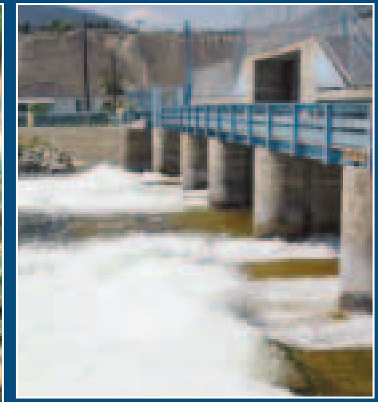
# Expanding the Dialogue on Climate Change & Water Management in the Okanagan Basin, British Columbia

## EXECUTIVE SUMMARY

### JANUARY 1, 2002 TO JUNE 30, 2004



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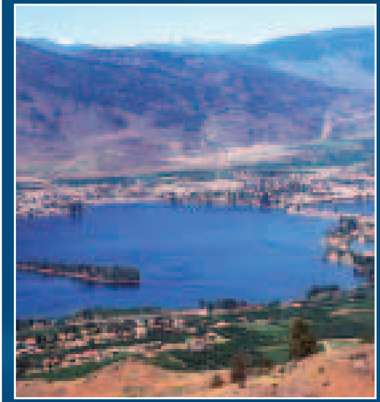

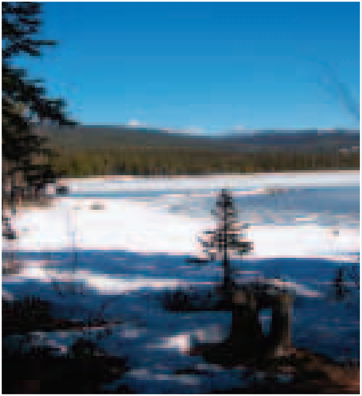

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An electronic copy of this report is available at the following web site:
**http://www.ires.ubc.ca**

The study team also produced an interim report in 2003.  It is available at the following web site:
**http://www.sdri.ubc.ca/documents/Okanagan_2003_Interim_Report_Final.pdf**

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Cover photo caption

1. *Trickle Drip Irrigation (Denise Neilsen)*
2. *Dam at South End of Okanagan Lake, Penticton (Wendy Merritt)*
3. *The Town of Osoyoos, and Osoyoos Lake (Denise Neilsen)*
4. *Ellis Creek Reservoir East of Penticton (Brian Symonds)*
5. *Overhead Sprinkler Irrigation (Denise Neilsen)*

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# Executive Summary

This is the final report of project A463/433 under the Climate Change Impacts and Adaptation Program (Natural Resources Canada) entitled, "Expanding the Dialogue on Climate Change and Water Management in the Okanagan Basin, British Columbia". The research activity described in this report is a collaborative, interdisciplinary effort involving researchers from Environment Canada, Agriculture and Agri-Food Canada, the University of British Columbia, the BC Ministry of Water, Land and Air Protection and the District of Summerland.

The goal of this study is to develop integrated climate change and water resource scenarios in order to stimulate a multi-stakeholder discussion on the implications of climate change for water management in the region. The study team hopes to achieve two main objectives: a) providing a set of research products that will be of relevance to regional interests in the Okanagan, and b) establishing a methodology for participatory integrated assessment of regional climate change impacts and adaptation that could be applied to climate-related concerns in Canada and other countries.

The study comprises five key components:

1. **Climate change scenarios:** downscaling global climate change scenarios to the regional level;
2. **Hydrological scenarios:** determining impacts of climate change on basin hydrology;
3. **Water demand scenarios:** developing future demand scenarios particularly for irrigated agriculture and municipalities, factoring in socio-economic trends;
4. **Adaptation options:** exploring previous management experiences and potential future approaches for augmenting water supply and/or reducing water consumption; and
5. **Adaptation dialogue with stakeholders:** learning about regional perspectives on adapting to climate change.

## Climate

The 8200 km$^2$ Okanagan valley is a long narrow basin stretching 182 km from Armstrong in the north to the Washington state border near Osoyoos in the south. The climate ranges from arid near Osoyoos to moist at higher forested elevations. Semi-arid conditions characterize much of the valley bottom. Annual and decadal variations are influenced by varying phases of the El Niño/Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO), which have led to periods of warming and cooling. In 1976, a warm PDO phase began, but there is evidence that it may have shifted to a cool phase in the late 1990s.

