State of Climate Adaptation

Rossland 2017

CITY OF ROSSLAND

COLUMBIA BASIN RDI RURAL DEVELOPMENT INSTITUTE

CONTENTS

INTRODUCTION

Purpose

Welcome to Rossland's 2017 baseline report using the State of Climate Adaptation and Resilience in the Basin (SoCARB) indicator suite. The SoCARB indicator suite measures community progress on climate adaptation across five climate impact pathways: extreme weather and emergency preparedness, wildfire, water supply, flooding and agriculture. 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.

This report summarizes the results of an analysis of SoCARB indicators for Rossland, and has been prepared as part of a two-year Columbia Basin Rural Development Institute (RDI) pilot project to test and refine the SoCARB indicator suite in communities across the Columbia Basin-Boundary region.

The information presented in this report is intended to highlight trends, changes, and impacts to the local climate and surrounding environment, and to inform local planning and decision-making. This includes changes in indicators outside of the City's jurisdiction such as glacier extent and wildfire starts, recognizing that a better understanding of trends associated with these indicators can help the community prepare for current and future changes. For other indicators, like 72-hour emergency preparedness and per capita water consumption, for example, communities will be better positioned to identify and track where local actions could increase community climate resilience.

Not all 58 SoCARB indicators are reported on in this document. Indicators that Rossland has not identified as a priority, as well as all indicators from SoCARB's Community Resilience Index (see page 2), have been excluded. Some indicators may be updated annually as part of the city's annual reporting, while others may be updated over a longer time scale, e.g. every three to five years, as time and resources allow.

Report Highlights

- Rossland's climate is changing, with data showing trends toward higher average temperatures, higher annual precipitation, more hot days, and more frequent freeze-thaw cycles.
- Shifts in these climate metrics are becoming evident through changes in environmental conditions, suggesting important focal points for efforts to enhance climate adaptation planning and action. For example, wildfire starts are on the rise, as is the amount of heat energy available for crop growth. Several environmental impact indicators lack sufficient data to infer trends, suggesting important focal points for efforts to enhance climate adaptation monitoring, planning and action.
- Rossland has taken important steps to adapt to changes that have already happened, and to prepare for future change. These actions are primarily related to emergency preparedness (with the preparation of an emergency preparedness plan), interface fire risk reduction, and community water supply (with extensive water conservation efforts including water loss mitigation). Opportunities exist to further Rossland's readiness to adapt, which include actions requiring involvement from residents such as improving uptake of 72-hour emergency

preparedness kits in Rossland households, and implementing Fire Smart measures in more of Rossland's neighbourhoods.

- While some datasets are not lengthy or complete enough to evaluate trends that would indicate the effectiveness of Rossland's adaptation efforts, 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 (SoCARB) indicator suite was developed in 2015 by a team of climate change professionals. The full suite groups indicators into two instruments:

1) a set of five thematic pathways (wildfire, water supply, agriculture, flooding, and extreme weather) that, through 58 indicators, measure climate change, climate change impacts, and climate change adaptation; and
2) a Community Resilience Index, which uses an additional 20 indicators to provide a sense of the socio-economic conditions in the community that contribute to its capacity to adapt.

A model of the Water Supply pathway is provided below to illustrate how SoCARB conceptualizes the relationships between categories of indicators. The pathways show how changes in the climate lead to environmental impacts which in turn lead to community impacts. These community impacts can be addressed through adaptation actions and capacity building thereby reducing community impacts and improving adaptation outcomes. In the case of the extreme weather pathway, environmental impacts are not included as extreme weather has direct impacts on communities. These relationships are described in more detail in the SoCARB indicator suite.

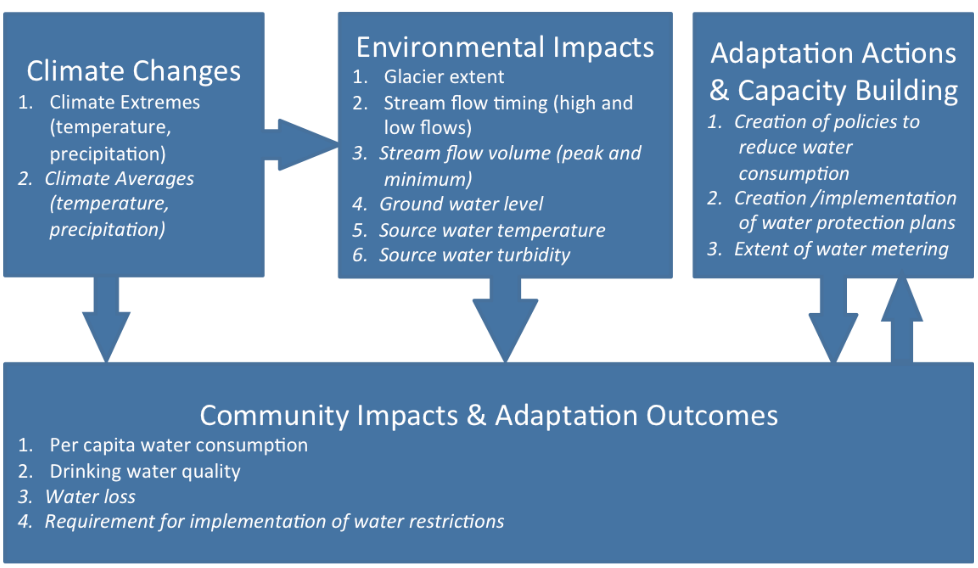

Figure 1: Water Supply pathway from the SoCARB indicator suite

For this report, Rossland City staff and consultants identified 41 of the pathway indicators that best reflect local priorities. Community Resilience Index indicators were not assessed as part of this report; however, most are addressed in the RDI's annual State of the Basin reports. The report includes an introductory Climate section, which presents climate change indicators common to all pathways, followed by sections on the four pathways that Rossland chose to focus on (water supply, extreme weather, agriculture, and wildfire) structured in accordance with Figure 1.

The City of Rossland has received detailed information as to the data source, analysis method, and reporting for every indicator in this report, so that each indicator can be updated and tracked over time.

Notes to the Reader

The indicators and their related data sets range from simple to complex. Additional detail on the existing datasets and analytical methods is available from the RDI (cbrdi@selkirk.ca). Understanding the data and its limitations is important for many reasons. The points below are general notes to keep in mind 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. Basin climate 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 have been used. For example, the closest weather station to Rossland is in Warfield. While overall climate trends are similar for both communities, temperature and precipitation patterns can vary due to the difference in topography. For this reason, climate data has been modeled for Rossland. More details are provided in the body of the report.
- **Confounding factors**. A variable can be influenced by many 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., new infrastructure, change in monitoring, unique events) should also be considered.
- **No obvious trend**. Some data may show no obvious trend. However, this data still has value as i) a trend may eventually emerge, and ii) the information can still help inform decision making.

CLIMATE

Four climate change indicators are common to all pathways in the indicator suite: 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 indicators all use two datasets—both of which are discussed for comparative purposes. Adjusted and Homogenized Canadian Climate Data (AHCCD) from Environment Canada provides long-term (since 1928) observed data for Warfield. North American Regional Reanalysis data (NARR) from the US National Oceanic and Atmospheric Administration provides shorter-term (since 1979) modeled data for Rossland[i]. To provide regional context, results of a composite analysis of average temperature and precipitation from AHCCD data available for six stations in the Southwest Canadian Columbia Basin are also discussed[ii].

