Smart Growth on the Ground

FOUNDATION RESEARCH BULLETIN:
Greater Oliver

Research compiled by:

Adaptation and Impacts Research Division, Environment Canada

No. 1
April, 2006

CLIMATE CHANGE AND WATER RESOURCES

1.0 Introduction

Research has examined the impacts of climate change on water resources in North America. This research suggests that global warming will cause changes in stream flow and other aspects of hydrological systems.[1] Changes in water demand are also expected in the future as a result of factors such as climate change, increasing world population, and increasing industrialization.[2]

Regional-level studies of climate change impacts in British Columbia's Okanagan Basin are consistent with these global projections. These regional studies suggest that the region can expect changes in the timing and quantity of peak stream flows and increasing irrigation and residential demands in the coming century.[3]

Adjustments to water management systems can reduce vulnerability to the impacts of climate change

Water management systems will be vulnerable to these supply and demand changes, and will need to adapt in order to sustain human health, economic well-being and ecosystem integrity. Adaptation, or adjustments to water management systems, may occur as a reaction to environmental stimuli or in anticipation of future impacts. Planned adaptation measures can reduce a system's vulnerability to the impacts of climate change and other stimuli while enhancing possible benefits.[4]

This foundation research bulletin summarizes results from a series of climate change studies conducted in the Okanagan. The studies were led by Environment Canada and Agriculture and Agri-food Canada and included contributions from researchers and practitioners at the University of British Columbia, the BC Ministry of Environment, Town of Oliver and several other water utilities. The studies investigated the impacts of climate change on the region's water supply and demand, and discussed options for adapting to the possible changes.[5]

2.0 Climate Change in the Okanagan

The Okanagan Basin is generally known for its semi-arid climate with warm summers, cool winters and low annual precipitation. Analyses of historical climate data have shown that the Okanagan has gotten warmer in the 20th century, with increases in both daily minimum and maximum temperatures. For example, at Summerland, daily maximum temperatures in winter rose by 2.4°C and daily minimum by 3.6°C over the past century. Frost-free days have also increased by approximately 3.1 days per decade.[6] Maximum and minimum temperatures in the other three seasons also increased by between one and two degrees Celsius.

Precipitation in the spring and summer has increased by 55% and 62% respectively over the past 100 years. No precipitation trend was observed in historical data in winter or autumn.

The warming trend found in the Okanagan's past climate is consistent with the trends that are simulated in models of future climate, though the degree of change varies between models. Six scenarios of the Okanagan's future climate[7] show average increases in winter temperatures of approximately 1½ to 4 degrees Celsius by the 2050s period,[8] when compared to the past climate represented by the 1961-1990 climate normals.[9] The scenarios also show an increase in summer temperatures of 2 to 4 degrees Celsius.

Warmer temperatures, especially in winter, could result in earlier snowmelt and earlier onset of spring peak flows

Unlike the trends observed in past climate, the future scenarios show increases in winter precipitation of 5 to 25 percent relative to the 1961 to 1990 climate normals. In summer, the modeled scenarios show the opposite trend with a 0 to 35 percent decrease in precipitation.[10]

3.0 Climate Change Impacts on Water Supply

The changes in temperature and precipitation described above could cause changes in the hydrology of the Okanagan basin. Warmer temperatures, especially in winter, could result in earlier snow melt at higher elevations and therefore, earlier onset of spring peak flows by approximately four to six weeks. While all of the climate change scenarios are consistent in predicting an earlier start to the spring thaw ("freshet"), changes in the volumes of peak flows throughout the season are less certain.[11]

These changes are important considerations for water managers in the region because design criteria for reservoirs and other infrastructure are based on the assumption that the average timing and volume of the freshet will remain constant over time.

Both the irrigation canal and groundwater will be influenced by climate change and the effects of increasing water demand upstream

The Town of Oliver is at the south end of the Okanagan basin, downstream of the major lakes and upland drainage. Oliver depends on the irrigation canal to supply agricultural users and groundwater to supply town residents.

