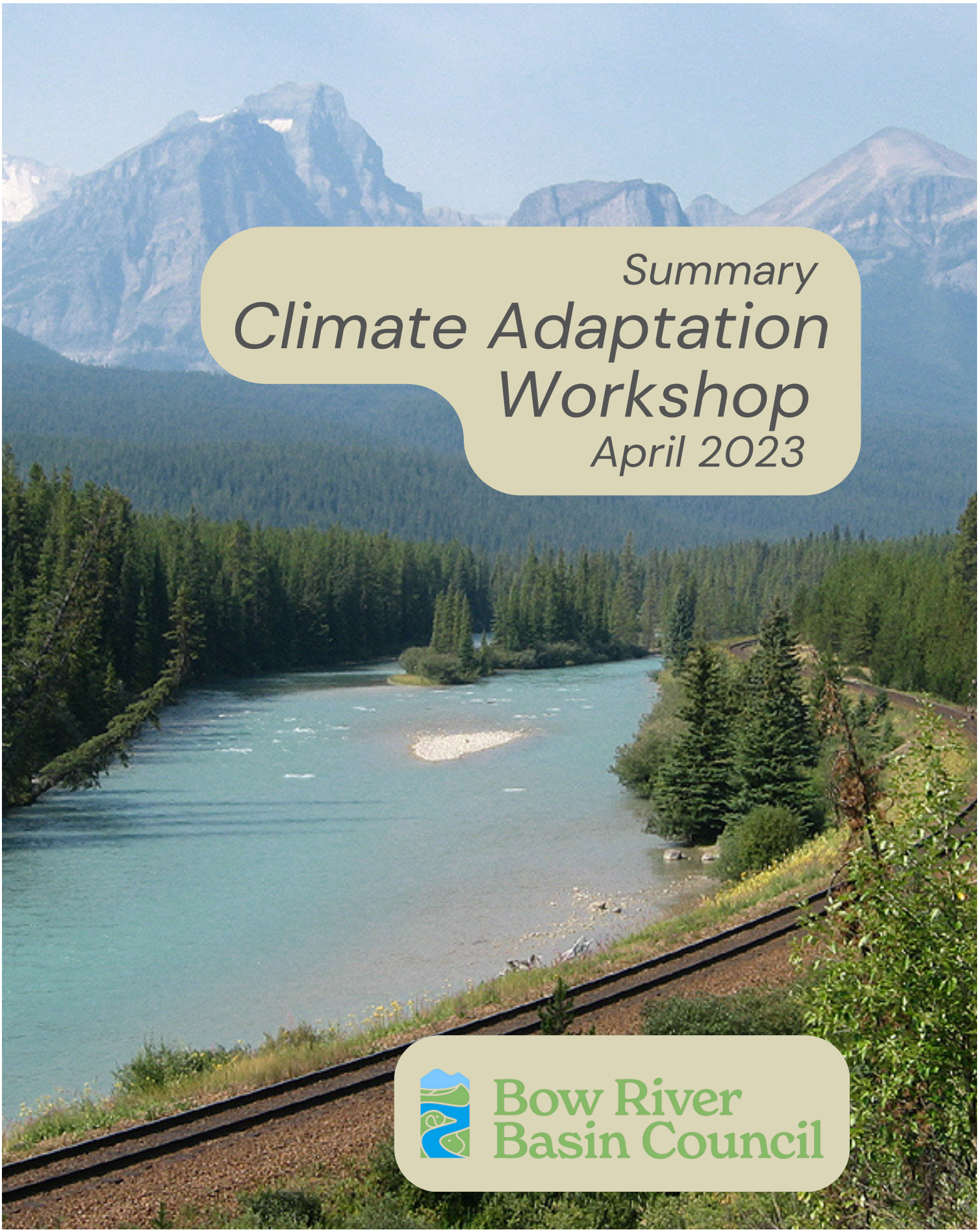


Summary

Climate Adaptation Workshop

April 2023

Bow River Basin Council

Climate Adaptation in the Bow River Basin

Workshop Summary Written by Alesia Cameron
Hosted by the Bow River Basin Council

Land Acknowledgement

The Bow River Basin Council acknowledge all those who share a deep connection with this land and its waters. In the spirit of reconciliation, the Bow River Basin Council acknowledges that this workshop took place in the traditional territory of Treaty 7 in Southern Alberta, which includes the Blackfoot Confederacy (Siksika, Piikani, and Kainai), the Tsuut'ina First Nation, the Îyâxe Stoney Nakoda and the Métis Nation of Alberta, Region 3. The Bow River Basin Council respects the histories, languages, and cultures of all of Canada's First Peoples and acknowledges that their presence continues to enrich our vibrant communities.

Acknowledgements

The Bow River Basin Council would like to thank the event moderator Steve Meadows and presenters Harris Switzman, Judy Stewart, Angela Ten, Liliana Bozic, and Jill Curley who graciously shared their talent and time. A special thank you goes out to the breakout session facilitators Sherry Young, Amy McLeod, Angela Ten, Nilo Sinnatamby, and Jill Curley and to the note-takers Anne Naumann and Florencia Said. Lastly, the Bow River Basin Council thanks the City of Calgary for providing the workshop space for this event which was held at the City of Calgary Water Centre. With its resilient design elements, this building is a leading example of an engineered asset which showcases thoughtful adaptive management.

Introduction

In the Bow River Basin (BRB), climate change is and will continue to result in diverse impacts and climate hazards. These are frequently detrimental and can result in cascading deleterious effects. Even when they're not harmful, these impacts and resulting effects lead to change in the watershed. While mitigation is crucial for managing climate change, it is not sufficient on its own. The BRB community needs to respond to this evolving reality through an iterative approach, incorporating adaptive strategies and management plans. Together, mitigation and adaptation improve the watershed's response to climate change and fosters a healthier environment for all its residents, including people, flora, and fauna.

On April 14th, 2023, the Bow River Basin Council (BRBC) hosted an adaptation workshop at the Water Centre in Calgary, Alberta. Community members were invited to learn about adaptation to climate change and adaptive work in the BRB. Five knowledgeable presenters from diverse backgrounds shared their perspectives on and experiences with adaptation. Engaged BRBC members facilitated two breakout sessions where attendees had the opportunity to share their relevant project work, ask questions, and discuss key elements of adaption strategies. The information shared during the presentations and breakout sessions was recorded, and this document provides a summary of the event.

Goals

The primary goals of the adaptation workshop were to foster community engagement and facilitate learning and discussion about adaptive work in the BRB watershed. The event provided attendees with a welcoming space to explore past, present, and future adaptation projects. Although individuals undertaking such work usually document their efforts, there have been limited opportunities for in-person sharing and collaboration. The BRBC offered an inclusive setting that fostered inspiration and motivation among BRB citizens to actively pursue and be successful in adaptive work in the basin.

Following the workshop, the documented information was refined for inclusion in the upcoming edition of the BRB State of the Watershed (SOW) report. Unlike previous reports, the newest edition will explicitly address climate change, as it has a significant influence on the watershed. A dedicated adaptation segment within the climate change section of the SOW report will highlight ongoing efforts in the basin and incorporate supporting details from the adaptation workshop. Going forward this information may enable the development of adaptation strategies that preserve, protect, and improve the watershed's condition. It may also provide a framework to establish metrics of success and to promote better monitoring and data collection.

Presentations

To capture an overview of what climate change looks like in the BRB and what adaptation means to a wide audience, the BRBC requested a diverse set of speakers to present at the event. The presentations included:

- Climate Adaptation in the Bow River Basin by Harris Switzman
- Legislation and Policies for Mitigation and Adaptation in the Bow Watershed by Judy Stewart
- Beaver Dam Analogues – Nature-based solutions for restoration by Angela Ten
- Implementing Resilient Practices – Challenges and Opportunities by Liliana Bozic
- Valuing our Natural Assets for Climate Adaptation by Jill Curley

The BRBC has summarized the key elements from each presentation in this report, as follows.

Climate Adaptation in the Bow River Basin

By Harris Switzman, M.A.Sc.

Our first presenter, Harris, set the stage for the adaptation workshop. The attendees of the workshop were shown photos of glaciers (in their past and present condition) and informed that there is rapid global glaciation occurring, due to anthropogenic climate change. They were asked to reflect on why changes to the Bow glacier matter. The audience responded with varied concerns about impacts on water quality and quantity such as potability, flooding, and drought. In addition, Harris voiced concerns about the impact on other species, on recreational use, and on environmental equity for future generations. There are different perspectives on what adaptation looks like and why it is important to adapt. Although there may be different reasons for concern, research shows that most people are worried about climate change and its potential impact on the future.

Though the terms adaptation and resilience are often conflated there is a distinct difference between the two concepts. Resilience suggests that a system will eventually recover from a shock, though it may not fully resume its original function or performance. Through understanding how systems fail, the design, procedures, or administrative controls can be adjusted accordingly thereby increasing the systems resilience. In the context of adaptation, there are certain key factors of the system disturbance that remain unknown, such as the duration of the shock, failure rate, and recovery rate. While both adaptation and resilience strive for system recovery, adaptation often necessitates a more fundamental shift in thinking and approaches, particularly in the face of climate change where the impacts are complex and uncertain.

When the outputs of the best hydrological models are analyzed, a large range of possible futures are identified which indicates that an extensive and diverse set of adaptation tools capable of changing course rapidly are needed. Accepting that uncertainty is intrinsically tied to climate change, water managers need to adapt their programs and assets to meet the needs of an uncertain future and budget (Currently, water retention provided by natural assets in the Calgary region is valued at $1.2B /yr).

Many adaptive strategies have the potential to become maladaptive due to various factors, resulting in uncertain outcomes. To address this, the adaptive management cycle should integrate current climate change science and knowledge and consider the entire hydrologic system of the Bow River Basin, including groundwater, surface water, and infrastructure, with a holistic and integrated approach to develop effective solutions. Strategies for adaptation can be found in nature as ecological systems have perfected this.

Harris proposed three essential strategies that can be implemented in the Bow River Basin. Firstly, there is a need to enhance the current system's function and resilience. This involves improving its ability to withstand and recover from disturbances. Secondly, it is crucial to create space or capacity for adaptive strategies to be employed. This entails allowing flexibility and innovation in the face of changing conditions. Lastly, there is a requirement to actively manage specific and known risks, adopting proactive measures to mitigate their potential impact. By focusing on these strategies, the Bow River Basin can strengthen its ability to adapt and respond effectively to the challenges posed by climate change and other threats.

Legislation and Policies for Mitigation and Adaptation in the Bow Watershed

By Dr. Judy Stewart

Mitigation aims to prevent or reduce greenhouse gas emissions (GHG) globally, while adaptation focuses on adjusting to the effects of climate change on a regional or local level. Climate resilience, as defined by the Centre for Climate and Energy Solutions, is the ability to prepare for, recover from, and adapt to significant impacts caused by the deleterious effects of climate change.