The Overall Picture

Both average annual and extreme temperatures appear to be rising in the area surrounding Rossland, with winter temperatures rising at the fastest rate. This could have negative implications for snow-related tourism, ecosystems, and infrastructure. Annual precipitation is also on the rise in the Southwest Columbia Basin and Warfield, with increases in spring and summer precipitation driving these trends. While the shorter Rossland record does not show a statistically significant trend, data from nearby stations suggests that the community should prepare to adapt to the environmental changes that may accompany shifts in precipitation, such as changes in the water supply, localized flooding, and agricultural viability.

Average annual temperatures are increasing

The composite Southwest Basin analysis shows a trend toward higher annual average temperatures, with temperatures having increased at a rate of 1.6°C per century since 1915 (Figure 2, Table 1).

	Annual	Winter	Spring	Summer	Fall
Rossland (since 1979)	3.6	No data			
Warfield (since 1928)	*0.1*	1.8	*-0.1*	*0.0*	*0.0*
Southwest Columbia Basin (since 1915)	1.6	1.9	1.1	0.8	1.0

Table 1: Annual and seasonal average temperature trends for Rossland and the Southeast Basin, in degrees Celsius per century. Results that are not statistically significant (reliable) are in italics.

Annual data for Rossland shows an upward trend of 3.6°C per century, while the annual Warfield data does not show a statistically significant trend. The average annual temperature for Warfield ranged from 7.3°C to 10.5°C between 1928 and 2015, while modeled data for Rossland (since 1979) shows slightly

[i] For the purposes of this report, to more accurately reflect local conditions, NARR data have been adjusted using known trends calculated from the AHCCD dataset. Data and analyses were provided by Charles Cuell and Climate Resilience Consulting. It is important to note that modeled trends based on the NARR analysis encompass only 37 years of data. Relatively speaking, this is a short record for climate trends. Short climate records are vulnerable to inordinate influence by natural fluctuations ("oscillations") in the climate cycle. For this reason, trends based on NARR data should be viewed and used with consideration of these limitations.

[ii] This analysis was provided by Mel Reasoner and Columbia Basin Trust.

lower minimum and maximum annual average temperatures, ranging from 6.7°C to 10.4°C. On a seasonal basis, all trends for the Southwest Basin are statistically significant and show the highest rate of change in the winter months (1.9°C per century). Warfield also shows an increasing trend for the winter season. Other seasons do not show statistically significant trends.

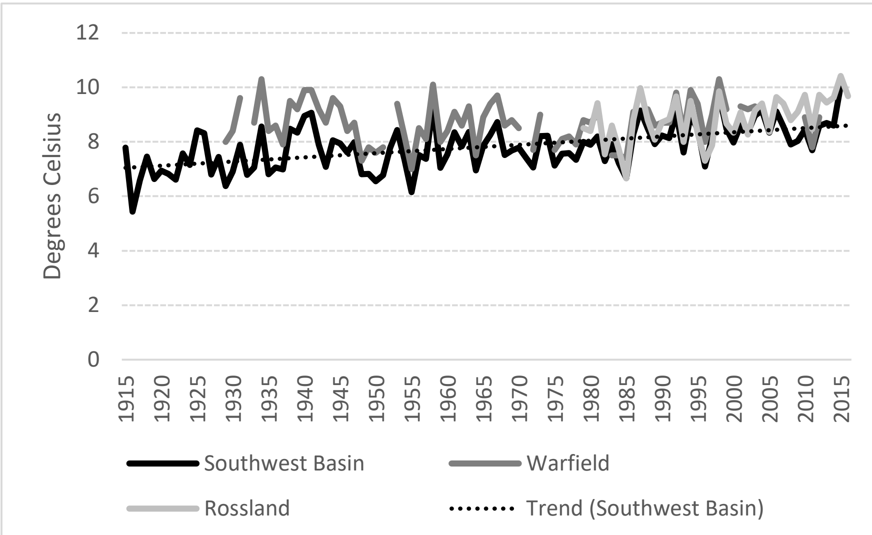

Figure 2: Average annual temperature for Rossland, Warfield, and the Southwest Columbia Basin

Annual precipitation is increasing

Annual precipitation in the Southwest Basin has increased at the rate of 218 mm per century since 1915 (Figure 3, Table 2). This dataset also shows increasing trends for spring, summer and fall. The average annual precipitation for Warfield ranged from 436 to 1052 mm per year from 1928 to 2002, while modeled data for Rossland shows a smaller range of between 500 and 961 mm since 1979. There is a statistically significant upward trend in annual precipitation in Warfield of about 2.5 mm per year (247 mm per century). This is driven primarily by increased spring and summer precipitation, which have both increased about 1.2 mm per year (120 mm per century). The shorter, modeled record for Rossland does not show a statistically significant increase in annual precipitation.

	Annual	Winter	Spring	Summer	Fall
Rossland (since 1979)	*141*	No data			
Warfield (since 1928)	247	*-5*	119	115	*43*
Southwest Columbia Basin (since 1915)	218	*18*	104	62	53

Table 2: Annual and seasonal total precipitation trends for Rossland, Warfield and the Southwest Basin, in millimetres per century. Results that are not statistically significant (reliable) are in italics.

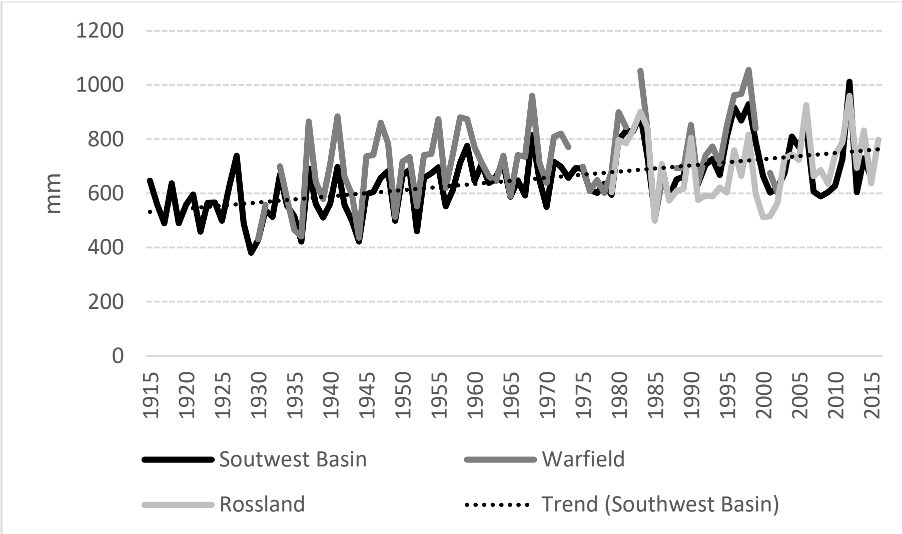

Figure 3: Total annual precipitation for Rossland, Warfield and the Southwest Basin

More hot days

The extreme temperature indicator measures the percentage of days where the temperature exceeds the 90th percentile for the baseline period (1961-1990). For Warfield between 1929 and 2015, this percentage has ranged between a low of 3.37% in 1984 and a high of 24.09% in 2015. For Rossland, it has ranged between a low of 2.4% in 1997 and a high of 26.3% in 2016. A steep and statistically significant increasing trend of 0.28% of days per year is present in the Rossland data (Figure 4).