It is likely that both sources of water will be influenced by climate change and the effects of increasing water demand upstream. Without taking upstream water demands into account, climate change is expected to significantly decrease total unregulated inflow to Okanagan Lake by as much as 50% in the coming century. This could affect the amount of water that is available downstream of the lake both for surface water supplies and groundwater recharge.

4.0 Climate Change Impacts on Water Demand

4.1 Agricultural Water Demand

Climate change will affect agricultural water demand in two ways. Firstly, warmer temperatures will increase the amount of water needed by plants resulting in increased evapotranspiration. Secondly, warmer temperatures in Spring and Fall will result in a longer growing season, so plants will require water over a longer period of time during the year.

Assuming no changes in crop type and distribution in the Oliver water utility over the coming century, climate change could result in increased irrigation water demand of 14 to 25% in the 2020s, 24 to 45% in the 2050s and 33 to 70% in the 2080s. Changes in the monthly irrigation requirements in each of the six climate change scenarios can be seen in Figure 1.

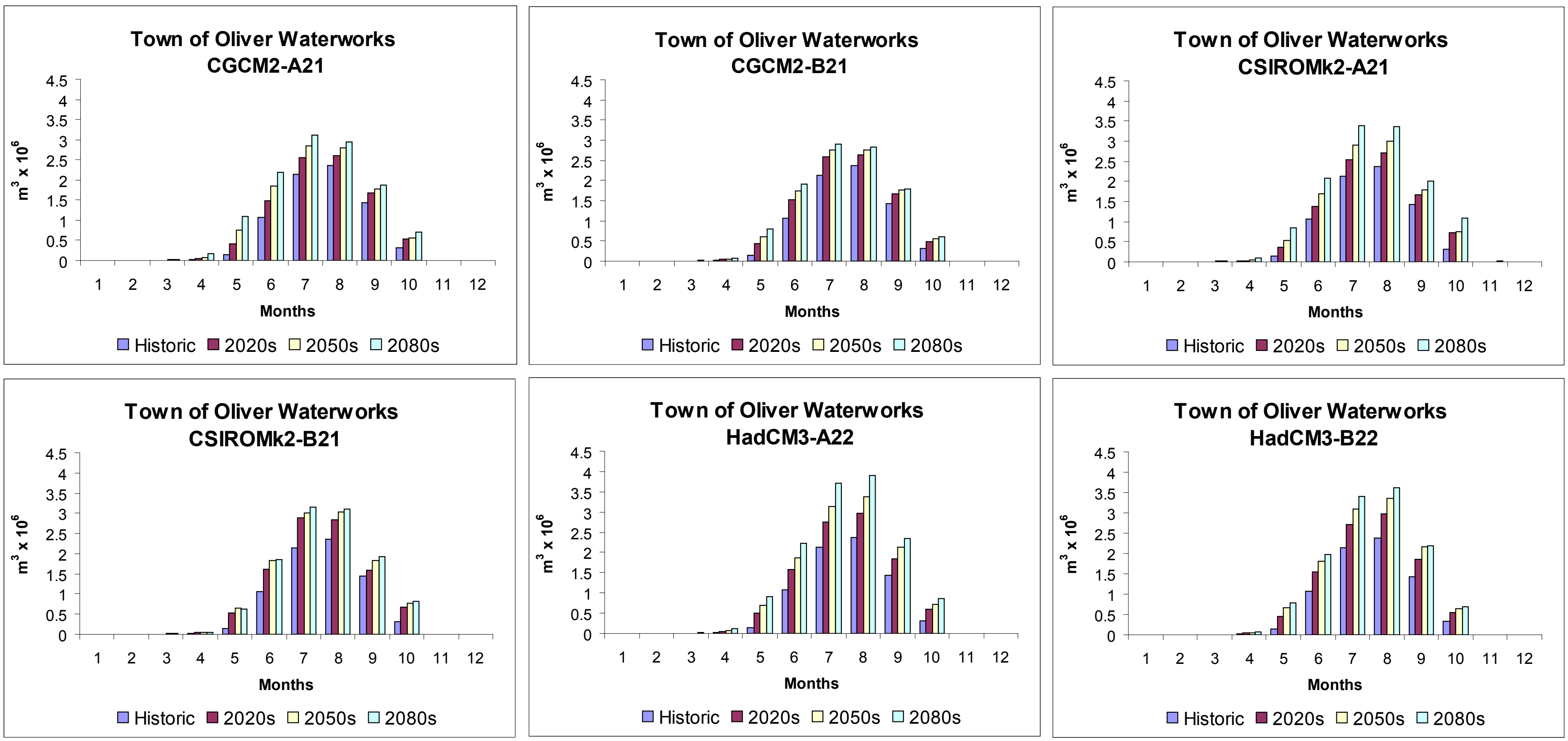


Figure 1: Monthly distribution of irrigation demand in response to six climate change scenarios for the Town of Oliver Waterworks

Higher demand is expected to correspond with lower in flows throughout the coming century

Higher demand is expected to correspond with lower in flows throughout the coming century, even before accounting for the increasing demands of a growing residential population or other non-agricultural irrigation water demands.

4.2 Residential Water Demand

