ROSENBERG INTERNATIONAL FORUM ON WATER POLICY

FORUM V
BANFF, CANADA
SEPTEMBER 6 -11, 2006

PROGRAM SYNOPSIS
&
LESSONS FOR CANADA
&
ALBERTA

Synopses
By
Henry Vaux Jr.
Chair, Rosenberg International Forum on Water Policy

Analysis
By
Robert Sandford
Chair, United Nations Water for Life Decade
Canadian Partnership Initiative

MINISTER'S SUMMARY

The Rosenberg International Forum on Water Policy was created in 1996. It is named for Richard Rosenberg, former Chairman of the Bank of America. Upon Mr. Rosenberg's retirement in 1994, the Bank of America endowed the University of California in his name with resources to help support an invitational biennial water forum for the world's leading water scholars and senior water management practitioners. The main thrust of these Forums is the resolution of conflict emerging from trans-boundary water issues. The first of these Forums were held in San Francisco, U.S.A.; Barcelona, Spain; Canberra, Australia; and Ankara, Turkey.

The 5th Biennial Rosenberg International Forum on Water Policy was held in Banff, Canada between September 6th and 11th, 2006. The principal sponsors of the Rosenberg International Forum on Water Policy are the University of California and the Bank of America. Local co-sponsors for the 5th Forum included Alberta Environment, Alberta Ingenuity Centre for Water Research, Alberta Irrigation Projects Association, The Banff Centre, The Max Bell Foundation, The Calgary Foundation, the Columbia Basin Trust, Zaragoza EXPO2008 and the United Nations Water for Life Decade initiative in Canada.

Participants in the Forum included 52 scholars and water managers from 24 countries. The theme of the Forum was: "Upland Watershed Management in an Era of Global Climate Change." The Forum included a two-day pre-Forum field trip through the UNESCO Canadian Rockies World Heritage Site to examine modern upland watershed practices, two days of formal presentations and a post-Forum field trip to the Columbia River Basin, which was the subject of a case study at Rosenberg Forum IV held in Ankara, Turkey in 2004.

There are seven over-arching lessons for Albertans and Canadians from the Rosenberg International Forum on Water Policy that was held in Banff in the fall of 2006.

1. Canada is not as advanced as it might like to believe in terms of public policy relating to water supply and quality assurance. There are issues of equity; inefficiencies associated with jurisdictional fragmentation of responsibility and accountability; an absence of reliable and commonly useful data and widespread examples of inadequate foresight and management of water in the context of other forms of resource development. There are many gaps in federal and provincial water management policy that need to be filled. The country needs to move past its own myths of limitless water abundance to create a new national water ethic based on conservation and different formulae for valuing water as a resource in its own right.

2. Compared to other places in the world, there is not yet a water crisis in Alberta or in the Canadian West. But Alberta, in particular, has all the makings of one. These elements include:

- Heavy agricultural reliance on water
- Rapidly growing populations
- Increased water demand from cities and industry
- Reduced flows in important watercourses
- Unpredictable climate variability

3. There are others from whom Canadians and Albertans can learn. Canadians should vigorously pursue access to global knowledge and experience, so that we do not make the same mistakes others have made. The old saying is true. Every time history repeats itself, the price goes up.

4. Though highly significant in a Canadian context, the Alberta Water for Life Strategy is not unique. Approaches similar to this have been explored in many other countries with varying degrees of success. It could become unique, however, simply for having been fully implemented. Such implementation, however, will require political support and appropriate funding.

5. Politics aside, the measure of Canadian water management success will be determined – not by what is said – but by what is actually done, in support of Water for Life and other water management initiatives.

6. Alberta presently has the resources to go right to the front of the world queue and get the management of water right.

7. The final lesson is that the longer policy makers in water scarce areas like Alberta wait to change their water management frameworks, the more investment there will be in current systems and the more difficult it will become to make needed changes. Alberta should move now while there is still slack it can take up in its systems and before it is facing crisis.

The world is watching. As Leith Boully, an Australian water policy expert said at the conclusion of the Rosenberg International Forum on Water Policy held in Banff in September of 2006, "Because of our current good fortune, Canada has a greater obligation than other countries to act soon, and appropriately."

ROSENBERG INTERNATIONAL FORUM ON WATER POLICY

FORUM V
SEPTEMBER 6-11, 2006
BANFF, CANADA

MANAGING UPLAND WATERSHEDS IN AN ERA OF GLOBAL CLIMATE CHANGE

EXECUTIVE SUMMARY

The Rosenberg International Forum on Water Policy was created in 1996 through an endowment gift from the Bank of America to the University of California. The gift, and the Forum which it supports, honors Mr. Richard Rosenberg, retired Bank Chairman and a long-time champion of the need to develop effective water management policies. The major thrust of the Forum is the resolution of conflict over water resources. Each edition of the Forum has its own special theme. Previous Forums have been held in San Francisco, USA (1997); Barcelona, Spain (1999); Canberra, Australia (2002); and Ankara, Turkey (2004)

The Fifth Forum was held in Banff, Canada in 2006. The principal sponsors the Forum are the University of California and the Bank of America. Local co-sponsor for the 5th Forum included Alberta Environment, Alberta Ingenuity Centre for Water Research, Alberta Irrigation Projects Association, The Banff Centre, The Max Bell Foundation, The Calgary Foundation, The Columbia Basin Trust, Zaragoza EXPO2008 and the United Nations Water for Life Decade initiative in Canada.

Participants in the Forum included 52 scholars and water managers from 24 countries. The theme of the Forum was: “Upland Watershed Management in an Era of Global Climate Change.” The Forum included a two day pre-Forum field trip through the UNESCO Canadian Rockies World Heritage Site to examine modern upland watershed management practices, two days of formal presentations and a post-Forum field trip to the Columbia River Basin, which was the subject of a case study at Forum IV held in Ankara, Turkey.

The formal sessions include three general sessions on topics related to upland watershed management practices around the world and the implications of global climate change for upland watershed management. There followed four case studies which included the Jordan, Saskatchewan and Rhone River Basins and the International Joint Commission, a bilateral institution created a century ago to resolve boundary water disputes between Canada and the United States. A copy of the Forum program is appended to this document. The following Executive Summary identifies the main themes from each session and the key lessons for Canada.

KEYNOTE SESSION

Key Themes

1. Water rich countries are afflicted with most of the same problems as water poor countries.

2. Mountains are sensitive indicators of environmental change. They are also critically important as regions where water supplies are generated.

3. One major response to the intensifying global water scarcity is to recognize and act on the need to accord realistic values to water and to reflect those values in prices.

Key Lessons for Canada

1. There is an urgent need for public information campaigns that dispel the myth of limitless abundance of water in Canada. Reform of the regulatory process governing drinking water quality should be continued and existing models of water pricing should be reformed. The long-term effectiveness of infrastructure grant programs should be assessed.

2. It is crucially important for Canadians and Albertans to recognize and address future challenges and threats to their water supply and distribution systems. Climate change will be both a challenge and a threat.

3. Mountain water in Alberta will be more valuable in the future since it will represent a major higher percentage of what is available regionally as climate change alters the traditional patterns and timing of precipitation, run-off and river flows. Though the protection of upland watershed areas for recreational and other uses is a source of pride, the importance of these areas as generators of future water supplies deserves increased emphases and attention.

4. The current level of knowledge about mountain hydrology is insufficient to meet the challenges of the future. This lack of knowledge will make sustainable water management and the long-term assessment of vulnerabilities more difficult than it needs to be.

5. As population grows, the need to manage upland watersheds with care becomes increasingly urgent. Hard engineering solutions are not sufficient. More scientific research is needed and better monitoring and evaluation systems are also urgently needed.

6. Effective stakeholder involvement and the development of effective regulatory systems demands that jurisdictional fragmentation be eliminated in favor of more unified and democratic institutions to manage upland waters.

SESSION 1

CHALLENGES IN UPLAND WATERSHED MANAGEMENT: FOR WHAT? FOR WHOM?

Key Themes

1. The management of water resources should be holistic. The focus should be on the management of ecosystems and not on the management of water in isolation.

2. The distinction between green water and blue water helps to focus attention on green water and how that can be managed. Historically, attention has been focused almost exclusively on blue water.

3. A new water management framework is needed and a new water ethic should be part of that framework. The framework should be international in scope and not simply restricted to single nations.

Key Lessons for Canada

1. The measurement of how trees and plants use water and the characterization of how their use affects the quantities of water available for other uses is an important way of looking at where water is and what it does in nature and in cultivated environments. Proper management of "green water", water contained within environments, can significantly augment the existing "blue water" sources which come from surface sources and aquifers.

2. The artificial separation of land and water resource management policies in Canada severely constrains the ability of Canadians to employ and practice integrated watershed management strategies. Management of "green water" will require a shift in Canadian land-use policies that could allow many communities to move toward more sustainable water and land use practices.

3. The heavy reliance on surface water storage, which dominated water management strategies in the 20th century, created a variety of adverse impacts on social and environmental systems. New management paradigms will be needed in the 21st century and these will need to emphasize social, economic and environmental values as well as facilitate participatory decision making. There is an urgent need for a new water ethic to facilitate the transition to the new paradigm.

SESSION 2

UPLAND WATERSHED MANAGEMENT AND GLOBAL CHANGE

Key Themes

1. There is consensus within the scientific community that global climate is changing.

2. Water resource development and management has been based on anomalous climatic patterns. In the northern plains and elsewhere drought will be far more common in the future than in the past.

3. Adaptive strategies need to be devised for dealing with climate variability and the uncertainties it entails.

Key Lessons for Canada

1. Past climatological patterns are anomalous and future patterns will be characterized by droughts that are of much longer duration than those of the 20th century. The development of anticipatory plans for integrated watershed management approaches to address the new realities of climate will be constrained by incomplete knowledge of supply trends and natural variability in climatic patterns. All signs point to less water availability. For North America, it will be critical to improve the accuracy, precision and timing of seasonal forecasts of precipitation.

2. Conservation measures will be a major adaptation to climate change and variability. Such measures will include water pricing regimes that more accurately reflect the real costs of water supply. Economic sectors that base future plans on assumptions of hydrologic stationarity will be unprepared to address changes in water availability regimes.

3. Impacts will be felt not just in regions where rainfall is decreased or where net evaporation will increase. Upland forests produce a range of marketed and un-marketed ecosystem services related to the supply of fresh water. These services include water storage and buffered releases as well as water purification. All such services will be adversely affected by drought.

4. Some of the drought scenarios predicted for Canada are already occurring in the United States. Experience in the U.S. shows that the impacts of drought intensity on expected profits are more severe than those associated with increases in drought frequency. American farmers were better able to adjust to more frequent moderate drought than to less frequent intense drought and this may be the case in Canada as well.

SESSION THREE

CASE STUDY: THE JORDAN RIVER BASIN

Key Themes

1. The problems of water scarcity in the Jordan River basin are probably the most severe in the world. If these problems are to be successfully addressed, effective cooperation among the stakeholders will be essential.

2. Adaptive management will be essential and will entail hard choices. The extent of irrigated agriculture will likely have to be reduced, perhaps drastically.

3. External help in the forms of financial and diplomatic aid will almost certainly be required if the regional water problems are to be effectively addressed.

Key Lessons for Canada

1. It is very difficult to manage the Jordan River watershed in an integrated way because the data are only available for downstream hydrology. Good hydrologic data are required for both upland and lowland portions of any watershed and should include also accurate characterization of both surface and ground water. Western Canada suffers from the same lack data as the Jordan River Basin.

2. Hydrologic data must exist in formats that make it easy to share across upstream and downstream jurisdiction as well as among provinces and countries. The availability of good hydrologic data will help minimize conflicts and to resolve conflicts that do occur in a scientifically informed fashion.

3. Although water scarcity in southern Alberta does not now approach the level of intensity exhibited in the Jordan Basin, it will begin to approach that level if attention is not paid to the development and implementation of comprehensive and well-coordinated water policies.

4. Experience in the Jordan Valley illustrates the importance and maintaining and enhancing water quality. Water quality issues abound in Canada, and they must be addressed avoid levels of scarcity that are more intense than they need to be.

5. Effectively functioning frameworks for resolving trans-boundary water disputes are crucial for long-term stability in any region. In their absence, political, social and military conflict may make it difficult or impossible to implement good water management solutions.

SESSION FOUR

CASE STUDY: THE SASKATCHEWAN RIVER BASIN

Key Themes

1. Despite the apparent abundance of water in Canada, water is scarce in the southern portions of the Prairie Provinces where the population and most economic activity is concentrated. The Saskatchewan River presents important water management challenges that must be addressed if water crises of the sort that plague the Jordan River basin are to be averted in the future.

2. Existing science points the way toward needed changes in water management practices. It will be important to base new and altered water policies on sound science. Science must not be used exclusively to identify water problems. It is equally important for scientists to develop science-based solutions to these problems.

3. Scientists and policy makers need to work closely together to ensure that contemporary policies are based on science and are consistent with scientific knowledge. Both scientists and policy makers need to be aware of and sensitive to the perspectives of their counterparts and act in ways that accommodate those perspectives.

Key Lessons for Canada

1. Population growth and climate change impacts on water availability are poised to create a crisis in the Saskatchewan River Basin in southern Alberta. Average flows of the river have been much reduced in the past century and reduced flows, in combination with climate warming, have increased water temperatures significantly.

2. Prairie agriculture supplies two-thirds of Canada's agricultural exports. Yet, it has resulted in a slow degradation of water quality in the basin which must be considered a serious long-term problem. New agricultural and industrial developments should only be approved if they do not require large quantities of water during the dry summer months.

3. A number of water policy shortfalls must be addressed and the Alberta *Water for Life Strategy* is a beginning. However, it must be implemented in a fashion that will lead to comprehensive changes in water management policy.

4. In the interim, Prairie Provinces should control the emissions of greenhouse gases to reduce the warming that causes increased evapotranspiration and glacial loss as well as limit the growth of populations in the dry parts of the Saskatchewan River basin so as not to exacerbate water scarcity.

SESSION FIVE

CASE STUDY: THE RHONE RIVER BASIN

Key Themes

1. The Rhone is a highly developed and heavily modified river. The impacts of global climate change are already evident in the basin and additional global change will require a proactive response to new hydrologic and environmental realities.

2. Adaptive management is the only workable strategy for dealing with global climate change in the Rhone River basin.

3. Stakeholder involvement in the development, review and evaluation of adaptive management plans will increase the likelihood of success. Social learning will be a crucial part of both stakeholder involvement and adaptive management and will also be important in its own right.

Key Lessons for Canada

1. A number of climate change impacts have already been observed in the region and they have direct relevance for western Canada. These changes effect upland tourism (skiing), agriculture and lowland urban areas. The Rhone experience provides a window on what western Canada's more populous future might be like.

2. Snow making uses enormous amounts of water, even compared with irrigation, and thus it may not be an attractive adaptation to the loss of snow cover in ski areas. It is highly unlikely that the ski areas of Alberta will be exempt from the kinds of occurrence that have plagued and continue to plague the Alps.

3. It will be important not to become trapped by existing infrastructure into making inferior decisions about how to manage the consequences of incremental climate change. Improvements in water productivity and efficiency among the big water users may be the only available strategy.

4. Existing management structures need to be adapted to respond to environmental change. Management structures must be flexible and based upon a systematic incorporation of new scientific knowledge as it becomes available. This contrasts with current management systems which are driven by imperatives of management structure rather than by the resource system.

5. New collaborative (participatory) processes and skills that will facilitate the involvement of joint interests in generating knowledge, finding solutions and making decisions will be essential. Stakeholders and others must be prepared to be accountable and responsible for their actions.

SESSION SIX

CASE STUDY: THE INTERNATIONAL JOINT COMMISSION

Key Themes

1. The International Joint Commission has been extraordinarily effective in resolving boundary water disputes between the United States and Canada. There are a number of factors which explain the success and they include:

   a. Commissioners are independent and not delegates of their nation, state or province.

   b. The Commission accounts for the views of local stakeholders - it promotes public engagement.

   c. Commissioners have a commitment to finding consensual solutions and their history provides them culture of success.

   d. Joint fact-finding leads to shared understandings which are an effective basis for debate.

2. One key to success is to have an institutional framework that has clarity about goals, scope and process for engaging the parties and resolving the issues. .

3. The extent to which the successful experience of the International Joint Commission could be transferred elsewhere is unclear. Nevertheless, the Commission's history and experience provide valuable lessons.

Key Lessons for Canada

1. The IJC has been enormously successful in resolving the great majority of disputes which have been referred to it over the past century. The success and importance of this institution are highlighted by circumstances where referral to the IJC are not forthcoming and the governments attempt to settle disputes through diplomatic and political channels. The record of both countries in resolving boundary water disputes without the IJC is not good at all.

2. There is concern that the referral powers of the Boundary Waters Treaty are not being employed as they were in the past. Important transboundary issues are not being referred to the IJC for resolution.

3. Growing pressures of scarcity on boundary water resources likely mean that Canada will need more rather than fewer avenues for resolution both among provinces and between the two countries.

OVERARCHING LESSONS FOR CANADA

1. Canada is not as advanced as it might like to believe in terms of the adequacy of its public policies related to water supply and quality assurance. There are issues of equity, inefficiencies associated with jurisdictional fragmentation of responsibility and accountability, an absence of reliable and commonly useful data and widespread examples of inadequate foresight and management of water. There are many gaps in federal and provincial water management policy that need to be filled. The country needs to move past its own myths of limitless water abundance to create a new national water ethic based on conservation and different formulae for valuing water as a resource in its own right.

2. Compared to other places in the world, there is not yet a water crisis in Alberta or in the Canadian West. But Alberta, in particular, has all the makings of one. These elements include:

    - Heavy reliance on water by the agricultural sector
    - A rapidly growing population
    - Increased water demands from cities and industry
    - Reduced flows in important watercourses
    - Unpredictable climate variability

3. There are others from whom Canadians and Albertans can learn. Canadians should vigorously pursue knowledge and experience from elsewhere in the world so as to avoid the mistakes of others. The old saying is true. Every time history repeats itself, the price goes up.

4. Though highly significant in a Canadian context, the Alberta Water for Life Strategy may not be unique. Similar approaches have been explored elsewhere with varying degrees of success. It could become unique, however, simply for having been fully implemented. Such implementation will require political support and appropriate funding.

5. Politics aside, the success of Canadian water management policies will be determined - not by what is said -but by what is actually done in support of Water for Life and other water management initiatives.

6. Alberta has the financial wherewithal to set an example for the rest of the world in managing its water resources.

7. The longer that citizens and government in Alberta wait to make needed changes in their water management frameworks, the more difficult it will be to make such changes. Alberta should act now while there is still slack in the system and it has some flexibility and choice in solving its water problems. Waiting invites crisis management where the range of choice is always narrowed.

ROSENBERG INTERNATIONAL FORUM ON WATER POLICY

PROGRAM SYNOPSIS
&
LESSONS FOR CANADA
&
ALBERTA

TABLE OF CONTENTS

INTRODUCTION

The Rosenberg International Forum on Water Policy was created in 1996. It is named for Richard Rosenberg, the founder and former Chairman of the Bank of America. Upon Mr. Rosenberg's retirement in 1994, the Bank of America endowed the University of California in his name with resources to help support an invitational biennial water forum for the world's leading water scholars and senior water management practitioners. The main thrust of these Forums is the resolution of conflict emerging from trans-boundary water issues. The first of these Forums was held in San Francisco, U.S.A.; Barcelona, Spain; Canberra, Australia; and Ankara, Turkey.

The 5th Biennial Rosenberg International Forum on Water Policy was held in Banff, Canada between September 6th and 11th, 2006. The principal sponsors of the Rosenberg International Forum on Water Policy are the University of California and the Bank of America. Local co-sponsors for the 5th Forum included Alberta Environment, Alberta Ingenuity Centre for Water Research, Alberta Irrigation Projects Association, The Banff Centre, The Max Bell Foundation, The Calgary Foundation, the Columbia Basin Trust, Zaragoza EXPO2008 and the United Nations Water for Life Decade initiative in Canada.

Participants in the Forum included 52 scholars and water managers from 24 countries. The theme of the Forum was: "Upland Watershed Management in an Era of Global Climate Change." The Forum included a two-day pre-Forum field trip through the UNESCO Canadian Rockies World Heritage Site to examine modern upland watershed practices, two days of formal presentations and a post-Forum field trip to the Columbia River Basin, which was the subject of a case study at Rosenberg Forum IV held in Ankara, Turkey in 2004.

The main conclusions of the Banff Forum were that global, national and local water problems are growing in scope and magnitude and that while important progress has been made in finding solutions, more is needed. Water resources and water use world-wide are undergoing a fundamental transition. We face two major global challenges. New ways to tackle old problems are needed. We can no longer tolerate the fact that a billion people do not have access to safe drinking water and more than twice that many have no access to adequate sanitation services. But we also need to understand and address new and emerging new problems. Global climate change is leading to new and difficult challenges to sustainable water management and use. All water challenges require better communication among scientists, policy makers, and the public.

Keynote addresses at the conference included perspectives from both the developed and developing world and from the public and private sectors. Don Lowry, President & CEO of Edmonton-based EPCOR Utilities Inc. identified the importance of public-private partnerships and appropriate incentives in addressing future water management challenges. Presentations on the special sensitivity of mountains to global warming and the special problems of managing upland watersheds rounded out the opening session. Experts from Germany, Spain and Canada put into relief global challenges associated with determining the focus of upland watershed management efforts. Climate change experts from Canada and the United States outlined current and projected future climate change impacts on mountain regions.

Of particular interest to participants and distinguished guests were four case studies, each designed to put in relief the kinds of public policy that will be required to address a growing global water crisis. Three river basins were discussed: management of the Jordan River in the Middle East, the Rhone River of Europe, and the Saskatchewan River in Canada. The final case study examined the history and success of the International Joint Commission in North America and its 100 years of success in resolving transboundary water issues between Canada and the United States.

Peter Gleick, an internationally distinguished water policy expert, summarized the important global lessons and directions that emerged from the Forum as follows:

1. The water policy community should move away from ideology and fixed ideas with respect to addressing water supply issues on a global basis. Thus, for example, the debate over public versus private aspects of water often hides real successes in both areas.
2. The tension over whether water should be treated as a human right as opposed to an economic commodity is not helpful. The quantities of water needed to sustain life should be considered a human right while quantities in excess of that might appropriately be subject to commodity-like approaches.
3. Speakers also emphasized the fact that economic development and human-well being are not inextricably linked to increases in water use, and Gleick noted that water use in the U.S. has dropped dramatically during a period of unprecedented economic growth due to improvements in the efficiency of use.
4. Many speakers also noted that new evidence about climate change must force water planners and managers to rethink water policy. Old assumptions that the climate is unchanging are no longer adequate, and water planning and management must be adaptive and flexible.

Dr. Gleick also emphasized that the discussions at the Forum had brought into relief the need to dramatically improve communication between scientists, industry, and public policy makers if current water management problems are to be addressed successfully. Such communication might take a number of forms. Scientists have to find better ways to communicate with policy makers and with industry. Policy makers have to make a genuine effort to understand science and what scientists can contribute to policy development. Finally, all parties must do a better job of communicating accurately and effectively with the public.

