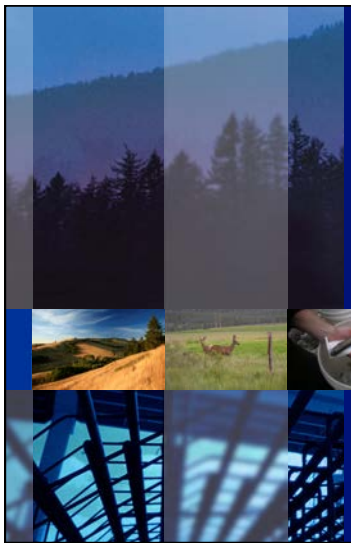

SUMMIT
ENVIRONMENTAL CONSULTANTS INC.
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International Joint Commission

Osoyoos Lake Plan of Study: Study 6 Climate Change and its Implications for Managing Water Levels in Osoyoos Lake

In partnership with:

POLAR GEOSCIENCE LTD.

Project 2011-8009.000
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Outline

1. Background
2. Climate and hydrologic changes likely to affect Osoyoos Lake
3. Implications of climate change for management of Osoyoos Lake
4. Recommendations to the IJC

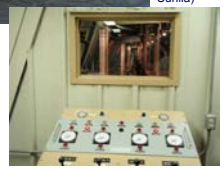
Osoyoos Lake at outlet (Photo: L. Uunila)

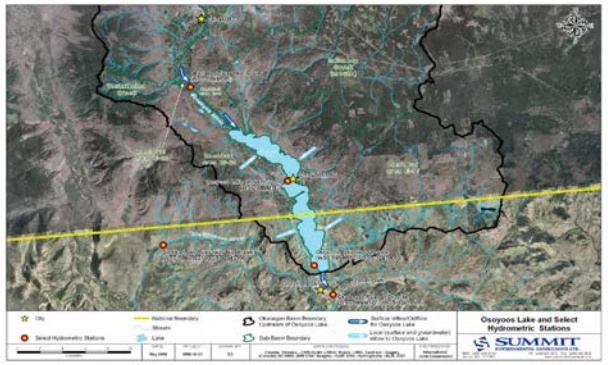
1. Background

- Osoyoos Lake water levels are managed according to International Joint Commission (IJC) Orders of Approval
- Current Orders will expire Feb 2013
- IJC questions:
  - What are the projected impacts of climate change on Osoyoos Lake and management of the lake?
  - Should the Orders be amended to account for climate change?
  - If so, how?

Zosel Dam gates and control room

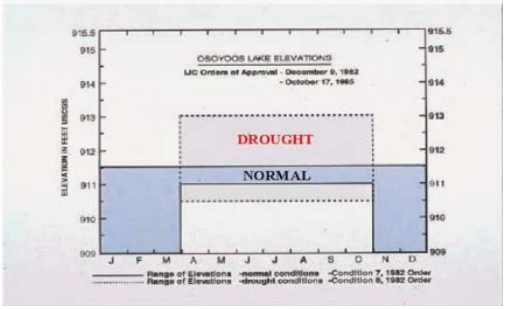
(Photo: L. Uunila)





1. Background

Osoyoos Lake winter and summer operating ranges within current Orders of Approval



1. Background

Any one of three criteria must be met to declare a drought:

- Similkameen River total April – July flow less than 1 million ac-ft (1.2 million cubic decameters)
- Net inflow to Okanagan Lake April – July less than 195,000 ac-ft (240,000 cubic decameters)
- Okanagan Lake level (June-July) fails to reach 1122.8 feet (342.2 m)

2. Future changes to climate and hydrology

Experts consulted

Climate Researcher	Title and Affiliation
Alila, Younes	Associate Professor, University of British Columbia
Allen, Diana	Professor, Simon Fraser University
Cannon, Alex	Senior Hydroclimatologist, Environment Canada; Adjunct Professor UBC
Cohen, Stewart	Research Scientist, Adaptation & Impacts Research Division Section (AIRS), Environment Canada, and Adjunct Professor, Department of Forest Resources Management, University of British Columbia
Coulson, Hal	Engineer (retired), B.C. Ministry of Environment, Lands and Parks
Fabro, Andrew	Librarian, Environment Canada
Gobena, Adam	Statistical Hydrologist, BC Hydro
Hamlet, Alan	Research Assistant and Professor, University of Washington
Hyatt, Kim	Research Scientist, Fisheries and Oceans Canada
Lall, Upmanu	Senior Research Scientist and Professor, Columbia University
Long, Karilyn	Fisheries Biologist, Okanagan Nation Alliance
Millar, Daniel	Senior Advisor, Water Issues, Environment Canada
Murdoch, Trevor	Climate Scientist, Pacific Climate Impacts Consortium, University of Victoria
Nielsen, Denise	Research Scientist, Agriculture and Agri-Foods Canada
Pike, Robin	Watershed Research Hydrologist, B.C. Ministry of Forests, Mines and Lands
Redding, Todd	College Professor, Department of Geography & Earth and Environmental Science, Okanagan College, Penticton
Schnorbus, Markus	Lead Hydrologist, Pacific Climate Impacts Consortium, University of Victoria
Scott, David	Associate Professor, University of British Columbia Okanagan
Tansey, James	Associate Professor, University of British Columbia
Weber, Frank	Hydrologist, Team Lead, Runoff Forecasting, BC Hydro
Whitfield, Paul H.	Emeritus Scientist, Environment Canada
Winkler, Rita	Research Hydrologist, B.C. Ministry of Forests, Mines and Lands.