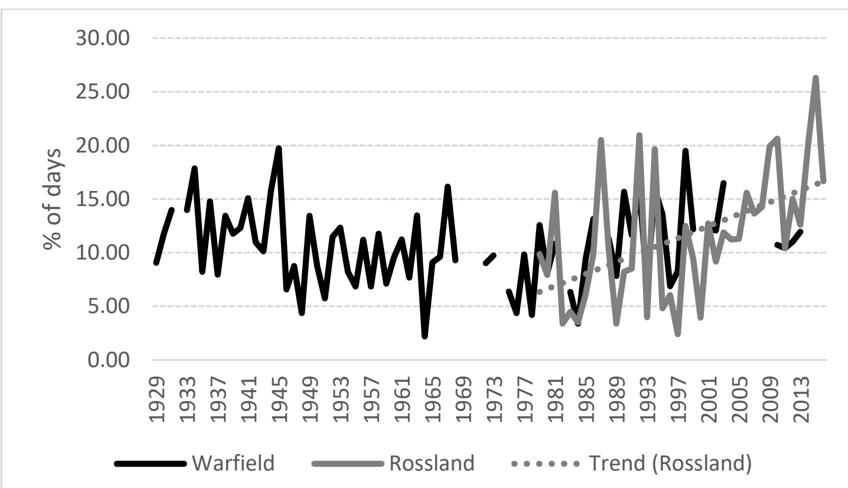

Figure 4: Days with extreme temperatures in Warfield and Rossland

No trend in extreme rainfall

The extreme precipitation indicator measures the annual sum of daily precipitation exceeding the 95th percentile—essentially the amount of rain that falls during very heavy rainfall days annually. Though the Warfield and Rossland datasets both show slightly increasing trends over the period of record, neither trend is statistically significant (Figure 5).

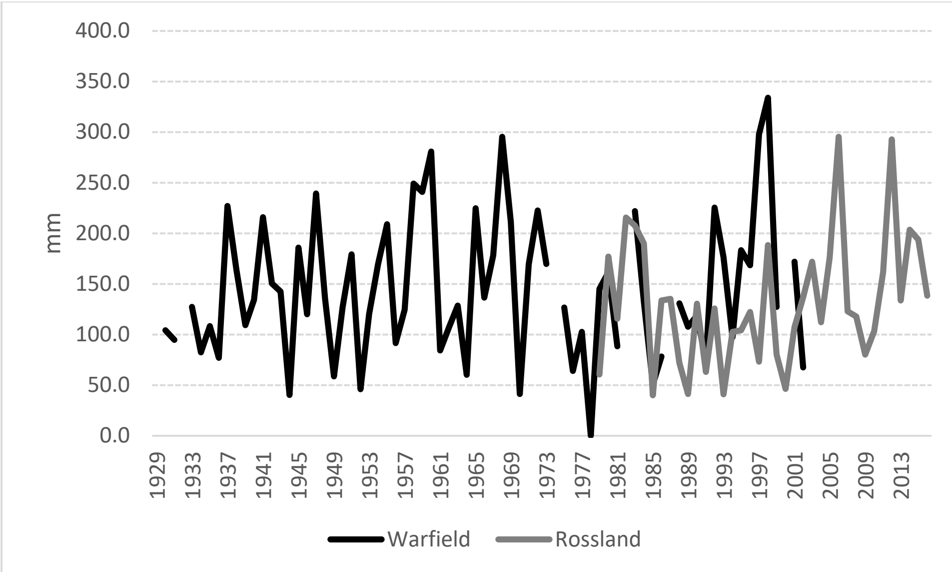

Figure 5: Amount of rain falling during extreme precipitation events in Warfield and Rossland

EXTREME WEATHER AND EMERGENCY PREPAREDNESS

Extreme weather events, such as extreme snowfall, windstorms and heat, can have significant impacts on communities, both positive and negative. Future projections for the Columbia Basin suggest an increase in some extreme weather events, such as extreme warm days and extreme wet days. Communities can prepare for extreme weather events with adaptations such as emergency preparedness plans, backup power sources and home emergency preparedness kits. The City of Rossland chose to collect, analyze and report data for eight extreme weather pathway indicators.

The Overall Picture

Extreme weather patterns are changing in Rossland, with the frequency of hot days, extreme heat days, maximum 1-day rainfall, and freeze-thaw days all on the rise. These shifts have implications for infrastructure planning and economic sectors that are closely linked to weather (e.g., winter tourism). There is insufficient data for extreme snowfall events and extreme wind events to draw any conclusions. These should be monitored over time. Rossland has taken some steps to prepare for extreme weather events by participating in a comprehensive regional emergency preparedness planning process, and planning short-term back-up power supply for some key City operations. Personal emergency preparedness, however, needs attention as the number of Rossland residents with 72-hour emergency preparedness kits may be below 50 percent.

Climate Changes

As discussed in the Climate section, Rossland has seen an increase in the frequency of hot days and no statistically significant trend in extreme rainfall. Additional climate indicators related to the Extreme Weather pathway are discussed below.

More extreme heat days

The extreme heat days indicator measures the number of days per year where the temperature exceeds 30°C. Based on modeled data, the number of extreme heat days in Rossland ranges from a low of 2 days in 1995 to a high of 43 days in 2015, with an average of 17 days per year between 1979 and 2016. The average number of extreme heat days in Warfield is 35 days per year. The Rossland data shows a steep statistically significant increasing trend of 0.6 days per year (60 days per century) since 1979. There is no trend in the data for Warfield. Heat waves and heat extremes have negative health impacts on vulnerable populations including the elderly, socially isolated, chronically ill, and infants.

More data needed on extreme snowfall events

The frequency of extreme snowfall events (+15 cm) per year relies on two incomplete data sets – one from the Rossland municipal yard, and one from Red Mountain Resort (Figure 6). There is insufficient data in either dataset to establish a trend. At Red Mountain Resort, the number of extreme snowfall events ranged from a low of 6 events in 2013 to a high of 21 events in 2006, with an average of 11 events per year between 2004 and 2016. Actual snowfall during extreme events often exceeded 15 cm and average snowfall on days that exceeded 15 cm from 2004 to 2016 was 32 cm, with a high of 48 cm on one day in 2007.

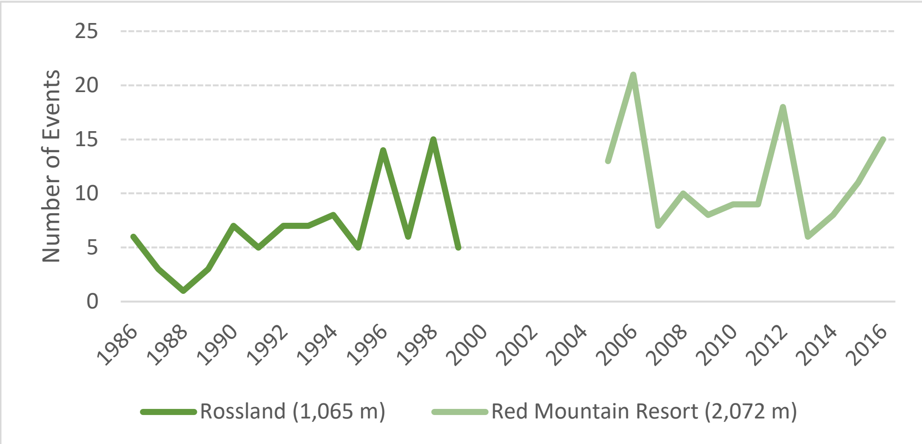

Figure 6: Extreme snowfall events at two Rossland stations

Increasing maximum 1-day rainfall

Maximum 1-day rainfall measures the amount of rain that falls on the highest rainfall day in a year. In Rossland between 1979 and 2016, modeled data show the maximum 1-day rainfall ranged from a low of 13.5 mm in 1991 to a high of 37 mm in 2013. There is a statistically significant upward trend in this data, with an increase of about 0.2 mm per year (17 mm per century) having occurred since the beginning of the record. Warfield data also shows an increasing trend of 0.1 mm per year since 1929. Heavy rainfall is a major cause of flooding of creeks and rivers, and can cause stormwater management issues. A warming climate increases the risk of extreme rainfall events.