Finally, Dr. Gleick concluded that the Forum pointed to the fact that we have to do a much better job of understanding our water vulnerabilities and managing risks on a global basis. Upland and mountain regions are especially vulnerable to development, external forces, and climate change. It will also be important to integrate issues and avoid jurisdictional and institutional isolation. Sustainable water solutions inevitably come from the merging of a variety of approaches. These approaches included adaptive watershed management, the integration of water and land use policy, interdisciplinary solutions and analysis of “soft” as well as “hard” approaches to water management problems.

At the close of each session, forum participants were invited to summarize what they considered the important points made by each panel or case study and in discussion following. A synopsis of the key themes and content from each of the Rosenberg sessions follows. The 6th Biennial Rosenberg International Forum on Water Policy will be held in Zaragoza, Spain in the spring of 2008.

ROSENBERG INTERNATIONAL FORUM ON WATER POLICY

KEYNOTE ADDRESSES

Keynote Speakers:

Mr. Don Lowry
President & CEO, EPCOR, Canada

Dr. Bruno Messerli
University of Berne, Switzerland

Dr. Sihem Benabdallah
Center for Water Research and Technologies, Tunisia

Key Themes

1. Water rich counties are afflicted with most of the same water problems as water poor countries.

2. Mountains are sensitive indicators of environmental change. They are also critically important as regions where water supplies are generated.

3. One major response to the intensifying global water scarcity is to recognize and act on the need to accord realistic values to water and to reflect those values in prices.

Synopsis

Management of upland watersheds is problematical both in the developed and developing world. Fragmented land ownership and the lack of institutional arrangements to channel the collective stake in good land/water management afflict most upland watershed areas of the world.. The importance of land use dynamics and its influence on both water quantity and quality are frequently overlooked. In developing countries erosion is a major problem and many watersheds have suffered rapid and serious degradation. Other land use practices which are inconsistent with the careful husbanding of water resources are manifest. The development and implementation of effective methods of watershed management must involve stakeholders. There is a need for additional research in social science subjects. Stakeholder processes are often not well understood and can be improved. Research can also be helpful in providing a basis for new, incentive-based policies which will be essential in achieving good watershed management.

Upland watersheds are particularly sensitive to environmental change. High altitude and high latitude environments tend to be especially sensitive and less resilient than other environments. Many lowland areas of the world depend upon uplands and mountains for their water supplies and the importance of this dependence is not generally recognized. The growth in population, economic activity, energy use, water use and life spans intensify the pressure on water resources

and present unique management challenges. The management of global climate change is a global problem, a problem of the global commons. Current policies are inadequate to address the challenges posed by global change and the science on which such policies should be based is not yet adequate to the task. The scientific community should take all necessary steps to ensure that monitoring information and other pertinent data are accessible on a global basis. The collection and management of such data should be a global undertaking and not restricted by regional or national considerations. These data will be crucial in understanding and managing the hydrologic manifestations of climate change in upland watersheds.

New ways, processes and arrangements must be devised for responding to the water problems of the future which are likely to be of increasing severity. It is important to recognize that the water problems facing developed and developing countries are very similar so that the need for improved management is pervasive. Typically, water problems are attended to only when some crisis occurs and demands intervention. This is a luxury the world can no longer afford. Historically, the management of water has been a public sector responsibility. The private sector has much to contribute to the solution of many of the world's water problems. Private sector/public sector partnerships must be part of the future of water management around the globe. The private sector will be an important source of both innovation and capital. Some of the characteristics and modes of operation of the private sector should be incorporated into new water policies. Thus, for example, it is no longer realistic to treat water as if it is limitlessly available. Simultaneously, the value of water should be recognized through appropriate pricing and pricing structures should be based on need to recover the full cost of necessary infrastructure. The public sector will need to establish and enforce clear and predictable rules and regulations. Public and private actors alike must be held accountable for their performance by both individual consumers and the public at large.

KEYNOTE ADDRESSES
LESSONS FOR CANADA & FOR ALBERTA

Mr. Don Lowry
President & CEO, EPCOR

Key Lessons

1. There is a need for public programming that dispels the myth of limitless abundance of water in Canada.
2. Continued reform of the drinking water quality regulatory process is urgently needed in Canada.
3. There is a need for a thorough review of the long-term effectiveness of existing infrastructure grant programs in Canada.
4. Existing models of water pricing in Canada are in need of reform.

5. It is important to recognize future challenges and threats, such as climate change, to both water supply and distribution in Canada.

Mr. Lowry is the chief executive of one of Canada's largest water and energy utilities. His remarks identified very specific directions for improvement in water management practices in Alberta and in Canada as a whole. Following are some of the points Mr. Lowry emphasized:

The Need for A New Water Ethic in Canada

- the need for public programming that dispels the myth of limitless abundance of water in Canada
- the value of support for public education that encourages incremental conservation measures in domestic, industrial and agricultural circumstances
- support for integrated watershed management research

The Need to Make Sure What We Already Have Works

- the need for continued reform of the drinking water quality regulatory process
- the crucial necessity of enforcing of already-existing legislation and regulations
- continued upgrading of operator accreditation standards and training
- more consistent and comprehensive monitoring of water quality
- better oversight of water system management

The Need to Get Out Of Our Own Infrastructure Trap

- the need for a thorough review of the long-term effectiveness of existing infrastructure grant programs in Canada
- on-going examination of new technology and evolving systems management improvements available presently in Canada
- exploration of new models for the design, operation and sustainable funding of a "next generation" water supply system in Canada

The Importance of Valuing and Realistically Pricing of Water Supply

- recognition that the notion of water as a human right is not incompatible with the need to treat water as a commodity at least in terms of drinking water treatment and distribution infrastructure and systems operation
- examination of existing models of water pricing in the context of the need to reform Canada's drinking water delivery system
- application of functioning models to the challenge of rebuilding Canada's drinking water delivery system

The Value of Exploring Public-Private Partnerships

- acceptance of the need for increased scale and capacity of water treatment and distribution systems
- realization of the need for customer-driven financial sustainability of water systems
- examination of successful public-private partnerships and the determination of where such successes might be repeated and built upon

The Urgency of Securing Sustainable Supply

- active support of source water protection programs
- encouragement and funding of watershed basin councils, trusts and authorities
- changes in governance that will allow such organizations both responsibility and authority in defining watershed-wide water management solutions

The Importance of Recognizing Future Challenges and Threats

- realization that further climate change could alter not only the volume of water supply but also impact source water quality
- examination of potential climate impacts on current water storage facilities, domestic water systems and storm water infrastructure
- the incorporation of potential climate change impacts into all land-use planning and future infrastructure development

Dr. Bruno Messerli
University of Berne

<u>Key Lessons:</u>

1. It is time Canada faced the fact that it now has water quality and availability problems similar to those experienced in other countries.
2. Though we take pride in the extent to which upland areas have been protected for recreational and other uses, we would be wise to reconsider the importance of these areas in terms of the important role they play in water supply.
3. Mountain water in Alberta is going to be far more valuable in the future because it will likely represent a much higher percentage of what is available regionally as climate impacts alter traditional precipitation patterns and timing.
4. The current state of knowledge about mountain hydrology is insufficient and makes sustainable water management and long-term assessment of vulnerabilities difficult.

Dr. Messerli is one of the world's most respected experts on mountain ecosystems and hydrology. He is the father of the United Nations global "Mountains As Water Towers" concept and an expert on the influence of mountain water supply on lowland regions around the world.

Dr. Messerli talked at length about what was happening to mountain hydrology globally in a manner that put Canadian circumstances into clear global relief. Following are some of the lessons that were derived from his formal paper and from his attendant presentation:

- Though Canada possesses considerable water resources on a per capita basis, it is facing problems with water quality and availability similar to those experienced in many other countries.

- A new global vision of the importance of the mountains as "water towers" is changing the way the world regards the value of upland areas as sources of freshwater discharge. Though we take pride in the extent to which upland areas, at least in the west, have been protected for recreational and other uses, we would be wise to reconsider the importance of these areas in terms of the important role they play in water supply.

- Mountains are going to be far more important in maintaining lowland areas globally. The Canadian prairies are a prime example of a lowland region utterly dependent upon mountain water sources.

- Catchments characterized as snow dominated are particularly sensitive to the impacts of climate change. Thus, it is likely that mountain water in Alberta is going to be far more valuable in the future because it will likely represent a much higher percentage of what is available regionally as climate impacts alter traditional precipitation patterns and timing. Maintaining the integrity of mountain water towers will be central to our adaptability.

- At present the Global Climate Observing System (CGOS) does not measure climate changes in regions of the highest projected temperature change at high elevations in the world's mountain ranges. Changes are not only taking place at night and in winter when we are least apt to be looking for them but in places – such as high altitudes in mountains – where we don't usually measure change. It is important to monitor and act upon these changes.

- There remains great uncertainty about model predictions on discharge rates in mountain areas. Taking into account the potential for increasing scarcity in western Canada, especially for irrigation and food production, today's state of knowledge about mountain hydrology is insufficient and makes sustainable water management and long-term assessment of vulnerabilities difficult if not impossible.

Dr. Sihem Benabdallah
Center for Water Research and Technologies, Tunisia

<u>Key Lessons:</u>

1. As the population of any country grows, it becomes more and more important to manage upland watersheds with greater care.
2. Hard engineering solutions are not enough to keep up with evolving water supply and

quality issues. Canada would be wise to also commit to more scientific research, more monitoring, better evaluation systems, better agricultural practices, more comprehensive links between land-use policies and watershed management practices, and better risk assessment techniques.

3. We have to overcome jurisdictional fragmentation, improve weak regulatory structures, improve our data collection and sharing and further democratize the watershed management processes in Canada if we want to advance to the next level of water management success.
4. Dr. Benabdallah is an expert in upland watershed management in the developing world. She has also played an active role in the evolution of broader public engagement in watershed management in Tunisia, a country experimenting with a public process not dissimilar to Alberta's Water for Life Strategy. Dr. Benabdallah made a number of observations that put into relief the strengths and weaknesses of Canadian water management approaches:

    - As the population of any country grows, it becomes more and more important to manage upland water sources with greater care. This is particularly true if those uplands are the water supply for lowland agricultural regions - like the Canadian prairies - which are important food-growing areas.

    - It is particularly easy to trigger erosion cycles in upland watersheds. Combine topographic relief with intense human activity and the impacts on water quality and availability can be huge. Tree removal, wood cutting, the introduction of livestock, intensive cultivation, agricultural development in marginal areas all contribute to the silting of streams which leads to more intense flooding, reduction in the life of dams, loss of water quality for drinking and reduction of aquatic ecosystem health and productivity. Only careful monitoring and good management can prevent this cycle from occurring.

    - National parks and similar protected areas can be important mechanisms for upland watershed protection. They can be protected for tourism and recreation but, provided they are not over-developed, they will still generate clear water. Water should be seen as an important forest product.

    - Engineering approaches to preventing upland degradation did not work in Tunisia. Water managers in that country soon realized that enduring solutions to water management issues would not emerge solely through technological proxy. What did work, however, was an integrated watershed management approach in which local people became responsible for their own watersheds through the formation of new cooperative institutions. In a manner not dissimilar to the process employed in Alberta's Water for Life Strategy, local watershed groups improved the health of their watersheds through the construction of check dams, flood control mechanisms, improved water table recharge and soil stabilization. Through the Tunisian "Water for Life Strategy" soil erosion was reduced resulting in increased food production, less silting of dams and reservoirs, revitalization of community enterprise and greater

prosperity which meant improved capacity to deal with evolving watershed management challenges.

- Another important lesson offered by Dr. Benabdallah that might prove valuable in the Canadian context was that big dams were not always the answer to water supply challenges, especially relating to agriculture. Small-scale water storage is not only affordable but far more appropriate in many agricultural circumstances.

- Dr. Benabdallah also pointed to the value of international examples and best practices in the formulation of evolving public policy with respect to water management. Many countries, including Canada, are in the process of reforming their water management policies, plans and programs in the context of new economic and environmental realities. By observing what others are doing well, countries like Canada can avoid mistakes others have already made in solving problems others have already addressed.

- In order to keep up with emerging water supply quality issues, Canada must commit to more scientific research, more monitoring and better evaluation systems, better agricultural practices, more comprehensive links between land-use policies and watershed management practices and better risk assessment techniques that result in more timely decision-making responses to challenges.

- The obvious lesson that emerged for Canadians from Dr. Benabdallah's presentation was that, like so many other countries, we have to overcome jurisdictional fragmentation, improve weak regulatory structures, improve our data collection and democratize the watershed management processes in Canada if we want to advance to the next level of success in the management of our water resources.

ROSENBERG INTERNATIONAL FORUM ON WATER POLICY

SESSION 1
CHALLENGES IN UPLAND WATERSHED MANAGEMENT:
FOR WHAT? FOR WHOM?

Presenters:
Dr. Holger Hoff
University of Tuebingen, Germany

Dr. Pedro Arrojo-Aguda
University of Zaragoza, Spain

Discussant:
Dr. Hans Schreier
University of British Columbia, Canada

Key Themes

1. The management of water resources should be holistic. The focus should be on the management of ecosystems and not on the management of water in isolation.

2. The distinction between blue water and green water helps to focus attention on green water and the how that can be managed. Historically, attention has been almost exclusively on blue water.

3. A new water management framework is needed and a new water ethic should be part of that framework. The framework should be international in scope and not simply restricted to single nations.

Synopsis

Water management and land management are inseparable. Water management schemes must include land management and the management of other parts of ecosystems. Upland watersheds are key elements in the hydrologic cycle but upland watersheds cannot be managed in isolation from downstream areas. Thus, for example, it is not often recognized that world trade is a driver of water use and upland watershed management. The growth in global population will also have important impacts on upland watersheds as the world strives to feed a significantly larger population. Successful upland watershed management will require a comprehensive understanding of upstream-downstream linkages and systems of incentives which cause upstream and downstream people to manage and use water in consistent and efficient ways.

The concept of blue water and green water can be very helpful in guiding new, integrated approaches to water management. The historical focus on blue water must now shift to green water. New emphases must be given to the effective management and use of green water, much

of which is soil moisture. Efficient use of green water can help to feed a larger population, for example. One way in which upstream and downstream interests could be linked is through a system of green water credits. The proper valuation of water and the use of water markets would also be helpful, though there remains much dispute over the use of markets and around the notion of values. Best management practices in upland watersheds can be encouraged by linking the gains and benefits that accrue to downstream users by way of such practices through compensation schemes.

A new water ethos and management framework will also be needed. The new framework should be international in scope so that transboundary water problems are directly addressed. Although the valuation of water-based environmental services continues to be problematic, it will be critical to find ways to value such services and processes through which those who protect and enhance such services can be compensated. The diversity of interests that must be accommodated calls for stakeholder participation and shared governance in formulating water and ecosystem management plans. Those plans should be implemented adaptively with stakeholders helping to identify appropriate adaptive adjustments. None of this will substitute for effective political leadership which will be necessary to facilitate the kinds of change identified above.

SESSION 1
CHALLENGES IN UPLAND WATERSHED MANAGEMENT: FOR WHAT? FOR WHOM?

LESSONS FOR CANADA & FOR ALBERTA

Dr. Holger Hoff
University of Tuebingen

Key Lessons:

1. Proper management of the "green water" held within ecosystems can contribute significantly to existing "blue water" resources available from surface sources and aquifers.
2. The measurement of how trees and plants use water and how much their use affects the quantities of water available for other uses is an important way of looking at where water is and what it does in nature and in cultivated environments.
3. We are unable to consider innovative water management approaches of this kind in Canada because our integrated watershed management strategies still separate water resource management from land management and land-use policy.
4. The management of "green water" will require a shift in established Canadian land-use policy. Such a shift, however, could allow many communities and regions to advance toward greater levels of sustainability.

5. Combined blue and green water management strategies may be crucial to future integrated watershed management success, particularly as climate change impacts already water scarce areas such as the Canadian prairies and in the dry central core of British Columbia.

Holger Hoff is conducting research at the University of Tuebingen in Germany and at the Stockholm Environment Institute in Sweden and looking into new ways in which we can imagine managing our water resources in a sustainable fashion. His presentation challenged Rosenberg Forum participants to consider the application of "green water" credits and other new approaches to integrated watershed management to transboundary situations. It would be of great value to explore some of Dr. Hoff's observations and conclusions more fully within the Canadian context.

- "Green water" is the water infiltrated into the soil from precipitation. It provides a large natural storage of water, similar to groundwater but is directly accessible to natural vegetation and agricultural crops. Almost all existing water management strategies focus on "blue water", water found in aquifers and surface water courses. Dr. Hoff maintains that better management of "green water" is an as yet undeveloped mechanism that could contribute significantly to sustainable water use.

- One lesson for Canada is that we have yet to explore important new ways of thinking about how water can be managed in a more effective manner. The measurement of how trees and plants use water and how much their use affects the quantities of water available for other uses is a different way of looking at where water is and what it does in nature and in cultivated environments.

- Another lesson Dr. Hoff put into relief is one we already have learned in Canada. Citing the City of New York, Hoff pointed out that it is common knowledge that it is cheaper to pay for natural upstream environmental services than for treatment and mitigation. Recently New York City invested $35,000,000 into improving land-use practices in the watershed that supplies its drinking water. The investment translated into greater productivity for farmers in the upland watershed and improved water quality for the city. This investment also made it unnecessary to build a $6 billion water filtration system. Thus, it can be seen that paying for foregone opportunity cost in a watershed may be far cheaper than paying to repair damage from developments that impact water quality or availability. There are many places in Canada that would do well to explore similar solutions. In Alberta, this includes costs that will have to be borne by the City of Calgary should further development be permitted in the headwater regions of the Bow and Elbow Rivers.

- Dr. Hoff challenged a popular misconception by offering that forests do not necessarily represent the highest water-holding state of any given landscape. Careful management of ecosystems, he added, can provide the added benefit of generating greater water

availability and improved water quality. The lesson for Alberta may be that the protection of the native prairie grassland complexes that still exist in uplands may be a climate adaptation option.

- In addition, the integration of blue and green water management suggests that the management of precipitation – and not just surface run-off and groundwater resources – as a basis for more effective upland watershed management in the future.

- A key to more effective management in the future may be reduction of non-productive green water flows. Presently we are unable to consider novel water management approaches of this kind. Integrated watershed management strategies in Canada still separate water resource management from land management and land-use policy.

- Dr. Hoff noted that climate impacts on water availability will be non-linear. This means, for example, that small changes in climate may have big effects on water availability. This is an especially important point in the Canadian context. Traditional mechanisms of managing surface and groundwater may not be adequate to address potential water availability challenges in areas of Canada that are already water scarce. Combined blue and green water management may become an important tool in future integrated watershed management regimes, particularly on the Canadian prairies and in the dry central core of British Columbia.

- Finally, Hoff pointed to the fact that many countries have chosen poor downstream management strategies over better, more cooperative, upstream management practices. Examples exist, however, of better decisions are being made on the value of managing of both blue and green water in upland areas. Hoff cited South Africa and its National Water Act of 1998 as an example of a breakthrough in integrated watershed management. Under the new act, a levy is charged against land-use activities that reduce streamflow. A subsequent study of blue and green water interaction proved that commercial tree plantations in South Africa reduced the nation's surface run-off by 1.4 million cubic meters a year, or 3.2% of annual flow. As a consequence, timber growers now need to apply for permits before establishing commercial tree plantations to ensure that their activities complement desired downstream water availability outcomes. The obvious lesson here is that there may be places in Canada where it would be beneficial to apply green and blue water management logic, especially in the context of pending climate change impacts.

Dr. Pedro Arrojo-Aguda
University of Zaragoza

Key Lessons:

1. During the 20th century some 50,000 dams were constructed worldwide resulting in a global loss of habitable valley bottoms, the irreversible disappearance of local values, compromised living conditions, impairment of social systems, increased transportation

costs and attendant downstream impacts for millions of people.

2. There is a limit at which dams simply don't make economic sense and they can make even less sense when ecological impacts and social efficiency criteria and not just increased market value are calculated into the measurement of their impacts.
3. Current water management models are under threat worldwide because social, economic and environmental values that are beginning to apply require new models of sustainable management and forms of participative government very different from those that were the norm throughout the 20th century. Hence the urgent need for a new global water ethic.

Dr. Pedro Arrojo-Aguda is a researcher in the Department of Economic Analysis at the University of Zaragoza in Spain. His presentation on Water Management in Alpine Regions focused on the failure of traditional public policy to achieve sustainable water management in Europe and elsewhere. Dr. Arrojo-Aguda concluded his presentation with a summary of a new water ethic presently being promoted within the European Union. Both Arrojo-Aguda's analysis of the failure of "Hydrological Structuralism in the 20th Century" and his pronouncements on the European Declaration for a New Water Culture, signed by 100 European Union scientists in 2005 put into relief important aspects of our own search for a better and more durable water ethic in Canada.

- In examining water policy and management practices world-wide, Dr. Arrojo-Aguda has observed that places that are very different emerge as being very similar in terms of how they have arrived at how to best manage their water resources. One reason for this is that water has similar qualities everywhere it is found. Another reason, according to Dr. Arrojo-Aguda, is that the world has been under a particular form of "hydro-populism" that has favor large-scale dam-construction over potentially more appropriate and less damaging ways of supplying and managing water resources.

- This form of "hydrological structuralism" has led to the flooding of hundreds of communities, serious ecological degradation and species extinctions in Spain. Predictably, these impacts have been particularly significant in mountain regions. Worldwide, the total number of people that have been displaced through dam construction numbers somewhere between 40 and 80 million. That no accurate numbers exist, suggests to Arrojo-Aguda that a "hydrocaust" has been quietly carried out in the name of one particular method of managing water which has proven not only to be unsustainable but counter-productive to long term economic good.

- Arrojo-Aguda cited a broad range of impacts on communities, local economies and ecosystems associated with upland dam construction in Spain. These include "the loss of habitable valley bottoms, breakdown of community connections, irreversible disappearance of local values, compromised living conditions, impairment of social systems, increased transportation costs and attendant downstream impacts".

- The lesson here is that we have also observed many similar impacts in Canada in areas like the Columbia River Basin and elsewhere. Nor are these impacts confined to loss of habitable areas. The construction of more than 50,000 large dams over the

course of the 20th century in the most suitable closed basins has, according to Arrojo-Aguda, resulted in diminishing returns as the marginal costs of such facilities rise. A point is reached at which dams are no longer economically justified. Moreover, the appeal of large dams has been further eroded because of their ecological impacts and the failure to meet social efficiency criteria.

- Disregard for the social and environmental impacts of large hydraulic structures has had a number of unfortunate consequences in Spain which are highly relevant in the Canadian context. These include:

    1. rivers being viewed as canals and not living ecosystems
    2. the failure to take into account the importance of rivers as nutrient flows
    3. the failure to recognize the importance of aquatic biodiversity
    4. the tendency to under-estimate local social and economic impacts
    5. the failure to respect links between community, local ecosystems and fluvial cycles

- Arrojo-Aguda also made some important points about lessons learned in Spain related to irrigation agriculture. Irrigation, he observed, not only doubles harvests but guarantees them. In Spain, however, further irrigation development is being questioned for a number of reasons. While Canadian irrigation agriculture is, arguably, unique, it is not immune to many of the same circumstances that are limiting its development elsewhere which include:

    1. diminishing marginal returns generated by cultivation of less desirable farmland
    2. a decline in agricultural productivity
    3. a sustainability crisis with respect to aquatic ecosystem health
    4. soil degradation (which now affects 20% of the world's irrigable land)
    5. the massive public subsidies that promote inefficient use have lost economic rationality
    6. too many examples of rich (often foreign) corporations receiving the benefit of public subsidies without returning support to local communities and economies

- Finally, Dr. Arrojo-Aguda commented on the need to create a new water ethic, something that has been identified as being crucially important also in Canada. He argued that our current water management models are not under threat simply because of ethical issues associated with regional imbalances, but because social, economic and environmental values that are beginning to apply in mountain areas and river basins require new models of management and new ways of accomplishing participative government will need to be very different from those that were the norm in the 20th century.