Local climate stations and snow courses have been analyzed for trends, and to determine the influence of ENSO, PDO, and other large scale atmospheric features. Significant warming, particularly during winter and spring, has been observed at two long term stations:

Summerland CDA and Vernon Coldstream Ranch. Daily minimum temperatures have increased at a faster rate than daily maximum temperatures. Spring and summer precipitation has been increasing during the last few decades, which is likely contributing to recent increases in lake inflow. The percentage of precipitation falling as snow (the "snow fraction") has been decreasing at low elevation valley stations, but not at higher elevations. Cloud cover has increased at Penticton Airport, especially at night. This has likely contributed to a decrease in annual mean solar radiation, while net radiation (sum of solar and terrestrial) has increased. The 1976 PDO phase change appears to have led to a reduction in snow water equivalent until the mid-1990s. Date of onset of snowmelt is occurring earlier than in previous years.

Conditions during 2002-2003 were considerably drier than in previous years. The 2003 drought was severe. Flows at Camp Creek were at 24-49% of the 1965-2003 mean due to low snowpacks and hot dry summer weather. This may be climatically similar to the drought of the 1920s and 1930s, but the impacts were probably worse due to the higher populations and expanded housing developments. Fires during 2003 destroyed more than 200 homes.

Many crops in the Okanagan Basin rely on various microclimates created by the complex topography. Microscale topographic variations in slope, aspect and elevation, and the different crop types give rise to an assortment of microclimates that have yet to be studied in detail. This project has used a network of 47 Hobo computerized temperature loggers to collect temperature data so that the microscale variations in climate could be mapped to aid the understanding of crop water demand and crop suitability. This network was set up at sites around Summerland and Naramata. Results for 2002-2003 shows that climate variation within these sites is as large as the differences in mean annual temperature between Armstrong and Osoyoos. The difference in accumulation of GDD10 between the warmest and coolest site was 31%.

Superimposed on the above variations and trends is the potential effect of increasing concentrations of greenhouse gases. Global Climate Model (GCM) experiments suggest that some warming has already occurred, and will continue to occur in the future. For this study, climate change scenarios were developed from three different GCMs (CGCM2-Canada, HadCM3-UK, CSIROMk2-Australia), and two scenarios of global greenhouse gas emissions from the Intergovernmental Panel on Climate Change's SRES series (A2—high increase, and B2—moderate increase). Simulations for three 30-year periods, centred on the 2020s, 2050s and 2080s, were obtained from the website of the Canadian Climate Impact Scenarios project.

For the 2050s, increases in winter temperature relative to the 1961-90 baseline lie in the range 1½ to 4 degrees Celsius with winter precipitation increases on the order of 5 to 25%. For summer, all models show a warming of roughly 2 to 4 degrees Celsius and precipitation changes ranging from almost no change to a 35% decrease in precipitation compared to the 1961-90 baseline. The greatest change in winter conditions is reflected by the Australian model (CSIROMk2) while the UK Hadley Centre model (HadCM3) shows the greatest change in summer climate.

## Hydrology

The UBC Watershed Model has been chosen to model precipitation-runoff processes. The model has been used extensively in British Columbia, and has been shown to adequately reproduce the hydrologic response of watersheds, and has previously been used in climate change studies.

Overall, the UBC Watershed model has been shown to be a suitable model for application to the Okanagan Basin. The arid climate of the basin and the deficiencies in the meteorological network make successful calibration of the model more difficult than in humid watersheds that exhibit less variability in precipitation across the watershed. Despite problems with representativeness of available climate data, the model was generally shown to perform adequately when the average parameter set and estimated precipitation parameters were used to drive the model. Likewise, model performance over the verification period indicates that the model is capable of predicting hydrologic response over different climatic periods.

