Co-constructing Rural Climate Adaptation: Insights from the State of Climate Adaptation and Resilience in the Basin Pilot Project

by

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Ethics Statement

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Abstract

Communities in rural regions face unique challenges when it comes to climate change adaptation planning. In the Columbia Basin of southeast British Columbia, Canada two communities came together in collaboration with regional institutions to pilot the State of Climate Adaptation and Resilience in the Basin (SoCARB) indicator suite to help monitor and inform climate change adaptation at the local scale. This study explores the process and results of the pilot project, employing an evaluative framework that assesses the SoCARB implementation feasibility and the utility for communities. The study findings highlight several feasibility constraints related to the indicators in terms of data availability, reliability and condition as well as through the fulfillment process in terms of local resource capacity. The study also finds community utility derived from fulfilling SoCARB through supporting community communications and decision-making pertaining to climate change adaptation, supporting funding mobilization and enhancing local knowledge systems. The study concludes with recommendations to improve upon SoCARB to increase uptake of the indicator suite by communities within the Columbia Basin region.

Keywords: Climate Change; Climate Change Adaptation; British Columbia; Rural; Community Planning; Monitoring and Evaluating

Dedication

Greet me with banners and balloons and my hard drive smashed to pieces
Nothing left for me to save when I write my master's thesis
It's all gonna change when I write my master's thesis
– John K. Samson

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I would like to thank the communities Kimberley and Rossland for being welcoming and engaging which allowed this research to take place. A big thank-you is also owed to the staff at Columbia Basin Rural Development Institute – without your support and leadership, this project never would have gotten off the ground. An additional thank-you is owed to the British Columbia Real Estate Foundation for their support in funding this research. And finally, to my supervisors, Dr. John Welch and Dr. Terri MacDonald, thank-you for your continued support throughout this project.

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List of Acronyms and Abbreviations

CACCI	Communities Adapting to Climate Change Initiative
CBT	Columbia Basin Trust
CRI	Community Resilience Index
GIS	Geographic Information System
ICLEI	International Council for Local Environmental Initiatives
LAC	Library and Archives Canada
NARR	North American Regional Reanalysis
NRCan	Natural Resources Canada
RDI	Columbia Basin Rural Development Institute
RACs	Regional Adaptation Collaboratives
SFU	Simon Fraser University
SoCARB	State of Climate Adaptation and Resilience in the Basin
SoTB	State of the Basin
The Trust	Columbia Basin Trust
The Basin	Columbia Basin

Glossary

Adaptive Capacity	The ability of a country, region, community, group or individual to monitor, assess and respond to change by moderating potential damages, taking advantage of opportunities, or coping with the consequences (Columbia Basin Trust; Columbia Basin Rural Development Institute, 2015).
Biogeoclimatic Ecosystem Classification	A system of natural taxonomic classification of ecosystems widely using in British Columbia (Forest Service of British Columbia, 2018).
Climate	The prevailing weather factors, such as temperature, precipitation, atmospheric pressure, wind velocity and humidity, in a given region, measured over several decades (Columbia Basin Trust & Columbia Basin Rural Development Institute, 2015).
Climate Change	A detectable shift in the average (mean) and/or the variability of a climate factor from one time period (typically decades or longer) to another (Columbia Basin Trust & Columbia Basin Rural Development Institute, 2015).
Climate Change Impacts	The positive and negative effects of climate change on natural and human systems (Columbia Basin Trust & Columbia Basin Rural Development Institute, 2015).
Climate Change Indicators	Climate change indicators measure changes in climate over time through the use of data on key trends relating to temperature and precipitation (Columbia Basin Trust & Columbia Basin Rural Development Institute, 2015).
Climate Change Adaptation	Climate change adaptation focuses on reducing the impacts of climate change. It is about being ready for a future that is different from what the community has experienced in the past due to changes in weather and climate (Columbia Basin Trust & Columbia Basin Rural Development Institute, 2015).
Community Impact Indicators	Community impact indicators measure the impact of changes in climate on human systems and infrastructure (Columbia Basin Trust & Columbia Basin Rural Development Institute, 2015).
Evaluation	Evaluation is the systematic assessment of the operation and/or the outcomes of a program of policy, compared to a set of explicit or implicit standards, as a means of contributing to the improvement of the program or policy (Weiss, 1998).
Indicator	A measure, often quantitative, that can be used to illustrate and communicate complex environmental,

	economic and social phenomena in a simple way and highlight trends and progress over time (Columbia Basin Trust & Columbia Basin Rural Development Institute, 2015).
Resilience	The ability of human and ecological systems to absorb disturbances while retaining the same basic structure and ways of functioning, as well as the capacity of those systems to cope with, adapt to and recover fully or partially from stress and change (Columbia Basin Trust & Columbia Basin Rural Development Institute, 2015).
Rural	Areas that are outside Census Metropolitan Areas (population >100,000) and Census Agglomerations (population of 10,000-99,999) (Statistics Canada, 2016a).
Vulnerability	The degree to which human or ecological systems are susceptible to and unable to cope with adverse climate impacts (Columbia Basin Trust & Columbia Basin Rural Development Institute, 2015).

Chapter 1. Introduction

Across the world communities are considering how climate change and extreme weather events will affect them and are taking steps to prepare and adapt. In the Columbia Basin (the Basin) of British Columbia (BC), Canada, rural communities and regional institutions have a history of working together to co-construct a process of climate change adaptation (CCA or adaptation). Local actors have collaborated again to build on previous undertakings and pilot a bespoke indicator suite, the State of Climate Adaptation and Resilience in the Basin (SoCARB) which was developed to provide communities in the Basin with data to support their climate adaptation efforts (Columbia Basin Trust (CBT) & Columbia Basin Rural Development Institute (RDI), 2014). This study explores the process and results of phase one of the pilot project, employing an evaluative framework that assesses the feasibility of implementing SoCARB and the resulting utility for communities.

In Canada, with its expansive land base, diverse regional interests, strong subnational governments, and numerous sectors at risk to climate change, a centralized hierarchical command and control approach to adaptation is virtually impossible (Henstra, 2017). Across rural Canada, a mosaic of adaptation is emerging as more municipalities develop and implement programs for adaptation (Federation of Canadian Municipalities, 2016; ICLEI Canada, 2016; Dickinson & Burton, 2011). Unfortunately, understanding the extent of these actions is challenging as no formalized tracking of CCA initiatives is taking place, and the possibility of standardized tracking has been questioned due to the nature and impacts of adaptation being complex and localized (Clean Air Partnership & ICLEI Canada, 2015). Further, local governments are engaged in adaptation activities that are not formally considered as such or go unreported (Robinson & Gore, 2011). Monitoring adaptation is inherently difficult for numerous reasons including, but not limited to, an absence of tools, datasets, and baseline research (Ford & Berrang-Ford, 2016). As a result, there is a gap in research exploring adaptation implementation, particularly in respect to rural places and what information is of benefit to them.

Planning for climate change at the local level is not without its challenges. National surveys show widespread agreement that a lack of awareness of climate change within the general public, political will and support, and the need for dedicated resources are the key barriers to local adaptation (Bowron & Davidson, 2012). Experience from rural Canada demonstrates that climate change can be a complex and controversial subject matter around which to build awareness and support, given differing public perceptions related to the seriousness of the problem and associated local impacts, as well as the difficulties of communicating climate science (Bowron & Davidson, 2011; Bowron & Davidson, 2012; CBT, 2011; Corporate Research Associates, 2012; Davidson et al., 2003; Ford et al., 2015; Canada Policy Research Initiative, 2010; Rescan, 2012; Sheppard, 2015; Tesluk et al., 2011)

A precursor to local adaptation planning is political buy-in. Regardless of the level of climate change understanding, local governments often prioritize immediate and short-term municipal issues over planning for anticipated long-term impacts associated with a changing climate (Bowron & Davidson, 2012; CBT, 2011; Jackson, et al., 2010; Rescan, 2012; Town of Windsor, 2010). Without strong political support, longer term planning initiatives, such as climate change adaptation, are not prioritized or are overruled by immediate concerns, reflecting their need for external capacity support and the unique role of adaptation ‘champions’ (Picketts, 2014). Local champions can accelerate networking and community engagement efforts, bridge gaps between external and internal stakeholders, and keep adaptation as a priority (City of Castelgar, 2011; Picketts, 2014; Richardson, 2010; Rodgers & Behan, 2006; Tompkins et al., 2010; Warren & Lemmen, 2014).

Local governments are typically constrained to a limited municipal tax base, and must contend with provincial and federal funding programs that often require local contributions they cannot afford, or focus on areas that are not local priorities (Federation of Canadian Municipalities, 2017). As a result of a combination of outdated and insufficient funding mechanisms and increasing demand for services, rural governments often operate on a limited budget, asked to do more with less (Locke, 2011; TD Bank Financial Group, 2002). The reality is that there is typically limited local government capacity in rural communities which limits their ability to engage in new initiatives (Breen & Markey, 2015). Rural communities often face a shortage of human capacity and staff often have limited time to devote to new initiatives (Brklacich et al., 2008). Further, rural communities often lack the resources or expertise to translate existing climate change information into practical forms that can be applied at the local planning level (Brklacich & Woodrow, 2007; Laurie, et al., 2010; Sander-Regler et al., 2009).

Evaluation of national climate change adaptation programming in Canada shows that there is a need to support municipalities to integrate adaptation into local planning and decision-making processes. Identified key needs for municipalities include localized information and data to inform land-use decisions that can reduce risk, and capacity support in the form of expertise to assist local planning (Natural Resources Canada (NRCan), 2015). Results from a national survey of local governments provide insights into where local municipalities are looking to find support for adaptation planning. ICLEI Canada (2016) identified provincial governments as the most important external stakeholder to assist in adaptation actions owing to their role in providing funding to municipalities. This is followed by science, academia and research centres, which are financially accessible sources of support and expertise outside of the municipality available to support CCA planning. Other alternatives include transnational municipal networks (TMNs) such as ICLEI-Local Governments for Sustainability, which have been identified as instrumental in advancing knowledge and methods for climate change mitigation and adaptation. However, due to human capacity constraints rural communities are not always able to engage in activities offered by TMNs (Fünfgeld, 2015; Homsy & Warner, 2013). Regional, place based initiatives may be a more achievable and appropriate option for rural communities (Fünfgeld, 2015). These initiatives are often tailored to the needs of the communities, as is the true for the Columbia Basin Trust's (CBT) Communities Adapting to Climate Change Initiative (CACCI), which supported Basin communities' projects and planning associated with adaptation (CBT, 2015) .

As more communities are engaged and supported in adaptation, it can be expected that a clearer image will emerge of the extent of adaptation achieved and the beneficial role of collaborative efforts. This research identifies what information local communities will benefit from to inform their climate adaptation programs as well as the barriers to collecting, analyzing, and using that information. Engle et al. (2014) notes that case studies play an important role in the application and development of climate change adaptation and resilience indicators. Data obtained through case studies are important sources of information on resilience-building strategies in their own right and can help provide process-related and context specific information that indicator reports often miss. Three primary questions guide this study:

1. What are the identifiable constraints for implementation of the SoCARB indicator suite in general and at a local level?

2. What is the value gained by communities through implementation of SoCARB?

3. Provided there is value, what support measures are required to facilitate uptake of SoCARB within the pilot communities and other communities within the region?

This study is part of a larger collaborative project undertaken by the researcher and with the Columbia Basin Rural Development Institute (RDI). The project involved a literature review on rural CCA that culminated in the authorship of three publicly accessible knowledge briefs. The briefs combine to introduce the process of CCA planning (Huck, 2016a), the associated challenges common amongst rural communities (Huck, 2016b), and the lessons learned from community experience to overcome such challenges and effectively implement CCA (Huck, 2016c). This study is structured as follows:

- Chapter 2 focuses on the introduction and evolution of the SoCARB suite and illustrates the agents present and process undertaken during the pilot project.

- Chapter 3 outlines research objectives and methodological considerations undertaken in the design and employment of this study.

- Chapter 4 presents the study project research findings according to evaluative themes of feasibility of implementation and utility of results.

- Chapter 5 discusses the guiding research questions using the research findings.

- Chapter 6 summarizes study conclusions and outlines recommendations for the future of SoCARB.

The preliminary findings and recommendations report from this study were delivered to the RDI in July 2017.

Chapter 2. SoCARB Project Background

This chapter provides a background overview of the SoCARB suite and the pilot project that this study focuses upon. First, the indicator suite is profiled. Next the SoCARB project is presented including project purpose, objectives and setting. This is followed by a detailed overview of the project process.

2.1 The SoCARB Suite

The SoCARB suite is the result of a collaborative regional research project undertaken in 2014 between the RDI and the CBT's Communities Adapting to Climate Change Initiative (CACCI) entitled, *Using Columbia Basin "State of the Basin" Indicators to Measure Climate Adaptation.* The project was part of national initiative led by Natural Resource Canada's (NRCan) Measuring Progress Working Group of the Adaptation Platform with objectives to:

i. Build the capacity to measure progress in addressing adaptation and adaptation outcomes; and

ii. Determine the availability and suitability of existing tools, techniques and data that could be applied in adaptation measurement in Canada (NRCan, 2017).

The RDI and CACCI project involved a review of the current state of research and experience associated with climate change, climate impact, vulnerability and climate adaptation indicators in jurisdictions around the world (Ellis, 2014). The review provided the groundwork for the conceptual design and indicator selection of SoCARB (CBT, 2015). The end result was an indicator suite tailored for Basin communities, designed for use at a regional level in a predominantly rural environment (CBT & RDI, 2015).

The SoCARB suite is comprised of a total of 61 indicators[1], each representative of one of four indicator types:

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[1] *Three indicators were introduced through phase one, bringing the new total number of indicators to 64. See Appendix A for a summary of SoCARB indicators.*

- *Climate Changes* measure changes in climate over time through the use of data on key trends in relation to temperature and precipitation.
- *Environmental Impacts* measure the impacts of changes in climate on biophysical systems.
- *Adaptation Actions & Capacity Building* measure how communities respond to climate impacts by building capacity and implementing adaptation actions, and the outcomes of those efforts.
- *Community Impacts & Adaptation Outcomes* measure the impact of changes in climate on human systems and infrastructure (Columbia Basin Trust, 2015).

These indicators are organized into one or more of five pathways: *Agriculture, Extreme Weather & Emergency Preparedness, Flooding, Water Supply*, and *Wildfire*. The pathways organize indicators conceptually and were selected based on an assessment of critical community assets and risks for Basin communities associated with projected climate changes and associated impacts. Table 1 summarizes the SoCARB indicators by pathway and indicator type.