Monitoring strong wind events

The strong wind event indicator is measured as total number of days each year with sustained wind of 70 km/h or more and/or gusts 90 km/h or more. Wind speed has been measured at Strawberry Pass since 2000, Warfield since 2007 and Red Mountain since 2014. During the period for which data has been collected at Strawberry Pass and Warfield, there were no strong wind events. At Red Mountain, there have been 12 days with sustained wind of 70 km/h or more and 4 days with gusts 90 km/h or more. All of these days occurred in 2015.

More frequent freeze-thaw days

The freeze-thaw cycle indicator measures the number of days when maximum temperature is greater than 0° Celsius and minimum temperature is less than 0° Celsius during the same day. In Rossland, between 1979 and 2016 the number of freeze-thaw days ranges from a low of 55 in 1983 to a high of 121 in 2002 (Figure 7). There is a statistically significant upward trend in the number of freeze-thaw days per year in Rossland, with the frequency increasing at a rate of about 0.7 days per year.

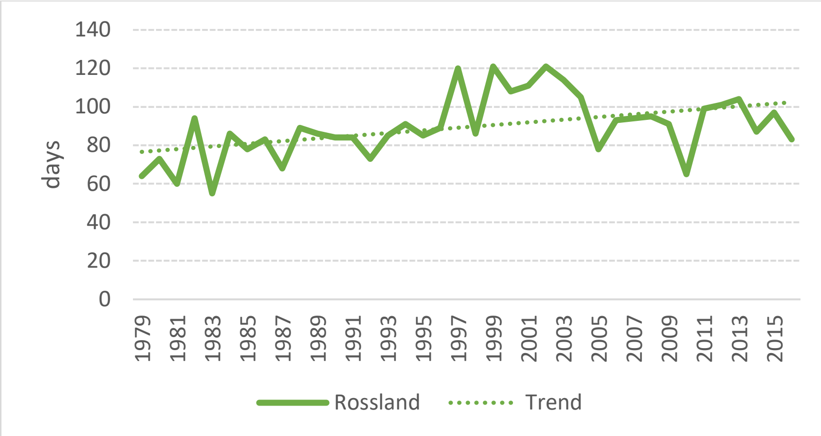

Figure 7: Freeze-thaw days in Rossland

Adaption Actions and Capacity Building

Emergency Preparedness Plan nearing completion

The existence of a comprehensive emergency preparedness plan is an important indicator of how prepared communities are to deal with climate changes and associated environmental impacts. The City of Rossland is participating in the development of a comprehensive regional emergency preparedness plan that includes a hazard risk assessment, emergency procedures, a community evacuation plan, and provisions for an emergency response centre and an emergency program coordinator (Table 3). A complete draft of the plan is currently undergoing final review.

Table 3: Emergency Preparedness Plan components in Rossland

	Yes	In Progress
Hazard risk assessment[1]	✓	
Emergency procedures	✓	
Municipal business continuity plan		
Community evacuation plan	✓	
Public communication plan		✓
Designated emergency response centre	✓	
Emergency program coordinator	✓	
Designated emergency response team	✓	
Identified emergency roles and responsibilities	✓	
Action list for each type of hazard	✓	
Designated emergency/reception shelter	✓	
Plan for shelter stocking		✓
Training and emergency exercise plan for response personnel	✓	
Contact list for all response personnel	✓	
Fan-out call list	✓	
MOUs with any agencies helping in response (e.g. neighbouring municipalities, school board, local service groups)	✓	

1: This is an external document

Few residents have complete emergency preparedness kits

Home emergency preparedness kits can help reduce the consequences of extreme weather events. A 2017 survey asking if residents have a 72-hour emergency preparedness kit found that the majority of respondents (63%) do not. Of those who did have a 72-hour emergency kit, only 30% had items consolidated in a single, accessible location, and just over 50% of kits included water, money and a battery-powered or wind-up radio. Items like copies of identification papers, emergency plans and prescription medications were even less common (Table 4). Many Rossland residents could improve their emergency preparedness by creating comprehensive and consolidated 72-hour emergency preparedness kits.

Table 4: Percentage of respondents with emergency kits indicating the presence of important items in their kit

Item	% Yes
Flashlight and batteries	95%
Candles and matches/lighter	95%
First aid kit	93%
Manual can-opener	91%
Food that will not spoil (min. 3 day supply)	89%
Extra keys for your car, house, safe deposit box	68%
Drinking Water (2 - 4 litres of water per person and pets per day)	62%
Cash in smaller bills and change	62%
Insurance policy information	56%
Battery-powered or wind-up radio	58%
Copies of identification papers (licenses, birth certificates, care cards)	49%
Special items such as prescription medications, infant formula or equipment for people with disabilities	48%
A copy of your emergency plan including contact numbers (e.g. for out-of-town family)	22%

Community Impacts and Adaptation Outcomes

No weather-related highway closures in past decade

Weather-related highway closures give some indication of how extreme weather events are affecting communities. Since 2006, there have been zero weather related highway closures on Highways 3B and 22 in the Rossland area.

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 could change the amount of water stored as part of the snowpack and the timing of surface water availability. 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 City of Rossland chose to collect, analyze and report data for ten water supply pathway indicators.

The Overall Picture

From the limited amount of data available, Rossland appears to be in a relatively strong position with respect to water supply. Stream flow volumes may be declining, but many positive actions taken by the Rossland community could help buffer the impact of reduced water availability. Maximum and minimum stream flow volumes appear to be generally stable although ongoing monitoring, and monitoring of Rossland's drinking water creeks in particular, is recommended and would add valuable information to Rossland's understanding of its water security. The addition of new storage capacity in the water system has reduced pressure on the supply, and there are several policies in place to reduce water consumption. Total water use per year has been decreasing over the past five years, and per capita water consumption in Rossland is low compared to the rest of the Columbia Basin. Non-revenue water use has also been decreasing. Water quality meets health standards as reflected by the lack of boil water advisories in Rossland in the last twenty years, and source water turbidity is generally low, but more monitoring is needed to establish clearer trends.

Climate Changes

As discussed in the Climate and Extreme Weather sections, average annual and winter temperatures are increasing, annual and spring/summer precipitation is increasing, the frequency of hot days is on the rise, and there is no trend in extreme rainfall.

Environmental Impacts

No apparent trend in April 1st snow pack

Springtime high elevation snow pack provides some indication of how much meltwater will be available to feed creeks in the early summer months. The April 1st snow pack data for Rossland comes from Record Mountain, which is at a slightly lower elevation than Granite Mountain. The data record is not long enough to establish any trends, particularly due to the effects of the Pacific Decadal Oscillation, which influences climate over 20 to 30 year periods. The data show no discernable trend in April 1st snow pack (Figure 8). June 1st snow pack shows a slight downward trend; however, this trend is not statistically significant.