There are several different pieces of climate change legislation in Alberta. Within the *Emissions Management and Climate Resilience Act*, SA 2003, c E-7.8 (EMCRA) there are many directives that mitigate GHG emissions and/or enable climate resilience. Several policies and programs have arisen from

implementation of the *Environmental Protection and Enhancement Act*, RSA 2000, c E-12 and the *Water Act,* RSA 2000, c W-3, that foster and enable climate change adaptation. Programs and strategic plans have emerged, such as Water for Life, Flood Hazard Mapping, the Alberta Biodiversity Monitoring Institute, and the Municipal Climate Change Adaption Centre (MCCAC).

Additionally, municipal planning and development decision-making and practices under the *Municipal Government Act*, RSA 2000, c-M-26 (MGA) must be consistent with the regional plans laid out in the *Alberta Land Stewardship Act* (ALSA), SA 2009, c A-26.8. In the case of municipalities without regional plans the Alberta Land Use Policies (1996) are followed. The ALSA also facilitates cumulative effects management through regional air quality and surface water quality frameworks. The MGA is the broad authority that regulates and controls the development of land and buildings in Alberta. It directs municipalities to foster the wellbeing of the environment, hence it empowers mitigation and adaptation plans and actions. As well, since the enactment of the Calgary and Edmonton charter regulations, the two big cities are authorized to pass bylaws for environmental management and climate resilience.

Both the Calgary Climate Resilience Plan and the Okotoks Climate Action Plan are leading examples of mitigation and adaptation strategies in the Bow basin. When needed, there are supporting organizations that help build adaptation plans, such as the MCCAC provides funding, technical assistance, and education to help Alberta municipalities adopt energy efficiency and renewable energy solutions and enables mitigation and resilience to climate change. An example of a MCCAC-based project is the *Ghost Lake Climate Adaptation Plan.*

To facilitate climate resilience, it is imperative to address critical elements in watershed planning. Key considerations encompass identifying the stakeholders involved, understanding the insights derived from monitored data, recognizing the risks and most significant vulnerabilities present, determining the actions that stakeholders can undertake to mitigate these challenges, formulating a climate resilience plan in collaboration with stakeholders, and establishing mechanisms for plan implementation, ongoing monitoring, and necessary amendments.

Revisions in policies are essential to accommodate the evolving nature of climate change and integrate emerging technologies. This necessitates the establishment of reliable mechanisms for data collection, analysis, monitoring, and reporting within the community. Moreover, considering the influence of economic and population growth, it becomes crucial to adjust the targets outlined in these policies accordingly. Judy emphasized several critical aspects that should be prioritized in climate change planning. These include incorporating trustworthy sources of information and data to inform decision-making, updating water conservation programs to align with current needs, enacting provincial laws and policies to protect natural infrastructure and riparian lands, replacing detrimental stripping and grading practices, and implementing licensing and monitoring measures for emissions from off-highway construction vehicles. By implementing new policies and introducing necessary amendments, the community can effectively facilitate mitigation and adaptation actions, thereby enhancing climate resilience in the Bow basin.

In conclusion, addressing climate change requires a multi-faceted approach that combines mitigation and adaptation strategies. By addressing these aspects and implementing necessary changes, the community can enhance climate resilience in the Bow basin and effectively respond to the challenges posed by climate change.

Beaver Dam Analogues – Nature-based Solutions for Restoration

By Angela Ten, B.Sc.

With many partners, volunteers, and funders, Trout Unlimited Canada built beaver dam analogues (BDAs) in the Whispering Pines West tributary (which feeds into the Ghost River and ultimately into the Bow River). This tributary has been seriously degraded and unnaturally straightened over time due to historical anthropogenic influence and the decimation of the beaver population. The tributary has deeply incised banks, little groundwater recharge and by the end of summer the shallow fast-flowing channel dries up and water pools in isolated pockets. Threatened fish species, such as the Bull Trout and Westslope Cutthroat Trout have been stranded in these pools, and many have died overwinter due to ice formation and lack of oxygen. This threat led to TUC's inquiry on how to resolve the issue.

Though grey infrastructure such as check dams have been used in these types of environments, TUC recognized that this 'solution' was inappropriate. Not only are they expensive and difficult to import to a remote location, but these dams are also difficult to install, and they inhibit natural aspects of the dynamic fluid environment.

To leverage the natural processes and elements of the tributary and to encourage the ecosystems to be self-sustaining, TUC decided to install beaver dam analogues (BDAs) – a type of low-tech process-based restoration (LTPBR) that is known to enhance resilience in riparian areas. Beavers once inhabited this area of the watershed where they positively influenced the shape of the landscape and tributaries. The primary goals of this nature-based project were to raise water levels, create ponds, and promote water retention. This in turn would foster healthy environments for all species, including threatened fish species and beavers. TUC and trappers have discussed translocating beavers to these BDA sites, as they can maintain and expand the ecosystems.

The BDA Project's specific details are as follows. In 2019, an area of concern was identified, and the installation process commenced on September 6, 2022. This timing was chosen to minimize the impact on fish, as the channel was relatively dry during that period, and obtaining permits was more straightforward. To ensure regulatory approval, TUC enlisted the services of an engineer. The engineer selected three locations for the BDA construction based on the topographical images of the tributary which revealed historical wetlands (likely created by beaver dams). Prior to the installation, the necessary permits were obtained.

For the construction, locally sourced untreated wood was used for the posts and structure, while cobble served as infill material. The equipment used during the installation was minimal and included small gas-powered tools and vehicles. Due to the scope of the project, a significant number of volunteers were

involved. The construction process followed the guidelines outlined in the LTPBR manual for BDA construction. To ensure a robust structure, water was added during the final construction phase to ensure tight packing.

In the initial stages of the BDA process, flow diversion is expected. This will cause the incised banks to slough off into the stream bed and will widen the channel. Sediment will become trapped and build up, thereby causing the water to flow outwards onto the floodplain. The groundwater will be recharged, and beavers will return to the area who then create complex, healthy ecosystems which are inviting habitats for other wildlife, including fish.

On April 10, 2022, seven months after the BDAs were installed, TUC returned to the area to assess the projects status. Two of the three BDAs were examined and found to be holding back water. The retention time was unknown, but this looked like a successful start. Since restoration is a long game, TUC may not be able to identify full success of the project for many years. Going forward, with the skills and knowledge that TUC has developed from this experience they will not likely hire engineers for similar BDA projects.

Currently, TUC has no formal plan in place for monitoring, aside from taking photos and partnering with other organizations to collect relevant data. Without the support of resident-beavers, the dams will only last 5 – 10 years so TUC will likely maintain the BDAs as needed. Other metrics of success that TUC may include are running e-DNA analysis (to determine fish species and population) which is repeated annually for 5 years and doing a riparian health assessment and/or inventory.

Overall, the BDA project is a positive step in restoring the Whispering Pines West tributary, fostering healthy ecosystems, and providing inviting habitats for wildlife, including threatened fish species. While there is still much to learn and monitor, TUC's commitment to nature-based solutions and adaptive management strategies will contribute to the long-term success and resilience of the Bow watershed.

Implementing Resilient Practices – Challenges and Opportunities

By Liliana Bozic, M.Sc., P.Eng.

Several basin-wide challenges need to be considered in the design and implementation of resilient watershed practices. Adapting to and mitigating the effects of climate change is crucial as extreme weather events such as drought and floods pose a significant watershed threat. Another challenge arises from the limited availability of new water licenses, emphasizing the importance of preserving and managing existing water resources. Additionally, land development activities have adverse environmental impacts on the Bow watershed. To minimize this degradation, more sustainable ways of managing urban runoff must be implemented. This includes incorporating and utilizing green infrastructure and low impact development strategies for stormwater conveyance and treatment, better planning practices that incorporate natural assets with built form and reducing urban sprawl through redevelopment and densification.

Though there are many policies which call for sustainable stormwater management, the actual implementation is lagging, and it is faced with many barriers. These include inadequate guidelines, cross-departmental misalignment, outdated land use planning policies, infrastructure issues (e.g., inadequate

right-of-way), and prohibitive costs. The examples of successful implementation within the city of Calgary (CoC) are limited to pilot projects. Some examples of large-scale low-impact development (LID) implementation can be found in surrounding communities (e.g., Harmony and Elbow Valley communities in Rocky View County), where lower density requirements and more flexibility with guidelines and standards contributed to the project success.

The current stormwater management practice in the Nose Creek Watershed is an example of high costs and questionable benefit to the creek. This Bow River sub-basin has been highly impacted by residential and commercial development, industrial growth, and agricultural activity. The area is a high priority growth corridor that has restrictive stormwater discharge targets, which necessitate stormwater reuse for irrigation and enlarging pond surface area to increase evaporation. Both approaches are very expensive to construct and operate and result in loss of developable land, going directly against the high growth planning policy. Holding water back from the creek in stormwater facilities to enable reuse and evaporation also results in a changed discharge regime when compared to predevelopment, potentially impacting the creek hydrology instead of preserving it.

An example of challenges with LID implementation is the reconstruction of Bowness Road in the community of Montgomery. The road was designed with bioswales to convey and treat stormwater, and it was one of the CoC-funded pilot projects. The project faced many stalemates due to the competing needs of the numerous and diverse stakeholders and different CoC departments. The existing guidelines and standards were inadequate and many design decisions needed to be made “in the field”. Concerns were also identified with the operations and maintenance responsibilities and equipment. Although the project was completed successfully, it did identify the need for updated standards and for various CoC departments to be better aligned on future similar projects.

Calgary is a significant wetland region, and prairie wetlands are an important natural asset. Preservation and protection of wetlands is strongly supported by both municipal and provincial policy. However, wetlands in urban areas are particularly at risk because land development can dramatically alter the wetland catchment. Trying to preserve a wetland in its natural form and function has proven very difficult and costly, with complicated hydroperiod substitution options such as pumping from a storm pond. Even with a high initial and long-term investment, it is often not possible to preserve the wetland’s predevelopment function. In many cases, a better option is to reconstruct the wetland to include a stormwater function in addition to biophysical function. If provincial guidelines for wetland reconstruction are followed, a healthy and productive reconstructed wetland can be created, which can fully replace the lost habitat and hydrologic function.

Several pieces of legislation and guidelines that support watershed resiliency include:

Provincial

- Water Act and Environmental Protection and Enhancement Act
- Stormwater Use and Water Reuse Policy (draft)
- Alberta Wetlands Policy 2018 Guide
- Watershed Management Plans

Municipal

- Climate Change Adaptation Planning
- Stormwater Management Strategy
- Stormwater Management and Design Manual
- Low-impact development Technical Guidance Documents
- Wetland Conservation Plan

In conclusion, while there are many challenges with implementation of resilient projects, these can often be overcome with a flexible approach, considering sustainable stormwater management early in the planning process, and recognizing that costs are one of the most important considerations for project success. In addition to flexible policies and guidelines, there is a need for better inter-departmental alignment and better technical tools to facilitate implementation.

Valuing our Natural Assets for Climate Adaptation

By Jillian Curley, P.Biol.

