St. Mary and Milk River Basins Study Update

Adapting to Changing Water Supplies in the St. Mary and Milk River Basins

WaterSMART Basin Study Program

The Montana Department of Natural Resources & Conservation

USGS science for a changing world

BUREAU OF RECLAMATION

Background, Purpose and Need

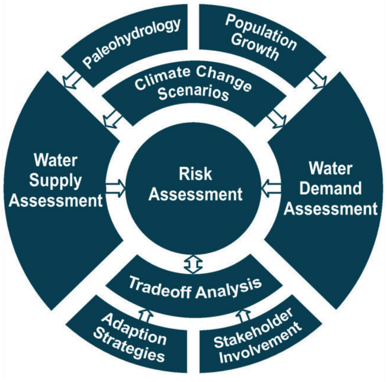

Fig. 1: Overview of the St. Mary and Milk Rivers Basin Study Update components.

Since 1922, the Milk River Project has delivered a reliable supply of water from the St. Mary River to the Milk River in support of agriculture, municipal uses, Tribal water rights, flood control, fish, wildlife, recreation and other needs. Sustaining the water supply and its benefits is critical to the many users and the ecology of the Milk River Basin.

In 2012, the Montana Department of Natural Resources & Conservation (DNRC) and the U.S. Bureau of Reclamation (Reclamation) launched a basin study to examine present and future needs and water availability in the St. Mary and Milk River Basins. The study analyzed water management operations and infrastructure under projected changes in water supplies and demands. The study also sought to quantify the impacts of climate change on these river basins.

This update to the 2012 study builds upon that foundation to evaluate water supply vulnerabilities and develop adaptation strategies that address changes in water supplies and demands for today and in the future. The study update offers a powerful modeling tool to analyze water availability and management throughout the St. Mary and Milk River Basins. The tool provides the ability to:

- Improve water management
- Improve drought planning and resiliency
- Evaluate the effects of climate change on future water supplies and demands

What is a Basin Study?

The Reclamation WaterSMART Basin Studies are collaborative studies cost-shared with non-Federal partners in the West where imbalances in supply and demand are occurring or projected to occur.

Key Findings

The range of projected climate change impacts is presented below. Projected impacts are compared to the 1980 to 2015 historical baseline period used for this study.

Projected Hydrological Effects from Climate Changes:

- Increased precipitation, temperature and runoff
- Increased temperature and precipitation variability
- Increased winter stream flows
- Shift to earlier spring runoff and reservoir peak storage
- Shift to earlier late season minimum reservoir storage
- Increased frequency and intensity of extreme events such as drought and flood

Projected Climate Change Impacts to Water Supply:

➡ Range of Percent Increase in Crop Demand

- 2020s: 15.8 - 18.8 %
- 2050s: 16.9 - 22.7%
- 2080s: 18.2 - 26.6%

➡ Range of Average Irrigation Shortages in Acre-Feet (AF)

- Historical = 80,000 AF
- 2020s: 80,000 - 100,000 AF
- 2050s: 85,000 - 117,000 AF
- 2080s: 89,000 - 139,000 AF

➡ Range of Percent Increase in Reservoir Evaporation

- 2020s: 7.2 - 10.6 %
- 2050s: 8.9 - 14.6%
- 2080s: 10.3 - 20.3%

Results are preliminary, subject to change during technical review.

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Study Area Description

The St. Mary and Milk River Basins are international watersheds that straddle the United States and Canadian border in Montana, Alberta and Saskatchewan. The Basin Study Update area includes the U.S. portion of the St. Mary River Basin and the entire Milk River basin. The U.S. portion of the St. Mary Basin drains about 490 square miles south of the Canadian border, while the Milk River basin encompasses 23,800 square miles in Montana, Alberta and Saskatchewan. St. Mary River water is conveyed via the St. Mary Canal to the North Fork Milk River. It then enters southern Alberta for 200 miles before re-entering Montana. The water is captured in Fresno Reservoir near Havre, Montana, where it is stored and released for downstream water users. A map of the Study area is provided in Figure 2.

