during the Water Smart initiative, so current leakage is likely lower; however, data is not available to confirm this assumption.

FLOODING

Projected climate change, 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. The Village of Silverton has expressed concern regarding the potential for an increased frequency of damaging ice jam floods associated with climate change. Flooding creates a risk to life and property, and affects water quality of surface water systems. Recognizing how the flood regime is changing allows communities to improve infrastructure and establish flood mitigation measures.

The Overall Picture

Silverton Creek is a high elevation watershed where extreme floods are a function of rapid snowmelt from areas above 1600 metres in elevation. Over the past four decades there have been no substantial changes to the flood regime of Lemon Creek, which is used as a proxy for Silverton Creek. The projected trend toward higher average spring temperatures and higher spring precipitation may drive more rapid snow melt in these high elevation watersheds, increasing the likelihood of flooding. However, the potential for increased flooding may be partially mitigated by a declining trend in spring snowpack at lower elevations. The potential for changes in the frequency of ice jam floods in Silverton Creek may not follow the same trends as water floods due to the different mechanisms that trigger flooding. Warmer winter and spring temperatures and increased precipitation at lower elevations will affect ice jam flood frequency to differing extents. Updated floodplain mapping data for the Slocan Valley was collected in the summer of 2019 as part of a project led by the RDCK. There is potential for the data relevant to Silverton to become available in the future.

Climate Changes

As discussed in the Climate and Extreme Weather sections, trends toward more extreme rainfall are not evident in the analysis of historic climate data for the New Denver climate station, the closest station to Silverton. An analysis of historical precipitation data shows rising annual and spring precipitation.

Freeze-thaw cycles are becoming less frequent

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 -2ºC and +2ºC. The historical data for Silverton covers 1968 to 2018, and indicates a statistically significant decreasing trend of -43 days/century in the winter season over that time period. Freeze/thaw cycles are projected to continue becoming less frequent in the spring, fall, and winter, dropping from 34.2 days per year in the 1961-1990 reference period to 17.4 days per year by the 2050s in a high carbon scenario and 21.6 days per year in a low carbon scenario.

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 and is relevant to both water supply and flooding. The April 1st snowpack data for Silverton is available for both low and high elevation sites in the region.[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. The data at the low elevation Sandon site reveals a downward trend in April 1st snow water equivalent (SWE), but this trend is also not statistically significant at the 95% confidence level (Figure 9). 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 10). 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. Given the 20 to 30-year cyclic influence of the Pacific Decadal Oscillation, 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.

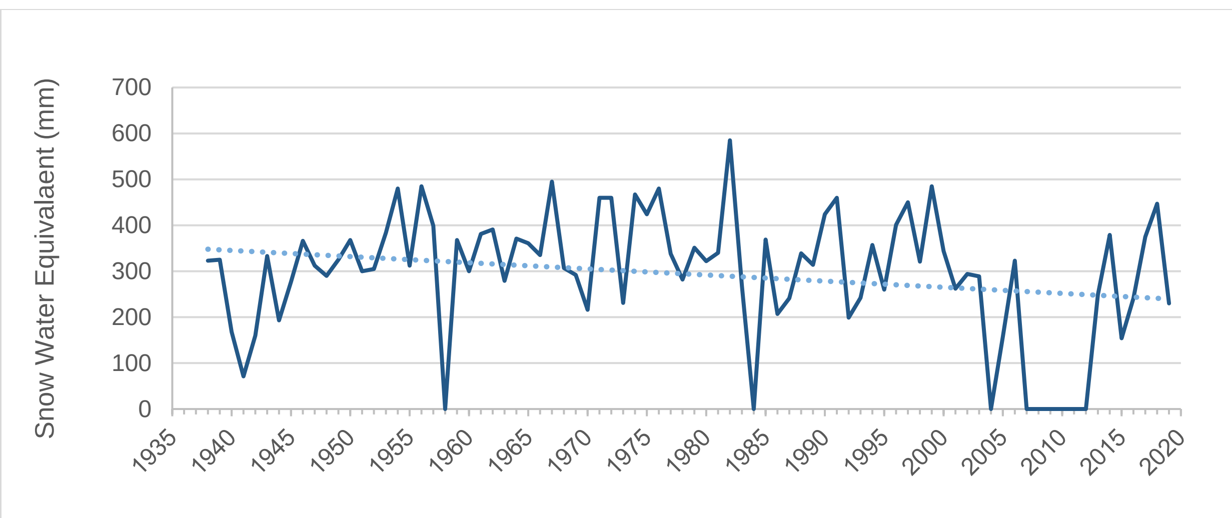

Figure 9*: April 1st snow water equivalent (SWE) and trend line at Sandon manual snow survey site. (Trend is not statistically significant).*