- A new European water ethic put forward by 100 European Union scientists in 2005 has five pillars. Each these pillars has application in the Canadian context especially given that we are in search of our own new ethic:

    1. **Water for Life:** this relates to basic survival functions of both humans and animals in their natural habitat, which should be recognized and prioritized in such a way that ecosystem sustainability is guaranteed, with universal access to adequate amounts of quality water constituting a right.
    2. **Water Citizenry:** *water for the common good*; as an instrument for safeguarding health and social cohesion related, for example, to water supply and sanitation services in connection with the social rights of citizens.
    3. **Water-Business:** *water for economic growth*, for legitimate economic activities, connected to productive work, in connection with the right of every individual to improve his or her standard of living. This water use is to be granted a third level of priority given that it would be unethical to allow such uses to interfere with water rights and uses pertaining to previous categories.
    4. **Water-Crime:** *water for illegitimate business activity with consequent destructive withdrawal practices, toxic spills and other socially unacceptable practices*; such uses should be avoided and prosecuted to the full extent of the law.

- In conclusion, the scientists who formulated Europe's proposed new water ethic argued that the new water ethic should be seen as an unavoidable circumstance to be managed rather than a tragedy to be avoided by way of public subsidies and ecosystem degradation. Whatever Canada creates in terms of a new water ethic, this same logic should apply in its adoption.

ROSENBERG INTERNATIONAL FORUM ON WATER POLICY

SESSION 2
UPLAND WATERSHED MANAGEMENT
AND GLOBAL CHANGE

Presenters:
Dr. David Sauchyn
University of Regina, Canada

Dr. Richard M. Adams
Oregon State University, United States

Discussant:
Dir. Adèle Hurley
University of Toronto, Canada

Key Themes

1. There is consensus within the scientific community that global climate is changing.

2. Water resource development and management has been based on anomalous climatic patterns. In the northern plains drought will be far more common in the future than in the past.

3. Adaptive strategies need to be devised for dealing with climate variability and the uncertainties that it entails.

Synopsis

There is now scientific consensus that global climate is changing (warming). This underscores the fact that hydrologic regimes are not stationary. Indeed, tree ring sampling for the northern plains shows that droughts have occurred with increasing length and frequency over the period 1411-2004. The length and frequency of drought in the future is likely to be much worse than anything experienced to date. Society is poorly prepared by experience to manage the long term relatively aridity which will almost certainly prevail. Past planning for water infrastructure and management schemes have been based on a climatic record that is anomalous. Failure to develop policies and management regimes that are adaptive and resilient means that the consequences of drought will be more frequent and more severe. The economic consequences are drought are very costly and will likely be more so in the absence of adaptive planning and management.

Globally, the fact that our future climate will be more variable and uncertain also calls for adaptive planning and management. What is needed is an integrated approach to adaptive management. The development of adaptive capacity includes the ability to frame or characterize issues, to mobilize society, and to employ cultural symbols as well as technological change. Bottom-up participatory processes can work well in both developed and developing countries.

The international dimensions of climate change deserve emphasis because a response based on these is likely to be well integrated and effective. Thus, for example, an international perspective will provide a more comprehensive picture of the consequences of climate change and permit the development of more effective responses. Actions (such as carbon sequestration) and incentives (such as a carbon tax) are already available but they need to be taken and applied adaptively. It will also be important to look at related environmental impacts (such as extinctions and invasions of plants and animals) to respond to climate change effectively.

SESSION 2
UPLAND WATERSHED MANAGEMENT AND GLOBAL CHANGE

LESSONS FOR CANADA & FOR ALBERTA

Dr. David Sauchyn
University of Regina

Key Lessons:

1. A new water ethic is emerging in Alberta based on the recognition that there are limits to the Province's water supply. The capacity to realize the goals of the Alberta Water for Life Strategy, however, is presently limited by incomplete knowledge of supply trends and natural climate variability patterns.
2. Water conservation will continue to be a major adaptation to climate change and variability. Conservation measures will have to include water-pricing regimes that more accurately reflect the real costs of water supply and treatment and measures that ensure that an increasingly scarce resource is properly allocated.
3. Economic sectors that base future plans on assumptions of hydrological stationarity are likely to be affected but are unprepared to address changes in water availability regimes. Public policy in areas of water and resource management, particularly in Western Canada, is not adequate to address the kinds of changes that are expected.
4. Adjustments to practices, policies and infrastructure operation are necessary to ensure that economic development can continue in the face of changing hydro-climatic regimes that point to less water availability.
5. In particular, public policy in western Canada has to be strengthened with respect to the development anticipatory integrated watershed management approaches that will able to embrace the very real threat of droughts of much longer duration than have occurred in the past century.

Dr. David Sauchyn is a climate scientist at the University of Regina in Saskatchewan and a principle in the Prairie Adaptation Research Collaborative, which researches climate impacts in the Great Plains region of Western Canada. He is also a Canadian representative on the UN Inter-governmental Panel on Climate Change. All of Dr. Sauchyn's remarks spoke directly to climate-related water availability and quality issues in Canada. His presentation was particularly

valuable in that it concluded with very specific public policy analysis and recommendations. Following are some of his observations:

- Western Canadian water policy reflects the dry circumstances in which European settlement occurred. Water was granted first to irrigators, and the rest was shared among a variety of jurisdictions. Mean annual water deficits, however, range from 35% to 50% which means that evapo-transpiration exceeds precipitation by these percentages on an annual basis.

- In Alberta a new water ethic is beginning to emerge through the Alberta Water for Life Strategy. This strategy is based on three principles:

    1. All Albertans must recognize there are limits to the available water supply.
    2. Alberta's water resources must be managed within the capacity of individual watersheds.
    3. Knowledge of Alberta's water supply and quality is the foundation for effective decision-making.

- Our capacity to realize the goals of the Alberta Water for Life Strategy are, according to Dr. Sauchyn, limited by incomplete knowledge of supply trends and natural variability patterns. Dr. Sauchyn offered that Alberta's supply forecasts were derived from instrumental records that are of too brief a duration to capture longer term variation in regional climate and hydrology. He also offered that current perceptions of water scarcity and precipitation variability may be skewed by 20th century experience and observations. Dr. Sauchyn argued that we are being deceived by the extent of glacial melt that cannot be sustained, the extent of current winter snowfall, the limited duration of 20th century droughts, as well as by our limited understanding of our own long-term impacts on landscape and hydrology.

- Extensive glacial recession has been observed, for example in the North & South Saskatchewan River Basins, which provide much needed water to the Canadian prairies. Roughly 50% of the glacial mass in the South Saskatchewan River Basin has disappeared since 1975. Some 23% of glacial mass has also vanished in the North Saskatchewan River Basin. These observations point to the fact that glacial melt contributions are set to decline during dry periods in those basins. Other basins, such as the Siffleur, have already experienced maximum glacier melt. These trends are likely to continue throughout the Rocky Mountains resulting in early and increased spring melt and decreased late summer flows in many prairie rivers.

- Dr. Sauchyn also drew attention to historic tree ring analysis which indicates that droughts of far longer duration than those we experienced in the 20th century have occurred in the past. He pointed out that we do not possess, at present, adequate water policy and management tools that would permit the Canadian prairies to adapt to droughts of as long as a decade, which appear to have been relatively common throughout the history of the Great Plains region.

- Sauchyn argued that water conservation will continue to be a major adaptation to climate change and variability. Conservation measures will have to include water-pricing regimes that more accurately reflect the real costs of water supply and treatment and measures that ensure that an increasingly scarce resource is properly allocated.

- Within the context of an increased focus on water conservation, resource economies that have planned their future on stationary hydrological regimes are going to be affected. Dr. Sauchyn believes that our water and resource policies, particularly in Western Canada, are not ready for this.

- Dr. Sauchyn made a number of specific observations with respect to the North and South Saskatchewan Basins:

    1. the quantity and influence of glacial melt water will decrease over time in both of these basins;
    2. the magnitude of changes in flow that will result from climate impacts cannot be predicted at this time
    3. evidence suggests that currently north streams flow and a diminished contribution from glaciers are occurring at the same time.
    4. flow changes are the most prominent in low flow years and in late summer
    5. increased precipitation may offset losses due to reduced spring snow pack
    6. it is unfortunate that the lack of natural storage will exacerbate reduction in late season flows.
    7. these impacts will be most significant in the mountainous headwaters of basins.

- Sauchyn then pointed to what he considered to be the strongest evidence of the growing impact in the Canadian West. According to the Intergovernmental Panel on Climate Change, flow contributions from glacier sources should, if the predictions of climate warning are accurate, generally increase in the short to medium term and decrease in the long term. In the eastern slopes of the Rocky Mountains, there is already evidence during critical periods of a reduction in water yield with reduced glacier area. In other words, the increase in flow associated with the initial impacts of warming has already occurred and now late season flow is declining. According to Dr. Sauchyn, this is amongst the strongest signals of the impacts of global warming in western Canada.

- Dr. Sauchyn then offered that it is only a matter of time before already diminished surface water flow is even further reduced by droughts of extended duration which were already an element of natural variability in this region before the impacts of global warming began to be felt.

- Dr. Sauchyn indicated that these trends could be translated into a number of public policy implications:

1. about 70% of irrigated farmland in Canada is in southern Alberta in a region vulnerable to climate change impacts
2. this 4% of the cultivated land in the province produces 18% of Alberta's agri-food product
3. in the South Saskatchewan River Basin, 75% of the allocated water is committed to agriculture
4. in the Oldman River Basin, 86% of water allocations go to agriculture
5. between 20% and 30% of the withdrawals return to the basin
6. irrigation in itself is an adaptation to climate variability and change
7. appropriate adaptation to climate change impacts should include further progress toward more efficient irrigation practices
8. the vulnerability of the region to climate impacts on water availability suggests that further exploration of water rights transfers will be an important part of on-going adaptation success

- In conclusion, Dr. Sauchyn put into relief five public policy actions that Canadian political leaders and decision-makers might consider in response to climate-related impacts on water availability in the Great Plains region:

1. practices, policies and infrastructure that will permit on-going economic development in the face of changing hydro-climatic regimes that point to less water availability will have to be adjusted
2. major water paradigms and practices will have to shift to accommodate changes in the timing of precipitation and the loss of buffering capacity from accumulated snowfall and glacial melt
3. integrated watershed management approaches will need to be strengthened to address the higher probabilities of the threat of droughts of much longer duration
4. much greater investment will need to be made in the acquisition of data and the development of new science to fill knowledge gaps
5. examine past trends to aid in understanding and validating future water scenarios

Dr. Richard M. Adams
Oregon State University

Key Lessons:

1. The kinds of drought-related scenarios predicted in Canada by Dr. Sauchyn are already occurring with substantial economic impacts in part of the western United States. We should expect some, if not all, the same impacts in Canada.
2. In those areas of Canada where net evaporative losses are expected to increase in summer, the threat of more frequent and severe droughts should be expected to rise. This includes many areas of the Canadian prairies. These droughts will be exacerbated by lower late season flows out of mountain rivers.
3. Impacts will not just be felt in regions where rainfall is decreased or when net evaporation will increase. Upland forests produce a range of marketed and un-marketed ecosystem services related to the supply of fresh water. These services include water storage and gradual water release and purification. All of these functions are affected by drought.
4. Analysis in the United States demonstrated that the impact of increased drought intensity on the level, variation and range of expected profits would be more severe than the impacts of increased drought frequency. Under current regimes, American farmers were better able to adjust to more frequent moderate drought than to less frequent intense drought. Under moderate ranges of climate warming, this may also be the case in Canada.
5. It is critical in North America that we improve the accuracy, precision and timing of seasonal precipitation forecasts so that those affected by changes will be able to trust in them. Improved forecasting, however, is just the beginning. We also need to make sure that we plan and act adaptively in response to these forecasts in service – not just of immediate economic interests – but of the long-term adaptive capacity of our ecosystems.

Dr. Richard Adams is a Professor in the Department of Agriculture and Resource Economics at Oregon State University in Corvallis. His paper, entitled *Climate Change and Water Resources: Potential Impacts and Implications* was written in association with Dr. Dannele E. Peck, an Assistant Professor at the Department of Agricultural and Applied Economics at the University of Wyoming in Laramie. In his Rosenberg presentation, Dr. Adams focused on the possible impacts of global climate change on water resources, with an emphasis on the frequency and intensity of drought. As this presentation was offered in tandem with Canadian perspectives on the same issue, it put climate impacts on western North America into bold relief. The lessons for Canada were obvious:

- The impacts David Sauchyn describes are beginning to appear in western Canada have already manifested themselves in the United States. Climate impacts in the western U.S. are manifold and include:

1. rising temperatures
2. lost agricultural productivity
3. record wildfires
4. fish kills due to water temperature increases
5. the decadal droughts predicted by Dr. Sauchyn for western Canada have already begun to appear in parts of the American west
6. increased frequency of extreme weather events

- Annual costs of the extended drought presently being experienced in the United States are estimated to be between $6 and $18 billion a year.

- The annual costs of flooding and hurricanes is presently between $3.6 and $7.2 billion a year and are expected to rise

- Further drought impacts are expected to create additional liability caused by:

    1. on-going crop failure
    2. increased fire damage and greater costs associated with fighting wildfire
    3. fish and wildlife mortality
    4. reduced hydro-power generation
    5. increased electricity prices

  The lesson is that we should expect some, if not all, of the same impacts in Canada.

- Water resource managers, agricultural producers, timber managers and policy makers in the United States are working to reduce the negative effects of drought through a number of strategies:

    1. revising water storage and release regimes for reservoirs
    2. adopting drought-tolerant cropping practices
    3. adjusting crop insurance programs
    4. pre-positioning fire suppression equipment
    5. supporting water transfer opportunities
    6. investing in better drought forecasting mechanisms

- Dr. Adams argued that it is important to understand adaptation to extended drought conditions in the context of climate impacts on both precipitation and evaporation. The carbon dioxide concentration in the Earth's atmosphere has risen 30% since the late 1880s. The average mean temperature of the United States has risen 0.6°C over the last century. A rise of between 3°C and 5°C is projected for the United States in the coming century. Precipitation has risen 5% to 10% over predictions in the United States in the 20th century. Precipitation in the Northeast U.S. has risen 25%, in the Midwest 10% to30% and by 20% in the Pacific Northwest. Precipitation declines, however, of up to 25% have been observed in Oklahoma panhandle, northern Texas, eastern Colorado and West Kansas. Evaporation rates have also risen.

- It has been estimated that precipitation must increase by at least 10% to make up for evaporative losses from a 4°C temperature increase. Net evaporative losses are expected in summer in many agricultural areas which will lead to more frequent and severe drought.

- The lesson for Canada is obvious. In those areas where net evaporative losses are expected to increase in summer, the threat of more frequent and severe droughts should be expected to rise. This includes many areas of the Canadian prairies. These droughts will be exacerbated by lower late season flows out of mountain rivers.

- The impacts of these droughts will be similar to what is presently occurring in the United States. There will be obvious impacts on hydropower generation, irrigation and recreational fisheries. There could also be problems meeting legal obligations of inter-jurisdictional water-sharing compacts and court decrees. Extreme weather events will accelerate erosion. There will be water quality issues associated with effluent release into reduced flows and there could be nutrient and contamination concentration in areas that receive less rainfall.

- Impacts of extended and more severe drought will be particularly severe in terms of aquatic ecosystem health. These impacts will include:

    1. reductions in primary production in lakes, streams and rivers
    2. changes in organic matter decomposition
    3. changes in nutrient cycling rates in lakes in streams resulting in lower dissolved oxygen levels
    4. increased evaporation rates from open water bodies will threaten to increase the salinity of surface water
    5. return flows from irrigation will threaten to further diminish water quality
    6. water quality impairment could become a threat to agricultural water supplies as well as to fish and wildlife

- Impacts will not just be felt in regions where rainfall is decreased or when net evaporation will increase. Upland forests produce a range of marketed and un-marketed ecosystem services related to the supply of fresh water. These services include water storage and gradual water release and purification. All of these functions are affected by drought.

- Sea level has risen 10 cm to 20 cm in the 20th century and is expected to rise between 38 cm to 66 cm in the coming hundred years. Rising sea levels will result in salt water intrusion into coastal fresh water systems.

- By virtue of its potential impact on interactions between the atmosphere and oceans, global warming may have significant impacts on ocean currents and wind and precipitation patterns, particularly in the tropical Pacific. Rising ocean temperatures are

expected to increase the frequency and intensity of El Niño events causing more severe droughts and floods on a more unpredictable basis. Canada will not be spared from the impacts of more frequent and severe El Niño cycles, especially when they act to create or prolong droughts brought about by other climate influences.

- Dr. Adams went to considerable lengths to present American perspectives on the best way to adapt to the threat of droughts of increased duration and severity. His observations could be a great value to America's northern neighbor. Dr. Adams pointed out that careful analysis in the United States demonstrated that the impact of increased drought intensity on the level, variation and range of expected profits would be more severe than the impacts of increased drought frequency.

- The conclusion at which Dr. Adams and his researchers arrived through their economic study was that, under current regimes, American farmers were better able to adjust to more frequent moderate drought than to less frequent intense drought.

- Adams also made the point that American farmers are – perhaps as expected given their reliance on weather – far ahead of many other economic sectors in climate change adaptation. As climate change impacts intensity, however, drought forecasting capacity becomes a very important economic instrument. A forecast accuracy rate of 70% with respect to El Niño occurrence, for example, could reduce American agricultural losses by 15% to 20%.

- Dr. Adams then moved his discussion from climate impacts on agriculture to impacts on fisheries in the Pacific Northwest. While the lessons offered here were of less interest to Canadian agri-food producers, they are very significant to the vitality of Canada's commercial fishery. Concerns expressed by Dr. Adams about the impact of climate change on salmon are of particular interest to Canadians living in the Columbia Basin.

- Dr. Adams indicated that his research demonstrated that global warming could be the death knell for many already stressed salmon runs. Salmon populations in the Pacific Northwest are already depressed due to a number of factors including over-harvesting, dams, logging and water diversions. Warming of stream and river water has recently been recognized as yet another threat to salmonids. The causes of this warming include mis-management of riparian zones in upland regions and water diversions which reduce flow volumes. These factors are being further exacerbated by rising temperatures caused by general atmospheric warming.

- Dr. Adams indicated that these impacts are substantial enough in some areas that lethal temperatures have been observed during critical summer and fall spawning periods in some streams. Moreover, changes in flow volumes are making it difficult to meet U.S. Clean Water Act regulations aimed at protecting endangered salmon runs. In other words, American salmon protection laws, and other related endangered special and habitat

protection legislation, are being overwhelmed by the cumulative effects associated with the failure to effectively integrate land-use policies in support of water quality. If this is happening in the United States, similar effects are likely being felt in Canada.

- A lesson that could be offered from this example is that saving salmon and their habitat is going to require levels of management we don't presently accept as reasonable in the context of other economic uses that have been established as precedents in western rivers like the Columbia.

- Another lesson that can be learned from the American experience is that it is critical that we improve the accuracy, precision and timing of seasonal precipitation forecasts so that those affected by changes will be able to trust in them. Improved forecasting, however, is just the beginning. We also need to make sure that we plan and act adaptively in response to these forecasts in service – not just of immediate economic interests – but of the long-term adaptive capacity of our ecosystems.

ROSENBERG INTERNATIONAL FORUM ON WATER POLICY

CASE STUDY ONE:
THE JORDAN RIVER BASIN

Presenters:
Dr. Allon Rimmer
Israel Oceanographic & Limnological Research Ltd.

Mr. Yousef Hasan Ayadi
Ministry of Water and Irrigation, Kingdom of Jordan

Discussant:
Dr. Moneef Zou'bi
Islamic Academy of Sciences

Key Themes

1. The problems of water scarcity in the Jordan River basin are probably the most severe in the world. If these problems are to be successfully addressed, effective cooperation among the stakeholders will be essential.

2. Adaptive management will be essential and will entail hard choices. The extent of irrigated agriculture will likely have to be reduced, perhaps drastically.

3. External help in the forms of financial and diplomatic aid will almost certainly be required if the regional water problems are to be effectively addressed.

Synopsis

Water scarcity may be more intense in the Jordan River system than in any other river basin in the world. The causes of scarcity are many and complex. Sparse rainfall and run-off coupled with a relatively large population are the root causes. The international nature of the basin and the failure to develop common institutions or common principles of governance have greatly exacerbated scarcity in some parts of the basin, perhaps needlessly so. One manifestation of the failure of governance is the failure to link the management of the upper Jordan River Basin with that of the lower Jordan River Basin. Global climate change threatens to make the situation even worse given that most of the Mediterranean region is predicted to be drier under most scenarios.

Systematic approaches to the management of the basin are needed. Systems analysis through modeling studies draws attention to the need to acquire and maintain accurate data on water quantity and quality. Collection and archiving of such data could form the basis of an effective international collaboration. Cooperation will also be required among the basin's stakeholders if essential programs of adaptive management are to be developed. Adaptive management will be essential but will entail hard choices. Thus, for example, a significant reduction in the quantities

of water devoted to agriculture maybe an adaptive necessity despite the general reluctance to consider reducing the scope of irrigated agriculture. The urgency of finding water to preserve and protect aquatic environments, which are now threatened with irreversible damage, only intensifies the need for timely programs of adaptive management. The political, social and diplomatic realities of the region suggest that problems of intensifying water scarcity cannot be effectively dealt with in the absence of external aid. Financial aid will be important but technical and diplomatic aid will also be essential. Technological "fixes" such as the Red Sea/Dead Sea project should be approached with caution. Such options are very costly and require that the same problems of common governance be solved as those that must be addressed in managing existing water resources. It seems likely that the water problems of the Middle East can only be solved as part of a larger, all encompassing agreement governing peaceful co-existence among the region's residents together with programs designed to improve the economic levels of living of all.

CASE STUDY ONE:
THE JORDAN RIVER BASIN

LESSONS FOR CANADA & FOR ALBERTA

Background

In addition to the papers presented at the Rosenberg Forum, analysis of the Jordan River Case Study benefited from perspectives offered on this basin by William Jury and Henry Vaux in a paper entitled *The Emerging Global Water Crisis: Managing Scarcity and Conflict Between Water Users* which was in publication in early 2007.

The Jordan River drains part of Israel, Jordan, Lebanon, and Syria. It is a small body, extending only 93 kilometres, about 50 miles, from its source waters in Lebanon to its final discharge into the Dead Sea. Nor is it a large river. By Canadian standards, its flow volume might not qualify it as a river, but as a large creek. Its waters, however, are of crucial importance in a heavily populated and very dry land.