Table 1: SoCARB Indicators by Pathway and Indicator Type

Pathway	Climate Changes	Environmental Impacts	Adaptation Actions & Capacity Building	Community Impacts & Adaptation Outcomes	Pathway Total
Agriculture	5	4	3	3	15
Extreme Weather & Emergency Preparedness	4	0	3	4	11
Flooding	3	3	4	4	14
Water Supply	4	6	3	4	17
Wildfire	1	3	3	5	12

Figure 1 conceptualizes relationships amongst the different types of indicators present within SoCARB. Indicators within *Climate Changes* influence *Environmental Impacts* and *Community Impacts and Adaptation Outcomes.* However, *Climate Changes* is not influenced by other indicators, which illustrates the limited influence individual communities' mitigation measures have on a global issue. The only relationship of mutual influence is through *Community Impacts and Adaptation Outcomes* and *Adaptation Actions & Capacity Building* which illustrates a community's ability to learn from experienced *Climate Changes* and *Environmental Impacts* and build their adaptive capacity to future changes in climate and environmental impacts.

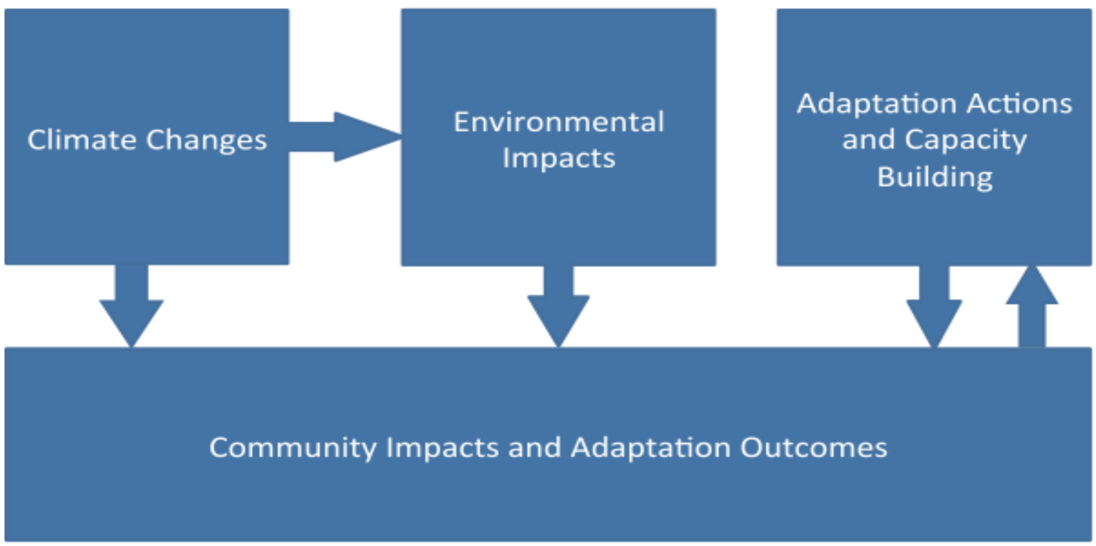


Figure 1: Basic Adaptation Pathway

Source: Columbia Basin Trust, Columbia Basin Rural Development Institute & Natural Resources Canada, 2015

In addition to the development of the five thematic pathways, a *Community Resilience Index* (CRI) was developed to measure socio-economic resilience and vulnerability. These two important concepts influence community ability to adapt to climate change or recover from extreme climate driven events (CBT & RDI, 2015). The CRI comprises 20 indicators attributable to six determinants selected to measure socio-economic resilience to climate impacts: information, economic resources, skills and management, institution and networks, built environment and technology, population wellness, and local production and self-reliance. The CRI complements the SoCARB pathways as some communities or regions have characteristics that are not specific climate change adaptations yet serve to increase community or regional resilience to climate change. Together, the adaptation pathways and the CRI are intended to interact to create a metric of climate adaptation and resilience that communities may utilize to monitor and inform their adaptation and community planning (CBT & RDI, 2015).

2.2 SoCARB Pilot Project

While the SoCARB indicator suite was intended to be a contextually appropriate monitoring approach designed with Basin communities in mind, the RDI and CACCI project did not test the feasibility of implementing the suite. Beginning in autumn 2016, the RDI created a project to pilot implementation of SoCARB in partnership with two Basin communities, Kimberley and Rossland. The project was funded by the BC Real Estate Foundation and supported by a working group coordinated by RDI staff.

The over-arching purpose of the SoCARB pilot project was to take an untested indicator suite and transform it into a process where communities can choose indicators of relevance to local priorities, then locate, collect and analyze the identified data and use it to assist in their community planning. The phase one project objectives are to:

i. Co-construct a process using the SoCARB indicators that allows communities to identify priorities, find and analyze data.

ii. Create a baseline report specific to the findings for each partner community.

iii. Evaluate the feasibility of the process for local communities and the utility of the results; and

iv. Based on this experience, develop supporting resources and refine the process to facilitate regional uptake of Basin-specific climate adaptation and resilience indicators.

The project was designed to be implemented over two phases. The first phase achieved objectives i., ii, and iii. providing a full-support package for two communities to pilot implementation of SoCARB, and initiating this study to evaluate the feasibility of the process and utility of the results at a local level. Phase two built off of the insights garnered through phase one to refine the process and support toolkit that can facilitate uptake of SoCARB amongst additional Basin communities and regional districts.

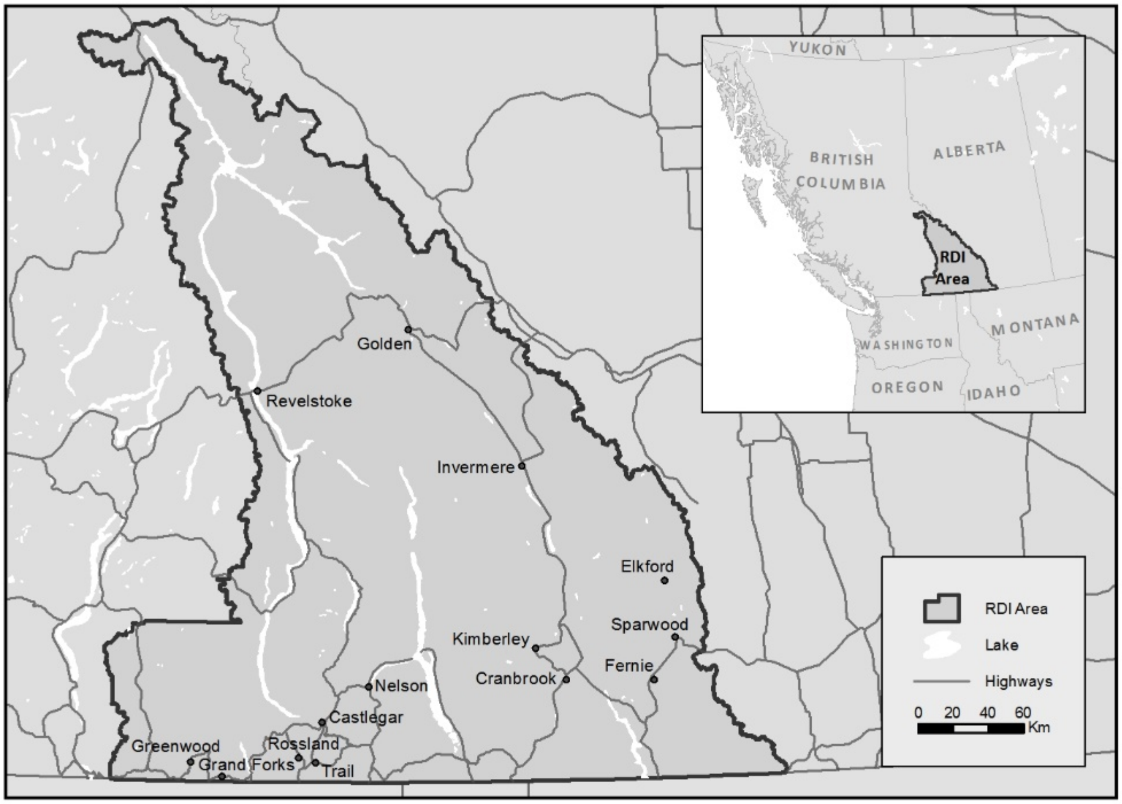
2.2.1 Project Setting

Basin Overview

The Columbia Basin-Boundary region located in the south-eastern corner of BC (see Figure 2) spans an area of 83,171 km^2 and is comprised of 28 municipalities and unincorporated rural areas that is home to a population of 167,425 people (RDI, 2017; Statistics Canada, 2016). The Basin is home to diverse landscapes, possessing seven of the 16 Biogeoclimatic Ecosystem Classification zones found in BC that provide ample recreation opportunity and habitat for a diverse group of species (Stevenson et al., 2011). Economically, the region is historically tied to natural resource development, including mining, forestry, and hydro-electric power generation (Breen, 2012). While natural resources remain the economic foundation of the region, Labour Force Survey data shows employment is dominated by trade, transportation, education, and health care (Statistics Canada, 2015)

With regard to future climate, communities within the Basin are projected to experience higher average annual temperatures along with a greater frequency of extreme heats days and heat waves. Precipitation is forecasted to decrease in summer while winter precipitation increases and is more likely to fall as rain instead of snow at higher elevations. Regional glaciers are expected to retreat, and snowpack will be reduced at lower elevations affecting seasonal stream flows. It is forecasted rainfalls will become more intense, flood events more frequent and droughts longer and hotter with an associated increase in wildfire frequency (CBT, 2012). These projected climate changes will affect the environment, economy, and quality of life across the region, albeit to varying degrees, and underscore the importance of proactive planning.

Figure 1: Map of Columbia Basin and Pilot Communities.



Source: Selkirk Geospatial Research Centre, 2017

Kimberley

The city of Kimberley, BC is located within the Basin's East Kootenay Regional District at an elevation of 1120 meters. The community has a land area of 60.62 km^2 and a population of 7,425 people (Statistics Canada, 2017a). The downtown core, situated downslope from an alpine ski-resort, is Bavarian-themed and surrounds, "the Platzl", a pedestrian only shopping area home to Canada's largest cuckoo clock. Formally established in 1896, Kimberley was named so in expectation that the newly established Sullivan mine and its lead, silver and zinc deposits would be as rich as the diamond mines of Kimberley, South Africa (City of Kimberley, 2014). The community had the foresight to recognize that local mineral resources would eventually be depleted and looked to their surrounding environment as a means of sustaining the community in the future. In 1973 the town's Bavarian theme was adopted and the transition from a top mining town to a recreation destination began (Liepa, 2009). In 2001, the Sullivan mine, the historical economic-life blood of the community closed, and the town needed to rebuild. An official BC resort community since 2007, Kimberley and its Platzl are home to locally owned and operated businesses that attract all-season tourists destined for the community's recreation opportunities, mountain culture and ever-blue sky.

With a culture enshrined within their natural environment and a history of looking to the future, Kimberley was an early implementer of adaptation planning. In 2008 the community participated in phase one of CACCI and completed a year long process using climate change scenarios to identify potential local impacts, vulnerabilities and risks specific to a changing climate (CBT, 2011). Using this information, the community developed strategies and actions to implement which culminated in the development of a report and plan to guide community adaptation measures (Liepa, 2009). Now, the community has shown their leadership in proactive planning once again in moving forward to fulfill SoCARB indicators to position themselves with knowledge of environmental effects and what is being undertaken to address them.

Rossland

The city of Rossland, BC, home to 3,729 people, is located within the Basin's Kootenay Boundary Regional District at an elevation of 1023 meters, with a land area of 59.79 km^2 (Statistics Canada, 2017). Not unlike other communities within the Basin, the roots of Rossland are in mining. Situated in an eroded crater of a long-extinct volcano, Rossland, nicknamed the "Golden City", born out of man's insatiable lust for gold was established in 1892 (Rossland Museum, 2017). While the gold boom did not last long, Rossland, situated less than 10km uphill from Trail, BC, where copper and gold smelting operations began in 1896, continues to benefit from the mining industry (British Columbia Ministry of Environment, 2009). Rossland is a regional recreational destination, laying claim to the title of Mountain Biking Capital of Canada and a ski resort renowned for their powder snow conditions. Visitors attracted to Rossland and their abundance of recreation opportunities find a community with a mountain culture proud and protective of their rich natural assets.

Rossland has shown itself to be a progressive leader in sustainability and adaptation planning. The city was one of the earliest adopters of Integrated Community Sustainability Planning and participated in CACCI as a phase two community (Smart Planning for Communities, 2015). In 2009, the community went through the adaptation planning process of using climate change scenarios to identify potential local impacts, vulnerabilities and risks (CBT, 2011). Using this information, the community developed strategies and actions which has guided their adaptation actions ever since (Ellis, 2010).

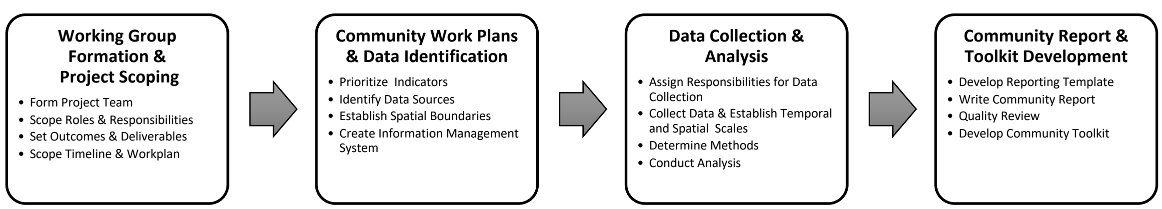
2.3 SoCARB Project Process

Phase one of the project was intended to be a fully supported 'test run' of SoCARB with communities supported by a project working group with expertise and knowledge of CCA planning, the SoCARB suite and the local communities. Phase one contained four principal stages:

I. Working Group Formation & Project Scoping.
II. Establish Community Work Plans & Identify Data Sources.
III. Data Collection & Analysis.
IV. Community Report & Toolkit Development.

These stages and their respective components are illustrated in Figure 3.

Figure 3: Overview of Phase one SoCARB Stages and Components



I. Working Group Formation & Project Scoping

With project funding established and communities signed on to participate, the first component of the process was the formation of a working group project team that would see the project through. The project team led by RDI included representatives from the communities including two community liaisons (one for each community), an RDI co-op student, two project advisors, and the author, an external researcher from Simon Fraser University. The roles, scope of responsibilities and budgeted time allocations of the working group are outlined in Table 2.

Table 2: Summary of Phase one Roles and Responsibilities, Time Allocations

Role	Responsibility
Community Representative ~3-5 days/month	• Provide input into development of overarching and community work plans. • Represent community perspective including identification of indicator priorities and community data sources. • Provide workspace, guidance and advice to co-op student. • Contribute to community reports and project evaluation.
Project Advisor 6 days	• Attend project meetings and provide input into development of overarching and community work plans and reports.
Community Liaison 31 days	• Attend project meetings and provide input into development of overarching and community work plans. • Provide guidance and advice to pilot community representatives and co-op student. • Participate and contribute to the development of community reports, project evaluation and final report.
Co-op Student 140 days	• Identify, collect, and analyze data related to SoCARB indicators. • Document methods utilized in indicator fulfillment and identify data constraints. • Participate in and contribute to community reports and project evaluation.
External Researcher 17 days	• Attend project meetings and document the project process. • Lead phase one process evaluation and contribute to final report and academic publications.

