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Historical Trends in Annual Water Yields for the Okanagan Basin, British Columbia, Canada

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The Okanagan Basin in south-central British Columbia, Canada, includes the Okanagan River watershed upstream from the outlet of Osoyoos Lake, with a total area of 8,046 km^2 (Figure 1).[1] The Basin is bounded on the east by the Kettle River Basin, on the west by the Similkameen River Basin, on the north by the Shuswap River Basin, and lies within the Thompson Plateau and Okanagan Highland physiographic regions. The regional physiography is a high plateau with elevations between 1,200 to 1,500 masl containing a north-south trending valley having bottom elevations ranging from about 250 to 500 masl, collectively hosting a number of mainstem and highland lakes. Okanagan Lake is the major water body in the Basin (surface area: 351 km^2; volume: 24.6×10^9 m^3), and drains into the Okanagan River which flows south through smaller lake systems and enters the Columbia River at Brewster, Washington in the United States.[2] Average annual precipitation in the semiarid Basin is about 530 mm, with about 80% lost via evaporation and evapotranspiration.[3]

Over the past century, the population of the Basin has grown rapidly, particularly during the last 50 years (Figure 2), and this trend is expected to continue. An estimate of total average annual human water use at 219×10^6 m^3 has been put forward,[4] which – if accurate – represents about 40% of the total annual water yield for the Basin. Previous work has also suggested that total annual inflows to Okanagan Lake may decline by up to 30% by the year 2080 as a result of projected warmer and drier summers.[5-9] Consequently, water management issues attract significant attention in the region, given projected declines in supply and increases in demand.

As a result of these concerns, we investigated the long-term temporal trends in regional annual water yield (net runoff) at the three major hydrometric monitoring stations on the Okanagan River downstream of Okanagan Lake. The Okanagan River is a regulated system with dams at the outlets of both Okanagan and Skaha Lakes. Thus, its

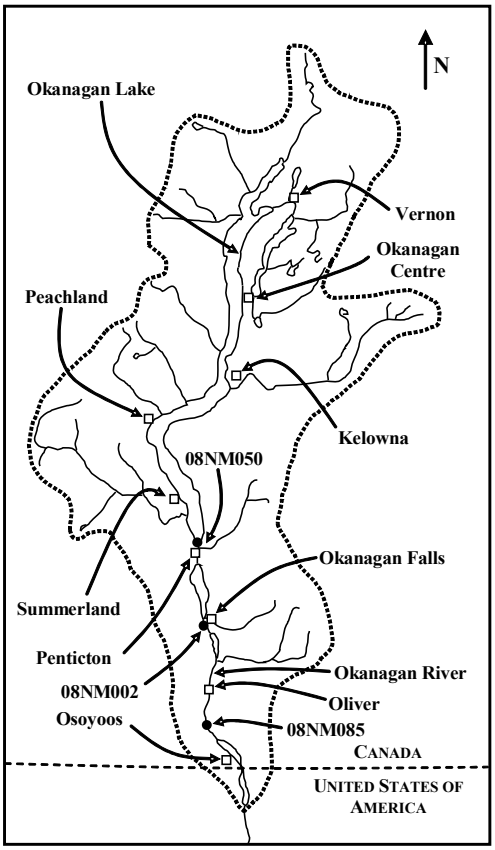

Figure 1. Schematic map of the Okanagan Basin showing locations of major municipalities, lakes, rivers, and the three hydrometric monitoring stations under consideration.

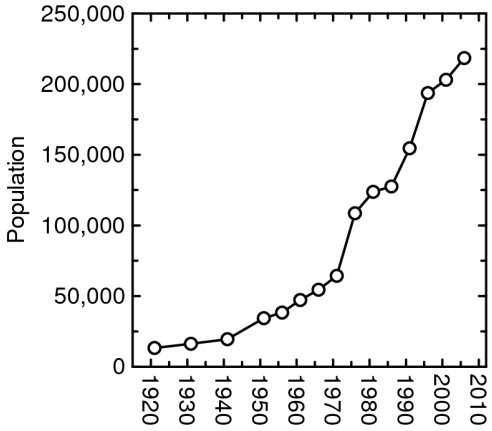

Figure 2. Temporal trends in the total population [10] of the major municipalities (Coldstream, Kelowna, Lake Country, Oliver, Osoyoos, Peachland, Penticton, Summerland, and Vernon) in the Okanagan Valley since 1921.