Each of the three streams forming the river's headwaters was originally in a different country, but since the end of the 1969 war Israel has controlled all of the stream areas. The upper reach of the Jordan drains into Lake Tiberias (also called the Sea of Galilee, or Lake Kinneret), which at 21 kilometres in length and 13 kilometres in width is Israel's largest fresh water body. The lake's outflow moves to the Dead Sea along the Jordan River valley.

The Yarmouk River, which originates in Syria and the Zarqa which flows out of Jordan are the two principal tributaries of the Jordan River. Extractions from the Jordan River itself occur at two major diversion works, Israel's National Water Carrier and Jordan's East Ghor Canal. The National Water Carrier transports water through a network of pipes to Tel Aviv and ultimately into the Negev. Water from the Yarmouk River is diverted via the East Ghor Canal to agricultural lands in the Jordan Valley. There are no treaties governing the use and allocation of water in the Jordan Basin. In the 1950s the United States brokered an allocation agreement,

called the Johnston Plan. The agreement was negotiated by technical representatives from all the basin's countries but never formally ratified by the governments in question. The terms of that agreement call for Jordan to receive approximately 75% of the flow of the Yarmouk and 19% of the flow from the Upper Jordan River (Jury and Vaux, 2007).

In their paper, William Jury and Henry Vaux point out that since the Six Days' War, Jordan has been greatly disadvantaged in its water use opportunities both because of its position as a downstream riparian on the Jordan River and its weak strategic standing on the Yarmouk River. Israel has virtually monopolized the waters of the Upper Jordan since the late 1960s. Today, only a highly polluted residue of wastewater flows to the Dead Sea. Jordan's use of the Yarmouk has also been restricted, both by Israeli withdrawals to replenish Lake Tiberias, and by increasing upstream use in Syria. The result is that Jordan is today using only about 25% of the flow of the Yarmouk, one-third of the allocation that would have been granted to it under the terms of the Johnston Plan. Jordanian farmers in the lower Jordan Valley struggle to survive on the supplies available today despite the fact that they have adopted a number of conservation practices designed to increase the efficiency and productivity of water use.

Jury and Vaux (2007) explain a further complication. "The Jordan River Basin is complicated further by the fact that both the West Bank and Gaza Strip of Palestine lie within the Basin and its service area. Per capita water availability in Palestine is a fraction of what is available in Jordan and an even smaller fraction of what is available to Israel. This makes the problem of allocating the very scarce waters of the basin among different users and claimants every more difficult (National Research Council, 1999). One recent study shows that water could be allocated according to its economic value, thereby minimizing the costs and disruptions now attributable to a lack of water. This study also suggests that desalination is not necessarily needed on a broad scale to address the region's water problems (Fisher, et al 2005)"

Jury and Vaux cite Wolfe, et al (1999) who report that solving the water disputes in the Jordan River basin has been superceded by the virtually continuous conflict that has occurred in the region. In the past half century only 37 water disputes have entailed violence. 30 of those involved Israel and one of its neighbors. Elsewhere in the world, there have been some 157 ratified treaties involving water and only 5 events that involved violence. Wolfe and co-authors also found that over 70% of the 1735 water-related events recorded between nations were devoid of any conflict. This suggests that water conflict seems to cause nations to make all efforts to resolve differences peaceably.

Perhaps the most important lesson that Canadians can learn from the difficulties that currently present themselves in managing the waters of the Jordan River is that effectively functioning frameworks for resolving trans-boundary water disputes are crucial for long-term stability in any region. As participants in the Rosenberg Forum were able to see later, institutions such as the International Joint Commission, which arbitrates water-related disputes between Canada and the

United States, can be of immeasurable value in maintaining harmonious relationships between nations that share water resources.

But the management of this basin offers more subtle lessons for Canada as well. The most significant of these may be that if Canadians do not attend to the very real water problems that exist today on rivers like the Saskatchewan, future situations will resemble those that exist today in Jordan.

Dr. Allon Rimmer
Israel Oceanographic & Limnological Research Ltd.

Key Lessons:

1. While the setting may be exotic to most Canadians, managers of the Jordan River face a number of very similar challenges to those we face in western Canada with respect to the knowledge gaps in our understanding of upland watershed hydrology.
2. It is very difficult to manage an important watershed like the Jordan in an integrated way based on knowledge confined to data available on downstream hydrology. In order to optimize water use especially in water scarce areas, it is important to be able to accurately characterize both surface and groundwater dynamics. We face the same challenge in western Canada.
3. To be useful, Canadian hydrological data has to exist in formats that can be shared easily or effectively both between downstream jurisdictions and between the diverse federal and provincial agencies responsible for water quality and availability.
4. The integration of water management and land-use will demand that hydrological data be available not just to government departments but shared willingly with researchers and other *bona fide* interests. In this way inevitable conflicts over water can be avoided and if conflicts do occur they can be resolved on the basis of accurate information.

Dr. Allon Rimmer is a hydrologist with Israel Oceanographic and Limnological Research Ltd. at the Yigal Allon Kinneret Limnological Laboratory in Migdal, Israel. His presentation focused on three studies of major hydrological problems in the upper catchments of the Jordan River and Lake Kinneret. These studies included research on precipitation and stream flow relationships among Jordan River sources, rates of evaporation and saline spring discharge and, finally, long-term prediction of salinity values in Lake Kinneret in response to operational changes such as reduced stream flows.

- While the setting may be exotic to most Canadians, managers of the Jordan River face a number of very similar challenges to those we face in western Canada with respect to the knowledge gaps in our understanding of upland watershed hydrology. While the headwaters of the Jordan in the Mount Hermon region were protected from human impacts in order to protect crucial hydrological processes, knowledge of the geohydrology of the region remains limited. The amount of snow and rainfall on Mt. Hermon was never measured systematically due to difficulties in maintaining a meteorological station above 2000 metres in altitude. As a result estimations of snow and rainfall at these high altitudes were based on extrapolations from data collected at lower elevations.

Though the geographical scale is different, we in western Canada have a lot in common with those who are striving improve understanding of the hydrology of the headwaters of the Jordan River. We do not possess or collect adequate meteorological data at high altitudes in any of the mountain ranges that form our headwaters. In searching for early evidence of the impacts of climate change, Canadians should be looking to where the dawn's light first strikes at the beginning of the day. It strikes the tops of mountains. It is at altitude that we are likely to witness global warming impacts that may ultimately affect water availability and quality in heavily populated downstream river valleys. Such data collection is crucial to the effective long-term resource management in water-scarce regions like the Middle East. Such data will be of no less importance in parts of Western Canada as population growth, limited water resources and climate change combine to create tension over the purposes to which water will be committed in each of the downstream provinces that depend on upland water sources for their prosperity.

- Dr. Rimmer pointed out that the thickness and the borders of the aquifers, water level fluctuations, hydraulic characteristics and local rainfall in the Mount Hermon region were unknown. He also indicated that location of different aquifers in the region, the recharge area of the three main tributaries of the Jordan, and the total recharge area of the Jordan River were unknown. In contrast of the gaps in hydrological knowledge of the Mount Hermon headwaters region, Dr. Rimmer explained, an excellent data base existed for the Jordan River south from Mount Hermon. This data base includes long-term stream flow data, daily rainfall, daily pan evaporation measurements, monthly water consumption and other information.

- Implicit in Dr. Rimmer's presentation, is the notion that it is very difficult to manage a watershed like that of the Jordan in an integrated way when only data on downstream hydrology is available. In order to optimize water use in water scarce areas, it is important to be able to accurately characterize both surface and groundwater dynamics. We face the same challenge in western Canada. We know a good deal about surface water flows as they leave their mountain headwaters. But we have an incomplete understanding of groundwater dynamics and have only partially characterized aquifer location and flow.

- A complete water balance for the Mount Hermon region – which forms the headwaters for this all-important watercourse – has been difficult to compute because stream and spring flow in the east and northeast region of Mount Hermon is in Syria and Lebanon and there is no data sharing between Israel and these two countries.

  The western Canadian provinces that share water flowing from the upland regions of the mountain West do have data pertaining to surface flows and other related hydrological processes although these data are incomplete. These data, however, do not exist in formats that can be shared easily or effectively either between downstream jurisdictions or between the diverse federal and provincial agencies responsible for water quality and availability. As the provinces and jurisdictions responsible for the management of western watersheds are not in conflict as they are in the Jordan River Basin, it should be a

simple matter to develop a shared-access monitoring and data collection program in western Canada that measures both green and blue water dynamics at a watershed scale. The goal of such a data collection system should be the integration of water management and land-use policy that would permit Canadian communities to adapt to climate change impacts and arrive at true environmental and economic sustainability as soon as possible. The achievement of this goal will mean that the hydrological data must be made available not just to government departments but shared willingly with researchers and other *bona fide* interests. In this way inevitable conflicts over water can be avoided and if conflicts do occur they can be resolved on the basis of accurate information.

Mr. Yousef Hasan Ayadi
Ministry of Water and Irrigation, Kingdom of Jordan

Key Lessons:

1. While existing water scarcity in southern Alberta is not presently as severe as in Jordan, scarcity is likely to intensify and may very well reach a degree of scarcity similar to that which prevails in the Middle East. We should be looking now at how scarce water resources are being managed in Jordan so that we can learn from their innovations and avoid creating situations that have made it difficult for them to achieve water security.
2. In contrast, national and provincial water policy in Canada lacks the clarity and comprehensiveness of Jordanian water policy. Indeed, when compared with Jordan, Canada appears lax in terms of public policy development relating to appropriate water management.
3. Neither Canada's federal government nor provincial governments have demonstrated that planning for the development of water resources is as important as plans for the development of other resources or other sectors of the economy.
4. Water quality issues abound in Canada and water scarcity is becoming a serious issue in a number of regions in the country. Canada should look now – before it faces crisis – at the public policy example of countries like Jordan for perspectives on how water scarcity may have to be managed in the future.

The Jordan Valley Authority, under the Ministry of Water and Irrigation, is entrusted with the integrated socio-economic development of the Jordan Valley. During the last 30 years, the Jordan Valley Authority completed a variety of infrastructure projects that changed the lifestyle of its inhabitants, attracted new settlers to the valley and reversed rural to urban migration. These improvements included a modern water control centre to monitor and control water management activities which has led to optimum water distribution of limited water resources to satisfy agricultural and domestic needs. A participatory approach – not unlike the one employed in Alberta's Water for Life Strategy – was also taken to water distribution challenges. Farmers were encouraged to form water-user groups to identify their specific needs and to share in water distribution responsibilities with the Jordan Valley Authority. Similarities between the Jordan Valley and the dry southern prairies of Canada do not stop there.

- Water resources in the Jordan Valley are scarce and deteriorating with increasing competition for ever more limited resources. The Jordan Valley is a small but crucial agricultural region. Though it represents less than 5% of the area of Jordan, it produces more than 60% of its fruits and vegetables.

- Though Alberta has a great deal more agricultural land in production, the similarities between the productivity of the irrigated Jordan Valley and the irrigated region of southern Alberta are obvious. Though its represents less than 5% of the arable area of Alberta, the combined irrigation capacity of southern Alberta is responsible for 20% of the province's agricultural gross domestic product. While existing water scarcity in southern Alberta is not presently as severe as in Jordan, scarcity is likely to intensify and may very well reach a degree of scarcity similar to that which prevails in the Middle East. Even now population growth and flow regime changes are creating greater competition for ever more limited resources. We should be looking now at how scarce water resources are being managed in Jordan so that we can learn from their innovations and avoid creating situations that have made it difficult for them to achieve water security. Some important lessons can be learned from the Jordan Water Strategy – a Middle Eastern equivalent of Alberta's Water for Life initiative.

- In 1998, the Jordanian Ministry of Water & Irrigation developed a set of policies related to irrigation, groundwater, wastewater and utility that together compose what is called the Jordan Water Strategy. The main features of this strategy that have relevance in the Canadian context are as follows:

    1. Water is recognized as a national resource and valued as such.
    2. Water is a central part of the national economy. A plan for the development of water resources is as important as any formulated for other sectors of the economy.
    3. Effective water management demands the maintenance of a computerized national water data bank and information system.
    4. Sustainable water management demands the linking of surface and groundwater, which must be seen, not as separate resources, but as manifestations of the same resource.
    5. There is an urgent need to explore for the existence of uncharacterized deep aquifers.
    6. There is no such thing as "waste water". Waste water must be collected and treated for other uses especially as they relate to agriculture.
    7. Brackish and water of marginal quality can be used for selected agricultural purposes.
    8. Genetic engineering of crop types must be employed to allow water of marginal quality to be used in agriculture.
    9. Social and environmental costs of foregone opportunities for water use have to be measured and quantified.

10. Allocation of water for basic human needs (100 liters per capita per day) constitutes a fundamental right and is the highest priority of the water system. The next priorities include municipal needs, tourism and industry.
11. Special care must be given to pollution prevention.
12. The mining of fossil water will be carefully planned.
13. Land use will be defined by water availability and impacts on quality.
14. The cost of all future development will be evaluated in terms of water requirement per unit of production.
15. Human resource development in leading-edge water management is a top priority. This priority will be recognized through education, on-the-job training and overseas training with leading institutions and practitioners of integrated watershed management.
16. There will be a constant evaluation of the institutional effectiveness of the country's water management systems.
17. There will be a constant updating of legislation to keep up with emerging needs.
18. Public participation in the evolution of the country's water management systems in not optional. The government will legislate the participation of stakeholders.
19. Public engagement will be orchestrated in such a way that challenges in the water sector are not faced solely by the government's water administration in association with related interests. The public must be engaged equally (if not more) in decisions that relate to the management of the country's water resources.
20. The government will set and strictly enforce national drinking water standards.
21. There will be an expansion of the private sector role in water management and in agriculture.
22. Utilities and water services will aim for cost recovery.
23. Cost recovery will be two-tiered. At the level of individuals and families it will be tied to the cost of living. Tourism, agriculture and industry users will pay fair market value for water resources.
24. Indigenous water research will be encouraged.
25. Links will be established outward to the international community so as to keep up with modern advances.

In contrast, national water policy in Canada lacks the clarity and comprehensiveness of Jordanian water policy. On a specific level, the Jordan Valley example makes even provincially progressive initiatives like the Alberta Water for Life Strategy appear incomplete.

While the scale of the country and the relative abundance of water may help to explain why Canadians have not developed such a sophisticated public policy framework for managing its water resources a comparison of the two approaches suggests that Canada may wish to do a great deal more to secure its water resource future, especially in an era of rapid population growth and changing climate conditions. Canada does not have a national water strategy. The federal government has abrogated almost all responsibility for water to the provinces and territories and where it has maintained responsibility it has done a demonstrably poor job of delivering on it

water quality mandate. (Of the 78 federally administered Indian Reserve water operations in Alberta, for example, only 14 were fully-certified in February of 2006. Today, 59% of reserve drinking water systems are considered "at risk".)

Neither Canada's federal government nor provincial governments have demonstrated that planning for the development of water resources is as important as plans for the development of other resources or other sectors of the economy. We do not have a national computerized water management information system. Federal and provincial hydrological data is difficult if not impossible to access. While products of water use, such as hydro-power, are well established industries in Canada, policy is lacking both federally and provincially that establishes the importance of water as a resource in its own right. There is no effective integrated management of both surface and groundwater anywhere in Canada. No integrated policy exists concerning alternate uses for brackish or water of marginal quality. Social and environmental costs of foregone opportunities for water use remain largely unmeasured and quantified and hierarchies of priority for accepted use are rare in this country. Presently, water use even in water scarce areas is still granted to anyone as long as water for allocation is still available. Federally and provincially Canadians still place greater focus on cleaning up pollution problems rather than preventing them. Land use in Canada is only now beginning to be tied to water availability or impacts on quality. Neither federal nor provincial governments invite evaluation of the institutional effectiveness of their water management agencies and where it does occur reaction is often defensive and input ignored. Legislation federally and provincially seldom keeps up with emerging water quality or management needs. While some provincial governments have encouraged public participation, public engagement is often hampered by the inertia of government departments and lack of adequate funding. Nor does Canada have enforceable national drinking water standards. In Canada water treatment and delivery assets are inconsistently managed often without adequate attention to fair market pricing policies that will ensure that maintenance and infrastructure replacement costs are recovered. Perhaps most importantly, there appears to be little genuine political interest in changing these circumstances.

While Canada may have had the luxury of taking water resources for granted in the past, it will unlikely to be able to do so in the future. Water quality issues abound in Canada and water scarcity is becoming a serious issue in a number of regions in the country. Canada should look now – before it faces crisis – at the public policy example of countries like Jordan for perspectives on how water scarcity may have to be managed in the future.

Discussant:
Dr. Moneef Zou'bi
Islamic Academy of Sciences

<u>Key Lessons:</u>

1. Effectively functioning frameworks for resolving trans-boundary water disputes are crucial for long-term stability in any region. In their absence, political and military conflict can make it difficult if not impossible to implement superior water management solutions.

2. Institutions such as the International Joint Commission, which arbitrates water-related disputes between Canada and the United States, are of immeasurable value in maintaining harmonious relationships between nations that share water resources. These institutions need to be maintained.
3. If Canadians do not attend to the very real water problems that exist today on rivers like the Saskatchewan, future situations will resemble those that exist today in Jordan.

Dr. Moneef Zou'bi is Secretary General of the Islamic World Academy of Sciences in Amman, Jordan. Dr. Zou'bi concluded his observations on the Jordan River Case Study by pointing out that the problems associated with solving water resource management issues in the Jordan River Basin cannot be addressed in the absence of regional political stability. He concluded by telling the Rosenberg Forum that without outside diplomatic and scientific assistance, experience and funding that the Jordan River could soon be lost forever, with unimaginable consequences for the Middle East and for the world.

The lesson Dr. Zou'bi offered to Canada was that it is of crucial importance to pay attention to water crises wherever they occur and to contribute where possible to their solution. It is important to do so not just for reasons of political and social stability elsewhere but because the solutions employed to prevent conflicts over water use, quality and allocation may be of great value should water scarcity impact transboundary relations in the region in which you live.

The suggestion here is that Canada is presently ill-prepared for inter-jurisdictional tensions between the provinces over water issues and badly positioned to manage trans-boundary concerns with its southern neighbor and will continue to be at considerable public policy disadvantage until its gets its own water management house properly in order.

ROSENBERG INTERNATIONAL FORUM ON WATER POLICY

CASE STUDY TWO:
THE SASKATCHEWAN RIVER

Presenter:
Dr. David Schindler
University of Alberta, Canada

Reaction Panel
Hon. John Nilson Q.C.
Minister of Environment, Province of Saskatchewan

Hon. Guy Boutilier
Minister of Environment, Province of Alberta

Round Table Discussion

Key Themes

1. Despite the apparent abundance of water in Canada, water is scarce in the southern portions of the Prairie Provinces where the population and most economic activity is concentrated. The Saskatchewan River presents important water management challenges that must be addressed if water crises of the sort that plague the Jordan River basin are to be averted in the future.

2. Existing science points the way toward needed changes in water management practices. It will be important to base new and altered water policies on sound science. Science must not be used exclusively to identify problems. It is equally important for scientists to develop science-based solutions to those problems.

3. Scientists and policy makers need to work closely together to ensure that contemporary policies are based on science and are consistent with scientific knowledge. Both scientists and policy makers need to be aware of and sensitive to the perspectives of their counterparts and act in ways that accommodate those perspectives.

Synopsis

Although Canada is richly endowed with water resources, it suffers from the same problem that plagues many of the arid and semi-arid regions of the world - a mismatch between the times and places where water occurs and the times and places where it is used. The Saskatchewan River and especially its southern fork is a relatively populated, water scarce area that is growing very rapidly both in terms of its economy and its population. The current state of the Saskatchewan River reveals the nature of the pressures on it. Aquatic ecosystems are being impaired and destroyed and more water is diverted and less is available to support water-based ecosystems; the

associated wetlands are disappearing very fast along with the ecological services that they provide; and, the eutrophication of lakes in the basin has become a big problem as summer algal blooms are common and recurrent during the summer months. The retreat of glaciers that form the headwaters has caused summer flows to decrease by as much as 80% during the last 100 years. Projected population and economic growth, together with possible adverse impacts from global climate change, threaten to cause a series of recurring water crises much like those currently plaguing the Jordan River basin. Action is needed now in the form water and associated resource management policies that are based on science and acknowledge the fundamental physical, biological and hydrologic characteristics of the river basin.

All of the problems in the basin can be addressed in a proactive fashion based upon existing scientific knowledge. Attention must be given to maintaining the minimum streamflows needed to support aquatic ecosystems and the services they provide. Attention must also be given to maintaining and enhancing water quality and to regulating and controlling activities that routinely lead to water quality degradation. In addressing these issues it will be essential to consider the interrelatedness of land and water resources. There are sharp limits on the extent to which water management practices can be improved in the absence of corollary changes and improvements in land management practices. The fact that much of the science needed to solve these problems is available draws attention to the importance of devising policies which are based upon science or, at least, are not inconsistent with science. It also draws attention to the importance of improving communications between scientists and policy makers.

Too frequently, scientists fail to put information into a form in which it can be clearly understood by policy-makers and the public. Scientists tend also to focus on identifying problems and sometimes fail to devote similar energies to the devising of scientifically based solutions to those problems that might be considered and adopted by policy makers. Policy makers tend to evaluate problems and solutions in very short time domains while scientists typically view the same problems and solutions in longer time domains. Policy makers frequently demand that scientific information be completely certain. Nothing is completely certain. Just as frequently scientists fail to acknowledge the fact that there results and information are subject to differing degrees of uncertainty. Systematic efforts to improve the flow of communications between policy-makers and scientists must be made.

An effective science-base framework for resolving the resource management problems of the Saskatchewan basin can be successfully developed only with broad public participation. Scientists will need to redouble their efforts to communicate clearly not only with policy-makers but with the public at large. This is doubly important since “political will” usually resides with citizens and voters rather than policy makers and political leaders.

CASE STUDY TWO:
THE SASKATCHEWAN RIVER BASIN

LESSONS FOR CANADA & FOR ALBERTA

Dr. David Schindler
University of Alberta

Key Lessons:

1. The average flow of the Saskatchewan River has been much reduced in the past century. These significant flow reductions have resulted is rising annual temperatures in the river.
2. While lower mean flows influence water temperatures, climate warming has also been a important factor in the changing hydrology of the basin. Alberta and Saskatchewan have already recorded a warming trend of 1°C to 4°C, mostly after 1970. Regional climate models predict that the average temperature will increase by another 4.8°C to 8° C by 2100. This range is outside our society's current willingness or capacity to adapt.
3. The prairies supply approximately two-thirds of Canada's $15 billion in annual agricultural exports. The conversion of the prairie to agriculture, however, has resulted in a slow degradation of water quality in the basin. While the gradual deterioration of water quality in the basin must be considered a serious long-term problem, it cannot be separated from the region's history of drought.
4. A number of public policy shortfalls need to be addressed. The Water for Life Strategy is a start but it must lead to comprehensive changes to water management policy.
5. In the interim, the prairie provinces would be wise to approve only those agricultural and industrial developments that do not require a great deal of water during the dry summer months; control greenhouse emissions so that we can reduce warming that is causing increasing evaporation and glacial loss; and keep populations in the dry part of the Saskatchewan River Basin low so as not to exacerbate water scarcity.