2. Future climate changes

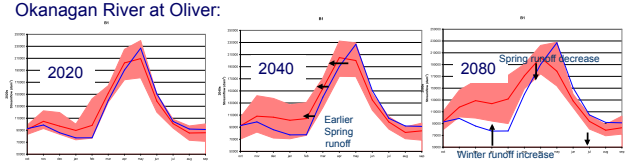
Projected climate change for South Okanagan - Similkameen

Climate Variable	Time of Year	Projected Change (from 1961-1990 baseline)		
		2020s	2050s	2080s
Mean Air Temp. (ºC)	Annual	+1.1ºC	+1.9ºC	+3.0ºC
Precip.	Annual Summer Winter	+4% -9% +2%	+6% -14% +6%	+8% -16% +10%
Snow depth	Winter Spring	-6% -33%	-14% -57%	-22% -78%
GDD	Annual	+175	+379	+571
FFD	Annual	+15	+26	+39

Source:
University of Victoria
PCIC Plan2Adapt Tool
– 15 GCMs

2. Future hydrologic changes

Okanagan River at Oliver:



Source: University of Washington – 10 GCMs

Lower summer flows (with longer duration)

- Annual total flow about the same
- Earlier spring snowmelt runoff
- Higher winter and early spring flow, but lower late spring, summer, and fall flows
- Lower peak flows

- From Phase 2 study: More water withdrawn from Osoyoos Lake (11% more by mid-20s; 22% more by mid-50s)
- more lake evaporation

3. Implications of climate change for management of Osoyoos Lake

Key management steps:

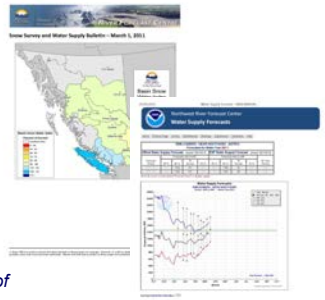
1.Water supply forecasts Jan-Jun (BC and Washington)

2.IOLBC review of forecasts (starting Apr 1st, updated every 2 weeks)

3.Declaration of *Drought* or *Non-drought* conditions

4.Zosel Dam operated in accordance with Drought or Non-drought conditions

The projected hydrologic effects of climate change were evaluated with respect to each of these key steps.



3. Implications of climate change for management of Osoyoos Lake

1. Water Supply Forecasts
   - Hydrologic models used by BC and Washington State are continually evaluated and updated over time. **There is no evidence to suggest these models have or may become less accurate in the future.**
2. IOLBC Review of Forecasts – starts April 1
   - Given the projection towards earlier spring freshet (by 4-8 weeks by 2080), **there is potential that a considerable volume of freshet runoff will occur in future prior to April 1.**
3. Drought" or "Non-Drought" conditions in summer
   - Although drought frequency has not changed, **there is potential for droughts to be declared more frequently in future**

3. Implications of climate change for management of Osoyoos Lake

Parameter	2020	2040	2080
Similkameen River Runoff (Apr 1 – Jul 31)	-1%	-3%	-7 to -16%
Okanagan Lake Inflow (Apr 1 – Jul 31)	-3 to -4%	-5 to -6%	-10 to -15%

Implication:
- droughts may be declared more frequently in future

3. Implications of climate change for management of Osoyoos Lake

SUMMARY: Management of Osoyoos Lake levels will have to contend with changing conditions including:

- **Earlier spring runoff:** could necessitate changes to decision dates (e.g. when drought vs. non-drought conditions are declared) and start/end dates of summer operating range.
- **Reduced snowpack and lower spring runoff:** may affect the total water supply in summer.
- **Increased winter precipitation and warmer temperatures:** may cause more rain and less snow resulting in increased winter runoff. This additional water may help mitigate the lower spring runoff, but only if storage is available and utilized. If winter runoff were stored, summer levels could possibly be reached earlier.
- **Higher water demand from Osoyoos Lake:** will increase the pressure on the reduced water supply.

4. Recommendations

1. Because of a projected earlier runoff in spring, we recommend **allowing droughts to be declared earlier** in the spring (e.g. March 1 instead of April 1)
2. **Allow more flexibility in filling the lake**. Increased flows are projected through winter and freshet is projected to begin earlier. Earlier storage may be required to take advantage of the available water.
3. **Allow ramping** over some defined period as opposed to setting strict date-specific water level requirements. This will provide flexibility, which is particularly important given the wide range of projections for future water supply.

4. Recommendations (cont'd)

4. **Evaluate whether a distinction between drought and non-drought conditions is required**. In its place, a flexible lake management strategy that applies to all years could be developed.
5. The **fixed-date summer and winter operating ranges should be evaluated** in light of the projected future advance of the lake inflows.
6. Incorporate an **adaptive management strategy** that includes re-evaluation of performance under the Orders every 10 years or after any year. This is particularly important since there is a wide range in projected future conditions.