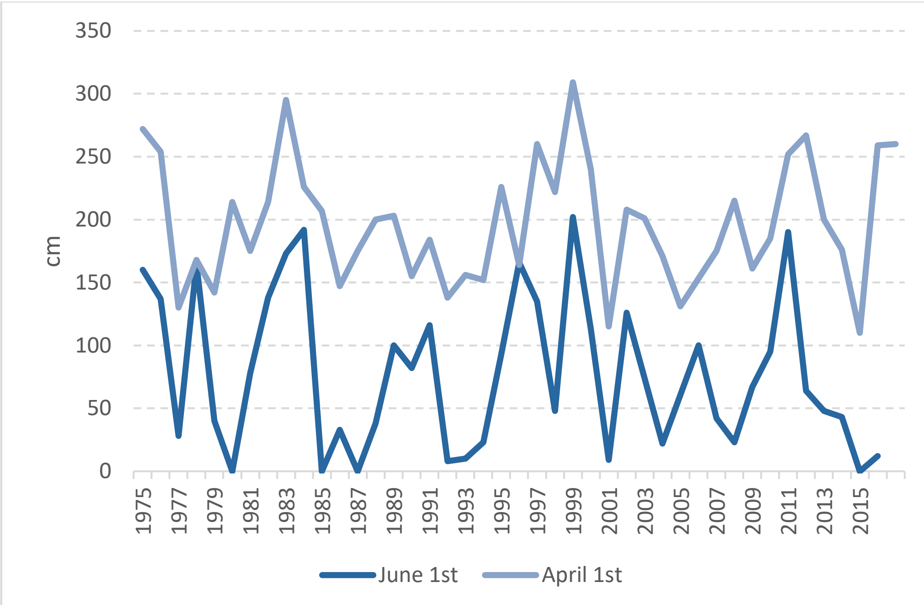

Figure 8: April and June 1st snow pack depth at Record Mountain

More stream flow volume data needed

The stream flow volume indicator measures trends in annual maximum and minimum daily discharge. Due to a lack of monitoring on Rossland's water supply creeks (Hanna, Topping and Murphy), Big Sheep Creek is used as a proxy. It is important to note the limitations of this approach, as the Big Sheep watershed has very different characteristics—slope, size and aspect—from Rossland's source watersheds. A local water expert cautions that Big Sheep Creek data is not a good proxy for freshet (spring melt) analysis on Hanna, Topping and Murphy Creeks. The low flow relationship between Big Sheep Creek and Hanna, Topping and Murphy is closer and therefore Big Sheep Creek data can be used cautiously as a proxy for Rossland's source watersheds for minimum flows.[iii]

Streamflow volume was considered from 1950 onwards. Although the linear trend in stream flow volume for both maximum and minimum flows (Figure 9) appears to be slightly down, the trend is not statistically significant.[iv]

[iii] Micklethwaite, Bill. (2008). "Rossland Water Resources". Available at: http://adaptationresources.pbworks.com/f/Rossland's+Water+Supply.doc

[iv] Flow data for Rossland's source watersheds was estimated using the methodology described in Micklethwaite (2008).

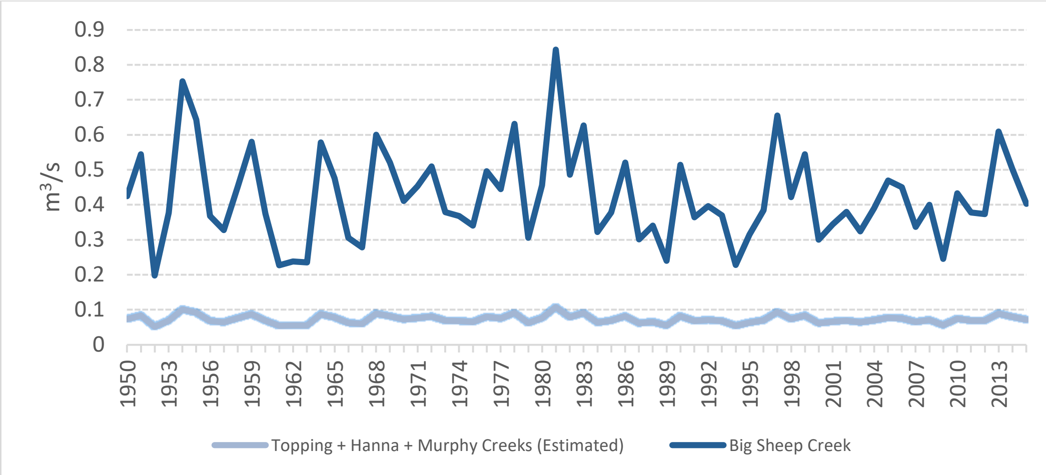

Figure 9: Minimum daily discharge for Big Sheep Creek (observed) and Rossland source watersheds (estimated).

More stream flow timing data needed

Stream flow timing is sensitive to climate change, especially in snowmelt-dominated river systems such as those in the Canadian Columbia Basin. Studies generally discuss a trend toward earlier peak flows, which results in a longer period of low flows; however, while present in the western Rockies of the U.S., this trend has not yet been detected by streamflow monitoring in the Canadian Columbia Basin.

Stream flow timing can affect water availability for capture and environmental needs. The stream flow timing indicator tracks the half total flow date, the timing of annual peak yield and the timing of late summer minimum yield. Half total flow date refers to the day of the year when half of the total annual volume of a stream has passed through a monitoring station. Big Sheep Creek is again being utilized as a proxy for Rossland's water supply creeks due to its proximity and the availability of data, and the same limitations of this approach that are discussed above, also apply here. Data shows that, since 1950, there is a slight trend toward an earlier half total flow date (Figure 10) and date of annual peak yield in Big Sheep Creek. These trends are not statistically significant, however.

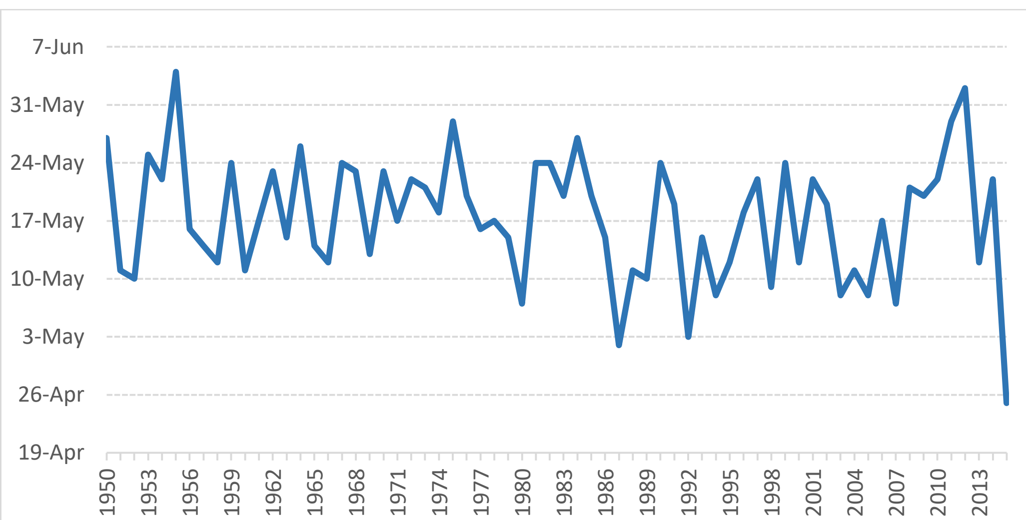

Figure 10: Half total flow date for Big Sheep Creek

More source water turbidity data needed

More rapid springtime melts can increase source water turbidity and necessitate more extensive drinking water treatment procedures. Water quality advisories are issued on unfiltered drinking water in BC when the turbidity exceeds 1 NTU. Spot checks have been undertaken on each of Rossland's drinking water creeks at various times over the past eight years and have rarely exceeded 0.2 NTU; however, readings following a period of heavy rain in November 2016 on both Hanna and Topping Creeks were 0.33 and 0.97 NTU, respectively. Insufficient data is available to evaluate trends in water turbidity.

Adaptation Actions and Capacity Building

Good implementation of policies to reduce water consumption

Rossland has effectively implemented many water consumption reduction policies with universal water metering, public education, consumer billing by amount of water used, and other important strategies (Table 5). Rossland participated in the Columbia Basin Water Smart program from 2009 to 2015, which recommended continued implementation of water loss management, public education, and full-cost water utility rate setting in order to achieve the highest possible future reductions in water demand.