Residential water demand is influenced by a number of factors including population growth, housing density, climate change and water conservation programs. Like agricultural water demand, climate change will also affect household water requirements. Lawns and gardens will need more water in hotter weather and will experience a longer growing season due to warmer spring and fall temperatures.

Due to reduced areas for lawns and gardens, increased housing density can slow growth in water demand and reduce the influence of climate change

Population growth is likely to have the greatest influence on increasing water demands. Due to reduced areas for lawns and gardens, increased housing density can slow growth in water demand and reduce the influence of climate change. Similarly, water conservation programs can also reduce growth in water demand by increasing efficiency of water use around the home.

Figure 2 shows the Town of Oliver's future residential water demand with several scenarios of population growth, climate change, housing density and water conservation measures. Green lines are low population growth scenarios (0.5% per year), blue lines are medium population growth scenarios (1% per year) and red lines are high population growth scenarios (1.5% per year). The horizontal dashed line represents the amount of water used by Oliver residents in the year 2001.

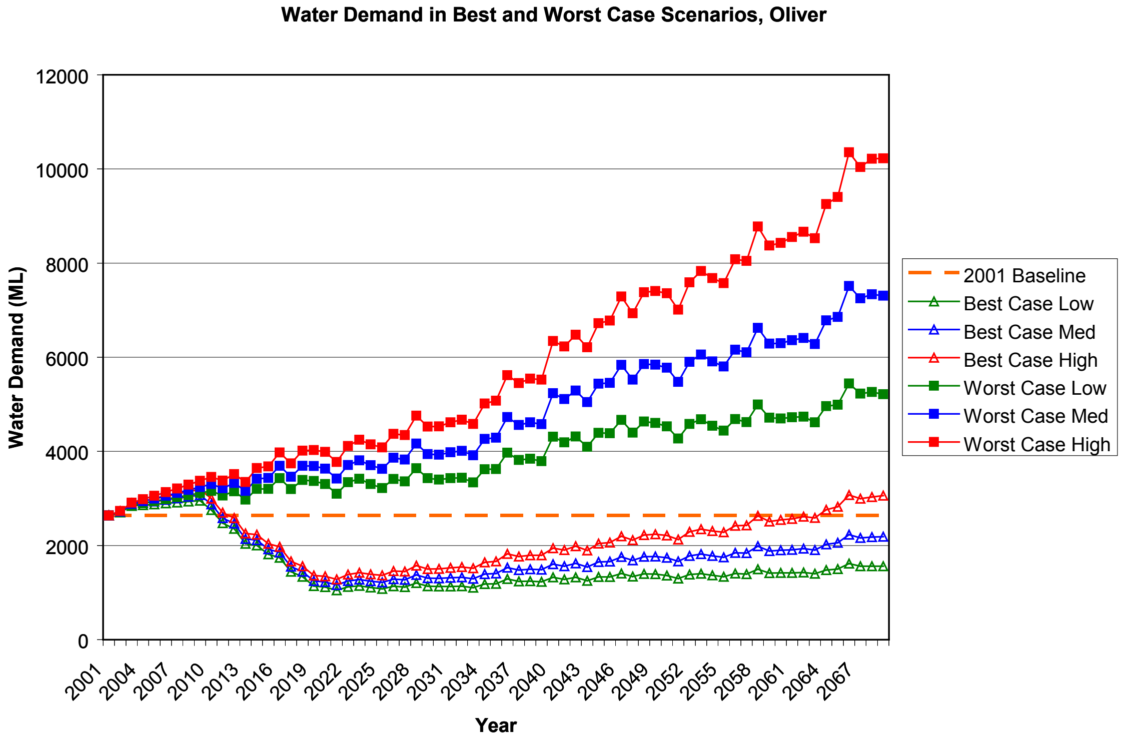
The three lines above the 2001 baseline show the "worst case" scenario for residential water demand. This includes the most severe climate change scenario, no change in current housing patterns and no water conservation measures.[12] Water demand in the worst case scenario increases between 2.5 to 5 times current demand by the end of the 2050s.