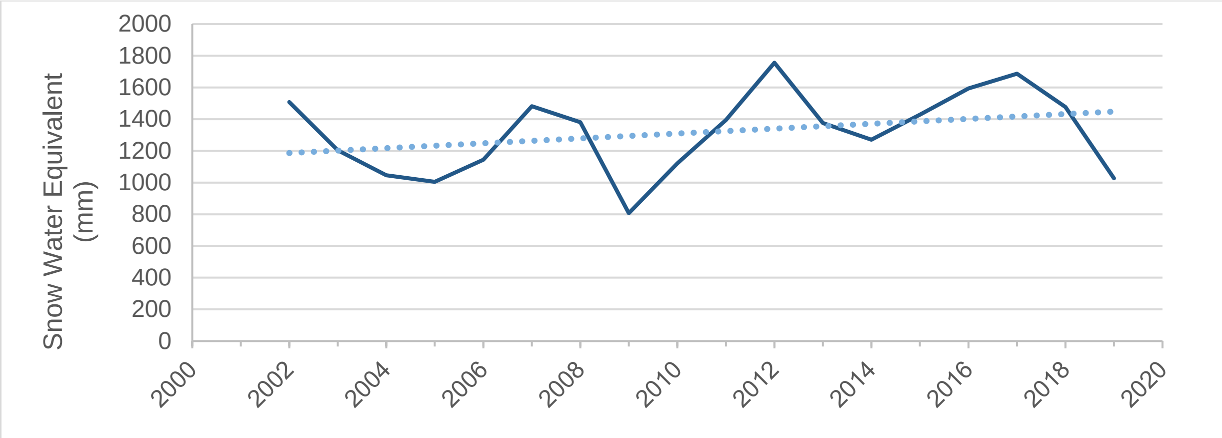

Figure 10: *April 1st snow water equivalent (SWE) and trend line at Redfish snow pillow site. (Trend is not statistically significant).*

No/minimal trend in peak flow timing

Using data from Environment Canada,[45] trend analysis was completed on Lemon Creek to explore the timing of peak flows. In alpine-driven fluvial systems such as Lemon Creek, projected climate trends are unlikely to affect the timing of spring peak flows, which are controlled primarily by seasonal solar radiation inputs. Results of the analysis indicate there is no trend in the timing of flows for Lemon Creek. As previously discussed in the Water Supply Pathway, the date of half-annual flow may be advancing, though the trend is not statistically significant. 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 11) 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 snowpacks.

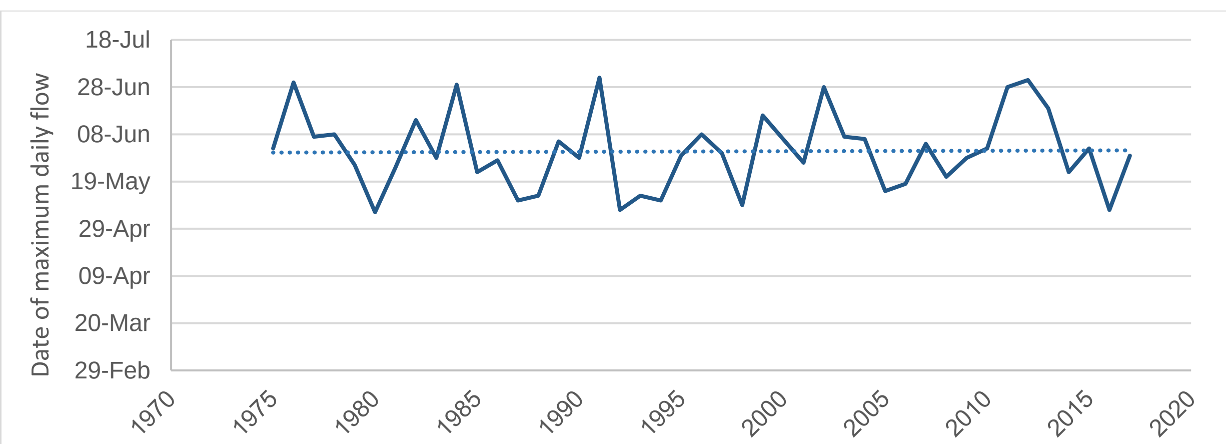

Figure 11: *Date of maximum daily flow for Lemon Creek and trend line. (No trend detected).*

No/weak trend in peak flow volume

Using data from Environment Canada,[46] trend analysis was completed on peak stream flow volume for Lemon Creek. Trends in the time-series of annual daily maximum flow volume (peak flow volume) can indicate changes in the meteorological factors generating the peak flows (i.e. solar radiation vs rain-on-snow). The 45-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 12).

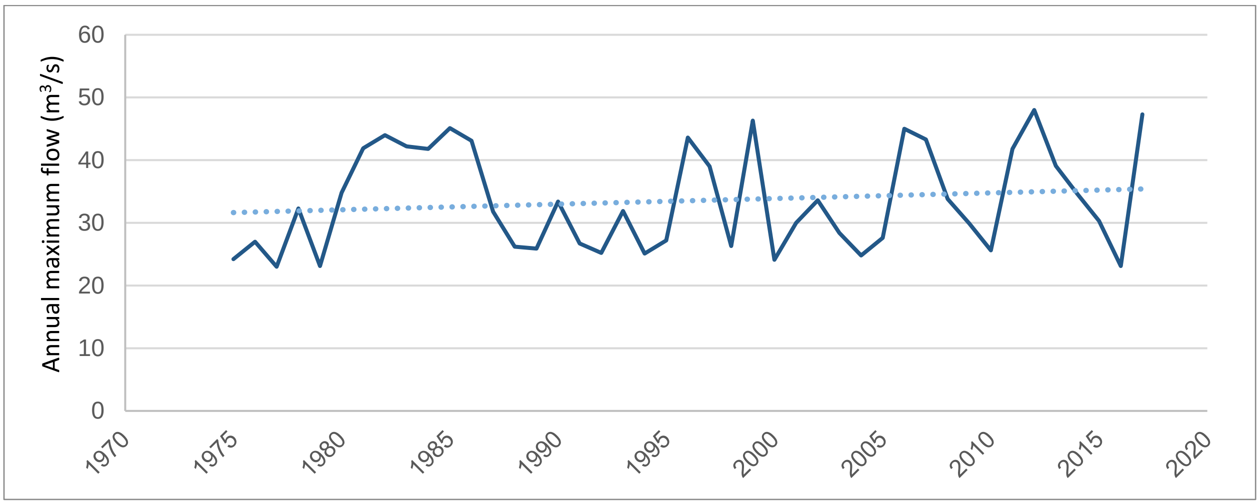

Figure 12: *Annual maximum flow and trend for Lemon Creek. (Trend is not statistically significant).*

No changes in flood frequency

To investigate if there have been changes in the frequency of flooding over the years with available data on Lemon Creek,[47] flood records are divided into subsets and compared (Figure 13). This analysis reveals no changes in the frequency of floods on Lemon Creek given magnitude between the subsets. 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.