The climate scenarios generated by the three climate models provide different, although equally plausible, outlooks for the future hydrology of watersheds in the Okanagan Basin. All climatic change scenarios consistently included an early onset of the spring snowmelt, a tendency towards a more rainfall dominated hydrograph and considerable reductions in the annual and spring flow volumes in the 2050's and 2080's. Of the three climate models, the CGCM2 model provided the most conservative predictions of the impacts of climate change in Okanagan Basin. Simulations based on the CSIROMk2 climate model suggested greatly reduced snow pack and flow volumes despite a sizeable increase in the winter precipitation. The HadCM3 model exhibits the greatest increase in summer mean temperatures of the three climate models.

The scenarios raise questions over the availability of future water resources in the Okanagan Basin, particularly as extended periods of low flows are likely to coincide with increased demand from agricultural and domestic water users. With the HadCM3 climate model, the hydrograph is peaky and quite confined in the period of elevated flows. Such a scenario would pose difficulties for water managers who would have to cope with the majority of water entering their reservoirs in a very short time frame. They would have to manage water levels in the reservoir(s) keeping in mind the prolonged shortage of flows downstream of the reservoir during the dry season. In contrast, the CSIROMk2 scenarios produce flatter hydrographs that distribute water more evenly through the season, in this sense making the job of managers easier. However, this would be offset by the extreme reduction in flows predicted by the climate model. Under both situations, managing for environmental flows may be more difficult. While provisions exist for maintaining sufficient flows for indigenous species during spawning and other key periods, what options are available if water resources are over-stressed, or peak flows increase? Additionally, a move towards a more rainfall dominated precipitation regime under warming may make forecasting more difficult. Managers of the lakes and reservoirs use the winter snowpack as a guide for releasing or storing water based on whether or not a water surplus or deficit is foreseen. With less snowfall events, anticipating extreme high or low flow periods and instigating pre-emptive management practices to cope with extreme flow conditions may prove problematic.

## Water Demand—Agriculture

The Okanagan Basin is highly subscribed to supply water for high value crops. Irrigated agriculture consists primarily of high value tree fruits and wine-grapes, pasture and forage, and a small area of vegetables. An agricultural land use database for the Okanagan basin has been compiled and incorporated into a GIS using ArcInfo™. These data have been incorporated into a valley wide model for crop water demand estimates.

The crop water demand model requires calculation of potential evapotranspiration (ET), based on temperature and solar energy, and length of growing season, based on seasonal start and end of accumulating growing degree days above critical minimum temperatures for each crop.

Another important consideration in the model is potential effects of elevated $CO_2$ concentration on plant transpiration. Although water demand reduction has been suggested for various crops in an elevated $CO_2$ environment, the literature does not give clear indication of any changes in water use by intensively managed irrigated tree fruit and vine crops. Field crops such as alfalfa may experience water demand reductions, but other investigators have shown these to be relatively modest for the U.S. Pacific Northwest. For this study, we have therefore assumed no effect.

Crop water demand scenarios generated from the climate change scenarios indicated increases for the Okanagan Basin above model estimates of current annual demand, which is around 200 million $m^3$. Increases would be 12-20% in the 2020s, 24-38% in the 2050s, and 40-61% in the 2080s. The greatest increase is for the HadCM3 scenario in the 2080s, which has the highest summer temperatures. This worst case scenario for the 2080s approaches the current total irrigation allocation of 323.7 million $m^3$.

There are also seasonal and regional differences among the scenarios, as well as differences among individual crops. From modeled demand the largest total amount of water was required for pasture and the least (44% of pasture requirement) for grapes. Apple required approximately 78% and cherry 87% of the amount needed for pasture. The low irrigation demand for grapes results from a shorter growing season and lower crop requirements during peak ET. In contrast, pasture and forage, being cooler season crops have a longer growing season with high demand. Tree fruits have a shorter growing season than pasture, but peak demand was higher. Given the differences among crops, regional and seasonal variations in demand were largely determined by the predominant land use. Thus, under conditions of future water shortage, crop profile may have a bearing on potential adaptation strategies. In addition, some crops, e.g. row crops, tree fruits and grapes are suitable for efficient micro-irrigation systems, which can lead to a considerable reduction in water use.