Table 5: Implementation of policies to reduce water consumption in Rossland

	Full implementation	Moderate implementation	Minimal implementation	No implementation
Implementation of policies to reduce water consumption:				
Universal water metering	✓			
Public education and outreach on water conservation	✓			
Public education and outreach on water consumption trends	✓			
Water meter data analysis	✓			
Consumer billing by amount of water used (volumetric)	✓			
Implementation of water utility rates sufficient to cover capital and operating costs of water system		✓		
Water conservation outcome requirements for developers				✓
Water conservation targets	✓			
Stage 1 through 4 watering restriction bylaw	✓			
Enforcement of watering restriction bylaw			✓	
Drought management plan				✓
Implementation of actions to address water system leaks:				
Targeted leak repair	✓			
Water operator training	✓			
Replacement of aging mains	✓			

Addressing private service line leakage	✓
Pressure management solutions	✓

Community Impacts and Adaptation Outcomes

Water reservoir levels

Water reservoir levels are generally measured once per week and the number of centimeters the reservoir is overflowing or drawn down is recorded. The new Ophir reservoir, built in 2009, has decreased the number of days per year Star Gulch reservoir is drawn down. Between 2001 and 2008, there were 6 years in which Star Gulch reservoir was drawn down during 10 or more weeks, while between 2009 and 2016 there were only 2 years where this was the case (Table 6). This is in part because water is diverted from Ophir to Star Gulch when Star Gulch gets drawn down. The amounts by which Star Gulch reservoir is drawn down have also dropped dramatically since the opening of Ophir.

Year	Weeks
2000	7
2001	21
2002	19
2003	12
2004	2
2005	0
2006	16
2007	15
2008	10
2009	6
2010	7
2011	9
2012	12
2013	2
2014	2

Table 6: Number of weeks per year with at least one draw down day on Star Gulch Reservoir

Per capita water consumption lower than BC and Basin averages

Per capita water consumption in Rossland in litres per day (lpd) has dropped from around 700 lpd in 2008 to just over 500 lpd in 2016. It is considerably below average water consumption in the rest of the Columbia Basin, and slightly below average water consumption in British Columbia (Figure 11). Rossland's water consumption reductions are primarily due to the implementation of universal metering and pipe repair/replacement.

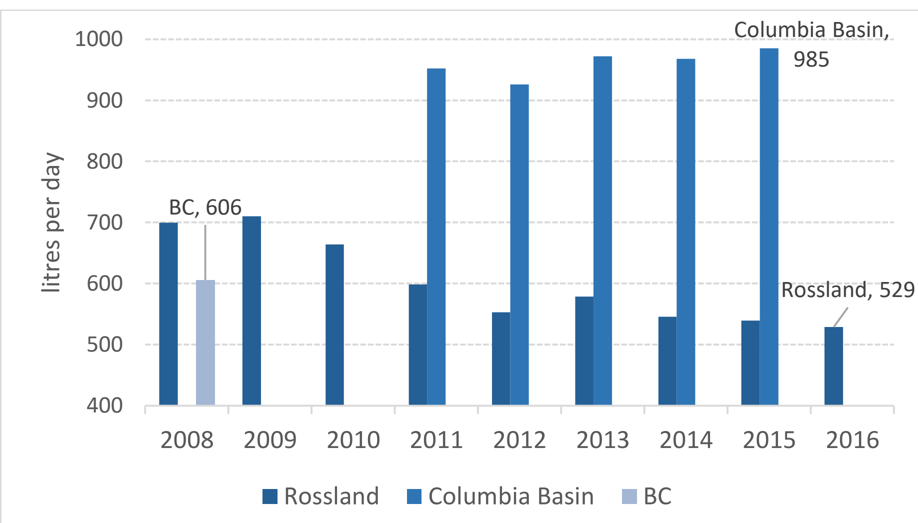

Figure 11: Per capital water consumption in Rossland, the Columbia Basin, and BC.

Water loss is declining but remains high

Non-revenue water, which includes leakage and un-metered usage, accounted for about 32% of total water use in Rossland in 2015. This is a decrease from 2012 and 2013 when non-revenue water accounted for 43% of total use.

AGRICULTURE

Although not a key economic driver for Rossland, the availability of agricultural areas and locally produced food is important to the residents of Rossland as evidenced by the long-standing weekly Farmers' Market, community gardens and the work of many local food groups. Climate has a significant, but complex, impact on agriculture, with some projected climate changes expected to increase productivity in some ways and reducing it in others. Climate change has the potential to negatively affect agricultural production in other parts of the world, and locally produced food and local food self-sufficiency could be important climate adaptations in the future. The agriculture pathway tracks the climate-related viability of both large- and small-scale agriculture, the impact of climate change on agricultural activity, and the degree to which farmers and backyard growers are prepared to deal with climate change. The City of Rossland chose to collect data and report on seven agriculture pathway indicators.

The Overall Picture

Area farmed on traditional farms in the Rossland area is declining, but this trend is likely reflective of the economic viability of farming rather than the climate trends that would otherwise be improving the viability of agriculture (e.g., more growing degree days and higher annual average temperature). Drought does not appear to be increasing, but ongoing monitoring is required due to the limited data available. Many Rossland residents grow at least a small portion of their own food, which benefits the adaptive capacity and food security of the community.

Climate Changes

As discussed in the Climate section, average annual temperatures are increasing, as is annual and spring/summer precipitation. The number of hot days is also on the rise while the trend in extreme rainfall is not clear, but the rain falling during the annual maximum 1-day rainfall appears to be increasing.

Environmental Impacts

Length of the growing season remains unchanged

The length of the growing season (days between the last frost in the spring and the first frost in the fall) is a key indicator of agricultural viability. Based on modeled data, in Rossland, the length of the growing season has ranged from a high of 264 days in 2010 to a low of 192 in 1982 and averages about 233 days per year. There is no statistically significant trend in the length of the growing season for Rossland between 1979 and 2016 or in Warfield between 1929 and 2012.

Growing degree days are increasing

Growing degree days[v] describe the amount of heat that is available for plant growth, and along with climate averages and extremes is another key determinant of agricultural viability. The number of growing degree days in Rossland averaged 2130 between 1979 and 2016 and shows a statistically significant increasing trend of 7.8 degree days per year (780 per century) (Figure 12). There is no statistically significant trend in the number of growing degree days in Warfield between 1929 and 2012.

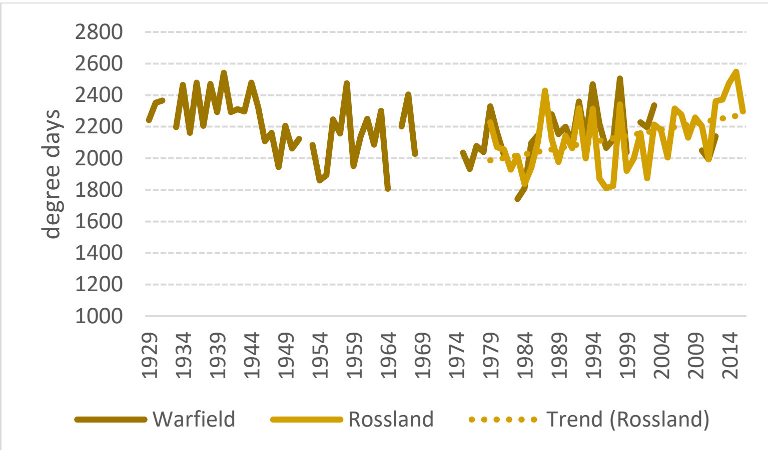

Figure 12: Growing degree days in Warfield and Rossland

Drought Index tracking begins in 2012

Drought is a leading factor influencing agriculture. The BC drought index has been calculated based on snow pack, precipitation and stream flow data since 2012. Data for the BC drought index for the Lower Columbia from 2012 to 2016 indicates that the Lower Columbia experienced 56 dry and 42 very dry days in 2015, 70 dry days in 2016 and no dry or very dry days in the three years prior to 2015. More years of data are required to determine any trends in drought. Under very dry conditions, serious ecosystem or socioeconomic impacts are possible.