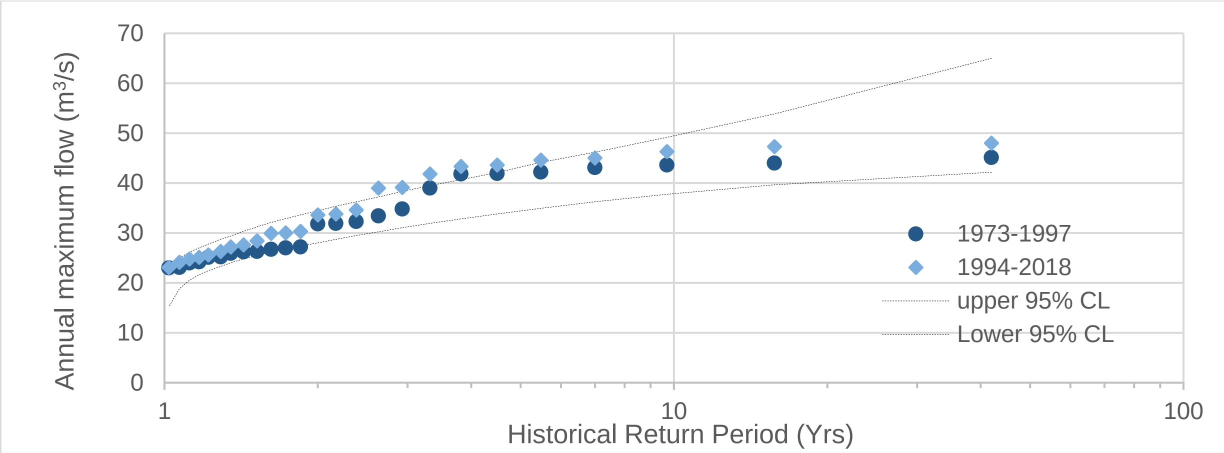

Figure 13: *Flood frequency analysis for two 25-year sub-sets of peak discharge on Lemon Creek using the 95% confidence level (CL)*

The relationship between water and ice jam flood frequency is not straightforward, and the two processes are not likely to be affected in a similar manner given the projected changes in climate. Ice jam flooding in snowmelt mountain streams occurs in response to a rapid increase in stream flow due to temperature increases and/or rain-on-snow events. Climate projections for the West Kootenay region indicate warmer, wetter winter and spring seasons. Increased spring temperatures that advance snowmelt at the lower elevations could reduce the frequency for ice jam flooding, while an increase in rain-on-snow events in winter and early spring months could increase the frequency of ice jam flooding in Silverton Creek. A recent study investigating trends in timing of and magnitude of ice jam flooding events indicates that in the southern interior of British Columbia these events are occurring three to five days earlier on average but have either no change or a maximum of 2% increase in magnitude compared the early 1900s.[48]

Adaptation Actions and Capacity Building

As discussed in the Extreme Weather section, the Village of Silverton and the RDCK have Emergency Preparedness Plans in place. Other indicators in this category are discussed below.

Floodplain mapping

The Village of Silverton has simple floodplain mapping from 1996 (Figure 14).[49] In 2019, the RDCK started the process of updating its floodplain mapping through funding from Emergency Management BC and Public Safety Canada under Stream 2 of the Natural Disaster Mitigation Program. LiDAR data was collected by GeoBC in summer 2019. The raw data still resides with GeoBC and a portal is being developed to make it available to stakeholders. The RDCK has plans to further study priority floodplains within Area H; however, Silverton Creek has not been identified as a priority location.[50]

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. The Village of Silverton has two dikes providing some protection from flooding in Silverton Creek. The Village budgets

$1,000 per year for minor vegetation removal on the dikes, as per provincial requirements. The Village will complete more flood protection measures as funding becomes available.[51]

Community Impacts and Adaptation Outcomes

Provincial emergency assistance data

As discussed in the Extreme Weather section, tracking emergency assistance funding issued by the province can provide some measure of the economic impact of disaster and associated recovery over time. The Village of Silverton has not received any provincial emergency assistance payments.[52]

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. Approximately 2/3 of the dwellings within the Village of Silverton fall within the floodplain. The red lines in Figure 14 show the floodplain boundary as delineated in 1996.[53]

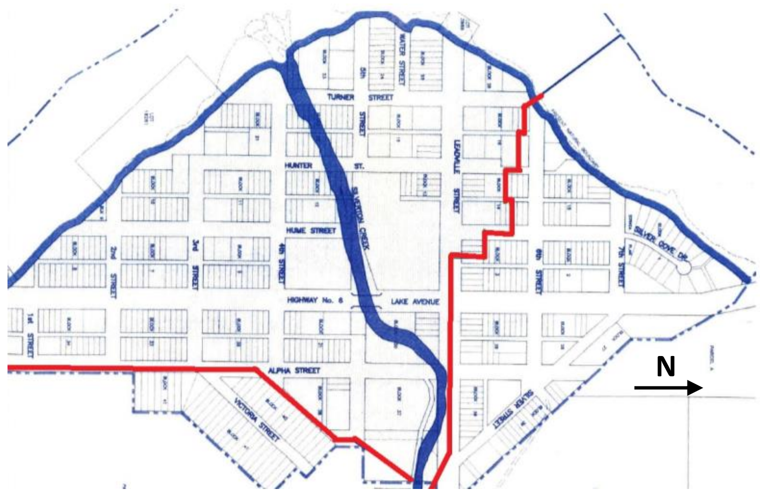

Figure 14: *Floodplain boundary (red line) for the Village of Silverton*

Flood-related highway closures

There are no records of flood-related highway closures in or around the Village of Silverton since the launch of Drive BC's monitoring program in 2006. Closures related to mudslides and avalanches are reported in the Extreme Weather Pathway.