In the absence of an overall estimate of basin water supply, modeled inflows to Okanagan Lake were used as indicators of changing basin hydrology and compared to estimates of crop water demand. Over the century, modeled Okanagan Lake inflow declined to around 69% of current inflows, suggesting an overall decline in supply which would potentially exacerbate shortfalls caused by increased crop water demand

## Water Demand--Residential

Analysis has taken place on the degree to which climate change, through changes in maximum temperatures, may affect residential outdoor water use, in the context of other socioeconomic patterns that also affect demand. Historical analysis and projections have been created that represent three principal patterns of change in the Okanagan region, using the city of Penticton as a case study. The three patterns considered were 1) population change, 2) changes in preferred dwelling types, and 3) climate change induced temperature change. As people in the Okanagan region age, they are more likely to live in ground-oriented dwellings with lawns and gardens, with consequent and significant outdoor water use.

Three different population scenarios were considered, and were combined with independently generated dwelling projections. Future indoor and outdoor water use for each dwelling type was estimated for the period 2002 to 2069, with adjustments to outdoor water use based on six different climate change scenarios, as well as a scenario in which climate change has not been taken into account.

Water use appears to vary significantly across the three population scenarios in all cases. Climate change is expected to have an additive effect to any population scenario. However, the variations across climate scenarios appear to be moderate. For example, in the high population growth scenarios, usage growth relative to 2001 is 297 to 328 %. Under a scenario of no population growth and no changes in dwelling preferences, water use increases for the climate scenarios range from 5.6 to 9.5 % between 2001 and the 2020s and from 9.1 to 17.8% between 2001 and the 2050s. This may be contrasted with the increases in use associated with population projections alone, which range from 54 to 265% between 2001 and the 2050s.

According to these initial results, if the climate change effect is considered in comparison with the effects of population growth, a 9% increase from climate change (the lowest change among the climate scenarios) from 2001 to the 2050s is equivalent to an acceleration of the 50-year population growth effect by 11 years for low growth, 7 years for medium growth, and 4 years for high growth. For the most dramatic climate scenario, HadCM3-A2, the 18 percent increase in use is equivalent to an acceleration of 18 years for low growth, 13 years for medium growth, and 7 years for high growth.

More case studies are needed in order to assess the interacting effects of population growth and climate change on residential water demand for various communities around the Okanagan. If climate change speeds up the population effect, this has implications for long range planning, especially when combined with projected increases in crop water demand.

## Water Supply and Demand Scenarios

One of the major risks facing Okanagan agriculture is the occurrence and frequency of drought. In production systems that are entirely dependent on irrigation, drought may be defined by the inability to provide an adequate water supply to maintain an economic return. There are two components to drought in this case; high demand and low supply. It might be expected that risk would increase when high demand and low supply are combined. In the current study we define risk thresholds associated with 1) operational limits on demand and hydrological limits on supply for Trout Creek which provides water for the District of Summerland, and 2)modeled maximum supply and demand for the period 1961-90 for Ellis and Penticton Creeks which supply the City of Penticton. Annual estimates for supply and demand were produced for four periods: 1961-90 historic climate, 2020s, 2050s and 2080s.

For Summerland, in an average year, total Trout Creek flows are estimated to be around 84.1 million m$^3$, of which 2.5 million m$^3$ would be withdrawn for commercial and domestic use, and a maximum of 10.5 million m$^3$ for irrigation. This value is about half of the licensed allocation for irrigation of 20.93 million m$^3$. In the CGCM2-A2 climate change scenario, the number of years when the modeled 1990s irrigation demand threshold of 10 million m$^3$ might be exceeded increased over time, to around eighteen years out of thirty by the 2080s. Differences in response between the A2 and B2 emission scenarios only became evident by the end of the century. Estimates of demand varied among GCMs, with the most extreme responses occurring in the HadCM3-A2 scenarios, so that by the 2080s, demand exceeded the threshold in every year. During 1961-90, there were no modeled occurrences of demand exceeding this 1990s threshold.

