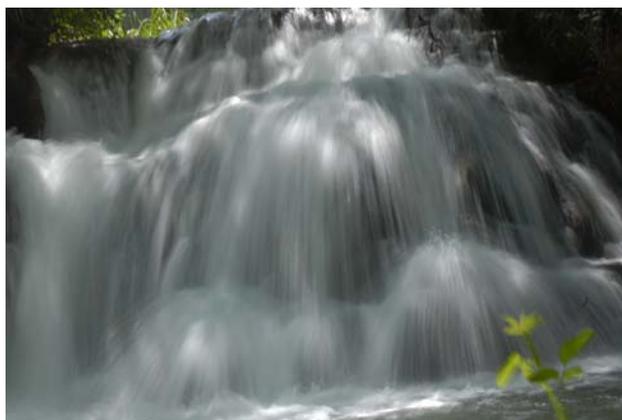




Water for Food In a Changing World

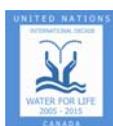
Reflections on the Rosenberg International Forum on Water Policy

Zaragoza, Spain
June 24 – 27, 2008



A Report for the Max Bell Foundation

Prepared By
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Converging Global Food & Water Trade-offs

Water for Food in a Changing World

Author's Note

The following reports represent the observations of just one of the participants of the Rosenberg International Forum on Water Policy held in Zaragoza, Spain in June of 2008. It should be noted that, while reviewed by the Chair of the Forum, Dr. Henry Vaux, other participants were not called upon to make observations on the meaning and value of the proceedings or their outcomes in a specifically Canadian context and may have different views based on their experience abroad.

It should also be noted that there are some materials and sources to which reference is made in this report that were not part of the Rosenberg VI proceedings. They have been included because they are held to be directly relevant to the issues we face with respect to water resource management particularly in the Canadian West.

Readers or researchers with specific interests in the proceedings of this forum are invited to view all of the papers that were presented in Zaragoza and at other forums on the Rosenberg International Forum on Water Policy website <http://rosenberg.ucanr.org/>.

The opinions expressed in this illustrated day-by-day report on the forum, including analysis of each of the papers presented as well as consideration of the lessons learned elsewhere that may have application in the Canadian context are those of the author only and in no way claim to be the views of the Forum organizers or participants.

The author wishes to acknowledge the support of the Max Bell Foundation in Canada and the University of Lethbridge for making this rich analysis possible.

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Reflections on Rosenberg VI

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Lessons From Rosenberg VI

Executive Summary

The 6th Biennial Rosenberg International Forum on Water Policy was held in Zaragoza, Spain from June 25 to June 27th, 2008. The theme of this Forum was “Water for Food: Quantity and Quality in a Changing World”. The program included keynote presentations by world experts on food and water security. Forum panels were held on a broad range of related subjects including integrated perspectives on agricultural water use; globalization and water; the optimization of water productivity in agriculture and balancing water for people and nature and the revitalization of water governance. The summary presentation detailed the modern Spanish water experience in the context of food production and water use.

The urgency of doubling global food production to meet staggering population growth projections is increasing the tension that exists in many regions of the world over who should get water for what purpose and the extent to which land-use should favor expanded agricultural production at the expense of cities, industrial production and the needs of biodiversity-based planetary life-support system function.

The needs of nature are seen as increasingly important with respect to the allocation of water resources. The concern is not only that we may simply not have enough water to meet the goal of increasing global food production to the level required to meet the needs of the population that is expected to exist by 2050. An equally troubling emerging concern is that even if there are adequate water supplies to grow food enough to feed nine billion people, the impacts on the Earth’s capacity to provide other critical ecosystem gifts may be degraded to the point that they no longer function as they have in the past. This would mean that we will be forced to employ expensive but ultimately inferior engineering solutions to perform many of the services ecosystems untransformed by agriculture and other human impacts used to supply for free. In addition to effectively putting most of humanity – or at least that portion that can afford it – on dialysis with respect to potable water supply there is a fear that we will lose much of landscape and cultural diversity that makes the world an interesting and engaging place. We would also lose a great deal of adaptability to changes in the human condition over periods of decades to centuries which will ultimately result in the diminished quality of the human experience.

The proceedings of the forum also underscored the limits of further agricultural productivity in the face of growing populations and the recognized need to supply adequate water reliably to nature.

As Spain's Elias Fereres pointed out, we have been far more successful in increasing agricultural yield than in decreasing water use, which suggests we have only gone half way in meeting the global food production and water supply challenge. Though we are already using almost all the water available to us to grow food in many parts of the world, we are still falling behind in our efforts to grow enough to keep up with the needs of our ever-expanding global population. This has become a Catch-22. We can't grow more food unless we improve our water productivity; but because the photosynthetic process in green plants demands that 50 to 100 molecules of water must be transpired to create each carbohydrate molecule even if we could further improve our water productivity we would still need all the water we saved to grow more food because of increasing food demand. Our best scientific and technical efforts continue to be mocked and overshadowed by continuing human population growth and rising dietary expectations.

As a consequence of growing populations and increased competition for land and water, humanity is converging upon the need to make uncommonly difficult public policy trade-offs that have never had to be made on a global scale before.

We are putting a great deal of faith in stressed and demonstratively non-sustainable agriculture. If we provide to nature the water it needs to perpetuate our planetary life-support system, then much of that water will have to come at the expense of agriculture, which means that many people will have to starve to meet ecosystem protection goals.

If, on the other hand, we provide agriculture all the water it needs to have any hope of feeding the populations that are projected to exist even in 2025, then we must expect ongoing deterioration of the biodiversity-based ecosystem function that has generated Earth's conditions upon which our society depends both for its stability and sustainability.

Despite these challenges, however, successful solutions to water problems are available and being implemented every day. We must continue to build on successes and learn from our failures, particularly those related to governance.

The most successful solutions in the future will be those that move beyond ideology; integrate concepts; communicate new information in new ways; and that lead to immediate action. We must continue to explore ideas related to integration and methods that embrace inter-disciplinary tools. We should be relentless in our pursuit of better ways to communicate with one another and the public.

We should do all we can to make what we know intelligible to decision-makers who will help us translate scientific research outcomes into timely, effective and durable public policy. In the end, adaptation to all the changes that are converging upon us, from population and economic growth, habitat change and loss to climate change start and end with how we manage water. Our ability as a civilization to adapt to future global circumstances will depend on how well we manage our fresh water resources.

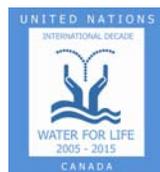


Lessons From Rosenberg VI

Part One

Background:

The Rosenberg International Forum On Water Policy



The Rosenberg International Forum on Water Policy

Background

The Rosenberg International Forum on Water Policy was created in 1996 by the Bank of America with an endowment gift to the University of California in honor of Richard Rosenberg upon the occasion of his retirement as Chairman of the Bank. The resources from this gift support the Rosenberg International Forum on Water Policy. The theme of the Forum is: Reducing Conflict in the Management of Transboundary Water Resources. The Forum meets biennially at different locations around the globe. Past Forums have been held in San Francisco, CA, USA; Barcelona, Spain; Canberra, Australia; Ankara, Turkey and Banff, Canada. Attendance at the Forum is by invitational only and is restricted to 50 water scholars and senior water managers from around the world.

Greater funding is not being made increasingly available for a broad range of scientific research into specific water quality and availability issues and little new capacity is being created to ensure that research is understood by policy-makers and translated into effective and timely action. Our knowledge about the state of our water resources continues to grow but our capacity to channel that knowledge into places of political influence remains confined to narrow, avenues of often linear discourse. One objective of the Rosenberg International Forum is to find new means communicating important new scientific findings directly to policy-makers in language they can understand and act immediately upon in the legislative domain.

Rosenberg International Forum Contributions in Canada

The fifth Rosenberg International Forum on Water Policy was held in Banff, Alberta from September 6th thru September 11th, 2006. The theme of that Forum was “Managing Upland Watersheds in an Era of Global Change. 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.

Seven over-arching lessons were identified as relevant for Albertans and Canadians at the Rosenberg International Forum on Water Policy 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.

A package including verbatim transcripts of the complete proceedings and summary recommendations and lessons for Canada and Alberta were sent to all participants and observers, to both Federal and Provincial Environment Ministers and to 100 leading experts on public policy related to water in Canada following the Forum. This outreach program was made possible through a generous grant from the Max Bell Foundation.

The sponsors of the fifth edition of the Rosenberg International Forum on Water Policy were the University of California and the Bank of America, permanent sponsors, and local co-sponsors including 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.

In addition to the main Forum, a special sub-forum of the Rosenberg International Forum on Water Policy conducted a high level analysis of water policy related to the provincial government's "Water for Life" strategy and a proposed Groundwater Action Plan for the Province of Alberta in June of 2006. This sub-forum produced a report for the province that included recommendations for strengthening existing policy and learning from other nations that have faced water scarcity and quality issues similar to those that have begun to emerge in Alberta. The "Rosenberg Report" was widely cited in both government and the media.

Rosenberg VI

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The Forum also included a mandatory pre-Forum field trip from Madrid to the Medieval town of Madinaceli and to the Monasterio de Piedro both in mountains of Aragon and on to Zaragoza. Such field trips are considered essential to the development of the level of collegiality required to create the most positive possible environment for serious dialogue. Adjunct to the formal proceedings of the Forum, participants were also invited to visit the Zaragoza World's Fair, the theme of which was WATER.

Eight Canadians were invited to attend Rosenberg VI. In addition to Bob Sandford, who is a member of the Advisory Committee for the Rosenberg Forum, other Canadians that participated included prominent international water policy expert, Margaret Catley-Carlson; Dr. Lorne Taylor, former Minister of Environment of the Province of Alberta; Ron Hicks, Deputy Minister, Executive Council, Government of Alberta; David Hill, program director of the Alberta Water Research Institute; Kindy Gosal, Senior Manager of Water Projects for the Columbia Basin Trust and John Nilson, former Deputy Premier and Environment Minister, Province of Saskatchewan. Representatives from 22 other countries also participated in Rosenberg VI in Spain.

Support from the Max Bell Foundation in Canada

The Max Bell Foundation was once again a co-sponsor of Forum VI. The foundation's funding support was dedicated to deriving specific meaning and value for Canada and for Alberta from the proceedings. With the support of the Max Bell Foundation it became possible to identify scientific research presented at the Zaragoza Forum that could be relevant in the Canadian context. The goal of this work is to translate research into language and perspectives useful to Canadian politicians and decision-makers in their efforts to foster the development and timely implementation of science-based public policy to guide and facilitate the management of fresh water resources.

Outcome and Deliverables

The organizers of the Rosenberg Forum have committed to utilizing the field trip and presentation content of Rosenberg VI to create a number of products relevant to Canadians:

1. A 20 – 30 page summary of what the implications of the content of the Forum mean in terms of public policy implications globally with respect to water.
2. A three-page summary document and a 20-30 page foundation report on the practical and public policy lessons for Canada and for Alberta based upon a thorough analysis of the science and public policy observations presented at the forum.
3. A public presentation on the practical and public policy lessons for Canada and Alberta suitable for audiences throughout Canada.
4. A full report on lessons for Canada and Alberta on the Rosenberg website.

This document contains the summary of the implications of the content of the Forum with respect to public policy on a global basis and public policy lessons for Canada and Alberta based on the proceedings of Rosenberg Six.

Public presentations on the practical and policy lessons for Canada and for Alberta can be arranged in Canada by contacting Bob Sandford, Chair of the Canadian Partnership Initiative in support of the United Nations Water for Life Decade at sandford@telusplanet.net or by contacting the Chair of the Rosenberg International Forum on Water Policy as vaux0@att.net.

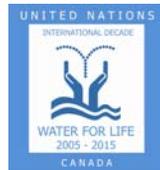
The final report on lessons for Canada and Alberta from Rosenberg VI can also be found on the Rosenberg International Forum on Water Policy website at www.rosenberg.ucanr.org.



Lessons From Rosenberg VI

Part Two

Issues of Water & Food Security Foreshadowed



The Forum Foreshadowed

1

Drought In Spain

Long before participants from around the world departed for the Rosenberg International Forum on Water Policy in 2008, each understood that there was probably no better place to hold high-level discussions about the relationship between water quantity and quality and food production than in Spain. In addition to possessing a large agricultural sector, Spain is a water-scarce country that has experienced for decades the kinds of water shortages that are only now beginning to present themselves in parts of Canada. As it happened Spain was at the time also facing a particularly acute water shortage as a result of recent drought. A little over a month before the forum opened, the *New York Times* ran an article by Lisa Abend on the problems that were confronting the city of Barcelona which at the time was facing the worst drought in a century.

According to the *New York Times* report, Barcelona was so short of water that it had been forced to charter ten water tankers for a period of six months to deliver 92 million cubic metres¹ of water a month from other parts of Spain and from France to augment the city's drinking water supply. This drastic measure was not going to be cheap. The bill for the six month supply of water was expected to be in the order of US \$68,000,000 or about \$12.36 for each of the 5.5 million men, women and children that currently rely on Barcelona's water supply.

Even if Rosenberg VI was not being held in Spain this would have been an interesting case study. Where water has generally been considered a free good to be reliably provided in perpetuity by nature, the people of the Province of Catalonia can no longer take water supply for granted. An invisible threshold has been crossed and there is no easy way back. Population growth, increasing withdrawals for agriculture and industry and climate change are pushing the region's hydrology toward disequilibrium resulting in more frequent drought and persistent water shortages. Spring rainfall in the region has been only 40% of the long-term average. Reservoirs in Spain are on average only 30% full at the outset of what many expect to be a very hot summer. The reservoirs that make life possible in the crowded city of Barcelona are only 20% full making action by the government necessary to prevent full-scale emergency.

Unfortunately, however, Barcelona is not the only place facing water scarcity. Almost everyone else in the region is facing the same conditions. The water tankers that will be supplying Barcelona will bring their precious cargoes from the French port of Marseille and from Tarragona and Andalusia in Spain. Farmers in these regions vigorously protested the transfers on the grounds that they simply didn't have the water to give.

¹ The article indicated a figure of 92 million cubic feet which we later determined was an error. The actual units were cubic metres.

Farmers in the Ter area north of Barcelona have been prohibited from irrigating so that the water that would normally be used to grow crops can be diverted to the city. As a result the Government of Spain will have to compensate irrigators for the water and the income they had to forego in the interests of the City of Barcelona adding further to the cost of supply.

This problem was not likely to go away any time soon. It is expected that climate change will likely exacerbate many of the problems that already exist in the Mediterranean region, including desertification, water scarcity and limits to food production.² This suggests we can expect increasing tensions over who gets water for what purpose and over how much specific economic sectors will be compensated for foregoing use in periods of persistent scarcity. Water managers and policy scholars are already thinking beyond immediate tensions in southern Spain to consider what it might mean to Europe as a whole if such scarcity becomes the norm over the long term in the Mediterranean.

In 2008 farmers in Spain were compensated for not growing food so that there would be enough water for people in neighbouring cities to drink. As a consequence food production dropped because there was not enough water for both agriculture and people. All evidence suggests, however, that the crisis will not stop here. This may just be the first of an eternity of increasingly thirsty Mediterranean summers. At the same time water is becoming increasingly scarce, the populations of Spain's major cities are expected to continue to grow, creating the prospect of even more tension over water supply.

In order to alleviate what could be long-term tension, the city of Barcelona is planning a diversion of the Ebro, Spain's largest river, which was expected to be completed in the fall of 2008. The plan, however, has been the object of bitter political opposition as adjacent regions circle the wagons in defense of their own agricultural economies and municipal interests. Underlying the debate is the clear realization that the regions that have enough water will have a future and those without will not. These realities have defined development and limited human settlement in the dry regions of the world for centuries but this is the first time that water scarcity on this scale has appeared on what appears to be a permanent basis in Europe. As Lisa Abend concluded in her *New York Times* article, that this new level of vulnerability to water supply disruption puts into relief how much more money and political energy will have to be invested in the management of water resources in the future, not just in Spain but around the world.

If there is a lesson for Canada in this it may be that we should take neither water demand nor hydrological stationarity for granted. We should recognize that serious problems with respect to water supply can develop even in the absence of drought if population pressures on limited water resources are exacerbated by climate change. Population growth in Southern Ontario will put pressure on local water resources just as surely as they have in Spain. Global warming could just as easily and suddenly reduce the amount of water available on the prairies as it has in the Mediterranean. At a certain point, cities and agriculture can find themselves competing for limited water resources. The Spanish

² See *Climate Change in the Mediterranean: Socio-Economic Perspectives of Impacts, Vulnerability and Adaptation*, edited by Carlo Giupponi and Mordechai Shechter, Edward Elgar, 2003, page 3.

example demonstrates that all of these problems can come together quite unexpectedly within a very short period of time. Regions that have not prepared for the sudden emergence of such problems or that do not have the institutions in place that can react to emergencies will be particularly vulnerable. Another lesson we learn from this is that institutions that have been created in earlier periods may not be prepared for the nature or magnitude of the kinds of problems that could emerge. Drought preparedness plans developed twenty years ago on the Canadian prairies will not be adequate to deal with the much larger populations and greater economic activity that presently exist in the region. Nor are attitudes and approaches that have served well in the past guaranteed to be adequate if drought becomes a more common and persistent feature of a warmer and more unstable climate. If we can learn anything from Spain it may be that we should expect a great deal of tension between big urban centres and the irrigation agriculture community if such circumstances come to be. We might also anticipate that the cost of emergency measures could be very high indeed – high enough in fact to alter the very structure of the economy around the dramatically increased value of a resource previously held to be so common as to have almost no value.

What is happening elsewhere in the world suggests that water is about to matter more than ever before in the Canadian West. As a result the potential exists to give greater value to everything related to water quantity and quality including the eco-hydrological properties of natural environments that produce, store, purify and release water into our streams and rivers. We should be preparing now for water scarcity in parts of the country while at the same time ensuring we know as much as we can about the potential impacts of this scarcity on those places that remain relatively water abundant. In the dry West, we should be developing every possible tool for making negotiation over water allocation and use as productive and cooperative as possible before we are confronted with drought of the lengthy durations we know have occurred in the past and are likely under most climate projections to occur more frequently in the future. All this said, it is not going to be easy to make these very real threats obvious in a society that still largely believes it possesses unlimited water resources. Oddly, the most serious threat at the moment in Canada is that a crisis will likely have to present itself before we are ready to act.

The Forum Foreshadowed

2

Floods in Spain

Three weeks after the *New York Times* reported on tanker transfers of water to stave off thirst in Barcelona, Drought's twin sister Flood also showed up in Spain. Heavy rain in the upper reaches of the Ebro River helped refill empty reservoirs but also caused flooding in some areas including Zaragoza where the Rosenberg Forum was scheduled to begin in only two weeks. It is interesting to see how very quickly drought can become its opposite. Also interesting is that it is possible to have both drought and flood in the same basin at the same time.

Particularly problematic for the Spaniards was the fact that flooding occurred at the site of the World's Fair in Zaragoza. What an irony it is that a site dedicated to the celebration of fresh water worldwide should be inundated by floodwaters just days before it was scheduled to be opened. The organizers scrambled to say the least and I imagine there will be no small amount of finger-pointing related to the decision to locate the site of the fair in the floodplain of the Ebro River.

The Forum Foreshadowed

3

Rising Global Food Prices

While some of Spain's drought woes will have been alleviated at least temporarily by the heavy rains, one very pressing problem remains. Food prices continue to rise around the world causing alarm especially in countries where large populations of poor people do not have enough to eat and possess little money to buy food. This is the very crisis that, Dr. Henry Vaux, the Chair of the Rosenberg International Forum on Water Policy, predicted when he spoke at the "Confronting Water Scarcity" conference at the University of Lethbridge in 2004. In his keynote address Vaux argued that groundwater overdraft and the simultaneous decline in water supply in a number of important food-producing countries would result in a food production crisis that could drive up prices enough to make western Canadian agriculture more important economically than perhaps even oil and gas. Vaux's proviso was that this could only happen if Canada committed itself to improving its agricultural practices so as to reduce environmental impacts such as pesticide contamination and the eutrophication of streams and rivers with nutrients washed from fields after fertilizer application. The wild card, Vaux said even then was climate change.

While the Vaux scenario for western Canada remains to be realized, it is interesting that his prediction of higher food prices has fulfilled itself. But water scarcity is not what is driving it. The drivers of this food price hike are rising fuel prices and the increased frequency of natural disasters like the droughts and floods that are taking place simultaneously in Spain.

The first sign of changes in food prices was evidenced by the cover story of the December 8th, 2007 issue of *The Economist*. This article observed that what was remarkable about the current "agflation" was that it was occurring at a time not of scarcity but of abundance. The global cereal crop in 2007 was estimated to be some 1.6 billion metric tonnes, the largest on record and 89 million tonnes more than in 2006, which was also a year of bumper crops in many places of the world. Given that prices were rising rapidly even though we had just witnessed the largest grain crop ever grown on the planet suggested that something fundamental had changed in the global food market. From a food production perspective prices should have been falling. Instead they were rising and fast which suggests that something out of the ordinary must have been happening to the global demand for cereals.

One thing that was happening is that incomes were rising fast enough in places like India and China to allow hundreds of millions of people to add more meat to their diet. While in many parts of the world the demand for cereals has remained relatively flat, the global demand for meat has doubled. This new demand has required that farmers worldwide to feed some 200 to 250 million tonnes more grain to livestock than they did 20 years ago. This increase alone is a significant portion of the world's total cereal production. What it also suggests is that global food production is now more than ever a moving target. While food production needs were fairly clear when they were tied directly to global population estimates and basic dietary needs the whole system has become uncoupled as a result of growing global desire to eat more meat. On a global scale we have ratcheted up our food expectations to such an extent that we are having trouble keeping up with livestock production demands.