No evacuation notices

There have been no evacuation notices due to flooding within the Village of Silverton in recent history.[54]

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.

The Overall Picture

A trend toward higher temperatures is influencing the growing climate in the region, with the Village of Silverton 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 projected decreases in summer precipitation affect agricultural viability, local food production, and local water demand. Survey results indicate an enthusiasm for food self-sufficiency, with 69% of respondents cultivating some of their own food.

Climate Changes

As discussed in the Climate and Extreme Weather sections, average annual and seasonal temperatures are increasing, as is annual and spring precipitation. While Silverton has experienced an upward trend in summer precipitation over the last 100 years, projections show it decreasing over the coming decades, alongside an annual increase. The frequency of extreme heat days is on the rise, and trends in extreme precipitation are uncertain.

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. Silverton is contained in the ‘West Kootenay Basin’ of the index. Since 2015, there has been an annual average of 59 ‘dry’ and 31 ‘very dry’ days in the West Kootenay Basin. The number of days under drought conditions varies from year to year. For example, 2018 was a particularly dry year with 98 days drier than normal conditions (70 dry and 25 very dry), while 2016 was a wetter year with only 70 dry days and no very dry days. [55]

Length of the growing season is increasing

A longer growing season[i] 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. Historic data for Silverton (1968-2018) shows a small increasing trend in growing season length of +13.6 days per century, but it is not statistically significant. By the 2050s, this trend is projected to jump to +50 and +58 days per century under low and high carbon scenarios, respectively. During the 1961 to 1990 baseline period, Silverton's growing season length averaged 214 days, and is projected to increase to between 242 to 247 days by the 2050s.

More growing degree days

Growing degree days[ii] (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. Growing degree days for Silverton (1968-2018) have been increasing by 581 growing degree days per century (Figure 15). By the 2050s, growing degree days are projected to increase by 624.3 and 797.6 for the low and high carbon scenarios, respectively, from a 1961-1990 baseline of 1829 growing degree days per year.

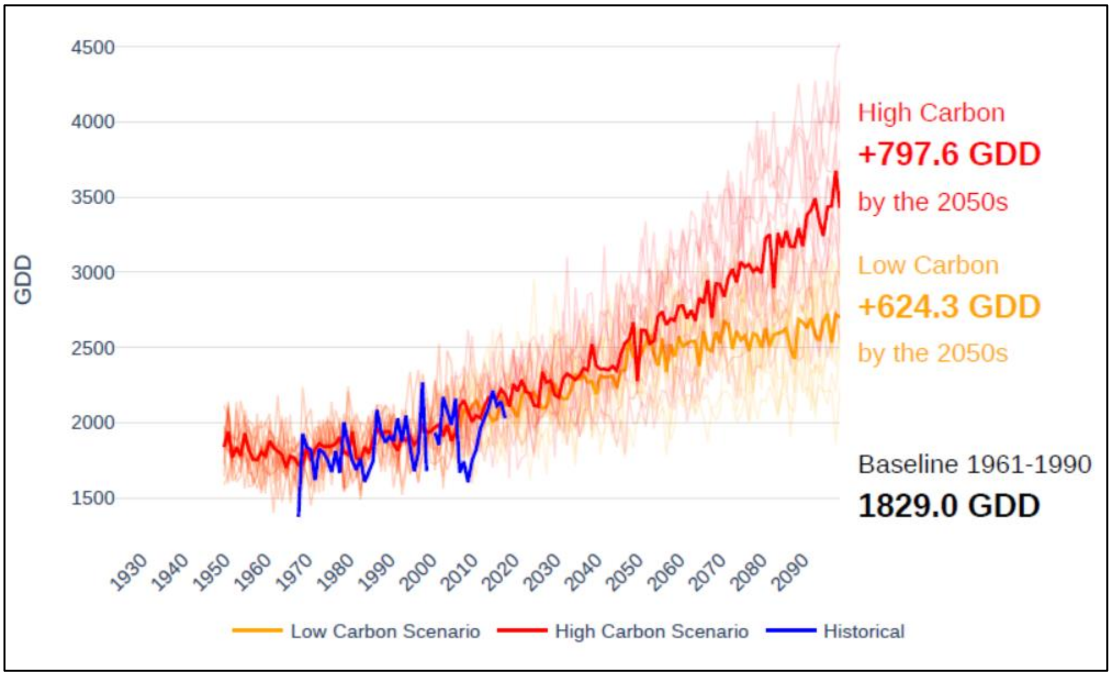

Figure 15: *Growing degree days in Silverton*

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[i] 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 5ºC.

[ii] For the purposes of this report, growing degree days was calculated by multiplying the number of days that the average daily temperature exceeds 5ºC (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.

Consecutive dry days

The annual maximum number of consecutive dry days for Silverton has declined at the rate of -7 days per century since 1924. During the 1961 to 1990 baseline period, Silverton's average annual maximum number of consecutive dry days was 15.4 days. This is projected to increase by 1.3 to 1.6 days by the 2050s under low and high carbon scenarios, respectively. In a high carbon scenario, the maximum dry spell is projected to be increasing at a rate of 10 days per century by the 2050s.