While demand is expected to increase, supply is projected to decline. A drought threshold of 30.3 million m$^3$ (36% of average annual flow) has been proposed for Trout Creek. During 1961-1990, there was only one occurrence in 30 years of modeled, unrestricted flow lower than the drought threshold, for a frequency of 3%. For the A2 scenarios, this increased to 7% by the 2020s, 17-24% by the 2050s, and 31-44% for the 2080s. The CSIROMk2 model provided the driest A2 scenarios. For the B2 scenarios, there were fewer extreme low flows than for A2, except for the CSIROMk2-B2 scenarios which produced more drought years in the 2020s and similar event frequencies in the 2050s and 2080s, when compared to A2.

It is apparent that the existing water infrastructure, which provides around 9.1 $m^3 \times 10^6$ of effective storage, will be unable to meet demands in years of extreme future climate. Crop water demand is more likely to exceed the current demand threshold in all climate change scenarios. Meanwhile, the frequency of annual flows below the drought threshold show similar increases under all scenarios. High risk outcomes to the Trout Creek system are defined as years in which demand exceeds 10.5 million $m^3$ and supply remains below the drought threshold of 30.3 million $m^3$. A2 scenarios resulted in high risk outcomes for HadCM3 in the 2050s (1 year in 6) and for all GCMs by the 2080s (1 year in 4 to 1 year in 2). Incidence of 'high risk' response for B2 scenarios was less than under A2.

A further concern is the timing of supply and demand. Model hydrographs generated with the UBC watershed model for Okanagan streams show that a characteristic response to climate change scenarios is earlier peak flow. Under such conditions, water available for irrigation from in-stream flow would not be available for much of the growing season, causing the supply system to be taxed by early dependence on stored water, as occurred in 2003.

Similar results were obtained for Penticton. For the A2 scenarios, the number of years when the 1961-90 demand threshold might be exceeded at Penticton Creek increased over time, from six years out of thirty by the 2020s to thirty years out of thirty by the 2080s. Estimates of demand varied among GCMs with the most extreme responses occurring in the HadCM3-A2 scenarios, so that by the 2050s, demand exceeded the threshold in every year. Similar responses were seen for the south irrigation area supported by Ellis Creek.

In contrast to the Trout Creek/Summerland water supply system, Penticton's water demand is dominated by domestic requirements. Modeled irrigation requirements for the combined north and south irrigation systems for the period 1961-2003 suggest that currently, irrigation requires just below half the amount of water required for domestic needs. The frequency with which modeled annual irrigation demand exceeded the most extreme years in the reference period of 1961-1990 increased for all models and scenarios throughout the century. Similarly, for both Penticton and Ellis Creeks, the scenarios resulted in an increased frequency of years with flow below the minimum modeled for the reference period. Consequently, for both north and south irrigation systems, there was increased risk of high demand coinciding with low supply over time. For all three GCMs, the A2 scenarios resulted in an increased frequency of these high risk outcomes; in the 2050s, between 1 year in 10 and 1 year in 6, and by the 2080s, between 1 year in 3 and 1 year in 2. High risk outcomes were fewer under B2 scenarios. In some very extreme years, there is a potential for demand to be greater than supply.

## Water Management (from the 2003 Interim Report)

There are three primary features of the Okanagan watershed which emphasise the complex, convoluted and multi-scale structure of interacting organisations and institutions involved in water management decisions:

- The water system crosses an international border
- Multiple levels of government
- Multiple in-stream and out-of-stream water uses meaning many advocacy organisations at different scales

Water management is shared by various levels of government (federal, provincial, local), as well as by regional bodies established to focus on particular issues. The latter include the Okanagan Basin Water Board that has recently worked on liquid waste disposal and Eurasian water milfoil, and the Okanagan Basin Technical Working Group that identifies and steers initiatives to rebuild fish stocks.

The Okanagan Basin also presents an interesting forum for exploring water allocation and licensing given its semi-arid climate, its growing population and the importance of irrigation to the regional economy. As of July 2002, there were approximately 4130 active water licenses in the Okanagan Basin listed in the Water License Query database maintained by Land and Water BC. These licenses represent approximately 1.05 billion cubic meters of allocated water on 980 streams for both consumptive and in stream uses. Sixty-six water license applications were also listed requesting a further 209 million cubic meters. Of the 1.05 billion $m^3$ of water allocated in the Okanagan, 476.8 million $m^3$ is allocated for consumptive purposes, where water is removed form the source. Around ⅔ is used for irrigation.