Calorie for calorie, it takes a great deal more energy to transform grain into meat than it does to transform it into bread. As *The Economist* article pointed out, it takes three kilograms of cereal grain to produce one kilogram of pork and eight kilograms of cereal grains to produce a kilogram of beef. While cereal demands for livestock production have been affecting food prices since 1980 by ratcheting up the demand for feed grains by 1% to 2% a year, there were also other factors affecting food prices. One of these is the rising cost of fossil fuels which in the end affects the cost of every step in the food production process from planting of seeds right through to the arrival of the final products at our tables. But neither increasing demand for feed grains nor rising fuel prices can account for the rapid increase in food prices during the first decade of the 21st century. The principal antagonist in this real-world threat appears to be a rampantly growing demand for ethanol to fuel American cars which puts a new twist on the link between energy, food and water.

The amount of crop area committed to biofuel production has been growing rapidly in the United States since public policy directions after the terrorist attacks on New York and Washington in 2001 favoured domestic energy sources over reliance on foreign oil. In 2000, about 15 million tonnes of American corn was being transformed into ethanol. By 2007, that volume had increased by nearly 6 times to 85 million tonnes. What is interesting about this is that the increase in corn production for biofuels has completely altered America's agricultural status vis-à-vis the rest of the world.

The Forum Foreshadowed

4

The Biofuels Issue

In the latter half of the 20th century, the United States was by far the world's largest exporter of corn. Now it uses more of its corn crop to produce ethanol than it exports. While politicians in the corn states may claim otherwise, the rapid recent rise of the cost of corn cannot be attributed to any other factor other than biofuel production which at the time of this writing absorbed a full one-third of the U.S. annual corn crop. The amount of corn taken out of food stocks for biofuel production impacts food prices because it

impacts how much remains available for livestock feed. More and more is being siphoned away from food production for people which drives up the price of food. Because of its rising price more corn is now being produced relative to wheat and soybeans which has in turn driven up prices for these commodities as well.

In late 2006, the price of tortilla flour in Mexico doubled.³ The reason for that increase was that U.S. corn prices rose from \$2.80 to \$4.20 a bushel over a period of just a few months and Mexico gets 80% of its corn imports from the United States. The link between rising American corn prices and the cost of tortillas, however, was not direct. Mexican tortillas are made principally from white corn that is grown in Mexico. But with the rising cost of corn imported from the United States, Mexican livestock producers began buying up the cheaper white corn for animal feed and processed products which pushed up white corn prices. The surging cost of white corn flour was further impacted by speculation and hoarding. With half of Mexico's 107 million people living in poverty and relying heavily on tortillas as their main food source, it didn't take long for the price rise to become an explosive political issue. In January of 2007, Mexico's new President Felipe Calderón had little choice but to cap food prices.

In 2007, corn production in the United States rose to 335 million tonnes. Much of this increase in production took place at the expense of other crops. Much of the increase also relied on expansion of productivity into marginal lands with a high associated cost in water use. In 2007 the overall stocks of cereals worldwide declined by some 53 million tonnes which clearly indicates the extent to which supply is beginning to be exceeded by demand in a market suddenly complicated by new uses for food products other than the direct feeding of human populations. It has been estimated that the demands of America's ethanol production alone account for nearly one-half of this planet's unmet need for cereals.

The article on rising global food prices in the December 8th, 2007 issue of *The Economist* cited the work of Nobel Laureate Gary Becker who is an economist at the University of Chicago. Becker argued at the time that if food prices rise by one-third they will reduce the standard of living in developed countries by 3%. The impact in poor countries, however, will be seven times worse. Many people in developing countries already spend 50% to 80% of their income on food. According to the World Bank, some 3 billion people live in rural situations in developing countries. This 3 billion represents ¾ of the world's poorest people. Some 2.5 billion of these people are farmers. In principle the poor in rural areas should benefit from higher food prices, but that is not what happens in the contemporary marketplace. Many, including net importers, will lose more from rising prices than they will from increased farm incomes. Developing countries in Asia such as Bangladesh and Nepal and Benin and Niger in Africa will together spent \$50 billion in 2007 on cereal imports, an increase of 10% in one year. Prices are expected to keep rising, along with the number of starving people.

³ See *How Biofuels Could Starve The Poor*, by C. Ford Runge and Benjamin Senauer, Foreign Affairs, May/June 2007, pages 41 – 53. See also *How Ethanol Fuels the Food Crisis* by the same authors, Foreign Affairs, www.foreignaffairs.org, May 28th, 2008.

With a one-third increase in food prices, the standard of living in poorer countries will drop by 20% which, given the fact that many of these countries are already struggling to feed their people, will mean further hardship if not outright starvation. It has been estimated that continued expansion of ethanol and other biofuel production could reduce caloric intake by an additional 4.8% in Africa and 2.5% in Asia by 2020. If this is allowed to happen it is logical to expect more of the kind of speculation, hoarding and rioting that took place in Mexico over the rising cost of tortillas in 2007. We should also expect inflation in those countries where rising food costs have become an economic burden.

In 2008, the average price of corn rose by some 60%, soybeans by 76%, wheat by 54% and rice by 104%. In only a year rising food prices created 100 million newly poor and hungry people. Food riots of the kind that had taken place in Mexico spread to Egypt, Guinea, Haiti, Indonesia, Mauritania, Morocco, the Philippines, Senegal and Yemen.

The U.S. produced 11.4 billion gallons of ethanol in 2008. Though America's national energy policy may change with the election of a new U.S. administration, production is expected to rise to 35 billion gallons by 2017 and to 60 billion gallons by 2030.

The debate in the United States about the efficacy of current biofuel reliance, however, is far from over. In 2007, the National Research Council of the National Academies of Science released a long-awaited report on the implications of biofuel production for sustainability of water resources in the United States.⁴ The report noted that the ways in which a shift toward growing more energy crops will affect the availability and quality of water would vary from region to region.

The primary concern with respect to water availability centred around how much new or reallocated water would be required for irrigation of energy crops and how such allocations might compete with existing needs for water. The question of whether more or less water will be needed to support fuel crops depends on what crops are being substituted and where the fuel crops were being grown. The report concluded that in the next 5 to 10 years at least, increased biofuel production was not likely to alter national aggregate water use. There are likely to be significant regional and local impacts, however, in parts of the United States where water resources are already stressed. It was noted that growing biofuel crops in regions already requiring additional irrigation water from already depleted aquifers was a major concern.

It was also observed that process water for corn ethanol production raised additional water quantity and quality concerns. The report noted that with the rapid expansion of ethanol production, some local communities and governments have not accurately estimated withdrawal levels and discharge volumes and have suffered the resulting water draw-downs and new water treatment requirements. In these cases new state and federal water withdrawal and point discharge regulation is required. Canada should take note.

⁴ See *Water Implications of Biofuels Production in the United States*, Water Science and Technology Board, Division on Earth and Life Studies, National Research Council of the National Academies, the National Academies Press, 2007

The report also observed that the growth of biofuel production in the United States has probably already affected water quality because of the large amounts of nitrogen and phosphorous fertilization required to produce corn. The report noted that extent of the dead zone at the mouth of the Mississippi River in 2007 was among the three largest mapped to date. The report linked the eutrophication of this estuary directly to the volumes of fertilizer used in upstream areas which is presently at or near its highest level. The report also observed that if not addressed through policy and technology development, the effect the extent of the damage in the Gulf could accelerate as biofuel production expands to 15% of domestic usage to meet President Bush's 2017 goal, and to the ultimate goal of 30% which the Bush administration promised to achieve by 2030.

The report warned that if projected future increases in the use of corn for ethanol production do occur, the increase in harm to water quality in the United States could be considerable. Expansion of corn production on marginal lands or soils that do not hold nutrients can increase loads of both nutrients and sediments in watercourses. To avoid deleterious effect, the report recommended that future expansions of biofuels focus more on perennial crops, like switchgrass, poplars, willows or prairie polycultures with proven capacity to hold soils and nutrients in place. The report further suggested that reducing the potential impacts of biofuel production required the development of new technologies that support both traditional and cellulosic feedstocks that use less water and fertilizer while at the same time optimizing fuel production.

Finally, the report hinted that, regardless of considerations related to biofuel production, it was important for the United States to improve its agricultural practices so as to reduce water quality impacts. In conclusion the authors of the report encouraged political leaders to formulate policies that encouraged water conservation and prevented unsustainable withdrawal of water from depleted aquifers.

There was no mention in the report of the impact of rising corn and other food staple prices on the rest of the world. Such considerations appear to have been outside the terms of reference of the National Academies study.

The Forum Foreshadowed

5

Food, Fuel & Climate Change

In June of 2008, a month after U.N. Secretary General Ban Ki-moon declared that the global food security crisis threatened to undermine the first Millennium Goal of reducing world hunger speculators were at it again, this time in the United States. Intense trading of corn futures pushed the price of corn to a never before imagined \$8.00 a bushel. Speculators based the higher price on concerns that extensive spring flooding was likely to reduce the area of farmland available for production in U.S. Midwest by some 5 million acres which could mean a reduction of the crop by as much as 700 million bushels.

Suddenly, in addition to changing dietary preferences and commodities speculation, a new hand was suddenly at play in the determination of global food prices, that of the increase in the number, frequency and intensity of extreme weather events associated with climate change.

Back at the University of Minnesota, researchers were standing by 2003 estimates that for every percentage of increase in the real price of food staples, at least 16 million more people would join the crowded ranks of those who do not have or cannot afford food security. These researchers projected that if prices remained as relatively high as they were in 2008, the number of chronically hungry people in the world will rise to 1.2 billion by 2025, 600 million than previously predicted. This suggests that climate change does not have to affect where you live to impact your life. In the food web that currently exists, an increase in the price of corn caused by extremes in spring weather in the United States translates directly into people not getting enough to eat in elsewhere. The poverty line around the world goes up and down with food prices in time with climate events.

As William Cline has pointed out, in the long list of potential effects of climate warming, the risk of damage to world agricultural production stands out as one of the most important.⁵ Cline underscores the widespread recognition that developing countries in general stand to lose more than developed countries from the effects of global warming on agriculture. One of the main reasons for this is that temperatures in developing countries, which are predominately located in lower latitudes, are already close to or beyond thresholds at which further warming will reduce rather than enhance agricultural productivity. Unfortunately, these countries also tend to have the least capacity to adapt to these changes. Moreover, agriculture constitutes a much larger fraction of the Gross Domestic Product in developing than it does in developed nations which means that a given percentage loss in agricultural potential imposes a larger proportionate income loss on a developing country than it might on an industrialized neighbour.

The Forum Foreshadowed

6

Food, Fuel, Climate Change & Water

What *The Economist* and other sources failed to report was the link that existed between cereal production and meat consumption and water. While it takes 900 kilograms of water to create a loaf of bread, it takes between 3500 and 5700 kilograms of water to create a kilogram of chicken, 10,000 kilograms to create a kilogram of pork and between 15,000 and 70,000 kilograms of water to create a kilogram of beef.⁶ Then there is the issue of growing energy instead of food. It takes on average 1000 litres of water to produce 1 litre of ethanol.

⁵ Cline, William R. *Global Warming and Agriculture: Impact Assessments by Country*, Centre for Global Development and the Peterson Institute for International Economics, 2007, pages 1 – 6.

⁶ See Agriculture and Forestry section of Environment Canada's website at http://www.ec.gc.ca/water/en/info/facts/e_agric.htm

Economists and policy makers all over the world are concerned that our excessive demands on planetary resources are consuming the Earth's assets and in so doing we are, in effect, creating a bubble economy. And a big part of this bubble relates to fresh water and the vital role it plays in food production. To meet the food demands that are projected to exist in the world in 2025, we will need to put an additional 2000 cubic kilometres of water into irrigation. This amount is roughly equivalent to 24 times the average flow of the Nile.

Given current water use patterns, the population that is projected to exist on the planet in 2050 will require 3800 cubic kilometres of water a year, which is close to all the fresh water that can presently be withdrawn on Earth. This would mean that the world would lose most of the irreplaceable environmental services aquatic ecosystems presently provide on our behalf. Simultaneously, on a global scale soil erosion is exceeding new soil formation by a rate of 10 to 40 times.

It is a troubling fact that there is simply not enough water or soil in the world to allow every developing country to enjoy the dietary luxuries that are taken for granted in today's Europe and North America. It is not only that the rest of the world cannot realistically aspire to these dietary expectations, developing countries are unlikely to be able to sustain these expectations even at current levels if populations continue to grow and groundwater exhaustion and climate change alters the amount of water available in many of the world's existing food production regions.

Henry Vaux's worry is that the current boost in global food prices is based solely on food security. He believes that the world can expect another far more pronounced boost in food prices to occur when water becomes scarce. There are a number of ways this pending crisis could be avoided. The first is to slow population growth. The second is to slow the emerging demand for high protein diets and the third is to stop using corn and soybeans as biofuel stocks. Though opposition to biofuel production is growing based on the sheer inefficiency of the process, it seems unlikely there will be much positive action on any of these indicators. As participants prepared to depart for Rosenberg VI in Spain, it appears that we will simply allow the world to blunder toward a new level of food insecurity and water supply crisis – the very crisis that Dr. Henry Vaux predicted in 2004.

The Forum Foreshadowed

7

Water and Food Production in Canada

We live very well on this continent, but it is increasingly clear – especially in the Canadian West - that we cannot be insulated from what is happening in the rest of the world forever. In addition to high mean temperatures, today's farmers are also the first generation to face widespread aquifer depletion and the resulting lost of irrigation water. The problem of falling water tables is more immediately problematic than temperature increase.

As world water demand has climbed, water tables in important food producing countries such as India, China and even the United States have dropped, in some cases dramatically. These countries produce half the world's grain. In addition to falling exponentially, water tables are also falling simultaneously in many countries. This means that cutbacks in grain harvest will occur in many countries at more or less the same time. And they will occur at a time in history when the world's population is growing at a rate equivalent to two Canadas a year.

So what does that mean to Canada? As countries around the world become water scarce, it will become more and more necessary to import water, not in its raw liquid state, but as water embodied in food. As has already been indicated, global experts have predicted that western Canadian agriculture will have a new and very prominent niche in the global economy. Some experts like Henry Vaux have predicted that this niche could ultimately be more important to the western Canadian economy than oil and gas which suggests that it may be unwise to assume we will be able simply take water away from agriculture for other purposes in the future.

Whether food prices will continue to rise enough to make this happen is unclear but what is clear is that western Canadian agriculture will not be able to occupy this new and very prominent niche in the global economy unless it is able to keep up with solutions to its own water availability and quality challenges related to agricultural practices and climate change. But it is not just agricultural water issues that are coming to the fore.

Given western Canadian population and economic growth over the last fifty years, it should surprise no one that many of the same pressures that have created a global water crisis elsewhere have begun to appear here. A number of water-related concerns are beginning to present themselves in Alberta and throughout the Canadian West which deserve consideration not just in relation to current and anticipated local population and economic growth trends and expectations but also in the context how these same pressures have influenced water availability and quality elsewhere in an increasingly crowded world. All of the water-related issues listed below have manifested themselves elsewhere. Each is a well-recognized component contributing to the global water crisis:

1. rapid population growth and attendant landscape change have already begun to have broader ecosystem and related water supply impacts
2. greater population concentration in urban areas has resulted in a gradual loss of public connection to place making it more difficult to draw attention to and act upon ecological and hydrological changes that are taking place around us
3. inappropriate development and recreational and resource exploitation activities are increasingly being permitted and encouraged in upland watersheds where natural processes central to the sustained function of the regional hydrological cycle

4. inadequate support exists for monitoring and research at upper elevations in the mountains of the West where climate change impacts on glaciers, snowpack and snow cover are expected to be felt first and where they are expected to be most pronounced in terms of their impacts on water supply to downstream regions
5. over-allocation of rivers originating on the eastern slopes the Rocky Mountains
6. the failure to implement serious regional water conservation measures
7. the continuation and expansion of agricultural practices that have led to the over-fertilization and eutrophication of thousands of western lakes and streams through nutrient loading (now exacerbated by rising water temperatures and lower flows as a result of over-allocation of water resources)
8. the loss of 70% of natural wetlands with subsequent impacts on surface flows, nutrient transfers, aquifer dynamics and erosion patterns
9. the failure to come to agreement on what constitutes adequate in-stream flow requirements necessary to sustain aquatic ecosystem health
10. the reluctance to control the growing number of groundwater wells while at the same time failing to adequately monitor changes in aquifer volumes and flow characteristics as a result of conjunctive use and trends toward reduced water availability as a result of glacier melt and diminishment of snowpack and snow cover
11. industrial production of huge volumes of liquid and water soluble toxins for which no technology exists for treatment in the short-term; and the storage of these carcinogenic wastes near major rivers in circumstances that create the threat of catastrophic contamination of entire water courses
12. the encouragement of wide-spread coal-bed methane extraction without clear understanding of long-term impacts on groundwater quality
13. institutional territoriality and jurisdictional fragmentation with respect to responsibilities for water quality and supply
14. a reluctance to transcend antiquated 19th century water management policies defined by first-in-time, first-in-right prior appropriation doctrines
15. the continued heavy reliance on water storage and engineering solutions to growing water supply problems

16. the creation of *ad hoc* water markets that respond to market efficiency without considering issues of equity and long-term sustainability
17. limited realization of our extreme vulnerability to droughts of duration now known to be far more frequent in the historical record than they were in the 20th century
18. on-going denial of the fact of anthropogenic influence on climate change at decision-making levels in government and in industry
19. the continued adherence to the myth of limitless water abundance and to the unsupportable claim that somehow we are world leaders in water management
20. an unwillingness to consider how the implications of the global water crisis may back up into our region from outside
21. the lack of effective joint federal-provincial leadership in addressing these problems in a unified way.

Even if we could instantly resolve our own manifold water quantity and quality issues, global problems are going to impact us in ways that will make heavy new demands on how we live. Issues such as the biofuels put the complexities of the global food marketplace into relief. While Canada is a net importer of corn and our biggest producer, Ontario, is only a small player in the global corn market, Canada is one of the world's great cereal producers. Because it exports so much wheat Canada is also one of the world's greatest exporters of virtual water – water embodied in food. Many nations buy Canadian grains because they do not have the land or the water to grow them themselves.

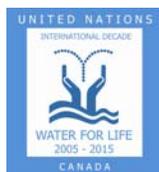
As transfers of water and the impacts of increasing food prices on water availability and quality were important themes on the Rosenberg Forum agenda in Spain, it was a timely moment in history for an expert delegation of Canadians to be attending and participating in the proceedings.



Lessons From Rosenberg VI

Part Three

Contemplating Water in Spain as a Prelude To the Forum



Tuesday, June 24th, 2008

It is customary that all Rosenberg Forums include a day or two in advance of the formal proceedings to allow new participants to familiarize themselves with one another and to become comfortable with the program. It is also when the small core of returnees makes time to catch up with one another on developments concerning transboundary water issues that were on the agenda of earlier forums. The field trip for Rosenberg VI began at the Auditorium Hotel near the Madrid International Airport where participants set out by motor coach for the Medieval town of Medinaceli and then on to the Monasterio de Piedro in the high sierras of the Sistema Iberico mountain range with a visit to an adjacent natural park famous for its waterfalls.

Each of these bus trips begins with instructions from Henry Vaux who outlines the protocols for the trip which demand that participants change seat partners at every stop so that everyone has an opportunity to know one another better. This has proved in the past to be very important as it permits participants from diverse cultural backgrounds to find common ground on water issues and to develop a level of confidence in one another's professionalism that leads to frank and honest dialogue once the formal Forum program begins.



Dr. Henry Vaux Jr. offering orientation to participants in the pre-forum Field Trip for Rosenberg VI.
Dr. Peter Gleick of the Pacific Institute in the United States is at right.

I spent the first leg of the journey with Ambassador Oktay Aksoy from Turkey discussing Middle East politics and water issues with a digression to have him update me on his understanding of where Turkey presently stood in terms of its proposed entry into the European Union, a matter of much discussion at Rosenberg IV in Ankara in 2004. We talked also of the deteriorating state of American relations with the rest of the world which concerned and frustrated the Ambassador. We agreed that in order to ensure stability in the Middle East this circumstance had to change. Both of us hoped that the November, 2008 election in the United States might herald the beginning of that change. Canadians live so close to the U.S. and are so reliant upon the American economy that we do not always fully appreciate the influence of American foreign policy abroad. That policy often has huge direct and indirect influence on how water is managed and shared in regions where it is scarce and a potential source of conflict between riparian neighbours. This is particularly true in countries like Turkey whose downstream riparian neighbours include Syria and Iraq.



David Hill of the Alberta Water Research Institute wandering the stone streets in the Medieval hilltop town of Medinaceli

At our stop at the spectacular hilltop town of Medinaceli, participants spent as much time talking with one another as they did wandering through the stone streets. Here at the frontier between Christian and Muslim worlds in the Middle Ages, conversation was easy and natural. One of the most interesting conversations I had on the pre-forum field trip centred on the kinds of water supply problems that were emerging in Australia. This is a part of an on-going dialogue I have been having with Leith Bouilly, a mother, farmer and natural resource and water management expert from Dirranbandi, Queensland since 2004.

Our common concerns relate to appropriate public policy choices available to politicians in the event that persistent drought becomes permanent, as appears to have happened in the Murray-Darling Basin in southwestern Australia. What Leith Bouilly has experienced as a farmer, as a founding member of the Wentworth Group of Concerned Scientists and as the chair of the community advisory committee of the Murray-Darling Basin Ministerial Council should be of considerable interest to anyone that relies upon the agriculture in the Canadian West. Her experience speaks to what happens to communities and economies when droughts don't end and aridity becomes the new norm in a formerly rich agricultural landscape.