With the working group established, the second component of stage one was to arrange a project kick-off meeting to provide for group introductions, overview the project objectives and the SoCARB suite, discuss roles and responsibilities, share project expectations in terms of outcomes and deliverables, discuss timeline and work plan and scope the project process accordingly. While support for the working group to travel to Castlegar, BC was provided, not all members attended the meeting in person owing to adverse weather conditions and travel time constraints. RDI set up a digital meeting portal to allow for remote video attendance, a tool that was often employed to facilitate meetings in future stages of the process.

Initial project expectations for project outcomes set by the RDI was for each community to identify and fulfill at minimum two pathways of interest based on local priorities with one common pathway fulfilled by both communities. Rossland identified *Water Supply* and *Agriculture* while Kimberley identified *Water Supply* and *Extreme Weather & Emergency Preparedness*. After reviewing the indicators within the pathways and noting that several of the indicators were not perceived to require much effort to fulfill, the working group agreed to expand the expectation of project outcomes and fulfill as many SoCARB indicators as time would permit. This expanded approach allowed the testing of a greater number of indicators and was deemed to be of greater benefit in terms of final product for the communities. The *Community Resilience Index* was deemed unrealistic in terms of time capacity for the pilot project and omitted from the phase one scope.

Project work plan discussions made it clear that the initial timeline of six-months start to finish, would be difficult to meet. Originally, it was envisioned the co-op student would spend the bulk of their time within the communities, however owing to scheduling constraints it was agreed the student would work remotely out of RDI with time spent in the communities as needed. Through initial discussions concerning data availability, baseline establishment, and community report structure, the working group agreed the project would need to maintain flexibility and make decisions after digging deeper into the indicators and the project progressed forward. To facilitate project progress and continued engagement RDI arranged monthly working group meetings to provide an opportunity for progress updates, discussion and project learning.

II. Establish Community Work Plans & Identify Data Sources

The next stage of the process involved establishing community work plans and identifying sources of data that would fulfill the indicators. To spearhead this work, RDI facilitated separate community meetings with the community representatives, liaisons and the co-op student. The first component of establishing the community work plans required the communities to individually rank SoCARB indicators based off of community interest according to a priority level: high, medium, low, and no-interest in fulfilling. In addition to the original 61 indicators, communities were asked to identify indicators going forward not present in SoCARB that would be of benefit to include in their community reports. Three indicators were introduced for consideration during the project by the communities to supplement a pathway.[2] Of the total 64 pathway indicators for consideration, Kimberley identified 48 indicators to fulfill: 37 high priority, eight medium and three low. Rossland identified 56 indicators to fulfill: 34 high priority, six medium and

[2] Introduced Indicators: Water Reservoir Levels, Consecutive Dry Days, and Freeze-thaw Cycle.

16 low. Table 3 summarizes the priority levels of the indicators within each pathway chosen by the communities.[3]

Table 3: Community Indicators Priority Level by Pathway

		Kimberley				Rossland			
Pathway	Total Indicators	High	Med	Low	No Fulfill	High	Med	Low	No Fulfill
Agriculture	16	5	3	0	8	8	2	6	0
Extreme Weather & Emergency Preparedness	11	8	3	0	0	6	1	4	0
Flooding	15	7	1	0	7	7	1	0	7
Water Supply	18	15	1	1	1	13	2	2	1
Wildfire	12	10	0	2	0	8	0	4	0

Both communities were interested in completely fulfilling the *Extreme Weather & Emergency Preparedness* and *Wildfire* pathways. The *Water Supply* pathway was also of high interest to both Kimberley and Rossland with one indicator for each community identified as not of interest: *reservoir level* and *glacier extent*, respectively. Additionally, Rossland expressed interest in completely fulfilling the *Agriculture* pathway. The community prioritization of the indicators served as a means to demonstrate community focus and information desires. It further provided guidance for indicator fulfillment to the project team given limited project working time: high-priority items first, followed by medium and low.

The next component of this stage required the community representatives, liaisons and the co-op student to identify sources of data for the prioritized indicators. In the development of SoCARB, potential data sources were identified for each indicator (CBT & RDI, 2015). This provided a starting place to look but it still required identification of a large number of data sources which involved frequent communications between the project working group and engagement with the data holders themselves, which

[3] Five indicators inform multiple pathways: *Maximum 1 day rainfall, Emergency Preparedness Plan, Stream flow timing, Climate Extremes and Climate Averages.* Three are present in two pathways, and two are present in three pathways. A full list of the indicators can be found in *Appendix A*.

included various divisions of local government, local businesses, and regional, provincial and national agencies.

An additional component of data identification included establishing spatial boundaries for data collection where applicable. This involved looking at the proximity of the data source or format the data was available in for each indicator and then discussing what would be relevant to include. For instance, *wildfire starts* is available at a regional level, but the data can be ‘clipped’ using GIS software to an appropriate spatial boundary for the community. Of the 64 indicators 31 can be characterized as local, 14 regional and 19 mixed, meaning they can be applied at either local or regional scales.

The last component of this stage of the process involved establishing a system of information management to keep track of the various data sources and additional information for the indicators within each of the community working groups. One of the underlying objectives of the project was to keep notes on the indicators that would facilitate a more formal understanding of fulfillment constraints to inform future process. To this end, an indicator journal was established where the co-op student recorded relevant information for each indicator, including: data source, temporal and spatial data availability, method for collection, hours spent on the indicator fulfillment, and challenges experienced.

III. Data Collection & Analysis

With indicator priority levels established and potential data sources identified the next stage of the process involved data collection and analysis. The first component of this was to assign responsibilities for data collection. The bulk of the data collection was performed by community liaisons and the co-op student supported by the community representatives and the RDI. While most requests for data were informal and to local level agents, formal data requests by RDI were required for indicators sourced from regional, provincial and national agencies. Further, certain indicators required the development and release of community surveys by community representatives.

An additional component nested within the data collection stage was the determination of baselines and appropriate temporal scales to inform data analysis. This was done on an indicator-by-indicator basis and as each indicator data set is unique required the data availability to inform the baseline establishment. The general logic amongst the working group was that the further back you can set the baseline, the better. For indicators with long-term and intermittent data sets, the data was collected and then a baseline was established that would allow for analysis when possible. Further, certain indicators are relevant only for certain times of the year, e.g. it was determined that *air quality* was only of interest to collect from the beginning of April to end of November.

As the data requests were fulfilled, the information was stored in a database by the co-op student and data analysis could begin. This first component of this process was establishing methods for each indicator by which to analyze the data. Methods were primarily identified and established by the co-op student through review of relevant sources. The next component was to use the appropriate methods to conduct analysis and establish data trends. This work was largely undertaken by the co-op student, however, external support was also required. External consultants with climate modelling expertise were recruited in fulfillment of *climate changes* and *environmental impacts* indicators from regional weather stations that were at different elevations from the communities to adjust the data through modeling with a goal to provide greater resolution of information for the community reports.

Over the course of the project Kimberley fulfilled 44 indicators and Rossland 43, combining for a total of 47 different and 40 common indicators. Table 4 showcases the total number, between the two communities, of fulfilled indicators that make up each pathway and indicator type and as a percentage of the total indicators within the pathways.

Table 4: Fulfilled Indicators by Pathway, Type & Percentage (%) of Completion

		Climate Changes		Environmental Impacts		Adaptation Actions & Capacity Building		Community Impacts & Adaptation Outcomes		Pathway Total	
	Agriculture	2	67%	4	80%	1	33%	1	33%	8	57%
	Extreme Weather & Emergency Preparedness	4	100%	0	-	3	100%	2	50%	9	82%
	Flooding	3	75%	4	100%	1	25%	1	25%	9	56%
	Water Supply	2	100%	6	86%	3	100%	4	100%	15	94%
	Wildfire	1	100%	3	100%	3	100%	4	80%	11	92%

IV. Community Report & Toolkit Development

The final stage of the process focused on developing the community report and an accompanying toolkit that warehouses the data and provides instructions for future fulfillment. A major component of this stage required the development of a report template that would be accessible to the general public while still providing enough depth of information that it met reporting purposes. The project working group convened to discuss potential reporting types and agreed that the report would need to be able to provide both a summary overview of the results for communication purposes as well as more detailed information for further reference. Two reporting templates, a summary overview and findings report, were developed by the RDI researchers and community-liaisons that would complement each other while meeting community needs.

The summary overview organizes the fulfilled indicators and an accompanying description according to indicator type. Each indicator is accompanied by symbols that denote their associated pathway and the results. The result symbols depict trend direction or insufficient data for temporal indicators as well as presence or absence for indicators that are static. The findings report presents the indicator results in sections according to pathway. Each pathway section includes information describing the indicator as well as graphs to illustrate trends and a sub-section that summarizes the pathway results. The report also includes background information on the project, notes to the reader that underscore considerations of uncertainty, data use rationale and next step action areas for the community (City of Rossland & RDI, 2017; City of Kimberley & RDI, 2017).

The primary component in this stage was the writing of the community reports undertaken by the community liaisons with the support of RDI researchers. Drafts were circulated for comment amongst the project working group and key stakeholders within local government prior to public release. An important subcomponent of the report writing was that it served as a quality review of the data analyses to identify potential errors. An additional component of this stage was the development of a toolkit to accompany the community reports. The toolkit provides instructions on data sourcing and methods for analysis, while also serving as a data-management system for the respective indicator data. The toolkit was developed by the co-op student with support from community liaisons and RDI researchers.

Chapter 3. Research Methodology

This chapter presents the qualitative case study approach undertaken to complete this research project. First, the research purpose and objectives are outlined. Second, an overview of the research design, evaluative criteria and methods of data collection used in this research are presented. Third, the means of data analysis are presented, followed by a discussion on identified limitations present in this research.

3.1 Research Purpose and Objectives

This study was conducted to provide an external review of phase one in accordance with meeting objective iii of the SoCARB pilot-project: *evaluate the feasibility of the process for local communities and the utility of the results*. The primary objectives of this research are to:

i. Record the pilot project as a case-study (see 2.3), identifying the process undertaken and related capacity needs and constraints (see 4.1 and 5.1).

ii. Perform an evaluation of the SoCARB project in phase one to:

   a. Examine feasibility of the SoCARB process (see 4.1) and its potential for future uptake (see 4.3 and 5.3).

   b. Determine the overall utility of SoCARB at a local level (see 4.2 and 5.2).

iii. Develop recommendations to improve the SoCARB initiative in terms of future community implementation feasibility and utility (see 6.2).

3.2 Research Design

A qualitative case study approach was undertaken that employed the use of semi-structured interviews and review of supplemental data that was analyzed using appropriate evaluative criteria.

3.2.1 Case study

The SoCARB initiative is amongst the first to use a suite of regional-level climate change indicators to measure CCA efforts in a rural context. Owing to the emergence of municipal planning practice of climate change adaptation within Canada, there is a shortage of research regarding tracking implementation and success of adaptation (Eyzaguirre & Warren, 2014; Picketts, 2014). Given this, a case study approach was appropriate as it allows the researcher to become familiar with a stand-alone initiative and develop a deep understanding of the initiative's unique characteristics and dynamics (Eisenhardt, 1989). Additionally, a case study approach is well suited when there is limited existing research and the context is of critical importance (Patton, 2002). This approach provides the necessary context needed to inform future researchers of this pilot project while still meeting research objectives.

3.2.2 Evaluative Criteria

A global review of climate change adaptation indicators and metrics revealed a broad number of approaches, and a diffuse set of contexts that suggest limited heterogeneity and no established best practices in adaptation evaluation approaches (Arnott et al., 2016). Another study emphasizes that owing to the emergence of adaptation planning research there are no established peer-reviewed methodologies for assessing adaptation progress and found that initial approaches have largely been qualitative and programme specific (Ford & Berrang-Ford, 2016). The establishment of comprehensive evaluative process criteria is challenging in situations when empirically verified best practice standards have not been established and the project objectives are exploratory in nature and do not provide a clear standard for assessing performance (Gunton et al., 2006)

The SoCARB pilot project is exploratory in nature. No-peer reviewed methodologies for evaluation of process feasibility and utility for climate adaptation evaluation and monitoring programs existed in 2017. Therefore, evaluative criteria were selected in line with the primary research objectives of the project: to assess the feasibility of SoCARB implementation and utility of the results at the local level. As the process of the project is largely related to the fulfillment of indicators, criteria for indicator evaluation that inform feasibility of implementation and interpretation and utility of results were adapted to fit the study scope and meet the project objectives.

In the development of SoCARB, the original project team developed and used a screening tool to assess the performance of potential indicators prior to their inclusion in the suite. The screening tool assessed indicators according to criteria specific to data, usefulness, understandability and acceptance (CBT & RDI, 2015). While sufficient for indicator screening, the criteria are inadequate to assess additional considerations of feasibility of implementation and utility of results needed for this study. To supplement data feasibility criteria present in the screening tool, well established strategic guidelines to evaluate indicators for selection in environmental monitoring programs in terms of conceptual relevance, feasibility of implementation, and interpretation and utility, were consulted to provide for a more robust evaluative framework (Kurtz et al., 2001). While providing a consistent framework to address indicator issues, the guidelines are flexible to meet the needs of diverse programs, while still providing robust framework with which to evaluate the results of the phase one SoCARB pilot.

The resulting evaluative framework combines to provide a lens in which to assess SoCARB implementation feasibility and the resulting utility for communities (see Table 5). The included criteria take into consideration the availability and condition of data, as well as the resources needed for gathering and analyzing data as appropriate and efficient for use in a community monitoring program. Additionally, they explore whether the indicators convey information that is understandable and meaningful for intended purposes and decision-making.

Table 5: Summary and Description of Study Evaluative Framework

Evaluative Criteria		Description
Feasibility of Implementation	Data Availability, Reliability & Condition	Is data available in an appropriate spatial and temporal format, and easily collected at regular intervals? Can data be collected in a format that is readily interpretable and analyzable using valid methods that generate meaningful findings?
	Required Resources	Are resources required to collect, analyze and report on indicators appropriate for the needs of the program?
	Information Management	Are developed indicator information management systems sufficient for program needs?
	Quality Assurance	Are means and methods of quality assurance identified and incorporated into program design?
Utility of Results	Attributability	Are indicator results specific and directly attributed to changes in the climate, climate impacts or adaptation and are sufficient for program objectives?
	Interpretation	Are communities interested in the results and can easily understand the significance of changes in the indicators?
	Relevance to decision-making	Are results useful for communities and contribute to supporting climate-resilient policy and planning decisions?

3.2.3 Semi-structured Interviews

Evaluation criteria in adaptation monitoring and evaluation have primarily employed qualitative approaches, especially interviews, focus groups, and surveys (Ford & Berrang-Ford, 2016). Qualitative methods are frequently exploratory in nature and provide the flexibility necessary to investigate emerging and understudied topics, and to capture the contextual details required to improve understanding of social realities and the perceptions of participants (Patton, 2002). To align with the evaluative framework, a series of questions were developed by the researcher with support from the RDI (see Appendix D for a Summary of Interview Questions). These were employed through semi-structured interviews to illicit responses from research participants that could be assessed against these criteria.