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annual hydrograph is managed and does not reflect natural processes in its upstream catchments. Instead, annual flow data in this river reflects an integrated response of the Basin hydrology to any long-term changes in precipitation, evaporation/evapotranspiration, and net losses due to human activities.

Historical streamflow data was obtained [11] for three hydrometric stations on the Okanagan River between the outlet of Okanagan Lake at Penticton and near the U.S. border at Oliver (Figure 1 and Table 1). Only years with complete monthly records and continuous recorder data were used.

Table 1. Hydrometric station information for the three sites on the Okanagan River.

	Okanagan River at Penticton	Okanagan River at Okanagan Falls	Okanagan River near Oliver
Station ID	08NM050	08NM002	08NM085
Latitude (N)	49°29'44"	49°20'26"	49°6'53"
Longitude (W)	119°36'55"	119°34'40"	119°33'50"
Gross drainage area (km^2)	6,090	6,860	7,590
Period of record	1936-2008	1915 1917-1966 1969-2008	1953-1955 1958-2008

No evidence of declining trends in regional annual water yields was observed at any of the stations (Figure 3 and Table 2). At the Okanagan River-Penticton (08NM050) and Okanagan River-Oliver (08NM085), temporal trends in annual water yields were non-significant (p=0.31 and 0.45, respectively). A significant (p=0.03; r=0.23) linearly increasing trend (0.068±0.030 $m^3 s^{-1} y^{-1}$) in annual water yield was found for the Okanagan River-Okanagan Falls (08NM002) station.

Table 2. Summary best-fit linear regression statistics for temporal trends in regional annual water yields (expressed as average annual flows in $m^3 s^{-1}$) at each of the three hydrometric stations downstream of Okanagan Lake on the Okanagan River.

	Okanagan River at Penticton	Okanagan River at Okanagan Falls	Okanagan River near Oliver
n	73	91	54
r	0.12	0.23	0.10
p	0.31	0.03	0.45
m	0.042±0.041	0.068±0.030	0.061±0.080

Collectively, the historical hydrometric data series on the Okanagan River between Penticton and the U.S. border indicate no temporal changes in regional annual water yields for the Okanagan Basin over the past century,

