paper 9

REGIONAL ASSESSMENT OF CLIMATE CHANGE IMPACTS IN CANADA:
OKANAGAN CASE STUDY

STEWART J. COHEN[1]

[1] *Meteorological Service of Canada and University of British Columbia, Vancouver, British Columbia, Canada.*
Email: scohen@sdri.ubc.ca

ABSTRACT. A collaborative study on climate change and water management in the Okanagan region of British Columbia, Canada, has been underway for several years. An interdisciplinary approach is used, incorporating participatory processes as part of the research on regional adaptation experiences and consideration of future responses. Results of hydrologic and water demand research efforts indicate that future climate changes are likely to result in reduced water supply, increased water demand, and an increased frequency of high risk years in which high demand and low supply occur concurrently. The region has experienced droughts in recent years, and several communities and water purveyors have initiated measures to manage water demand. Future climate change will require a portfolio of supply and demand measures, and need to be considered as part of a basin-wide strategy that integrates with regional development plans.

Keywords: water resources management, climate change, adaptation, participatory integrated assessment, Okanagan region

1. Introduction

Human-induced climate change, evolving from continued increases in atmospheric greenhouse gas concentrations, represents a problem of great complexity. If the world warms as projected by global climate model simulations, there will be implications for climate-sensitive natural resources, and the communities that depend on them. One example is water resources. A warmer climate will affect all aspects of the hydrologic cycle, leading to changes in streamflow and available water supplies. Demand for water is also likely to change, both for supporting agriculture as well as ecosystems, industries and cities.

A number of case studies have been carried out for various watersheds around the world (Arnell et al., 2001). These illustrate the sensitivity of watersheds to recent climatic trends, as well as to future climate change scenarios. The number of people experiencing increased water scarcity is expected to rise.

Improved understanding of the human implications of changing water resource conditions requires increased research efforts in hydrology and water demand, but in addition, we must recognize the importance of the regional context of governance and decision making. The severity of projected impacts, and the ability of regions to respond, will depend on the region's exposure, vulnerability and adaptive capacity. Previous experience with droughts and other climatic extremes provide opportunities to examine how regional stakeholders planned for such events, and acted on knowledge and advice provided by professional staff and regional constituents (e.g. large irrigators, municipalities, watershed committees).

One approach that can be considered when assessing the bio-physical and human implications of climate change is a collaborative interdisciplinary research effort, which is based on developing a partnership between researchers and stakeholders. This is meant to create an exercise in shared learning. Dialogue processes are critical to this process, extending beyond simply performing an outreach function. In this approach, dialogue contributes important information on how adaptation options may be considered by governments, private enterprises, and community groups. Advocates of this approach, known as participatory integrated assessment (PIA), suggest that this can lead to an increase in stakeholder commitment to both the study process, as well as to subsequent use of research findings in policy decisions. As well as shared learning, this approach can create a sense of shared ownership in problem framing and study results. Rotmans and van Asselt (1996) have described integrated assessment as a process that can promote active dialogue and knowledge sharing between scientists, in the form of interdisciplinary research, and local knowledge holders, who use their experiences and judgements to help frame research questions and express response options that satisfy the region's interests. A participatory approach can complement research produced through quantitative models and fieldwork (Hisschemöller et al., 2001).

This paper describes a case study of the Okanagan region of British Columbia, Canada. It is a semi-arid watershed, around 8,200 km^2 in area. The region is experiencing rapid population growth, doubling since the 1970s. Agriculture is very important to the regional economy (Figure 1), and almost half of the region's cropland is irrigated.