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 completed by 38 Silverton residents in summer of 2019 found that 69% of respondents reported growing some of their own food, mostly in home gardens, in plots ranging from less than 5 square feet to over 300 square feet (Table 7). Almost half of respondents (48%) reported growing or raising between 1 and 10 percent of their total food intake. Most home gardeners reported growing vegetables (88%), 56% reported growing fruit, 48% reported growing herbs, and 8% reported growing nuts. The most popular items grown were tomatoes, onions, cucumbers, herbs, radishes, and beans. Composting was very common among respondents, with 84% indicating they compost food scraps and yard waste and 72% indicating they use that compost in their food gardens.

Table 7: *Area under cultivation (excluding orchards and berry patches) by growers in Silverton*

Area	% of respondents	# of respondents
Less than 5 square feet	8.7	2
5-15 square feet	21.7	5
15-30 square feet	8.7	2
30-50 square feet	13.0	3
50-100 square feet	13.0	3
100-200 square feet	21.7	5
200-300 square feet	0.0	0
More than 300 square feet	13.0	3

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. Silverton is situated within the RDCK Area H and Arrow Fire Zone, which falls within the boundaries of BC's Southeast Fire Centre.

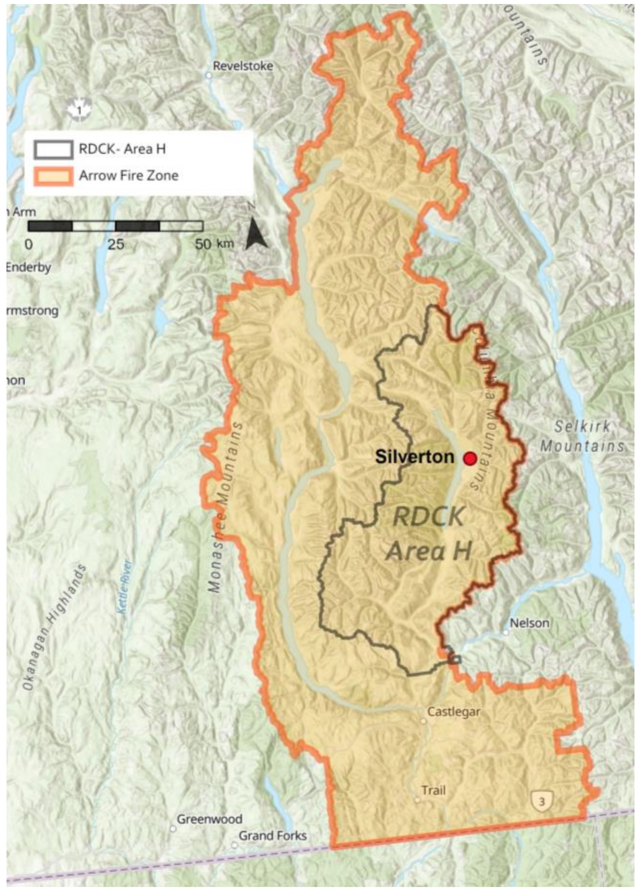

Figure 16: *Location of Silverton within RDCK Area H and the Arrow Fire Zone.*

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. RDCK Area H has seen significant increases in lightning-caused wildfires and in the number of wildfire starts greater than one hectare. Although Silverton has not had any interface fires, the history of interface fires in Area H coupled with future climate projections underscores the need for fire prevention education and fuel management, as most human-caused fires occur near communities. The strong commitment to FireSmart principles and the recent release of a Community Wildfire Protection Plan for Area H, including Silverton, marks another important step in addressing wildfire risk.

Climate Changes

High fire danger is increasing

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 stations had an average of 24.2 days per year with a danger rating of high or above. This is the nearest danger forecasting station to Silverton. 1994 had the greatest number of days above a high danger rating at 65 days, followed by 2017 at 58 days and 2007 at 52 days (Figure 17). 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.[56] These stations emphasize differences in sub-regional climates and are more representative of southern portions of Area H.

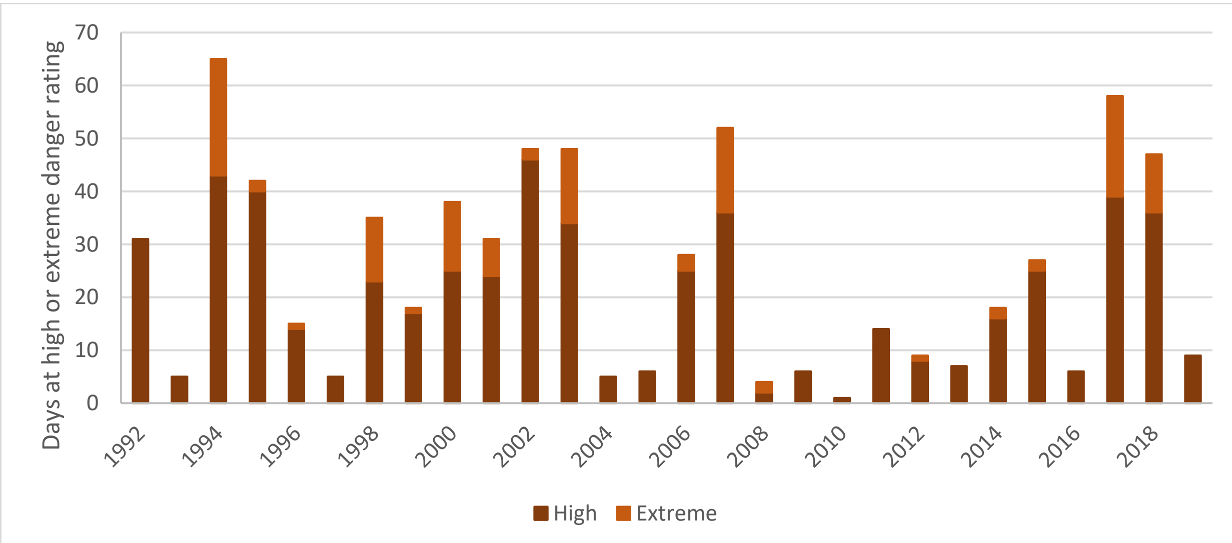

***Figure 17**: Days with high or extreme fire danger rating at the Slocan fire weather station*

Environmental Impacts

Air quality lacks data

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.[57] The nearest $PM_{2.5}$ monitoring station to Silverton is in Castlegar. This is too far away to accurately represent local smoke impacts but 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.[58,59]

