CLIMATE CHANGE, WATER SECURITY AND BEST PRACTICES

EDMONTON METROPOLITAN REGION CLIMATE RESILIENCE EXCHANGE

This is a summary of two research studies, one conducted by the Prairie Adaptation Research Collaborative (Climate Change and Water Security) and one by Associated Engineering (Best Practices for Managing Water Resources). For more information visit:
allonesky.ca/edmontonclimateexchange

PROJECT GOAL

Climate Change and Water Security: Summarize existing research and knowledge about the impacts of climate change on water security in the Edmonton Metropolitan Region, including historical and projected surface water supply, quality and demand.

Best Practices for Managing Water Resources: Identify best practice approaches for managing climate change risks to water security in the Edmonton Metropolitan Region.

WHAT IS WATER SECURITY?

Achieving water security means maintaining acceptable levels of four risks to water resources:

1. Risk of shortage (including droughts): Lack of water to meet demand.
2. Risk of inadequate quality: Lack of water of suitable quality for a particular purpose.
3. Risk of excess (including floods): Overflow of the normal confines of water systems or destructive accumulation of water.
4. Risk of undermining the resilience of freshwater systems: Exceeding the coping capacity of the surface and groundwater sources.

Water Management is about "reducing and avoiding water risks".

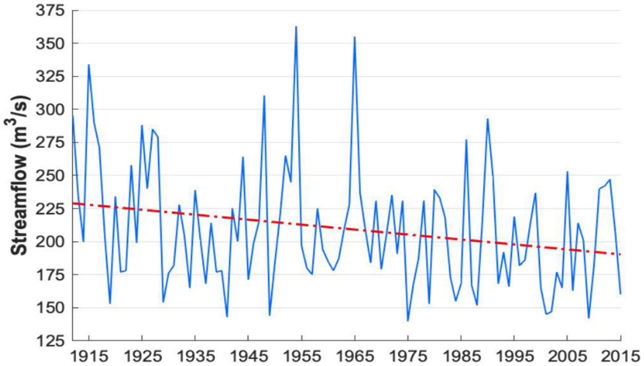
THE NORTH SASKATCHEWAN RIVER

The North Saskatchewan River (NSR) is the primary source of water for the Edmonton Metropolitan Region (EMR). The NSR in Alberta extends approximately 1,000 km from its headwaters at the Saskatchewan glacier in the Rocky Mountains to the provincial boundary, draining an area of approximately 57,000 km^2. The natural flow of the NSR is typical of a snow-dominated mountain watershed. Roughly 40% of the annual discharge occurs in June and July from melting of the mountain snowpack and rainfall upstream of the EMR. Relatively high flows are maintained throughout the summer due mainly to melting of snow, and to a lesser extent, glaciers at high elevations. Glacier meltwater accounts for about 3% of flows at Edmonton during the summer months.

TRENDS IN STREAM FLOWS

The mean annual flow of the North Saskatchewan at Edmonton has trended downward since 1911 (when a water level gauge was first installed). This trend is consistent with observed changes in the regional climate. The EMR is getting much less cold, mainly because of rising minimum winter temperatures. As a result, winter flows are increasing. However, these increases are offset by declining summer flows, due to loss of glaciers and high elevation snowpack.

The observed decline in annual flows is nonetheless relatively small compared to large natural inter-annual and decadal variability in flows.

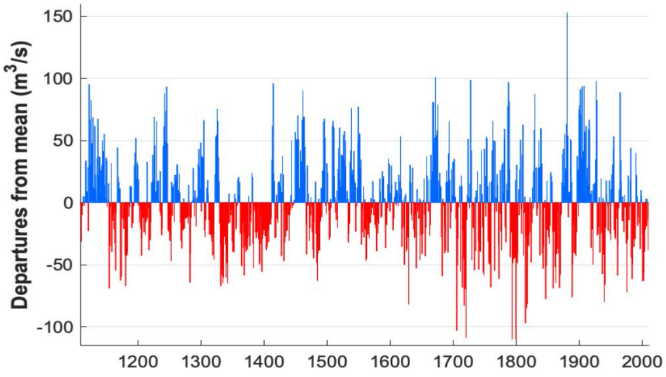


AVERAGE ANNUAL STREAM FLOWS IN THE NSR AT EDMONTON FROM 1912–2016

PALEOHYDROLOGY: LONG-TERM VARIABILITY IN FLOWS

Annual rings of long-lived trees can be used as a proxy for water levels in the NSR over the last millennium.

Natural cycles of water levels in the NSR are very apparent in a 900-year reconstruction of river flows from tree rings collected in the upper part of the river basin. Natural variability captured by the tree rings exceeds the range of annual flows recorded since 1911. A decadal cycle is particularly evident in the paleohydrology and has been associated with long periods of consistently low river levels and hydrological drought. Indeed, droughts like the 1930s are not uncommon. The tree-ring record also shows sustained periods of high stream flows, including the early 20th century which was an unusually wet period.