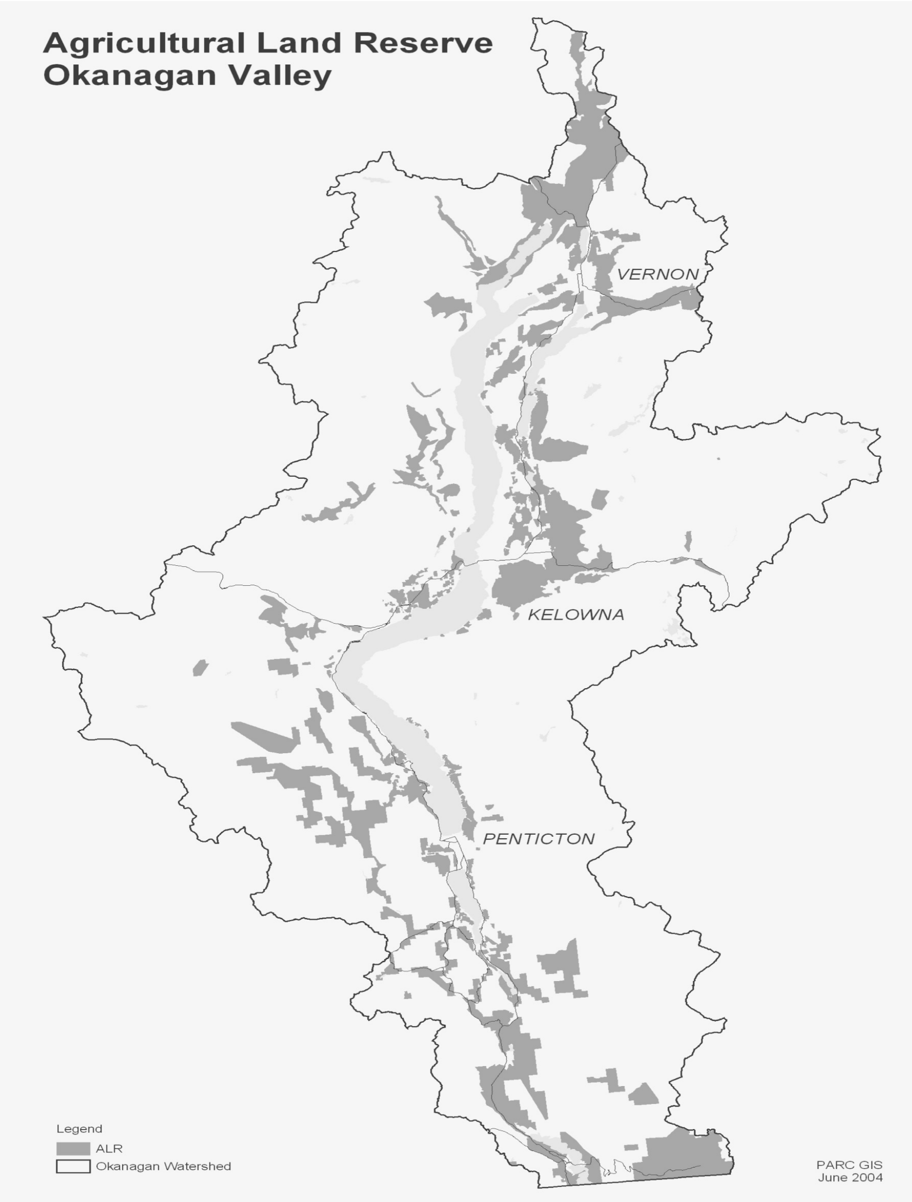

FIGURE 1

The Agricultural Land Reserve (ALR) in the Okanagan Basin, British Columbia, Canada (Neilsen et al., 2004b).