Climate data can inform us of climate change risks. To comprehend the full breadth of risks and potential impacts, Calgary climate projections use the RCP 8.5 emissions scenario as detailed by the IPCC. According to the data, the Bow basin will experience greater changes in the temperature and precipitation. Warming will occur at an accelerated rate and these temperature changes will result in shorter winters, earlier springs, longer summers, and fall arriving later. There will be a shift in the precipitation types and timing, resulting in smaller snowpacks, glacial runoff, and decreased summer runoffs. Resulting low flows will reduce water quality and increase drought and wildfire risk. Given the interconnected nature of hazards, it is crucial to conduct effective analysis of climate data in order to determine suitable adaptation measures.

Climate change is causing drastic impacts on the Canadian economy. Annual catastrophic insurable losses exceed $2 Billion annually while the uninsurable losses are 3-4X this value. Since the latter is absorbed by the taxpayer, the government's budget is negatively impacted. This reduces the finances available for other sectors, programs, and services. Bloomberg Financial L.P. has reported that the impacts to the Property and Casualty insurance sector should be viewed as a proxy for how other industry sectors will be affected. The City of Calgary (CoC) looks to the Insurance Bureau of Canada (IBC) for guidance as IBC works to advance nature-based solutions as a cost-effective and under-utilized way to protect Canadians from flooding and other climate risks.

"Natural infrastructure refers to a range of assets from natural through engineered which rely on ecological and hydrological processes to provide municipal, ecosystem, and societal services as well as resilience benefits." This definition of natural infrastructure was developed in collaboration by the CoC and is similar to the Canadian Council of Ministers of the Environment and the International Institute for Sustainable

Development definition. Currently, CoC is focusing on evaluating the natural and enhanced assets and not the engineered ones. The quote that highlights the mindset shift that the CoC is trying to create at all municipal levels is found in the Municipal Development Plan, section 2.6,

> *Natural infrastructure is better able to self-adapt to the stresses and shocks associated with Calgary's changing climate than hard infrastructure. Protecting and using natural infrastructure appropriately can offset costly investments in new hard infrastructure, while providing additional social, economic, and environmental co-benefits.*

- Natural assets rely on natural ecological processes to function. The CoC is working diligently to safeguard and preserve natural assets such as wetlands, riparian areas, and aquifers in their undisturbed state. For example, the CoC, with the aid of Green Analytics, created a Natural Asset Inventory dashboard that contains condensed asset data overlain with Environmentally Significant Area data. This tool will provide a deeper understanding of critical areas; it will be publicly available on the CoC's open-access GIS system (this integration is occurring over the next year).

- Enhanced assets have been strategically modified or managed to improve their hydrological and ecological functions in order to restore and naturalize areas. Dale Hodges Park (NW Calgary) was a degraded brownfield site that was revitalized through the collaboration of multiple disciplines including the CoC. The enhanced asset now manages and treats stormwater, provides habitat for wetland flora and fauna, and is used for recreation.

- Engineered Assets are types of infrastructure that are human built. They are often the only or best option in high-density communities or redevelopment areas. These projects attempt to incorporate natural biological and ecological processes, though continuous operation and maintenance is required. Engineered assets include green stormwater infrastructure such as bioretention beds or green roofs.

The Calgary Climate Strategy, released in 2022, includes an Adaptation Plan in which one of its key themes is Natural infrastructure. One of its long-term actionable steps already in progress is 'implement operational practices that improve climate resilience of natural infrastructure'. An example of this can be seen in stormwater management which is conventionally controlled by grey infrastructure. By relying more on natural infrastructure, flood mitigation and water quality and water quantity control can be improved. This novel change enables climate resilience and results in many co-benefits. Currently the CoC is working on the implementation phase of the Climate Strategy.

In collaboration with a cross-corporate stakeholder groups, key ecosystem services provided by Natural infrastructure assets were identified and evaluated. This valuation allows one to understand the replacement cost of these 'services'; it does not put a price on the natural element itself. Through examining this data one can determine critical points where investment is necessary or most beneficial. By

understanding the Natural Asset Inventory and value of ecosystem services, the CoC can better factor long-term costs in projects at the planning, design, construction, and maintenance phases.

The critical natural infrastructure services, provided by the assets in the upstream area of the Bow watershed were identified in 2022 by Associated Engineering. These services included water purification, flood and drought management, carbon sequestration, and more. The recognition of these services affirms that investments in the protection, restoration, and enhancement of the upstream watershed is rational. Southern Alberta Land Trust are a prime example of investors when they conserve riparian land.

Breakout Sessions

In each breakout session the attendees were split into three groups which included a facilitator and a note-taker. Instructions and materials were provided, along with the queries and a supporting index of ideas or guideposts. The information shared and discussed was documented.

Breakout Session #1: Adaptation Projects in the Basin

During the first half of this breakout session, participants shared information about the adaptation projects that they are currently or were previously involved in. They discussed essential aspects such as the individuals involved, the nature of the projects, their locations, the reasons behind their implementation, some adaptation strategies implemented, and the timelines associated with them. To improve group engagement those who had worked on a project were encouraged to share their responses with those who had not previously done a project.

Outcome #1: Project Details

Project	Why? Purpose?	Who?	Strategy	When	Location
Beaver adaptation & flood mitigation	Infrastructure protection & ecological assistance	Multiple actors	Innovative plan: pond levelers, exclusion fencing, & beaver proof culverts	Completed	Foothills county – 2 locations; video taken by C&F
Stormwater mapping & modelling	To better understand risk areas, to update stormwater modelling & to better manage risk	AEPA & CoC	Mathematical & GIS modelling	Current	Calgary
Jumping Pound Watershed Study: Maintaining Drinking Water Quality	Investigating potential to protect Calgary's water quality from land use development & climate change by purchasing natural preserve in Bow watershed	CoC water services as client; Miistakis as partner of associated engineering; CoC approval	Natural asset framework & costing an emerging field; included costing study of avoided costs & natural assets value	Completed	Jumpingpound Creek east of Cochrane, west of Glenbow Ranch
Riverbank Makeover Project	Riparian restoration & public education; to consider risks & impacts to water quality & quantity; to reduce erosion, increase water quality & quantity, provide habitat & shade for fish, etc.	CRV with $ & approval from CoC & landowners; this year with $ & approval from GOA & help of Leaf Ninjas	Following Calgary Riparian Action Plan to improve health of riverbank and creek, used C&F Riparian Health Assessments, & monitor over time; followed planting selection & location advice; learned about harvesting willows from TUC	2018, 2019, 2020, 2021, 2023	Private homes near Elbow River in elbow & rideau park (2018/19); West Nose Creek near Hanson Ranch & city land near pathway (2020); 3 GOA buy-back properties on Elbow River (To be approved in 2023)
Glenmore dam improvements & gates upgraded	Increase reservoir storage for flood & drought mitigation	CoC with approvals through AEPA, etc.		Completed 2020	Glenmore Reservoir
Community drainage improvement program	Improve stormwater service level from 5 years to 25 years; LID: increase safety of infrastructure	CoC consultant	Improve old infrastructure plan- execution	On-going	Calgary
Beavers at habitat / water managers	Improve erosion & channel movement, allow space for floods & meandering, and opportunities for change		Allow beavers to exist in the landscape & make the modifications required	Currently and over past 40 years	Ranch lands along Fish Creek

Bioengineering in the Elbow River	To restore natural riparian areas; currently used as demonstration site	ERWP, Off-highway vehicle group volunteers, GOA	Followed bioengineering protocol & used data from C&F	Completed	Maclean Creek land use area
Carrington Reconstructed Wetland	Reconstructed wetland as a stormwater facility, wetland replacement & protection of natural assets	Urban Systems as consultant; Mattamy Homes as developer, CoC and AEPA for approvals	Follows wetland construction guidelines		Calgary NW
Farmer-led projects	Multiple varieties & combinations of farm-based alternative land use services projects; riparian area focused, wetland conservation & native grassland/pasture conservancy	ALUS, RVC, with residents (local farmers)	Project specific; 5-year contracts are standard	Now and for the past 5 years	Throughout RVC
Nose Creek Watershed Modelling Project	DEM, HEC-RAS, SWAT; riparian intactness assessment partnership between several high growth jurisdictions; riparian setbacks	NCWP, RVC, CoC, Airdrie, Crossfield, BRBC	Nose Creek Watershed Management Plan	Past 20 years and on-going	Nose Creek/ West Nose Creek watershed
Enabling food security and the local economy via urban farming	Food & security; green infrastructure; economic diversification	Sponsored by the Alberta Real Estate Foundation and Executed by SAIT, targeting Calgary & Edmonton	No adaptation framework followed: a policy review with semi-structured interviews and workshop with key stakeholders to better understand the opportunity of urban farming in Alberta	2022-2023	Calgary & Edmonton
360 Tour of the Bow River Basin	Education & awareness: beautiful landscape, our residents, resources, challenges, & diversity	Alberta Tomorrow Foundation, SAIT, and BRBC	No adaptation framework followed: based on education using immersive approaches: 360 video tour along the basin	Started 2022 – on-going still (meant to be living project)	Aims to target sub-basins of the Bow basin
Beaver dam analogues	To use nature-based solutions to improve water retention on the land; to improve habitat but also have human-utility aspects (e.g., livestock watering); adding a groundwater monitoring system	Miistakis, C&F, Blood Tribe Land Management, TUC	Does not follow a framework but examples from States and a manual; ecosystem restoration & conservation strategies	Began in 2022 and on-going	*Not in the Bow River Watershed*

Integration of climate change in drainage infrastructure restoration	To ensure water quantity and quality risks are managed and management objectives are achieved over asset lifespan; to protect water quality over a range of conditions in Nose creek; to support on-site water reuse & conservation of potable water	CoC, SAIT Integrated Water Management Program, engineering & design firms	Follows our climate resilience goals in YYC Airport Authority corporate sustainability strategy; use of climate models in design, sensitivity analysis, consideration of alternative solutions		Calgary, YYC International Airport
South Saskatchewan River Operational Model: Economic Impacts	To see impacts of climate change within the basin, looking at options assessment (i.e., looking at new reserves or other infrastructure) that may impact water quality or quantity within the basin	Municipalities within the SSRB, GOA, NGO's, irrigation districts		2022 – 2024	SSRB, including the BRB

Table Acronyms:

- AEPA – Alberta Environment and Protected Areas (formerly AEP)
- C&F – Cows and Fish
- CoC – City of Calgary
- CRV – Calgary River Valleys
- ERWP – Elbow River Watershed Partnership
- GOA – Government of Alberta
- NCWP – Nose Creek Watershed Partnership
- RVC –Rocky View County
- SAIT – Southern Alberta Institute of Technology
- SSRB – South Saskatchewan River Basin
- TUC – Trout Unlimited Canada

To determine if an adaptation project is successful or effective, it is critical to gather, evaluate, and monitor quantitative and/or qualitative data. This data provides a means to assess progress, performance, or desired outcomes in a tangible and measurable way. These metrics of success are typically defined prior to undertaking a task or project and serve as benchmarks against which actual results can be compared. A goal or project is considered successful when it achieves its intended purpose or desired outcomes within the defined parameters. Tracking and acknowledging lessons learned is critical in managing projects, as it facilitates continuous improvement, enables adaptation, and enhances informed decision-making.