In the context of adaptation to climate change in the Okanagan, British Columbia's regulatory system provides several challenges. Rising water demands due to population growth and changes in water supply and demand resulting from climate change may result in increased activation of the prior appropriation principle, resulting in increased conflict. Even though conflict is often resolved in the field through more fair methods, increased water stress makes the situation more vulnerable. Under the same conditions, the beneficial use principle could become a more significant requirement in allocating licenses as water sources become saturated. The perpetual nature of water licenses and the limited ability of managers to modify water rights e.g. transferability and conditionalities, may become restrictive in the face of increasing demands to manage water for multiple objectives (which may or may not be subject to water licensing). Balancing in-stream (e.g. fish) and out-of-stream uses (e.g. domestic & irrigation) could become increasingly difficult under a climate change scenario.

This question of balancing various water uses is made more difficult by the failure to define acceptable minimum fish flows. Also, the BC government's Fisheries Protection Act, which has language which would allow managers to grant water licenses to protect in-stream flow, and to reduce water use during drought conditions, has not yet been proclaimed.

## Adaptation Case Studies

Adaptation to climatic change impacts, and other stressors, on water resources in the Okanagan is an important challenge for both local and provincial decision-makers, but how have local authorities in the Okanagan Region adapted to current pressures on water resources? In order to learn more about what adaptation entails and to identify specific local challenges, four case studies of water management practices at the local authority level were selected. Each represents the adoption of a different water efficiency approach, specifically: domestic metering in Kelowna, irrigation metering in SEKID, wastewater reclamation in Vernon and institutional change, specifically amalgamation of individual water utilities, in Greater Vernon. The latter three represent "early adopters" in the region.

The primary objective of the case studies was to explore how local authorities are *adapting* to changing circumstances that impact their water resources: what factors trigger early adaptation, the options selected and the success or failure of implementation, as well as what capacities facilitated adaptation i.e. *adaptive capacity*. Exploration of adaptation from a multi-stress perspective accentuates the contextual nature of adaptation to climatic change; that many factors i.e. other environmental pressures, socio-economic and political issues, will ultimately constrain, impede or encourage effective adaptation. Secondary objectives of the study included analysing the *effectiveness* of the four management practises and exploring the role of *learning* in the adaptation process. 28 semi-structured interviews with local water managers, Council/Board members and other key informants were undertaken.

These cases show that adaptation is not a linear, clear-cut process. Although, in each case a specific trigger could be identified, specifically drought episodes and provincial lead studies, different conditions shaped attribution i.e. interpretation of cause, and the appropriate mode of action to be taken. Action was immediate or lagged, depending on the interpretation of signal characteristics such as magnitude (relative to previously experienced related events), immediacy and tangibility, as well as socio-political factors. Ultimately in each case, action was pursued when a perceived coping threshold was fast approaching. Option selection was influenced by option availability, local and provincial agendas and values (including financial incentives), and previous proved effectiveness. Decision and implementation processes were less fraught with conflict when user groups were well informed. The effect of short political cycles on the development and continuation of a given management approach was especially evident in one case; at each cycle, new authority values resulted in a shift in direction, diffusing ultimate effectiveness.

Overall, the actions employed in the four cases appeared to be successful. Water "savings" were achieved in both metering examples. Kelowna achieved the pre-set 20% reduction target of their single family metering project. Allocated yearly water allotments in SEKID were reduced by 10%. Although water reclamation was initially implemented as a water treatment strategy (and an effective one), it is now considered as a potential water re-use, and therefore, efficiency strategy. As for amalgamation of local authority water utilities in Greater Vernon, effectiveness is not easily measured. This action could eventually lead to a more efficient use of available water sources through sharing of water sources that were previously earmarked for individual authority use. Cost sharing has been another advantage to amalgamation.

There are some clear lessons learned from these case studies that are important in answering the question - how to adapt to climate change in the Okanagan? The fear of change - the challenge of transition - runs throughout. Many factors either exacerbate the difficulty of change or smooth out the process: public perceptions and differing political agendas are two key issues. Agricultural users have a strong sense of ownership over water resources due to historical dominance in the region. In addition, low water rates are expected, as this has been the norm for many years. The divergent relationship between local, regional and provincial authorities means that finding any unified approach in the region could be a long-winded political struggle. Finally, any adaptation option will ultimately achieve efficiencies to simply allow for further development in the region, without a change in the development agenda. Such approaches will not reduce local vulnerability to climatic change impacts.