By contrast, the three lower lines in the graph represent the "best case" scenario for Oliver's residential water demand. This includes the least severe climate change scenario, increased housing density and an aggressive water conservation program.[13] The best case scenario would result in significant reductions from current water use, despite the effects of a growing population and climate change over the next six decades.

Water conservation has the greatest influence on reducing water demand

Of the factors used to calculate these residential water demand scenarios, it must be noted that water conservation had the greatest influence on reducing water demand. It is clear that current choices in how Oliver develops and how water is managed will affect how sensitive Oliver's water demand will be to future climate change and population growth.

Figure 2: Future water demand for the Town of Oliver in the "best" and "worst" case scenarios for all three population growth scenarios. The worst case scenario includes HadCM3 A2 climate change, current housing patterns and no additional demand side management measures beyond those in place in 2001. The best case scenario includes CGCM2 B2 climate change, increased housing density and an aggressive demand side management program including xeriscaping, high efficiency plumbing retrofits and water metering with an increasing block rate pricing structure.



Additional Resources

Adaptation and Impacts Research Group
http://www.ires.ubc.ca/nav.php?page=airg_research_projects

References

1 Cohen & Miller, 2001
2 Arnell & Liu, 2001
3 Cohen & Kulkarni, 2001; Cohen, Neilsen, & Welbourn, 2004
4 McCarthy, Canziani, Leary, Dokken, & White, 2001
5 Detailed reports on these studies and information on ongoing research efforts can be downloaded from: http://www.ires.ubc.ca/nav.php?page=airg_research_projects
6 Brewer & Taylor, 2001
7 The six scenarios, studied by Taylor et. al. (2003), were created using three global circulation models (CGCM2, CSIROMk2, and HadCM3) and the A2 (high) and B2 (low) greenhouse gas emissions profiles from the Intergovernmental Panel on Climate Change's Special Report on Emissions Scenarios.
8 The 2050s refers to the thirty year period between 2040 and 2069.
9 The 1961-1990 climate normals are averages of climate variables, such as temperature and precipitation, over a 30 year period.
10 Taylor et. al. 2003
11 Hamilton, 2001; Merritt & Alila, 2003
12 The worst case scenario consists of the HadCM3 A2 climate change scenario, current housing patterns (mainly single detached dwellings) and no additional water conservation measures beyond those in place in 2001.
13 The best case scenario consists of the CGCM2 B2 climate change scenario and a 23.7% reduction in single family dwellings and same increase in apartments. The scenario also includes water savings from water metering with an increasing block rate pricing structure, high efficiency appliance retrofits in all homes and retrofits of all landscaping to xeriscaping.

Contact Us

Design Centre for Sustainability
University of British Columbia, 394-2357 Main Mall, V6T 1Z4
t. 604-822-5148, f. 604-822-2184
For more information visit the following websites:
www.designcentreforsustainability.org, www.sgog.bc.ca