During the second half of the first breakout session, attendees explored past and present adaptation projects to share their metrics of success, achievements, and valuable lessons learned. It was suggested but not necessary that they continue using the same project written about in part A. To inspire creativity and for the sake of time supporting lists of ideas were provided. Many of the recorded responses were accompanied by an organization's name but there were several anonymous contributors as well.

Outcome #2: Project Stories

Calgary River Valley

Calgary River Valley (CRV) identified several metrics of success in their Riverbank Makeover project. These included riparian health assessments, observing the health and progression of native plants, evaluating the resilience of riparian zones in the face of climate change, and identifying long-term behavioral changes among river-adjacent landowners. CRV successfully planted and established native vegetation in riparian zones and saw improvements in riparian health. Another significant achievement identified by CRV was an improvement in their relationships with private landowners along the river. This facilitated better engagement and the exchange of knowledge about various riparian options. CRV holds the belief that the accomplishments made in enhancing riparian health notably contributes to the long-term sustainability of these zones. CRV gained insights from these experiences. In restoring riparian areas of government-owned land, they found that the approval process was both very slow and difficult to understand. There wasn't clear direction available or offered which proved to be a barrier. Additionally, CRV has learned that consistent landowner engagement improves adaptation project outcomes.

Rocky View County

Rocky View County (RVC) provided information about a modelling project being led by the Nose Creek Watershed Partnership. RVC indicated that some of the metrics of success for this +20-year project are identifying changes in the hydrological processes, community and stakeholder engagement, and long-term sustainability. Noteworthy achievements identified by RVC are improved flood and drought management and long-term sustainability. RVC's adaptive projects have encountered challenges due to competing demands and regulatory barriers, yet these have provided valuable learning opportunities.

City of Calgary

The City of Calgary (CoC) shared details about a completed project which was the modification of the Glenmore dam. To gauge success, the CoC measures changes in the downstream (Elbow River) flow and evaluates climate resilience. The changes to the Glenmore dam have led to successful outcomes, including better control of the downstream flow, and enhanced flood and drought management.

Jumpingpound Watershed Creek

During part B of the breakout session, valuable details were shared about a Jumpingpound Watershed Creek study. The focus of the study was to assess the feasibility of acquiring a land reserve in the Bow watershed in order to preserve drinking water quality. However, one of the challenges encountered was determining the monetary value of the reserve since natural asset costing is still an emerging field. Furthermore, continuing the study would have required more money, but there was uncertainty regarding the source of funding.

Anonymous

Several of the attendees contributed to part B anonymously. They marked an X next to a concept provided in a list with either no comment or with a comment.

Metrics of success

- Water quality indicators: To quantify impacts
- Aquatic ecosystem health & biodiversity: To use data to define bylaw
- Land-use changes: To see decrease of turf
- Climate resilience: To understand drought impact
- Long-term sustainability

Achievements

- Water quality improvement
- Aquatic ecosystem health & biodiversity: Less turbidity
- Hydrological processes: Water quantity reduction and less peak flow
- Flood management: Improved flooding network for traffic

Lessons Learned

- Uncertainty: Capacity building and how to educate community so they have an appreciable understanding of risks

- Lack of knowledge & awareness: Shift messaging to encourage community uptake, particularly when we have cultural bias (e.g., subjective, cultural perception that manicured lawns and areas are better than natural areas)
- Barriers: Getting climate lens buy-in

Notes

Several conversations among attendees during the breakout sessions were important to track in this workshop, even though many responses were recorded on handouts and poster boards. The notetakers made an appreciable effort to accurately capture these details. However, due to the multifaceted and diverse nature of the conversations, the notes lack seamless continuity. Nonetheless, it was important to document this information to generate ideas that can guide future adaptation research and workshops.

Projects Discussed

- Reconstructed Wetlands
- Operating Stormwater Management
- SAIT projects with students
- Beaver Dam Analogues by Trout Unlimited Canada
    a) TUC was asked if they could build a meander channel instead of a straight channel, this would slow down the water in a natural way, she replied that eventually beavers will help convert the straight channel into a meander.
    b) The erosion caused by meanders is important, and beavers are good at creating these meanders “beavers are so powerful, they win all the time, they are a good tool”.
    c) Erosion makes watersheds work, but we have to be mindful of the space.
    d) TUC said that the BDAs carved a little channel, and that they are hoping for nature to take place.
- Mardaloop project from the City of Calgary
    a) They target adaptation measurements, and they built an index with a number of indicators:
        i. Built systems.
        ii. Climate projection to identify major hazards on communities.
        iii. Identify matrix, that help identify what issues address first.
    b) To integrate project adaptation with operation support, transportation, etc.
        i. We have to do background, monitoring and a lot of different studies that will make the project adaptable.
        ii. No land use change.
- Stormwater designs from Alberta Environment and Protected Areas
    a) They create maps to identify floodings and areas at risk.
    b) The South part of the city is more resilient to flooding.
- Artificial Turfs from the City of Calgary

a) Quantify things such as vegetation, drought scenarios that affect vegetation and real data will help to provide solutions.
b) Parkland golf takes a lot of water and in Calgary nobody measures because it's not treated water, it comes right from the Bow.
c) The water usage of a golf course is substantial, but the impacts and problems caused with the use of turf outweighs the concerns of water usage.
d) All golf courses should be reporting the use of water to the government.
e) CoC research what is best for use in golf courses: turf or no turf, based on application, temperature, run-off, etc.
f) Can determine what communities have vegetation that is low-water tolerant and offer turf removal if appropriate.

- Nose Creek Watershed Partnership – the adaptation plan based on the Nose Creek Watershed Management Plan
    a) Involving all communities within the Nose Creek watershed to help ensure that developers don't just "shop around" for easier options regarding stormwater management, outside the Nose Creek basin.
    b) This levels the "playing field" between municipalities.
    c) This sets water flow control rates for the watershed.
- City of Calgary – infrastructure upgrades to mitigate the impacts to community drainage
  Calgary River Valleys – riparian restoration projects
    a) To remove some non-native vegetation adjacent to rivers & creeks in Calgary and replace them with native species that are adapted to thrive in a riparian zone.
    b) Restoration projects also have an educational component, to encourage other river-adjacent landowners to also restore their own river-adjacent properties to a higher level of riparian function.
    c) Helps reduce erosion from high water events (due to the long root systems of this type of native vegetation), among other benefits.

Issues Encountered & Lessons Learned

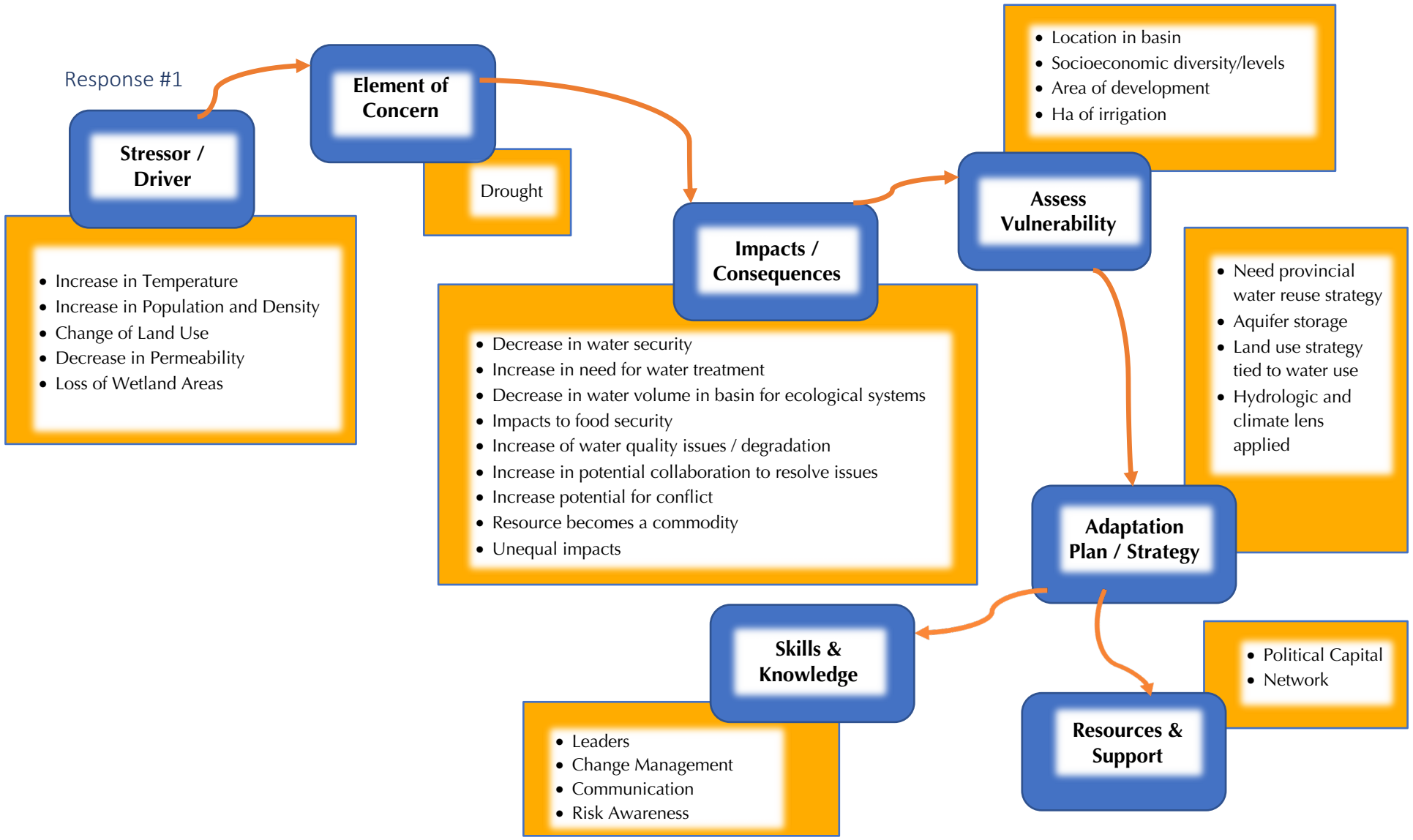
- How do the current regulatory frameworks calculate credits/payments on constructed wetlands where there may have been smaller wetlands in place previously?
- How do leaders and innovators receive compensation for innovations, or on the other side of the coin how do we remove barriers to innovate?
- YYC - adaptation resistance - unknown and unproven tools, things that are new
- Costing biological value (natural asset evaluation)
- Low certainty in new things/strategies/tools
- Capacity building - what do we need to teach/mentor - understanding and communication risk
- Holistic approach is needed
- Public interest, level of acceptance to change
- Getting all components of land planning/management, implementation working together