Not unlike the interior plains of North America, much of Australia is semi-arid or arid in nature. Like the Canadian prairies, Australia's rainfall history features several distinctly dry periods of a decade or longer. As happened in Canada, the mid-to-late 1920s and the 1930s were periods of drought over most of Australia with low rainfall persisting over the eastern states through most of the 1940s. Another drought occurred in the 1960s over central and eastern Australia.⁷

As often happens in Canada during dry periods, not every year during these periods of prolonged drought was dry. The problem was that in most years rainfall was below the long-term average which compounded the effect of runs of years with recurrent dryness. Australia's drought of record – known as the “Federation drought” – persisted through the late 1890s until 1902. It was a drought of this kind. The drought of 1991 to 1995, which affected Queensland, northern New South Wales and parts of central Australia and the most recent drought that most of Australia has been experiencing for much of the past decade are further examples of this most severe kind of drought event in which one or two very dry years follow several years of generally below-average rainfall.

Despite nearly two decades of lingering drought, evidence suggests that the situation is not about to improve for Australian farmers. As part of the Australian Government's ongoing review of national drought policy, the Australian Bureau of Meteorology and the Commonwealth Scientific and Industrial Research Organization were commissioned to evaluate the impact of climate change on the nature and frequency of exceptional climatic events. The assessment examined past and future changes in the intensity and frequency as such events with a specific focus on the impact high temperatures, low rainfall and low soil moisture. Their joint report concluded that, compared to the past 100 years, there is an increased risk of severe dryness over the next 20 to 30 years, particularly over southern Australia. The reason: increased drought risk will be exacerbated by increasing temperatures – so that droughts in the future will be hotter. In other words, the dryness normally associated with drought in many parts of Australia is about to become the norm rather than the exception.

Researchers noted, however, that this does not necessarily mean the end of farming in Australia. It does mean, though, that farm families, rural businesses and communities are going to have to adapt to the new conditions, which isn't going to be easy. Some areas of

⁷ See *It's About People: Changing Perspectives on Dryness*, A Report to Government by an Expert Social Panel, Commonwealth of Australia, 2008.

Australia have now been experiencing what have been defined as “exceptional circumstances” for 13 of the past 16 years. In the middle of June, when Leith Bouilly and her colleague, water and rural policy expert Wendy Craik, departed Australia for the Rosenberg Forum in Spain, a significant portion of the entire Australian continent was once again experiencing persistent drought conditions.

While Australian agricultural has always been in a state of constant adjustment to natural climatic variation, current extreme circumstances have brought in their wake not only the usual economic stresses associated with change, but growing widespread distress which has reduced the capacity of rural families and communities to cope. Rural Australia is at the very limits of its ability to adapt to climate change impacts. Many inland agricultural communities are now so reduced in population they are on the cusp of viability. In many of these places the social fabric of community is unraveling. Suicide rates have climbed, especially among males, and many rural communities are increasingly divided socially over appropriate responses to what many are still having difficulty accepting as permanently changed circumstances.

From the Australian example we learn that not only do most societies depend upon relative hydrological stationarity – that is to say a relatively stable and reliable precipitation regime and water supply – but the structures by which we are governed have come to be defined by such stationarity. Our governance structures and its all our infrastructure have hardened into place around how much water we have, when it is available to us and what we need it for. We can deal with variability in supply that is within the range of past experience. But when suddenly there is a lot less we have problems. If the new range of variability of supply remains permanently outside of our experience and therefore beyond the design capacity of our infrastructure then the system upon which we depend for stability begins to breakdown. Paralyzed by past habits and expectations and hedged in by infrastructure and institutions that have suddenly become inadequate to our needs we are forced to struggle to adapt. That appears at least to have been what happened in Australia.

The depth of the economic and social upheaval caused by the appearance of permanently persistent drought in Australia demanded changes in almost every institution in the country. There were systemic changes to values as idealistic imperatives such as environmental sustainability were challenged by the urgency of making real-life trade-offs in support of community survival. Australians quickly learned that history matters with respect to laws, policies, institutions and traditions. Unresolved Aboriginal issues stood out in immediate relief. Litigation soared along with buy-backs and sales of land and water rights. There were interests that took to hoarding and profiteering.

Established notions of jurisdiction soon came under attack. Individual states became unruly in defense of their own self-interest. As the crisis deepened Australians ceased to be moved by rhetoric. As community outrage focused more and more upon the failure of state governments to properly frame and address issues related to the emergency, central power ultimately emerged as a dominant influence on national direction. Despite enormous resistance from interests that could not have previously conceived of such a

development, the only way the problem could be managed in the end was to have individual states relinquish their powers to the federal government.

Previously fragmented and territorial political jurisdictions are now forced to work together and even amalgamate their efforts and programs in ways that would have been unthinkable in the absence of the emergency. The very foundation of the country's laws had to change in order to accommodate shifts in agricultural practices, jurisdiction, power and decision-making processes. Even though both federal and some state governments fell in part as a consequence of their perceived failure to move quickly enough in the right direction to address the impacts of the drought, ten years have passed and Australian institutions are still trying to facilitate the kinds of changes that may make adaptation to the new climatic circumstances and water supply regimes possible in the future.

Lessons for Canada and for the rest of the world derive from the fact that as a consequence of climate change Australia was confronted with an unprecedented period of major upheaval in its agricultural sector for which the governments and major institutions of the country, by virtue of the way they are structured, were slow to respond. The Australian circumstance is something to which we should pay close heed. On the Canadian prairies climatic conditions are already at a threshold at which rising temperatures could create aridity as quickly as they did in Australia and in so doing could push our agricultural sector beyond its current capacity to adapt with devastating impacts on our regional environment and economy. Our institutional arrangements with respect to water resources management in Canada are presently as territorial and jurisdictionally fragmented as they were in Australia at the outset of the change in climatic circumstances that devastated the country's agriculture.

We may wish to advance reform of our institutional arrangements so as to enhance our adaptability to climate change effects before unforeseen events make our society vulnerable to the same social and economic catastrophe that befell Australia. One option is to create a regional drought preparedness plan linking jurisdictions, not just on the prairies, but in all western provinces and northern territories that rely upon rivers that have their origins in the Rocky Mountains for their water supply. A related option might be to step up research on drought prediction and to provide enhanced monitoring and research at upper elevations in the mountains of the West where climate change impacts on glaciers, snowpack and snow cover are expected to be felt first and where they are expected to be most pronounced in terms of their impacts on water supply to downstream regions. A complementary option might be movement in the direction of an over-arching, pan-Canadian framework for sustainability with respect to the management of our water resources on a watershed basis.

Viewed in the context of the good it might bring, climate change effects may in fact present an important historical opportunity in Canada to redraw jurisdictional lines around watersheds. By being proactive in anticipating climate-related impacts on water quantity and quality, we may at least be able to consider the option of returning to the point in our history at which we drew artificial lines of jurisdiction on a map to create

Canada as we know it today; and in so doing restore the watershed as the fundamental geographical and hydrological unit in the country.

Leith Bouilly had the last word in our conversation about the drought problem in Australia. As we were ready to board the coach she cut to the chase. In the direct no-nonsense language that only an Australian mother could summon she protested that in terms of the state of contemporary public policy with respect to water, “We have got to get past discussions of motherhood and get down to changing the nappie.”

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On the next leg of the journey I sat with Dr. Margaret Wilder of the University of Arizona. Though this was the first time we had actually met, I had been in regulation communication with her and her mentor, Dr. Helen Ingram, for several months in preparation for the session on equity with respect to water governance I had agreed to chair at this Forum. Before earning her PhD. under Dr. Ingram, Margaret worked for many years in senior positions in municipal governments so has practical as well as academic experience in governance. Dr. Wilder’s most recent work related to equity issues that have emerged as a result of the introduction of new water policy in Mexico. It was interesting to note how the issues she hoped to put into relief through her work overlapped with those that so animated Leith Bouilly in her analysis of Australia’s efforts to adapt to persistent drought.

Margaret pointed out that many countries in Latin America, including Brazil, Columbia, Chile, Peru, Nicaragua, Costa Rica, Honduras and Mexico have all recently instituted water management reforms each containing similar elements. She has been studying the new institutional landscape for managing water in both urban and rural settings in Mexico with a focus on equity implications of these changes. Equity, in the context of Wilder’s work, referred to both political and economic equity.⁸ In referring to political equity, Wilder is referring to the institutionalization of local participation in water policy-making as well as to the quality of participatory mechanisms, issues of considerable importance in Mexico and of growing importance in countries like Australia and Canada. By economic equity, Wilder means a wide range of socioeconomic aspects of water including accessibility, affordability and productivity.

Wilder explained that urban water systems in Mexico are currently in transition between a subsidized service provided by the government to a self-sufficient autonomous model shaped by and partially funded by the World Bank. Under decentralization, Wilder told me, urban water managers have largely inherited deteriorated infrastructure close to the end of its life. They have also inherited the usual lack of water metering and a high percentage of water loss in leaky systems combined with low tariffs for water supply that make it impossible to cover operational costs or to replace worn out infrastructure. The same was effectively true of Mexico’s deteriorating rural water infrastructure which in

⁸ See *Equity and Water in Mexico’s Changing Institutional Landscape* by Margaret Wilder in *Water, Place and Equity*, edited by John M. Whiteley, Helen Ingram, and Richard Perry, MIT Press, 2008. Pages 95 – 116.

the mid-1990s limped on in the face of systemic losses due to leakage of as much 50% in some irrigation districts.

On the positive side, Mexican water reforms have created a host of new institutions charged with responsibility for making decentralized management work. Of particular interest to this Canadian was the fact that Mexico has created a national network of 25 river basin councils each with a mandate to influence sustainable long-term planning at the basin level. Water user associations were also created to manage water supply and delivery within 81 irrigation districts. Civil associations were also created to make decisions about water management at the sub-irrigation district level. Just as in Canada, the ultimate effectiveness of watershed basin councils remains to be determined.

Dr. Wilder held that in theory the creation of the river basin councils represent a progressive step forward in using integrated water resource management tools to solve problems, undertake long-term planning and to make environmental sustainability possible in any given watershed. Instead, Dr. Wilder's research revealed that logistical and jurisdictional obstacles to the effective functioning of watershed basin councils still remained.

In April of 2004, the Mexican government of Vicente Fox updated national water law to include an enhanced focus on decentralized governance, local participation, integrated watershed management and environmental sustainability – all of the things we also claim as crucial elements of effective water reform in Alberta. It is interesting to note that in Mexico regulations that would allow the implementation of the proposed reforms were not adopted.

Since the launch of Alberta's very similar Water for Life strategy in 2003, many watershed basin council volunteers in the province have had the same complaint. While it is good to encourage local participation in the development of integrated watershed management plans, that participation could ultimately mean little if recommendations are not implemented. It is one thing to claim that decision-making processes have changed and that new inputs are invited, quite another to ensure they are. It appears to be a universal problem. We were still talking about the global shift from social equity to economic efficiency and about how to avoid elite capture of participatory processes related to the management of water resources when we arrived at the Monasterio de Pedro.



The immaculately maintained courtyard of the Monasterio de Pedro

Like everything else of any antiquity in Europe, Monasterio de Piedro was something else before it became a monastery. A thousand years ago the Moors built Piedra Vieja Castle, a defensive fort on this lovely forested site in the Sistema Iberico Mountains in Aragon. When Alfonso II reclaimed Aragon for the Christians he gave the castle to the Cistercian Order of monks. An Abbot from Tarragona and twelve monks were dispatched to Aragon to spread the Christian faith for this serene centre. It took the 23 years between 1195 and 1218 for the monastery to be completed, a brief span in those days which can be attributed to the fact that the builders did not need to quarry or dress the stone as it was there for the taking by just simply breaking down the walls of the old Moorish castle. Such is way buildings were constructed in the Middle Ages.



The vaulted ceilings above the cloister gallery surrounding the courtyard.

The ground plan of the Monasterio de Piedro is highly representative of an architectural style associated with the Cistercian order. Monks apparently lived here with only three minor interruptions for the almost 700 years between 1195 and 1835 which suggests the world for the most part passed this beautiful place by for a very long time. During the last years as a functioning monastery Monasterio de Piedro was attacked and looted three times, first in 1808 during the War of Independence, again between 1820 and 1823 during the Carlist War and finally in 1835 when Mendizabal, one of Isabel II's senior ministers, expropriated the lands of the contemplative orders and sold them at auction to raise money for the country's numerous and very expensive wars. In 1840, the Monasterio de Piedro became the private estate of one Pablo Muntadas Campeny. The monastery now houses a wine museum and a chocolate factory, which has made it a very popular attraction for people who like to drink and eat while they contemplate the history of faith at the thousand year old frontier between the Christian and Muslim worlds.

At lunch I made a point of sitting down next to Sweden's Dr. Malin Falkenmark who is widely regarded as a pioneer of the modern eco-hydrological movement and one of the most respected scientists working in water in the world today. Dr. Falkenmark wasted no time on pleasantries. She went immediately to her point that contemporary discussions about sustainability were largely irrelevant because we do not as a society know what sustainability means. Neither wine nor the monastery's chocolate would sway her from this view, about which she scheduled to say much more during the formal proceedings of the Forum.

The area surrounding the Monasterio de Piedro is composed of stunningly beautiful forest made very pleasant by the presence of at least nine waterfalls which are compressed into an area no larger than a city block. Fed by springs higher on the mountain, these cascades were nearly in full spate offering not only tranquility but also respite from the heat.



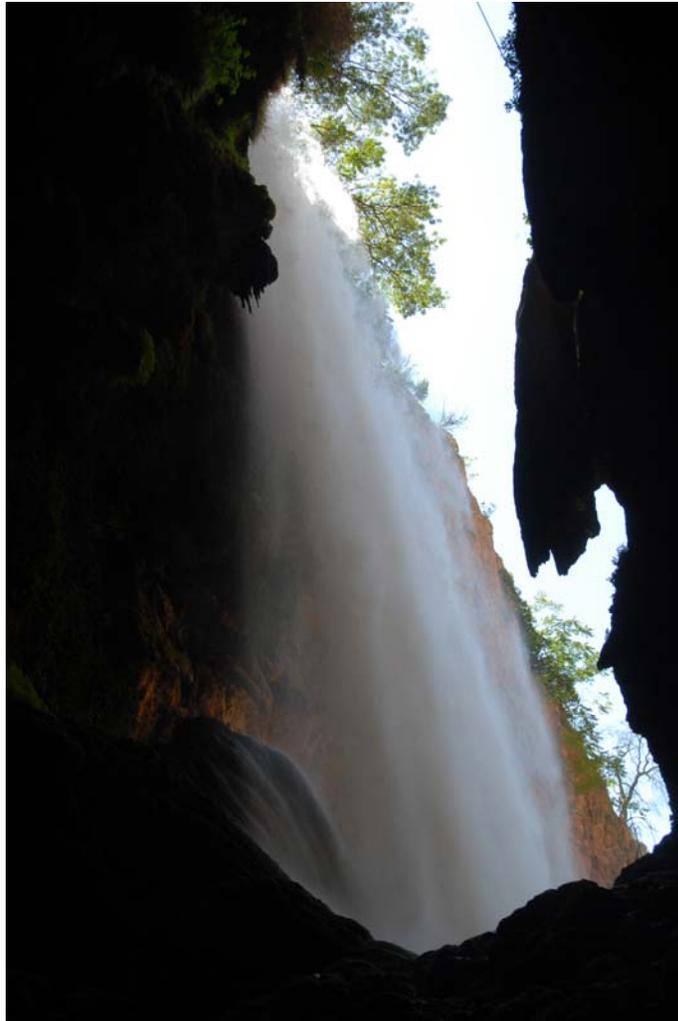
Baño de Diana

Walking down from the park gate, the first falls we encountered was the Baño de Diana, a small cascade that formed a pleasant pool below the heavily beaten trail. A low stone wall in front of the falls was irresistible place to stop. Forty generations of monks must have done the same thing. In the shadows above Baño de Diana was a larger fall, the Cascada la Caprichosa which fell like liquid silver down a spectacular cliff face that were it not for the exotic vegetation could have been the Upper Falls in Johnston Canyon in Banff National Park. Here in the centre of arid Spain we found ourselves in the midst of the glory of an upland watershed.



Cascada la Caprichosa

The highlight of the Monasterio de Pietro experience was the descent through a series of caves down many flights of steep steps that one behind a falls called the Mirador Cola de Caballo, to place where one could see the waterfall from inside the hollow it had created in the rockwall over which it fell. Here we were in mist and spray looking out through the cascading thunder at the valley far below. Photographs only capture a fragment of the experience of being under the Mirador Cola. Photographs show the water falling but give no sense of what it was like to be in the grotto with the air full of mist and the stone floor of the cave vibrating ever so slightly to the rising and falling thunder of the falls.



The Mirador Cola de Caballo.

I sat with Helen Ingram for the last leg of the trip from the Monasterio de Piedro to Zaragoza. Like Malin Falkenmark, Dr. Helen Ingram held little esteem for the substance-less manner in which the term “sustainability” had been appropriated by so many public and private interests today. She argued that it was difficult to tell if the word had any meaning in many contemporary contexts. “What does it mean,” she asked, “when a government department that is responsible for resource extraction such as forestry or oil

and gas decides to put ‘sustainable’ in front of its name?” Ingram’s question is not one that can be ignored in an age of public relations persuasion. Does putting the word “sustainable” in front of the name of a government department simply imply that the bureaucracy intends to sustain *itself* into the future regardless of what happens to the public lands for which it is responsible? What is meant to be sustained, the government department or the landscape it is charged with protecting? What does the public do when one has little or nothing to do with the other?”

We agreed that a question like this would have appeared academic when populations and our collective human footprint were smaller. The growth of human populations and expansion of our material desires were not always a zero sum game as they are now. At some point we crossed a line where suddenly almost everything we do as a society involves a trade-off against any hope of true sustainability. Allowing special or vested interests to appropriate and subvert the meaning of the term just makes the problem worse. When the words upon which we rely the most to measure our impacts and make sense of the world have been politicized to the point where they no longer have any substantive meaning, how can we progress? How can our dialogue even make sense? How can we make good decisions when the very words we use to frame such decisions keep changing and losing meaning? How can we govern ourselves when the language upon which we base our consent to be governed is being so continually manipulated toward self-interest? How will we know the truth when we see it? Or will it have to take our head off just to get our attention?

We arrived in Zaragoza and checked into the Meliá Zaragoza on Avenida César Augustus which despite a rather plain exterior and lobby turned out to be one of the nicest hotels in which I have stayed in all my many trips to Europe.

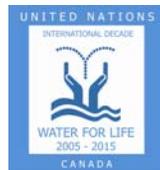
The opening reception for the Rosenberg Forum proper was held at the spectacular Edificio Pignatelli, the seat of the Government of the State of Aragon, a fifteen minute walk from our hotel. As it was a warm and pleasant evening, the reception was held outside in the Patio de Protocolo, the scene one would suspect of hundreds of official public ceremonies and military formalities since this palace was built god knows when. As we were the guests of the Government of Aragon, we should not have been surprised at either the elegance or the formality of the event. It was clear that the Rosenberg Forum was highly regarded which put participants who were new to the forum on notice that much of value was expected to emerge through the official forum dialogue that was to follow during the rest of the week.



Lessons From Rosenberg VI

Part Four

The Formal Proceedings of the Forum



Wednesday, June 25th, 2008

The opening session of the Sixth Biennial Rosenberg International Forum on Water Policy took place beginning at 09:00 sharp at the Palacio de la Antigua Capitanía General de Aragón, a military palace where the King and Queen of Spain hold court when they are on formal royal visits to Zaragoza. The tight security, the presence of Spanish soldiers in uniform and the stunning palatial setting added gravity to the opening and raised expectations that this was to be a forum at which much of importance might be learned. In his incomparably dignified way, Henry Vaux fueled even greater expectations with his eloquent opening remarks and highly considered introductions.



The Palacio de la Antigua Capitanía General de Aragón.

Before the keynote presentations, Dr. Vaux invited Fred Cannon of the United States to offer a brief history of the Rosenberg Forum which Fred did articulately with well-measured pride. Cannon explained Richard Rosenberg's enthusiasms for water issues which in themselves provided lessons for Canada and for Alberta. Mr. Rosenberg, Cannon explained, could see very clearly when he was the Chairman of the Board of the Bank of America that California was moving from an era of water development to an era of water management. In order to ensure an orderly transition from water resource development to more efficient use Rosenberg pressed for the creation of a business council in California that would focus on water issues that influenced the state economy. This, Cannon pointed out, was not an act of altruism but of realism.

Dick Rosenberg understood that California faced the same problems that semi-arid regions elsewhere in the world were experiencing. To be successful at addressing these problems California could only benefit from careful examination of what was happening elsewhere in the semi-arid world. It was this vision that led to the creation of the Rosenberg Forum.

Rosenberg identified three elements which he felt should inform the direction in which the forum that would bear his name would go:

1. Public-private partnerships were important to making the transition from water development to a new era of increasingly efficient management.
2. Fact-based scientific knowledge is crucial to the development of good public policy.
3. A global dialogue is necessary to bring solutions from elsewhere home.

Finally, one of the most important parameters of the Rosenberg Forum was that it had to have the capacity to turn good ideas intentions into action. To that end Cannon reported that while Dick Rosenberg was unable to attend this forum in Spain he was thrilled that his vision of on-going research and dialogue on the management of water in arid lands would continue to develop through the “Iranian Regional Rosenberg” to be held in California in August at which 15 Iranian water scholars will hold a dialogue with American counterparts. Iran’s Sayed-Farhad Mousavi, who was present at Rosenberg V in Banff and at this forum was identified as a principal in organizing the Iranian-U.S. forum.

The first of the two opening bookend keynote addresses was offered by John Brisco, who is the Director of World Bank operations in Brazil. Dr. Brisco spoke to the subject of defining sustainability in a future world.

Citing a lifetime of experience, Brisco began his presentation by pointing out quite reasonably that solving people’s problems at a practical rather than idealistic level was the key to legitimacy in development issues. He argued that the biggest challenge to development was on-the-ground implementation of practical policies. He put forward that leaders in developing countries were suspicious of partners in the developed world that proposed solutions that had not worked in their own countries. While skirting the issues of sustainability and the World Bank’s tradition of advancing the conservative agenda of smaller government, privatization, cuts to social programming and environmental monitoring and regulation, Dr. Brisco concluded by pointing out that good water management was, in itself, good politics.