Research Participants

Recruitment of interview participants involved contacting working group members involved directly with the pilot project and municipal staff and elected officials from the pilot communities identified as potential users of the information. Altogether, 22 people who were involved in the SoCARB working group or representative of local government or staff were contacted to participate in interviews. Of those contacted, 18 agreed to participate. Interviews were conducted over the period May to August 2017, with the majority of interviews (14 of 18) conducted in-person in June and the remainder conducted via telephone or video conference outside of June. Prior to any interviews, ethics approval was obtained. Interviews were audibly recorded with permission.

Research participants are sorted into two primary groups: members of the project working group familiar with the process and external people not directly involved with the project and representative of municipal government. The first group includes: two external project advisors, two RDI employees, two community liaisons and three community representatives who are also municipal employees. The second group includes: four elected officials and five municipal employees from the project communities. Of the combined research participants, four are independent of the pilot communities, eight are from one community and six are from another.

3.2.4 Supplemental Data

Supplemental data used within this research includes a spreadsheet journal provided by an RDI employee which details indicator methodologies, time spent on indicator fulfillment, and noted challenges and general observations derived from experience in fulfilling the indicator. A journal structure was provided to the RDI employee at the beginning of phase one in order to document the resources needed and challenges present with SoCARB fulfillment. Further, project working documents, community reports and researcher observations recorded during and after meetings inform aspects of the analysis and findings.

3.3 Data Analysis

Qualitative data analysis is a process of inductive reasoning, thinking and theorizing. To guide in this process, a textbook on qualitative data analysis was used to approach data analysis in a structured approach: read and reread data, noting possible themes, consider various ways of labeling and organizing data, determine lines of analysis to pursue, establish themes and develop codes, sort data into codes, compare data and refine analysis (Taylor et al., 2015). To assist in this approach, data collected through interviews was analyzed using NVivo, a qualitative data analysis software package.

Recorded interviews were digitally transcribed and uploaded into the NVivo software. Next, themes and subthemes nodes were developed that align with the evaluative criteria. The interview transcripts were then coded to align the thematic nodes. The coded interview data was then analyzed for patterns and relationships which were utilized to compile and interpret the study findings.

3.4 Research Limitations

The primary identified limitations in this research project that may affect the validity and reliability of the results are as follows:

- The bulk of the interviews were scheduled at a period shortly after the draft SoCARB Community Reports were delivered. Therefore, the utility of results is a function of perception and not derived from application or experience.
- Interview respondents were selected based on their role in the project or in the community, not selected at random. The interpretations of the findings are not necessarily representative of the communities as a whole.
- The qualitative, conversational style of interviews meant that questions were not identically phrased in every interview. Open ended questions also allowed respondents to answer questions prior to being asked, leaving potential for repetition or inference of response. Also, not all questions were asked to respondents, depending on their role in the project.
- This project is a targeted study, focused on a small sample size, and provides a qualitative evaluation of the pilot project. Statistical tests were not conducted because the sample size is not large enough to have valid statistical power.
- Communities possess distinct geographical, socio-economic and political characteristics, and the findings may not be representative of other rural locales inside the Basin.

Chapter 4. Findings

While the SoCARB indicator suite was intended to be a contextually appropriate monitoring approach designed for the Basin's rural communities, the RDI and CACCI project did not test the feasibility of implementation or utility of application of the suite. This chapter presents the primary research findings of the study, assessing the feasibility of implementation and utility of results of the SoCARB indicator suite using the evaluative criteria described in Table 5.

4.1 Feasibility of Implementation

Feasibility of implementation examines whether the process and methods for gathering and interpreting indicators are technically feasible, appropriate and efficient for use in a monitoring program. In essence, it seeks to identify the data and on-ground resources needed to complete SoCARB and the constraints in the process. Presented below is an indicator fulfillment overview as well as the results of SoCARB assessed against key criteria that inform feasibility of implementation: data availability, reliability and condition, required resources, information management, and quality assurance.

4.1.1 Fulfillment Overview

In order to provide an assessment of the feasibility of implementing SoCARB indicators it is useful to provide an overview of the indicator fulfillment during the pilot project. Only indicators that were tested during the pilot study can be assessed as to their data availability, reliability and condition. During phase one of the SoCARB pilot project a total of 51 of 64 indicators were tested, while 47 were fulfilled. Testing of indicators was contingent upon community interest in the indicator and time available within the pilot project.

Of the 51 tested indicators, 47 were fulfilled by at least one community, while 40 were fulfilled by both communities. Appendix B summarizes fulfilled indicators as well as noted issues with the indicators, Appendix C summarizes unfulfilled indicators and some general notes with the indicators. Table 6 showcases the total number of fulfilled indicators in phase one by pathway and indicator type and as a percentage of the total indicators within the pathways. Kimberley fulfilled 43 indicators in total: eight *Agriculture*, nine *Extreme Weather & Emergency Preparedness*, eight *Flooding*, 16 *Water Supply*, and 11 *Wildfire.* Rossland fulfilled 42 indicators in total: ten *Agriculture*, nine *Extreme Weather & Emergency Preparedness*, eight *Flooding*, 17 *Water Supply*, and 11 *Wildfire.*

Table 6: Fulfilled Indicators by Pathway, Type & Percentage (%) of Pathway

	Climate Changes		Environmental Impacts		Adaptation Actions & Capacity Building		Community Impacts & Adaptation Outcomes		Pathway Total	
Agriculture	4	80%	4	80%	1	33%	1	33%	10	63%
Extreme Weather & Emergency Preparedness	4	100%	0	-	3	100%	2	50%	9	82%
Flooding	2	67%	4	100%	1	25%	1	25%	8	53%
Water Supply	4	100%	6	86%	3	100%	4	100%	17	94%
Wildfire	1	100%	3	100%	3	100%	4	80%	11	92%

4.1.2 Data Availability, Reliability & Condition

A key determinant of feasibility is the availability, reliability and condition of the data used to fulfill the indicators. This section explores whether data is available in an appropriate spatial and temporal format that can easily be collected at regular intervals. It further explores whether data can be collected in a format that is readily interpretable and analyzable using valid methods that generate meaningful findings.

There are feasibility constraints in terms of data availability for 21 tested indicators during phase one, four unfulfilled and 17 fulfilled. Four tested indicators during phase one went unfulfilled by either community due to data unavailability. For two indicators identified as high priority by communities data was unavailable owing to cited privacy concerns by the data holder.[4] Two other indicators were noted as having either *Limited Spatial Data Availability* or *Limited Spatial and Temporal Data Availability*. *Limited Spatial Data Availability* means that no data source was available in close proximity to the community and *Limited Spatial and Temporal Data Availability* means

[4] Unfulfilled Indicators with unavailable data: *Weather-related power outages;* and *Fire-related power outages*

that in addition to no local availability the closest data sources dataset is not intact and does not allow for a long-term trend to be established.[5] Of the indicators that were fulfilled by the communities there were 17 indicators in total with the result *Insufficient Data / Data Under Construction*. There were 12 cases of *Insufficient Data* that prohibited indicator trend establishment. This included five cases of *limited temporal data availability*, one case of *limited spatial availability* and six cases of *limited spatial and temporal data availability.* Regarding *Data Under Construction*, there were five cases were data was available but was either not able to be collected and analyzed owing to institutional constraints or was collected but trends are unable to be inferred owing to their recent recording. In these cases, baselines have been established and continued future monitoring may provide for a reduction in the number of indicators in this category. Institutional constraints are characterized by situations in which data were not able to be collected because of the inability or unwillingness of an individual or institution to share the data. This concept is best exemplified by a statement made by one interviewee:

> … It's difficult to gather the data. We had problems getting data, people were busy or leaving, it just wasn't high on their priorities. I'd identify the data, ask for it, and a couple weeks later, I still don't have it. Roadblocks are people man, they just don't get you the data in time. – Interviewee 8

The reliability and condition of the available data to be collected in a format in that is readily interpretable and analyzable using valid methods that generate meaningful findings is another key determinant of feasibility. Six indicators in total are static and are fulfilled by denoting the presence or absence of *Adaptation Actions & Capacity Building*. These indicators are straightforward and easy to fulfill with no constraints regarding data reliability and condition. However, it is important to note that two indicators are survey based, with the reliability of the resulting information dependent upon survey design and response. Of the 18 indicators with an upward or downward trend, nine were denoted as having *limited temporal data availability.* This means that while the historical data sets were not intact, it did not prohibit trend establishment. Five indicators were denoted as having *limited spatial and temporal data availability,* meaning the historical data sets were not intact and not available within a nearby spatial boundary. Two indicators with no discernible trend had *limited spatial and temporal data availability*, while one indicator

[5] Unfulfilled indicators with limited spatial and temporal data availability: *Frequency of hailstorms*; and *Frequency of rain-on-frozen ground events*.

had *limited temporal data availability*. One indicator with a stable trend had limited *temporal data availability*.

To note, one of the four indicators that was tested, *Frequency of rain-on-frozen ground events,* was unable to be fulfilled owing to an inability to develop an appropriate methodology. However, it has been asserted by an interviewee it may be possible to develop an appropriate methodology:

> We were going to do rain-on-frozen ground, but it didn't end up working because we couldn't develop an appropriate methodology for it. I think it's still possible and something that the communities are still interested in, but the co-op student couldn't develop a methodology and I never had the time. – Interviewee 6.

Further, one unfulfilled and untested indicator *Invasive Species* is an existing SoTB indicator, meaning that it should be feasible to implement at a regional scale.

4.1.3 Required Resources

An additional criterion for feasibility assesses whether the resources required to collect, analyze and report on indicators in terms of time and expertise are appropriate for the needs of the program.

Pilot communities had a great deal of support from the working group in identification, data collection and analysis and report writing. Community representatives were able to rely upon liaisons familiar with the pilot communities and the co-op student to fulfill collection of the data needed to implement their chosen indicators. The communities identified this external support as critical for their implementation of SoCARB. There was consensus amongst interview participants that without the dedicated support provided they would not have engaged in the project and been able to undertake the process. It was noted as beneficial to have liaisons that were familiar with the SoCARB suite and had worked within the respective communities on CCA in the past as it provided for knowledge of local actions, data sourcing, and an established working relationship with the community representatives.

> We never would have been able to do this, organizing all these metrics, doing all the calculations, writing the report. To have that focus of a person on one thing was super beneficial…having someone who has

> expertise to crunch data was valuable and their presence was a good push to get things done. – Interviewee 8
>
> Just how local government is, constantly pushed-pulled in different directions. Without having someone dedicated to this I think we wouldn't have been able to get this done, in terms of our workload, but also the data analysis. Having a community liaison familiar with the city and [co-op student] for data support was the most beneficial aspects of support. – Interviewee 7
>
> It would not have been possible, especially without [community liaison] and [co-op student] who did so much for the data. I probably could sit down and access this data and figure it out, but it would take me way too long. The relationship between the [co-op student] and the [community liaison] was the most important thing in moving this forward. It helped to have a community liaison that was so familiar with the city and the field. – Interviewee 9

Further, the role of RDI was identified as instrumental in the overall success of the project. The RDI arranged project funding, assembled and supported the project team, and oversaw day-to-day project management. In addition, RDI played a central role in the identification and collection of data from non-municipal sources. This required data requests from regional and provincial institutions. Further, RDI staff played an active role in the development of community reporting templates.

Timeline

An important consideration of the overall resources required to implement SoCARB is the time required to collect, analyze and report the data. The timeline from the project start in September to conclusion in June with the development of the community reports did not reflect the initial phase one timeline. In the original work plan, community reports were to be completed by January 2017. The proposed original timeline was revised in consideration of the availability of the co-op student for two semesters (September to April) and the expanded scope of the project to include the fulfillment of additional indicators. At the project outset, those involved in the project generally agreed that the timeline was overly optimistic given the extent of work involved in data gathering analysis and report writing. The realized timeline was not viewed negatively by the communities, given the nature of a pilot project and the constraints of the project in terms of their time availability and the obstacles present in sourcing indicator data.

> At the outset, it was clear that the timeline was unrealistic. Anytime you go down one of these projects, it always takes longer than you think… you have to get the team together and determine what we're doing and sort through the data, there's so many things to think through. – Interviewee 7

> … when you are trying something for the first time there needs to be a lot of flexibility, adaptability, time for reflection and forbearance…. You could have written all kind of work plans but then there is reality… there are so many things you cannot predict in terms of some of the challenges in data collection, third party data holders, getting the data out of municipal coffers so to speak. We had the right people, the right personalities, the right dedication to get to a product that was worthwhile. – Interviewee 5

> I don't think the process felt rushed, but there was some difficulties that did impede the process along the way… some of the data was not readily available, and it took some more digging and searching. No fault of the project, or anybody's, just the way it is. – Interviewee 8

The second stage of the process, *Community Work Plans & Data Identification*, started in late September and continued into January. The process taken to identify indicator data sources and to establish spatial boundaries was iterative. It required engagement with potential data holders and formal requests within and external to the communities to determine data availability. Most of the *Data Collection & Analysis* started in October and continued until mid-April, with analysis conducted by external consultants continuing into June. An identified constraining factor associated with the timeline is the response time of external data holders from data request to collection. In addition, one person, the co-op student was largely responsible for collecting and analyzing data for both communities, which created an impediment to the process as they were limited by the number of hours they could work in a given week during this stage.

The discussion regarding templates for the *Community Report & Toolkit Development* started in January, with the templates largely conceptualized by end of April. The report writing started in late April and community reports drafts were available in early June. One of the constraints noted affecting the development of the reporting templates and community reports was that the expectation of community liaisons to take on the role of primary report authorship was not articulated well in advance. Liaisons were not surprised with the responsibility of writing the reports, however, they noted it would have benefited them in terms of time budgeting had the expectation been established earlier in the process.

Recorded Time

The time spent on indicator fulfillment provides important insight into the resources required to support the SoCARB pilot process. Total recorded time spent for fulfilling indicators by the co-op student for both communities is 361 hrs: 190 hrs attributed to Rossland and 171 hrs to Kimberley over a period of six months. Time spent on indicators ranged from 0.5 hours to 16 hrs, with an average of 4 hrs per indicator. 15 indicators required 8 hrs or more to complete for one community. In addition to the time spent by the co-op student to identify, collect and analyze the data, it is necessary to account for time spent by others supporting the project. This includes time spent on indicator prioritization, identifying and requesting data sources, conducting community surveys, as well as time to prepare the community reports.