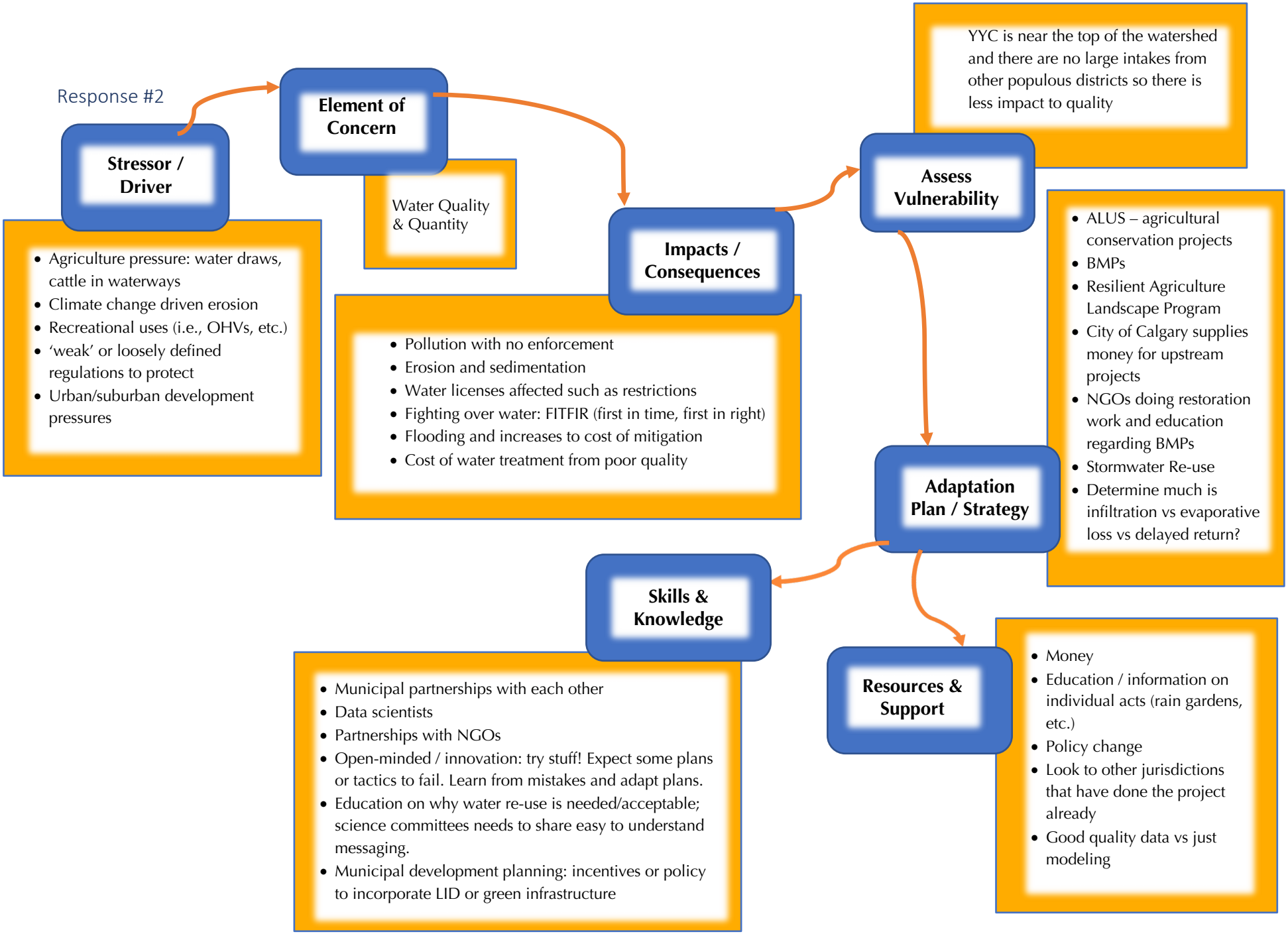
- Institutional/municipal training and acceptance to try new tools (i.e., new wetland designs may need different maintenance protocols and tools and training for staff)
- Initial cost may be higher to implement climate adaptation measures compared to status quo
- Space to work with has an impact on whether adaptation will work (i.e., density of urban vs rural)
- Mardaloop project - population is worried about nature and natural spaces
- Insurance issues:
    a) Difficult to determine when to get insurance as climate change and impacts present almost a 'chicken and egg' dilemma
    b) Landowners recognize the need for insurance but insurance is expensive so they can't often afford it
    c) Determining what type of insurance is appropriate and does it pay for damage resulting from climate change such as flooding?
    d) For small NGOs that want to do Climate Adaptation projects – the requirement to have a high-level coverage of insurance ($2 Million to $5 Million in coverage) is a barrier, as they often can't afford it

Breakout Session #2: Building Adaptive Capacity in the Basin

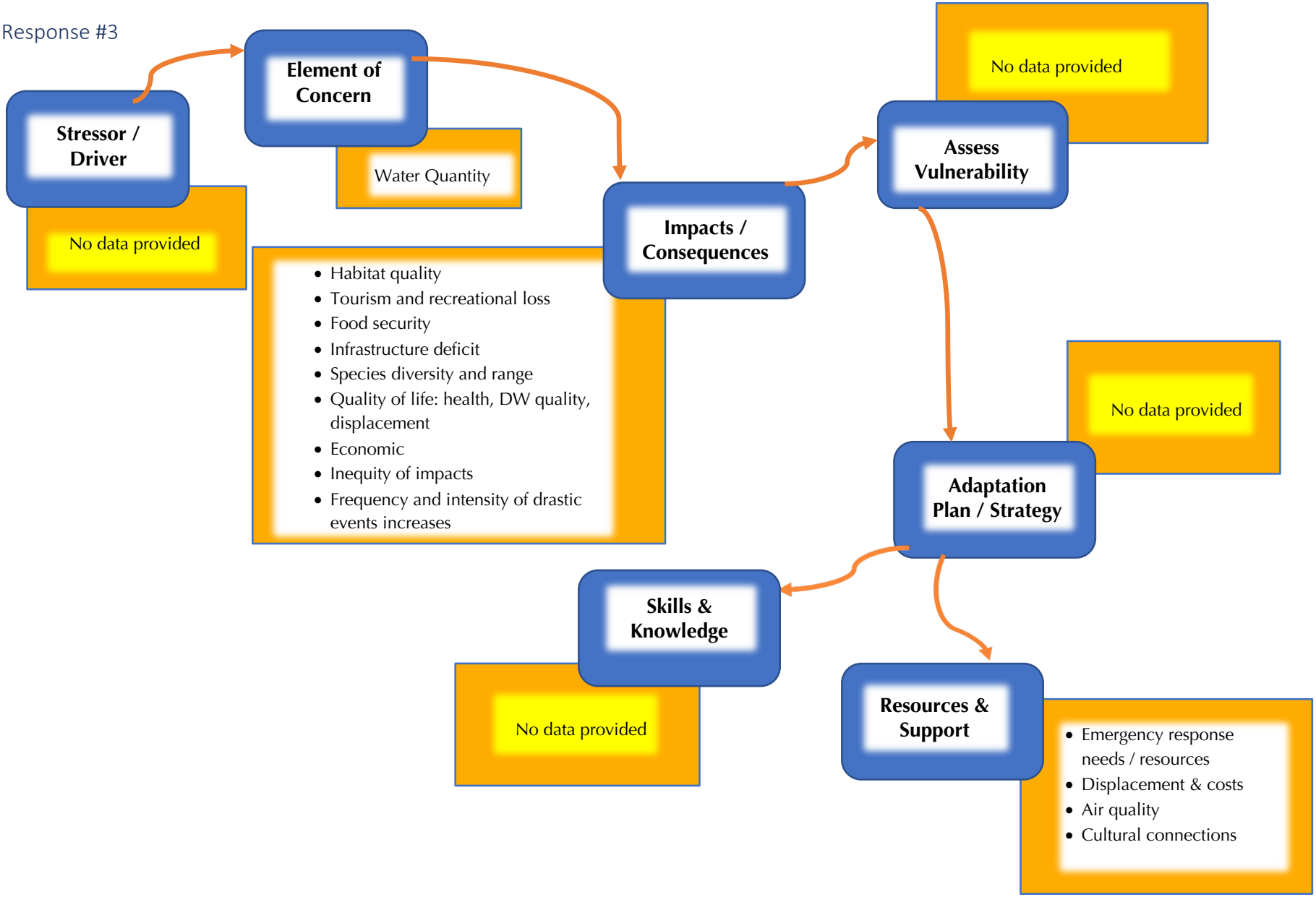
To effectively plan a climate adaptation strategy, numerous elements need to be considered. While an impact may be the initial indication of an issue, it is crucial to examine the interconnected factors that contributed to that effect. Climate change presents a circular dilemma, making it challenging to establish a framework for adaptation planning. Only after analyzing fundamental data and features can strategies and implementation be devised.

The objective of this breakout session was to foster community collaboration and generate ideas for building adaptive capacity in the basin. Participants were first prompted to identify an environmental or biological element in the BRB believed to be affected by climate change. They then proposed plausible climate driver(s), the associated risks and impacts, and estimated the element's vulnerability. To preserve and protect the identified element, groups were then asked to devise simple adaptation strategies. Additionally, they were asked to formulate an inventory of resources and supports for plan implementation and identify some of the skills and knowledge required for success. This succinct exercise provided attendees with an opportunity to see the utility of a basic climate adaptation framework for planning projects, while it simultaneously fostered discussion.