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 18).[60]

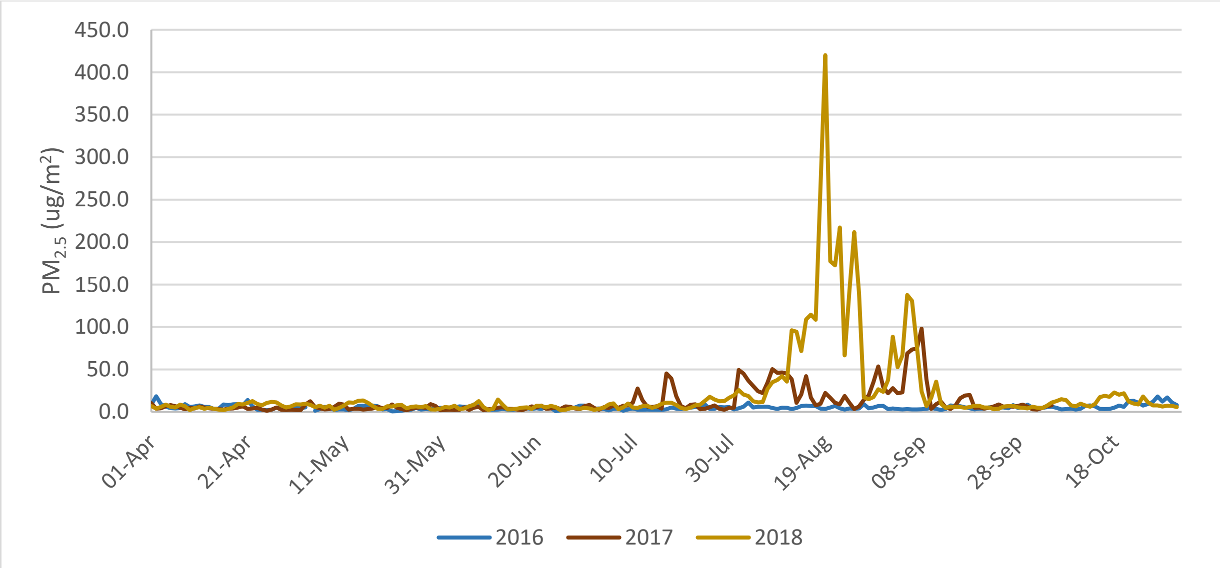

Figure 18*: Daily average $PM_{2.5}$ readings at Castlegar Zinio Park in 2016, 2017 and 2018*

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.[61]

Wildfires starts

This indicator tracks the total number of human-caused and lightning-caused wildfire starts per year. Since the mid-1900s, there is 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. Silverton falls within RDCK Area H, so data related to Area H is reported here. Area H shows a significant increase in lightning-caused fire starts 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.[62]

A significant upward trend is also present in the number of fires in the Southeast Fire Centre region that grew larger than 1 ha in size (Figure 19). This aligns with recent reports that BC's fire seasons are becoming more extreme as a result of climate change.[63]

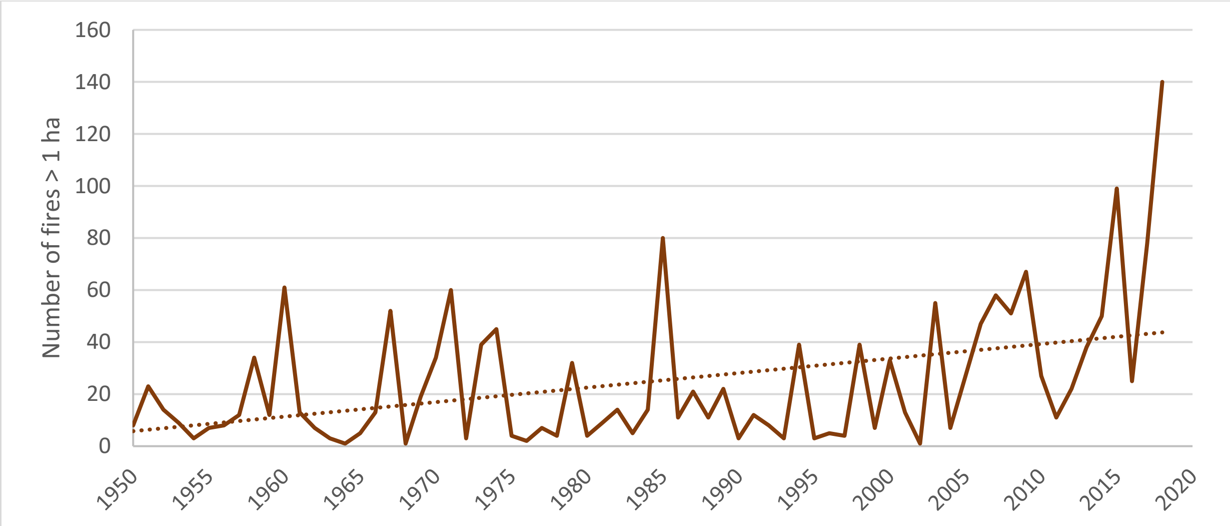

Figure 19*: Fires >1 ha in the Southeast Fire Centre region, 1950-2018*

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.[64]