David Schindler is the Killam Memorial Professor of Ecology at the University of Alberta. He founded and directed the Experimental Lakes Project near Kenora, Ontario, conducting experiments on whole ecosystems to directly test the effects of nutrient inputs, acid rain, climate change and other human insults. His work on eutrophication and acid rain has been widely used in formulating ecological management policy in Canada, the USA and in Europe. Dr. Schindler has received numerous national and international research awards, including Canada's highest scientific honor, the NSERC Gerhard Herzberg Gold Medal for Science and Engineering. He is a Fellow of the Royal Society of Canada, the Royal Society of London (UK), the Royal Swedish Academy of Engineering Sciences, and a member of the U. S. National Academy of Sciences.

- Cumulative human and climate impacts, less water and higher concentrations of nutrients and other contaminants threaten the health of the Saskatchewan River. While the upper basin is well protected, 50% of the wetlands in the basin have been filled or drained and pollutant loads, of both nutrients and pathogens, have increased as a result of agricultural

practices. Coordination of all levels of government will be essential if the health of the river is to be restored.

- The Saskatchewan River drainage encompasses some 334,000 square kilometers, of which over 1800 square kilometers are in the United States. The mean flow of the river at its mouth is 241 cubic meters a second. Its mean flow where it enters Lake Winnipeg is 567 cubic meters a second. Most of the water that forms the river comes from snow melt from the headwaters region in the Rocky Mountains. This produces a situation in which large parts of the basin contribute little to the flow of the river. The Battle River tributary, for example, drains 40% of the watershed but contributes only 3% of the flow of the river. While the average annual contribution of glacial melt to the river is less than 5%, glacial contribution to the flow of the river can reach 50% in dry years.

- The average flow of the river has been much reduced in the past century. During the last 100 years, the average flow of the North Saskatchewan at Edmonton has been reduced by 15%. Over the same period the flow of the river at Saskatoon has been reduced by 30% and at North Battleford by 40%. The flow of the South Saskatchewan River at North Battleford has been reduced by 85% over the same one hundred year period. These significant flow reductions are one of the reasons why the average temperature of the water in the river is rising.

- There are some 36 species of fish in the North Saskatchewan River. This number increases to 44 species once the river reaches the Cumberland Marshes near the Saskatchewan-Manitoba border. The river's aquatic ecosystem, however, has been altered significantly by the deliberate introduction of invasive fish species which are also found in Lake Winnipeg.

- While lower mean flows influence water temperatures, climate warming has also been a important factor in the changing hydrology of the basin. Alberta and Saskatchewan have already recorded a warming trend of 1°C to 4°C, mostly after 1970. Regional climate models predict that the average temperature will increase by another 4.8°C to 8° C by 2100. **"**This range is outside our society's current willingness or capacity to adapt", Dr. Schindler warns.

- Some 67% of the Saskatchewan River catchment is now farmed. The population of the basin is now 3.5 million, which translates to less than 10 people per square kilometer outside of urban of areas. Human activity has been responsible for a variety of associated changes on the landscape including:

    - Forest clearing
    - Dam construction
    - Canal construction
    - Irrigation diversions
    - Draining and filling of wetlands
    - Population growth

- Oil and gas exploration
- Other industrial and municipal land use activities

- Of the 770 dams that have been constructed in Canada's Prairie Provinces, most are in this river basin. Reservoirs created by these dams are important water sources. Lake Diefenbaker, for example, supplies drinking water for 40% of Saskatchewan's population, as well as for irrigation, industry and 10 potash mines which contribute significantly to the province's economy.

- It has been found, however, that the impoundment of water in reservoirs does have significant impacts on downstream flows. Impoundments that fluctuate widely often cause decreased production of macro-invertebrates which require a full year to complete their life cycles in cold waters. In many instances, they are replaced by smaller, shorter-lived species of less value for supporting fish stocks. Impoundment also impacts water temperature. Thermal impacts can be felt for 110 kilometers below reservoirs. While widely touted as a clear source of electricity, dams are not as environmentally neutral as was once thought. Impoundments increase mercury concentrations in the water and increase both CO_2 and methane release.

- The prairies supply approximately 2/3 of Canada's $15 billion in annual agricultural exports. The conversion of the prairie to agriculture, however, has resulted in a slow degradation of water quality in the basin. Unlike the Great Plains in the United States, which relies far more on groundwater, most of the agriculture in the Saskatchewan River Basin relies on surface water supplies. In applying nine aquatic health criteria to the 18 main tributaries of the North Saskatchewan River, four were found to still possess good aquatic health, nine were rated as fair and 5 rated as poor.

- The South Saskatchewan River is divided into 33 distinct reaches. When the same nine aquatic health criteria were applied, only one reach was rated as unchanged or recovered. Of the remaining 32 reaches, 31 were rated as moderately to heavily impacted. The gradual deterioration of water quality in the basin must be characterized as a serious long-term problem and it cannot be separated from the region's history of drought.

- The impacts of drought on the region are well documented. In the 1930s, 250,000 farmers were forced to leave the prairies in a drought that affected 7.3 million acres of land. Though better managed, droughts in the past two decades have caused agricultural export losses of up to $4 billion in some years.

- Secure water supplies are important to agriculture. For this reason irrigation is by far the most consumptive use of prairie water. Irrigation agriculture became a feature of the Canadian prairies with the passage of the Northwest Irrigation Act of 1894. Today, 13 irrigation districts now distribute 2.5 cubic kilometers of mountain water to 1.63 million acres of land. It is estimated that this 5% of arable lands produce 20% of the province's gross agricultural production. This production, however, has significant impacts on the quality of the water that flows back into the South Saskatchewan River. About 20% of

this water (about 0.5 cubic kilometers) is returned to the river, but it can be heavily contaminated by nutrients, pesticides, herbicides and pathogens.

- Dr. Schindler noted that in addition to crop production, "Alberta also has 6 million cattle and 2 million hogs and has a goal of doubling these numbers in the future. Such growth is bound to further impact water levels and the already reduced aquatic health of the river system."

- Mercury in fish is the primary toxin of concern in the Saskatchewan River. Mercury concentrations in the river may be naturally high which means that further additions are even more problematic. Forest fires add mercury to water courses and lakes and as the frequency and intensity of forest fires increases across the west as a result of global warming, mercury contamination will increase.

- The most threatened parts of the Saskatchewan River system are Oldman and Bow river basins. The Oldman contributes 40% to the flow of the South Saskatchewan, as does the Bow. The remaining 20% is added by the Red Deer River. The combination of climate warming, by way of its effects on glacial melt, evaporation and accelerated spring melt, plus high water temperatures, increasing human populations, agricultural use and industrial development have put the Bow and Oldman rivers in precarious states.

- Under a 1969 Inter-Provincial Master Agreement, apportionment of 50% of the flow of the South Saskatchewan must flow from Alberta into Saskatchewan. As the Bow and Oldman are already fully – if not over – allocated, water to meet this commitment comes from the Red Deer. To date, over allocation has not been a problem because not everyone has taken their full allocation but this will soon change as human activity increases.

- Fish in these rivers are approaching the limits of tolerance to increases in water temperature. It is estimated that instream flow needs of 85% of natural flows will be required to sustain aquatic ecosystem health in these rivers. This, however, is impossible given already established withdrawal allocations in both the Oldman and the Bow.

- A moratorium has already been placed on further water licenses but it will only be a matter of time before conflicts begin to occur as economic development in southern Alberta is limited by the inflexibility of the existing licensing structure.

- Below the Banff National Park boundary, little of the Bow River remains in its natural state. Some 68% of the river's natural flow has been allocated by the time it joins the Oldman to become the South Saskatchewan. Of this 66% allocation, 76% is allocated to irrigation. Water quality declines along the length of the river as a result of coliforms, bacteria, nutrients, pesticides and salts.

- Dams on the Bow River have essentially the same impact on endemic fish species as dams do on the Columbia River. Fish hatcheries and stocking programs in the Bow Basin

are no more successful than salmon restoration programs have been in the lower Columbia Basin.

- The City of Calgary gets 50% of its water from the Bow River and 50% from the Elbow River and the Glenmore Reservoir. The City of Calgary's water conservation program has been successful. Summer water demand in 2002 was 7% less than it was in 1987, despite a 39% increase in population. The base flow of the Bow River, however, continues to diminish. At the Bassano Dam, the average summer flows of the Bow River are currently 50% of what they were in the 1960s when record-keeping began. Urban impacts on the health of the river and its flow are expected to grow with the population of Calgary, which is expected to reach 1.5 million by 2030.

- The Oldman Basin covers 3 million hectares, but has no glacial inflows. About 160,000 people live in the Oldman Basin, of which half live in Lethbridge. About 266,000 hectares of the basin is under irrigation agriculture. This area represents 40% of all the irrigation presently being undertaken in Alberta. The greatest density of livestock operations in the province is also concentrated in this basin. Thus, Oldman River basin is the locale of one of the most intensively managed agricultural regions in the country. In addition to agriculture there is also greater pressure to develop oil, gas and coal-bed methane resources in the basin, in spite of the fact that the average summer flows in the Oldman system are only 40% of what they were 100 years ago.

- Flow reductions in the Saskatchewan River basin have had a significant impact downstream on Lake Winnipeg. Nutrient inputs to the lake have increased largely as a result of increased livestock production, fertilizer use and growth of human populations in the southern part of the lake's catchment. Lake Winnipeg is the 12th largest freshwater lake in the world, and the 5th largest freshwater lake in Canada. That this 24,400 square kilometer body of water is in the midst of advanced eutrophication as evidenced by the fact that in the summer of 2006, a 6,000 square kilometer blue-green algae bloom appeared in Lake Winnipeg.

- Dr. Schindler indicated that a number of public policies shortfalls needed to be addressed if the health of the Saskatchewan River was to be sustained, especially in the face of increasing human populations, growing land-use impacts and diminishing water supplies. The public policy issues he identified included the following:

    - Land managers and policies makers fail to consider the cumulative effects of human activity, drought and climate change.
    - In the western Prairie Provinces integrated watershed management is rarely found.
    - Science is not adequately considered in the planning process
    - Land-use decisions are made on a project-by-project basis by virtually all parties despite the fact that they have huge potential impacts on water
    - Only recently have instream ecological flow needs given any consideration
    - The potential for conflict among water users grows because inattentive

management has resulted in over allocation of the waters of at least one river
    - When environmental concerns lead to resist development, local decision-making powers are frequently moved to provincial political levels
    - Agencies charged with enforcing laws have become less effective because of budget cuts
    - Critical data on weather, snowpack, water quantity and water quality are missing or incomplete because of short-signed budget decisions
    - Piecemeal solutions that are reactionary and come from different departments and levels of government are usually too late to be effective
    - Despite the fact that Alberta's Water for Life Strategy is a beginning, there is not now any set of comprehensive policies for managing water problems

- Dr. Schindler concluded with policy recommendations that would permit effective solutions to emerge. These recommendations include:

    - New agricultural and industrial development activities should be approved only if they do not require a great deal of water especially during the dry summer months
    - Greenhouse emissions must be controlled so as to reduce the extent of warming on the prairies which will, in turn, reduce evaporation and slow glacial loss
    - Population growth in the dry portions of the Saskatchewan River Basin should be kept at minimal levels to avoid intensifying water scarcity further and avert the serious problems that now beset the Southwestern United States and other populous dryland areas.

Round Table & Later Discussions

Key Lessons:

1. Population growth and climate impacts on water availability are poised to create a crisis in the water scarce Saskatchewan River Basin in southern Alberta.
2. As water scarcity begins to impact urban and other forms of rural economic development, greater public attention will fall on the amount of water used particularly in irrigation.
3. It may soon be difficult for the provincial governments to avoid establishing new mechanisms for transcending existing first-in-time, first-in-right licensing arrangements so that the economic, social and environmental future of the province is not limited or diminished by failure to properly manage water scarcity.

Some of the Discussion

Population growth is a serious issue with respect to the management of water in Alberta. During the past century, the population of Canada grew six fold, the population of the province of Saskatchewan grew 11 fold, and the population of Alberta has grown 44 fold. Most of the growth in Alberta has occurred in the past twenty-five years. Simultaneously, quantities of water flowing in Alberta's southern rivers and especially the Saskatchewan River Basin have diminished. If a

serious water-related crisis is to occur in the Canadian West, it is likely to happen first in southern Alberta where water is scarce.

History elsewhere has dramatically demonstrated that over-allocating rivers in water scarce areas invariably leads to conflict between users. That at least one river in southern Alberta has permitted allocations of more than 100% demonstrates poor planning and management of the resource. The established mechanisms for managing water appear to be at or near their capacity to manage emerging water scarcity situations.

Existing water management processes are not likely to be adequate in the face of current population growth and industrial and agricultural development. Political processes are not moving fast enough to keep abreast of emerging problems. Public policy development with respect to utilization of water in agriculture and established resource exploitation industries has advanced far beyond the known limits of the resource. Short-sighted licensing mechanisms have granted rights to sectors without regard to either the environmental services that healthy aquatic ecosystems can and must provide or to the ultimate limits of water supply. A great deal of investment has been made in already established and deeply entrenched water rights. This rights system, however, is highly vulnerable to the impacts of extended drought and diminished water supply, which appear likely in all projected climate change scenarios.

Alberta is not alone in its failure to be proactive in addressing potential water scarcity. The province, in fact, exemplifies an unfortunate global trend. As was proven in 2001 and 2002, water conservation can be dramatic during droughts but water use returned to pre-drought levels as soon as the drought was over. As David Schindler pointed out, though water scarcity has been identified as a potential problem in Alberta, the issue remains to be addressed. What this means is that aggregate productivity of water remains less than it should be. Collaborative arrangements in which there is a commitment to allocating water to its highest and best use would go a long way to make sure the people of Alberta get the most out of their water.

Climate impacts on water availability are poised to create a crisis in water-scarce southern Alberta. That pending crisis will not be a failure to imagine solutions to the problems of water supply and quality in the province for such solutions clearly exist. If there is a crisis it will be one of governance. In the absence of mechanisms for breaking the current stalemate of conflicting interests and making real progress toward a new water ethic and new ways of learning to productively share the resource, Alberta could be destined to follow the path of many countries that failed to take the threat of water scarcity seriously until it was too late. Only proactive public policy will ensure that Alberta's economic and social development are not slowed or reversed by water scarcity.

While a factor during periods of low flow, municipal water use does not necessarily have to contribute significantly to overall water supply issues even in a water scarce area like the South Saskatchewan River Basin. Although industrial and municipal withdrawals of water worldwide are significant, much of their withdrawal is returned to the supply base, leaving only 6.4% that is actually consumed. Proper wastewater treatment can make a measurable difference to downstream water quality. Dr. Schindler points out that Lethbridge, Alberta, is a good

illustration of this phenomenon. After installing a new water treatment plant, downstream point source nitrogen inputs into the Oldman River from the City of Lethbridge were reduced from 59% to 11%. Bacterial inputs were reduced from 82% to 0.1% and phosphorus reduced from 87% to 24%. Better treatment, in concert with strict conservation strategies, can go a long way to ensure sustainable water supply to western Canadian cities in the future. That does not mean, however, that there will not be conflicts over water allocation and use.

The biggest potential loser in the absence of proactive public policy with respect to water allocation and use in the face of diminishing supply could be agriculture. Despite improvements, agricultural practices continue to have considerable impact on water quantity and quality in the Saskatchewan River Basin. As water scarcity begins to impact urban and other forms of rural economic development, greater public attention will fall on the amount of water used in irrigation.

As water becomes scarce, urban and industrial users will begin to question agricultural water use and rights. It will not be possible to hide the fact that the public cost of agricultural subsidies in Alberta has been substantial through time. Rights for huge volumes of water have been given to farmers in perpetuity at little cost. The public has born the cost of dams and related infrastructure to support a vast irrigation network in the province. The public then pays again for the negative impacts on downstream flow volumes and contamination.

It may soon be difficult for the provincial governments to avoid the need for new mechanisms for transcending existing first-in-time, first-in-right licensing arrangements so that the economic, social and environmental future of the province is not limited or diminished by failure to properly manage water scarcity.

ROSENBERG INTERNATIONAL FORUM ON WATER POLICY

CASE STUDY THREE: THE RHONE RIVER BASIN

Presenters:
Dr. Jean-Paul Bravard
Université Lumière-Lyon, France

Dr. Claudia Pahl-Wostl
University of Osnabrück, Germany

Discussant:
Dr. Bruno Messerli
University of Berne, Switzerland

Key Themes

1. The Rhone is a highly developed and heavily modified river. The impacts of global climate change are already evident in the basin and additional global change will require a proactive response to new hydrologic and environmental realities.

2. Adaptive management is the only workable strategy for dealing with global climate change in the Rhone River basin.

3. Stakeholder involvement in the development, review and evaluation of adaptive management plans will increase the likelihood of success. Social learning will be a crucial part of both stakeholder involvement and adaptive management and will also be important in its own right.

Synopsis

The Rhone River is highly developed and bears little resemblance to the unmodified water course of four centuries ago. Today, headwater glaciers have lost up to 50% of the ice volume present a century ago. Some 94% of the floodplain has disappeared and this has resulted in more severe and frequent floods in recent years. The biological and ecological functions of the river are severely impaired and action is needed to reestablish and revitalize them. Already some of the effects of global climate change are evident with changes in sediment flows and bank sloughing being relatively recent phenomena. Climate change will pose significant challenges to the river's managers but it is only one of a number of pressures on the river that will have to be addressed in the immediate future. Thus, for example, flood control is already a problem but it will likely become an even more significant problem as global climate change progresses.

The ultimate manifestations of global change upon the river are uncertain and there will likely be an entire series of changes as global warming intensifies. The effects of other pressures - both

singly and interactively with climate change - present a highly uncertain range of possible effects and outcomes. Adaptive management is probably the only workable strategy in the face of such uncertainty. While existing infrastructure may have to be refurbished, there will be limits on the extent to which technical and economic measures can solve problems. Social scientists should be engaged and urged to design and evaluate social adaptive management processes. Innovators will need latitude to introduce and experiment with new approaches.

Broad stakeholder involvement will increase the likelihood of success of the adaptive management plans. To date, there has been much political rhetoric about the need to resolve river management problems. This rhetoric has not found its way into operational regimes and has had little impact on outcomes. Only by involving stakeholders in a broad participatory process in which adaptive management plans are developed and the results evaluated can relative success at addressing the problems of the basin be assured. Public education and the consequent social learning will be central to such participatory processes because the results of the process will depend in part on a well-informed group of stakeholders. Social learning is important in its own right. Irrespective of specific outcomes, it leads to a better informed, more sophisticated group of stakeholders who will likely make better decisions than in the absence of social learning.

CASE STUDY THREE:
THE RHONE RIVER BASIN

LESSONS FOR CANADA & FOR ALBERTA

Dr. Jean-Paul Bravard
Université Lumière-Lyon, France

Key Lessons:

1. Because it possesses extensive upland tourism developments such as ski resorts, big lowland urban areas and extensive agriculture, the Rhone Basin provides Canadians with a glimpse of what it might be like to manage our water resources in a much more populous future.
2. A number of climate change impacts have already been observed in the region. All of these should be of interest to western Canadians who are beginning to see similar patterns emerge in our mountain headwaters.
3. The impact of climate warming on ski areas in the Alps has been known for more than a decade. A projected increase of mean annual temperature of 2°C to 3°C by 2050 will adversely affect ski areas between 1200 and 1500 meters. This is already begun to happen. Similar trends have also been observed in the Canadian Rockies.
4. Snow cover in the Alps has already become more and more uncertain at lower altitudes as it has in Canada. A modest 2°C warming will reduce the reliability of Swiss ski resorts from 85% in the late 20th century to 63% by mid-century or earlier, particularly at low altitudes.

5. One of the responses to these climate related changes in snowpack has been a movement to relocate existing lower altitude ski resorts – or the ski runs associated with them – to higher terrain. In crowded Europe, however, this movement has resulted in conflict with the protection of remaining natural areas or watersheds.
6. Where ski areas cannot move or extend their lifts into higher terrain, lack of reliable snow is being compensated for by costly improvements in snow-making equipment and investment in other types of tourism activities.
7. In 2002, 85% of the 162 ski resorts in the French region of the Rhone Basin were able to produce artificial snow. They did so on 15% of their ski surface, between 1500 and 2000 meters. The altitude at which snow making has become necessary, however, continues to rise, just as it does in the Canadian Rockies.
8. Because the need for snow making occurs during periods of already low river flow, ski areas in the Alps are beginning to compete with themselves and with others for increasing limited water resources. This is also likely to happen in the Canadian Rockies.
9. Europeans have also found that snow making has measurable impacts on aquatic environments as a result of the strategies they have had to employ to ensure adequate winter water supply.
10. It is not just in winter that climate change impacts on water availability are being felt in the Rhone River Basin. Throughout the basin, water supply for swimming pools, lawns and golf courses is being reduced by decreases in summer precipitation and related increases in evaporation.
11. It is highly unlikely, given the climate change impacts projected for Western Canada, that the tourism industry in Alberta will be immune to many of the same impacts as have already been experienced in the Rhone River Basin.
12. If current trends continue to manifest themselves, the Canadian Rockies – like the Alps – are going to be very different by 2030.
13. While climate impacts on upland regions of the Rhone Basin have been well described, it is important to note that these impacts will also influence agricultural productivity in the downstream lowlands, just as they will in Canada.
14. Watershed managers can be trapped by their own infrastructure into inferior decisions on how to manage changes in hydrological regimes brought about by incremental human impacts and broader changes related to climate impacts. The more river discharges are affected by withdrawals from aquifers, the more difficult it will be to tell the difference between anthropogenic impacts and impacts attributable to climate change – even in well studied basins like the Rhone.
15. It is also clear that once you reach the level of water use and increasing scarcity that is presently being experienced in the Rhone Basin, the only room to move – beyond the re-engineering of the entire basin – may reside in improving water use efficiency among big users. Inevitably, irrigation agriculture will be targeted as an important area in which conservation improvement will be crucial to secure water availability in other economic sectors.

In addition to being a professor in the Geography Department at Université Lumière in Lyon, Dr. Jean-Paul Bravard is also the Head of the Rhone Watershed Workshop Zone. Dr. Bravard is an expert on the impacts of climate change on the management of the upland regions of the Rhone River Basin in France. Dr. Bravard's presentation offered dozens of considerations for Canadians as we begin to see climate impacts in the upland regions of our own western watersheds. These considerations may be of particular value as Canadians contemplate the future of the ski industry in Western Canada.

- The Rhone River basin encompasses some 98,000 square kilometers including 10,000 square kilometers in Switzerland. The relative scale of this watershed and the comparative density of human population is put into relief by the fact that this basin is roughly ¼ of the area of the Saskatchewan River Basin in Canada. The degree of human development in the comparatively smaller Rhone Basin, however, is many times that of the Saskatchewan, which provides Canadians with a glimpse of what it might be like to manage our water resources in a much more populous future.

- In terms of flow, however, the Rhone is much larger than the Saskatchewan. With an average discharge into the Mediterranean of 1700 cubic meters a second, its flow is approximately three times the average flow of the Saskatchewan where it enters Lake Winnipeg.