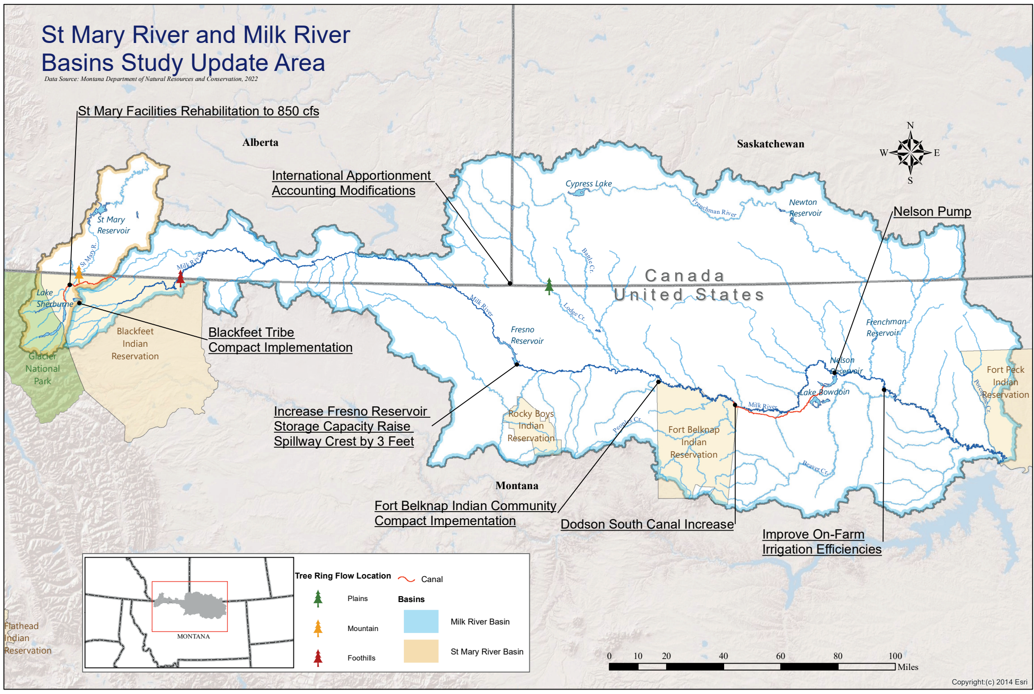

Fig. 2: *Map of the St. Mary and Milk River Basins study area.*

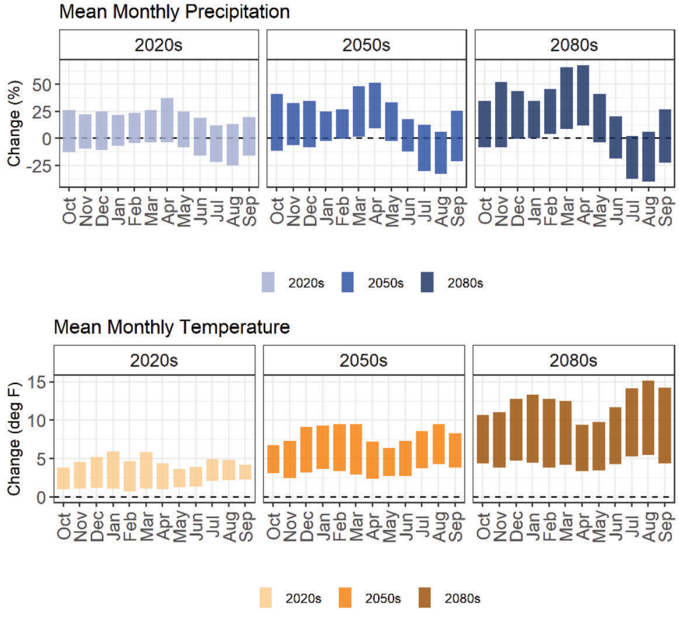

Fig. 3: *Projected changes in average monthly precipitation (%) and air temperature in degrees F° across the Study area.*

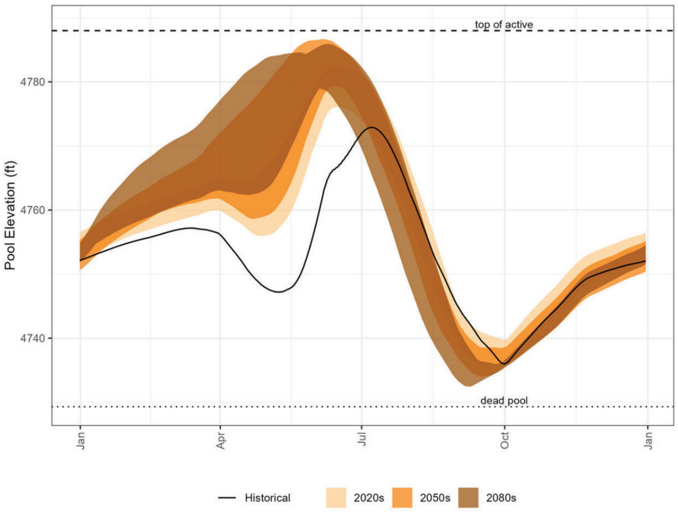

Fig. 4: *Average modeled daily historical and projected future pool elevation of Sherburne Reservoir. The figure illustrates the projected shift toward earlier peak and minimum storage into the future.*

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Adapting to Changing Water Supplies in the St. Mary and Milk River Basins

What is Climate Change

Climate change refers to long-term shifts in temperature, precipitation, and weather patterns. These shifts may occur naturally or in combination with changes driven by increasing greenhouse gas concentrations.

