South Saskatchewan River Basin (SSRB) Adaptation to Climate Variability

Prairie Regional Adaptation Collaborative, Advancing Local Adaptation, Calgary

Mike Kelly

March 20, 2013
Presentation Outline

• What’s the value this project?

• The Bow River Project and the collaborative modeling process

• The SSRB Adaptation Project

• Next steps
The Bow River Basin

25,000 km$^2$ (9650 mi$^2$)
644 km long (400 miles)
1.4 million people
Why Now?

Water challenges require attention

- Loss of glacier storage (lower natural summer flow)
- Bow Basin closed to new water allocations
- Rapid population and recreational demand growth
- Low dissolved oxygen concerns in Calgary
- Periodic low flows downstream of Bassano
- Reach-dependent impacts on fisheries
- Growing global demand for irrigated agriculture production
- No system-wide approach to manage/mitigate drought/flood
- Lack of overarching regulatory or governance framework
- Concerns over impacts from climate variability & change
- Bow managed like a series of reaches, not as a system
Concern about our Water Supply is Understandable

Bow Glacier Recession Since 1898

1898 - Main Glacier - 2002

We must carefully manage the water we have
Historic and tree ring data indicate future flood/drought events could be far more severe than recent record.
The Bow is a Managed River

Bow River at Calgary - Natural vs. Managed Flows (38 years data)

It can be managed for environmental and economic benefits

Source: BRBC State of Watershed Plan
Participants hold 95% of Water Licensed for Use on the Bow System

Alberta Water Research Institute
Alberta WaterSMART
Bow River Basin Council
Bow River Irrigation District
Calgary Regional Partnership
City of Calgary
County of Newell
Ducks Unlimited Canada
Eastern Irrigation District
HydroLogics Inc.
Rocky View County
Trout Unlimited Canada
University of Lethbridge
Water and Environmental Hub
Western Irrigation District

Participation from: Alberta Environment; Sustainable Resource Development; Alberta Agriculture & Rural Development; Alberta Tourism, Parks & Recreation
Stakeholder Participation is Essential

• A collaborative process of involvement is essential for:
  • Common knowledge base
  • Defined objectives
  • Society-wide issues
  • Adaptation, not prevention
  • Shared costs
  • Public support
  • Credibility

Project participants:

• WPACs
• Municipal governments
• NGOs with water interests
• Irrigation districts
• Alberta Government
• Academia
• Technical experts
• Industry
The Collaborative Modelling Process

Computer Aided Negotiation, Computer Aided Dispute Resolution, Computer Modelling for Decision Support.... Many names, similar approaches

4 Steps:
1. Performance Measures
2. Build the model
3. Test the model and explore alternatives
4. Reaching consensus and implementation
Bow River Operational Model (BROM)
Project Created Four Alternate Scenarios

**Scenario 1**
Stabilized Lower Kananaskis Lake and Kananaskis River

**Scenario 2**
Stabilized Kananaskis + “Water Bank” at 40,000 af

**Scenario 3**
Stabilized Kananaskis + “Water Bank” at 60,000 af

**Scenario 4**
Stabilized Kananaskis + Water Bank at 60,000 af + Increasing Spray by 61,000 af

*current preferred scenario*

Hundreds of options and dozens of other scenarios were tested using BROM
Improvement of Environmental Flows below Bassano

Performance Measure Results (PMs)

Current Operations Base Case
Scenario 1: Stabilized Lower Kananaskis Lake and Kananaskis River
Scenario 2: Water Bank at 40,000 af
Scenario 3: Water Bank at 60,000 af
Scenario 4: Integrated Scenario

Number of days across entire record

(1200 cfs - 800 cfs)  (800 cfs - 400 cfs)  <400 cfs  >=1200cfs (right y-axis)
If we manage the Bow River differently, collaboratively, we can have:

- Protection of water sources for economic and municipal growth (50 years+)
- Healthier in-stream aquatic systems, fisheries and riparian zones
- Sufficient water for irrigation needs and expansion (retain water access)
- Renewal of Kananaskis tourism, recreation & aquatic ecosystems
- Achievement of the Water for Life Goals

The proposed changes can be implemented for relatively modest cost, and step-by-step over a reasonable period of time.

- Collaborative decisions among existing storage managers and users a prerequisite:
  Governance Matters!

Bow River at Canmore
The Simulation outperformed current operations and the preferred scenario, as shortages were drastically lowered in the Simulation operations.
SSRB Adaptation Project is Funded in Alberta

- Two year project ending Spring 2014
- Funded by the CCEMC
- Project budget is $1.6M (may be add-ons funded by others)
- Executed by Alberta Innovates Energy and Environment Solutions
- Engaging external experts and resources throughout
A collaborative project of southern Albertans to explore practical options for adapting to climate variability and change.