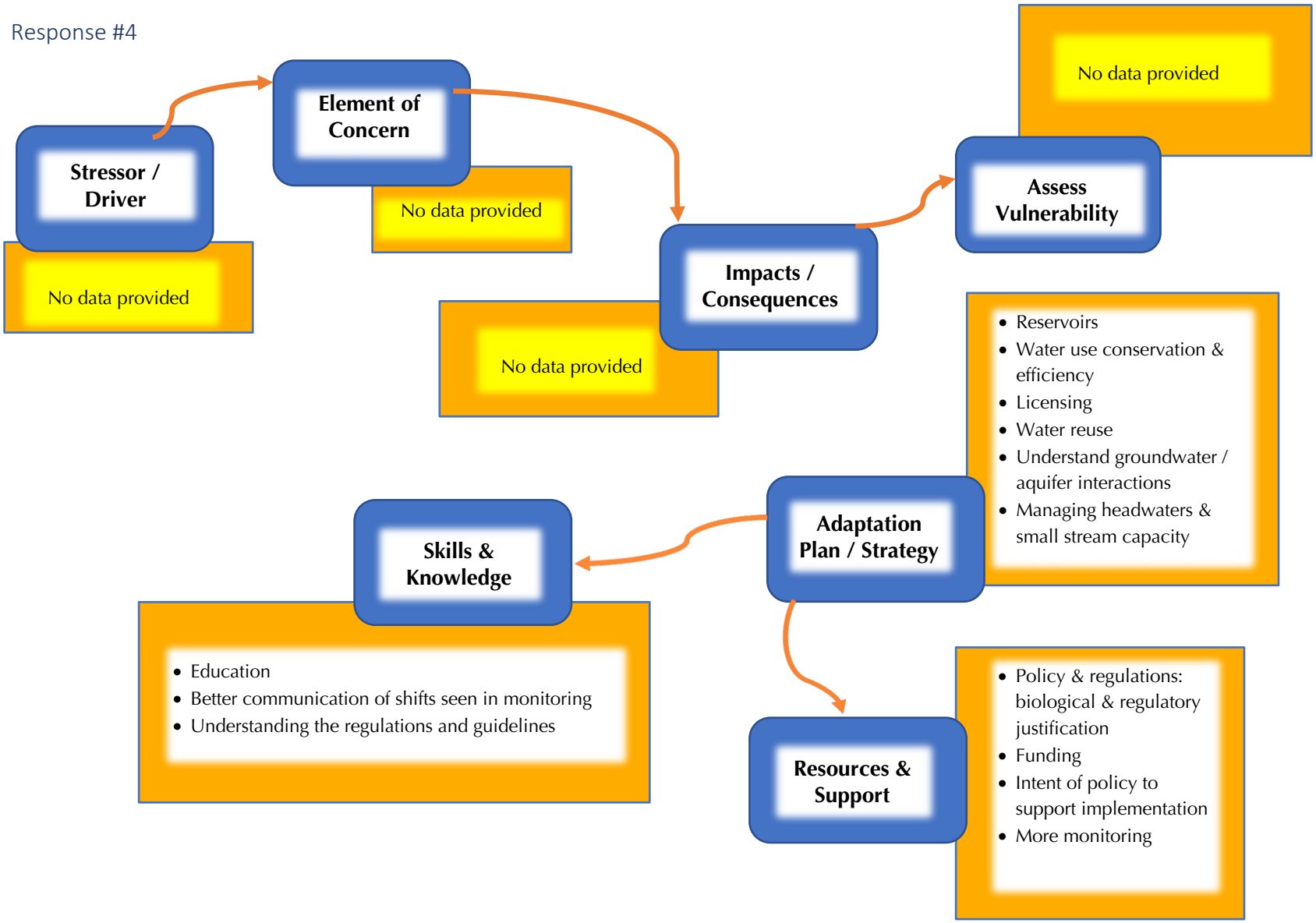

Response #1
Stressor / Driver
Increase in Temperature
Increase in Population and Density
Change of Land Use
Decrease in Permeability
Loss of Wetland Areas
Element of Concern
Drought
Impacts / Consequences
Decrease in water security
Increase in need for water treatment
Decrease in water volume in basin for ecological systems
Impacts to food security
Increase of water quality issues / degradation
Increase in potential collaboration to resolve issues
Increase potential for conflict
Resource becomes a commodity
Unequal impacts
Assess Vulnerability
Location in basin
Socioeconomic diversity/levels
Area of development
Ha of irrigation
Adaptation Plan / Strategy
Need provincial water reuse strategy
Aquifer storage
Land use strategy tied to water use
Hydrologic and climate lens applied
Skills & Knowledge
Leaders
Change Management
Communication
Risk Awareness
Resources & Support
Political Capital
Network


Response #2
Stressor / Driver
Element of Concern
Water Quality & Quantity
Impacts / Consequences
Assess Vulnerability
Adaptation Plan / Strategy
Skills & Knowledge
Resources & Support
YYC is near the top of the watershed and there are no large intakes from other populous districts so there is less impact to quality
• Agriculture pressure: water draws, cattle in waterways
• Climate change driven erosion
• Recreational uses (i.e., OHVs, etc.)
• 'weak' or loosely defined regulations to protect
• Urban/suburban development pressures
• Pollution with no enforcement
• Erosion and sedimentation
• Water licenses affected such as restrictions
• Fighting over water: FITFIR (first in time, first in right)
• Flooding and increases to cost of mitigation
• Cost of water treatment from poor quality
• ALUS – agricultural conservation projects
• BMPs
• Resilient Agriculture Landscape Program
• City of Calgary supplies money for upstream projects
• NGOs doing restoration work and education regarding BMPs
• Stormwater Re-use
• Determine much is infiltration vs evaporative loss vs delayed return?
• Municipal partnerships with each other
• Data scientists
• Partnerships with NGOs
• Open-minded / innovation: try stuff! Expect some plans or tactics to fail. Learn from mistakes and adapt plans.
• Education on why water re-use is needed/acceptable; science committees needs to share easy to understand messaging.
• Municipal development planning: incentives or policy to incorporate LID or green infrastructure
• Money
• Education / information on individual acts (rain gardens, etc.)
• Policy change
• Look to other jurisdictions that have done the project already
• Good quality data vs just modeling

Response #3


Element of Concern
Water Quantity
Stressor / Driver
No data provided
Impacts / Consequences
Habitat quality
Tourism and recreational loss
Food security
Infrastructure deficit
Species diversity and range
Quality of life: health, DW quality, displacement
Economic
Inequity of impacts
Frequency and intensity of drastic events increases
Assess Vulnerability
No data provided
Adaptation Plan / Strategy
No data provided
Skills & Knowledge
No data provided
Resources & Support
Emergency response needs / resources
Displacement & costs
Air quality
Cultural connections

Response #4


Stressor / Driver
No data provided
Element of Concern
No data provided
Impacts / Consequences
No data provided
Assess Vulnerability
No data provided
Adaptation Plan / Strategy
Reservoirs
Water use conservation & efficiency
Licensing
Water reuse
Understand groundwater / aquifer interactions
Managing headwaters & small stream capacity
Skills & Knowledge
Education
Better communication of shifts seen in monitoring
Understanding the regulations and guidelines
Resources & Support
Policy & regulations: biological & regulatory justification
Funding
Intent of policy to support implementation
More monitoring

Notes

During the second breakout session, most of the conversation was recorded by a facilitator on posterboard. However, like the first breakout session several conversations were occurring at once. The notetakers captured some of these details. Again however, due to the multifaceted and diverse nature of the conversations, the notes lack seamless continuity.

Discussion #1

The concern of drought caused by climate change was discussed and recorded by the facilitator and notetaker. Drought causes the temperature to increase, results in hard and dry landscapes, and impacts groundwater. Tipping points get harder to avoid (i.e., ecosystem pressures, fish, DO, Water Quality). Drought can result in legal fights over water signifying that agreements must be in place between users. These need to be equitable: there need to consider socio-economic diversity and rights and access to the basin. Agriculture changes will result from drought so there may be a need for a land use strategy that brings all users together and gains agreement of strategies. Change Management Specialists may be a good fit for mediating and resolving some of these issues.

Discussion #2

Mixed list of concerns and impacts:

- Water quality
- Water quantity
- Habitat quality
- Species diversity and range
- Frequency and intensity of drastic non-natural events
- Displacement and cost
- Air quality
- Health impacts
- Drinking water
- Recreation loss opportunities and tourism
- Quality of life
- Infrastructure deficit
- Agriculture and food security
- Cultural/Spiritual connections
- Cost of new reservoir for drinking water (Bow Reservoir)
- Emergency-Response/ needs
- Inequity of impacts

Discussion #3

Concern around water use was discussed with regards to the building of a Bow reservoir. The investment needs for this project are substantial. Animal agriculture uses vast amounts of basin water. To meet water quantity needs should we consider using more groundwater? That way we do not impact the volume and flow of the river as much. Changing Ag practices is a sensitive subject. We need to take a wide-lens view to see where we can make a concerted effort in conserving water. This includes placing more value on educating the community and educators on water conservation. There is no one-single solution; we have to try to find the best fit for each context. Polices and regulations are required to improve water conservation, and this information must be shared with the community to improve their behaviors. Lastly, the community needs to understand the data and trends from modeling and be kept up to date.

Annex

Itinerary

Bow River Basin Climate Change Workshop: Adaptation in the Watershed

Friday April 14th, 2023

Bow River Rooms, City of Calgary Water Centre

Agenda

When	Presenter	Details
8:30 – 9:00	Coffee and Networking	
9:00 – 9:15	Steve Meadows (event moderator) & Alesia Cameron, BRBC	Welcome/goals of the workshop/overview of the day/ guest introductions
9:15 – 9:45	Harris Switzman, GM of Environment and Sustainability at the Calgary Airport Authority	Climate change in the basin and why is adaptation important in addressing the associated risks and impacts.
9:45 – 10:15	Dr. Judy Stewart (Recorded)	Climate change legislation and policies relevant to the basin and ideas for revisions and additions.
10:15 – 10:30	15-minute Coffee Break	
10:30 – 11:15	Angela Ten, Junior Biologist with Trout Unlimited Canada	An overview of nature-based adaptation project(s) implemented by Trout Unlimited Canada in the basin that includes metrics of success, achievements, and lessons learned.
11:15 – 11:40	Breakout Session #1: Adaptation projects in the basin	
11:40 – 12:10	Liliana Bozic, Senior Water Resources Engineer with Urban Systems Ltd.	The role of adaptive water management in the face of risks and impacts caused by climate change. Challenges and opportunities that exist in implementing adaptive projects.
12:10– 12:50	Lunch, provided by BRBC. Note that lunch is 40 minutes.	
12:50 – 1:20	Jill Curley, Professional Biologist and Corporate Environmental Specialist with the City of Calgary	Resources and support offered by the City of Calgary to support climate change adaptive work in the basin and an introduction to the Natural Asset Inventory.
1:20 – 1:45	Breakout Session #2: Building Adaptive Capacity	
1:45 – 2:00	Alesia Cameron	Final Questions, Comments & Wrap Up

Bow River Basin Council

Presenter Bios

- Harris Switzman, M.A.Sc.

Harris is the General Manager of Environment and Sustainability for the Calgary Airport Authority and a proud volunteer with the BRBC Science Committee. He has worked on climate change adaptation and resiliency in a variety of contexts, including the Bow River Basin, for the last 15 years and joined YYC in 2018. He is currently the chair of the Calgary Climate Panel, a Board member with the Climate Risk Institute, vice-chair of the Canadian Airports Council Environment Committee and an environmental geoscientist by training.

- Dr. Judy Stewart

Judy Stewart is a retired lawyer. She volunteered a lot. BRBC is her favourite NGO. She loves to talk. Hopefully, you enjoy this one.

- Angela Ten, B.Sc.

Angela Ten is a biologist with Trout Unlimited Canada, based in Calgary. She is not an angler, but against all odds, came to love the world of fisheries anyway. She works on aquatic habitat rehabilitation projects throughout the Eastern Slopes of Alberta and is especially interested in projects involving non-sport fish. At home, Angela keeps several aquariums and terrariums.

- Liliana Bozic, M.Sc., P.Eng.

Liliana is a stormwater engineer with close to 30 years of experience and a background in both public and private sector. As a strategic services engineer with the City of Calgary, she was responsible for the development of 2005 stormwater strategy, watershed planning, and low-impact development initiatives. Since moving to private sector consulting, she has worked with municipalities on the development of drainage strategies and policies, watershed protection and integrated stormwater management planning.

- Jillian Curley, P.Biol.