Adapting to Climate Change Impacts on the St. Mary and Milk River Basins Water Supply

Water Management Impacts

Warmer global temperatures contribute to an overall increase in atmospheric moisture and precipitation intensity. Modest increases and changes in precipitation timing are projected for the St. Mary and Milk River Basins (Fig. 3). Peak runoff and the wet season are expected to occur earlier followed by increasingly hotter, drier summer months affecting reservoir storage (Fig. 4). Snowpack is expected to decline while annual average stream flows are expected to increase in response to increased precipitation (Fig. 5). The impact of climate change for the study area is a net increase in water supply shortages due to increased reservoir evaporation and water demands from crops, pasture and other vegetation (Figs 6 –7). Projected increases in precipitation and temperature variability and the frequency of extreme events such as drought and flood will present additional water management challenges.

Adaptation Strategies

Building resiliency through informed planning and adaptive water management strategies is essential. The study analyzed six adaptation strategies:

1. 50 cubic feet per second (cfs) Nelson Pumping Plant: Pump Milk River water into Nelson Reservoir.
2. Change international apportionment accounting balance period from bi-weekly to annual.
3. Increase St. Mary Canal from 600 cfs to its original design capacity of 850 cfs.
4. Increase Fresno spillway crest by three feet.
5. Increase Dodson South Canal capacity from 500 cfs to 700 cfs.
6. Increase on farm efficiency by 17%.

Individually, these strategies provide minimal benefits, but in combination, they compliment one another to provide greater benefits.

Anticipated Tribal compact implementation for the Blackfeet and Fort Belknap Indian Community Tribes were recognized in the study, but not considered adaptation strategies. Compact areas are identified on the Map in Figure 2.

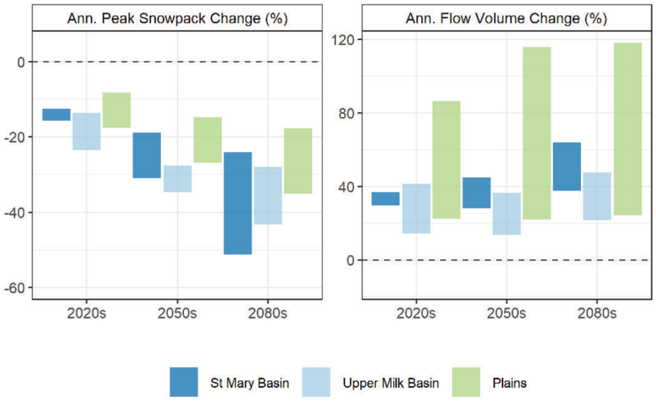


Fig. 5: *Range of projected changes in annual peak snowpack and annual flow volume in percent compared with historical baseline (1980-2015). Plains scenarios show a range of percent increase from 24% to more than double (120%) by the 2080s. Small changes in precipitation in the Plains may result in large changes in flow on a percentage basis. Additional seasonal analysis indicates projected increases in winter season flow and decreases in summer flow.*

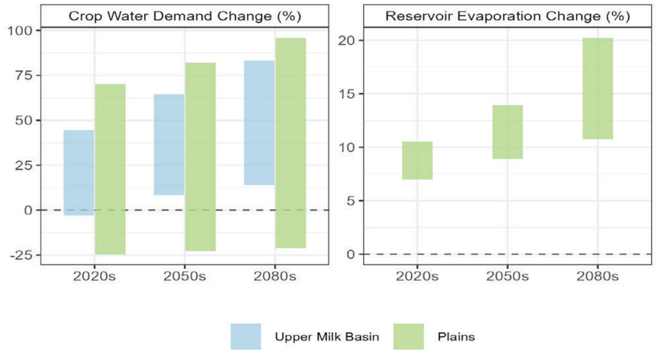


Fig. 6: *Range of projected changes in annual crop water demand and annual reservoir evaporation in percent for the 2020s, 2050s, and 2080s compared historical baseline (1980-2015). Crops will generally demand more water as temperatures continue to increase and the growing season becomes more arid. Evaporation will increase with rising temperatures.*

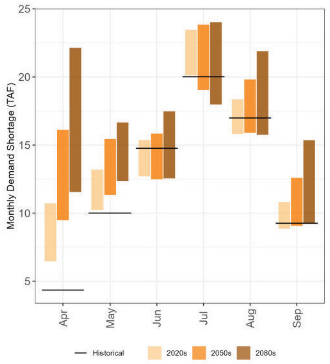


Fig. 7: *Range of projected demand shortages during the growing season across the study area for the 2020s, 2050s, and 2080s and for the baseline historical period. Projected increases in shortages in spring likely correspond with shifts toward earlier demand for water as temperatures increase and crop growth begins earlier.*

Results are preliminary, subject to change during technical review.