The second keynote address was offered by Margaret Catley-Carlson who spoke on the engaging subject of “Managing Water in an Increasingly Unreal World.” As her title implies, what made her presentation effective was her ability to put into relief what was real about our water resource circumstances and what was unreal or unrealistic about our

responses to what has become a growing global water crisis. These lessons for Canada and for Alberta were very clear.

The Reality of our Current Circumstances

- Populations in many parts of the world are growing
- Material and lifestyle expectations are also growing
- Water use is growing
- Climate change impacts are accelerating
- River basins are being closed to increased water use
- About 1/3 of the world's population lives in basins that have to deal with water scarcity
- Agricultural productivity is becoming increasingly vulnerable to extreme weather events
- Global food demand is expected to double over the next fifty years
- Meanwhile fuel and fertilizer costs have doubled in the past year
- Add the impacts of biofuels on the demand for water and land and on the price of cereals for human and livestock consumption and you realize that:

Limits have been reached and breached.

The Un-Reality of our Current Circumstances

- Investments in agricultural research are falling
- There are few changes in the incentives that would lead to greater water productivity
- Subsidies remain high even in high-priced agricultural product markets
- There is a closed-door, closed-mind attitude toward drought
- We refuse to consider the potential value of drought-resistant GMOs.
- We let populations continue to expand without consideration for the future
- We continue to ignore the potential severity of climate change impacts
- Our political institutions remain focused on short-term interests and partial solutions

Do We Have Answers? Maybe

- We have hypothetical solutions on paper but we have not employed them
- Agricultural yield improvements were occurring more often than area expansion (at least until biofuel production began to increase)
- We know that without increased agricultural productivity we will have to double water needs
- We need more investment in agricultural efficiency
- We need to upgrade rain-fed agricultural capacity
- We need to integrate aqua- and agricultural productivity

Catley-Carlson concluded by pointing out that no new scientific innovation is required to address 90% of current global water issues. She noted in addition that policies outside the water sector – such as those related to diet choices, biofuel production and lifestyle decisions will also have huge impacts on water availability and use in the future.

Catley-Carlson, who is a Member of the UN Secretary General Advisory Board on Water and Chair of the Water Resources Advisory Committee for Suez of Paris, the former President of the Canadian International Development Agency and the former Ontario Minister of Health then offered a simple formula for understanding the relationship between water and our future:

ADAPTATION = WATER

Finally, Catley-Carlson responded directly to the question:
Will There Be Enough Water To Grow The Food We Need?

The rest of the world appears, she said, to be answering this question in this way:

Yes, if ...

Catley-Carlson's answer to the question was more circumspect and evocative:

No, unless we change.

**We focus too much on what should be done and not enough
on why it isn't done.**

Margaret Catley-Carlson

The ambient noise level in the Palacio de la Antigua Capitañia General de Aragón rose instantly the moment Dr. Vaux announced a break following the keynote addresses. The contents of the two keynote presentations were cause for considerable discussion during the half hour that followed. Margaret Catley-Carlson in particular had struck a collective nerve with her presentation. Many participants felt she had characterized an number of almost universal concerns about the urgency of acting upon what we already know about solutions to the world's water challenges.

After a break the forum turned to the papers prepared for presentation on the theme of Water for Food in a Changing World. The first to present was Malin Falkenmark who presented a paper on eco-hydrological perspectives and how they might be integrated into the Global Water Budget.

Malin Falkenmark

Integrating Agricultural Water Use With The Global Water Budget

Some Background

As Dr. Hong Yang would later acknowledge in her Rosenberg Forum presentation, Malin Falkenmark altered contemporary understanding of global water resources when she introduced the concept of “green” water in 1995. This fundamental eco-hydrological principle holds that “green” water performs a different role in nature than the “blue” water that flows in our streams and rivers. In Falkenmark’s view, green water was defined as the return flow of water to the atmosphere as evapotranspiration. Green water is composed of a productive element – transpiration through plants – and a hitherto unproductive component – direct evaporation – which she explained is lost from the soil surface, from lakes and ponds and by way of water intercepted by vegetation canopies. Later “green” water also came to be associated also with water stored in unsaturated soils. It is also recognized now that “green” water is in fact the water source of rainfed agriculture. This recognition has led to evolution of refined agricultural practices aimed at optimizing the use of “green” water in crop production and in the management of upland watersheds so as to optimize water capture, storage and release.

Malin Falkenmark and Johann Rockstöm are now acknowledged leaders in a new way of thinking about the water we use and need. They think not just about the “blue” water that flows in streams and rivers, but also about the “green” water that falls as precipitation, is absorbed into the soil and evaporated from the earth and evapo-transpired through plants as a second vital and almost untapped water resource.

Falkenmark and her colleagues believe that the management of these two water sources in tandem will allow further expansion of our global food production capacity while at the same time allowing more water to be reliably available for a variety of environmental requirements including in-stream aquatic ecosystem flow needs.

Falkenmark and other leaders in the eco-hydrology field do not need to press the urgency of this approach. Consumptive water use in agriculture globally is now estimated at 7000 cubic kilometres a year, and is expected to rise a further 3000 cubic kilometres a year to 10,000 cubic kilometres a year by 2050. At present no one is exactly sure where all this additional water is going to come from especially in areas that have already allocated all their blue water resources at a time when changes in management practices and land-use policies are only now beginning to embrace the notion of “green” water capture and use.

Though they recognize huge potential neither Falkenmark nor Rockstöm are under any illusions about eco-hydrological breakthroughs becoming a panacea for the world’s growing water crisis. Both acknowledge from the outset that even after combining blue

and green water utilization potential, a number of countries in North Africa, the Middle East, West Asia and South Asia will not be able to meet their food production needs on a self-sufficient basis. Falkenmark and Rockstöm offer a combination of five strategic choices for countries in which water shortages do not allow the production of enough food for the local population:

1. *Irrigation* where the supply of blue water permits;
2. *Horizontal* expansion of crop fields by “grabbing” green water from surrounding lands; this can include rainwater harvesting on neighbouring land for use as supplementary irrigation. Based on a realistic assumption of necessary increases in water productivity and irrigation expansion, this would require that a minimum of 900 cubic kilometres a year of consumptive water use in agriculture would be needed, which would have to be created through the expansion of agricultural area or through the virtual import of water in the form of food.
3. Cultivation of a *vapour shift* that decreases evaporation losses from open soil through increases in vegetation cover;
4. Direct reduction of water use through the reduction of dietary requirements and through increased agricultural, transportation and food distribution efficiencies
5. Benefiting from the abundance of combined blue and green water resources elsewhere by importing virtual water in the form of food

Falkenmark and Rockstöm concluded, however, with a much understated warning. No amount of improvement in efficiency can save you if competition for water for biofuel production and other non-food crops such as cotton reduce land and water availability for food production. If climate change is a wildcard then biofuel production will eat up all eco-hydrological water management gains and put global food production self-sufficiency out of reach. In other words, increased biofuel production could end the game.

Malin Falkenmark’s Paper

Water is a crucial component in food production both in terms of grains and meat. While we simply think of water being a requirement for life, the specific function of water in food production is actually a great deal more complicated than most people imagine. Water plays a central role in the process of photosynthesis, both as a raw material that is as important to the process as carbon dioxide and as a nutrient-carrying substance that rises in plants from the very roots to the leaf surfaces where it is evapo-transpired when leaf stomata open to take in carbon dioxide from the atmosphere.

It is often pointed out that agriculture is the largest human water consumption activity – an activity that accounts for 70% of all human water withdrawals. This calculation, however, only takes into account the percentage of “blue” or surface water flows in

streams and rivers. There is a different way of calculating actual agricultural water use. As farming also relies on rainfall, the amount of water actually available to agriculture is much greater than the volume taken from stream and rivers for irrigation.

If we consider “green” water as well as “blue” water, the consumptive demands of agriculture are actually three times greater than current surface and groundwater withdrawals. This increase, however, is more than compensated for by the dramatic increase of “green” water availability which is many times greater than what flows in streams and rivers. While global agricultural withdrawals of “blue” water are estimated to be around 7000 cubic kilometres of water per year, the total amount of “green” water in the form of precipitation is around 110,000 cubic kilometres a year. In this context agriculture really only uses 6% of the total amount of water that circulates each year as rain in the global water cycle. That does not mean, however, that water scarcity doesn’t exist. Arable agricultural land represents only a small fraction of the Earth’s surface and rain – as we all know – doesn’t always fall in areas of heavy agricultural concentration.

In the past there has been a very clear conceptual separation between rainfed and irrigated agriculture. Falkenmark and Rockstöm point out, however, that with serious constraints related to global food supply before us, separating dryland and irrigated agricultural practices is an outdated concept. If we want to feed a growing world population we will be forced by necessity to improve dryland agricultural practices through the employment of supplementary irrigation that will serve to mitigate drought. This means an increased focus on rainwater harvesting and conservation farming techniques that increase water filtration and mulching to increase the water holding capacity in dryland soils. Green water resources have suddenly been recognized as an additional source of moisture that can be added to water traditionally withdrawn from streams and rivers to make agriculture prosper where surface waters may not have been abundant enough to permit agricultural self-sufficiency.

Green water resources are deemed inadequate when the resource is below that which is required to meet per capita food requirement. Even when they are adequate they are never – at least in the Falkenmark-Rockstöm lexicon – perceived as being abundant. If green water resources are deemed adequate they are characterized as “freedom from shortage”. Blue water resources are deemed inadequate when there are more than a 1000 people relying on a flow unit of 1,000,000 cubic metres of blue water recharge per year. Once again in the Falkenmark-Rockstöm lexicon there is no term for abundance of blue water. If you have more than a million cubic metres of water available to each 1000 people in a given area this is characterized once again as freedom from shortage.

The shift in thinking that Falkenmark and Rockstöm are proposing relates to the careful management of blue water in combination with better capture and utilization of precipitation, facilitation of penetration of rainfall into soil, the prevention of soil evaporation and the careful and timed distribution of combined blue and green water to plants and the reduction of lost productivity through control of evaporation and plant transpiration.

Falkenmark and Rockstöm argue that the amount of water required for agriculture can be moderated by limiting water losses. In irrigated areas this can be accomplished by reducing evaporation from canals and reservoirs. In dryland or rainfed areas this can be accomplished by reducing evaporation from open soil surfaces.

Falkenmark and Rockstöm contend that evaporation from wet soils between plants often exceeds the amount of moisture loss through transpiration, resulting – in the tropics for example – in greatly reduced water productivity. By shifting non-productive evaporation to productive transpiration through crop and soil management, more food can be produced with the same amount of green water. This improvement in green water productivity is an important opportunity for large agricultural water savings at the field level, which at the same time allows more food to be produced without impacting downstream water users.

The fraction of rainfall that is used for productive transpiration is generally less than 30%. This amount, however, can be dramatically influenced by careful management. In Sub-Saharan Africa, for example, only 15% to 30% of rainfall is actually transpired through crops. In temperate regions, this amount has been increased to 45% to 55% of total rainfall.

In order to understand and calculate the planet's potential eco-hydrological agricultural productivity gains, Falkenmark and Rockstöm created a dynamic global vegetation and water balance model which they validated against biochemical and hydrological observations which included river discharges, soil moisture monitoring, leaf transpiration studies and analysis of crop yields. They based their model on a food-water requirement that assumed current water productivity and a global food supply need of 3000 kcal/p/day of which 20% would be supplied in the form of animal products. This translated into a planetary water requirement of 1300 cubic metres of water per person per year to generate the food supply deemed to be necessary to avoid under-nourishment which is the average developing countries are currently aspiring to achieve by 2030.

Other model constraints included projections of population increases and future economic development expectations established by the World Bank based on moderate climate change impacts as put forward in the Hadley CM2 scenario, moderate cuts to carbon dioxide emissions and a slow transition to lower human fertility rates expected to occur between now and 2050.

In examining the total potential of combining blue and green water in an agricultural context, Falkenmark and Rockstöm discovered that many African countries that are typically viewed as suffering serious economic water scarcity, and which often suffer from severe malnutrition as a result, turn out to have much more green water than they knew when evapo-transpiration was calculated into the way croplands and pastures were managed. Some of the countries with the most surprising potential to capitalize on green water resources were some of the driest countries on Earth. These include Namibia, Botswana, Chad, Zambia, Mozambique and Sudan which, according to Falkenmark and

Rockstöm, all have more than 7000 cubic metres per person per year of green water availability.

Falkenmark and Rockstöm also identified a substantial potential to increase agricultural yields in other countries through combined blue and green water management strategies that increased water productivity. These countries included Bangladesh, Pakistan and India. More modest improvements in water productivity were also seen as possible in China, Iran, Iraq, Israel and Jordan. This said, however, it was also pointed out that there are places in the world where water scarcity will continue to be a serious problem even when blue and green water availability are added together. Close to that threshold are parts of China, Mali and Ethiopia.

It is interesting to note that Falkenmark and Rockstöm tied reduction in water use directly to economic well-being. They point out that once a population in a developing country reaches a per capita income of \$10,000 a year, water requirement tend to stabilize around 5 cubic metres per person per day or about 1825 cubic metres per person per year. This, however, begins to change dramatically as more and more people want to include meat in their diet. Water consumption in societies that have a lot of meat in their diet usually have much higher water demands. These demands usually manifest themselves at 2000 cubic metres per person per year and higher.

Falkenmark and Rockstöm also observed that not everyone is relying on blue water for agriculture as we do so heavily in North America. In fact, in Europe, Africa and South America, agricultural crop production is dominated by green water use. Only in North America and parts of Southern Asia does agricultural production rely more heavily on blue rather than green water.

Falkenmark and Rockstöm go on to calculate that the estimated amount of current virtual trade in water is about 1140 cubic kilometres a year. Though they are circumspect about how much of this form of trade is likely to exist in the future, they acknowledge current projections that anticipate a significant increase in the population of the world by 2050. If, as the Falkenmark and Rockstöm model predicts, some 53% of the population of the world in 2050 is facing one form or another of water scarcity, then countries that need to make up for inadequate water supply by having to import water virtually as food will require a virtual global transfer of 7500 cubic kilometres of virtual transfer a year. Since present food trade is principally between the industrialized countries, this represents more than a doubling of food trade internationally between now and 2050, which is no minor proposition.

There are, however, a couple of hitches to all this and one is that is that you need a minimum base flow of blue water to even begin to capitalize on green water conservation strategies which some countries simply do not possess.

The second hitch relates to the role of biomass in meeting our global energy demand. Although modest at present, the contribution of biofuels to our global energy supply is expected to grow quickly. This means that competition for agricultural land and water by

2050 will not just be between other crops and other forms of human use that will emerge as populations grow, but also with bio-energy production and with non-food crops like cotton for which demands are expected to more than double by 2050.

In other words, all the agri-ecological advances that are likely to be made that we hope will improve water availability and quality widely in the world will be wiped out by population growth and greater agricultural and industrial water withdrawals that we are experiencing now. The only way we may be able to prevent this from happening is if we embrace the eco-hydrological principals put forward by Falkenmark and Rockstöm and their colleagues and hope we can restore our eco-hydrological systems to the optimal efficiency to which it was possible to aspire before our population growth, industrial development and agricultural practices began to create problems for us faster than we have the means, technology and wherewithal to solve them.

URIEL SAFRIEL

Balancing Water for People and Nature

The key point of Uriel Safriel's paper flowed directly from the main points made by Malin Falkenmark. Natural systems have survival value for people. In order to provide water as well as other benefits to people nature needs water, too. The point then is that nature itself should be regarded as a legitimate water customer in the context of all water management regimes.

Safriel, who is a Professor of Ecology at the Hebrew University in Jerusalem, began his presentation just as he did his paper by introducing and exploring the emerging view that the long age of self-willed as opposed to human defined nature has for the moment at least come to an end posing real challenges for our world view and to established traditions of terrestrial and aquatic ecosystem management. The shocking realization of the growing human impact on Earth systems, Safriel told us, began to emerge in the 1970s when a three-year program examining the contemporary structure and function of ecosystems was launched under the International Biological Program. The parameters of the program demanded that research sites be set up around the world in "natural" areas only. The problem was that no one could find any such places. Even prospective sites in remote places like Point Barrow, Alaska proved to be too impacted by human activities to qualify as completely natural sites. Since that time, population growth has exacerbated this trend to the point that it is no longer believed that absolutely natural places exist anywhere on this planet any longer. The very notion of the term "natural" is now under siege.

A generation after this discovery the consequences of human impacts on our natural planetary life-support system are beginning to undermine some of our most cherished institutions. The notion that protect areas, nature reserves and national parks actually

preserve nature *per se* is now outdated. Our land management traditions developed in service of the protection of such areas are now increasingly seen to constitute “unnatural” interventions. The whole idea of what “nature” really means is now up in the air.

From these alarming realizations there emerged the “Man and the Biosphere” notion which evolved around the Biosphere Reserve concept which celebrated a gradient of naturalness and an inverse gradient of human use centred around a core of wilderness such as a national park and radiating outward toward areas of intensifying human use. If true wilderness no longer exists then at least places little impacted by human activity could point to a vision of desirable human relationship with the natural processes that make life on Earth not only possible but meaningful.

As populations continued to grow, however, the Biosphere Reserve concept no longer accurately reflected constantly accelerating human influence on every aspect of natural system function. In this century our relationship to nature has been defined anew through the Millennium Ecosystem Assessment which puts forward that “nature”, or the environment is everywhere and that natural processes that are important to people happen not only in the few pristine environments that remain on Earth but everywhere on the globe, even in those places most heavily populated and impacted by human activity.

Nature is of survival value for people and much of its survival value is established through its provision of water.



In order to provide water and other critical benefits to people nature needs water, too.



It follows, hence, that nature should be considered a legitimate water customer.

Uriel Safriel

The importance of this new world view should not be under-estimated. What it suggests is that we have in effect reconciled the centuries-old debate of whether we are part of

nature or not, and if so, to what extent. What this new world view suggests is that we now regard ourselves as not only being part of nature but as being nature itself. One outcome of this new perspective on our relationship to the systems that created the circumstances out of which we evolved as a species is that the terms “nature” and “environment” are for most intents and purposes being replaced by the term “ecosystem”. The notion here is that ecosystems differ only to the extent of how much self-willed “nature” they still possess.

The great breakthrough here – which must be considered something of a revolution in human thought – is that millennium notions of “ecosystem” supersede earlier ideas of “nature” and make cultivated and urban ecosystems part of a global ecological whole. The new construct recognizes that actively managed ecosystems now constitute more than half of the ice-free Earth, and that 11% of these are cultivated. It also recognizes that it is not just pristine ecosystems that provide marketable goods and generate priceless services such as water purification, aquifer recharge, soil development and – until recently – relative climatic stability. It is also a given that when humans impair the provision of goods and services generated by either natural or passively managed ecosystems these must be replaced by artificial means. What we have discovered, however, is that artificial technology replacements for naturally or passively managed ecosystem function invariably turn out to be expensive and inferior to goods and services provided by “natural” ecosystem function.

In the last few years, according to Professor Safriel, the Millennium Assessment has refined these notions in a number of important ways. First, it defined “ecosystem services” as “benefits people obtain from ecosystems”, which does away with the distinction between “goods” and “services”. Goods were in this way incorporated into services which were classified into four major functional groups.

Supporting services are the combined benefits that healthy ecosystems contribute in service of provision of all other critical services nature makes possible on Earth such as the primary production that provides the material basis for all life on this planet; nutrient cycling that is essential to primary production; soil formation, stabilization and conservation; the filtration of water entering aquifers as well as the supporting biodiversity that is essential to the maintenance of the systems that make life on Earth possible.

Provisioning services are “goods” that are either produced by ecosystems such as food and freshwater, or those which though not produced by ecosystems, are supplied to us by them.

Regulatory services are benefits obtained by regulation of ecosystem processes. These include regulation of the volume and velocity of run-off through the architecture and combined influence of vegetative components. Regulatory benefits also include water purification regulated by the activities of freshwater ecosystems.

Cultural services are the non-material benefits obtained from ecosystems such as aesthetic and spiritual inspiration. While everything in our time is expected to be reducible to some dollar value, cultural services tend to be difficult to evaluate by way of this parameter.

In all of these classifications **biodiversity** matters enormously because it is the foundation of the provision of a broad range of ecosystem benefits that together define the structure of the living world which derives its integrity and adaptability from its own self-reinforcing complexity.

As Dr. Safriel pointed out, the issue of whether or not all species are instrumental in and essential for the provision of ecosystem services is not always easy to resolve. We cannot always predict how much the loss of a single species may compromise the extent to which ecosystems are able to provide benefits to humans or other species within a given ecosystem. In some ecosystems there are examples of exotic species replacing indigenous species and providing equivalent ecosystem services. On the short term at least, this may suggest that some species in some natural systems may be “redundant” with respect to overall ecosystem function. Safriel noted, however, that such a view is misleading. There are instances where there is no question that species losses do undoubtedly result in the diminishment of ecological services. This situation presents itself when the lost species:

- has no apparent role in service provision but other species that do have a role depend upon that lost species for their vitality
- is quantitatively dominant in that ecosystem
- differs strongly from others species in that ecosystem

The key point that Dr. Safriel made in this regard is that it has now become very clear that though individual species may not be tightly associated with ecosystem service provision, the services themselves may only be provided *when a large number of species very different from one another jointly function in providing this service.*

Rich biodiversity provides insurance against changes in ecosystem processes that may impair service provision. In other words, biodiversity imparts resistance and resilience against disturbances that disrupt ecosystem function and that world in less diverse situations reduce or diminish the benefits it can provide to itself and to humans.