Jill Curley has been an Adaptation Specialist within Climate and Environment at the City of Calgary for the past four years. Her background includes a B.Sc. in Environmental Science and a certificate in Applied Land Use Planning. She currently guides the natural infrastructure program, as directed in the Calgary Climate Strategy, to champion the use and protection of natural infrastructure for climate adaptation. Jill is a Professional Biologist, a current Director with the Alberta Low Impact Development Partnership, as well as a member of the Calgary Biodiversity Advisory Committee to support our climate and environmental resilience in the urban environment. After seven years in the environmental consulting industry developing a base in environmental assessment, regulatory approvals, and project management there came a chance to shift directions. A transition to municipal work six years ago provided an opportunity to develop the stormwater program in a small municipality, working closely with operations, engineering, and planning to guide stormwater management. This led to the opportunity to join Calgary Climate Team as it began implementation of the 2018 Calgary Climate Resilience Strategy and developed the current 2022 Strategy and Adaptation Plan.

Workshop Rationale

Presentations

When undertaking an assessment of a watershed, it's important to consider the intended function or utility of the SOW report. According to the Handbook for State of the Watershed Reporting: A Guide for Developing State of the Watershed Reports in Alberta, published by the Government of Alberta in alignment with the Water for Life Strategy, a SOW report can be used for multiple purposes. These include:

- providing background information for future watershed planning,
- addressing regulatory concerns,
- identifying sensitive areas and threats,
- highlighting information gaps,
- informing restoration initiatives, and
- monitoring progress and effectiveness.

Given the versatile purposes of the SOW report it was determined that the workshop would provide a broad perspective on climate adaptation in the BRB and would include a diverse audience. The presentations mirrored the list of uses that a SOW report can serve. They included:

- Climate Adaptation in the Bow River Basin,
- Legislation and Policies for Mitigation and Adaptation in the Bow Watershed,
- Beaver Dam Analogues as nature-based restoration solutions,
- Implementing Resilient Practices, and
- Valuing our Natural Assets for Climate Adaptation.

Breakout Session #1: Adaptation Projects in the Basin

Climate adaptation encompasses a wide range of strategies and actions specifically designed to address the unique needs, characteristics, and challenges of a particular environment. It is context-specific but applicable to many different situations.

To gain a better understanding of adaptation projects in the basin, it is valuable to gather basic project details from the attendees. These details will be compiled into a table, allowing participants to see information about other projects. This compilation will provide an overview of the ongoing activities across different sub-basins and offer insights into their purposes. Some of these project details may be incorporated into the SOW report. Moreover, starting the breakout sessions with this simple exercise can enhance participant engagement and inspire them to initiate their own adaptation projects.

Tracking indicators is crucial for measuring the success and progress of a project. These indicators are monitored, measured, and evaluated to serve as metrics of success (or failure). By requesting attendees to provide information on these indicators, they will be prompted to carefully consider their choices and the significance of these metrics in adaptation work. This exercise allows for a deeper understanding of the connection between the purpose of the project and the desired outcomes, ultimately helping to define

climate change indicators for the SOW report. Furthermore, by exploring their achievements and lessons learned, valuable insights can be gained to inform the design of future adaptation projects.

Breakout Session #2: Building Adaptive Capacity in the Basin

During the second breakout session, the focus will be on strengthening the adaptive capacity of the BRB community to address climate change. Adaptive capacity is influenced by internal system characteristics and external factors. While there are generalized frameworks to describe and assess adaptive capacity, there is no universal set of indicators for measurement; there's no one-size-fits-all approach. Therefore, indicators need to be identified and tailored for each specific project or vulnerability assessment. Measuring the adaptive capacity of communities is challenging due to its variability. To guide the session, a flexible framework will be used that helps address challenges in different situations. This provides a structured approach and facilitates decision-making. Some guiding questions to assist in designing the framework include understanding the nature of the system or population being assessed, identifying the principal hazards faced by the system or population, determining the impacts of these hazards and the vulnerabilities of specific elements or groups, and exploring measures to reduce vulnerability and the factors influencing their implementation.

During the session, participants will share project details through use of the framework. These insights will contribute to our understanding of adaptive capacity in the BRB. By compiling this information, we can gain a comprehensive view of the basin's adaptive capacity. Applying the framework will ensure consistency and efficiency in our approach. It will also help identify the basin's needs, such as resources, skills, policies, and funding.

Breakout Session Worksheets

Instructions

Breakout Session #1

1. Fill in the worksheet called PART A. The main goal of this step is to gather as much information from attendees about adaptation work that has been done in the Bow basin. You will need one sheet per project. If you have never done a project, please join a person or group that is filling out the worksheet. There are guiding worksheets to help you answer the questions.

2. For PART B there are 3 worksheets with the titles 'Achievements, Lessons Learned and Metrics of Success' that are for the entire group to fill out. Think about projects that you have implemented or have seen done before in the basin. Place your coloured dot next to the possible matching option(s), add your name, and a comment next to the dot to be specific. Ideally, you will consider the project that you shared in part A, but it is not necessary. Feel free to brainstorm ideas. You can add other ideas below this list or to the back of this sheet.

Breakout Session #2

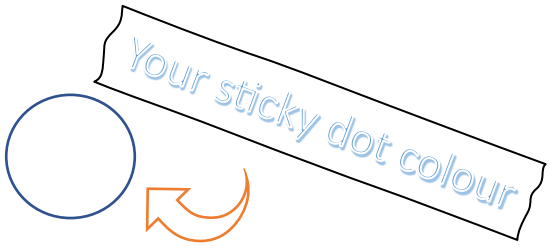
The objective of this breakout session is for the community to collaborate on ideas on what can build adaptive capacity in the basin. Ultimately, the goal is to address the last 3 questions posed and be fairly quick in answering the first 4.

First, look at one environmental or biological aspect from the basin that is or will be impacted by climate change. Go through the steps with that in mind. Some steps can have many answers so you may want to respond to the exercise with a mind map. Try to stay on task without getting too lost in the details. This isn't about creating large mind maps but rather collaborating on what adaptation plans might be, and what resources and skills are needed to effectively implement these projects.

Fill in Worksheets

Breakout Session #1

Sharing Adaptation Projects



PART A

Please answer these questions to the best of your ability. The projects can be past or current.

Name and/or Organization:

Project Title (be descriptive and/or creative):

Why is the adaptation project being done? What is the purpose? Is it due to vulnerable populations or aspects, risks, impacts, or is it mandated? *See Adaption Plan and Climate Change Impacts*

Who is involved? *Name the group, government, industry, academia/research, and any partnership involved. Which organizations or agencies were needed to approve the project or get the project going?*

When is it being done?

What is the adaptation plan? Does it follow a framework? How was the project carried out?

Where is the project located? *Locate on the map with your sticky dot (matching colour) and print your name beside it*

Breakout Session #1

Use your sticky dot colour

PART B

Place your coloured dot next to the matching option(s), add your name and a comment next to the dot to be specific or add other ideas below and to the back of this sheet.

ACHIEVEMENTS

Water quality

Aquatic ecosystem health & biodiversity

Hydrological processes (streamflow, groundwater recharge, and sediment transport)

Land-use changes (deforestation, urbanization, & agriculture)

Engagement

Economic benefits

Flood management

Drought management

Long-term sustainability

Breakout Session #1

Use your sticky dot colour

PART B

Place your coloured dot next to the matching option(s), add your name and a comment next to the dot to be specific or add other ideas below and to the back of this sheet.

LESSONS LEARNED

Uncertainty

Limited resources

Competing demands

Limited engagement

Lack of knowledge & awareness

Barriers – regulatory

Barriers – physical

Breakout Session #1

Use your sticky dot colour

PART B

Place your coloured dot next to the matching option(s), add your name and a comment next to the dot to be specific or add other ideas below and to the back of this sheet.

METRICS OF SUCCESS

Water quality – indicators

Aquatic ecosystem health & biodiversity

Hydrological processes (streamflow, groundwater recharge, and sediment transport)

Land-use changes (deforestation, urbanization, & agriculture)

Engagement

Economic benefits

Climate resilience

Long-term sustainability

Breakout Session #2

Brainstorming for Building Adaptive Capacity

As a group, you are encouraged to discuss concepts around adaptive capacity, to share your perspective and brainstorm ideas. This is all about collaboration so that everyone can add input, and everyone learns something new. Try to be specific and answer the following, either in a stepwise manner or as a mind map. See the Guiding Worksheets for support.

1. Within the Bow basin, identify the environmental or biological aspect of concern (i.e., fish health, riparian habitat)
2. Identify the potential watershed stressors / drivers (i.e., excess nutrients, flooding)
3. Determine the potential impacts / consequences
4. Assess vulnerability (think of this as a function of exposure and sensitivity). Vulnerability is a central concept to adaptation. Vulnerability to climate change is the "degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes" (IPCC, 2001). Rate as severe (s), moderate (m), or low (l) and write this word next to the answer in step 3.
5. Determine an appropriate adaptation project / plan (keep it brief)
6. What resources and support are required to help this project?
7. What skills and knowledge are required to do this project?

Breakout Session Guidance

Index of Ideas and Guideposts for Attendees During Breakout Sessions

Key Challenges

- Uncertainty
- Limited resources
- Competing demands
- Limited engagement
- Lack of knowledge & awareness
- Barriers – regulatory
- Barriers – physical

Adaptation Strategies

- Improve water storage & distribution
- Enhance water-use efficiency
- Implement nature-based solutions
- Land-use management
- Ecosystem restoration & conservation
- Engagement & education
- Disaster preparedness & response

Metrics of Success

- Water quality – indicators
- Aquatic ecosystem health & biodiversity
- Hydrological processes (streamflow, groundwater recharge, and sediment transport)
- Land-use changes (deforestation, urbanization, & agriculture)
- Engagement (government)
- Economic benefits
- Climate Resilience (Flood & Drought)

Watershed Stressors/Drivers

- Land use change
- Climate change
- Water withdrawals
- Nutrient overload
- Pollution
- Natural disasters

Climate Change Impacts

- Water quantity
- Water quality
- Aquatic ecosystems
- Increase of wildfire
- Agricultural Production
- Infrastructure Damage
- Public Health

Vulnerabilities & Risks

- Identify the watershed boundaries
- Identify the potential stressors
- Assess vulnerability
- Determine the potential consequences
- Quantify the risk
- Prioritize management actions

Resources & Support

- Financial
- Technical
- Data & Information
- Institutional (Regulatory) Support
- Community member Engagement
- Capacity Building (training & education)
- Monitoring & Evaluation

Knowledge & Skills

- Climate Science
- Water management
- Ecosystems management
- Risk assessment
- Adaptive planning
- Collaboration & communication
- Technology & innovation

Expanded List of Important Adaptation Aspects

Key Challenges

- Uncertainty: Climate change impacts can be uncertain and difficult to predict, making it challenging to plan and implement effective adaptation measures.
- Limited Resources: Limited financial and technical resources can hinder the ability of communities and governments to implement effective adaptation measures.
- Competing Demands: There may be competing demands for the use of resources in a watershed, such as agriculture, industry, and recreation. This can make it difficult to prioritize adaptation measures and implement them effectively.
- Limited Community member Engagement: Lack of community member engagement and collaboration can lead to insufficient buy-in for adaptation measures and result in ineffective or unsustainable solutions.
- Lack of Knowledge and Awareness: Lack of knowledge and awareness about climate change and its impacts can prevent communities from taking action to adapt. Education and awareness-raising initiatives are necessary to promote effective adaptation measures.
- Regulatory and Institutional Barriers: Regulatory and institutional barriers, such as outdated policies and laws, can hinder the implementation of effective adaptation measures.
- Physical and Natural Barriers: Physical and natural barriers, such as topography and land use, can limit the range of adaptation options available in a watershed.