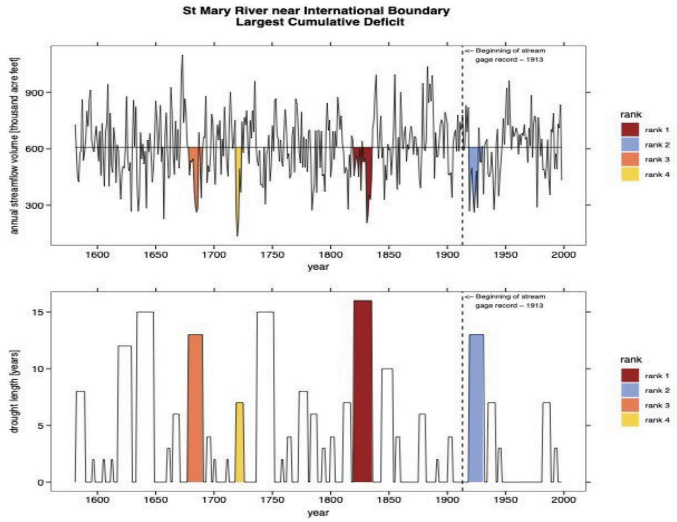
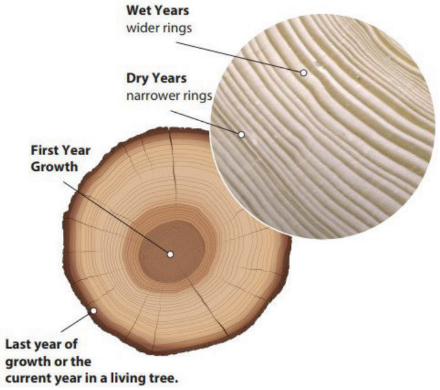


Fig. 8: *Paleo-reconstructed droughts for the St. Mary River. The top plot shows the accumulated volumetric deficit for the four largest droughts ranked by cumulative deficit. The bottom plot shows duration of the same droughts. Note that the 4th ranked drought (yellow), though significant in cumulative deficit, was relatively short compared to other droughts in the record. The second ranked drought (blue) represents the 1930s dust bowl drought.*

Site	Rank	Cumulative Deficit (acre-feet)	Event Years	Duration (Years)
St. Mary at International Boundary	1	-2,406,743	1820-1835	16
	2	-2,193,397	1919-1931	13
	3	-1,889,061	1678-1690	13
	4	-1,467,432	1719-1725	7
Milk River at Western Crossing	1	-669,122	1861-1876	16
	2	-595,164	1702-1725	24
	3	-566,777	1931-1946	16
	4	-456,264	1800-1817	18
Lodge Creek at International Boundary	1	-180,636	1919-1945	27
	2	-164,133	1701-1725	25
	3	-112,233	1856-1876	21
	4	-99,679	1735-1749	15

Table 1: *Paleohydrology droughts at the St. Mary International Boundary, Milk River at the Western Crossing and Lodge Creek at the International Boundary ranked by cumulative deficits with event years and duration. Blue represents the 1930's dust bowl drought.*

Paleohydrology



Paleohydrology uses tree rings and other paleo information to understand stream flow prior to stream gage records. Tree ring growth is often influenced by the same climate-related variables, such as temperature and precipitation, that affect stream flow. Paleohydrology reconstructions can extend the hydrological record by hundreds of years!

Comparing droughts of the past to those in the historical flow records offers a better picture of the range of events that occurred at a specific location and helps water managers evaluate how current operations could withstand the stresses of historic events.

The paleo drought record for this study included impacts on the St. Mary River at the International Boundary, the Milk River at the Western Crossing, and Lodge Creek at the international Boundary (Fig. 2). The St Mary example is shown in Fig. 8, however, the four largest droughts in the St Mary do not necessarily match those identified at the Milk Western Crossing or Lodge Creek at the International Boundary. Table 1 shows how droughts impacted each area differently.

Drought comparisons over time depend heavily on how droughts are defined. It is worth noting that sustained dry conditions beginning in 1919 on the St. Mary River lasted well into the 1940's despite this entire time period not being classified as a single drought by the definition used in this study.

Additional Resources

https://www.climate.gov

https://www.drought.gov/states/montana

https://www.montanaclimate.org/

https://www.usbr.gov/watersmart/

https://www.wcrp-climate.org