Detailed time records for community representatives and staff were not made available for the purposes of this research. However, while time spent by community representatives on the project was not recorded, representatives noted that they did not utilize their full-time commitment of 3 to 5 days per month. At time of interview, liaisons noted that they had not yet utilized their full 31-day time commitment in phase one. One liaison noted they used approximately 18 days while the other noted they spent about 15 days. Built into this is the time spent attending project meeting, establishing community priorities for assessment, identifying data sources, gathering data, and reviewing project deliverables

Estimated Future Time Requirements

An important consideration of indicator fulfillment is the frequency of reporting period as that is a key determinant of how much future work time needs to be budgeted for the monitoring program. The reporting period reflects the time in between the initial time an indicator is collected and its subsequent fulfillment. For the 47 indicators tested in the pilot project, 33 have a reporting period of one-year, five have a three to five-year period, and nine have a five-year period. The co-op student recorded the estimated hours that it would take to fulfill indicators now that the data sources had been identified and methods documented.

It is estimated to take 86 hrs to fulfill the 44 indicators for Kimberley and 87 hrs to fulfill the 43 indicators for Rossland. Estimated time spent on indicators ranges from

0.5 hrs to 4 hrs with an average estimated time of 2 hrs per indicator. To maintain the monitoring program in accordance with the proposed recording periods, with no indicators removed or added, would take approximately 224 to 228 hrs over a five-year period to fulfill the indicators (see Table 7). In addition, the time it takes to update a community report would need to be considered.

Table 7: Recorded Pilot and Estimated Budgeted Time (Hrs.) Required for Monitoring

Community	Year 1 - Pilot	Year 2	Year 3	Year 4	Year 5
Kimberley	171	46	55	46	77
Rossland	190	47	56	47	78

Expertise Required

An additional consideration that informs the required resources and the ability for communities to maintain the monitoring program is the technical expertise required. Altogether, 14 indicators present in SoCARB and fulfilled in the pilot project required technical expertise to fulfill, eight of which required the solicitation of external expertise.[6] Six *Climate Changes Indicators* and eight *Environmental Impacts* indicators required technical expertise. Technical expertise largely took the form of using advanced statistics software within the data analysis to determine results. External expertise was required to model data from climate stations in proximity to the communities and to adjust the data to the elevation of the communities with the aim to create more relevant information. An additional seven indicators require knowledge in GIS to fulfill.[7]

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[6] Indicators requiring technical expertise: Climate Averages (Temperature, Precipitation), Climate Extremes (Temperature, Precipitation), Length of Growing Season, Growing Degree Days, Maximum 1 day rainfall, Frequency of Extreme Heat Days, April 1st Snowpack, Stream Flow Volume, Stream Flow Timing, Peak Stream Flow Volume, Consecutive Dry Days, Freeze-thaw Cycle.

[7] GIS Indicators: Weather-related Highway Closures; Interface Fire Risk Reduction; Annual Area Burned; Frequency of Interface Fires; Wildfire Starts; Fire-related Highway Closures; and Amount of Area Being Farmed

4.1.4 Information Management

Another key criterion examines whether developed indicator information management systems are sufficient for program needs. Management of information generated by an indicator, particularly in a long-term monitoring program, can become a substantial issue. It is pertinent to identify requirements for data processing, analysis, storage, and retrieval for each indicator to ensure that it can be fulfilled during future updates of the monitoring program.

A key component of the overarching process was to develop a toolkit that serves to provide instruction on collecting data, employing the methods for analysis, while also serving as a data-management system for the respective indicator data. The toolkit developed primarily by the co-op student took the form of .xls workbooks that contain multiple spreadsheets that serve to warehouse historical datasets and provide information including indicator rationale, data source, geographic scale, as well as instructions for methodology and reporting of indicators.

The adequacy of the toolkit, particularly the level of detail needed within methodologies and instruction is difficult to ascertain until the toolkit is used for updating the indicators. However, the workbooks and spreadsheets in their current form have been identified as useful for future implementation of SoCARB within the pilot communities.

> The excel spreadsheets are useful, the templates and methods information will be super beneficial when I am tasked with updating this in the future. A lot of communities wouldn't know how to access this data, or what to do with it, this can help with that. – Interviewee 8

It was also identified by one participant that information management present within the pilot project is insufficient for future fulfillment needs. It was asserted that sufficient detail and instruction would be required within the toolkit to support future community use.

> The information would need to be recorded really, really well with all the resources laid out and with clear instructions in order for someone to fulfill a lot of these indicators… the methodology in the tool kit, potentially falls short of what the communities would need to fulfill SoCARB themselves... Even with the tool kit, for municipal staff to do this, it would be difficult. I don't have a lot of faith in the capacity of local government to keep this going. – Interviewee 5

4.1.5 Quality Assurance

Quality assurance criteria seek to assess whether means and methods of quality assurance are identified and incorporated into program design. For accurate interpretation of indicator results it is necessary to examine their degree of validity and to assess the fit of the data and methods in fulfilling the indicator against those of the monitoring program. While the co-op student was primarily responsible for the establishment of the information management system for data collection as well as data analysis no formal quality assurance component was built into the larger project working plan. However, a lot of this work was vetted as part of the process by RDI staff, introduced external experts and during the community report development. One working group member with technical expertise allowed for many of the indicator methodologies to be vetted during the process.

> I expected as part of the process, that I would be looking at the data, making sure it makes sense and actually measures what the indicator was meant to measure. For all of our community indicators I went through the data and made sure it all made sense. There was a few indicators like stream flow where you can't just look at the data and do some quick tests, so I just had to trust that the [co-op student] did it correctly – Interviewee 6

While quality assurance was present in the data methods, not all of the interviewed participants were satisfied with the quality assurance measures built into the project, specifically in regard to their knowledge of the oversight of the work being completed by the co-op student. One respondent noted that process would have benefited from having clearer communications and role assignment within the project team regarding review of the data collection and analysis.

> The QAQC (Quality Assurance Quality Control) on this project was fragmented. I don't feel that there was always a rigour in the review of what [co-op student] did. Some of the things I as a community liaison could review, other things, I couldn't – it's not my training. Who assumes that role in a project like this? – Interviewee 5

4.2 Utility of Results

Utility of results examines whether indicators convey information that is understandable and meaningful for intended purposes and decision-making. Key components that distinguish interpretation and utility include: interpretation of results, attributability, and relevance to decision making.

4.2.1 Community Objectives

To assess whether the data gathered, and the information presented in the community reports possessed utility for the community it helps to consider the objectives and expectations of the communities for the project. At project outset, the communities noted they joined the project primarily as they possess no means of measuring adaptation and they were looking for a formal means to track their adaptation efforts and community progress. In regard to initial project expectations, it was noted they envisioned more robust data would help inform adaptation planning decisions and facilitate dialogue between municipal staff, local government, and the community. An additional expectation by one community was that the project can build their GIS information management capacities. Over the course of the project, the community objectives did not change. When communities were asked at the end of the process what their project expectations were, a similar sentiment was echoed.

> We were hoping for some way to help us to more clearly communicate that there is progress being made, or not being made. To continue and build more awareness of climate change impacts and the decisions being made. – Interviewee 7

> I saw SoCARB as a tool to identify what the warning signs are and what we need to adapt to in the long term. And also use it to convince council on the actions that we need to take… but also to get our record management in better shape. It ties into our inventory, asset management strategy, etc. – Interviewee 8

> We were hopeful that this project would help to build a GIS system for us, and I wouldn't say that this project enabled that. We have really struggled as an organization to get GIS set-up, and while we are working to develop that. It would be great to see some of this information enter into that. – Interviewee 7

There were also reservations about the project identified in interviews, particularly as to whether the information would be available to fulfill the indicators and be useful to the community.

> I was a bit skeptical actually on the availability and usefulness of the data, I didn't know though, anything really, I mean I read the SoCARB report they wrote, and I couldn't find many that we would have

> information on, or that would be that useful. I knew we didn't have a weather station up here, and that we didn't have flow data for our creeks. I did say we had some wildfire stuff, but in the bigger picture, I didn't think it [SoCARB] would be that useful. – Interviewee 9

4.2.2 Interpretation of Results

Interpretation of results assesses whether communities are interested in indicator results and can easily understand the significance of changes in the indicators. The results of the indicators were presented to the municipalities in the form of a two-page *Assessment Results at a Glance* overview sheet and an accompanying *Community Report* with greater background information on the indicator results as they relate to their respective pathways. The presentation and structure of the community reports was generally well received by those who reviewed the documents with plenty of positive opinions and no major criticisms. The structure was perceived to be able to accommodate multiple local audiences while still being informative and digestible.

> There are multiple audiences, council who represent the community overall, the clear-concise information, the layout, will give them something to think about. It will also help with larger conversations with the community, they can skim it over and get some highlights, short text, images, graphics and use that. It pairs really well with our initial adaptation plan, a great follow-up. – Interviewee 7

The *Assessment Results at a Glance* were noted as being valuable owing to the ease of interpretation of results and ability to be utilized for reference and communications.

> The two-pager summary is really valuable, quick and easy to get your head around, and can be used for communication and quick reference. – Interviewee 7

> The summary sheet is easily understandable by a lot of people. It highlights the data gaps and helps to drive the point home, that we don't have this data. – Interviewee 8

One respondent noted that they appreciate the simplicity and the intention behind the *Assessment Results at a Glance* but feel the use of symbols to inform indicator results could be improved upon.

> I don't really like the first page, the symbols for the results, I don't find them very intuitive. Just some change in the graphics. I like the simplicity of overview sheet and the report on the whole I can reference

> it for information, for a grant application or whatever, and it's good to know on a day-to-day it's there, although I can't think of how often I'd use it. – Interviewee 11

The inclusion of visual components such as graphs and plotted trend lines were viewed by multiple participants as beneficial to help communities interpret results and utilize findings for communication purposes. Multiple participants suggested that even more graphics could be added, particularly inclusion of maps with clearly defined spatial boundaries. It was noted that the multiple spatial boundaries associated with the indicators, e.g. electoral areas, fire service areas, etc., are difficult to interpret. Additionally, it was noted that inclusion of regional trend lines on indicator graphs would be useful for local versus regional comparison. Participants generally felt the community reports provided clear language regarding uncertainty, and indicator rationale, however it was noted technical wording related to modelled weather data, baselines and ranges could hinder community understanding.

> The report has a lot of technical language, baselines, NARR and homogenized weather data that likely wouldn't be understood by the general public. – Interviewee 17

Overall, communities viewed the structure of community reports positively. They expressed confidence that results were portrayed in a manner that could assist community and local government understanding of climate impacts and adaptation measures while highlighting data gaps and areas of concern.

4.2.3 Attributablity

Attributability examines whether indicator results can be directly attributed to changes in the climate, climate impacts or adaptation measures and are sufficient for program objectives. There were mixed responses amongst participants that the information provided adequate information in regard to tracking of adaptation efforts and community progress. When asked whether SoCARB sufficiently measures community climate change adaptation approximately half of community respondents felt that it provided the necessary information, whereas others were uncertain, or felt that the information was not adequate.

> "Yea, I think so. (SoCARB sufficiently measures community adaptation) I don't see anything that I thought was missing, Yea, I think it does."

> We're doing a lot more adaptation than mitigation, you know we're tiny. – Interviewee 14

> It provides a snapshot in time, and it's useful, it'll help raise awareness of issues, and the reasons of why we want to move forward with projects and initiatives.... If we can keep this thing alive, it will be really important, as we've established a baseline in a sense and we can see if there are projects and initiatives in place to influence those trends in a positive way. – Interviewee 7

> Yes, I think so… my one issue with the results is the data, it's not that awesome – the climate data, the stream data, stuff that's measurable. I know this data is not from my community, it's been extrapolated from somewhere else. We got all that climate data from (station name), and then it seemed to be not correct and then was being adjusted by modelling… and it just seemed like, meh. Everything else is pretty good. When I think about where this data came from, that's all good. – Interviewee 9

> I don't know if the results show where we are at in terms of adaptation efforts… because there are not a lot of adaptation indicators, we have the climate indicators and we have the environmental indicators, and we have the adaptation indicators. We never reported on a large number of adaptation indicators which there are less of in the suite, too. The results show us where we are at in how vulnerable we are, and do we need to implement more adaptation actions and which ones do we need to implement. – Interviewee 6

> I think it does give a reflection of the state of climate adaptation, there were many things, I mean a bunch of indicators that are insufficient data/data under construction that we really don't know what is going on… and we won't know what's going on unless we collect data over some time. – Interviewee 5

There was general expression amongst participants that the results of SoCARB would have benefited from the presence of more complete pathways and a greater number of trends. Although respondents understood that indicator selection and unavailable or incomplete data served as barrier to complete pathways and trend generation.

> Had the indicator suites been fulfilled completely, it may provide a clearer idea on the pathways and adaptation within those pathways as a whole. – Interviewee 8

> We are missing data for wildfire and some other key indicators, it would be good to have that information to provide a full picture. – Interviewee 13

> Having this data is good, although some of the trends are fairly small and may be overwhelmed by other things. It's important to track these

> things, get parameters that are relatively easy to get so you are not putting a lot of effort into them and follow them over time, so you can see what trends emerge and develop. This report brings to light issues where the data is not available, and it should be and can serve as a call to gather data like interface treatment work that can potentially inform budgets. – Interviewee 16

To note, one of the considerations when SoCARB was developed was to ensure that meaningful indicators were included, even if data is unavailable as it can mobilize efforts to collect that information in the future.

> A common practice in adaptation indicators is to include indicators where there is no data as placeholders, to spur that data collection. Instead of dropping that indicator, and say it doesn't matter, because it shows that it does matter. – Interviewee 6

The spatial and temporal data constraints present within indicator data in many cases may not provide the necessary resolution for community actions and decision-making. Several participants expressed that it would be desirable to form metrics and combine data within indicators such as extreme rain events and sewer flows, freeze-thaw cycles and road conditions, etc.

> I think that's useful information… the weather data, the frequency of extreme weather events, the freeze-thaw events not only for our linear assets but also for operations. I would love to have that data, the rainfall, rain-on-snow, just correlate that the weather patterns with our sewer flows. I would love to have that accurate weather data for our I & I (inflow and infiltration). We have really good data on sewer flows, I would just like to have access to better weather data. – Interviewee 15

While overall there were mixed feelings related to the community report and the indicator results in terms of ability to adequately assess community adaptation, there was consensus amongst participants that it is an important first step in the right direction. It served to identify information knowledge gaps and establish baselines that may provide greater understanding of climate impacts and adaptation efforts in the future.

4.2.4 Relevance to Decision-Making

A key determinant in the utility of SoCARB is whether the results are useful for communities and contribute to supporting climate-resilient policy and planning decisions. Community participants brought forth multiple applications of SoCARB results that can be utilized at the local level to the benefit of the community, including:

- To facilitate and support communications with local government and the community at large in respect to climate change and community adaptation actions.
- To inform priority areas and support decision-making for future adaptive actions through the provision of policy, project, and local planning rationale.
- To provide reference and evidence of progressive community actions for use in community reports and bolster future community and community group grant applications.
- To help prioritize and build internal knowledge systems and capacity to warehouse and access data and information.