Adaptation Strategies

- Improve water storage and distribution: Climate change is expected to cause increased variability in water availability, so improving water storage and distribution infrastructure can help to ensure that water is available during periods of low precipitation.
- Enhance water-use efficiency: Improving water-use efficiency can help to reduce the amount of water needed for agriculture, industry, and households. This could include investing in more efficient irrigation systems for agriculture, implementing water conservation measures in urban areas, and exploring new technologies for water treatment and recycling.
- Implement nature-based solutions: Nature-based solutions, such as restoring wetlands, planting trees, and creating green infrastructure, can help to increase the resilience of watersheds to climate change by reducing the impacts of extreme weather events and improving water quality.
- Ecosystem restoration and conservation: To help aquatic ecosystems adapt to changing conditions, it may be necessary to restore degraded habitats and protect critical areas of biodiversity. This could involve restoring riparian vegetation along the riverbanks, protecting wetlands and other important habitats, and implementing measures to reduce nutrient and sediment runoff.

- Land use planning and management: To help reduce the vulnerability of communities and ecosystems to climate change. Can include strategies, such as reducing urban sprawl, implementing zoning regulations to limit development in flood-prone areas, promoting sustainable land use practices like conservation tillage, protecting critical infrastructure from natural hazards, preserving wetlands and riparian zones, and implementing erosion control measures.
- Support community engagement, public education, and outreach: Educating and engaging the public is critical to building awareness and support for climate adaptation strategies. This can be achieved through education, public awareness campaigns, and community-based adaptation projects. Examples include promoting water conservation and efficiency measures, raising awareness about the impacts of climate change on ecosystems and public health, and encouraging community members to take action to reduce their carbon footprint.
- Disaster preparedness and response: Developing early warning systems for floods and other extreme weather events can help to reduce the impact of these events by giving people and communities more time to prepare and take action. This could include improving emergency response infrastructure and developing community evacuation plans.

Metrics of Success

Overall, metrics of success in watershed environments should be tailored to the specific goals and objectives and should be monitored regularly to ensure that efforts are effective in achieving their intended outcomes. Here are some commonly used metrics of success in watershed environments:

- Water quality: Water quality is a critical indicator of the health of a watershed, and metrics such as pH, nutrient levels, and fecal coliform counts are used to monitor water quality. Improvements in water quality are a key metric of success in watershed management. Water quality indicators can be algae, dissolved O2, *E. coli*, Nitrate, TSS, Total dissolved P, temperature.
- Aquatic ecosystem health & biodiversity: The health of aquatic ecosystems, including fish populations and habitat quality, is another important metric of success in watershed management. Monitoring of these metrics can help identify areas that require restoration or management actions. A healthy ecosystem will have a diverse array of plant and animal species. Monitoring the number and variety of species present can help assess the success of adaptation efforts.
- Hydrological processes: Hydrological processes such as streamflow, groundwater recharge, and sediment transport are essential for the health of watersheds. Monitoring these processes and identifying changes can help managers make informed decisions to protect and restore watershed functions.
- Land use changes: Land use changes, such as deforestation, urbanization, and agriculture, can have significant impacts on watersheds. Monitoring land use changes and identifying areas at risk can help managers take actions to protect the watershed.

- Community member engagement: Success in watershed management depends on effective community member engagement and collaboration. Metrics such as the number and types of community members engaged, the frequency of engagement, and the effectiveness of communication and outreach efforts can help assess the success of these efforts.
- Economic benefits: The economic benefits of watershed management activities, such as improved water quality and management, job creation, increased recreational opportunities or tourism, and increased property values, can also be used as a metric of success.
- Flood management: The plan includes objectives to reduce the risk of flooding in the Bow River watershed. Metrics of success in this area include the implementation of flood mitigation measures, such as flood mapping, floodplain zoning, and infrastructure improvements.
- Long-term sustainability: Watershed adaptation efforts should be designed to be sustainable over the long term. Measuring the sustainability of adaptation efforts, such as the ability to maintain infrastructure and funding over time, is an important metric for success.

Watershed Stressors/ Drivers

- Land use change: Human activities such as urbanization, deforestation, and agriculture can alter the natural landscape and disrupt the natural water cycle, leading to changes in water quality and quantity.
- Climate change: Changes in precipitation patterns, temperature, and extreme weather events can affect the water balance of a watershed, altering water availability and causing flooding and drought.
- Nutrient Overload: excessive amount of nutrients, such as nitrogen and phosphorus, that are introduced into a watershed from various sources, such as agricultural runoff, sewage treatment plants, and stormwater runoff. This can lead to eutrophication, a process in which excess nutrients cause an overgrowth of algae and other aquatic plants, which can harm water quality, aquatic habitats, and the health of fish and other aquatic organisms.
- Water withdrawals: The demand for water for human consumption, irrigation, and industrial uses can reduce the amount of water available in a watershed, affecting the health of aquatic ecosystems and the availability of water for other uses.
- Pollution: Point and non-point source pollution from urban and agricultural runoff, industrial discharge, and sewage can contaminate surface and groundwater resources, leading to water quality problems and potential health risks.
- Natural disasters: Natural disasters such as wildfires, floods, and landslides can have severe impacts on watersheds, causing erosion, sedimentation, and loss of habitat.

Climate Change Impacts

Overall, the Bow River Basin is vulnerable to a range of climate impacts that could have significant social, economic, and environmental consequences. Some of the potential climate impacts in the Bow River Basin are:

- Changes in water availability and quality: Climate change is expected to affect the timing and magnitude of water flows in the Bow River, which could impact water availability for human and

ecosystem use. Changes in temperature and precipitation could also affect water quality by altering nutrient levels and the amount of sediment in the river.

- Changes in aquatic ecosystems: Changes in water temperature and flow could impact the health and distribution of aquatic species in the Bow River. Warmer water temperatures could lead to increased stress and mortality for cold-water species like trout and salmon, while altered flow regimes could impact the spawning success of some species.
- Increased risk of wildfires: Drier conditions and more frequent heatwaves could increase the risk of wildfires in the Bow River Basin. Wildfires can have significant impacts on water quality, erosion, and aquatic ecosystems, as well as human health and safety.
- Changes in agricultural productivity: Changes in temperature and precipitation could impact agricultural productivity in the Bow River Basin. Warmer temperatures could lead to changes in the types of crops that can be grown, while changes in precipitation patterns could impact irrigation needs and water availability for crops.
- Infrastructure damage: Extreme weather events, such as floods and landslides, could damage infrastructure in the Bow River Basin, including roads, bridges, and buildings. This could impact transportation and communication networks, as well as access to emergency services.
- Public health impacts: Changes in temperature and precipitation could impact public health in the Bow River Basin by increasing the risk of heat-related illnesses and vector-borne diseases.

Vulnerability & Risks

Determining vulnerability and risk in the Bow watershed is a complex process that requires expertise in environmental science, hydrology, risk assessment, and application. It involves assessing the likelihood of negative impacts on the ecosystem and the people that depend on it. Here are some steps to follow:

1. Identify the watershed boundaries: The first step is to determine the geographic area that makes up the watershed. This can be done using topographic maps, satellite imagery, or GIS tools. Recognize that the watershed does not abide by these boundaries but it's a good place to start.
2. Identify the potential stressors: Identify the potential stressors that can impact the watershed, such as land use changes, pollution sources, or climate change.
3. Assess vulnerability: Determine the vulnerability of the watershed to the identified stressors by considering the physical characteristics of the watershed, such as topography, soil type, and hydrology.
4. Determine the potential consequences: Evaluate the potential consequences of the stressors on the ecosystem, water quality, and the people that depend on the watershed.
5. Quantify the risk: Quantify the risk by combining the vulnerability assessment with the potential consequences to determine the likelihood and severity of negative impacts.
6. Prioritize management actions: Prioritize management actions based on the level of risk and the ability to address the stressors.

Resources & Support

What resources or support do you need to effectively adapt to the impacts of climate change in the Bow River basin?

- Financial Resources: Adequate financial resources are required to fund adaptation projects, such as the construction of water infrastructure, the development of conservation plans, and the implementation of ecosystem-based adaptation strategies.
- Technical Support: Technical support, such as expertise in water management, climate science, and ecosystem management, is necessary to design and implement effective adaptation strategies.
- Data and Information: Access to data and information, such as climate projections, hydrological data, and ecosystem assessments, is necessary to inform adaptation planning and decision-making.
- Institutional Support: Strong institutional support, including government policies and regulations that support climate change adaptation, is necessary to create an enabling environment for adaptation.
- Community member Engagement: Engaging community members, including local communities, NGOs, and private sector actors, is necessary to ensure the relevance and effectiveness of adaptation strategies.
- Capacity Building: Investing in capacity building, including training and education programs for relevant community members, is necessary to develop the necessary knowledge and skills to effectively adapt to climate change impacts.
- Monitoring and Evaluation: Monitoring and evaluating adaptation measures are necessary to assess their effectiveness and inform adaptive management strategies.

These resources support highlight the need for a coordinated and collaborative approach to climate change adaptation in watersheds. Access to these resources and support can help build the necessary capacity to effectively adapt to the impacts of climate change in a watershed.

Knowledge & Skills

Developing and investing in capacity building programs that address knowledge and skills can help support effective adaptation measures. Who or what organization can offer these? What knowledge or skills do you feel are necessary to effectively adapt to the impacts of climate change in the Bow River basin?

- Climate Science: Understanding the science of climate change, including the impacts on weather patterns, water availability, and ecosystems, is necessary to inform effective adaptation strategies.

- Water Management: Knowledge of water management principles, including conservation, efficiency, and reuse, is essential to ensure the sustainable use and availability of water resources in the face of climate change impacts.
- Ecosystem Management: Understanding the functioning and value of natural ecosystems, including wetlands, forests, and rivers, is necessary to support their resilience and ability to adapt to changing conditions.
- Risk Assessment: Conducting risk assessments to identify potential climate change impacts and vulnerabilities is necessary to inform and prioritize adaptation strategies.
- Adaptive Planning: Developing and implementing adaptive planning strategies that can be adjusted as climate change impacts unfold is essential to effectively respond to changing conditions.
- Collaboration and Communication: Building effective partnerships and communication channels with community members, including government agencies, NGOs, and community members, is necessary to ensure coordinated and effective adaptation strategies.
- Technology and Innovation: Adopting innovative technologies, such as weather monitoring systems, irrigation technologies, and renewable energy systems, can help support effective adaptation to climate change impacts.