- A number of climate change impacts have already been projected for Rhone Basin, which are not dissimilar to the impacts that have been projected in western Canadian basins. These include:

    - A decrease in total discharge of the river
    - An increase in winter as opposed to spring and summer discharge
    - A marked decrease in summer flow
    - A decrease in ice and snow cover which will induce a change in river flow regimes

- The social and economic impacts of climate change have been considered. They include:

    - Reductions in hydro and thermal power generation capacity
    - Impacts on agriculture
    - Impacts on tourism
    - Increased human health risks

- While much research to date has been done in the basin on river discharge, little integrated study has been focused on dealing with the river as a resource in its own right that is now prone to locally intensive use and sensitivity to climate change.

Climate Impacts in the Rhone River Basin

- There has been a great deal of work done, however, on previous human impacts that have caused landscape degradation, desertification and human desertion in the Mediterranean region of the lower Rhone. It has been observed that climate change impacts greatly influenced the course of earlier human settlement in the area.

- A number of climate change impacts have already been observed in the region. All of these should be of interest to western Canadians who are beginning to see similar patterns emerge in our mountain headwaters. Dr. Bravard listed a number of impacts which include:

    - 30% to 50% of the surface areas of glaciers in the European Alps, about half the volume, has been lost in the last century
    - During the 1980s and 1990s the period of snow cover in the Alps was reduced by 3 to 4 weeks in duration
    - The ski season in the Alps is reduced by one month each winter
    - There has been a dramatic increase in landslides and rockfalls because of increased freezing and thawing in weak geological formations and the loss of permafrost
    - Increase in erosion activity results in larger sediment inputs to rivers which causes increases in flood levels that have large impacts on mountain infrastructure
    - In the very hot summer of 2003, traditionally moist areas like Vercors, experienced the first forest fires they have had in decades
    - Average water temperature in the Rhone has increased between 1.3°C and 3°C at different stations on the river
    - Dams obstruct and slow river flows thereby stimulating temperature increases. The presence of nuclear power plants that require cooling water further accentuates the problem
    - Invasive species and progressive changes in native aquatic community structure have already been observed
    - Perhaps the most important observation are that no recovery has been observed after disturbances and the sensitivity aquatic communities appears to increase with time
    - Impacts on mountains lakes have also been observed

- Climate impact trends in the Rhone River Basin are not static. As these trends continue to accelerate through time, the cumulative impacts of water will be dramatic. These include:

    - Snow depths in lower altitude valleys may be reduced as much as 50% annually
    - In the upper Rhone Basin the snow line is projected to rise by roughly 150 meters for every 1°C increase in mean temperature
    - The 4°C temperature increase forecast for the region would reduce average winter snow volume in the Swiss Alps by 50%

- Global warming scenarios with temperature increases in the range of 2°C to 4°C would result in the loss of 30% to 50% of the existing glacial mass in the Alps
- Lowland vegetation is expected to advance upward into the Alps but simultaneously less water, lower soil moisture and higher stress on plants will result in higher fire sensitivity and greater soil erosion
- Forest fires are expected to occur where they have not been common before
- A 2°C increase in water temperature will alter which fish are able to dominate in changing aquatic ecosystems

Climate Impacts On The Energy Sector In the Rhone River Basin

- Under reduced flow regimes, energy sector impacts on aquatic ecosystems in the Rhone Basin are expected to be substantial. Currently, water release from nuclear plants are strictly regulated by rigid rules to ensure that temperatures of inflows do not raise river temperatures beyond the capacity of existing aquatic ecosystems to adapt. Dr. Bravard offered, however, that these regulations may have to be relaxed at the expense of aquatic ecosystem health as they were during the hot summer of 2003. This is even more probable given that the temperatures of 2003 are expected to occur in the region every other year on average under most climate change models.

Climate Impacts On Winter Tourism In The Rhone River Basin

- The impact of climate warming on ski areas in the Alps has been known for more than a decade. A projected increase of mean annual temperature of 2°C to 3°C by 2050 will have adverse impacts on ski areas that have already begun to happen.

- Warmer winters will impact ski resorts in a number of ways, each of which should be of interest to ski resort operators in Canada:

    - Less snow at low altitudes
    - Snow will melt faster reducing the number of ski days
    - The viability of many ski areas – as defined by a snow cover of at least 30 centimeters over a period of at least 100 days – will be greatly reduced

- A modest 2°C warming will reduce the reliability of Swiss ski resorts from 85% in the late 20th century to 63% by mid-century or earlier, particularly at low altitudes.

- Snow cover in the Alps has already become more and more uncertain at lower altitudes as it has in Canada.

- One of the responses to these climate related changes in snowpack has been a movement to relocate existing lower altitude ski resorts – or the ski runs associated with them – to higher terrain. In crowded Europe, however, this movement has resulted in conflict with the protection of remaining natural areas or watersheds.

- Dr. Brevard notes that where ski areas cannot move or extend their lifts into higher terrain, lack of reliable snow is being compensated for by:

    - Investing in high cost improvements in snow-making equipment
    - Developing better vegetation cover on ski runs
    - Building of new resorts at high altitudes
    - Investing in other types of tourism activities

- As a result of less reliable condition at low altitude resorts, Dr. Brevard notes that over-crowding is predicted at high altitude ski areas in Europe. In the lower altitudes, Christmas and Easter holidays will generate less income for ski areas. As well the value of on-hill homes and property will diminish at lower altitude resorts. Thousands of seasonal workers will have shorter work seasons and reduced income.

- In 2002, 85% of the 162 ski resorts in the French region of the Rhone Basin were able to produce artificial snow. They did so on 15% of their ski surface, between 1500 and 2000 meters. The altitude at which snow making has become necessary, however, continues to rise.

- The Europeans have also discovered that snow making can be detrimental to local water resources. The reasons for this are compound:

    - It requires 1 cubic meter of water to make 2 cubic meters of snow – snowmaking is water intensive
    - 4000 cubic meters of water are required to make enough snow to cover one hectare of ski terrain. By contrast in Europe only 1700 cubic meters are required to grow corn. Thus it requires 2.35 times as much water to make snow as it does to grow corn
    - Ski areas in the Savory region use the same amount of water in snowmaking a a city of 170,000 people
    - Snow making always occurs when streamflows are at their lowest comparatively

- Because the need for snow making occurs during periods of already low river flow, ski areas in the Alps are beginning to compete with themselves and with others for increasing limited water resources.

    - More than 1/3 of ski resorts in the French Alps experience shortages in water supply for their own domestic uses
    - Water shortages are caused by the fact that snow making competes with human use in 25% of the ski resorts
    - In the Alps, half the ski resorts have had to built artificial water tanks (storing from 20,000 to 150,000 cubic meters) to ensure that there will be sufficient supplies for both drinking and snow making

- Europeans have also found that snow making has measurable impacts on aquatic environments as a result of the strategies they have had to employ to ensure adequate winter water supply. These impacts derive from a number of circumstances. Storage tanks are filled during the summer season impacting lakes and wetlands from which the water is withdrawn. Further withdrawals in winter occur at low flow stressing the entire aquatic ecosystem of streams and rivers from which the withdrawals are made.

- Dr. Bravard notes that Europeans have determined that water withdrawals for snow making by ski areas are economically important in that they have impacts on water use and resulting productivity downstream. As a result they must be monitored carefully.

Climate Impacts On Summer Activities In The Rhone River Basin

- It is not just in winter that climate change impacts on water availability are being felt in the Rhone River Basin. Throughout the basin, water supply for swimming pools, lawns and golf courses is being reduced by decreases in summer precipitation and related increases in evaporation.

- Mountain reservoir releases are being timed to ensure minimum flow on some rivers to permit canoeing etc, but the best reservoir sites have already been developed or are presently being put to other uses. Maintaining high water in lakes, for the sake of aesthetics and tourism, has also become a challenge.

- It is highly unlikely, given the climate change impacts projected for Western Canada, that the tourism industry in Alberta will be immune to many of the same impacts as have already been experienced in the Rhone River Basin.

- If current trends continue to manifest themselves, the Canadian Rockies – like the Alps – are going to be very different by 2030. Without careful management, the Canadian Rockies tourism industry may lose some of its special appeal. While Canadian Rockies ski areas may enjoy temporary benefits as climate impacts affect European resorts on a more frequent basis, the same fundamental disruption of precipitation patterns may well occur here. As some of western Canada's most prominent ski areas are in national parks and a UNESCO World Heritage Site, ski promoters should expect resistance to ski area applications for snow making withdrawals during low flow periods especially in areas where aquatic ecosystems are already under stress. Ski areas may also find themselves competing with downstream towns and cities for limited water resources during what are expected to be longer late season low-flow periods.

- The impacts will not be confined just to winter. The spectacular color of our glacially fed lakes can be expected to fade as glaciers recede and their summer flows diminish. Golf courses and other water-based recreational activities will be competing with municipalities and downstream agricultural and industrial interests for water use.

Climate Impacts on Agriculture in the Rhone Basin

- While climate impacts on upland regions of the Rhone Basin have been well described, it is important to note that these impacts will also influence agricultural productivity in the downstream lowlands. The impacts of climate change should be expected to affect western Canadian agriculture in different ways, and it is instructive to compare what we expect to happen here with what Europeans are already experiencing in the Rhone Basin.

Some of the changes identified by Dr. Brevard are:

  - A doubling of the mean CO_2 concentration in the Earth's atmosphere will result in a seasonal cycle for condensed cultivation that is 21% shorter and will lead to a projected 15% loss in annual yield.
  - Agriculture can adapt by economizing on irrigation water use and by switching to less water-dependent crops
  - Pressures on both surface and groundwater will change in a very complex way
  - Water pricing and other economic instruments are already having providing effective means of adapting. Industrial consumptive uses are decreasing and municipal use remains flat demonstrating that water use and economic development are not inextricably linked
  - There is no standard approach to adaptation. Different eco-regions have successfully employed different public policy options to deal with periods of water shortage
  - The most successful adaptation strategies seem to emerge at the regional level. Some very important lessons are being learned.

- The responses of European farmers to current drought circumstances put into relief how adaptive processes emerge and evolve – sometimes successfully and sometimes not – over time. Canadians can learn a great deal from what is happening in the Rhone Basin as we adapt to more frequent drought and less water in the prairie West.

Dr. Bravard describes what is happening in the Rhone Basin:

  - Farmers built storage tanks in eco-regions prone to the drying up of rivers and deprived of groundwater resources.
  - Hundreds of such tanks were built along the eastern rim of the Massif Central of the Alps.
  - Severe reductions in summer streamflows resulted and the affects on aquatic ecosystems were so severe that public authorities discontinued support for the initiative even though it was deemed to be economically efficient.
  - Another adaptation that was explored was the drilling of wells into the alluvial aquifer bordering the river but this was not a sustainable solution as aquifers failed. Ultimately, pumping had to be limited.

- Most recently a deep and very rich aquifer was tapped in the sandstones of the Alps and Jura foothills.

- Water levels declines over the entire region because extractions were so large. In some locales the decline has been so great that ground water is no longer available for domestic use.
- It has been very difficult to devise effective controls on extractions from the deep aquifer.
- Human impacts are now such that it is very difficult to separate them from climate impacts.

- These impacts, according to Dr. Bravard, "… are further exacerbated by other large scale lowland water uses. Big withdrawals on some lower tributaries and the creation of massive diversion canals to supply water to coastal Mediterranean cities to secure water supply in support of tourism growth have severely compromised the lower Rhone."

- Reductions in precipitation and increases in temperature will make it difficult to sustain current levels of withdraw. There are not clear opportunities for further exploitation of water resources in the lower Rhone Basin.

- With sea level rise, coastal dunes protecting the Camargue Delta will be threatened. Brackish water will extend further upstream. As sediment supply from the Rhone has decreased because of retention in reservoirs, embankment stabilization and reforestation, coastal retreat is accelerating and will continue to do so particularly if sea storms and tidal surges become more intense as is projected. The cost of preventing salt water incursion upstream is beyond imagination.

- The French are limited by the complexity of these combined circumstances in their response to these problems. Efforts to restore the natural dynamics of the river's flow and all the services that flow provided will be costly and take decades to complete. In the short term, the French government has acknowledged the need to reinforce irrigation regulations in order to respect the low stream flow objectives of the newly adopted European Union Water Framework Directive.

- One lesson here is that watershed managers can be trapped by their own infrastructure into inferior decisions on how to manage changes in hydrological regimes brought about by incremental human impacts and broader changes related to climate impacts. The more river discharges are affected by withdrawals from aquifers, the more difficult it will be to tell the difference between anthropogenic impacts and impacts attributable to climate change – even in well studied basins like the Rhone.

- It is also clear that once you reach the level of water use and increasing scarcity that is presently being experienced in the Rhone Basin, the only room to move – beyond the re-engineering of the entire basin – may reside in improving water use efficiency

among big users. Inevitably, irrigation agriculture will be targeted as an important area in which conservation improvement will be crucial to secure water availability in other economic sectors.

The Impact of Severe Rhone River Floods

- While many Canadians will find it counter-intuitive that water scarcity should bring extreme flooding in its wake, extreme weather events are expected to become more common which, in combination with ecosystem changes and certain land-use practices will result in bigger floods. Certainly this has been the experience in the Rhone River Basin. What has happened in the Rhone provides an excellent meditation for Canadians pondering what a projected 5°C to 8°C mean annual temperature increase on the western prairies might mean in terms of the potential extreme floods.

- In the last 15 years, severe floods have occurred in the upper reaches of the Rhone. These floods may be simply part of a natural cycle of high discharge or they may be the first signs of higher flood peaks associated with climate change. Whatever the cause they very much reveal the vulnerability of the Rhone to flooding.

- The "One in 100 year" flood in 2003 motivated the French government to create the Rhone Masterplan which includes a slate of measures aimed at mitigating the human consequences of flooding. According to Professor Bravard, however, the measures that have been proposed to reduce hydrological hazards are impractical.

- The biggest weakness of the plan is that the impacts of climate change on flood intensity have not been taken into account despite a measurable increase in extreme winter events which may have their cause in precipitation falling as rain instead of snow.

- The Rhone Masterplan has defined risk prevention as being of central importance to adaptation as is better weather forecasting.

In Conclusion

Dr. Bravard concluded his remarks by arguing that changes are happening now in the Rhone River Basin and are a direct result of climate warming. In many cases, these changes are being masked in this heavily populated and developed watershed by anthropogenic impacts. Residents of the Rhone River Basin can expect significant further hydrological, ecological and economic impacts of these kinds in the future.

Dr. Claudia Pahl-Wostl
University of Osnabrück, Germany

Key Lessons:

1. Water management has been successful in the past in securing the availability of water-related services and protecting society from water-related hazards through technical means. This control approach can reach its limits particularly in upland rivers that experience extreme weather events.
2. Prospects of global and climate change leading to possible increases in extreme weather events and changes in values mean that more attention needs to be focused on water flows and river structure.
3. Environmental and socio-economic parameters and ideals change over time and this should affect management goals. Existing management structures will need to adapt to environmental change. Management measures no longer yield predictable outcomes because of the complexity of the ecosystems that are being managed. Management structures must be flexible and based upon a systematic incorporation of new scientific knowledge as it becomes available.
4. Current water management systems are not adaptive. Management is driven by the management system rather than the resource system.
5. The Third Rhone River Correction Project has been conceived to address issues related to flood protection, the re-establishment and strengthening of the biological functions of the river and the re-establishment of historic social and economic legacies that were once associated with the river.
6. Such a project will require massive changes in land-use in flood plain areas that will affect hundreds of thousands of people. A key strategy in this plan is to focus on different resulting adaptive drainage and discharge characteristics that, while not offering complete safety, do not lead to wholesale disaster if the system fails.
7. While accepted in principal, the movement toward the realization of such truly adaptive management approaches has been slow. The reason they have been slow is that such processes demand radical changes in management structure, accountability and habit.
8. To accomplish these goals we have to change consultation practices in which different stakeholder groups and the public at large are invited to offer their opinion on management plans or scenarios that have already been completed by experts. New mechanisms must be established which encompass processes that involve *bona fide* interests in joint generation of knowledge design of solutions and decision making that involves taking shared responsibility for outcomes.
9. This is not going to be an easy process in the Rhone Basin or anywhere in Canada because resource management traditions have become habitual.
10. The new Water for Life environment – in Alberta and abroad – suggests that we will not be able to manage increasingly complicated water and ecosystem management challenges without new collaborative and adaptive management skills. We can't turn back.

Dr. Claudia Pahl-Wostl is a Professor at the Institute of Environmental Systems Research at the University of Osnabrück in Germany. Her paper and forum presentation focused on adaptive management tools in upland river systems facing global change. During her presentation she offered general insights and specific considerations for adaptive management of the Rhone River Basin. Dr. Pahl-Wostl's observations will be of considerable interest to Canadians who are searching for better collaborative mechanisms for integrating what appear to be disparate elements of watershed management. Dr. Pahl-Wostl's experience may be of particular value in Alberta where the Alberta Environment is seeking to revolutionize water management in the province through its Water for Life Strategy. This leading-edge provincial water strategy incorporates many of the adaptive management processes Dr. Pahl-Wostl has identified as essential to successful water management in response to changing climate regimes.

- Water management has been successful in the past in securing the availability of water-related services and protecting society from water-related hazards through technical means. Rather than adapting to periodic variability in water levels (i.e. flooding), the approach has been to control rivers to provide for hydropower generation or shipping. The strategy of controlling rivers has limits when upland watersheds are subject to extreme weather events.

- Channeled rivers, for example, can be subject be subject to serious flooding in the event of unusually heavy rainfall. There has been an increase in such events and in damage caused since people begin relying on infrastructure to permit to begin settling in vulnerable areas such as flood plains.

- Once high risk areas are settled, however, economic investments and assets need to be protected from natural disasters, despite the fact that land-use in these vulnerable areas should have been restricted. Continued reliance of engineered infrastructure for protection against water-related hazards means that societies have become more vulnerable when this infrastructure fails.

- Prospects of global and climate change leading to possible increases in extreme weather events and fast-changing socio-economic boundary conditions mean that more attention needs to be focused on water flows and river structure. The growing awareness of complexities and unexpected consequences of management strategies as well as an increase in uncertainties have triggered critical reflection about prevailing water management paradigms. More robust, flexible and adaptive strategies are now needed.

- There are ambiguities and conflicts of interest inherent in differing operational goals for water management that require participatory goal-setting based on diverse kinds of knowledge.

- Dr. Pahl-Wostl pointed out that, "Environmental and socio-economic parameters and ideals change over time and this should affect management goals. Environmental change challenges all existing management parameters. Outcomes of management

measures are becoming increasingly uncertain due to the complexity of the ecosystems we have set out to manage. Evolving new systems of knowledge must become part of the management process."

- Reducing and controlling uncertainties has been a fundamental resource management goal. We now need a more coherent approach to deal with uncertainties because we have created a situation in which former mechanisms of control management are no longer adequate to the realities we are facing. Acknowledging uncertainties through open processes is the first step toward true integrated watershed management.

- Adaptive management is predicated on the realization that our ability to predict key drivers and influences on ecosystems is extremely limited. Therefore we must manage adaptively in response to emerging environmental events and circumstances.

- The requirements for adaptive management are diverse. They include:

    - New information
    - Different performance indicators
    - Monitoring over appropriate time scales
    - A wider range of actors able to process new information to draw new conclusions
    - Open learning processes
    - The capacity to actually implement agreed upon proposed changes

- Current water management systems are not adaptive. They demand to be run in a very specific way without latitude for changes which means that management is drive by the management system and does not respond to changes in goals and objectives. The explanation for this lies with some of these reasons, all of which combine to ensure that there is little room for innovation for flexibility:

    - The high investment costs of infrastructure
    - Rigid regulations to ensure that investment costs are recaptured
    - Inflexible operation standards to ensure productivity and profit

- Dr. Pahl-Wostl then proceeded to examine the Rhone River situation with the idea of applying adaptive management strategies to the challenges Dr. Bravard put forward in his preceding presentation. While she focused on Rhone, Dr. Pahl-Wostl could just as easily been describing the challenges Canadians presently face in the management of a system like the South Saskatchewan.

- Dr. Pahl-Wostl identified fourteen climate change related impacts on hydrological regimes that are expected to be common in Alpine watersheds. These included:

    1. The increase in temperature will result in a decrease in the amount of precipitation in the form of snow in winter.

2. Glaciers will disappear resulting in reduced natural water storage capacity.
3. Changes in the seasonal distribution of precipitation will occur with more rain in winter and less rain in summer.
4. An increased probability of extreme precipitation events will result in greater likelihood of extreme floods in winter and spring and a high chance of drought and low-flow conditions in summer.
5. Due to temperature increases the altitude of the permafrost zone will be higher, which in combination with increased extreme precipitation events will likely lead to more frequent landslides.
6. Overall, the alpine region will be subject to more extreme weather events.
7. The water management sector will have serious challenges ahead, particularly in the management of extreme and unpredictable climate conditions.
8. In summer water shortages are expected due to decreasing precipitation and the increased likelihood of drought periods.
9. There will be a decline the natural buffering capacity relating to low flow periods due to the retreat of glaciers and snow fields.
10. There will be an intensification of water demand for irrigation.
11. Increased irrigation demand will have undesirable consequences for water temperature and quality.
12. Due to the increased likelihood of winter and spring floods, there will be increasing demand to use reservoir storage for flood prevention.
13. Downstream areas will press for balanced water flows to buffer extremes.
14. Such requests will require negotiations about changing water use priorities and potential trade-offs in reservoir and flood management.

Thus the need for adaptive management processes.

- Over the last century, the Rhone River has been straightened and channeled reducing ecological function. Dams and reservoirs have now altered the flow of alpine tributaries. Pristine natural floodplains have been lost to development which was now subject to greater risk of flooding. Over the last century, 94% of the original floodplain of the Rhone was lost and 170 species of floodplain plants and animal endangered. One of the major adaptations Dr. Pahl-Wostl proposed for the Rhone River Basin was the reconstruction of existing flood protection to new standards that would allow this infrastructure to respond to more intense flooding events.

- The Third Rhone River Correction Project has been conceived to address issues related to flood protection, the re-establishment and strengthening of the biological functions of the river and the re-establishment of historic, social, and economic uses that were once associated with the river.

- The established tendency in such processes is to identify participation with consultation which invariably means that the public is invited to express an opinion on already planned concepts. This means that we can only use the opportunity for consultation to either endorse or express opposition to any given project proposal.

- This form of consultation does not work when profound changes are required that demand more from established or from new actors in larger change processes. To accomplish the goals of the Third Rhone River Correction Project, it will be necessary to widen the current river bed of the Rhone from two to four times in width.

- Such a project will require massive changes in land-use in flood plain areas that will affect hundreds of thousands of people. A key strategy in this plan is to focus on different resulting adaptive drainage and discharge characteristics that, while not offering complete safety, do not lead to wholesale disaster if the system fails.

- While accepted in principal, the movement toward the realization of such truly adaptive management approaches has been slow. The reason they have been slow is that such processes demand radical changes in management regimes.

- It was interesting to note that the need for adaptive strategies has been accepted in Switzerland but though the circumstances are identical they have – for all the talk about their merits – not be adopted in Canada, probably for the same reason.

- There are important lessons for Canada in Dr. Pahl-Wostl's presentation. Our need for reliable water supplies; our habit of relying and dams, reservoirs and large-scale infrastructure for water storage; our regime of engineering rules of good practice and regulatory structures that ensure long-term viability and profitability of these systems are mutually dependent and are designed to stabilize one another. The stability of this mutual dependence, however, materially and psychologically blocks the emergence of new and potentially better ways of managing water in an integrated way. We may wish to move past this "locked in" situation in Canada to see the advantages inherent in new management approaches that allow for far more adaptive management regimes.