Water is fundamental to community sustainability and growth

How water is managed in the SSRB will become even more important in the face of changing weather patterns and climate

This project will develop new data from climate change models, historic/prehistoric data, PDO, build on and integrate existing data, tools, capacity and knowledge to:

- Improve our shared understanding of climate impacts and implications
- Explore options to manage for the range of potential impacts
- Support collaborative testing of adaptation responses
- Increase capacity for water resource management throughout the SSRB

Work will be conducted with Stakeholders, by Stakeholders
Next Steps (I)

Bow Basin

Highwood Basin

Oldman Basin

Red Deer Basin

South Saskatchewan Basin

Southern Tributaries

OASIS Schematic of the South Saskatchewan River Basin
27 May 2008
Build Out of the Full SSRB Model

Old SSRB model

CUT

UPGRADE

Enhance

Red Deer

BROM + Highwood/Sheep

Oldman + SSask + S.Tribs

INTEGRATE

Integrated SSRB model
Next Steps (II) GCM to RCM+Land Cover

Water management information and adaptation strategies
Choosing 5 of the 50 Climate Scenarios

- 9 Global Climate Models (GCMs) and 3 emission scenarios: A1B (moderate), A2 (high) and B1 (low)
- 50 climate scenarios (runs) in all: 15 A2, 17 A1B, 18 B1 = 50 scenarios of plausible future climates from 2025-2054 (30 years) = 1500 * 365 = 547,500 days with flow calculated for dozens of tributary inflows: narrowed to 5 scenarios

<table>
<thead>
<tr>
<th>Selection Criteria</th>
<th>Scenario Run (GCM, Run, Emission Scenario)</th>
<th>Scenario Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th Percentile Lowest Annual Average Flow</td>
<td>CGCM3T47_3A2</td>
<td>1yr Min</td>
</tr>
<tr>
<td>10th Percentile Lowest 2yr Consecutive Minimum Annual Flow</td>
<td>CGCM3T47_2B1</td>
<td>2yr Min</td>
</tr>
<tr>
<td>10th Percentile Lowest 3yr Consecutive Minimum Annual Flow</td>
<td>CGCM3T47_3B1</td>
<td>3yr Min</td>
</tr>
<tr>
<td>Maximum of Annual Median Flow</td>
<td>MRI_5B1</td>
<td>1yr Median</td>
</tr>
<tr>
<td>Median of 2yr Consecutive Median Flow</td>
<td>CCSM3_1A2</td>
<td>2yr Median</td>
</tr>
</tbody>
</table>
5 Chosen Scenarios with Comparison of 2000-2001

Average Weekly Natural Flow below Bassano
TransAlta Storage (top) and Flows Below Bearspaw (bottom)
Shortages at Okotoks

Shortage at node 871 -- Okotoks (17)
CV_CB8.6_3yrMin

Date
03/07/46 05/06/46 07/05/46 09/03/46 11/02/46 01/01/47 03/02/47

Shortage (AF)
0 1.0 2.0 3.0 4.0 5.0 6.0 7.0

Shortage -- Demand -- Delivery
List of adaptation strategy ideas to be explored for the Bow River basin:

1. Restore Spray Reservoir capacity to original full supply level (FSL) - 60K af more storage
2. Build a new 50K af off-stream reservoir in the WID (Bruce Lake)
3. Divert municipal licences from Highwood/Sheep to Bow confluence (returns to H/S)
4. Raise the storage capacity between Travers and Little Bow by 20K af
5. Build new on-stream storage downstream of Bassano
6. Lower Calgary minimum flow to 900cfs for 90 days (Oct-Dec), triggered if <400,000 AF total storage on Oct 1, with management conditions
7. Lower Calgary minimum flow to 1000cfs
8. Changing rule (fill) curves for three largest TA reservoir to be full July 31st then hold flat until September
9. Increase winter carryover in Travers and McGregor Reservoirs
10. Review winter storage in all irrigation district reservoirs for various purposes
11. Institute a formal, commercial sharing agreement on water restrictions
12. Dam on Crowfoot Creek (east end of the WID system)
13. Change municipal diversions and/or returns to explore impact of water reuse measures
14. Others TBD...
In Summary

• Still to be done: Red Deer River, SSRB model integration, physically-based modelling, RCM analysis

• Collaborative, innovative work is the key to advancing integrated water management and can yield significant adaptation options

• Changes in weather, macro-weather, and climate even to match historic and pre-historic levels will present major challenges to water management, water users, and the Alberta public

• Challenges will provide opportunities for innovation and creativity for water management in Alberta

• So, no, Chicken Little, the sky may not be falling . . .

But it’s essential to prepare!
Water: The Key to Our Sustainable Future

For more information:
Alberta WaterPortal
www.albertawater.com

Alberta WaterSMART
www.albertawatersmart.com
Food yield changes to 2050

Source: Müller and others 2009.

14 January 2010

Steven E. Koonin, Under Secretary for Science, U.S. Department of Energy
Upstream Hydro Sites Enable Flow Changes
## Oldman & South Saskatchewan Modeling

### Draft Workplan

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kickoff meeting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSSK model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>development &amp; testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance Measure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>development &amp; testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunity exploration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(live modelling session)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate variability data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>development &amp; testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adaptation exploration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(live modelling session)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project completion &amp;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Kickoff meeting
- OSSK model development & testing
- Performance Measure development & testing
- Opportunity exploration (live modelling session)
- Climate variability data development & testing
- Adaptation exploration (live modelling session)
- Project completion & communication