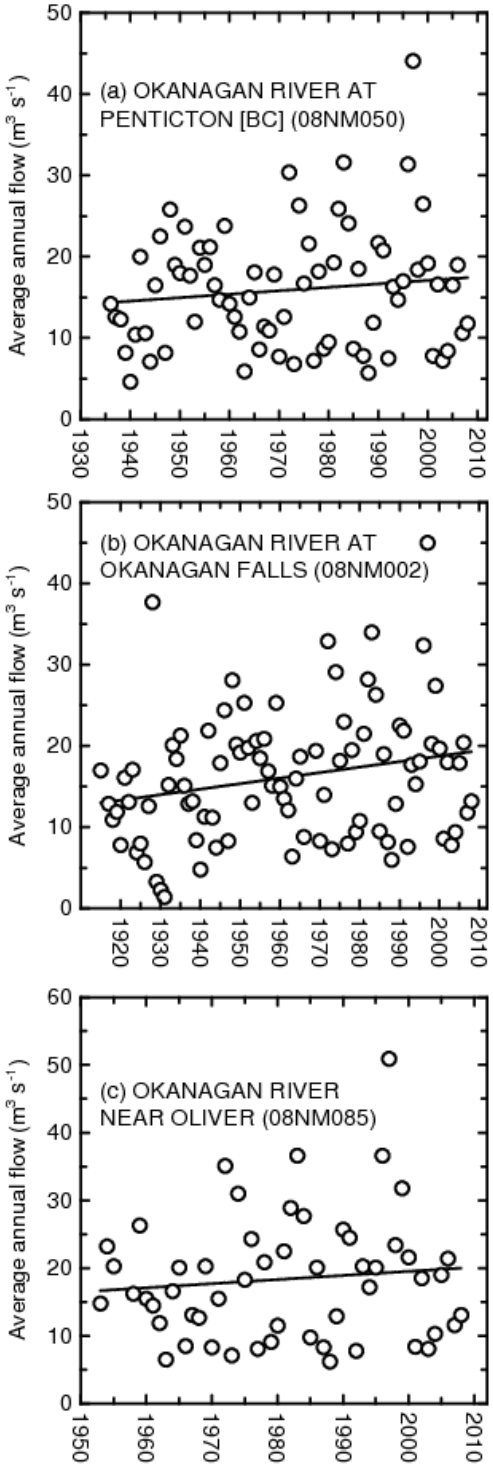

Figure 3. Temporal trends in regional annual water yields (expressed as average annual flows in $m^3 s^{-1}$) at each of the three hydrometric stations downstream of Okanagan Lake on the Okanagan River. Solid lines are best-fit linear regressions.

despite large increases in population and agricultural activity over this time. Although rapid and extensive human settlement and development of the region, along with possible climate change signatures during the 20th century, has potentially altered the inflow hydrographs to tributary streams in the Basin, the overall water yield of the region appears to be stable and possibly increasing.

Literature Cited

[1] *Final Report - Okanagan Basin Water Supply and Demand Study: Phase 1*. Summit Environmental Consultants Ltd.: Vernon, BC, Canada, 2005.

[2] *Main report of the Consultative Board. Report (including Comprehensive Framework Plan) prepared under the Okanagan Basin Agreement*. Consultative Board: Ottawa, ON, Canada, 1974.

[3] Cohen, S.; Kulkarni, K. *Water Management and Climate Change in the Okanagan Basin*. Environment Canada and University of British Columbia: Vancouver, BC, Canada, 2001.

[4] *Key Findings: Okanagan Water Supply and Demand Project - Phase 2. Okanagan Basin Water Board*: Kelowna, BC, Canada, 2010.

[5] Cohen, S.; Neilsen, D.; Welbourn, R. *Expanding the Dialogue on Climate Change and Water Management in the Okanagan Basin, British Columbia - Final Report, January 1, 2002 to June 30, 2004*. Climate Change Action Fund: Ottawa, ON, Canada, 2004.

[6] Cohen, S.; Neale, T. *Participatory Integrated Assessment of Water Management and Climate Change in the Okanagan Basin, British Columbia*. Environment Canada and University of British Columbia: Vancouver, BC, Canada, 2006.

[7] Cohen, S.; Neilsen, D.; Smith, S.; Neale, T.; Taylor, B.; Barton, M.; Merritt, W.; Alila, Y.; Shepherd, P.; McNeill, R.; Tansey, J.; Carmichael, J.; Langsdale, S. (2006). Learning with local help: Expanding the dialogue on climate change and water management in the Okanagan region, British Columbia, Canada. *Climatic Change* **2006**, 75, 331-358.

[8] Merritt, W.; Alila, Y.; Barton, M.; Taylor, B.; Neilsen, D.; Cohen, S. Hydrologic response to scenarios of climate change in the Okanagan Basin, British Columbia. *J. Hydrology* **2006**, 326, 79-108.

[9] Neilsen, D.; Smith, S.; Frank, G.; Koch, W.; Alila, Y.; Merritt, W.; Taylor, B.; Barton, M.; Hall, J.; Cohen, S. Potential impacts of climate change on water availability for crops in the Okanagan Basin, British Columbia. *Can. J. Soil Sci.* **2006**, 86, 909-924.

[10] Province of British Columbia. *BCStats: British Columbia Municipal Census Populations, 1921-2006*. Available online at http://www.bcstats.gov.bc.ca/data/pop/pop/mun/Mun1921_2006.asp (accessed 30 September 2010).

[11] Environment Canada. *Real-Time Hydrometric Data*. Available online at http://www.wateroffice.ec.gc.ca/index_e.html (accessed 30 September 2010).

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