Support Communications of Climate Change Impacts & Adaptation Actions

All community participants identified that SoCARB would benefit and support communications within local government and the community at large in respect to climate change impacts and adaptation actions. Several participants noted that there are challenges discussing climate change and adaptation issues, largely owing to a lack of understanding of the nature of potential impacts. Adaptive measures are difficult to implement without support of elected officials and the community at large, which is gained through community communication and understanding. Measures that improve community adaptive capacity but are implemented on private land within the municipal boundaries or within household, e.g. fire-smart measures, emergency preparedness, etc., are largely contingent upon communications. Further, the results serve to showcase progress on community objectives and can assist in overcoming communications challenges by providing an evidence-based narrative to justify municipal actions.

> I think, you know, the importance of being aware and informed both from the city point of view as well as having this information to share for the community. We need information to educate the community and things like this are really informative, right. It's succinct and it's usable, so I think that's really important… council represents the community, so if we know the importance of it, and the community knows the importance of it, it's likely to get done. One of the reasons we need to get it done is particularly for looking at threats to our community, looking at how we need to size our infrastructure, for instance. It we start seeing more major storm events, we're going to start changing how we size our pipes, that kind of stuff. – Interviewee 14

> This is useful for us, especially you know, if we are identifying what needs to be done, and not come out from in a position of fear, for what we need to do. We don't get a lot of projects done because, oh my god something terrible is going to happen. The public wants some evidence, they need to know why? I know you are afraid, but you need to tell me why. This data can support that. – Interviewee 10

> Local governments and local staff want something that can show they are doing a good job. We can use this, and say look at this, this data shows that. – Interviewee 7

> Having the science-backed information allows us to communicate to people, that is going to happen, and this will impact you in your lifetime. This is why we should be doing this. Any data, any information is good, what it does is it allows us to tell stories to council and educate the public on why we are doing things. – Interviewee 13

> SoCARB can be a driver to facilitate change, it can be a tool to educate people who are going off of anecdotes. Well you can say actually, (knocks twice on wood), based on the facts it can help steer people into opposition or lack of opposition, depending. It's a useful tool for a lot of things. – Interviewee 12

Guide Local Adaptation and Support Decision-Making

An additional application agreed upon by community participants was its use to inform priority areas and support decision-making for future adaptive actions through the provision of policy, project, and long-term local planning rationale. The results or, alternatively, the gaps in results, identify areas for discussion within local government that can inform priority areas for community policy development and action in regard to adaptation. Likewise, the monitoring results of SoCARB can be used to support decision-making, through provision of evidence-based rationale. Several respondents noted that the information present within indicators can be of benefit in the creation of medium to long-term planning and operations budgeting.

> This is a filter in which we can view decision making through. The things we are doing, around water conservation, infrastructure to deal with major storm events, it's good to capture that it shows us what we've done and reinforces areas that need more attention. – Interviewee 16

> I want to get this out when it's finalized, get it out into the community. I see it as a tool to educate the community and for the city I see it as a tool we can use to make decisions about things, some of the things that I wrote down while reading this report are directions I'd like to go that I hadn't thought about or hadn't thought about in a long while, and this serves as a good reminder, you know, we really should be doing that. When we sit down as a council and direct staff to do things, we can be

> looking at this every year, and we can look at this and say how are we going to take what we learned from this into our financial plan for instance, because it's going to take money to get stream monitoring, well let's make sure we budget for that, let's make sure that that happens. – Interviewee 14

> I see it as a tool to inform decision-making and provide decision-support. It will improve awareness of issues, and the reasons and wants of why we want to move forward with projects and initiatives. It provides good information for the rationale of some projects that may be competing with others that may have more tangible measurements like pot-hole filling. It'll serve as a discussion tool for fire-smart, and what we are doing for fire mitigation measures…. I see the potential to use this to provide rationale for council, for instance, we can use this for reference to mobilize support for projects that have an adaptive response. – Interviewee 7

> Wildfire pathway, days in high fire danger, and interface work are super important and are spot on for what needs to be communicated it tells council how many days someone is holding a gun to our head. The information can be utilized to explain recommended actions to council, such as mandatory fire-smart, internal water supply, all that sort of stuff. The data can get that ball rolling. – Interviewee 10

> Any information that we can get that is out there that helps us make informed decision and helps us provide information to people... we're always getting questions, "why are you guys doing that, we don't need to do that", well we can say, you know trending is saying that we should be looking at this stuff and be more proactive than reactive. It costs you less money if you can plan for it and do it than to react to it. To systematically do that kind of planning, and this is one of those activities, that helps you do that… We have this conversation all the time, "why did you guys do that, you guys are a bunch of dummies". Right, so there's a reason why we do everything, but sometimes we don't portray it well enough, or we don't educate and do the messaging hard enough and sometimes we're not going to win the argument anyways. – Interviewee 18

> People don't change their actions unless they are directly affected by impacts. Most people think selfishly of themselves and their pocketbook. It's short sightedness, they don't want to spend money on something that does not have immediate short-term benefits. Having the science-backed information allows us to communicate to people, that is going to happen, and this will impact you in your lifetime. This is why we should be doing this. – Interviewee 13

The key benefit of community monitoring efforts, such as SoCARB, is that it provides evidence-based rationale and support for local decision making that may otherwise be anecdotally made. It provides a lens to view decision-making through indicators based off climate changes, environmental and community impacts, and the necessary community responses.

> This data in this report is extremely valuable from an operations planning perspective. I use a lot of the data (data within SoCARB indicators) daily, it can help to inform long-term operational budgets, sanding, snow removal… It's really key to create a centralized source of data, because you can tie in the science and data to provide rationale for incorporating objectives and components of CCA, ICSP planning into working plans. – Interviewee 13

> It kind of sums up why I think it's so important, so many decisions are made anecdotally, right because no one can remember these things, I can't remember what I did last week. Having this, something based on facts, I like to be fact based, and if I can't remember facts, how can I make good decisions. – Interviewee 12

Reference for Community Reports & Funding Mobilization

Community respondents anticipate SoCARB will be used to provide reference and evidence of progress in community reports and bolster future community grant applications. Municipal governments are required to submit annual reports that include a statement of municipal objectives, and the measures that will be used to determine progress respecting those objectives for the current and subsequent year (Community Charter [SBC 2003] Chapter 26, 2017). The SoCARB reports have been identified as source of information that can be easily referenced for municipal annual reports as means to show progress on community adaptation and sustainability objectives.

> Every local government needs to complete an annual report, what we've done, what we intend to do, and we talked about a way, how can we simplify this process, and demonstrate a way of tracking progress on initiatives. Some elements of this can be incorporated into that report. We can use certain indicators in that reporting process. – Interviewee 7

Additionally, the information in SoCARB can bolster grant applications for appropriate grant programmes by providing evidence of need, reference of previous actions, and a demonstrated system in place to monitor progress. Rural communities rely heavily upon external funding and the better they can position themselves to access grant programmes the more they can accomplish without raising taxes.

> In general, they [grant providers] want to know what you are doing to adapt, and how the project you are proposing supports that. And I think I would use this to identify the problem and there are a bunch of recommendations in regard to adaptations (community adaptation plan), as much as we can say that the problem's been identified here, and we're just following up on a recommendation that was made there. I think that is really strong support that people want to see. They want

> to see things aren't ad-hoc that you're not just making things up. – Interviewee 11

> Adding this into our grant applications, for some stuff, to talk about why, you know extra rationale, why we are asking for a project, why we're doing an upgrade, is pretty golden actually. Other communities', people ask all the time, "what's your secret, how you are getting grant programs all the time", I say, "we can't tell you because we're competing with you". But one of the things we do do, is that we have stuff life this (taps community report), and the visions to actions, and we signed on to the climate action charter... this stuff gives lets us get those grants. – Interviewee 18

> We can move forward with infrastructure development, water, sewers, roads, while keeping taxes low because we can get grants. Any information that can help us get grants to help us offset taxes is huge. – Interviewee 13

> I'm sure we'll leverage this for grant applications. I think this is going to help, it's certainly not going to hurt our grant writing efforts. To have this and say that we do it on a regular basis will help us get grants. – Interviewee 14

SoCARB serves to assist communities in their reporting, making it easier to demonstrate progress on adaptation and sustainability objectives. Additionally, it can be leveraged to access external funding that can alleviate financial pressures by supporting grant applications through providing evidence of need, success of past initiatives, and a demonstrated system to monitoring progress on objectives.

Enhance Local Knowledge Systems

The majority of participants expressed that SoCARB can help prioritize and build internal knowledge systems and capacity to warehouse and access data and information. Both communities share common challenges related to information management that extend beyond the scope of this project but affected the identification and collection of data for SoCARB indicators. Local data collected in the past has been lost or is in a format that does not provide for easy accessibility and interpretation. Relevant data may be in the possession of external agencies and is not readily accessible. Or information may not have been recorded historically owing to lack of an established system to collect it. Regional data that can be of value for community planning and operations have not been aggregated and centralized within the community. Further, local government are constrained in their ability to invest in new software systems that can facilitate interpretation of information.

> We used to have a weather station, a manual one within the community, 15 years ago. I don't know what happened to that data. All the people that had that data are all gone now. – Interviewee 15

> The information is spread across a lot of organizations, or was held by someone, and when they left, that information was lost. A lot of information is held by key persons, and once they retire or leave, that information is lost. – Interviewee 8

> This is the mess we are dealing with, the city is paper-based, there was no GIS, no electronic data… there's no budget for software, I have to patch together open-source software to use... In the future, once we get a system in place to digitally manage this information, it'll be easier to update SoCARB in the future. – Interviewee 8

> We haven't been collecting data here internally. We want to collect all the data up to now, create a system and go forward from. – Interviewee 10

While SoCARB is not viewed as a solution to alleviating information management issues, the process of fulfilling SoCARB highlights information management constraints within the communities and has been identified as a potential catalyst to improve local information management. Further, the results can be leveraged to enhance current and developing knowledge systems. For example, at the time of interviews both communities were currently in the process of developing an asset management strategy and accompanying system to inform long-term infrastructure planning.

> This report brings to light issues where the data is not available, and it should be and can serve as a call to gather data. The information should be in a database and used to inform municipal planning… we can look at it and then say we should look at this area and this area over the next five years, and what's the budget for doing that, so staff can come to council and get that money. – Interviewee 17

> We're working on our asset management strategy now and we'll be sure to incorporate the climate impact data into that work. I think it'll be helpful for that. – Interviewee 12

While SoCARB itself serves as a means to track adaptation progress and identify trends in climate changes and associated impacts, the SoCARB results and the process of undertaking SoCARB serves as a catalyst for discussion related to information collection and management within communities that may otherwise not be present.

4.3 Future Implementation of SoCARB

Overall, the majority of respondents optimistically expressed that the current results and continued fulfillment of SoCARB will be of benefit to their communities. Doing so will enhance the potential to establish trends that were not able to be presented owing to data constraints, to provide a greater understanding of climate change adaptation for their communities. Further, continuing SoCARB provides for an ongoing tool that can be used for multiple community applications, as discussed above.

> "Yeah, oh yeah, definitely, definitely, I mean baseline is one thing, but you definitely want to see how things are changing. Like freeze-thaw cycle, right, that impacts us in public works. There are all these things that have an impact on us that we need to keep track of. I see the value in it as a one-off, as I already made some notes off of it – that I should be doing this, that, or the other thing. But the real value is the long term, and that's the way I feel about other indicator projects. You need to take the long-term view, and that's difficult to do from a political stand-point. We are trying to get the long-term view institutionalized, no matter who comes in (future elected officials) they can't screw it up.
> – Interviewee 14

However, the communities also expressed reservations regarding their ability to maintain SoCARB as a monitoring tool. One line of questioning in the interviews probed the likelihood of communities to update SoCARB in the future. While respondents believe it is possible, the feasibility of doing so were contingent on local political will and budgeted resources made available to do so. The priorities of newly elected government will influence the resources budgeted within the community to maintain SoCARB as a monitoring tool. Several of the information gaps identified in SoCARB will only be overcome with investment by communities in local monitoring, e.g. stream monitoring, local weather station. This will require initial investment as well as long-term maintenance and operations responsibilities considerations.

Community responses were unanimous in identifying time as the single largest constraint in future fulfillment. Municipal staff would require dedicated time spent on SoCARB in order to keep it up-to-date, and that time is hard to come by, as the local staff that would be responsible for updating it possesses numerous responsibilities that contribute to a full workload. Capacity in terms of expertise was not viewed by interview participants as a limiting factor within the pilot communities, although it was emphasized that having in-depth instruction on indicator fulfillments would be a contributing success factor.

> Well that kind of depends on what the city staff have to say, if we are looking at capacity within city hall. It's one thing if it is all set-up and all you have to do is, you know, pull this stuff out – that's probably doable. But I looked at the wildfire info and there's a lot there, and that's just the fire, so it's going to depend. My guess is we could, but honestly that's me saying I want us to and not me necessarily saying that staff has the time to do it. It's the kind of thing that this council, the council that is in right now, would see the value of this and say this is important and we would direct staff to make the time and we would allocate the resources. I can't say for the next council… so, it really depends, it depends on political will and that changes every four years. – Interviewee 14

> The initial cost is setting up the data systems, once we have that information the biggest constraint is time, to crunch the numbers and see the results. We are constantly dealing with complaints of the day, which makes it tough to proactively plan for the future. If we could budget the time, we have data geeks who would love to crunch it. – Interviewee 13

> Bigger cities might be able to assign a person to this or have a whole department…. We don't have a sustainability department dedicated to this type of stuff and their desk is consistently full. It would be great to update it but that's just it. – Interviewee 18

> When it comes to budgeting time, and like, council is looking at a whole bunch of needs and scarce resources. "Are we going to fund a study or are we going to get that road repaved, what's going to get me re-elected here". And that's not to by cynical, that's just the reality of stuff that people can look and touch as opposed to the indirect benefits of this sort of thing. That said, I think the evidence based-approach is really important and we are lucky to have regional institutions pushing us along. – Interviewee 11

> Well I could see realistically it being paired down a little bit, to some of those key indicators that are most relevant to decision-making and yeah, I think council would need to make a commitment to resourcing it, you know, probably somebody in operations that's crunching those numbers that they have access to a lot of that information. I think it's important, as I say, it helps a lot… when you write grant, trying to get other people to prioritize your issues, you have to have evidence to say we're not just making this stuff up. – Interviewee 11

4.3.1 Basin Uptake of SoCARB

An additional line of questioning focused on participant perceptions on the potential of other Basin communities to utilize the process and the toolkit created in this pilot project and implement SoCARB in the future. The likelihood of other communities to fulfill SoCARB was generally contingent upon four things: the culture and will of the communities' local government, the perceived value of the information for local use, the capacity of local government in terms of time and expertise, and the support made available to communities to do so.