Safriel then made a critical scientific claim. *Differences in species responses to disturbances and environmental extremes make it unlikely that over time scales of decades or centuries there is much ecological redundancy in the species composition of a functioning ecosystem.*

The problem in our time is that biodiversity is being irretrievably lost in many of our ecosystems before it's economic and survival value can be proved or evaluated. We are

tearing apart a system that was designed by nature to deal with decades to centuries-long variability. In so doing we are exposing ourselves to huge adaptive vulnerability.

We know that ecosystem service provision is directly linked to biodiversity, and that the relationship of species composition to ecosystem function is non-linear. We know that a biodiversity threshold has to be crossed in order to significantly impair the provision of ecosystem services. The problem is that we do not know where these thresholds are. We do not, for example, know when losses in the diversity of fish species in a lake will equate to marked observed changes in water quality. We know that the costs of ecological restoration rise steeply if ecosystems have to be forced back across thresholds of decline in order to restore them. Yet the locations of these thresholds and the extent to which these thresholds are defined by individual species remain largely unknown. Nor do we – in addition to these primary unknowns – understand how already-altered biodiversity will respond to further human-induced changes. All we have presently to protect ourselves from these threats is the notion of the “precautionary principle”, an inconsistently applied dictum that holds that where there is a threat of significant reduction or loss of biodiversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat.

The precautionary principle, as Safriel explains, recognizes that biodiversity may be irretrievably lost before we figure out how to prove its function or appropriately value its contribution to the ecological benefits to which it contributes. The precautionary principle argues it is prudent to accept that an extinction or ecosystem damage threshold may exist which, if crossed, can result in unacceptable degradation of ecosystem benefit provision. It suggests that if we were wise we would not make decisions on the real cost of extinctions or extirpations until we have a better understanding of the relationship between biodiversity and ecosystem delivery.

There is hardly anything new in these perspectives. High school students taking biology or ecology all know the general applications of this principle in ecosystem management decisions. What is different about Safriel’s approach in the Canadian context at least is that he is arguing that the precautionary principle should be applied also to biodiversity concerns related to the provision of one specific ecosystem benefit – the supply of fresh water.

Threats to biodiversity are threats to the provision of ecosystem services, including those that provide water, regulate its flows and quality and the balanced allocation of water to both people and nature

Uriel Safriel

According to Dr. Safriel, freshwater constitutes a good provided by ecosystems. By definition then freshwater supply falls under the category of ecosystem product. Safriel notes that most people normally associate the provision of freshwater exclusively with freshwater ecosystems such as lakes, rivers, streams, ponds and wetlands. In fact the ability of these ecosystems to provide water very much depends on terrestrial ecosystems which by their character and function largely define both the quantity and quality of the water that make a freshwater ecosystem what it is. Both aquatic and terrestrial ecosystems are involved in the supply of fresh water for both people and nature.

To understand how fresh water is made available to us by nature we have first to understand the functional continuum that marries terrestrial ecosystem dynamics to aquatic ecosystem health. For fresh water ecosystems to provide water, the water regulation service of terrestrial ecosystems must come into play. This terrestrial ecosystem service is provided by vegetative diversity.

On a global scale it is plant diversity that regulates the single largest exchange of water from the biosphere to the atmosphere. The flux of water from the soil through plants to the atmosphere occurs by way of the ecosystem function of evapotranspiration. Vegetation also counteracts its own evapotranspiration function through another ecosystem provision – the creation of shade that reduces soil surface evaporation.

Other factors also play a role in how vegetation defines water availability to aquatic ecosystems. The physical-chemical components of any given terrestrial ecosystem include soils and ground surfaces. These, in combination with the physical structure of root systems of all the diverse plant species combined and the architecture of canopies together regulate rainfall contact with ground surfaces to determine the fate of each raindrop. Rain either penetrates the soil directly to end up as soil moisture or groundwater or it contributes to run-off to become part of a stream or river or even a flood. When there is enough of it run-off pools create marshes, ponds or lakes but eventually surface water flows to the ocean where its freshwater qualities at least are lost both to terrestrial ecosystems and to people.

In direct association with the water cycle terrestrial ecosystems also play a huge role in determining the nature and character of the Earth's atmosphere. By virtue of their vegetative cover, terrestrial ecosystems contribute to the regulation of the global climate. Water, through the ecosystem functions of photosynthesis and respiration are involved in determining the gaseous composition of the atmosphere by determining how much oxygen and carbon dioxide there are in the atmosphere at any given time. Vegetative cover also influences how much solar radiation the Earth's surface reflects back into the atmosphere. Plants, through their collective role in transpiring water, can be seen as a green fuse that prevents our planet's climate from changing rapidly. Or put another way, water is the electricity that flows through this green fuse into the atmosphere and into the sunlight that makes our world possible.

The diverse regulatory functions performed by water are particularly important in arid lands which comprise 41% of Earth's terrestrial surface. In the dry lands of the world

primary environmental production is limited by how much water is available. The provision of the most fundamental ecosystem benefits – that of producing the primary organic basis for complex ecosystem development and optimal biodiversity – is reduced to the extent to which water is available to support life. When rivers cease to flow and groundwater stored in dry lands can no longer be extracted for purposes of irrigation, dry land peoples lose the provisioning services that would otherwise be provided by natural ecosystems.

Uriel Safriel has spent a lifetime thinking about what water provides in dry lands and how vegetative cover can be manipulated to enhance how much water can be made available not just for agriculture but for nature. Dr. Safriel has clearly demonstrated the extent to which cultivated terrestrial ecosystems can be made to differ from “natural” ecosystems or ecosystems that have been transformed into cultivated ecosystems by controlling vegetation cover with the aim of optimizing moisture availability. In Israel in 1993, scientists calculated that the potential water yield of that country’s natural Mediterranean scrubland – that is to say the volume of rain falling during a given year on a given surface minus the volume of water returned to the atmosphere from the same area in the same year – is about 1590 cubic kilometers a year. In little more than a decade scientists experimenting with diverse arrays of agricultural plant species were able to increase the potential water yield of this region by some 16% to 1846 cubic kilometers a year by transforming it into an optimally diverse cultivated ecosystem. This was accomplished by altering the water provision function of the “natural” Mediterranean scrubland ecosystem so as to reduce the amount of soil moisture that was evaporating.

The case Safriel makes here is an important one. While he argues that the Israeli example demonstrates that human ecosystem transformations undertaken with the aim of enhancing the water regulation function of a given ecosystem can result in increased soil water content being available for agriculture, the point Safriel makes is of much broader significance. It is possible to modify whole ecosystems – or to prevent changes in ecosystems – so as to optimize their water provision function in ways that will serve defined ends. There are, however, limits to that optimization. Safriel warns there can be trade-offs between resulting desired affects such as the loss of the soil conservation service as a consequence of placing emphasis on the water conservation service. Such trade-offs become more difficult and immediate, however, the moment biodiversity is compromised.

Safriel carefully outlined examples of unsustainable trade-offs that have occurred when biodiversity was not respected in the context of how ecosystems influence what water does and the benefits that accrue thereof.

In many arid and semi-arid regions of the world highly adapted cyanobacteria, unicellular terrestrial algae, lichens and mosses symbiotically create a hydrophobic soil crust that ensure that at least some of the run-off that occurs during infrequent rainfalls stays on the surface rather than being absorbed by the dry soil. During rainstorms this organic crust channels surface run-off to the root zones of patchily distributed perennial shrubs. This prevents water from being thinly distributed over the hot soil where it would be quickly

evaporated and allows the shrubs to survive long, hot, dry seasons. This water regulation service which is provided free courtesy of biodiversity also minimizes flash floods and their associated damages including on-site topsoil loss and off-site clogging of reservoirs with silt. The mere presence of such biodiversity also decreases sedimentation and turbidity – two major influences on the decline of water quality in freshwater ecosystems.

The water redistributing services of this ecosystem also allows shrub communities to become “islands of fertility” in which soils develop and growth of plant species is promoted adding to the desert’s primary productivity. It was these qualities that made the Mediterranean one of the world’s earliest rangeland. Overstocking of such rangeland – a practice common in grazing lands since the beginning of human agriculture – leads not only to overgrazing but to the breakdown of the hydrophobic organic crust which diminishes the biodiversity upon which this ecosystem depends for its life-giving qualities. This breakdown of biodiversity inevitably results in the cascading degradation of water regulation, soil conservation, primary productivity and forage provisioning services that has been observed not just in Mediterranean scrubland but in parts of the Canadian prairies.

This cascading degradation of the Mediterranean scrublands qualifies in many expert circles as one of the three great human-caused ecological disasters in human history. The lesson here is that overuses of the provisioning services of an ecosystem leads to degradation which often results in the decline of water quality and change in water availability. Such changes are known to lead to desertification. If there is a lesson for Canada in this is that exactly the same kinds of changes are happening now on the Great Plains of North America.

Uriel Safriel is of the opinion that over-development of agriculture or urban infrastructure actually results in measurably less water availability for both people and nature. Vegetation cover, according to Safriel, is instrumental in regulating the amounts of rainfall that will be stored in the soil column and in aquifers. When vegetation is denied the water it requires for its own maintenance and functioning, water availability for people is curtailed. This happens when infrastructure and land are developed for urban and agricultural uses that interfere with normal surface and subsurface rainwater penetration into the soil which, had such developments not been permitted, would be providing moisture to surrounding vegetation. This can also dramatically affect downstream flows.

Safriel’s logic makes sense. Agri-monocultures and urban monocultures do the same thing to water. Both reduce the amount that can be absorbed by soils and captured and made available to surrounding vegetation. Agri- and urban-monocultures dry out adjacent areas by reducing the sponge capacity of once diverse plant communities that surrounded them. They suck up all the water for their needs which leaves less for surrounding areas which affects both water quality and quantity. This drying out is further exacerbated by the draining of wetlands.

Wetlands can be defined as lands composed of physical, chemical and biological features that reflect recurrent or sustained inundation or saturation. Wetlands provide the service of water purification through absorption of compounds harmful to the functioning of the freshwater ecosystem itself. In so doing wetlands also remove substances that would be harmful to people who rely upon such ecosystems for water provision.



Courtesy of Dr. Helen Ingram, United States

The slow rate of water movement in wetlands promotes the deposition of suspended material and provides time for biological mineralization of organic compounds and biodegradation of toxic synthetic chemicals. The slow water movement supports submerged wetland vegetation which further slows water movement and adds organic material to the bottom of the wetland. This gradual filling in of the wetland contributes to its spatial expansion which further augments the wetland's water regulation function which occurs as a result of water storage during floods and its resultant affect on slow water release.

The water purification function of freshwater ecosystems is not, however, confined to what happens in wetlands. Rivers and streams also provide water purification services that can be substantial enough in ideal circumstances to augment or even make drinking water treatment less unnecessary. The biodiversity instrument nature employs in providing this ecosystem benefit is the combined influence terrestrial ecosystems and micro-organisms in the water. The great collective oxygen demand created by these micro-organisms in the processing of organic material contributed to the river system by through the addition of wastewater effluents is satisfied by the oxidizing properties of the stream current itself.

Under normal conditions, freshwater herbivores and their predators control the populations of these wastewater-treating species and in so doing regulate their biodiversity in such a way as to optimize overall capacity to treat the range of compounds that need to be degraded or recycled to perpetuate the water quality upon the entire system depends for its stability. In other words, a properly functioning river system functions within limits as its own sewage treatment plant, cleaning its own water as it flows. Only when the pollution load, either quantitatively or qualitatively exceeds the capacity of the biodiversity within it to provide this service does a river become a “polluted” ecosystem which requires rehabilitation to restore its services.

It could be said that rivers themselves were the original wastewater treatment plants and performed this function very successfully in support of their own health for millions of years. It could also be said that rivers have evolved their own immunological capacity which functions to perpetuate water quality at the level at which the greatest aquatic ecosystem biodiversity can be maintained. Only when we put too much of ourselves into them does the immunological capacity of our river systems fail to the extent that engineering interventions become necessary anywhere we need to generate clean water for ourselves.

All of this would seem academic to Canadians who believe that they enjoy a limitless abundance of clean water. Unfortunately, the very processes of global aquatic ecosystem decline that Uriel Safriel described in his paper and presentation are occurring widely in Canada especially on the Canadian prairies. Ducks Unlimited Canada has recently completed Phase I of a multiphase research project (under partnership with the University of Guelph and Tarleton State University, a member of the Texas A&M University) to determine the impacts of wetland loss and associated drainage activity in the Broughton’s Creek watershed located north of Brandon in southwestern Manitoba.⁹ The area was selected as a study watershed because the land use and wetland loss trends are representative of other agricultural watersheds across the Prairie Pothole Region of Canada. Results from the first phase determined that wetland loss since 1968 in the Broughton’s Creek watershed has resulted in:

- a 31 per cent increase in area draining downstream (an additional 19 square kilometres)
- an 18 per cent increase in peak flow within the creek following rainfall
- a 30 per cent increase in stream flow
- a 31 per cent increase in nitrogen and phosphorus load from the watershed
- a 41 per cent increase in sediment loading
- the release of approximately 34,000 tonnes of carbon, equivalent to 125,000 tonnes of CO₂– the annual emissions from almost 23,200 cars
- an estimated 28 per cent decrease in annual waterfowl production

⁹ To learn more about this research project or to download the fact sheet, visit the Ducks Unlimited website www.ducks.ca.

Lakes also provide the service of wastewater treatment though not as effectively as streams and rivers at least in terms of their ability to process organic loads. Lakes, however, are superior to rivers and streams in their capacity to process suspended solids. Lakes also regulate the flow of out-going rivers and serve an important water storage function. From this we can see that nature was already heavily invested in organic damming and water regulation systems long before engineering made them popular and then necessary.

The function of lakes in the provision of ecosystem services is being compromised world-wide. Unfortunately the same processes that are causing problems in lake ecosystems worldwide are especially in western Canada. A book published in Canada just after the Rosenberg Forum in Spain situates the Canadian problem in a global context.¹⁰

One would not expect a book on nutrient-overload of the world's lakes to contain important perspectives on the impacts of human activity on climate change on the Canadian West. That might be true if one of the authors wasn't David Schindler. Considered by many to be one of this country's most respected scientists, Dr. Schindler is renowned around the world for the outstanding work he has done in service to better understanding of our aquatic ecosystems. His groundbreaking work in the Experimental Lakes Area in Ontario in the 1960s and 1970s contributed significantly to the banning of phosphates in detergents which helped preserve aquatic ecosystems in thousands of lakes in Canada and around the world.

While chapters of this book are dedicated to the remarkable story of that research, this book is about the health of lakes in the northern hemisphere following that ban. The title of the book is important in the context of what Schindler wants the reader to know about what is happening to our lakes and how changes that are already taking place will be exacerbated by global warming. The title is also a tribute to John R. Valleryne who published the first edition of this book in 1974. Though he did not live to see this volume printed, the theme of his first edition persists throughout this landmark new work. As Schindler explains in his preface, Valleryne predicted 35 years ago that unless something was done to stop the cavalier way we are treating our lakes we would find ourselves in an Algal Bowl in the Canadian West that would be more destructive of our ecosystems and our economy than the Dust Bowl that preceded it.

Eutrophication is a word that scientists use to describe the overfertilization of lakes with nutrients and the changes that occur in them as a result. While many of the causes of eutrophication that were described in Valleryne's book have been mitigated in lakes in eastern North America and Europe, eutrophication has been largely ignored in Western North America where population growth and intensification of agriculture and industry have all been accelerating in the past decades. Schindler also points out that in addition to the eutrophication of freshwater bodies which is occurring widely in Western Canada, we

¹⁰ See *The Algal Bowl: Overfertilization of the World's Freshwaters and Estuaries* by David W. Schindler & John R. Valleryne, University of Alberta Press, 2008.

are also beginning to see eutrophication of estuaries and coastal waters around places like Vancouver and Victoria.

Schindler and Vallentyne both feared that the extent of eutrophication has the potential to disrupt ecosystems, displace human populations and cause economic hardship over an area that equals or exceeds that of the Dust Bowl.

While the bulk of the book is about what water does while it is contained within lakes and how ecosystems develop within that water, there are a number of references to climate change impacts on water resources that are of crucial importance to our understanding of how the future will differ from the past in the Canadian West. Schindler and Vallentyne point out that lakes are not passive or static in relation to the atmosphere as once thought. Lakes establish intimate relations their waters and the airsheds above them and actively correct carbon and nitrogen concentration changes so as to maintain optimal phosphorous-proportional planktonic growth. If you can limit phosphorous you can limit eutrophication, but only if the system is in productive balance with the atmosphere. Climate change has already begun to affect these processes.

Aquatic ecosystems also provide another important service and this is food production in the form of fisheries. It is interesting to observe that such fisheries do not always emerge spontaneously from pristine circumstances. While many freshwater ecosystems can still be considered wildlife habitat, many “natural” systems have been altered by the human introduction of exotic and invasive species. Many artificial ecosystems have also come into existence in the form of fishponds, wetlands constructed for wastewater treatment or stormwater storage, irrigation canals and open-air reservoirs. Such is the nature of water that its mere presence generates life. Even the smallest artificial water bodies quickly generate biodiversity, in the form aquatic micro-organisms, plants and invertebrates.

Safriel has not been reluctant to submit his valuation of the importance of ecosystem services to cross-examination by economists. Ecosystem services Safriel noted, have been defined as “flows of materials, energy and information from natural capital stocks” which combine with manufactured and human services to produce human capital. He notes that the authors of this definition had also attempted to value ecosystem services by estimating what people were “willing to pay” for them. Safriel points out that while this pioneering approach to economic valuation did attract a great deal of criticism, it also serves the purpose of drawing attention to the significant value of water-related ecosystems relative to others.

A recent study of the estimated value of 17 ecosystem services provided by 16 worldwide ecosystem types was estimated at an average of US\$ 33 trillion a year which is nearly twice the global gross national product which is currently estimated at \$18 trillion per year. It is interesting to note that the highest value ecosystem service provided by nature was nutrient cycling. The overall planetary value of nutrient cycling was estimated at about \$17 trillion a year, nearly half of the total value of all the services provided free to us by our planet’s functioning ecosystems.

From this it becomes evident that, while all services are essential, water-regulating functions are overall of greater value than other regulating services. While one might not agree with the value attached to these services or even with dollar accounting for what nature does in service of making life on this planet possible, an important point is put into relief by this kind of audit. Despite their small area globally, aquatic ecosystems are found to be of extraordinary nominal and relative value. In terms of actual value coastal estuaries were deemed the most productive of all freshwater ecosystems. More striking, perhaps, is the comparative value of global freshwater ecosystems to terrestrial ecosystems.

While all freshwater ecosystems together comprise on 2.4% of all non-marine ecosystems they provide 40% of the value of all of these ecosystems combined. The average annual value of services per hectare of a freshwater ecosystem in dryland areas is 16.8 times that of an average hectare of a non-aquatic system.

Uriel Safriel is under no illusions as to the short-comings of this kind of valuation but he also realizes that some significance resides in the establishment of comparative ecosystem analysis as a means of putting the importance of the health of various ecosystem types into relief. As Safriel points out these relative ecosystem valuations draw attention to the danger of ignoring or under-valuing the services of ecosystems just because they have not been recognized as having value in the marketplace. This valuation also draws attention to the disproportionate value of water-related ecosystems and the considerable value of the hydrological processes that generate them. These ecosystems matter and are likely to matter a great deal more in the future.

Because of growing habitat destruction and diminishment, the natural capital that provides the vitality of aquatic ecosystem services is projected to become scarcer in the future. As happens in all economies defined by free market ideology the value of the services provided free by natural aquatic ecosystems will continue to rise as these services are diminished in availability and will continue to do so until an irreversible threshold is crossed after which the value of these services could rise to infinity.

With this as background, Safriel then took on the very notion of what water resource development means in our time. While we often talk about how we are inspired by integrated watershed management principles or eco-hydrological ideals, what we practice, according to Safriel, is in essence simple water resource management. Water resource management in the contemporary context means intensification of water-related ecosystem services as they relate to the provision of water. This intensification is achieved through “development” which encompasses the management of both pristine and modified freshwater ecosystems. The term “development” in this context refers largely to such “improvements” as dams for increasing storage capacity, increasing water supply by enlarging diversions and the construction of water conveyance systems such as canals, pipelines and water distribution systems.

By way of these mechanisms, water provided as an ecosystem service in one place can be transported to another to create cultivated ecosystems through irrigation applications in

which the services of primary production and food provision can be intensified to meet our needs. As a direct result of this mechanism of “water resource development” the amount of irrigation agriculture has been able to grow worldwide from 140 million hectares in 1961 to 270 million hectares in 2000. These water resource development activities, however, often cause unintended changes in the quality of other ecosystem services, especially in areas where that water used to but no longer flows. Water resource development in this context results in trade-offs in the provision of ecosystem services that we are only now beginning to understand.

Safriel argues that when “water resource development” promotes not only agricultural but urban expansion in drylands, detrimental effects on biodiversity invariably result. Since biodiversity is instrumental to the provision of ecosystem services it is the damage to biodiversity that makes water resource development and its attendant rural and urban development non-sustainable.

The damage caused to biodiversity by the transformation of ecosystems into urban areas and agro-ecosystems begins the impacted areas and then radiates outward, resulting in degradation of broader ecosystem productivity in surrounding areas. This damage is often missed because of our focus on what interests us. Farmers, for example, do not usually concern themselves with the loss of ecosystem services that existed prior to the transformation of their land to agricultural purposes. Their focus is on one ecosystem service and one ecosystem service only – that of the biological productivity service the farmer harnesses in the interest of greater crop production. The farmer may not notice or be concerned that the transformation-induced damage to biodiversity permeates outward from transformed farmland to surrounding areas sometimes to great distances.

The fact remains, however, that the simplification of ecosystem function that occurs when a natural landscape is transformed into an agricultural region or into a city permeates outward from the transformed area to various distances and impinges on the remaining non-transformed “natural” ecosystems. The reason this happens is that the survival of any given species depends upon population size. The smaller a species population size the greater the chances of its local extinction. Since population size is directly related to the area of the ecosystem upon which it depends, and because agricultural and urban transformation reduces the non-transformed habitat area, such transformation invariably leads to population decline, which may be detrimental to the provision of the broader range of ecosystem services to which any given species directly or indirectly contributes.