No trend in consecutive dry days

The number of consecutive dry days also provides some insight into periods of drought. Based on modeled data, the maximum annual number of consecutive dry days in Rossland from 1979 to 2016 ranged from a low of 12 in 2010 to a high of 53 in 2011 (Figure 13) with an average of 25 consecutive days with no precipitation per year. There is no statistically significant trend in the number of consecutive dry days in Rossland between 1979 and 2016 or in Warfield between 1929 and 2004.

[v] For the purposes of this report, growing degree days was calculated by multiplying the number of days that the mean 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.

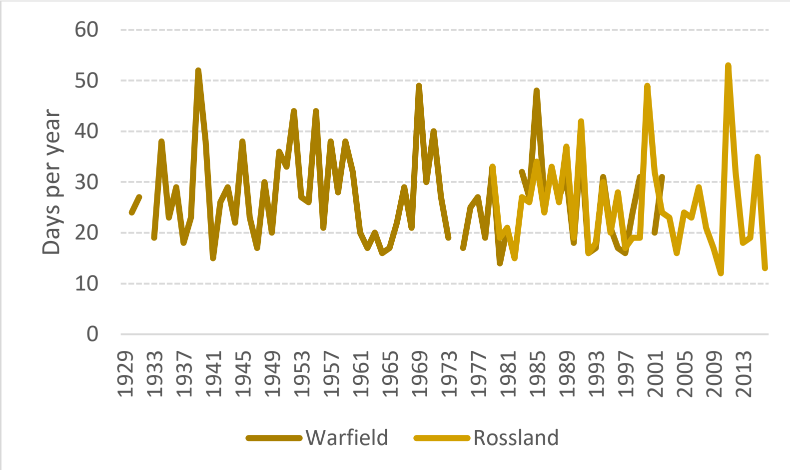

Figure 13: Consecutive dry days in Warfield and Rossland

Adaptation Actions and Capacity Building

Many Rossland residents grow some of their own food

The community food production indicator tracks the number of people in the community who grow at least some of their own food, giving a sense of local self-sufficiency and food security. Based on a 2017 survey of 168 Rossland residents, 70% grow at least some of their own food, ranging from less than 1% of their own food to over 21% of their own food (Table 5).

The most commonly grown foods in Rossland include: tomatoes, lettuce, carrots, beans, kale, peas, garlic and onions. In addition, 50% of respondents had fruit trees, with 32% having three or more, and over 50% of respondents had a berry patch. Livestock production is not common in Rossland, but 9% of respondents keep chickens.

Table 7: Percentage of own food grown by Rossland residents

Percentage of own food grown	Count	%
Less than 1%	35	21%
2% to 9%	40	24%
10% to 20%	29	17%
21% to 100%	13	8%
Total	117	70%

Community Impacts and Adaptation Outcomes

Less area being farmed

The annual number of hectares being farmed gives some indication of agricultural viability and the amount of food being produced in an area. The overall area being farmed in the Kootenay Boundary is declining. According to the 2011 Agricultural Census, in Kootenay Boundary Electoral Area B there were 1,377 hectares reported as being farmed, with 45 farms, down from 2,437 hectares in 2006, a decrease of 43%. The trend toward fewer farms continues, with preliminary data from the 2016 Agricultural Census showing 36 farms for Area B. For the purpose of the Agricultural Census, Area B includes Rossland, Trail, Warfield, Fruitvale, Montrose and Christina Lake. Based on a survey of 168 Rossland residents, at least 21,830 square feet were under cultivation in backyard gardens and the community gardens in the City of Rossland in 2017. The majority of the plots (57.3%) were under 100 square feet, but 17.3% of respondents were cultivating areas in excess of 300 square feet. More data will be needed to assess trends in the area in Rossland under cultivation in the form of backyard farming.

WILDFIRE

Wildfire can cause serious damage to community infrastructure, water supplies and human health. It is projected that climate change may increase the 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. The City of Rossland is reporting out on ten indicators from the Wildfire pathway.

The Overall Picture

Studies generally suggest that wildfires will become more frequent and extensive. While this trend is present at the national scale, it has not yet become apparent in the Rossland area, perhaps owing to the small geographic scale of this dataset. The size and frequency of wildfires in the Arrow Fire Zone and Southeast Fire Region vary significantly from year to year, but fires within 5 to 10 km of Rossland have historically been small and limited in number. Local-scale data relating to wildfire danger, frequency and size does not show reliable trends but provides a baseline for future assessments. Ongoing monitoring of fire incidents will help Rossland understand the level of risk that wildfire poses. The City of Rossland has taken some steps to prepare for wildfires with interface fire risk assessment and fuel treatment activities, and Fire Smart initiatives in some neighborhoods.

Climate Changes

Unclear trend in days in high and extreme danger class

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 class tells us the number of days when a fire may start easily and spread rapidly. The short record for this data means that trends should be interpreted with great caution. When the number of high and extreme days are considered together, the overall trend appears to be up for the Nancy Greene weather station from 1992 to 2016 (Figure 14) but with wide variability.

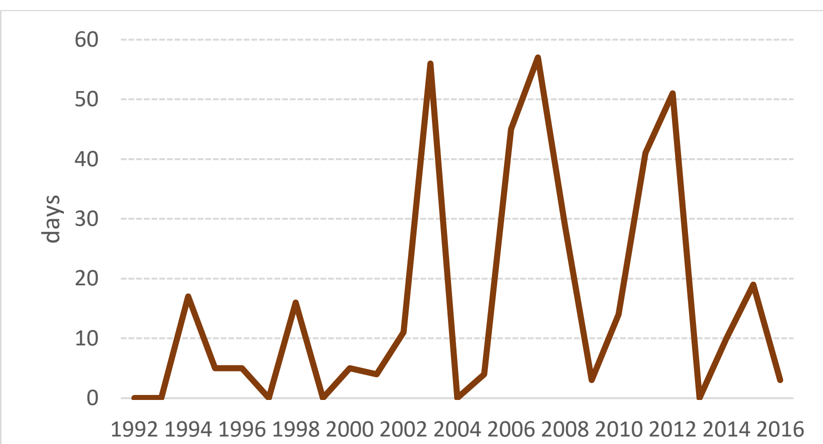

Figure 14: Number of high and extreme danger days at the Nancy Greene weather station

When the number of extreme days is considered alone, there is no notable trend and the overall number of extreme days remains low – with zero extreme days in 16 out of the 25 years considered. The overall fire risk at the Nancy Greene weather station is highest in July, August and September, peaking in August with an average of 16 days per year rated as 'high' or 'extreme.' Extreme fire danger days have occurred as early as May and into September, and high fire danger days have occurred as early as April and as late as November.

Environmental Impacts

Wildfire starts average 2 per year

The wildfire starts indicator tracks the number of human- and lightning-caused wildfire starts per year. Though national-scale data point to increasing frequency of wildfires, there are no notable trends since 1985 in the Arrow Fire Zone (Rossland is in the Arrow Fire Zone, which is part of the Southeast Fire Centre region) or a custom area 5 to 10 km around the City of Rossland. Over this period, the Arrow Fire Zone has averaged 101 fire starts per year while the Rossland area averages just over 2. A higher percentage of the fire starts in the Arrow Fire Zone are lightning-caused versus human-caused when compared to other fire zones within the Southeast Fire Centre region. The small geographic scale of this dataset may be preventing effective evaluation of trends. Across the whole Southeast Fire Centre region, since the onset of provincial wildfire suppression efforts in the mid-20th century, there is a statistically significant upward trend in the number of fires that have been tracked by the BC Wildfire Service, indicating that they grew to over 1 hectare in size (Figure 15).