## Costs of Adaptation Options (from the 2003 Interim Report)

A number of adaptation options are available that can help meet possible shortages due to climate change and other factors such as population growth. These options include both demand side measures and supply side measures. Demand side options include water conservation alternatives such as irrigation scheduling, public education, metering and adoption of efficient micro irrigation technologies. Supply side options include increasing upstream storage and switching to the mainstem lakes or rivers as a supply source, thereby relying on the large storage capacity of Okanagan lake.

The costs of both demand and supply side options will vary greatly depending on various features of the individual water supply systems and the type of demands served. In summary, there is no one least cost adaptation option for all water systems since costs will vary significantly from system to system. The lowest cost option in one area may turn out to be a higher cost option in other areas. Other factors, such as water quality and treatment options will also enter into the decision. Often a combination of options will be necessary in order to achieve full insurance against future water shortages and demand increases.

For future budgeting purposes, it appears that systems that are already near capacity would have to consider costs of at least $1000 per acre-foot to conserve or develop supplies of water to adapt to climate change. If projections indicate that large amounts of water must be conserved or supplied then probably $2000 per acre-foot would be a reasonable figure to consider in future budgets. Site-specific engineering studies would have to follow to obtain more accurate figures.

## Dialogue with Stakeholders

Dialogue with stakeholders has been used to communicate research results to local water practitioners and interests, and also to learn about regional perspectives on how adaptation options might be implemented at the community and basin scales.

Two case study locations, Oliver and the Trepanier Landscape Unit, were selected for the two community adaptation workshops in the Okanagan. Oliver is a small agricultural community in the south of the Valley. Trepanier Landscape Unit, including Peachland and unincorporated areas around Westbank, is a fast-growing area to the west of Kelowna. Participants in the workshops were presented with a range of technically viable supply and demand side water management options and were asked to evaluate them according to eight questions. The questions addressed three broad themes: the social acceptability of the options, the current legal acceptability and political/jurisdictional concerns.

The results of these workshops reveal the complex political landscape that overlay the physical landscape of the region. Historical commitments to users in the agricultural community shape the current allocation of water resources and strongly influence the acceptability of adaptation options. Education and conservation interventions were considered useful in both communities. With respect to groundwater utilisation, many participants pointed out that while it may represent a viable alternate source in some areas, extraction is currently unregulated. Increasing drought pressure on traditional water sources may therefore result in largely unregulated groundwater withdrawal.

A third workshop focused on the topic of implementing an adaptation portfolio at the basin scale. This event was an additional opportunity to discuss the feasibility of anticipatory adaptation measures, but this time the discussion centered on changes that would affect, or be implemented in, the entire region. Because the scale of discussion was broader in geographic area, the adaptation measures discussed were also broader. General supply side and demand side approaches were discussed rather than site-specific strategies. There was also a greater emphasis on governance structures that could implement and orchestrate change on this scale.

Dialogue at this scale was more strategic. Participants expressed support for expanding the role of the Okanagan Basin Water Board (OBWB) and Okanagan Mainline Municipal Association (OMMA) in regional water quantity management. There was support for basin-wide management of various measures, including increased use of Okanagan Lake and groundwater sources, a coordinated "water smart" program for residential users, and various measures that could be regionally coordinated for agricultural users such as irrigation scheduling.