> Well it's all going to depend on their staff. I think one of the problems is we have so many tiny municipalities here (the Basin), there aren't very many big staff, and there's a difference in philosophy amongst communities, some of us have like minds. You look at all the people that participated in Water-smart, those are probably pretty good communities to go to for target communities, if they're interested in water conservation and improving their water quality and the rest of it, this kind of stuff would be of interest to them. The one's who weren't interested in Water-smart probably not going to be interested in this either. – Interviewee 12

> It would come down to the level of interest that each community has at working with something like this. It would definitely vary by community to community. Often when there's something that's a bit outside the norm that municipalities or regional districts are interested in acting on it helps to have some degree of outside support, to help orient them to the new tool or practice, whatever it is. Often when that outside support isn't there, it'll just peter out. Unless it's part of the municipalities core mandate. – Interviewee 4

The pilot communities benefited from having undertaken formal CCA planning as part of CACCI, this allowed them to have clear priorities for indicators and a wealth of information related to their formal adaptation actions. While this is definitely a contributing factor to their success, it may not be a hinge factor for the use of SoCARB.

> I think it'd be trickier to take on (if a community never had formal adaptation planning), yeah. It really comes down to the toolkit provided to the communities, and what sort of information is present in it. If the toolkit were presented in such a way that it was clear on how to use the tools, then planning might not be necessary. That said, planning is very useful step to get a sense of what the unique climate vulnerabilities. – Interviewee 3

Throughout the interviews it became clear that monitoring climate change adaptation is just one additional aspect of community planning that local governments need to take into consideration over the long-term. The ultimate goal of adaptation planning is to create a culture where considerations of climate change are integrated into the local-decision making process. While the results of SoCARB can be utilized to help inform planning and decision-making, it has been identified that it may be best for communities to integrate SoCARB into broader community monitoring initiatives.

> It's going to be a long time until this is ingrained in the planning culture. I work with local governments a lot, I understand, they just have so many things happening, so much going on. The reality is that monitoring climate impacts, climate change, and adaptation, should really fit within a broader community monitoring program. If we are going to mainstream climate adaptation, the monitoring of this needs to be routine within how you monitor everything within the community. We're not there yet and that's why we are doing these pilot projects. In my view, it doesn't make sense for every community to develop their own climate adaptation monitoring program. It makes sense for every community to monitor their quality of life and their sustainability, and climate adaptation/resilience is section of that. I don't think it's sustainable in the long run for every community to have a climate adaptation and resilience monitoring. – Interviewee 6

Further, given the scarceness of resource capacity within basin communities, it becomes a matter of prioritization and allocation of those resources that can best increase the adaptive capacity of communities. The benefits of SoCARB, in terms of the knowledge provided and the applications would need to be clearly explained to communities, along with a clear expectation of the amount of time they would need to budget. Communities will need to decide whether to spend time on a monitoring framework or to undertake competing priorities.

> Would the value be worth the cost? Juries out on that. How much detail do we need to know that we actually have to adapt. Some people want evidence-based decision making, but let's be practical, it is very clear that climate is changing and there are more things we need to adapt to. Are you going to put your resources into something like this, or actually into adapting? – Interviewee 5

The predominant feeling among participants was that the uptake of SoCARB, as a stand-alone monitoring programme or for it to be integrated into a broader community programme, would likely be extremely limited without external support, as communities are overburdened to undertake new initiatives without it.

4.3.2 Desired External Forms of Support

Participants were asked what forms of support would be most beneficial to assist their own community or an external communities uptake of SoCARB. To continue updating the report the communities identified they would benefit from council support for budget and time to dedicate to the project and external technical support for data gathering and analysis.

> There's not necessarily a need to financially incentivize (communities), but there needs to be a clear communication of what the communities will get for their effort. Clearly scope their commitments (e.g. 10 working days for meetings, so that they commitment is tangible and they can make their decisions). – Interviewee 9

RDI was frequently identified as being able to assist communities in the future uptake of SoCARB. Study participants viewed the RDI as an appropriate agency in supporting them championing this work given their experience with SoTB indicators, in-house expertise, as well as their institutional and community connections.

> It would be if RDI could create a central clearinghouse of this information. Have that on tape! If we could just go to RDI and pull all the information for our reports. – Interviewee 7

> Because of some of these indicators are more complex, centralizing the expertise, and working with the communities to establish the data collection processes… having the number crunching performed at RDI would be beneficial. – Interviewee 1

The toolkit was identified as a positive means of external support in providing technical guidance and assistance to communities in updating SoCARB in the future even if key staff leave their positions.

> It's kind of like a cookbook, tells you what you need to get and where, if we have that and it goes into the work plan, and it gets done. As long as that cookbook is kept up to date, regardless if someone leaves, whoever is responsible for that will know what to do, because it's written down here… …having person hours required, having detailed information regard data sources, and data methodologies. This is a really useful tool that can help us work this into our staff plan. – Interviewee 14

Chapter 5. Summary Discussion

The primary objectives of this study were to record the SoCARB pilot project as a case-study, identifying the process undertaken and related capacity needs and constraints. Further, to evaluate the feasibility of the process itself and the potential for replicability for future uptake of Basin communities and assess the utility of the final community reports at the local level. Using the study findings, a subsequent objective is to develop recommendations that can improve the SoCARB initiative in terms of future community implementation feasibility and utility. To guide discussion of the research findings, three questions are presented and discussed below.

5.1 What are the identifiable constraints for implementation of the SoCARB indicator suite in general and at a local level?

Throughout the pilot project there were several identifiable general and local level constraints present within the implementation of SoCARB in terms of indicator data availability, reliability and condition, as well as the components of the process itself in terms of required resources. While several of these experienced constraints are inherent within the pilot project and provide learning opportunities to alleviate those constraints going forward, some constraints will need to be addressed to support future implementation in general and more specifically at a local level.

A general limiting constraint that was present within phase one of SoCARB that will persist into the future concerns the data availability, reliability and condition of several of the indicators within the indicator suite. The results of the indicators are a function of the spatial and temporal scale chosen as appropriate over the project to fulfill the indicator in accordance with. One of the issues is that SoCARB was designed for a regional level and as demonstrated throughout this pilot, communities must rely upon regional weather stations and institutions that provide information at regional scales for fulfillment of many indicators. While local data sources were identified as preferential to regional data sources for community application as they are perceived to provide greater information resolution, long-term local data availability is often not present, or is in a condition that makes trends analysis difficult or impossible. That said, study participants noted that knowledge of regional trends is better than no knowledge. or indicators with insufficient local data, regional indicators may serve as a good-enough proxy for community knowledge over a long-term or in the interim while collection systems are established.

On a related thread, there are potential capacity constraints inherent to rural local communities that have been identified through this pilot project. In the SoCARB introductory report, it notes that while the indicators can be applied to individual communities, the level of effort associated with data collection and analysis may not make them practical for use by smaller communities working on their own (CBT & RDI, 2015). The pilot project had a great deal of human capacity support in the fulfillment of the indicators. The level of support, while necessary in a pilot project is likely not feasible to sustain in the future. The amount of time required to fulfill SoCARB, at the same level as the pilot communities would require an estimated 224+ hours over a five-year period, plus additional time for local specific data identification and the time needed to prepare a report. Further, a key constraint is the necessity of technical expertise, of which 14 indicators present in SoCARB required to fulfill. While technical expertise was required in this case for modelling data, which may not be required depending on the spatial scale of interpretation communities are willing to accept for climate indicators, there will still be a requirement to understand and use advanced statistics and GIS software.

5.2 What is the value gained by communities through implementation of SoCARB?

The pilot communities joined the project as they possessed no formal means to track their adaptation efforts and community climate-related vulnerabilities. They envisioned more robust data would help inform adaptation planning decisions and facilitate dialogue between municipal staff, local government, and the community. There is a general consensus amongst those engaged in this study that there is community benefit derived from participating in this project. It was identified SoCARB supports community communications of climate change impacts and adaptation outcomes, guides local adaptation and supports decision-making, serves as a reference for community reports and supports funding mobilization as well as enhances local knowledge systems.

The outcomes of SoCARB are more than a text on paper that can be subsequently referenced to rationalize community initiatives and support decision-making or assist in applications for funding. Bringing the community together through these exercises establishes and entrenches a culture that aligns decision-making with climate change adaptation considerations. This alignment is not always a formal consideration, rather it stems from an inherent community culture developed through undertaking of these community processes.

Indicators are helpful for informing residents, organizations, and governments regarding key trends in climate adaptation and resilience, facilitating understanding of complex issues, evaluating the effectiveness of various adaptation measures, and motivating change (CBT & RDI, 2015). The SoCARB suite is a useful tool for monitoring essential understanding of the natural environment that envelopes and sustains community well-being. Each pathway tells a story of climate and community change and is used as a lens in which to view key indicators through. The story provides the narrative to guide discussions amongst the residents, elected officials, local government, and other communities within the Basin region.

In rural communities with a constrained tax-base and ever-present problems of the day, the community support to undertake proactive planning initiatives is not always present and the decision-making process needs to be rationalized. This is especially so when undertaking adaptive measures that are outside of the purview of core responsibilities of local government – water, sewer, roads, and waste management. In the hands of motivated communities, the SoCARB framework can be leveraged to guide and support local decision-making. The monitoring results or alternatively, the gaps in results can serve to inform priority areas for community policy development and action in regard to adaptation. Further, knowledge provision of long-term trends in climate changes and associated impacts can be of benefit in the creation of medium to long-term community planning and provide needed evidence-based rationale to support decision-making.

Regardless of monitoring and evaluation limitations, the pilot communities noted they would benefit from fulfilling SoCARB in the long-term. It not only provides valuable information, it can help to establish a system of monitoring, and information management within a community. As the pilot communities have experienced, as people retire or leave, data of use can be lost. Having ready access to information is important as often that information can serve as reference to assist with community reports and can bolster applications for grant programmes. In the future, it is conceivable to predict that there will be greater frequency of funding availability for communities for to prepare for climate change, and the results of SoCARB may position communities to take advantage of those funds.

5.3 Provided there is value, what support measures are required to facilitate uptake of SoCARB within the pilot communities, and other communities within the region?

As discussed above there is perceived community level value derived from the piloting of the SoCARB. That said, while there was a desire from the pilot community representatives to maintain and improve upon SoCARB into the future, without targeted support measures the likelihood of future uptake both within the pilot as well as other Basin communities is diminished. The predominant feeling among research participants was that the uptake of SoCARB, as a stand-alone monitoring programme or for it to be integrated into a broader community programme would likely be extremely limited without external support, as communities are overburdened to undertake new initiatives without it.

As highlighted previously, community responses were unanimous in identifying time as the single largest constraint to future uptake. In a rural municipal context this is not surprising given that municipal staff would require dedicated time spent on SoCARB in order to maintain it (~224 to 228 hours over 5 years), and that time is hard to come by, as the local staff who would be responsible for updating it have numerous responsibilities that contribute to a full-workload. Given this support measures that reduce the time required to maintain the indicator suite are key to facilitating the uptake of SoCARB within the pilot communities.

While communities identified that the presence of political will to ensure that SoCARB was included within annual work planning would mitigate the need for external supports, dedicated external resources to SoCARB in terms of human capacity to fulfill the indicators and develop or update the community reports is viewed as the most surefire way to support uptake and maintenance of SoCARB within the Basin. That said, there is merit to building community internal capacity when it comes to monitoring and evaluation of climate change adaptation. Community-based CCA monitoring and evaluation transfers ownership of project monitoring and evaluation to the community, which is seen as being better positioned to evaluate changes and results due to the geographical nature of the work and increases the likelihood of communities utilizing the information to inform local and regional planning (Climate-Eval Community of Practice, 2015).

In absence of dedicated external human capacity support for SoCARB, a key support mechanism that would benefit communities is a refined toolkit that includes detailed instructional methodologies for indicator fulfillment. Altogether, 14 indicators present in SoCARB and fulfilled in the pilot project required technical expertise to fulfill, of which eight required the solicitation of external expertise. Given this, even in absence of human capacity support for SoCARB, and with a refined toolkit, ensuring adequate funding or in-kind support for technical expertise would improve upon the likelihood of uptake and maintenance of SoCARB into the future.

Another support consideration comes from spatial scale of the indicators and information gaps identified through the piloting of SoCARB. Several of the information gaps identified in SoCARB will only be overcome with investment by communities in local monitoring; e.g., investing in stream monitoring or a local weather station. This will require initial investment as well as long-term maintenance and operations responsibilities considerations. There are varying degrees of resolution that are needed to inform climate change adaptation decision making. Regional trends serving as a proxy for localized trends, while being identified as beneficial to the absence of information to guide decisions, are not sufficient for certain purposes, e.g. having hyper localized monitoring of precipitation can help when looking at water loss, municipal infiltration and inflow, or other asset management issues. Investment in municipal monitoring systems is paramount to ensuring high-resolution information that certain indicators within SoCARB rely upon.

Chapter 6. Conclusion & Recommendations

6.1 Conclusion

In the Columbia Basin of British Columbia rural communities and regional institutions have a history of working together to co-construct processes to support climate change adaptation. The piloting of the State of Climate Adaptation and Resiliency in the Basin indicator suite is another example of two communities, Kimberly and Rossland, BC, working with a regional institution, the Columbia Basin Rural Development Institute to build a foundational knowledge base to monitor and inform adaptation planning. This pilot study captures the process of the pilot project and presents key findings which will help to inform the SoCARB indicator suite development and application going forward.

6.2 Recommendations

Outlined below are a series of recommendations informed by this study for the continued future of the SoCARB indicator suite. A preliminary findings and recommendations report was delivered to the RDI in July 2017 to inform phase two of the SoCARB pilot project.

SoCARB Process Recommendations

- Establish clearly defined Terms of Reference (TOR) with future project stakeholders to establish expectations of time-commitments, roles and responsibilities for data collection, analysis and report writing.
- Expand local project engagement and participation. Initial community meetings would benefit from an expanded inclusion of community personnel. For example, in this study it was noted the inclusion of Operations from the beginning has the potential to assist in this regard as they often use data present in indicators and often serve as the focal liaison with external bodies (e.g. consultants) that currently collect, or historically have collected relevant data.

- Ensure that future implementors of SoCARB are provided access to the required expertise. Communities will benefit from continued technical support for analysis of gathered data, particularly for analysis of data to inform trends for indicators. In this study, the RDI and Selkirk College have been identified as the most likely and preferential partner to provide this support for communities going forward.

SoCARB Refinement Recommendations

- For SoCARB revision, consider revising indicators where identified insufficient data availability diminished establishment of local historical baselines and indicators were data was unavailable or were low priority or not of interest for community fulfillment. Consider including amended and newly introduced indicators into the SoCARB suite.

- After phase two is complete, assemble the original creators of SoCARB as well as participant communities to discuss the indicators and community knowledge needs. Through enabling continued dialogue focused on SoCARB, communities and practitioners will be able to fine-tune and improve upon indicators to support regional and local adaptation planning.

Recommendations to Increase Regional Uptake

- The RDI or another regional agency deemed appropriate continue to advance implementation of SoCARB and serve as the agency responsible for SoCARB refinement, process development and coordinating technical assistance and support.

- Ensure methodologies within the SoCARB toolkit are clearly articulated in order to ease future fulfillment and maintain consistency and replicability of results. Provision of detailed data collection and analysis methodologies and templates for community surveys will increase the potential for communities to fulfill SoCARB.