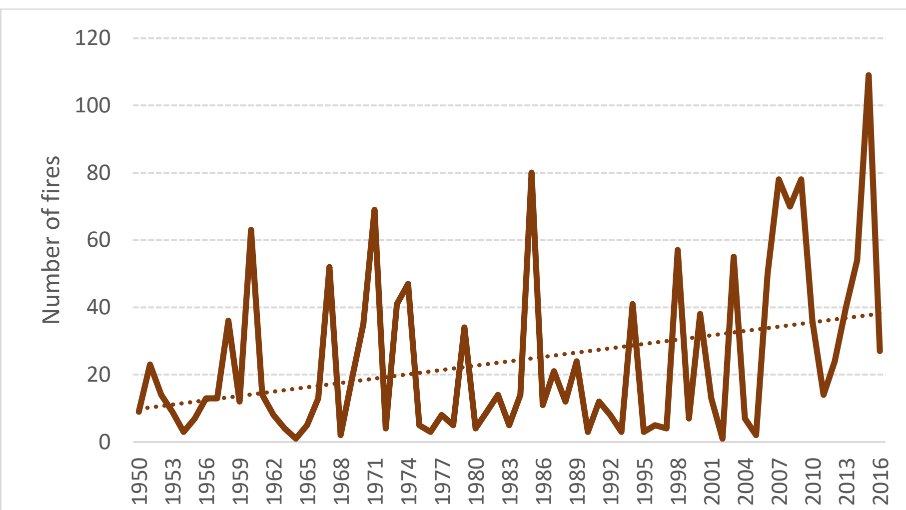

Figure 15: Fires >1 ha in the Southeast Fire Centre region, 1950-2016

No local trend in area burned annually

Rossland is part of the Arrow Fire Zone in the Southeast Fire Region. While national-level data shows a trend toward more area burned annually by wildfires, there is no such trend for the Arrow Fire Zone or the Southeast Fire Region from 1985 to 2015. The area burned ranges widely from year to year for the Arrow Fire Zone, averaging about 1000 ha, with a high of over 10,239 ha burned in 2003, to a low of 1 ha burned in 2011. The Arrow Fire Zone ranks fourth out of six fire zones in the Southeast Fire Region with respect to area burned since 1985.

Within the Rossland municipal boundary and watershed, fires have tended to be small and limited in number. The total area burned between 1985 and 2015 was 3.27 ha in the municipality and 5.15 ha in the watershed. There have only been two years since 1985 where the area burned within a custom area within 5 to 10 km of Rossland exceeded 5 ha (in 2006 when 27.5 ha were burned and in 2015 when 227 ha were burned).

More air quality data needed to determine trends

The air quality indicator measures concentrations of fine particulate matter ($PM_{2.5}$) in the air and is strongly influenced by wildfire. High $PM_{2.5}$ concentrations can have significant impacts on human health. The closest active air quality monitoring station to Rossland is Zinio Park in Castlegar and data is available from 2011 to 2016. Data from this station is limited by the fact that certain years are missing multiple data points. From 2011 to 2015, $PM_{2.5}$ levels during the fire season (April to October) do not often exceed the 24-hour objective of 25 micrograms per cubic metre (ug/m^3). Of note, however, during the 2015 fire season, 10 exceedances of this threshold were recorded. Annual $PM_{2.5}$ data shows that the annual threshold of 8 ug/m^3 has not been exceeded in any of the years for which data is available. More years of data are needed to evaluate trends.

Adaptation Actions and Capacity Building

Neighbourhoods working toward Fire Smart status

Fire Smart is a Community Recognition Program whereby communities or neighbourhoods undertake work to reduce their fire risk. Participation in this program is a measure of citizen involvement in decreasing risk of wildfire to their homes. Currently there are no Fire Smart-recognized neighbourhoods in Rossland, but Iron Colt and Black Bear are in the process of becoming Fire Smart-recognized and three other neighbourhoods are expected to engage in Fire Smarting in the next few years.

City engaging in interface fire risk reduction

Interface fire risk reduction involves assessing and treating high risk areas to reduce wildfire risk. Within a 2-km buffer surrounding the urban area of Rossland, 843 ha are classified as high risk (out of a total of 5,223 ha). Approximately 65% of the high-risk area is located on private lands.

In total, 117 ha (76 ha of which were in the high-risk area) have been assessed for treatment within the buffer. Treatment has been conducted on 65 ha (58 by the City and 6.4 on private land) and 52 ha did not require treatment. As a result, 9% of the high-risk area within 2 km of the urban area of Rossland has been assessed and 7% of the high risk area has been treated.

Community Impacts and Adaptation Outcomes

Frequency of interface fires

There were 11 wildfires within the interface (2-km) of the City of Rossland in the last 32 years. All of these fires were less than .2 ha in size. Five were human caused, while 6 were caused by lightning.

NEXT STEPS

Action Areas

Assessment results indicate that Rossland has a high level of awareness regarding the importance of climate adaptation and has taken significant steps to improve its adaptive capacity. It will be important to maintain the commitment to programs like water loss management and interface fire risk reduction to maintain momentum toward climate resilience. Analysis results suggest four specific areas for continued action or improvement:

- **Water Monitoring**. Over the past several decades, efforts to monitor water quality and quantity in Rossland's source watersheds have been limited in scope. Flow metrics from Big Sheep Creek do not provide reliable insights for Topping, Hanna and Murphy Creeks since stream flow is complex and site-specific. Additionally more monitoring of source water quality at consistent and more frequent intervals in all three Rossland source watersheds would provide insight into the effects of climate change on water quality. It would be valuable for the community to have current data on water quality and quantity in its source watersheds.

- **Personal Emergency Preparedness**. Encouraging emergency preparedness among residents would help foster resilience to the type of extreme weather that is expected to increase with climate change. Almost two-thirds of Rossland residents do not have an emergency kit. This is higher than the Canadian average. Municipalities have an important role to play in personal emergency preparedness as they are often the 'front line' for residents when disaster strikes.

- **Infrastructure Planning**. Trends show an increasing number of freeze-thaw days and maximum 1-day rainfall, both of which can have infrastructure implications. Reviewing Rossland's infrastructure planning and maintenance policies with these climate changes in mind could help Rossland be more prepared for climate change.

- **Backyard Farming and Small-Scale Agriculture**. The overall area being farmed in the Kootenay Boundary region is declining while climate change could be negatively affecting agricultural productivity on a global scale. Climate change appears to be increasing agricultural viability in the Kootenay Boundary region with a longer growing season, higher annual average temperatures and more rainfall. Local interest in backyard farming and small-scale farming appears to be high. It may be valuable for the City to capitalize on that interest and support and encourage agriculture on a local and regional scale to increase local self-sufficiency. Resources are available on the RDI's website.

Future Assessments

While some indicators are already reported annually by the City, it is recommended that the next full report be conducted in five years (2022). An update cycle is included with the documentation provided for specific indicators. Many indicators are tracked as part of the State of the Basin initiative, which means substantial data will be available through the RDI.

The SoCARB Pilot Project

This pilot project has produced a toolkit for Kimberley to enable future assessments and reporting on the SoCARB indicators. In addition, the results from this pilot will help shape the next stage of the project by informing revisions to the indicator suite and articulating strategies to promote uptake by other communities in the Columbia Basin.