Even more problematic is the fact that a species’ population can be reduced to a species-specific threshold and become easily extinct. When that happens the ecosystem services to which that species contributed will either be diminished or simply cease to be provided by the system. What happens on the micro-scale also happens on the macro-scale. As the reduced area of an ecosystem reaches an ecosystem-specific threshold, the number of its species declines whereupon overall ecosystem service degradation may occur. From this we see that population decline of individual species, local extinctions and the overall reduction in the number of species together translate into gradual deterioration of the

ecosystem service production capacity of untransformed landscapes adjacent to and surrounding areas transformed by agriculture and urban development.

An additional challenge to the persistence of biodiversity is the fragmentation of “natural” ecosystems associated with contemporary development. Even if ecosystem transformation reduces the overall habitat area by only a small fraction, if that development fragments the formerly contiguous non-transformed “natural” ecosystem then the population in each fragment is bound to be smaller and at further risk of decline and ultimate extinction.

The impact of transformed areas on “natural” ecosystems that surround them does not end with the mere reduction of biodiversity by virtue of spatial incursion. Both urban and agricultural landscape transformation can actually be poisonous to surrounding ecosystems. The increasing use of agricultural pesticides, especially when applied by air, results in dispersal into adjacent and distant non-transformed ecosystems. We have already seen how insecticides and herbicides are often concentrated at the highest levels of the biodiversity food chain, sometimes reaching lethal concentrations in top predators. But what is not being widely recognized is the fact that the widespread dissemination of these substances into agricultural ecosystems is dramatically reducing the capacity of non-transformed ecosystems to provide important services that have value far beyond crop production. The services most diminished by contemporary agricultural practices are those that function to provide water and to allow self-purification of the waters a given ecosystem can produce.

Pesticides, for example, are transported by run-off and can contaminate freshwater ecosystems and groundwater supplies. Fertilizers are also applied in large quantities in many agricultural circumstances and are now in some cases being added directly to irrigation water. Fertilizers inevitably get into surrounding freshwater ecosystems and also contaminate groundwater resulting in eutrophication. Agricultural drainage water can also contain high concentrations of harmful trace elements such as selenium. Though we tend to ignore these realities and focus only on the ecosystem service of crop production, the impacts of agricultural practices on the provision of water-related ecosystem services is obvious. Water drawn from rivers, lakes, and aquifers for irrigation use is returned to aquatic ecosystems in reduced volumes and in a contaminated state which reduces biodiversity resulting in the degradation of ecosystem services such as water supply and self-purification. These services must in turn be supplied or enhanced by artificial means usually at considerable public cost. We take for granted that this is and always has been necessary because we have either forgotten or never fully realized the extent to which “natural” ecosystems once provided all of these services free on our behalf. This suggests that, at the moment at least, we have accepted that we live in a diminished and self-contaminated world and always will.

Safriel concludes this part of his paper with the following point. The “water resource development” ideology that drove water management practices at the local level of the individual farmer are widely perceived to have been very successful. On a greater spatial scale, and over a longer period of time, however, the sustainability of current agricultural

practices is in serious doubt. This is particularly so where resulting reduced biodiversity has resulted in degraded ecosystem service provision away from the farm and the area transformed by agricultural activities. Unfortunately for Canada, as evidenced by the current state of Lake Winnipeg and thousands of other western lakes, large areas of prairies fit this description.

What Safriel is saying is that the short-sighted focus on the enhancement of just one ecosystem service – the provisioning service focused on crop production – is resulting in the loss or diminishment of the regulating and supporting services that were once provided by both transformed and surrounding non-transformed ecosystems. Safriel's point is that the sacrifice of important and valuable water supply, regulation, self-purification and biodiversity-enhancing ecosystem services to the single purpose of agricultural food production is not sustainable. It is not sustainable because our intensive agricultural practices are wiping out biodiversity far beyond the regions in which that agriculture is being practiced resulting in the gradual decline of the very ecosystem functions that together constitute the life-support and survival system of our planet for which we have no satisfactory artificial or technological substitutes. In order to address this serious problem we must transcend current “water resource development” ideology so as to align future urban development and agricultural practices with a greater understanding of the total range of services and benefits that both transformed and “natural” ecosystems provide and can be made to provide in service of the biodiversity upon which our society ultimately depends for its sustainability.

Safriel goes on to explain just how damaging our short-sighted focus on intensive agricultural production has been to the capacity of both transformed and untransformed ecosystems to provide critical benefits both to nature and to humanity. He cites how groundwater-based agriculture in dryland areas has resulted in the transformation of species-rich, vegetatively diverse systems into single-species seasonal vegetation complexes. Such practices can be self-limiting in terms of their effect on water supply. Since the recharge of groundwater in these areas depends upon the water regulation services of non-transformed ecosystems and their vegetation cover, the reduction in the area of this cover reduces overall recharge which in turn results in diminished irrigation water being available for cultivated ecosystems.

Safriel explains that the extent of this reduced recharge depends upon the geomorphologic properties of the transformed ecosystems, their geographical placement relative to regional aquifers and the properties of local vegetation biodiversity. Extent of recharge also depends on the agro-technological practices and kinds of crops being cultivated in the transformed ecosystems. Often large-scale transformations of “natural” ecosystems results in reduced structural and landscape diversity which impairs resilience to heavy rainfall events. The large-scale removal of perennial vegetation and its replacement with agricultural crops can result in regional changes in albedo, evaporation, cloud formation and rainfall distribution. But the impacts don't stop here. When landscape structural diversity around freshwater ecosystems is reduced, irreversible chemical, physical and biotic changes can occur which can seriously affect the prospects for continued water withdrawal for the purposes of irrigating cultivated ecosystems.

Safriel goes to great pains to tell us the same thing in as many ways as possible. Many of our big agri-monocultures are drying out the landscapes around them by constraining and then altering the chemical, physical and biological properties of the landscapes they occupy resulting in changes that radiate outward from cultivated areas to untransformed surrounding regions. When David Schindler tells us that the average annual flow of the South Saskatchewan River has been reduced by 40% to 60% in the past century, this is what he is talking about. We are drying out the West and if we don't stop it will turn to dust. The "water resource development" to which we have hitched our agricultural star is not working. It isn't working and it won't work because it reduces rather than promotes the ecosystem service of water provision through its direct and indirect assault on biodiversity. That contemporary water resource development strategies are non-sustainable becomes particularly obvious in the context of what we are doing to wetlands in Manitoba on the prairies as a whole.

Conventional wisdom in contemporary "water resource development" is that wetlands in agricultural areas should be drained so as to reduce evaporative loss and to expand the agricultural land base. We know that the draining of wetlands creates impacts that cascade to adjacent and remote ecosystems. Uriel Safriel offers an example of the kinds of cascading impacts that have occurred in the Jordan River Valley. Interestingly, these mirror impacts we have seen in Manitoba, Saskatchewan and parts of Alberta. Safriel's example centres around the Hula, a small valley at the head of the Jordan River Basin. In the 1950s a swamp that flowed into a small lake was completely drained and replaced by cropland, except for a small section upon which a nature reserve was constructed.

More than a mere ecosystem transformation, the Hula Valley represented a complete ecosystem reconstruction in which the service of primary productivity formerly delivered by freshwater species was to be provided instead by an intensification of terrestrial ecosystem function. Not surprisingly, however, the exposure of the wetland's peat bottom to air did not intensify the service of primary production so much as it stimulated the service of nutrient cycling. The rich organic matter that had previously been stored and prevented from decomposing by the anaerobic conditions of the swamp rapidly mineralized leading to the generation and accumulation of high concentrations of nitrates. Winter flooding led to the washout of the nitrates which were carried by the Jordan River to Lake Kinneret, also known as the Sea of Galilee. The added nitrate load threatened the initiation of processes that could have rapidly led to the eutrophication of the lake which, besides being one of the country's most important tourism attractions, happens to be the most important drinking water reservoir in Israel. That's the part that made the news.

The part that didn't was that the decomposition of the peat and the subsequent peat fires caused surface subsidence in the Hula Valley which led to winter flooding of sections of the drained wetland which made agricultural cultivation impossible thus undermining the purpose for draining the wetland in the first place. But even that wasn't the end of it. Even after further investments in "water resource management" put out the peat fires and countered the subsidence so that mono-cultural cropping could proceed on a large scale, ecosystem push-back continued. Just as everything looked like it was finally going to

work, the disturbed area was visited by a plague of voles of almost Biblical proportions. Safriel's description of what happened would be hilarious if the outcome wasn't so sad. His account:

Massive rodent control with toxic bait make the intoxicated voles easy prey for local and migratory raptors, causing secondary poisoning of the birds, some of which belonged to endangered species.

There was, however, something of a silver lining in all this. Eventually the area that had subsided most was transformed into a recreational lake and serves now as a waterfowl refuge. The promotion of the cultural services provided by the lake compensate in part at least for the fact that farmers were not able to earn the incomes to which they aspired by way of full cultivation of the wetland area.

Safriel also tells us in a postscript that the eutrophication of Lake Kinneret was ultimately avoided. The intensification of its water service provision function, however, continues to cause serious downstream impacts. So much water is taken out of the Sea of Galilee and out of the Jordan River system as a whole that flows into the Dead Sea have been greatly reduced. Water supply in Israel now has to be augmented by expensive desalination processes. Safriel argues that had water managers known the role and limitations of ecosystem services in water provision and regulation two generations ago the situation in Israel could have been very different today. The whole Jordan River Valley watershed could still be intact. The full diversity of its ecosystem services could still be functional. Water demands that could not be met by intact local ecosystems would now be satisfied with freshwater generated and recycled through wastewater treatment and through desalination. The biggest difference, however, would be that the valley today would be far more habitable. Ecosystems operating at the highest level of productivity would supplying more water than there is today. Wastewater treatment and even desalination would still be necessary perhaps but they would not be operating in the virtual desert that exists today. Instead they would be functioning within the geographical context of a thriving Mediterranean scrubland ecosystem that optimized its own water production in a far more efficient and sustainable way than occurs now. In other words, water treatment and recycling as well as desalination were a given within the context of human population pressure. If you were developing the Jordan River Valley today - instead of over the past three millennia – you could have arrived at water treatment and desalination without first destroying natural ecosystem water provisioning and regulation capacity. Starting over you could miss completely the step of destroying ecosystem function and qualities of place and let technology help you retain the integrity of landscape function. That would be a great deal better than putting nature and all of humanity on dialysis as we are doing today in the name of the “water resource management” were are practicing today all over Canada and particularly in Alberta.

Safriel goes on to detail exactly what was lost in the Hula Valley as a result of “water resource management” decisions that were made with respect to the drainage of wetland areas to allow for the expansion of agricultural production. The study clearly underscores

the extent to which freshwater ecosystems are exposed to risks of biodiversity loss resulting directly in service degradation.

Prior to drainage some 585 freshwater animal species – not counting unicellular or parasitic species – were recorded in the Hula Valley wetlands. Of these 19 were represented by peripheral populations, meaning that they occurred at the southern or northern limit of that species' global geographical distribution. Another 12 species were endemic and found nowhere else in the world except in the Hula Valley. Despite the efforts made to reconstruct part of the wetland as part of a nature reserve after the draining, 119 species or 20% of the ecosystem's biodiversity disappeared. Among these were 11 of the 19 species that were at the limit of their geographical distribution and 7 of the 12 endemic species that existed nowhere else. In other words seven species of living things disappeared from the world forever as a result of the draining of a single wetland. But this is just the start of what was lost.

There was also a massive species extirpation. Thirty-six species lost to the Hula have never again been recorded in Israel. Of the 36 bird species that were found in the wetlands prior to the drainage, ten have ceased to breed there and five were replaced by species that did not breed there prior to the drainage.

There were, however, gains as well as losses. An astonishing 212 new aquatic species have been recorded in the Hula since the drainage. While some of these may have existed in the region and escaped detection, clearly the majority of the aquatic species are new colonizers indicative of the changes in habitat extent and diversity and in the changed quality of the water resulting from the drainage. Safriel points out that it is not known whether or to what extent the more than 200 new species compensate in terms of their total ability to contribute to the provision of ecosystem services for the 120 species that were lost. What is known, however, is that before the Hula wetland was drained the region was a transition zone for species whose origin and centre of distribution was in Europe to the north, the Mediterranean basin to the west, Iran and Iraq to the east and Egypt and Africa to the south. As such interactions occurred nowhere else, the Hula wetlands like produced a unique array of ecosystem services. Safriel argues that the damage in such a rare climatic transition zone simply adds to the loss.

The draining of the wetlands in Israel is having a measurable effect on biodiversity which, in Safriel's estimation, will ultimately reduce the capacity of the country's diminishing ecosystems to generate water. In Israel 14% of terrestrial species are threatened with extinction while 35% of the country's aquatic species are at risk. This suggests that further reduction in the size or water quality in Israel's remaining aquatic ecosystems could result in a loss of more than a third of vertebrate and plant species which would be a huge blow to water provisioning and other ecosystem functions these systems provide to people which include carbon sequestration and climate change moderation.

The loss of the Hula wetlands did not just impact biodiversity and ecosystem function in Israel. The Hula was on the route of an important cross-desert bird migration where

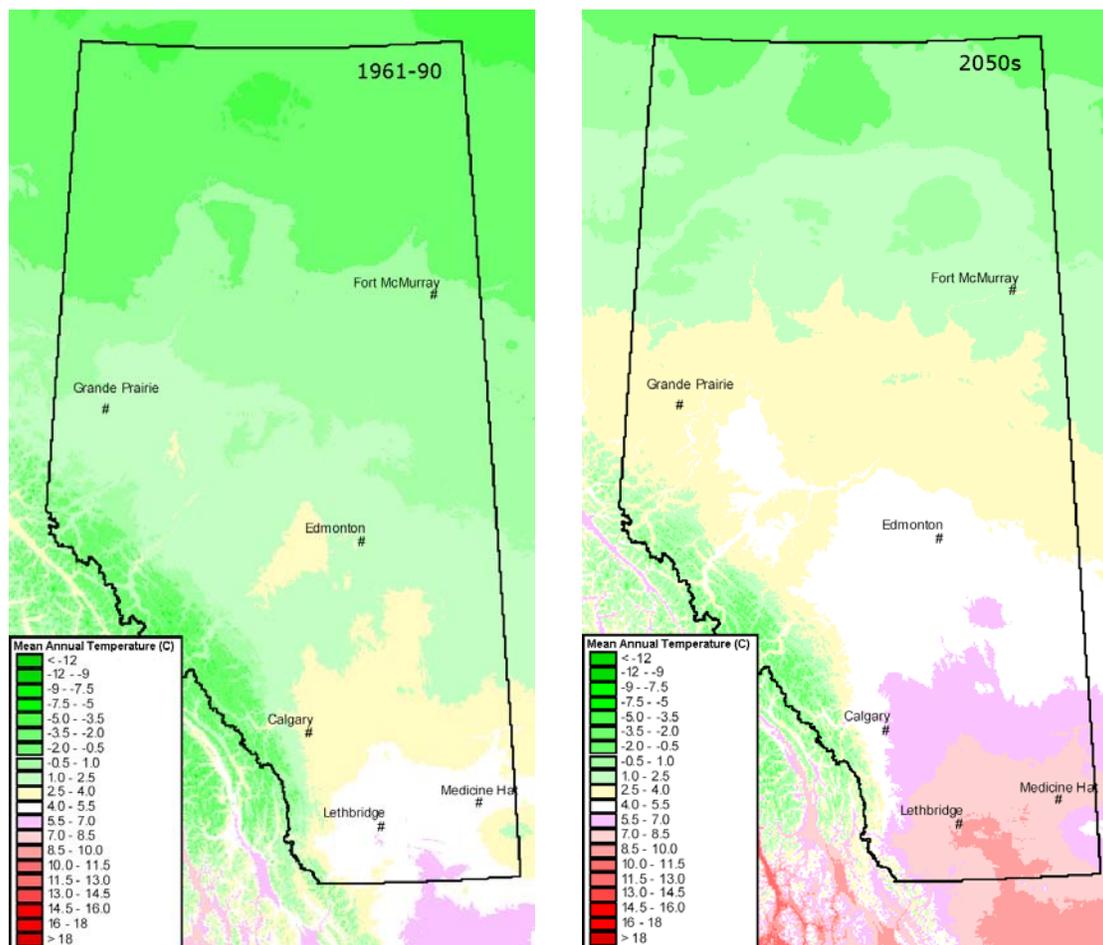
migrants rested and fed before and after making the difficult crossing of the Sahara. The drainage of the Hula likely had detrimental effects on the service provision capacity of both European and African ecosystems to which the avian migrants contribute in both summer and winter.

Among the most important lessons that can be derived from Uriel Safriel's work for Canada and Alberta relate to the role that aquatic ecosystem health plays in global climate change regulation. The UN Intergovernmental Panel on Climate Change has put forward that the best way to mitigate growing climate change impacts is to reduce emissions, promote processes that remove carbon dioxide from the atmosphere and store it in stable "sinks" and to create "reserves" in which organic matter is secured from being oxidized into atmospheric carbon dioxide. Until we began to generate more carbon dioxide than our expanded ecosystems can naturally absorb while simultaneously enhancing biodiversity, all the global ecosystems worked in combination to regulate the concentration of greenhouse gases in the atmosphere.

As the service of climate regulation is principally provided on behalf by vegetation and since the growth of vegetation is determined in much of the world by water availability, a reduction in the allocation of "nature" would exacerbate global warming. This suggests that the more water we take for ourselves at the expense of aquatic and terrestrial ecosystem health as defined by biodiversity the more we are contributing to global warming. Simplifying dryland ecosystems like the Canadian prairies has no less an effect than deforestation in more humid regions. The added effect of wetland drainage not only contributes to nutrient loading and pesticide and other contaminations of diminished prairies rivers it exacerbates climate change by creating a positive feedback to rising temperatures which will lead to desertification and even higher temperatures. All this because we have over-allocated water to such an extent we no longer have enough to give to "nature" so that it can provide the service of climate regulation on our behalf.

Among the impacts we can therefore expect from the clearing of additional land to increase agricultural productivity includes further diminishment of "natural" ecosystem services as a result of biodiversity loss, growing desertification and a self-reinforcing deterioration of global ecosystem function and production. Because we have already done so much damage to our landscapes, even balancing water supply for people and for "nature" will not suffice to break this vicious circle in the absence of population limits and a diminishment of global material desire. Recognizing the importance of supplying enough water to nature to permit it to continue offering water provision and climate regulation services on our behalf, however, may be a very wise start in the direction of true sustainability. On this Safriel offers some very valuable advice.

One option for mitigating the detrimental effects of climate change on biodiversity and hence on ecosystem service provision is to refrain from "water resource development" in ecologically important transition zones. The reason we should refrain from traditional forms of development in these zones is that these areas may provide the critical ecosystem service of mitigating detrimental impacts on ecosystems already affected by climate change.



Mean annual temperature (°C) in Alberta for the baseline period, 1961-90, and for the 2050s (1940-69) as derived from a median climate change scenario (HadCM3 B2(b)). (Source: Barrow and Yu, 2005) If Safrieli is telling us it is important to conserve biodiversity at the desert/non-desert climatic transition interface because water resource development there can end up causing desertification under which peripheral populations will surely not survive then it may be that by 2050 when the desert interface reaches the Fort McMurray area that we will, in combination with already existing impacts, set the stage for much of Alberta to become desert.

Climate transition zones are interesting in that they represent maximum climate variability of each of the over-lapping ecosystems represented within them, such that in some years the climate in the transition zone resembles that of one side of the transition and in other years another. This exposure to fluctuating climates results in high genetic variability within peripheral populations of species which means these populations are likely to persist in the climatic transition zone even under projected conditions associated with projected conditions of global climate change. While populations of the same species inhabiting the core distribution areas not possessing the same genetic diversity may go extinct the transition zone if left intact may survive and in so doing moderate climate change impacts while serving as a source of biodiversity contribution to surrounding ecosystems that are at risk. Thus, Safrieli concludes, ecosystems of climatic

transition zones provide the service of supporting biodiversity that can contribute to the rehabilitation of other ecosystems, whose services will be impaired by projected climate change impacts. Now here is the really important part:

The genetic biodiversity supported by ecosystems in climatic transition zones may be lost if population pressures in these zones bring about water resource development that encourages the transformation of “natural” ecosystems into cultivated or urban areas which do not provide appropriate services required to support these genetic resources. What Safriel is telling us is that it is important to conserve biodiversity at the desert/non-desert climatic transition interface since water resource development there can end up causing desertification under which peripheral populations will surely not survive. Applied to the Canadian prairies this would translate into pumping resources into ensuring the integrity and stability of those terrestrial and aquatic ecosystems at the interface of upward advances of projected temperature increases that may if unchecked cause increased aridity in future climate change scenarios. The locations of these interfaces have already been identified in climate models as identified below which suggests that large areas of central Alberta are at risk.

Safriel then asks what may well be the question of the century. The issue at stake, Safriel declares, is not how much water we need to allocate for “nature” at the expense of people so that “nature” is somehow sustainably maintained. The really important question is how much water can be allocated for driving current trends of global population and economic growth without reducing and degrading ecosystem services to the point that they can no longer support either people or nature.

Ecosystems, irrespective of their degree of naturalness, require water in order to maintain the biodiversity essential to the provision of the services they must supply to themselves in order to survive. Humanity is present utilizing a great deal of the water that is required to keep the water provision and regulation functions of these other ecosystems operating. Even though these ecosystems are presently still able to serve people at the expense of their own functions they cannot continue to do so if population and economic growth continue unabated. If we keep taking more and more water for human purposes we will witness biodiversity collapses that could degrade ecosystem function to such an extent that we could lose the services nature presently provides that make life not only possible but meaningful. By starving nature of water we could lose most of the benefits of natural water supply and self-purification. We could lose the functions of water flow and climate regulation upon which our increasingly urban and infrastructure-reliant culture depends for its stability.