- Reduce the number of indicators communities would be responsible for fulfilling by collecting, analyzing and reporting on regional-level indicators. Reducing the total number of indicators communities need to fulfill may facilitate fulfillment feasibility.

- Utilize the Digital Basin Portal to warehouse and present SoCARB indicators at spatial scales appropriate for each indicator type: climate changes (e.g. basin hydrologic regions)[8], environmental impacts (e.g. fire zones) and community impacts & adaptation outcomes indicators (e.g. community boundaries).

- RDI seek and establish institutional agreements with other boundary organizations to develop information sharing protocols to enhance data collection and compilation. For example, the Pacific Climate Impacts Consortium maintains a BC station data aggregation service for relevant data that could be leveraged for autonomous trends analysis for climate changes and environmental impacts indicators.[9]

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[8] Basin Hydrological Regions: Canoe Reach, Columbia-Kootenay Headwaters, Kettle-Inonoaklin, Lower Columbia-Kootenay, Mid-Columbia Kootenay, Northeast Columbia, St. Mary-Moyie, Upper Columbia, Upper Kootenay.

[9] PCIC BC Station Data: http://tools.pacificclimate.org/dataportal/pcds/map/

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Appendix A. Overview of SoCARB Indicators

SoCARB Indicator	Description	Pathway					Type			
		Agriculture	Extreme Weather & Emergency Preparedness	Flooding	Water Supply	Wildfire	Climate Changes	Environmental Impacts	Adaptation Actions & Capacity Building	Community Impacts & Adaptation Outcomes
Agricultural productivity	*ratio of agricultural outputs to agricultural inputs. Measured as market value or crop yield per hectare.*	X								X
Air quality	*concentrations of fine particulate matter in the air*					X		X		
Amount of area being farmed	*annual number of hectares being farmed*	X								X
Annual area burned	*number of hectares burned on an annual basis*					X		X		
April 1st snow pack	*depth of snowpack on April 1 each year*			X				X		
Backup Power Sources	*presence of backup power source for critical community services and infrastructure*		X						X	
Campfire bans	*number of days each year with a BC Wildfire Management Branch issued campfire ban*					X			X	
Climate averages: precipitation	*average monthly precipitation*	X			X		X			
Climate averages: temperature	*average monthly temperature*	X			X		X			
Climate extremes: precipitation	*annual amount of total precipitation that occurs during days when precipitation exceeds 95th percentile*	X		X	X		X			
Climate extremes: temperature	*frequency of days where the maximum temperature exceeds 90th percentile*	X			X		X			

Community Food production	*number of people in the community who grow at least a small portion of their own food*	X							X	
Cost of fire suppression	*total amount of money spent on fire suppression annually*					X				X
Crop damage due to drought, high temperatures, frost, storms, pests, and disease	*annual insurance payouts for crop damage and loss as a result of drought, high temperatures, frost, storms, pests and disease.*	X								X
Developed properties in the floodplain	*total number of developed properties that are located within known and active floodplains in the Basin.*			X						X
Disaster financial assistance for flooding events	*total amount ($) of disaster financial assistance payouts to property owners in the Basin for flooding events.*			X						X
Disaster financial assistance payout for extreme weather events	*total amount ($) of disaster financial assistance payouts to property owners in the Basin for extreme weather events - landslides, avalanche, snow, wind, or freezing rain.*		X							X
Drinking water quality	*length of drinking water advisories or boil water notices annually*				X					X
Drought Index	*number of days per BC Drought Index Level*	X						X		
Emergency Preparedness Plan	*presence of an emergency preparedness plan, including a community evacuation plan that has been updated within the last 5 years*		X	X					X	
Farming practices to reduce soil erosion and increase fertility	*number of farms engaging in fallow land, no-till seeding, tillage incorporating most crop residue into soil, manure application, crop rotation, rotational grazing, ploughing down green crops, winter cover crops, and nutrient management planning.*	X							X	
Fire-related highway closures	*number (per year) and/or duration (hours) of highway closures due to wildfire*					X				X
Fire-related power outages	*The number (per year) and/or duration (hrs.) of highway closures caused by wildfire.*					X				X
Fire-smart-recognized communities	*recognition through FireSmart Canada's Community Recognition Program*					X			X	

Flood mapping extent and updates	*proportion of Basin floodplains where flood maps are available, and the proportion that have updated their flood maps since 2003 Flood Hazard Statutes Amendment Act which downloaded responsibility to local governments.*			X					X	
Flood-related highway closures	*number (per year) and/or duration (hrs.) of highway closures caused by flooding.*			X						X
Frequency of extreme heat days	*total number of days each year where maximum daily temperature exceeds 30°C*		X				X			
Frequency of extreme snowfall events	*total number of days each year with snowfall amounts of 15 cm or more within 24 hours*		X				X			
Frequency of hail storms	*annual frequency of occurrence of hail storms*	X					X			
Frequency of interface fires	*annual number of wildfires within 2 km*					X				X
Frequency of rain-on-frozen ground events	*total number of days each winter with ROF ground events.*			X			X			
Frequency of strong wind events	*total number of days annually with sustained winds of 70 km/h or more and/or gusts to 90 km/h or more*		X				X			
Glacier Extent	*area of glaciated terrain in the Basin*				X			X		
Ground water level	*average monthly ground water level for monitored aquifers.*				X			X		
Growing Degree Days	*amount of heat energy available for plant growth (product of number of days when mean daily temperature exceeds 5°C and number of degrees above that threshold)*	X						X		
Hectares irrigated	*hectares irrigated by electoral area*	X							X	
Implementation of water restrictions	*number of days annually where water restrictions are active*				X					X
Interface fire risk reduction	*percentage of mapped high priority area that has been treated to reduce wildfire risk*					X			X	
Invasive Species	*list of and estimate of aggregate area covered by invasive species*	X						X		
Length of Growing Season	*annual number of days between the first occurrence of 6 consecutive days when maximum temperature exceeds 5°C and the first occurrence of 6 consecutive days when minimum temperature is less than 5°C*	X						X		
Local government expenditures	*amount ($) or budget proportion of local government expenditures allocated towards flood protection*			X					X	

on flood protection										
Maximum 1 day rainfall	*annual maximum 1-day precipitation*		X	X			X			
Number of days in extreme danger class	*annual number of days in high or extreme danger classes of Canadian Forest Fire Danger Rating System*					X	X			
Peak stream flow volume	*annual maximum daily discharge*			X				X		
Per capita water consumption	*volume of total water supplied annually, reported by utility and expressed per capita*				X					X
Percentage of impervious surface in municipality	*proportion of land area with municipalities that is impervious (road, sidewalks, and buildings)*			X					X	
Policies to reduce water consumption	*implementation of policies/practices that have incorporated water consumption considerations in legislation*				X				X	
Provincial emergency assistance for flood response and clean up	*total amount ($) of disaster financial assistance payouts to local governments in the Basin for flooding events.*			X						X
Provincial emergency assistance for storm clean-up	*total amount ($) of disaster financial assistance payouts to local governments in the Basin for extreme weather events - landslides, avalanche, snow, wind, or freezing rain.*		X							X
Residents with 72 -hour emergency preparedness kit	*proportion of residents with 72-hour emergency preparedness kits*		X						X	
Source water temperature	*monthly average temperature for monitored surface water sources in summer months*				X			X		
Source water turbidity	*monthly average Nephelometric Turbidity Units (NTU) for monitored surface water sources*				X			X		
Stream flow timing	*tracks half total flow date, timing of annual peak yield and timing of late summer minimum yield*			X	X			X		
Stream flow volume	*annual minimum daily discharge*				X			X		
Water loss	*percentage of water supplied annually that is lost to leakage*				X					X
Water loss detection practices	*implementation of water loss detection practices*				X				X	

Water protection plans	*implementation of water planning measures that consider projected climate changes*				X				X	
Weather-related Highway Closures	*number (per year) and/or duration (hours) of highway closures caused by landslides, avalanche, snow, wind, or freezing rain*		X							X
Weather-related power outages	*number (per year) and/or duration (hrs.) of power outages caused by landslides, avalanche, snow, wind, or freezing rain.*		X							X
Wildfire evacuation orders	*number of evacuation orders due to the threat of wildfire issued by the wildfire protection branch*					X				X
Wildfire starts	*total number of both human caused and lightning caused wildfire starts per year*					X		X		
Consecutive Dry Days*	*maximum number of consecutive dry days*	X						X		
Freeze-thaw cycle*	*total number of days annually where maximum temperature > 0°C and minimum temperature < 0°C during the same day*			X				X		
Water Reservoir levels*	*number of weeks per year with at least one drawn down day*				X			X		

* Indicators highlighted in yellow denote those not included in the original SoCARB suite.

Appendix B. Summary of Fulfilled Indicators

	Pathway					Type				
SoCARB Indicator	Agriculture	Extreme Weather & Emergency Preparedness	Flooding	Water Supply	Wildfire	Climate Changes	Environmental Impacts	Adaptation Actions & Capacity Building	Community Impacts & Adaptation Outcomes	Identified Issues
Climate Averages (temperature, total precipitation)	X		X	X		X				Limited Spatial and Temporal Data Availability
Climate Extremes (temperature, total precipitation)	X		X	X		X				Difficult to Interpret Data
Drought Index	X						X			Limited Temporal Data Availability
Length of Growing Season	X						X			
Growing Degree Days	x						X			
Community Food production	X							X		
Amount of area being farmed	X								X	Limited Spatial and Temporal Data Availability
Maximum 1 day rainfall		X	X			X				
Frequency of extreme snowfall events		X				X				Limited Spatial and Temporal Data Availability
Frequency of strong wind events		X				X				Limited Spatial and Temporal Data Availability
Frequency of extreme heat days		X				X				

Residents with 72 -hour emergency preparedness kit		X						X		
Emergency Preparedness Plan		X	X					X		
Backup Power Sources		X						X		
Weather-related Highway Closures		X							X	
Provincial emergency assistance for storm clean-up		X							X	Limited Temporal Data Availability
Stream flow timing			X	X			X			Poor Spatial and Temporal Data Availability
Peak stream flow volume			X				X			Limited Temporal Data Availability
April 1st snow pack			X				X			Limited Spatial and Temporal Data Availability
Provincial emergency assistance for flood response and clean up			X						X	
Glacier Extent				X			X			
Stream flow volume				X			X			Limited Spatial and Temporal Data Availability
Source water turbidity				X			X			Limited Spatial and Temporal Data Availability
Source water temperature				X			X			Limited Spatial and Temporal Data Availability
Creation of policies to reduce water consumption				X				X		
Water protection plans				X				X		
Water loss detection practices				X				X		

Per capita water consumption				X					X	
Drinking water quality				X					X	Limited Temporal Data Availability
Water loss				X					X	Difficult to Interpret Data
Implementation of water restrictions				X					X	
Number of days in extreme danger class					X	X				
Annual area burned					X		X			
Air quality					X		X			Limited Spatial and Temporal Data Availability
Wildfire starts					X		X			
Interface fire risk reduction					X			X		
Fire-smart-recognized communities					X			X		
Campfire bans					X			X		
Frequency of interface fires					X				X	
Cost of fire suppression					X				X	
Fire-related highway closures					X				X	
Wildfire evacuation orders					X				X	
Water Reservoir levels				X			X			Limited Temporal Data Availability
Consecutive Dry Days	X						X			
Freeze-thaw cycle			X				X			

Appendix C. Summary of Unfulfilled Indicators

SoCARB Indicator	Pathway: Agriculture	Pathway: Extreme Weather & Emergency Preparedness	Pathway: Flooding	Pathway: Water Supply	Pathway: Wildfire	Type: Climate Changes	Type: Environmental Impacts	Type: Adaptation Actions & Capacity Building	Type: Community Impacts & Adaptation Outcomes	Notes
Frequency of hail storms	X					X				Limited Spatial Data Availability. No or low interest by pilot communities.
Invasive Species	X						X			No or low interest by pilot communities.
Hectares irrigated	X							X		No or low interest by pilot communities.
Farming practices to reduce soil erosion and increase fertility	X							X		No or low interest by pilot communities.
Agricultural productivity	X								X	No or low interest by pilot communities.
Crop damage due to drought, high temperatures, frost, storms, pests, and disease	X								X	No or low interest by pilot communities.
Weather-related power outages		X							X	Tested. Data unavailable.
Disaster financial assistance payout for extreme weather events		X							X	Tested. Data Unavailable.

Frequency of rain-on-frozen ground events			X			X				Limited Spatial and Temporal Data Availability.
Flood mapping extent and updates			X					X		No interest by pilot communities.
Local government expenditures on flood protection			X					X		No interest by pilot communities.
Percentage of impervious surface in municipality			X					X		No interest by pilot communities.
Disaster financial assistance for flooding events			X						X	No interest by pilot communities.
Flood-related highway closures			X						X	No interest by pilot communities.
Developed properties in the floodplain			X						X	No interest by pilot communities.
Ground water level				X			X			Low priority by pilot communities.
Fire-related power outages					X				X	Tested. Data unavailable.

Appendix D. Summary of Interview Questions

- Did you have an active role in the SoCARB pilot implementation?
- Previous to this beginning of the pilot project, did you hold any expectations of the process/results? If so, what were they?
- What do you think are the principle reasons to fulfill SoCARB is?
- What were your expectations of the Columbia Basin Rural Development Institute (RDI) at the beginning of the pilot project?
- In the absence of support from RDI do you believe that your community would have fulfilled SoCARB?
- What specific aspects of the support do you think were most beneficial for your community/Rossland/Kimberley?
- Do you believe that RDI met your expectations in their role facilitating and managing the SoCARB pilot project?
- Do you have any other thoughts about the role of RDI in the pilot project?
- What obstacles can you identify that impeded the process of implementing SoCARB?
- If your community/Rossland/Kimberley needed to update the SoCARB results in the future, do you think you would be able to do so unsupported? If yes, what forms of support would help you best? If no, what forms of support do you think you would need?
- What aspects of RDI support do you think could be improved upon for future implementation of the SoCARB indicator suite with other communities?
- How do you intend to use the results of SoCARB? Please elaborate.
- Do you believe that SoCARB sufficiently measures climate adaptation efforts or has the potential to do so in the future?
- Do the results of SoCARB assist your community/Rossland/Kimberley in understanding climate change and climate change adaptation? Please elaborate/ What more would be needed?
- Do you believe that the information will help decision makers make more informed decisions in the future? Please elaborate.
- Do you believe the results of SoCARB can be used to motivate change within the community? In what ways?
- Do you think that your community/Rossland/Kimberley will gain value by continuing to update SoCARB in the future?
- When looking at the results of SoCARB, which pathway/indicator do you believe is most relevant to your community/Rossland/Kimberley? Which is least relevant?
- Which pathways/indicators do you think are most relevant at a regional level?
- What indicators do you think could be collected by RDI at the regional level and still be applicable to your community?

- Can you identify any gaps in data or measurement in the SoCARB results that should be brought to light?
- If you were given a magic lamp, and granted three wishes that could be used in improving SoCARB what would they be?