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, and thus Silverton, 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 and 4,000 hectares of forest burned respectively. Notably, 2018 was a significant fire season for Silverton with 2,350 hectares burned in the Silverton Creek watershed. This was the largest fire to burn in the watershed in recent history – by a factor of ten.[65] 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.[66] 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 20)

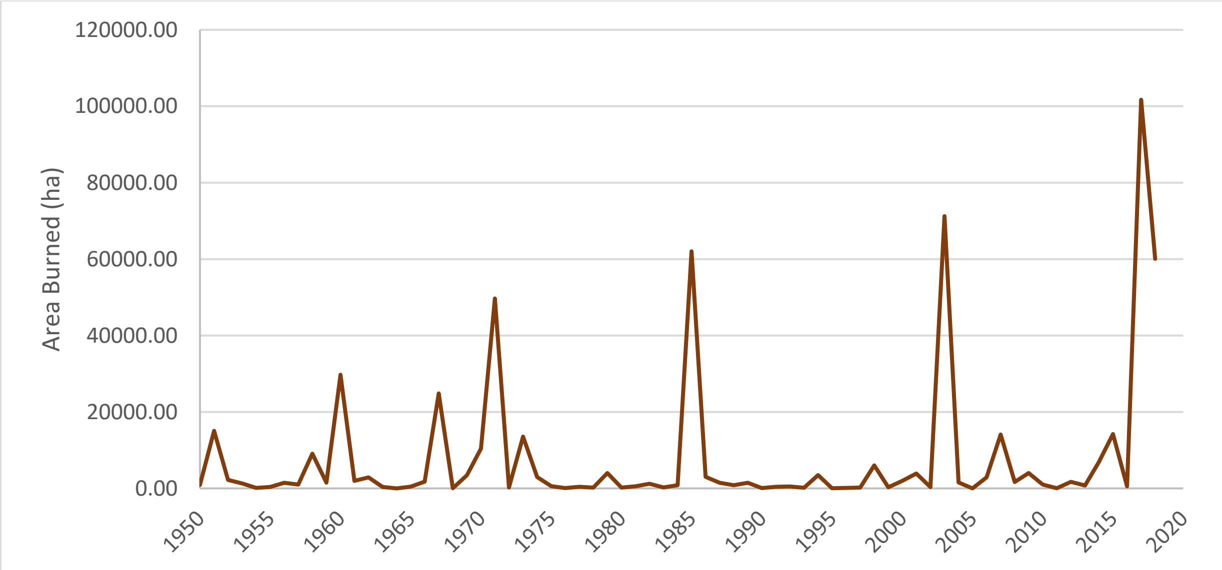

***Figure 20**: Annual area burned in the Southeast Fire Region*

Changes in the size of wildfire 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.[67] 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 (CWPP) have just been completed for Area H north and south. The CWPP for Area H north includes Silverton. Within this plan, 3571 hectares of Area H north (16.3% of the total area of Area H north) is classified as high to extreme wildfire threat as per the Provincial Strategic Threat Analysis. This analysis evaluates the conditions necessary for a wildfire to threaten a community. Since 2009, 398 hectares of Area H north has had fuel treatment, with 276 hectares of that identified as being near Silverton. Assuming this fuel treatment takes place in the high to extreme risk areas, this equates to fuel treatment of 11% of high to extreme risk areas in Area H north.[68] Due to the Village of Silverton being immediately adjacent to Slocan Lake and significant fuel treatment in the forests surrounding Silverton, the Village has 360 degrees of protection, with the exception of private properties. Private land and crown land hold opportunities for further fuel treatment.[69]

FireSmart policies are in place

The RDCK has a comprehensive FireSmart program, which has included the Village of Silverton. 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. In 2018 throughout Area H, 79 FireSmart assessments were completed under the Home Partners Program. There were an additional 24 homes assessed in 2019. Of those, only one property in Silverton was assessed.[70, 71] The RDCK has no Wildfire Hazard Development Permit Areas within Area H.[72] The Village of Silverton's Official Community Plan (OCP) indicates that Development Permit Areas may be established to protect the community from hazards, such as wildfire.[73] In 2019/20, FireSmart work is being transferred from the RDCK to a sub-region including Silverton, New Denver, and Slocan. This fire resiliency work is being done in partnership with the Slocan Integral Forestry Cooperative (SiFCO).

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 21). Since 1950, Silverton has not experienced any interface fires.[74] However, there were two interface fires close to Silverton that resulted in evacuation alerts for rural residences near Silverton. These were the Springer Creek Fire in 2007 and Mt. Aylwin Fire in 2015.[75]