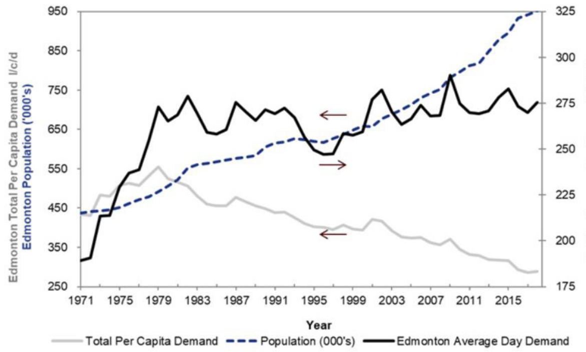


900 YEAR TREE RING RECONSTRUCTION OF ANNUAL FLOWS IN THE NSR

TRENDS IN WATER DEMAND

Only about 20% of the NSR is allocated for use; two-thirds of allocated abstractions occur in the EMR.

Despite increases in absolute water use and population in recent decades in the EMR, per capita water consumption has declined. This decoupling of water demand from population growth is attributed to effective water use efficiency and conservation strategies.



AVERAGE DAILY WATER USE, POPULATION AND PER CAPITA DEMAND OVER THE PERIOD 1971–2018 IN EDMONTON

ANTICIPATED CLIMATE CHANGE

Future projections for the EMR suggest warmer and wetter conditions in winter and spring and, on average, drier conditions in mid to late summer. The intensity of rainfall events is anticipated to increase. In general, a warmer climate will amplify both wet and dry phases in the natural hydro cycle.

ANTICIPATED IMPACTS OF CLIMATE CHANGE ON WATER SECURITY

Changes in streamflow: In response to projected climate changes, the seasonal pattern of river flow will shift, with future river levels peaking about one month earlier. Cold season (winter and early spring) flows will be significantly higher. River flows in June to August will be, on average, lower than in the past. As a warming climate amplifies the hydrological cycle, the range of river levels will expand, with larger departures from a shifting baseline of higher winter flows and lower summer flows.

Changes in water quality: Because water quality in the NSR is directly related to both runoff from the landscape and instream flows, it will be affected by climate change impacts on river flows and on runoff generated by (intense) precipitation and snowmelt. Higher concentrations of turbidity, colour, nutrients and algae are anticipated as a result of increased precipitation, a larger range of flows in the NSR, floods, droughts, forest fires, and higher water temperatures.

Changes in future water use and demand: While there are little available projections of future water demand, one current study finds that 1) conventional water demand forecasting models tend to overestimate long-term demands by failing to account for water conservation, 2) future demand could depend on the link between outdoor watering in the summer and daytime maximum temperatures, which are projected to rise, and 3) impacts associated with changes in water use depend on the timing of demand in a typical day and week.

Impacts to Infrastructure: The operation, and possibly structural integrity, of infrastructure for drainage, water supply, and treatment is vulnerable to projected climate change. Much of the risk is due to the expectation of more intense precipitation, prolonged low water levels, and more extreme weather events, which existing infrastructure is not designed for.

> The worst-case future scenario is a reoccurrence of consecutive years of severe drought, such as occurred in the 1930s and in preceding centuries. A key goal for adaptation planning will thus be how to manage uncertainty from low probability-high consequence extreme flows.

BEST MANAGEMENT PRACTICE THEMES FROM MUNICIPALITIES

1 WATER SOURCE PROTECTION

Enhancing or improving degraded water resource systems and protecting and restoring watersheds impacted by climate change events such as wildfires, floods and low river flows.

Municipalities can:

- Support Low Impact Development such as permeable pavements, storm ponds, bioswales, absorbent landscape, green roofs, and rain gardens to store excess water and filter our contaminants.
- Improve, restore and/or enhance buffer areas around natural infrastructure such as wetlands, shorelines and riparian habitat.
- Restrict development in flood-prone areas and develop flood hazard maps and bylaws to control development in flood plains.
- Install riverbank armoring, and conduct restoration work to guard against river quality degradation during flood events.

2 WATER EFFICIENCY

Water conservation programs to reduce water consumption, alleviate water production demand and water withdrawal from the natural system.

Municipalities can:

- Implement water conservation efforts through water restrictive use, education, and public awareness.
- Develop interactive public information and awareness programs including tips, videos, and educational information to curb careless water consumption behaviour.
- Re-use water in accordance with the Alternative Solutions Guide for Small System Reclaimed Water Reuse.
- Meter water consumption and use a tiered water rate system to incentive reductions in water consumption.
- Develop a Drought Management Plan, considering potential climate change impacts.
- Harvest rainwater in accordance with the Alberta Guidelines for Residential Rainwater Harvesting Systems, and other best practices.

3 COMMUNICATION & COLLABORATION

Communication, education and collaboration with the public and other stakeholders.

Municipalities can:

- Develop an overarching water management plan for your community, including:
  - identified and prioritized climate impacts to water security;
  - water management goals, objectives, and strategies;
  - water conservation targets and a timeline to meet the targets;
  - monitoring requirements and reporting;
  - communication with the public through engagement, education, and reporting; and
  - annual reporting to show progress and improvements.
- Work with stakeholders across the province to advocate for green infrastructure solutions.
- Initiate a committee or task force to ensure accountability and responsibility for long term success of water management programs.
- Work collaboratively with EPCOR to share relevant information and concerns, identify potential issues, and resolve issues.

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MUNICIPAL PARTNERS