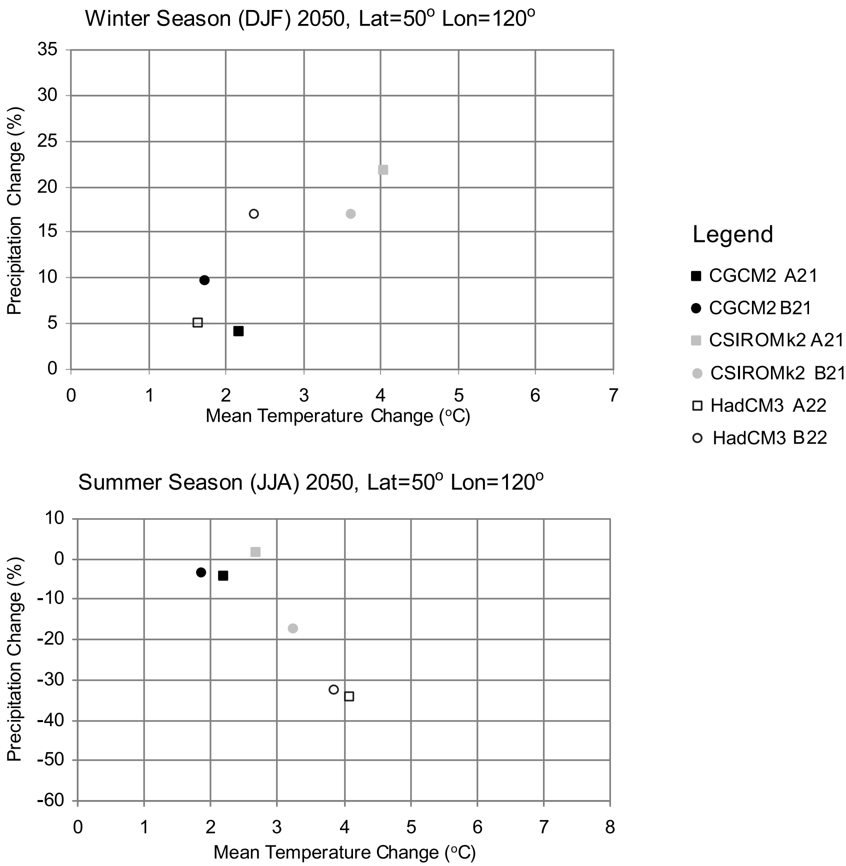

FIGURE 2

Scatterplots of projected changes in average daily temperature (degrees Celsius) and precipitation (percent) for the 2050s relative to 1961-90 for winter (top) and summer (bottom) for three GCMs and two SRES scenarios for southern BC (Taylor and Barton, 2004).

2. Climate and Hydrology

Scenarios of future climate change were obtained from the results of 3 global climate models and 2 scenarios of global greenhouse gas emissions. The climate models selected were Canada's CGCM2, Australia's CSIROMk2 and the United Kingdom's HadCM3 (Figure 2). The emission scenarios were A2 (high growth) and B2 (low growth) from the Intergovernmental Panel on