Insomuch as water is critical to the ecosystem health that is the foundation of our planetary life-support system, the biodiversity responsible for the creation and function of that life-support capacity needs space and relief from pollution as much as it needs water to function productively. To get back on a sustainable track we need to understand exactly how much water and space ecosystems need to have to generate the conditions upon which our survival depends.

A prevailing notion is that all effluents need to be removed from freshwater ecosystems. But the grim prospects of severe water shortages suggests that many rivers will dry up if the discharge of high quality effluents back to them is not practiced. The notion of using wastewater to support biodiversity is based also on the belief that many ecosystems can “serve themselves” by processing wastewater to a level that supports their needs.

Uriel Safriel

Unfortunately, we don't know how much water the global landscape needs to maintain effective function. We do, however, have a good idea at least in some parts of the world of how much water we are taking compared to how much we are allowing nature to have. Safriel tells us that only 0.2% to 2.0% of the total mean annual renewable water supply in Israel is allocated to protected ecosystems. This means that between 98% and 99.8% of all the water resources in the county of Israel are committed in one way or another to human activities and interests. To say that enough water does not exist to sustain freshwater and riparian ecosystem productivity under these conditions is an understatement.

While few countries in the world are as water-scarce as Israel, Safriel makes an important point. We have no choice but to ensure that aquatic ecosystems serve themselves first so that they can serve us later. Our current legal allocations for aquatic ecosystems are largely arbitrary or based on persistent self-interest that prevents agreement on scientific definitions of adequate in-stream flow needs of aquatic ecosystems. As a consequence people in many parts of the world are diminishing the very ecosystem functions upon which their prosperity and future will ultimately depend. Moreover we are depriving aquatic ecosystems of the water they need for proper function while at the same time raising the temperature at what increasingly thirsty ecosystems have to function in service of their own and human needs.

Safriel believes we need new development criteria based not simply on water availability but on impacts on the ecosystems that provide that water, on the biodiversity of those ecosystems and on the services that could be diminished due to the compromise of the delivery of all water-related services. The first step in this process is to compare the economic development benefit of a particular project to the value of the benefits provided by the ecosystem that it would transform. Unfortunately, the required knowledge for making such comparisons is presently insufficient. As the demand for such evaluations is growing faster than the pace of research existing knowledge will have to be employed until the research catches up. This does not prevent Safriel from making a number of

recommendations regarding new development evaluation criteria that respects ecosystem service provision as it relates to water.

Valuation of Terrestrial Ecosystems in Planning Processes

According to Uriel Safriel, new forms of ecosystem service evaluation need to explore at least the following:

- (a) the state and trends of the ecosystem services provided by the ecosystem;
- (b) the state and trends of the ecosystem's biodiversity, and the role of its components in the provision of the different services;
- (c) the susceptibility of the ecosystem to damage and its resistance to anthropogenic disturbances as measured by potential loss of ecosystem service along with its potential for rehabilitation following disturbance.

Each of these criteria can be quantified by applying current knowledge, paradigms, or prevailing notions, as follows.

Measuring Ecosystem Health, The State of Ecosystem Biodiversity & The Quality of the Services An Ecosystem Provides

Regarding regulation services, it is customarily assumed that the larger the number of vegetation layers, the greater is the infiltration potential and the smaller the risk of soil erosion and intense surface runoff. It is also assumed that the larger the number of species, the greater the number of vegetation layers. Conservationists, however, are always presented with choices to be made with respect to conservation of individual species, and thus try to rank value of a given ecosystems by the prevalence of high ranking species within them.

According to Safriel, the comparative economic value of different ecosystems can be ranked – at least in the ecosystems in which we was working in the Middle East - according to the species involved in provisioning services in the following order:

1. progenitors of cultivated species;
2. wild relatives of cultivated species;
3. non-cultivated species currently collected for nutritional, medicinal, ornamental, aromatic, biofuels, and industrial purposes;
4. forage or fishery species;
5. species represented by peripheral populations, hence with high genetic diversity;

6. species identified by IUCN criteria under categories of vulnerable and rare (including species whose economic significance has not yet been explored, but whose extinction would prevent the elucidation of value, if it exists);
7. species instrumental in the provision of cultural services (which often translate to economic benefits);
8. species of scientific interest (which also have economic value, including value generated through scientific discoveries); and
9. species that provide or manipulate habitats for other species.

An ecosystem can be scored by the number of its species in each of the above categories, multiplied by the rank of the category.

Because freshwater ecosystems also affect biodiversity of adjacent terrestrial ecosystems by provisioning water for terrestrial vegetation, and water and food for terrestrial animals, terrestrial ecosystems in proximity to freshwater ecosystems should be ranked higher than other terrestrial ecosystems.

The evaluation of freshwater ecosystems needs to take into account that they are relatively scarce and small in size compared to terrestrial ecosystems especially in dryland areas. Because of this their biodiversity is inherently at risk. It is important, therefore, in comparing the value of freshwater and terrestrial ecosystems that the scores for each of the nine criteria noted above should be higher in freshwater ecosystems than in terrestrial counterparts.

Measuring Ecosystem Susceptibility to Damage and Resistance to Anthropogenic Disturbances

Another criterion for ecosystem ranking in the planning process is their comparative disposition to rehabilitation of their biodiversity and ecosystem services following disturbance and ecosystem transformation. Ecosystem restoration and recovery following disturbance is generally faster when the altered ecosystem is close to sources of immigrants.

These sources are other areas with protected biodiversity, so their significance increases as they are closer to the disturbed or transformed area which underscores once again the value of protected natural areas particularly in regions of high disturbance and low water availability.

The extent to which a disturbed area can be penetrated by species dispersed from areas of protected or healthy biodiversity is often inversely proportional to the distance between the disturbed area and the sources of natural restoration and recovery. In this it is important to know that a surrounding agricultural area is far more penetrable to species dispersed from a natural area than surrounding urban area.

Safriel notes that for ranking freshwater ecosystems with regard to rehabilitation potential their distance from polluting sources and the existence of corridors such as streams that connect isolated freshwater ecosystems are important. The presence of these qualities should score them higher than terrestrial ecosystems with respect to their value and conservation needs.

Safriel also offers that the most valuable ecosystem for a reliable provision of ecosystem services is almost invariably the one with highest biodiversity. It is the one with the largest component of species with potential economic significance and of known contribution to the provision of diverse ecosystem services. This means that the most valuable ecosystems are likely the ones with the largest contiguous size and that are connected by corridors to other similar ecosystems.

Using the above rather generic guidelines, it is feasible to evaluate ecosystems with regard to their performance as water-related service providers. The creation of such an evaluation mechanism would, in Uriel Safriel's estimation, be the first stage in trying to strike a balance between the level of human well-being to which we can afford to aspire, and the ability of ecosystems and their biodiversity to provide for that well-being over time.

Safriel's Recommendations

In his paper and his Rosenberg Forum presentation, Uriel Safriel equated "nature" with its role in maintaining a sustained flow of ecosystem services. These included water-related services which are of great importance to the functioning of the ecosystems themselves as well as to human well-being. Safriel believes that the value of these services increases with climatic aridity, on both spatial and temporal scales.

Thus, balancing water for nature and people simply means maintaining "nature" as defined above. There is, however, a gradation of "naturalness" of ecosystems. Absolutely natural ecosystems are nearly non-existent, yet all the rest, even those most aggressively transformed by humanity, do provide ecosystem services. The problem is to recognize, identify, measure and evaluate the quality and quantity of services required by people against the potential of the different ecosystems to provide them, including their involvement in water-related services – the main driver of human development especially in drylands. Unfortunately, much of the knowledge required for these undertakings is not yet available.

The following sections highlight the scientific knowledge needed to be developed for better understanding the relationships among ecosystem services, ecosystem structure and function, and biodiversity, and also the information required for assessing the balances and tradeoffs in development that inevitably results in ecosystem transformation.

Research recommendations

1. Identify and quantify the services provided by each ecosystem type. Identify the optimal and minimal water (quantity and quality, in time and space) and land (size and spatial pattern) required by each of these ecosystems for securing the sustainability the provision of their services, in different mixes that can be determined by development needs and trends.
2. Determine which of the ecosystem types within the landscape proposed for development play landscape-relevant keystone roles, and explore means to maintain ecosystem processes, and hence biodiversity at the landscape and regional scale, in balance with designed development projects.
3. Identify species that are endangered or at risk of becoming endangered, assess the contribution of each to water-related as well as other ecosystem services, identify the causes for the endangerment of these species, and explore means to reduce the risks.
4. Compare local water losses from evapotranspiration in different ecosystems under the different management and uses, to water gains accrued directly and indirectly from the provision of other services of each of these ecosystems.
5. Assess biodiversity components of current and potential economic significance, especially in freshwater ecosystems and climatic transition zones inhabited by peripheral populations, and determine the water allocation (including ground water resources and local runoff), as well as the extent of land and its spatial configuration, required for their conservation.
6. Conduct long-term studies to evaluate the effects of damming storm water on biodiversity at the lower reaches of watersheds, especially in dryland regions, and use the results to prescribe water quantities that must be released to reduce damages to downstream biodiversity component, and thus secure their involvement in identified service provision.
7. Evaluate the amount of water lost through appropriation of different ecosystem types by agriculture and urban development, for generating guidelines to be followed in land use allocation in areas planned for future development.
8. Study the rate of change of population sizes and number of species of species due to fragmentation, transformation and reductions in size of “natural” ecosystems, and use the results to provide guidelines for placement, size and spatial configuration of projected land uses and transformation under different development scenarios.
9. Evaluate the amounts of water allocated to protected areas and for supporting biodiversity in other areas, and the fraction of this water that recharges

groundwater and hence can be reused, and assess the rate of service provision by protected areas to non-protected ones expected under various circumstances.

10. Study the role of freshwater ecosystems in treating wastewater of various qualities, the degree to which freshwater allocated to natural ecosystems can be replaced by treated wastewater and the technologies appropriate for this substitution.
11. Conduct the research required to define improved criteria for evaluating the significance of biodiversity in providing ecosystem services, including the degree of redundancy to be expected under various circumstances.

Management Recommendations

Safriel's management recommendations are particularly enlightening in a North American context.

1. Planners need to internalize that allocating water to freshwater ecosystems is not a concession to the "greens" or done just for aesthetic and recreational objectives, but it is a pre-requisite for making the planned development sustainable, when different spatial and temporal scales are pre-defined for addressing the aspired sustainability.
2. In planning a development project or in reviewing it, include all "externalities" in the project's costs and especially the expected reduction in service provision rate, at several spatial and temporal scales. These reduced rates need to be translated to projected costs to other, existing and projected development and to the value of the reduced opportunity.
3. Water allocations to ecosystems should be based on pre-determined goals in the state and trends of services of these ecosystems. Benchmarks and indicators for the provision of these services and monitoring programs for each of the water-allocated ecosystems should be developed to review and update the allocations.
4. When ecosystems of special significance, such as those in climatic transition areas or those supporting progenitors and relatives of cultivated crops are targeted for water-driven development, it would be prudent to consider setting aside within them protected areas sufficiently large to serve as repositories of genetic resources.
5. The costs and benefits of avoiding, reducing, or mitigating the effects of ecosystem fragmentation by a projected development projects needs to be evaluated against different degrees of the aspired sustainability of the project and of the resulting human well-being.

6. Projections of the local and regional effects of global climate change on water-related and other ecosystem services need to be consulted and considered in the planning, execution, operation and monitoring of current land uses and projected development projects.

Preliminary Lessons For Canada and For Alberta

If Uriel Safriel's description of highly valued ecosystem service provision qualities aligning themselves around relatively natural areas of large contiguous size with corridor connections to other similarly diverse and productive ecosystems sounds familiar to people living in western Canada it should not be a surprise. These are precisely the qualities possessed by contiguous national and provincial parks and adjacent protected areas and well managed ranchlands in the upland foothill and mountain watersheds of Alberta. The water provisioning, purification and regulation services provided by these protected and carefully managed upland areas also benefit the downstream provinces of Saskatchewan and Manitoba. Neighbouring British Columbia and the Northwest Territories also enjoy the upstream benefits of protected upland watersheds in the Rockies.

It is time to leave the adversarial traditions that have characterized the environmentalism of the last fifty years behind. We have to return to the original argument for protecting water sources in the Canadian west, which was to protect water quality, maintain the self-purification capacity of natural freshwater ecosystems and to regulate downstream water supply. We know now that healthy freshwater ecosystems not only provide such services at a cost and at a level that we cannot afford to provide ourselves but also ensure continued natural capacity to stabilize and moderate climate at a time when changes wrought by population and economic growth and climate change threaten to disrupt the provision of fundamental ecosystem services upon which our well-being and continued prosperity ultimately depend.

The suggestion that emerges from such consideration is that in order to optimize the natural ecosystem capacity that is the foundation of our way of life we may wish to emulate the high level of biodiversity-based service provision that relatively intact ecosystems in the upland watersheds of the Rockies contribute to water quality and regulation as well as to regional climate stability. We may wish to do this by protecting or restoring similar ecosystem biodiversity in other important biogeographical regions in the Canadian West. The first place in which we should be careful to ensure that we spare enough water for nature so that nature can continue to supply enough water for our needs is in the area in which we already have the most protection: that crucial climate transition interface zone that exists between the mountains and foothills and the Great Plains. As populations in this region are growing rapidly and much of the water available at this interface has already been allocated for human use, freeing of water for nature will not be easy now or in the future.

We will only have enough water for nature and for people in this area if concerted water conservation activities come into existence in our southern cities and in the large

agricultural regions that surround them. In addition, if we want to assure the continued function of the water provisioning and purification capacity of remaining upland watersheds it may be wise to curtail further development in our headwater regions now and in the future.

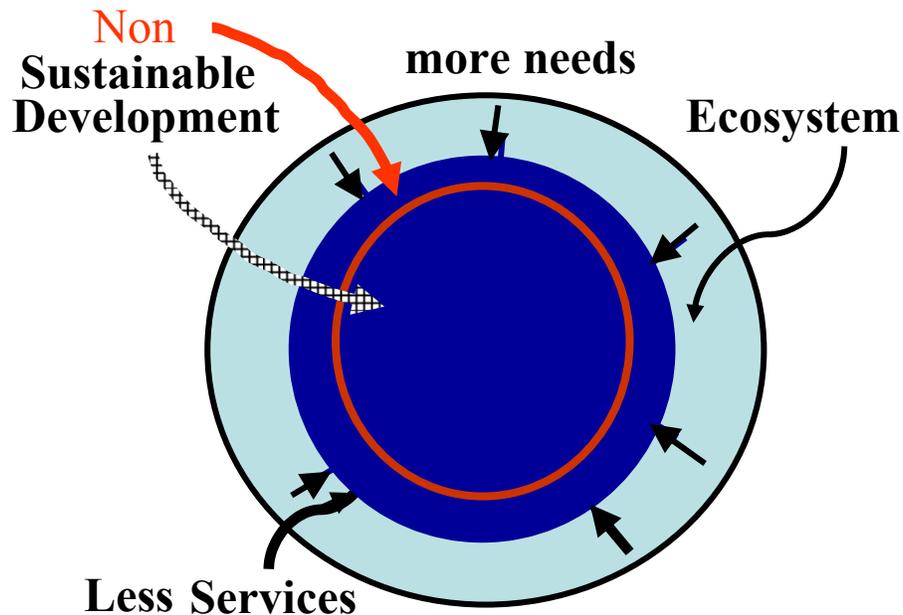
The next places in which we may want to be especially careful to provide enough water for nature as well as for people and to manage for the greatest biodiversity-based ecosystem service provision are in those areas presently at the margin of the driest parts of the prairies where desertification is already occurring and is projected to accelerate under all climate change scenarios. Stabilizing these areas will slow or even prevent further desertification as soil moisture continues to decrease in the face of higher mean temperatures and seasonal changes in precipitation timing and extent.

Another place we may wish to be especially careful to ensure that there is enough water to stimulate the optimal range of ecosystem service provision is in the climate transition zone that exists at the expanded interface between the parkland and northern boreal forest ecozones. Large areas of this region are already being heavily impacted by extensive forestry and oil sands mining activities. The nearby presence of an immediate source of the wide-ranging natural biodiversity will be crucial to the restoration of these damaged areas following exploitation. We know also that this interface is likely to be subject to dramatic climate change impacts that will be made worse if we fail to allow natural ecosystem diversity and function to moderate the affects of rising temperatures. This is also an region in which the cultural benefits provided by freshwater and related ecosystems are highly valued, especially by Aboriginal peoples, and where the on-going high quality provision of biodiversity-based ecosystem services is considered a fundamental right.

Broader Considerations Evoked
By
The Uriel Safriel Rosenberg Presentation

For all our talk about sustainability we are on the wrong track with respect to achieving it. Contemporary “water resource management” strategies won’t get us there because they expand human needs outward at the expense of surrounding biodiversity-based ecosystem services that are the foundation of any hope of sustainability. Instead of ensuring that those services continue to be offered free on our behalf by “nature” we destroy natural ecosystem capacity and replace it with inferior and far more costly engineering solutions that provide only a fraction of the diverse range of services nature used to provide. The resulting cascading diminishment in the range and quality of ecosystem delivery erodes the planetary capacity to support expanding populations threatening both the integrity of our natural systems and the sustainability of every living thing that depends upon them for their well-being. Uriel Safriel is telling us that we have to stop compromising and degrading the self-creating, self-regulating, self-purifying and self-perpetuating biodiversity-based system that supplies our life needs or face irreversible decline of our societal well-being. We have to give nature enough water to allow it to function in service of our ultimate interests.

The Link Between Biodiversity, Ecosystem Vitality and Human Sustainability



One of the most evocative and memorable images Uriel Safriel showed in his Rosenberg VI presentation was one he used to illustrate how developments become non-sustainable over time.

This image started with a small dark blue dot in the centre of a lighter blue circle. The dot represented the development and the blue field the ecosystems that provided services to that development whether it be a city or an agricultural region. While the dot remained small, the surrounding bio-diversity rich ecosystems were able to provide all the services the development needed for vitality including water provision, self-purification and regulation, nutrient transportation and climate moderation.

As the dot grew, however, it diminished the area surrounding reducing the amount of ecosystem service provision it could supply. As the needs of the development grew the surrounding regions was able to provide fewer and fewer service until the system crossed a critical threshold from being sustainable in the context of the ecosystem services surrounding landscapes were able to provide it to being non-sustainable to the extent that it had begun eating away at the very services upon which the development's well-being depended.

The biggest problem we face today, suggested Safriel, is that we do not really know where that threshold is on a region or on a global scale.

We have to stop taking water for ourselves without thinking about how much water nature needs in order to continue delivering services crucial to the maintenance and function of basic natural processes upon which our survival depends. Instead of looking after our interests first we have to strike a balance between the level of well-being to which we aspire and the ability of biodiversity-based ecosystems to provide what we desire. Until we do that we have no hope of achieving sustainability.

Personally, I will no longer give credence to anyone touting claims of sustainability corporately, municipally, regionally or nationally who cannot demonstrate that they have identified, measured and evaluated the quality and quantity of services required by people in the constituency they claim to represent and measured them against the potential of local landscapes to provide those services. Furthermore, I do not think that anyone who is not actively and thoughtfully providing water to nature as well as people should be permitted by their peers to claim any degree of sustainability in either economic or environmental terms. As Uriel Safriel so clearly points out biodiversity-based systems have survival value. In order to provide water as well as other critical benefits to people, nature needs water, too, and hence must be considered a legitimate customer when it comes to allocating increasingly scarce water resources.

It is in our own long-term survival interest to stop putting our own water demands ahead of those of the natural systems upon which we depend to supply services we cannot afford to duplicate or do not know how to reproduce ourselves. Our almost total acceptance of inferior or partial engineering and technological solutions to the dangerous threats we are posing to our own sustainability through accelerating human impact on biodiversity-based ecosystem service delivery could, in itself, become a central cause of the collapse of our civilization.

R.W. Sandford



The "Water Tower" at Expoagua
Zaragoza 2008

DANIEL P. LOUCKS

Optimizing Water for Life

Dr. Pete Loucks is a professor of civil and environmental engineering at Cornell University in Ithaca, New York in the United States. While Dr. Loucks' presentation did not provide the gold mine of new ideas relating to the link between good water management and societal sustainability provided by Uriel Safriel, it did point out through example just how hard it is going to be to give water back to nature in places where it is already fully allocated to human populations. Dr. Loucks also shed further light on the limits of engineering solutions to address the importance of natural ecosystem service delivery confirming Uriel Safriel's claim that human and ecosystem needs for water must be seen as equal and equivalent.

Dr. Loucks pointed out that in developing countries more than 90% of the sewage and 70% of industrial wastewater is dumped untreated into surface water. Nearly half of the world's wetlands have been lost and dams have seriously altered the flow of roughly 60% of the world's major river basins. He noted that even the United States is depleting groundwater on average 25% faster than it is being replenished. If we assume "business as usual" by 2050 about 40% of the projected global population of 9.4 billion is expected to be facing water stress or scarcity. With increasing climate variability being predicted by global climate models, Loucks explained, we are likely also to have more people without adequate water more of the time, even in water rich regions.

Competition for Scarce Water Supplies

Loucks pointed out that when water is scarce, competition among users increases, increasing the potential of conflict between them. He noted that a number of developed countries were currently facing tensions over water. These include Belgium, the United Kingdom, Poland, Singapore and the United States. In southern England, for example, urban demand for water is outpacing the capacity of rivers and aquifers to meet supply demands during dry summer months. Loucks also pointed out that in the Western United States there was already growing tension between farmers who want more water for irrigation for their crops and growing urban populations that want more water for household and municipal use. Though these same pressures are beginning to mount in parts of Western Canada we still seem to be operating under the misperception that our national boundary will somehow prevent these kinds of problems from moving north. But our populations are growing just as rapidly as they are in the United States and we are doing nothing different from what our American neighbours did to avoid the problems they presently face with respect to water scarcity.