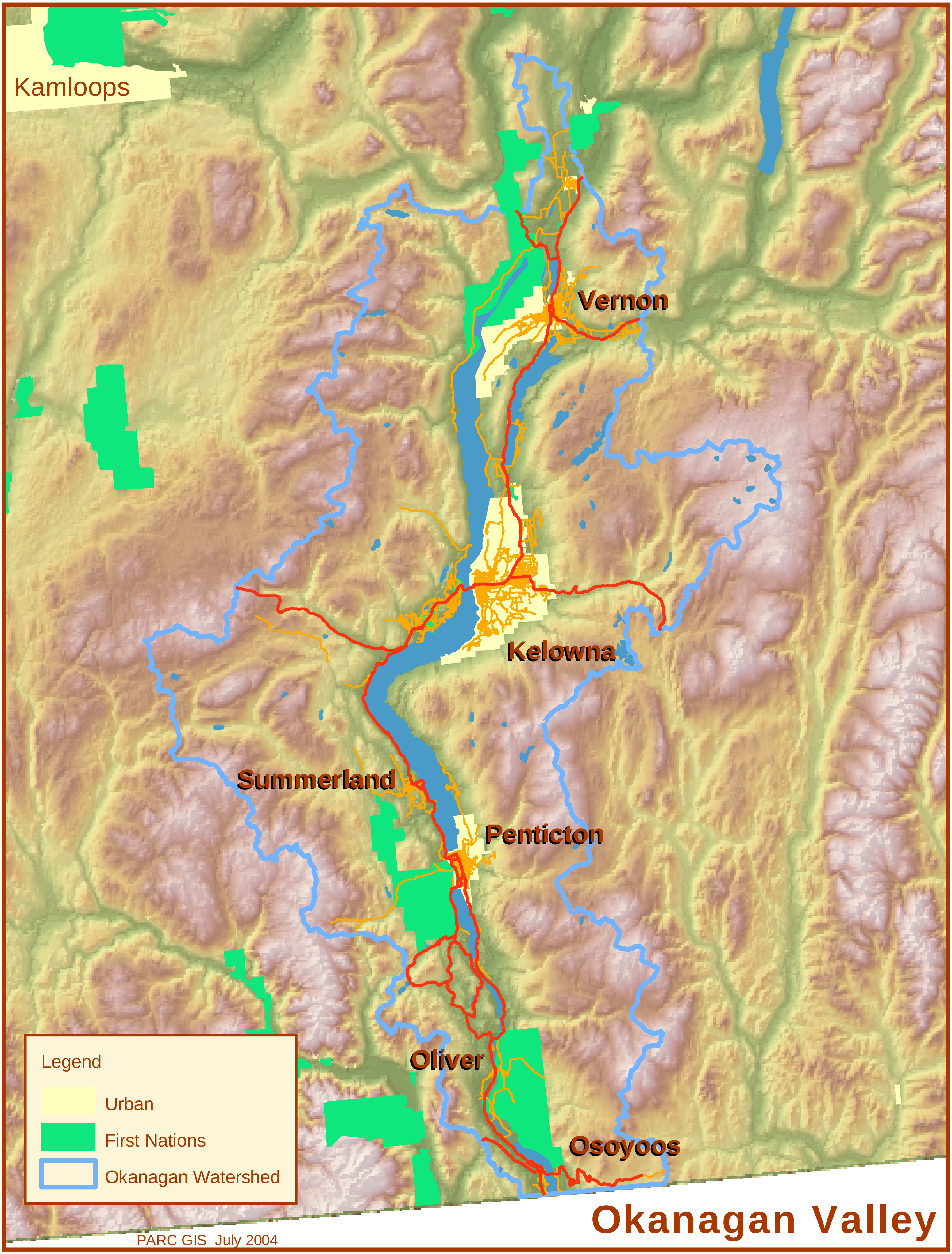
One recurring theme at the regional scale was the need for support from the local level, and encouraging a sense of "belonging to the basin." Participants also expressed the need for better integration of water issues with local development and planning.

## Towards Decision—A Look Ahead

This collaborative study has outlined a scenario of climate change and its implications for water management in the Okanagan Basin during the 21st century. This study has depended on field research, computer-based models, and dialogue exercises to generate an assessment of future implications, and to learn about regional views on the prospects for adaptation. Along the way, it has benefited from strong partnerships with local water practitioners and user groups.

The next step is to explore specific adaptation policy options. We are pleased to report that a follow-up proposal has been approved for 2004-2006 by the new Climate Change Impacts and Adaptation Program of the Government of Canada. The objective of this new exercise is to create a systems model of the Okanagan water management system, with the help of regional experts, and to use this model to support a new dialogue on adaptation policy.

We look forward to this new opportunity.



Okanagan Valley

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