- Improvement in the state of the environment, within the context of efforts to create sustainable human societies, almost invariably implies a change in governance structures.

- As has been demonstrated in Alberta, it may be time to make the transition away from a system in which regulating authorities composed largely of engineers work independently developing plans that are presented complete to the public to a system in which regulatory authorities contribute to adaptive management processes that share responsibility not just among engineers but among municipal systems planners, ecologists, land-owners, farmers, ranchers and business people

- We have to go from a system in which insurance companies sell coverage against damage caused by extreme climate events and infrastructure failure to a system in which insurance companies are involved in the evolution of adaptive management processes along with other impacted interests. Through this process we may decide to

slow or even stop development in high risk flood plains. We may have to restore the natural function of wetlands and we may have to protect naturally adaptive ecosystems such as grasslands. Once we have completed this task we may decide to take on even greater challenges such as the optimization of our capacity to management persistent drought.

- To accomplish these goals we have to transcend consultation traditions in which different stakeholder groups and the public at large are invited to offer their opinion on management plans or scenarios that have already been completed by experts. These mechanisms – in many cases – will have to be replaced by processes in which bona fide interests are involved in co-generation of knowledge, co-design of solutions and co-decision making that involves taking shared responsibility for outcomes.

- This is not going to be an easy process. Because we have been managing our water resources in Canada in the same manner for so long, habits toward process are almost second nature in our culture. We are used to management as a form of control. We are used to employing technology as a means of driving management options. We are used to make choices based on the quantification of minimum risk.

- The new Water for Life environment – in Alberta and abroad – suggests that we will not be able to manage increasingly complicated water and ecosystem management challenges without adaptive management skills. The foundation of adaptive management of water resources demands that we:

    - embrace water as a multi-functional resource
    - carefully orchestrate risk dialogue
    - work toward the constant evolution of adaptive measures in response to emerging extremes
    - focus on the development of ever-improving real-time forecasting systems
    - genuinely commit to the implementation of negotiated decision-making processes

- To arrive at a truly productive form of adaptive management of our water resources – in the world and in Canada – we have to reform our major institutions until they are comfortable with downloading not just responsibility for watershed decisions but the authority to make and implement water allocation and related land use policies at the regional level.

- Despite our best efforts in Canada, there remains a great deal of institutional fragmentation with respect to the management of water. Responsibility for source protection, water quality, flood protection, aquatic ecosystem health and regional water management are often scattered among diverse agencies.

- Better horizontal and vertical integration of formal institutional accountability can be facilitated through the creation of basin councils and trusts provided they have

defined decision-making capacities and authority to implement their own decisions. There is little point, however, in creating such institutions, however, if government continues to favor only "hard" approaches to system design options that continue to support heavy investment in expensive infrastructure that can only be justifiably inflexible legal and operational regulation.

- Reliance on such approaches entrench traditional management processes which favor specific singular infrastructure choices at the expense of adaptive management approaches that rely more on a portfolio "soft" management considerations that may ultimately be easier to implement and cost far less expensive over the long term.

- The shift toward adaptive management demands an emphasis on social learning, which requires coordination of the knowledge and capacity of diverse authorities, experts, interest groups and a concerned and increasingly informed public in the service of river basin management. Such a shift in management process will not only be of service to better water and land-use management, but would also serve to strengthen our communities and our democratic way of life.

ROSENBERG INTERNATIONAL FORUM ON WATER POLICY

CASE STUDY FOUR:
THE INTERNATIONAL JOINT COMMISSION

Presenters:
The Hon. Jack Blaney
Commissioner, Canadian Section
International Joint Commission

The Hon. Dennis Schornack
Chair, United States Section
International Joint Commission

Discussant:
Mr. Philip Weller
International Commission for the Protection
of the Danube

Key Themes

1. The International Joint Commission has been extraordinarily effective in resolving boundary water disputes between Canada and the United States. There are a number of factors which explain the success and they include:

   a. Commissioners are independent and not delegates of their nation, state or province.

   b. The Commission accounts for the views of local stakeholders – it promotes public engagement.

   c. Commissioners have a commitment to finding consensual solutions and their history provides them with a culture of success.

   d. Joint fact-finding leads to shared understandings which form an effective basis for debate.

2. One key to success is to have an institutional framework for engaging and resolving issues that has clarity about goals, scope and process.

3. The extent to which the successful experience of the International Joint Commission could be transferred elsewhere is unclear. Nevertheless, the Commission's experience and history provide valuable lessons.

Synopsis

The International Joint Commission (IJC) was established nearly 100 years ago to address and resolve boundary water disputes between Canada and the United States. Its record of achievement has been extraordinary. The Commissioners – three from Canada, three from the United States – have come to unanimous agreement in more than 90% of the cases which it has decided. Accordingly, the IJC has its own traditions and history which confer upon it a culture of success. The fact that the Commissioners are independent of the national, state or provincial government is an important explanation of its success. The typical process, which includes joint fact-finding, leads to shared understandings about the problems at hand and permits the Commissioners to focus on solutions rather than on controversies over facts. Another critical explanation for success lies with the fact that the Commission typically solicits the views of local stakeholders and promotes public engagement in the processes through which problems are addressed and ultimately resolved. The Commission approaches problems on a watershed basis. Frequently, national differences can be resolved by focusing on the fact that residing in a watershed confers its own "watershed citizenship." There are other examples, notably the Commission to Protect the Danube River, which illustrates how the notion of "watershed citizenship" can be used to transcend national differences.

The Commission's many successes are also attributable to the fact that the processes for resolving disputes are clear and open. The processes for deciding what issues are to be engaged and how to engage them are clear as are the processes for resolving issues. Of equal importance is the fact that the goals of the IJC, the scope of its responsibilities, as well as the processes are clear. This clarity, when combined, with the independence of Commissioners, the commitment to a watershed or hydrologic focus and the tradition of involving stakeholders at the watershed or local scale are all part of the success story.

It is not clear to what extent the IJC paradigm can be translated to other situations. There are very important boundary water problems – the Columbia River Treaty, for example – that do not get referred to the IJC. The countries in question are wealthy and developed. The boundaries of the two countries are generally not in regions or areas that are acutely scarce of water. Thus, for example, it is not at all clear that a Commission organized along these lines could succeed in the Jordan basin simply because the economic consequences of its actions would be relatively more important there. There was general agreement, however, that the lessons of success from the IJC were invaluable. The importance of joint fact-finding, of involving stakeholders, of focusing on watersheds and of seeking consensual solutions were all cited as valuable lessons.

CASE STUDY FOUR:
THE INTERNATIONAL JOINT COMMISSION

LESSONS FOR CANADA & FOR ALBERTA

Key Lessons:

1. While the IJC has been successful in resolving the great majority of disputes which have been referred to it over the last century, the record of both countries in resolving issues without the aid of established institutions such as the IJC has not been stellar.
2. The main issue at present is that the referral powers of the Boundary Waters Treaty are no longer being employed in the manner in which they were in the past. Put simply, important transboundary water issues are not referred to the International Joint Commission to be resolved.
3. When referrals to the IJC are not forthcoming, the considerable resources—procedural and other—of this important institution do not get brought to bear on transboundary issues which can result in inferior solutions to these problems.
4. Growing pressure on our suddenly limited water resources in the southern part of the country suggests that this Canada may need additional rather than fewer avenues of resolution to meet the requirements associated with the management of inter-provincial waters and to deal with emerging new relations with our southern neighbor.

The Remarkable Achievement of the IJC

A great deal has been written about the history and function of the International Joint Commission. The relationship between Canada and the United States has been defined for almost a century by the Boundary Waters Treaty which was signed between the two countries in 1909. This treaty addresses a broad range of transboundary water issues including definition of boundary and transboundary surface waters and the joint-study of these waters with reference to their potential use. The treaty establishes mechanisms for the approval of certain uses and permission for obstruction or diversion of transboundary waters that may affect flow volumes in either country. The treaty also contains provisions that prohibit pollution that may result in injury of health or property on either side of the international boundary. The treaty is widely considered as an exemplary model of an international transboundary agreement. In a paper entitled *Thirsty Neighbours: A Century of Canada-US Transboundary Water Governance*, water policy scholar Ralph Pentland and former IJC Commissioner Adèle Hurley (Pentland and Hurley, 2007) wrote that there are many Canadian water policy experts that doubt that Canada could negotiate as favorable an agreement as the Boundary Waters Treaty in today's political climate.

Beyond establishing rules for transboundary water management, the Boundary Waters Treaty also created a means for resolving disputes in the form of the International Joint Commission. The IJC performs two essential functions. It approves remedial or protective works, obstructions or dams on transboundary waters and sets terms and conditions the operation of such works. It also investigates and makes recommendations on questions relating to operating rules or disputes that are referred to it by either or both governments. The key point here is that the IJC has to be

invited by one or both federal governments to investigate disputes and to collaborate with conflicting parties in the interest of creating durable solutions to transboundary water issues.

While the International Joint Commission has enjoyed legendary success in the resolution of such issues, concerns have been growing over its current effectiveness. There is no one reason for this. The biggest reason for the decline in effectiveness of the IJC, however, may reside in the fact that neither Canadian nor American governments are supporting it – and utilizing it – to the extent they once did.

The main issue here is that the referral powers of the Boundary Waters Treaty are no longer being employed in the manner in which they were in the past. Put simply, important transboundary water issues are not referred to the International Joint Commission to be resolved. Instead of relying upon historically successful institutional approaches to dispute resolution, the federal governments in both Canada and the United States are choosing to address these issues in the political domain. Pentland and Hurley (2007) state it simply: "The International Joint Commission can only be as successful as American and Canadian governments want it to be." When one or both federal governments are disinclined to cooperate on transboundary water issues then the IJC is sidelined. Presently, unilateral actions by individual states and provinces are undermining the spirit and intent of the Boundary Waters Treaty and neutralizing the effectiveness of the IJC. The cases in which the IJC has not been invited to be involved are highly instructive for they demonstrate just how quickly the good will created through generations of cooperation can be lost.

Limits To Cooperation In Transboundary Water Disputes Between Canada and the United States

While the IJC has been successful in resolving the great majority of disputes which have been referred to it over the last century, the record of both countries in resolving issues without the aid of established institutions such as the IJC has not been stellar. Two examples, Devils Lake and water-borne contamination in the Columbia River, are discussed by Pentland and Hurley (2007).

The Devil's Lake Diversion

Devil's Lake is located some 160 kilometers south of North Dakota's northern border with the Province of Manitoba. The lake's name is associated with the fact that this body of water has no natural outlet. As a consequence, the lake has become increasingly contaminated as a result of human activities in the basin over the last century. The rising waters led to a proposal to create a diversion that would allow the lake to be drained into the nearby Sheyenne River which flows northward into the Red River and, in turn, flows into Lake Winnipeg in Manitoba. In 2002, the United States government requested that the matter of the diversion be referred to the International Joint Commission. The Canadian government, however, refused to allow the referral. Pentland and Hurley (2007) note that the justification which the Canadian government offered for rejecting the referral to the IJC was that environmental studies were not adequate at the time and that a "wait and see" approach to the problem would be more appropriate given the

circumstances. The situation, however, worsened. The waters of Devil's Lake continued to rise, flooding some 30,000 hectares of farmland. Faced with what it perceived as an emergency, the State of North Dakota unilaterally decided in 2004 to build the proposed diversion. As the plans for the diversion advanced, opposition began to grow. It was a precedent that troubled not only the Government of Manitoba, but the governments of Ontario, Quebec and the eight Great Lakes states, environmental groups and Aboriginal interests on both sides of the border. The main concern is that: "The diversion sets a precedent for unilateral water management decisions on both sides of the border that do not respect potential downstream environmental impacts." (Pentland and Hurley, 2007).

The construction of the Devil's Lake diversion was completed in September of 2005, but was shut down by the North Dakota Department of Public Health ten days after water began being diverted because of the unacceptable level of pollutants it was introducing into the Sheyenne River. It has since been reopened and concerns continue to be expressed over its impacts. . Opponents of the diversion cite Article IV of the 1909 Boundary Water Treaty which states that transboundary water flows "shall not be polluted on either side to the injury of health or property on the other." Opponents also argue that if the issue had been referred to the International Joint Commission in the first place, the outcome would not have been far more satisfactory to both countries.

Subsequently, the Canadian government asked that the matter of the Devil's Lake diversion be referred to the IJC, but to date the government of the U.S. has not responded. Meanwhile the pollution from Devil's Lake continues to contaminate the Sheyenne and Red Rivers and continues to flow in Lake Winnipeg. The pollutants include high concentrations of mercury, phosphorous, arsenic and salts. The concentrations of these contaminants in the water flowing through the diversion are so high that the water cannot be used even for irrigation purposes. It is estimated that some 20 tons of phosphorous will reach Lake Winnipeg each year from this source, resulting in a layer of algae 12 centimeters thick on 16 kilometers of beach.

Water Pollution in the Columbia River Basin

While the history of the International Joint Commission demonstrates a relatively successful model for resolving transboundary water disputes, the Devil's Lake example illustrates that there remain issues between the two countries that are not being resolved in the formal manner for which the IJC has become so highly regarded. Devil's Lake, however, is not the only example of how, in the absence of institutional intervention, unilateral actions on either side of the border can make cooperation and collaboration in service of solutions of transboundary issues more difficult and expensive. Another watersheds in which this has proven to be so is the Columbia River Basin where another issue of cross-border water pollution remains to be fully resolved.

This dispute between Canada and the United States centers around the introduction of heavy metals into the Columbia River some 16 kilometers before the river crosses the international boundary into the state of Washington. The source of the heavy metals is an estimated 10 million tons of mining slag that was dumped into the river as a by-product of decades of metal smelting that took place at a mining operation at Trail, British Columbia. Saunders and Wenig (2007)

observe that the issue in question is the transboundary movement of water-borne contaminants. The heavy-metal pollution is carried downstream where it has caused substantial contamination of Lake Roosevelt, a 220 kilometer-long reservoir that backs up behind Grand Coulee Dam. This reservoir is a popular recreational destination and also composes the boundaries of the Colville and Spokane Indian Reservations in North Central Washington (Saunders and Wenig, 2007).

The smelting operation, which is now owned by Teck Cominco Metals Ltd. of Vancouver, has a long history of environmental controversy in which its pollutants have already figured in at least one landmark international legal decision. The smelter was so notorious for pollution during the early decades of its operations that the town's famous hockey team was known as the Trail Smoke-Eaters. Trail's emissions were so substantial that in 1941 an international arbitration decision made the smelter's case the foundation for legal precedents related to the obligations and rights of a state with respect to transboundary pollution (Saunders and Wenig, 2007).

Saunders and Wenig (2007) observe further that the current transboundary issue centers around an order issued by the United States Environmental Protection Agency related to a U.S. Superfund effort to clean up the Columbia. Under this order Teck Cominco is required to investigate and report upon the nature and extent of the contamination it has released downstream in the United States. While Teck Cominco demonstrated a willingness to remedy the contamination problem, it was not prepared to comply with the Environmental Protection Agency order because the Canadian company, operating in Canada, did not feel it was subject to American law. When Teck Cominco ignored the U.S. government order, the Environmental Protection Agency undertook its own investigation with the aim of recovering costs in a future court action. Cominco and the Environmental Protection Agency later reached an accord which committed the company to fund additional impact studies in exchange for the withdrawal of the American order. But this did not satisfy two members of the Confederated Tribes of the Colville Reservation who brought forth their own citizen's court action demanding that Teck Cominco comply with the original Environmental Protection Agency order.

Cominco responded to this legal challenge by arguing that the American Superfund legislation was not intended to apply to non-U.S. companies that release pollution that enters the United States from outside the country. A U.S. court judge, however, didn't agree that Teck Cominco should be exempt from the law because it was a Canadian company operating in Canada. In the judge's opinion what mattered was that the smelter's pollution was contaminating a U.S. site. The judge's opinion was later upheld in a higher court.

The Canadian government has been unsuccessful in its attempt to resolve this issue through diplomatic channels. Saunders and Wenig (2007) argue that the precedents set as a result of this dispute could have significant legal and public policy reverberations for transboundary water management on this continent. They argue, also, that the case demonstrates that even with the Boundary Waters Treaty in place and the fine record of the International Joint Commission, there are obvious limits to the amount of cooperation between Canada and the U.S. on transboundary water issues. Clearly, neither country is above acting unilaterally if bilateral processes are not brought into play in a timely manner. The dispute over transboundary pollution emanating from Canada and flowing downstream into the United States in the Columbia River demonstrates that

neither country fully trusts international institutions or processes to satisfactorily resolve transboundary watershed issues, it can be argued (Saunders and Wenig, 2007).

While the Devil's Lake and Columbia pollution cases were not the highlight of the IJC's Rosenberg presentation, these two examples underscore the power of joint fact finding which is becoming the *sin qua non* of dispute resolution. When referrals to the IJC are not forthcoming, the considerable resources—procedural and other—of this important institution do not get brought to bear on transboundary issues which can result in inferior solutions to these problems.

This challenge to effective and durable transboundary water policy has been the focus of other case studies discussed by the Rosenberg Forum. One of the main lessons from the case histories of thousands of years of transboundary water management on the Tigris, Euphrates and the Nile at the Fourth Forum in Ankara, Turkey in 2004, was that over the long-term, self-interested unilateral actions create more grief than good. A state or a country that goes ahead with a project like a major diversion without consulting downstream riparians who may be negatively affected invites persistent conflict over its actions. The reason – which was put forward so eloquently by Kenya's Water Minister is that unilateral actions perpetuate disparity, which in turn promotes dispute, which eventually results in conflicts that lead to lose-lose situations for everyone involved. Institutions such as the International Joint Commission can be of great value in resolving and avoiding transboundary water disputes. To be useful, however, they cannot be sidelined without good political reason.

Growing pressure on our suddenly limited water resources in the southern part of the country suggests that this Canada may need additional rather than fewer avenues of resolution to meet the requirements associated with the management of inter-provincial waters and to deal with emerging new relations with our southern neighbor. We will also need to be able to manage new circumstances that will undoubtedly emerge as long-term land-use impacts manifest themselves in unexpected ways and as climate change alters the timing and nature of precipitation and volume of flows in mutually-important transboundary rivers.

ROSENBERG INTERNATIONAL FORUM ON WATER POLICY

OVER-ARCHING LESSONS
&
SPECIFIC CONCERNS

Trending Toward Solution To the Global Water Crisis

Peter Gleick, a highly regarded water policy expert, summarized some of the important lessons and directions that emerged from the Forum. Dr. Gleick urged the water policy community to move away from ideology and fixed ideas with respect to addressing water supply issues on a global basis. He offered two examples. First, there is tension between the position that water should be treated as a human right and the position that water should be treated as an economic commodity. The Forum put into relief the futility of this argument. The quantities of water needed to sustain life should be considered a human right while quantities in excess of that might appropriately be subject to commodity-like approaches. Second, the debate over whether water management should be a public or private endeavor is similarly unproductive. The argument masks that fact that both private and public sector entities have records of success.

Gleick emphasized the conclusion of the Forum that water challenges globally cannot be successfully addressed without better communication among scientists, policy makers, and the public. It is not just enough to do research. Bridges have to be built between scientific researchers, policy-makers and the public. Thus, scientists will need to find better ways to communicate with policy makers and with industry. Policy makers have to make a genuine effort to understand science and what scientists can contribute to policy development. Finally, all parties must do a better job of communicating accurately and effectively with the public.

Another important conclusion that was reemphasized in the Forum is that economic development and human-well being are not inextricably linked to increases in water use. Dr. Gleick noted that water use in the United States, has dropped dramatically during a period of unprecedented economic growth due to improvements in the efficiency of use. There are a variety of explanations for this but it is largely due to improvements in the efficiency with which water is used.

A major conclusion of Forum V was that mounting evidence about climate change means that water planners and managers cannot simply rely on existing models and policies. Old assumptions that the climate is unchanging are no longer adequate, and water planning and management will have to be adaptive and flexible in response to climate-related impacts. Climate change is leading to new and difficult challenges to sustainable water management and use globally. A lesson for us is that we may want to catch up with the rest of the world in recognizing that threat as just one of a number of problems we will need to address.

To this end, it will also be important to integrate issues and avoid jurisdictional and institutional isolation. Sustainable water solutions inevitably come from the merging of a variety of approaches. These approaches included adaptive watershed management, the integration of water and land use policy, interdisciplinary solutions and analysis of "soft" as well as "hard" approaches to water management problems.

Discussions at the Forum also revealed that national and local water problems are growing in scope and magnitude; that there is little difference as between the water problems of the developing world and the developed world; and that there is indeed an emerging global water crisis. Important progress is being made finding solutions but the prospect of population and economic growth around the world mean that much more progress is needed.

New ways to tackle old problems are needed but it will also be crucial to understand and address new and emerging new problems and, more importantly, to anticipate them. . We live in a period of very rapid change and new paradigms in the management and use of water will have to be developed in response to such change. This is clear in Canada as Canadians witness the fact that water is entering Canadian consciousness as it never has before.

Canada In The Context of Global Change

In their paper, *The Emerging Global Water Crisis: Managing Scarcity and Conflict Between Water Users* William Jury and Henry Vaux make the claim that the next hundred years will be very different than the century that has just passed in that 3 billion more people are likely to join the 6.5 billion people who presently inhabit our planet.

The authors argue that there are four trends which, if continued, could combine to trigger a global catastrophe in the 21st century. The first trend is that of steady population growth. The second is the continuing fragmentation and degradation of terrestrial, aquatic and marine ecosystems. The third is climate change which is already upon the planet but whose specifics remain uncertain. The fourth and final trend is the depletion of the world's water resources through misuse, overuse and the degradation of water quality.

Jury and Vaux then go on to point out that without immediate action and global cooperation, a water supply and water pollution crisis of unimaginable dimensions will confront humanity, limiting food production, access to drinking water, and the survival of innumerable other life forms. Jury and Vaux base their dire forecast on the extrapolation of current human activities and trends on this planet. They identify four key trends:

1. First, unlike estimates of the global supply of scarce minerals or buried hydrocarbons which remain uncertain, planetary supplies of water have been well characterized. There are no large ground water deposits awaiting human discovery in readily accessible locations. Any new sources that happen to be discovered will be very expensive to develop.

2. Second, many vital human activities are dependent on ground water supplies that are being exhausted or contaminated.
3. Third, much of the population growth of the next century is likely to occur in areas of greatest water shortage. There are no plans for addressing the problems that will inevitably follow. It should be pointed out that not all of these places are in Africa or in the high interiors of South America. Many participants at the Rosenberg Forum that took place in Canada were surprised to find themselves in an area of growing scarcity, in which population growth is rapid and unchecked and in which limits to water availability are already apparent.
4. Finally, global economic forces are luring water and land from food production into more lucrative activities, while at the same time encouraging pollution that impairs drinking water quality for a large and ever-growing segment of the population.