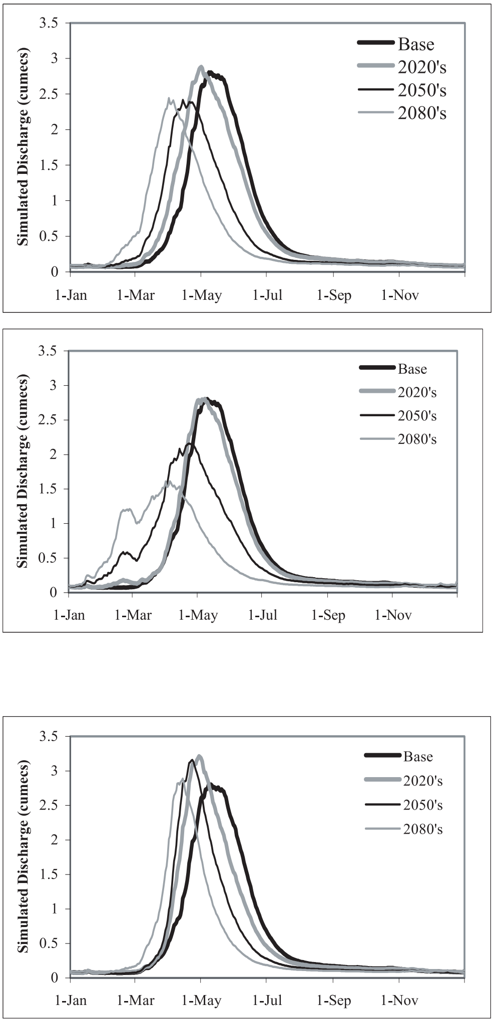

FIGURE 3

Impacts of climate change scenarios on Whiteman Creek, near Vernon (Merritt and Alila, 2004), using the A2 emissions scenario for CGCM2 (upper left), CSIROMk2 (upper right) and HadCM3 (lower left). *Note: Images as provided by author.*

Climate Change (IPCC, 2000). These scenarios indicate that temperatures would increase between 2 and 4 degrees Celsius by the 2050s. Winter precipitation would increase between 5 and 20 percent. Summer precipitation remains the same in some cases, and declines in others. The worst case is for HadCM3-A2, with a summer precipitation decrease of 30 percent (Taylor and Barton, 2004).

The climate scenarios were used as input to a hydrologic model, the University of British Columbia (UBC) Watershed Model, in order to simulate changes in streamflow and water supply. Results show that for all 6 scenarios, the annual peak streamflow would occur earlier in the year due to earlier snowmelt. However, the nature of the peak would vary among the scenarios. An example is shown for Whiteman Creek in the north Okanagan (Figure 3). The CSIROMk2 showed lower peaks extending over a longer period, while the HadCM3 scenarios showed a more compressed peak, higher at first but then becoming lower than present day peak flows (Merritt and Alila, 2004).

Estimates of annual water supply were generally lower than present day supplies. These reductions would be modest during the 2020s, but would become more severe during the 2050s and 2080s. For a reservoir in the southern Okanagan, near the city of Penticton, the worst case reduction would be 35 percent by the 2050s and 66 percent by the 2080s (Merritt and Alila, 2004).

3. Water Supply and Demand

Water demand for agriculture and residential users was determined based on established local relationships between climate and crop type or population growth, respectively (Nielsen et al., 2004a; 2004b). A longer warmer growing season is expected to lead to increased water demand on a per hectare (agriculture) or per capita (residential) basis, assuming no change in water delivery policy or technology. The increased growing season temperatures are expected to lead to increased evapotranspiration. Once this estimate is provided, there could be an opportunity to look at the effects of various options to reduce water demand.

Although most of the summer precipitation scenarios describe decreases in June to August rainfall, the demand functions used in this study are based only on temperature. Winter demand in the Okanagan is assumed to be unaffected by climate change. It is also assumed that there is no direct effect of elevated atmospheric carbon dioxide due to the inconclusive nature of the literature on such effects as they pertain to irrigated crops and orchards (Neilsen et al., 2004b). These various assumptions, however, contribute to the

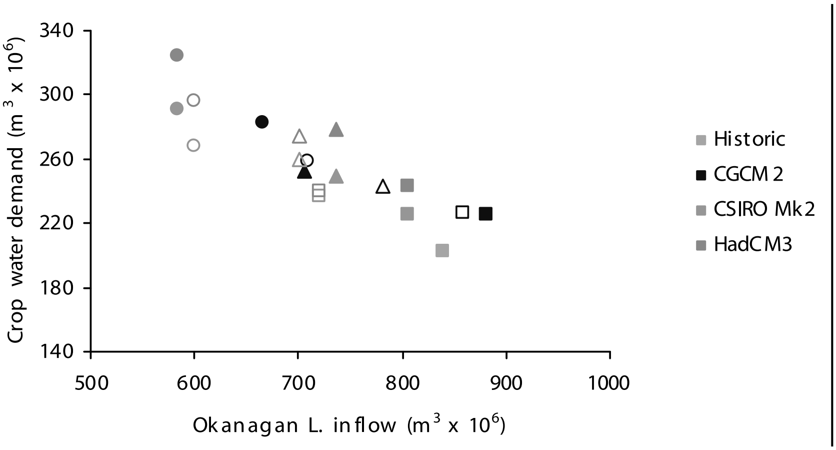

FIGURE 4

Comparison of estimated demand for irrigation water in the Okanagan Basin and estimated inflow into Okanagan Lake under historic conditions and six climate scenarios at three time slices: 2020s (■), 2050s (▲), 2080s (•). Filled symbols are A2 scenarios and open symbols are B2 scenarios. (Neilsen et al., 2004b).