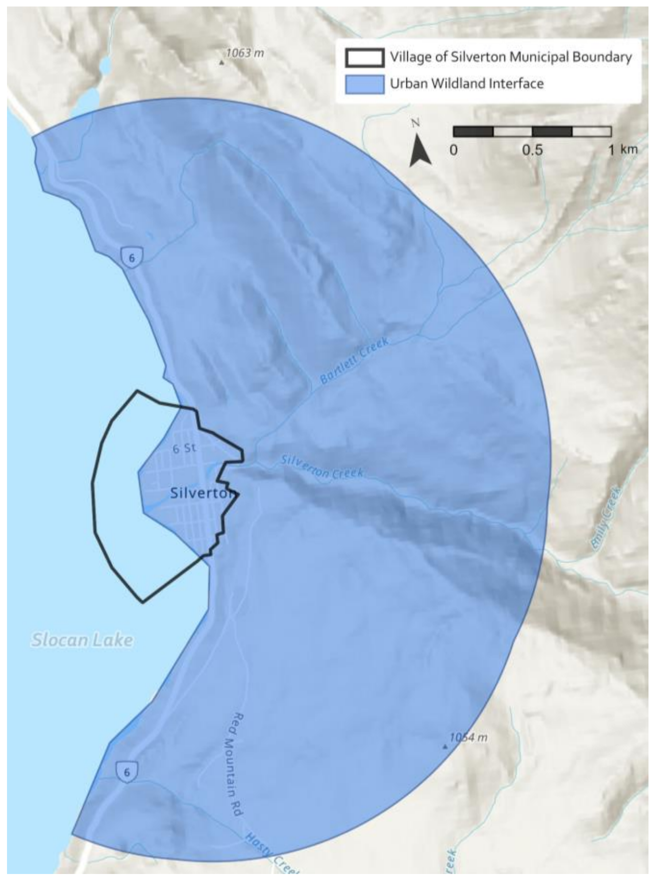

Figure 21: 2 km wildland urban interface zone around Silverton.

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. [76] Costs of fire suppression will vary from year to year and are significantly influenced by prevailing weather conditions. The dataset shows an upward trend over the period of record (Figure 22); however, given that reported values are not corrected for inflation, the true direction and magnitude of this trend cannot be assessed.

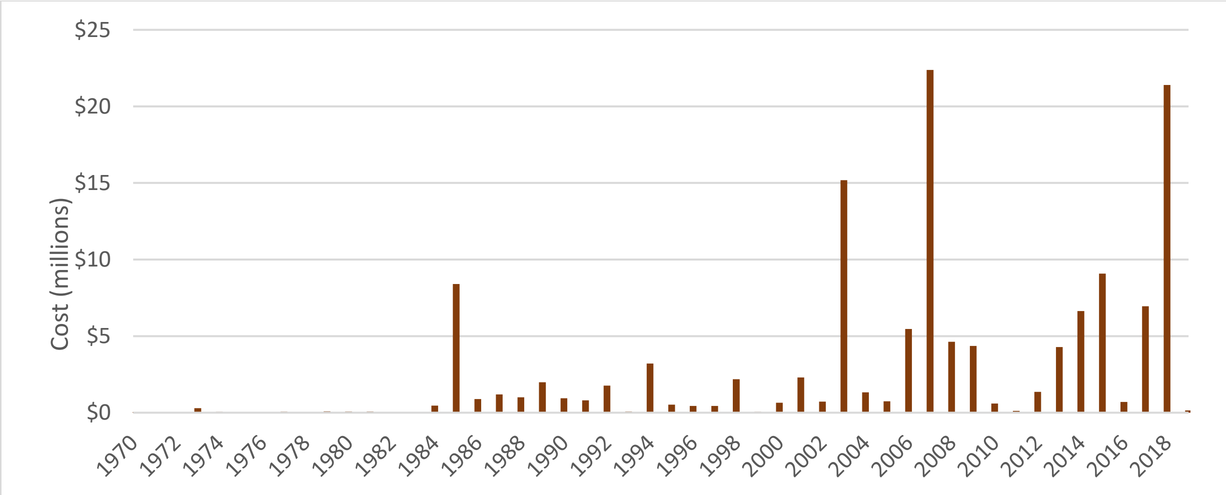

Figure 22: *Annual cost of fire suppression in the Arrow Fire Zone. (Data values from the 1970s are generally too small to show on the scale needed to show data from recent years.)*

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 in the area. Drive BC began recording this data in 2006.[77]

Provincial emergency assistance

As discussed in both 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. There have been no provincial emergency assistance funds paid to the Village of Silverton.[78]

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.[79] Long term tracking of this indicator is necessary to establish a trend.

No evacuation notices

There have been no evacuation notices due to wildfires within the Village of Silverton in recent history.[80]

NEXT STEPS

Action Areas

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

- **Emergency Planning and Response**. Improved communications between the RDCK and the Village of Silverton would help ensure that both parties clearly understand roles and responsibilities if and when an emergency happens within or near Silverton.
- **Wildfire risk reduction**. The recently adopted Area H North Community Wildfire Protection Plan identifies priority fuel treatment areas and measures to reduce interface fire risk, which is critical given that 89% of high priority areas are currently untreated. Due to jurisdictional limitations, fuel treatment can be challenging. By engaging other agencies and private land owners, the Village of Silverton may be able to advance creative solutions to this issue, an approach that is supported by the province's new community wildfire resilience framework. The RDCK's commitment to FireSmart public engagement and education, and the emerging sub-regional approach to fire resiliency, will advance 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.** Local food self-sufficiency can be an important contributor to the resilience of a community, and the enthusiasm for farming and backyard food growing in Silverton is evident. At the same time, growing agricultural water demand and climate impacts on water supply during the growing season could result in water use conflicts and shortages in the future. Leadership from the Village could help Silverton residents navigate these challenges in the years ahead.
- **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 Silverton's 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.
- **Community trees.** The combination of historical and projected climate changes will increasingly cause stress to community trees and forests as the local bioclimatic regime

changes. Trees under stress are more susceptible to damage by high winds, freezing rain, heavy snowfalls, drought, floods, disease, and insects. Fallen trees and branches are already the leading cause of power outages. Tree care and procedures for identifying and addressing “danger trees” may warrant new approaches, including education and engagement of residents and property owners.

Future Assessments

It is recommended that the next full SoCARB assessment be conducted in five years (2025). In the interim, Silverton may wish to track certain priority indicators on a more frequent basis to inform Village planning and decision making on policy, operations and capital expenditures. A number of SoCARB indicators are tracked as part of the State of the Basin initiative, which means substantial data may be available through the RDI.

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