Jury and Vaux also offer some important statistics that place the Canadian situation in a global context. Total global surface run-off has been estimated at about 42,700 cubic kilometers, but, because considerably less than this volume is geographically available to us, only about 12,500 cubic kilometers is potentially available for human use. In 1990, it was estimated that about 18% of all available water was being used by humans and that an additional 34% was necessary for ecosystem function. These two needs, however, are projected to require 70% of the available run-off by 2025. Although projected human use is still less than 25% of the surface water supply, humans cannot utilize all of the available surface water without destroying ecosystems that depend on water for survival.

Jury and Vaux then went on to report on projections based on the work of Falkenmark and Rockstrom (2004) and others, and conclude that some 29 nations will be classified as water scarce by 2025. Among them will be countries, like the United Kingdom, that we would not have expected to have water availability problems. Of these 29 nations, 17 are predicted to be desperately water scarce. Another 47 nations are expected to be classified as water scarce or water stressed at the same time. Secure sustainable water resources for generations to come in some of these countries will not be possible without population decline or massive – and very expensive – water transfers.

Canada is not immune to what is happening in the rest of the world. Though they have largely occupied themselves elsewhere, there is no reason the four horsemen can't ride the Canadian range. Alberta's population is growing. Terrestrial ecosystem fragmentation and degradation are happening here – and so is climate change. Water availability is already a real concern. Albertans should be mindful of there history. Decade-long droughts have occurred here in the past. In order to secure sustainable water resources for generations to come, Albertans would be wise to remember that.

SPECIFIC CANADIAN CONCERNS

Issues of Equity

Securing sustainable water resources for generations to come is a global issue. We have a great number of problems with water supply in many areas. At present 1.1 billion people on this planet are without reliable sources of drinking water and 2.6 billion do not have access to adequate sanitation services.

The United Nations has declared reliable access to clean drinking water a basic human right. This basic human right does not presently appear to extend to all First Nations in Canada. In legal fact, this right may not legally extend to any Canadian. The weakness in public policy in Canada is underscored by University of British Columbia law professor, David Boyd in his book *Unnatural Law: Rethinking Canadian Environmental Law and Policy*:

Many Canadians believe, incorrectly, that they have a right to clean, safe water. While this right may exist at a philosophical level, it does not exist under Canadian law. There is no such right provided in Canada's Constitution, the *Charter of Rights and Freedoms*, or in the common law. A British Columbia Supreme Court justice recently ruled in a lawsuit where citizens sought unsuccessfully to halt logging activities in their watershed; "There is not before me an established case for the concept of a right to clean water."

Given that such legal confusions exist in a First World country with abundant water resources should be seen as a national embarrassment. The situation also puts into relief gaps in public policy and accountability related to federal versus provincial responsibility for water resources. Whether they are legally entitled or not, part of the Canadian population is assured of high quality water supply while another part is not.

Canadians should be reminded that issues of equity are important and that aboriginal legal claims related to water rights have been upheld in courts elsewhere with significant consequences for water policy. In the United States, for example, untested Federal Reserve treaty rights relating to water have been described as an unknown with almost "thermonuclear" potential to change the water policy landscape, particularly in the water-scarce West. It was clear from the presentations at the Rosenberg Forum that First Nations water rights in parts of Canada have yet to be fully characterized. One wonders what would happen in Canada if all the First Nations in Alberta and Saskatchewan suddenly declared that they had enough of unreliable and unsafe drinking water supply and sued both federal and provincial governments over their inability to protect water quality. It was surprising to some participants in the forum that this has not already happened.

There is also the unresolved issue of how much water First Nations may be entitled to under their treaty rights. It may well be held, as it has been in some cases in the United States, that First Nations are legally entitled to water supplies sufficient to meet the development needs identified in the treaties they signed, even if those water resources have in the meantime been claimed by others. Treaties with First Nations in Alberta and Saskatchewan predate the issuance of water

licenses to farmers, ranchers and communities. The activation of reserved First Nation water claims could potentially force deconstruction of the current "first-in-time, first-in-right" water rights hierarchy in the Canadian West. Policy makers should view this concern as both a challenge and an opportunity.

Upland Watershed Protection

Canadians are to be congratulated on the enlightened manner in which much of the upland mountain headwater region of the Rocky Mountains has been protected as both National and Provincial Parks. A large portion of the upland region is in almost pristine condition and as such produces a wealth of ecological services that would be expensive if not impossible to provide through engineering infrastructure. Caution, however, is advised with respect to the management of fragile mountain steam ecosystems. While terrestrial ecosystems in the mountain National and Provincial parks are well managed, aquatic ecosystems appear to receive less attention.

David Schindler pointed out that 41% of the flow of the Bow River inside Banff National Park was regulated. This regulation is a consequence of the construction of a dam on Lake Minnewanka, which was approved, against considerable opposition against the presence of such structures in National Parks, under authorization by Order in Council under the War Measures Act in 1941. The usual problems associated with dams, however, have manifested themselves, just as opponents predicted. Flow regimes in the Cascade River were dramatically reduced. As no fish ladders were installed back up Cascade Creek, the natural ecosystem declined dramatically. As a result of draw downs in the winter and refilling in summer, changes in the lake's littoral zone have been dramatic. Since the dam was constructed, lake-bottom fauna changed from 50% macro-invertebrates to over 90% chironomids. Stocking with invasive fish species and diversion of the river around the original channel have virtually destroyed the riparian habitat of the Cascade River.

Upland watershed protection will become more and more important as population growth, diminishment of water supply and climate change conspire to change the hydrology of the Canadian West. While the water storage capacity of the reservoir may be of some importance, the Minnewanka dam is no longer a critical regional source of hydro-electricity. While restoration of the system might be expensive, it should be seen as an option leading up to the expiry of the dam's operating license in 2032.

Given that water scarcity has already been identified as a potentially limiting factor in the economic and social development of southern Alberta it may be important to re-assess the value of upland areas in the context of water supply and the ecological services they provide. It may be wise to consider special upland designation for no other reason than watershed protection. In examining upland watershed protection options, it should be noted that while our mountain national parks are now considered valuable tourism resources, they were original purpose resided as much in water resource protection as in tourism promotion. This was particularly true of large parks like Jasper, which was initially set aside as a forest park in 1907.

As the Oldman River Basin has already been identified as a water-scarce region in which over-allocation could potentially lead to conflict over water use, its upper reaches may be a good candidate for special watershed protection. The proposed 1400 square kilometer Andy Russell-I'tai sah kop Park at the headwater of the Oldman has the highest recorded annual precipitation and snowfall along the eastern slopes of the Rockies in Alberta. While the proposed park would cover less than 4% of the area of the Oldman Basin, it annually generates some 20% to 30% of the river's annual flow. Within this small area are 26 headwater streams and rivers which feed the Castle, Oldman and Waterton systems. Not surprisingly, it is also an area of great natural beauty. Protecting such a valuable upland region will pay for itself over and over again in the value of the ecological services it provides alone.

Irrigation Efficiency

Jury and Vaux (2007) point out that global water availability is inextricable linked to food production. Without one, you don't get the other. In 1995, about 3800 cubic kilometers of fresh water was withdrawn globally from surface and groundwater supplies. Of that amount some 2100 cubic kilometers was consumed, and thus removed from the supply base. Industry and municipal withdrawals are significant, but much of their withdrawal is returned to the supply base, leaving only 6.4% that is actually consumed. Agriculture is by far the dominant global consumer of water, accounting for nearly 85% of water use globally. It is projected that we will need to raise food production by nearly 50% in the next fifty years to maintain our present per capita supply. This, of course, assumes that the present productivity of existing farmland does not decline.

Jury and Vaux also point out that despite earlier successes associated with what has widely been called "The Green Revolution", the ratio of global grain stocks to annual consumption has fallen steadily during the last decade. Optimists in the field of global food supply argue that there are many factors that suggest that we have little at present to worry about in terms of food production. Crop yields in numerous poor countries are far below maximum attainable yields that have been reached in other regions. Substantial land is available for agricultural expansion and the introduction of evolving irrigation technology is sure to increase production far beyond what has been historically possible in areas of marginal rainfall. Optimists also argue that genetic alteration of plant species could greatly improve the productivity of almost all sectors of agriculture.

Jury and Vaux also put forward the contrary case. Pessimists to the great hope of the Green Revolutions cite challenges that appear insurmountable. A significant part of the world's agricultural land is being managed unsustainably – including land in Canada – and cannot continue to be farmed indefinitely. Market forces in developing countries are driving the conversion of agricultural land to urban and industrial use. Loss of topsoil from water and wind erosion is decreasing the fertility of soils all over the world. The most compelling of all arguments offered by pessimists, however, has to do with global water availability. In the next 50 years, we may – quite simply – run out of water.

It is anticipated that irrigation water withdrawals will expand by 685 cubic kilometers of year between 1995 and 2025. While water used for this purpose will reduce the per capita water requirement to produce food for a growing population, we will not be able to meet future food production needs unless irrigation methods become more efficient. Irrigation efficiency is determined by dividing the amount of water required for 100% yield divided by irrigation withdrawals.

Seckler et al (1998) estimate that in 1990, average irrigation efficiency for 118 countries in the world was 43% (Average irrigation efficiency is here defined as the water required for maximum crop yield divided by the quantity of irrigation withdrawal. In North America it is about 53%. These authors also show that if irrigation effectiveness were to be increased by 70%, the need for additional water supply for all sectors could be reduced by 50% by 2025. The total savings would be 944 cubic kilometers a year. This would go a long way to ensure sustainable water resources for generations to come.

Irrigated agriculture produces approximately 40% of the world's food on only 17% of the total land under production. It is about 325% more productive than rain-fed agriculture (Fereres and Soriano, 2006). Irrigation farmers, especially in southern Alberta, are very proud of these statistics, but they are not cause for abandoning efforts to improve the efficiency and productivity of irrigated agriculture. Indeed, efforts to secure sustainable water resources for generations to come will require improvements in the productivity and efficiency of both irrigated and rainfed agriculture.

Irrigation efficiency of 70% is not impossible in Canada. There are at least four categories of improvement that can be made to enhance the productivity of irrigation. They are technical, agronomic, managerial and institutional. Technical improvements entail the utilization of techniques which permit water to be applied uniformly and reduce the losses to evaporation, run-off and deep percolation. Agronomic improvements consist of better agricultural practices that minimize water loss from evaporation. Managerial improvements include improvements in irrigation scheduling and water delivery timing as well as the movement toward demand-based irrigation. Institutional improvements include but are not limited to the development of effective water user organizations, reducing or eliminating subsidies for irrigation water and implementing effective conservation incentives. Improvements in rain-fed agricultural productivity are also possible through better methods of rainwater capture; supplemental irrigation and integrated land and soil management.

All of these tools will be necessary to improve the efficiency of agricultural water use. Such improvements will be crucial if Canada wants to both improve agricultural productivity while at the same time allow further population and industrial growth in already water scarce areas.

Resolving Transboundary Disputes

Established divisions of accountability for water management between the federal and provincial governments are not adequate to some circumstances. Since confederation, the federal government has deferred to the provinces in domestic and transboundary water issues. While this

deference has respected the terms and conditions of the form of cooperative federalism that is at the heart of the Canadian Constitution, there are some situations in which greater federal presence in the solution of transboundary water issues is likely necessary in order to ensure enduring solutions that result in optimal management of our shared resources.

There are two levels at which stronger federal presence may be useful. The first is in the resolution of transboundary disputes between the provinces and the second in the domain of transboundary disputes between individual provinces and our American neighbors. In the case of inter-provincial water disputes, the capacity of a given provincial government to respond to basin-wide needs may be limited by jurisdictional self-interest. Similarly, the legal powers of a province may not be adequate to the challenges posed by increasingly complex legislation protecting one country from impacts originating in another. Resolution of such issues may require nation to nation negotiation and cooperation. But, before it can be effective in resolving issues at either of these levels, the federal government in Canada has to come to terms with the absence of a coherent national water policy.

Work should be done immediately both in clarifying federal-provincial relations and in improving relations with the United States with respect to transboundary issues. It is only a matter of time before the most important compacts that exist between the provinces and treaties Canada has with the U.S. are no longer adequate to the circumstances we have created on this continent since these treaties were signed.

The Alberta Water For Life Strategy

The presentations at the Rosenberg Forum on International Water Policy put into relief efforts that are being made world-wide to develop wider collaborations to achieve better water management. At this time, no nation has been able to break through tradition and habit to create a fully adaptive and integrated form of water stewardship that combines water management with land-policy in a way that assures true sustainability. Many countries can be excused for their failure. Despite serious efforts, it is almost impossible for a country like Jordan to fulfill the promise of integrated watershed management in the midst of intense regional conflict and uncertainty. While a solid foundation has been laid down for adaptive management in the Rhone River Basin, sheer population size and investment in already existing infrastructure will make wholesale change in water management process slow if not ultimately impossible. In Alberta, however, no such obstacles exist to the creation of an integrated watershed approach. The province is stable politically and economically. Its population is still relatively small and there is still a great of slack that can be taken in the management of the province's water resources. Though habits of entitlement will be hard to break, a strong case for new strategies for coming together over issues of allocation and use is already being made through the Alberta Water for Life Strategy. While not as yet fully funded, this strategy still has the potential to succeed in areas that other similar initiatives have failed.

While it would be easy to compare the Alberta Water for Life Strategy with other like initiatives that have been undertaken around the world, perhaps the most important comparison is domestic.

While earlier water management policies were adequate to the pioneering circumstances settlers confronted in the newly opened Canadian West, they are not adequate in a suddenly heavily populated region that faces limits to its social and economic future unless it finds ways to make regional water resources do more and go further than they have in the past.

In June of 2006, a panel of acknowledged world experts on water police related to both surface and groundwater resources was convened in Calgary, Alberta to examine and review the Province of Alberta's Water for Life Strategy and its Groundwater Action Plan. The proceedings of the Rosenberg sub-forum suggest that the Alberta Water for Life strategy could work and, in so doing, could become a model for others who want to break out of long-standing but not necessarily effective habits of water resource management. The review clearly indicates that the Alberta Water for Life strategy can be successful if:

- in the face of accelerated energy production and population growth all efforts are made to advance the research and regulatory activities needed to protect water resources that could be threatened

- the Ministry of the Environment and the Government of Alberta continue to pursue and support the development of an evolving Provincial water strategy based on the *Water for Life* model and that considerable emphasis continue to be placed on collaborative approaches involving an ever widening circle of interested stakeholders and public participants

- the strategy is modified to include a balanced portfolio of measures for managing water scarcity. The portfolio should include water conservation, storage – both surface and ground, conjunctive use of ground and surface water, water re-use and other appropriate measures

- the strategy is made to contain a substantial and continuing commitment to the support of applied and basic research and on-going programs of monitoring that will address specified problems, develop new knowledge to fill gaps and be the platform for developing high-level professional capacity

- policy objectives are translated into implementation targets that can be monitored, measured and compared. Targets should be modified over time as part of a learning process that specifically incorporates new scientific knowledge and changing social preferences

- water governance is open, transparent, accountable and effective and outside reviews are undertaken periodically to assess the extent to which: 1) partnerships remain effective; 2) participatory processes remain open; and, 3) all processes of governance remain accountable

- the strategy acknowledges that current agreements with Provinces and the Federal Government may need to be modified and updated in response to changing circumstances

- inter-jurisdictional collaborations with shared responsibilities for the management of water resources are created to oversee the development of databases on transboundary watersheds and aquifers and to facilitate the collection and exchange of data and information

- institutional arrangements are developed to ensure that watershed and aquifer management plans are reconciled and are compatible with each other

- the strategy ultimately includes a list of implementation instruments that could be used to achieve each policy objective. The strategy should also encourage the development of new and innovative instruments

- the monitoring networks for assessing the quantity and quality of both surface and groundwater are expanded and strengthened. Monitoring networks and indices for assessing ecosystem health also need to be developed and implemented. Monitoring networks need to be maintained over time and be sufficiently dense to allow trends to be measured and analyzed and to permit early detection of contamination episodes
- all provincial Ministries become mindful of policies and activities within their respective domains that involve or have impacts on water resources. These policies should acknowledge interrelationships with water and include appropriate provisions for the protection of water quality and availability. This recommendation will require commitment and support from the highest levels of the Provincial government

THE LAST WORD

There are perhaps seven over-arching lessons Albertans and Canadians can learn from the Rosenberg International Forum on Water Policy that was held in Banff in the fall of 2006.

1. Canada is not as advanced as it might like to believe in terms of public policy relating to water supply and quality assurance. There are issues of equity; inefficiencies associated with jurisdictional fragmentation of responsibility and accountability; an absence of reliable and commonly useful data and widespread examples of inadequate foresight and management of water in the context of other forms of resource development. There are many gaps in federal and provincial water management policy that need to be filled. The country needs to move past its own myths of limitless water abundance to create a new national water ethic based on conservation and different formulae for valuing water as a resource in its own right.

2. Compared to other places in the world, there is not yet a water crisis in Alberta or in the Canadian West. But Alberta, in particular, has all the makings of one. These elements include:

- Heavy agricultural reliance on water
- Rapidly growing populations
- Increased water demand from cities and industry
- Reduced flows in important watercourses
- Unpredictable climate variability

3. There are others from whom Canadians and Albertans can learn. Canadians should vigorously pursue access to global knowledge and experience, so that we do not make the same mistakes others have made. The old saying is true. Every time history repeats itself, the price goes up.
    1.
4. Though highly significant in a Canadian context, the Alberta Water for Life Strategy is not unique. Approaches similar to this have been explored in many other countries with varying degrees of success. It could become unique, however, simply for having been fully implemented. Such implementation, however, will require political support and appropriate funding.

5. Politics aside, the measure of Canadian water management success will be determined – not by what is said – but by what is actually done, in support of Water for Life and other water management initiatives.

6. Alberta presently has the resources to go right to the front of the world queue and get the management of water right.

7. The final lesson is that the longer policy makers in water scarce areas like Alberta wait to change their water management frameworks, the more investment there will be in current systems and the more difficult it will become to make needed changes. Alberta should move now while there is still slack it can take up in its systems and before it is facing crisis.

The world is watching. As Leith Boully, an Australian water policy expert said at the conclusion of the Rosenberg International Forum on Water Policy held in Banff in September of 2006, “Because of our current good fortune, Canada has a greater obligation than other countries to act soon, and appropriately.”

ROSENBERG INTERNATIONAL FORUM ON WATER POLICY

PROGRAM SYNOPSIS
&
RECOMMENDATIONS FOR CANADA
&
ALBERTA

REFERENCES

Adams, R. 2006. *Climate Change and Water Resources: Potential Impacts and Implications.* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th. .

Arrojo-Aguda, P. 2006. *Water Management in Alpine Regions.* Hoff, H. (2006) *Challenges In Upland Watershed Management: For What? For Whom?* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th.

Ayadi , Y. 2006. *Policy Adaptation in the Jordan Valley*, Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th.

Bakker, Karen. ed. 2007. *Eau Canada: The Future of Canada's Water.* University of British Columbia Press, Vancouver, British Columbia

Benabdallah, B. 2006. *Upland Watershed Management in the Developing World.* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th.

Blaney, J.2006. *An Overview of the IJC.* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th.

Boyd, D. 2003. *Unnatural Law: Rethinking Canadian Environmental Law and Policy*. (Vancouver, BC: University of British Columbia Press).

Bravard, J.P. 2006. *Impacts of Climate Change on the Management of Upland Waters: The Rhone River Case.* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th

Falkenmark, Mahlin, and J. Rockstrom. 2004. Balancing Water for Humans and Nature.(London: Earthscan).

Fereres, E. and M. Soriano. 2006. Deficity Irrigation for Reducing Agricultural Water Use. Journal of Experimental Botany. Doi:10.1903/jxb/erl 1 65.

Fisher, Franklin M., A. Huber-Lee, I. Amir, S. Arlosoroff, Z. Eckstein, M. Haddadin, S. Hamati, Jarrar, A. Jayyousi, U. Shamir, H. Wesseling, A. Salman and E. Al-Karasblieh. 2005. Liquid Assets: An Economic Approach for Water Management and Conflict Resolution and Beyond (Washington, DC: RFF Press).

Hoff, H. 2006. *Challenges In Upland Watershed Management: For What? For Whom?* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th..

Jury, William A. and Henry Vaux, Jr. 2005. *The Role of Science in Solving the World's Emerging Water Problems.* Proceedings of the National Academy of Sciences. Vol. 102, No. 44, 15715 – 15720.

Jury, William. and Henry Vaux, Jr.. 2007. *The Emerging Global Water Crisis: Managing Scarcity and Conflict Between Water Users*. Advances in Agronomy, Vol. 25. (in press)

Lowry, D. 2006. *Factors for Success: Private & Public Sector Roles in Securing Safe and Reliable Drinking Water Supply In A Time of Global Change.* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th..

Messerli, B.(2006. *Mountains of the World – Water Towers for the 21st Century.* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th..

National Research Council. 1999. Water for the Future: The West Bank and Gaza Strip, Israel and Jordan (Washington, DC: The National Academy Press).

Nevin, J. 2006. *The International Joint Commission: A Case Study in the Management of International Waters.* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th.

Nilson, J.2006. *A Case Study of the Saskatchewan River System: Saskatchewan Perspective.* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th..

Pahl-Wostl, C. 2006. *Adaptive Management of Upland Rivers Facing Global Change: General Insights & Specific Considerations for the Rhone Basin.* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th.

Pearce, F. 2006. *When The Rivers Run Dry: Journeys Into the Heart of the World's Water Crisis.* (Toronto, ON: Key Porter Books).

Pentland, R. and Adele Hurley. 2007. Neighbors: A Century of Canada-US Transboundary Water Governance. In Karen Bakker, ed. Eau Canada: *The Future of Canada's Water* (Vancouver, BC: University of British Columbia Press).

Rimmer, A. 2006. *System Hydrology Tools for the Upper Catchments of the Jordan River and Lake Kinneret, Israel.* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th.

Sandford, R. 2003. *Water & Our Way of Life*. United Nations International Year of Fresh Water and Wonder of Water Initiative, (Fernie, BC: Rockies Network).

Schindler, D. 2006. *A Case Study of the Saskatchewan River System.* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th.

Schnorack, Dennis and J. Nevin. 2006. The International Joint Commission: A Case Study in the Management of International Waters. Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th.

Sauchyn, D. 2006. *Upland Watershed Management and Global Change – Canada's Rocky Mountains and Western Plains.* Paper presented at the Fifth Rosenberg International Forum on Water Policy, Banff, Alberta, Canada, September 8th & 9th.

Saunders, J. Owen and Michael Wenig. 2007. Whose Water? Canadian Water Management and the Challenge of Jurisdictional Fragmentation. In Karen Bakker, ed. Eau Canada: The Future of Canada's Water (Vancouver, BC: University of British Columbia Press) 440 pp.

Seckler, D.U., U. Amarasinghe, D. Molden, R. de Silva and R Baker. 1998. World Water Demand and Supply 1990 to 2025: Scenarios and Issues. International Water Management Institute Research Report 19, International Water Management Institute, Sri Lank.

Vaux, H.2007. *Report of the Rosenberg International Forum On Water Policy To The Ministry Of Environment, Province of Alberta*, February, 2007. Rosenberg International Forum on Water Policy, University of California, Division of Agriculture and Natural Resources, 324 Giannini Hall, University of California, Berkeley.(unpublished manuscript).

Wolf, A., J. Natharius, J. Danielson, B. Ward and J. Pender. 1999. International River Basins of The World. International Journal of Water Resources Development. Vol. 15. 387-427.