uncertainty associated with scenario-based studies of climate change impacts and adaptation.

Crop water demand for the region as a whole is projected to increase by 30 percent or more by the 2080s (Figure 4), compared with the estimate for the 1961-1990 historic climate (Neilsen et al., 2004b). Projected decreases in Okanagan Lake annual inflows are 15-30 percent. Residential water demand is also expected to increase, primarily because of projected population growth, but climate change would accelerate this increase (Neilsen et al., 2004a). This scenario of reduced supply combined with increased demand suggests an increasing risk of water shortages during the next several decades.

4. Adaptation—Experiences & Dialogue

The Okanagan region is no stranger to managing for water shortages. Water managers and planners have foreseen potential problems for regional water resources, such as the implications of population growth (Obedkoff, 1994). Case studies of early adopters of alternative management strategies indicate that there is an ordered sequence of stages, where local actors a) detect a signal, b) attribute this signal to a particular cause, c) make a decision to respond, d) implement the decision, and e) evaluate the effectiveness of this response.

There were four case studies, two on demand reduction through metering, one on water reclamation and one on amalgamation of 4 separate municipal utilities into one regional water delivery system (Shepherd, 2004). These cases reveal that although the basic stages are followed, each case has its own specific conditions that create challenges and opportunities for adaptation to climate change. Briefly, these are a) values and perceptions toward the resource, b) financial aspects, and c) regional politics and policy. There are both objective and subjective aspects. Analysis of these cases suggests that the two metering cases represent strategies that are more likely to be successfully implemented. The other two would have to overcome more barriers, both technical, financial, and/or institutional (Shepherd, 2004).

Subsequent dialogue with regional water interests focused on the future scenarios of climate change. Local and whole basin workshops were organized during the winter of 2003-2004 (Tansey and Langsdale, 2004). The objectives were to report on research findings, to gain local insight on the feasibility of various adaptation options, and to discuss issues associated with the potential implementation of these options as part of an adaptation 'portfolio' at the local and whole basin scales. A wide range of options was available for discussion, including augmenting supplies with increased storage capacity or access to additional surface water and groundwater sources, and managing demand through metering, education, regulation and new delivery technologies (e.g. drip irrigation).

The two community workshops were held in Oliver, British Columbia, Canada, a small town in the southern Okanagan, and the Trepanier area, an unincorporated region near Kelowna experiencing rapid population growth. These communities had quite distinct reactions to the various options. Oliver favoured an approach that would enable it to maintain its focus on agriculture and avoid rapid population growth, while Trepanier wanted to anticipate rapid growth with access to more sources. Both were interested in expanded groundwater use, but were concerned about potential environmental implications (Tansey and Langsdale, 2004).

Bringing this dialogue to the scale of the whole basin proved to be difficult. There was indeed a different character to this dialogue, one that was broader, more strategic than the local discussions. An important theme that emerged from here was the need for integration of water and land use planning, and for some form of basin-wide governance on water issues (Tansey and Langsdale, 2004).

5. Conclusion

A warmer climate, as described in the scenarios used in this study, would lead to reductions in annual water supply and increases in agricultural and residential water demand in the Okanagan region of British Columbia, Canada. Many adaptation options are available, and the region has had previous experience with many of these, but each one comes with its own attributes and challenges, and some may be easier to implement than others.

The study's interdisciplinary approach, and the collaborative aspects with regional water interests and expertise, enabled the development of a positive working relationship, and an experience of shared learning. It is hoped that this establishes a good foundation for continuing collaborative efforts in the future.

The final report of this study (Cohen et al, 2004a) is now available. During 2004-2006, there will be a new phase on developing a dialogue on adaptation policy. This will be supported by an exercise to build a decision support model of the Okanagan system, through a group model building process (Cohen et al., 2004b).

6. Acknowledgements

This study was a collaborative between researchers from Environment Canada, Agriculture and Agrifood Canada, University of British Columbia, British Columbia Ministry of Water Land and Air Protection, and regional partners. Support was provided by a grant from the Climate Change Action Fund; project A463/433 (now Climate Change Impacts and Adaptation Directorate), Natural Resources Canada, Ottawa. Opinions expressed here are those of the author and not necessarily those of Environment Canada and the study partners.

7. References

Arnell, N., C. Liu, R. Compagnucci, L. da Cunha, C. Howe, K. Hanaki, G. Mailu, I. Shiklomanov and E. Stakhiv, 2001. Hydrology and Water Resources. In: *Climate Change 2001: Impacts, Adaptation, and Vulnerability.* Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change [McCarthy, J., O. Canziani, N. Leary, D. Dokken, and K. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Cohen, S. D. Neilsen, and R. Welbourn (eds.). 2004a. Expanding the Dialogue on Climate Change & Water Management in the Okanagan Basin, British Columbia. Environment Canada, Agriculture & Agri-Food Canada & University of British Columbia. Project A463/433, submitted to the Adaptation Liaison Office, Natural Resources Canada, Ottawa. Available at [http://www.ires.ubc.ca].

Cohen, S., J. Tansey, S. Langsdale, D. Neilsen, B. Taylor and S. Smith. 2004b. Towards decision—a look ahead. In Cohen, S., D. Neilsen, and R. Welbourn (eds.), Chapter 13.

Hisschemöller, M., R.S.J. Tol and P. Vellinga. 2001. The relevance of participatory approaches in integrated environmental assessment. *Integrated Assessment,* 2, 57-72.

Intergovernmental Panel on Climate Change (IPCC). 2000. *Emissions Scenarios. A Special Report of Working Group III of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, U.K. 599 pp.

Merritt, W. and Y. Alila. 2004. Hydrology. In Cohen, S., D. Neilsen, and R. Welbourn (eds.), Chapter 7.

Neilsen, D., W. Koch, W. Merritt, G. Frank, S. Smith, Y. Alila, J. Carmichael, T. Neale and R. Welbourn. 2004a. Risk assessment and vulnerability—case studies of water supply and demand. In Cohen, S., D. Neilsen, and R. Welbourn (eds.), Chapter 9.

Neilsen, D., W. Koch, S. Smith and G. Frank. 2004b. Crop water demand scenarios for the Okanagan Basin. In Cohen, S., D. Neilsen, and R. Welbourn (eds.), Chapter 8.

Obedkoff, W. 1994. Okanagan Basin Water Supply, File No. 42500-60/S Study No. 384, Province of British Columbia Ministry of Environment Lands and Parks. Victoria, BC.

Rotmans, J. and van Asselt, M.B.A. 1996. Integrated assessment: a growing child on its way to maturity. *Climatic Change*, 34, 327-336.

Shepherd, P. 2004. Adaptation experiences. In Cohen, S., D. Neilsen, and R. Welbourn (eds.), Chapter 10.

Tansey, J. and S. Langsdale. 2004. Exploring anticipatory adaptation in the Okanagan, BC. In Cohen, S., D. Neilsen, and R. Welbourn (eds.), Chapter 12.

Taylor, B. and M. Barton. 2004. Climate Change Scenarios. In Cohen, S., D. Neilsen, and R. Welbourn (eds.), Chapter 5.