Loucks also observed that there has been considerable tension between Indian states over water rights and dams that might provide more water to one state and the expense of

another.¹¹ Loucks also notes that China is presently practicing what some have called the “zero sum game of water management” meaning that authorities are increasing water supply to one user by taking it away from other. This game is being played between competing areas in the country and between competing uses. In the Chinese circumstance we see once again the recurring theme of cities competing with farmers for water.

According to Dr. Loucks, China’s Yellow River is so oversubscribed that its waters have dried up before reaching the coast on an average of 70 days a year. In 1995, the period in which no flows reached the sea extended to 122 days, a third of the year. To meet increasing urban needs in its capital, the government of China is now planning an aqueduct that will carry water from the Danjiangkou Reservoir in Henan Province to Beijing, a distance of some 1300 kilometres across heavily farmed land – land that also needs water for food production.

In nearly all the water-scarce areas of the world prospects for regional conflict over water continue to grow. Loucks cites the fact that in Africa some 50 rivers are shared by two or more countries. As populations continue to grow Loucks predicts that issues of access to water from the Nile, Zambezi, Niger and Volta river basins could ignite conflict.

In discussion of Central Asia, Loucks pointed to the now classic example of the Aral Sea as a symbol of how international conflicts can emerge from the dissolution of political jurisdiction. While Dr. Loucks only mentioned the situation relating to the increasingly complex situation in the Aral Basin in passing, the glaciers of central Asia have enough to teach us about water and politics in the wake of empire to be worthy of a brief digression.

The Tien-Shan and Pamir-Alay Mountains are the water towers of Central Asia. Rising to 7000 metres in altitude, these ranges give birth to two of Asia’s most important rivers, the Amu Darya and the Syr Darya Rivers. The Syr Darya rising in eastern Kyrgyzstan and then flows westward through Kyrgyzstan, Tajikistan and Uzbekistan to Kazakhstan and into what is left of the Aral Sea.¹² The Amu Darya rises in the Pamir region of Tajikistan and then forms the border between Tajikistan and troubled Afghanistan before becoming the border between Uzbekistan and Turkmenistan before flowing like the Syr Darya into the Aral Sea. From this lesson in Central Asian geography we learn that Kyrgyzstan is a crucial upstream riparian region that supplies water to its downstream neighbours. In addition, Kyrgyzstan also contains nearly half of all of the glaciers that exist in the Central Asian Republics that were part of the Union of Soviet Socialist Republics until it collapsed in 1989.

¹¹ Though Dr. Loucks did not mention it, there is also considerable tension between India and Pakistan over water availability. Many observers believe that this tension is serious enough to destabilize the entire region and perhaps even lead to nuclear war between Pakistan and India. For this scenario see *Climate Wars* by Gwynne Dyer, Random House, 2008, pages 113 – 124.

¹² This is a summary of a paper entitled *Glaciers and Efficient Water Use in Central Asia* by Urs Luterbacher, Valerii Kuzmichenok, Gulnara Shalpykova, and Ellen Wiegandt, pp. 249 – 257, in *Darkening Peaks: Glacier Retreat, Science and Society*, Edited by Ben Orlove, Ellen Wiegandt and Brian H. Luckman, published by the University of California Press, 2008.

All of these former Soviet satellites are dependent upon irrigation to supply local food needs and are thus highly reliant on the resources of the Amu Darya and Syr Darya river systems and the glaciers that feed them. Unfortunately, the legacy of Soviet central planning has been disastrous to the region. Over-development of irrigation has famously led to over-allocation of water resources and to a 35% reduction in the area and a 58% loss in the volume of the Aral Sea. Commitments to supply the huge volumes of water necessary to continue current irrigation agriculture in downstream regions is depriving upstream countries of amounts of water necessary for on-going economic development. In the absence of central Soviet control, resulting water shortages have led to tension between the newly independent upstream republics of Kyrgyzstan and Tajikistan which both rely heavily on glacial meltwater for the production of hydro-power.

The economic development of both Kyrgyzstan and Tajikistan is heavily reliant on expanding hydro-electric capacity. Unfortunately, worsening ecological conditions, unsustainable downstream demands on water resources caused by over-development of irrigation for cotton production, population growth, deteriorating economic circumstances and the growing potential for explosive civic and inter-state conflict in the wake of the collapse of the U.S.S.R. are exacerbating efforts to resolve issues relating to the equitable regional sharing of water resources. Where they were once managed by Moscow, water systems in the region have suddenly fallen under the control of separate sovereign states that have no history of water sharing treaties or compacts and little historic appetite for cooperation in the creation of regional coordination efforts.

In recent years, the upstream countries have begun holding back the release of water and threatened to charge for delivery downstream to pressure the downstream republics to compensate them for the energy production that is forgone when they are forced to release it for downstream irrigation. This has led to legal reprisals. To date, however, Soviet allocation arrangements have been upheld legally. Even though these patterns of allocation were reaffirmed in the Almaty Treaty of 1992, they are not perceived to be equitable by either Kyrgyzstan or Tajikistan. But there is more. While Kyrgyzstan and Tajikistan would like more water with which to expand their economies, their dominant upstream circumstances does not permit them to do so because of their political weakness in the face of Kazakhstan and Uzbekistan's control over regional coal and natural gas supplies.

After independence Kazakhstan and Uzbekistan introduced global market prices for coal and natural gas which Kyrgyzstan could not pay. In order to make up the difference Kyrgyzstan increased electrical production and reduced downstream flows through expanding water storage capacity. This meant that Kazakhstan and Uzbekistan had less water for its important agricultural sector. In breaching established agreements Kyrgyzstan and Tajikistan have become subject to reprisals from downstream states.

Glaciers presently have an important place in this geo-political powder keg. Glaciers within Kyrgyzstan constitute some 47% of the total glacial area in the region. The largest of these glaciers are clustered around 4000 metres in altitude. Current trends and climate models both suggest that accelerating glacial melt and loss of ice mass over time will in

the short term at least increase the annual flows of several major rivers. This increase in supply is expected to be enhanced not only by accelerated glacial melt but also by an expected regional increase in precipitation. Under current climate change projections, the country's hydro-electric potential is expected to grow dramatically which could have positive impacts not just on Kyrgyzstan but on its neighbours.

A change in mindset in the region will be required, however, if this potential advantage is to be realized and shared regionally. An appropriate response to climate change impacts on the glacier melt in Central Asia must face up to the diminishing relative economic importance of inefficient agricultural production. Agriculture's privileged access to water is being contested globally as competition between economic sectors and individual nations and regions intensifies. Reducing tensions over water issues before they incite civil strife or warfare will require new organizations that can imagine the best ways to optimize and distribute all the benefits that water can produce in a region – not just those established in the past that favour outmoded and damaging irrigation schemes that divert water from other important purposes and economic functions.

If we learn anything from Central Asia is that glaciers will in the future figure far more prominently in economic and geopolitical circumstance in many regions of this increasingly populated planet. The era in which glaciers were simply seen as interesting landscape features is over.

Dr. Loucks also mentioned the Southeastern Anatolia Project in Turkey, known as GAP after its Turkish title (Guneydogu Anadolu Projesi), a network of 22 dams and 19 power plants which have together reduced the downstream flow of the Euphrates River into Syria and Iraq causing salinity problems that have had serious impacts on agricultural productivity in both countries. As the public policy implications of this massive project were the focus of Rosenberg IV held in Turkey in 2004, there were many in the room, including Ambassador Oktay Aksoy and Turkish legal scholar Yuksel Inan, who supported Loucks' view that cooperation among the riparian states that shared the river had the potential to reduce the threat of conflict over water in this important basin.

Dr. Loucks then returned to transboundary issues that continued to dog the United States as a consequence of over-allocation of the Colorado as a result of heavy agricultural demands and the explosive growth of desert cities in the Southwest. He noted that the Colorado trickles out of existence somewhere in the desert south of the U.S. – Mexico border, an issue that remains a constant source of irritation between the two countries. In light of these existing sources of potential conflict over limited water resources and the growing need for more water for cities and agriculture, Loucks wondered if it was still going to be possible to allocate at least some of the water that is available to environmental flows.

Pete Loucks asks an important question. Over large areas of the planet we are already over-allocating water resources to human purposes. In the face of such widespread global over-allocation how will we find enough water to sustain aquatic and other ecosystem function? After you have given all the water away, how do you take some back to give

nature? This is a question that should be seriously considered in the context of lessons that can be derived from Rosenberg VI for Canada generally and for the Canadian West in particular.

The first lesson we might derive is that public policy in Canada should move toward supplying adequate water to nature as well as to people before over-allocation for human purposes makes it difficult to do so. Another perspective that might emerge from the Rosenberg proceedings is that it will be very difficult for those claiming to be leaders in the management of Canadian water if they have already fully allocated or over-allocated water to human uses without reconciling the water needs of the larger ecosystem in terms of optimal ecological service provision. While it will hardly endear me to the irrigation community in Alberta or Saskatchewan for saying so, they are among the country's least sustainable water users when their use is examined in the context of the long-term health of the river systems in which they so intensely practice this form of agriculture.

While southern Alberta irrigation is far more efficient in terms of production per unit area than dry land farming, it can hardly be said to be sustainable in the long-term when the demands it makes on surrounding biodiversity-based ecosystem function upon which humans depend in addition to their food production needs are brought to account. I question how the southern Alberta irrigation community can claim to be leaders globally in the management of water resources when allocation of some of the rivers upon which they depend has reached 118% of the water that is typically available. How can you say that southern Alberta irrigators are outstanding stewards of water resources when they have been responsible, because of the extent of their withdrawals, for an average decline in the flows of the South Saskatchewan River of some 30% over the period flows have been measured in this system? How can the irrigation community make the claim that they are managing southern Alberta's rivers in a superior manner when 50% of the wetlands in the basin in which they practice this form of intensive agriculture have been drained and when 31 or 33 reaches of the South Saskatchewan river are listed as moderately to heavily impact or degraded because of nutrient and pesticide loading that are direct impacts of non-sustainable agricultural practice? How can the irrigation community argue that it is a superior steward of our western Canadian water resources when the entire water management system in southern Alberta is tied first and foremostly to agricultural production that defines aquatic ecosystem health in terms of how much biodiversity exists in and around its storage reservoirs rather than in the streams and rivers from which it diverts 70% of licensed allocation for its purposes? How can the irrigation community pronounce itself a world leader in water management when it is so obvious that their commitment to maintenance of ecosystem function is so superficial? Scientists point to the fact that the health of the entire South Saskatchewan River is in persistent long-term decline and will continue to do so until agricultural practices with respect to the management of water improve significantly.

Whenever such issues are brought up in any kind of forum the automatic public relations response of the irrigation community is to loudly protest that any criticism of agriculture is an attack on the history, heritage and economic foundation of the Canadian West. The irrigation community's public relations strategy is to dismiss the first hint of criticism by

claiming that anyone who would question irrigation agriculture practices is “just another ungrateful city slicker who doesn’t know or appreciate where their food comes from. Such responses do much to ensure that important questions don’t get asked – and that the true value of agriculture to our future may never be realized or understood until it is too late to realize that potential because of our failure to address the need to improve agricultural practice. The questions that are not presently being asked are crucial to our future. What happens if our agricultural practices are, in fact, compromising and degrading our system’s overall capacity to supply a broader range of biodiversity-based ecosystem services that are just as important to our sustainability as a society over time as food production? What if it is true that we have to share more water with nature if we are going to be able to ensure other forms of ecosystem services delivery upon which we depend for our well-being? If we really do need more water for nature – and clear evidence was presented at this Rosenberg Forum to suggest we do – how are we going to get the irrigation community to give that water up?

At present the irrigation community is antagonistic to any outside claims that water for agricultural is not being managed in anything but the most progressive way. In the context of traditional “water resource development” ideology they have a point. Unfortunately, the focus of traditional “water resource development” has been proven non-sustainable in the global context. The irrigation community in southern Alberta is unwilling to accept that. Instead they are standing fiercely by legal interpretations of an outmoded and unfair first-in-time, first-in-right licensing system that grants them all the water they want first even in a drought and permits them to use that water for any purpose they desire even if it means denying towns and cities around them the drinking water they need for survival purposes. No one doubts that at least some of them will bring out their guns the moment the equity, practicality and sustainability of these antiquated and backward water rights are challenged. Their angry resistance, however, will not change the fact that anyone with any knowledge of the climate and water resources history of the West has recognized for years that droughts of long enough duration to tear apart the current rickety water allocation system have been the norm for most of the past 5000 years and that the moist era in which our current agricultural circumstance developed is fast coming to an end. In the meantime governments will try their best to avoid the issue with the hope that the inevitable explosive collision between history and contemporary reality won’t occur during their term in office. Irrigation districts will continue to overdraft water resources and nature will not get the water it needs to supply other services upon which our society ultimately depends for sustainability. Year by year the West will keep drying out and heating up until it is a desert. As Uriel Safriel has pointed out, the impacts will radiate outward from the dry centre. We will need more and more of the water that is available for ourselves. Nature will get less and less until all that is left is thirst.

Pete Loucks used the example of what recently happened in Atlanta, Georgia to make clear just how difficult it will be to get water back from people so that it can be given to nature. After a number of years of persistent drought, in the southeastern United States, Lake Lanier, the reservoir serving the metropolitan area of the city was drawn down to a critical level during the summer of 2007. The reservoir served a number of important

functions. It supplied water to meet the city's needs and it provided environmental flows to the Chattahoochee River to protect downstream mussels and sturgeon species. The flows also allowed the operation of a Florida power plant. Downstream cities such as Columbus also depended upon the flows for their water supply, and a certain minimum flow was required to allow proper assimilation of treated wastewater back into the river.

The Lake Lanier reservoir is operated by the infamous Army Corps of Engineers which is required by law to maintain flows at levels that meet both human and environmental needs. In a remarkable turn of events tied to water shortage, the City of Atlanta sued the Corps to stop the release of downstream environmental flows. Atlanta lost the suit, but the case is now held up as an illustration of the political pressure that anyone making allocations to meet environmental as well as domestic water needs will experience when there is a shortage of water. Loucks' point was that we should expect to see what happened in Atlanta to occur far more widely in the future.

Another example Dr. Loucks offered was the very costly effort to bring the Everglades back which suggests how difficult and expensive it is to restore damaged aquatic ecosystems. The Loucks examination of the Everglades made it clear that ensuring the optimal availability of biodiversity-based ecosystem service provision is often a race between repair and restoration and climate change. The Everglades example offers Canadians a glimpse at what it is going to cost and how much effort is going to be required to restore the damage we have done to prairie lakes and streams and to major lake systems such as Lake Winnipeg.

On The Value of Good Models

Estimating just how much water should be allocated to instream environmental flows, particularly in data-poor arid areas can be challenging. Those deciding on what water allocations to recommend or make can benefit from having models that can predict ecosystem and geomorphologic responses to flow changes, and the impacts of such changes on the other users of the rivers. Generally these predictions depend on several characteristics associated with the flow regime.

Dr. Daniel P. Loucks

Dr. Loucks noted the South Florida has undergone significant changes in population, land use, and hydrology over the past 100 years resulting in substantial changes in ecosystem structure and function. Drainage efforts began in the Everglades in the early 1900s when

the region was largely considered a swamp wasteland. Hurricanes and floods prompted further drainage efforts which over time led to the construction of over 2600 kilometres of levees and canals, 150 flood gates and other water control structures and 16 major pumping stations. Most of these projects were designed in the 1950s when it was anticipated that the population of the region might be as high as two million by the year 2000. By 2000, however, the population was at least 10 times that, at least in winter. While the storage and flood control systems have worked remarkably well in making the region less vulnerable to extremes of drought and flooding, considerations relating to environmental protection or ecosystem benefits were not considered in their design.

The channelization of the Kissimmee River caused the loss of 11,000 hectares of floodplain habitat. Nutrient run-off from dairy and cattle operations accelerated the eutrophication of Lake Okeechobee and phosphorus enrichment from sugar cane farms began to alter ecosystem structure and function in the northern Everglades. Changes in the discharge patterns into estuaries have resulted in large diebacks of seagrass and other natural species and compounded the decline of the Everglades. The regional economy which is highly reliant on visitors interested in experiencing the pristine Everglades is now in decline because these unique ecosystems have been degraded by economic development and by altered hydrologic flow regimes brought through the flood and drought control efforts of the Army Corps of Engineers. Efforts are now being made, however, to reverse half a century of engineering direction to make it more compatible with the way the Everglades system used to function. While the Everglades will never be restored to their former glory, the 25 year Comprehensive Everglades Restoration Plan demonstrates that, with enough money, it may be possible to reconnect parts of the ecosystem that have been disconnected and fractured in ways that will enhance both the economy and the ecology of the region.

If there is a lesson for Canada in what has happened in the Florida Everglades it may be that we ought to engage in restoration of seriously damaged aquatic ecosystems like Lake Winnipeg and prairie lakes and streams before it becomes too expensive and complicated to do so. A second lesson may be that if we even make a substantial commitment we should expect that any meaningful level of restoration of these damaged systems will produce visible results for at least a generation after which we should expect to have to manage human use carefully in these areas forever to prevent the same damaging influences from reappearing.



The World's Fair Site at Expoagua Zaragoza 2008

Akissa Bahri

Integrated Watershed Management: Towards Sustainable Solutions In Africa

Dr. Bahri works with the International Water Research Institute in their regional office for Africa in Accra, Ghana. Her paper was on integrated watershed management in the Rufiji River Basin in Tanzania where new public policy considerations were brought to bear on a situation that could be very similar to ones that could emerge in parts of Alberta in the not-to-distant future.

The Great Ruaha River, which is a major tributary of the Rufiji is one of Tanzania's most important water courses. The 84,000 square kilometre Ruaha River Valley is one of the country's main rice growing regions. Within it also resides some 50% of Tanzania's hydropower capacity as well as an economically important national park and RAMSAR-designated wetlands. Until the mid-1990s the Great Ruaha was a perennial river. Recently, however, the river began to stop flowing during the dry months of the year.

It was ascertained that the cessation of the Ruaha flows were caused by declining levels in a large wetland located near the headwaters of the river. While there was still water in

the wetlands, levels had dropped below a critical threshold causing outflows from the wetland to cease. The reason this had begun to occur was an increase in irrigation diversions on the Usangu Plain upstream of the wetland. The area under irrigation on the Usangu Plain had increased from 10,000 hectares in 1970 to 45,000 hectares in 2004. The attendant increase in water withdrawals was now damaging ecosystem health in both the Usangu Plain and in the wetlands below from which it was estimated that some 95% of the population derived at least some economic benefit.

This is hardly an unusual circumstance. Such conflicts over how much the food production service of agro-ecosystems should be permitted to compromise or degrade the provision of other biodiversity-based ecosystem services are occurring widely. What happened in the Great Ruaha Basin is what happens when you are forced or choose to expand agricultural regions to increase food production without taking into account the broader range of services ecosystems adjacent to agricultural areas may provide. This is happening widely in Africa, and is happening as well in Canada where the desire to maximize production is compromising and degrading water quality in major river systems through systematic wetland draining and short-sighted agricultural practices that do not respect the fact that nature needs water in order to supply other benefits to people that are ultimately as important to society well-being as food production.

The urgency of doubling global food production to meet staggering population growth projections is going to increase the tension that already exists in many regions of the world not only over who should get water for what purpose but the extent to which land use should favour expanded agricultural production at the expense not just of other human activities but at the expense of other biodiversity-based ecosystem services such as water supply and self-purification, climate regulation, tourism and the desire to live in a world that is not ecologically reduced and visually diminished by the domination of landscapes by agro-monocultures.

What becomes obvious when we think seriously about the implications of having to double global food production by 2050 is not just that we may not have enough water to achieve this goal. Even if there are adequate water supplies to grow food enough to feed nine billion people, the impacts on the Earth's capacity to provide other critical ecosystem gifts may be degraded to the point where it will be necessary to employ expensive but ultimately inferior engineering solutions to perform many of the services ecosystems untransformed by agriculture used to supply for free. In addition to putting most of humanity – or at least that portion that can afford it – on dialysis we will lose much of landscape and cultural diversity that makes the world interesting and engaging. All there may be is cities and the world outside of them that has been transformed utterly in service of human dietary and material needs. Clearly, I am not the only person for whom such a vision is an anathema. Even in struggling Africa, public policy is responding to the need to protect biodiversity and the ecosystem services that flow from it.

Akissa Bahri and her colleagues at the International Water Management Institute are working to transform the tradition of “water resources development” into a sustainable

form of integrated water resource management that respects and supports the perpetuation of the broadest range of biodiversity-based ecosystem service provision in watershed planning decisions. The fundamental principles of this new approach were applied to the conflict between irrigation agriculture and other water uses in the Great Ruaha Basin in Tanzania. A five-year study was undertaken in the basin between 2002 and 2007 that aimed to determine the potential of new approaches in the Rufiji and specifically in the Ruaha sub-basin. Key elements of the study included:

- The determination of the flow requirements that would be necessary downstream of the Usangu wetlands to ensure that the Ruaha river would continue to flow year-round;
- Analysis of the mechanisms that would be required to improve irrigation efficiency and productivity in order to release sufficient water for downstream uses;
- Analysis of the role that economic valuation of different water uses should play in determining water allocation in the watershed now and in the future;
- Determination if the formal water management systems that were being introduced under the aegis of integrated watershed management approaches would in fact restore the Great Ruaha River to year-round flow;
- How different kinds of conflict resolution and decision-support systems might best be employed to improve water management and related land-use decision-making processes.

In itself, the fact that the river stopped flowing in the Great Ruaha Basin should be of interest to Canadians. The water in a number of rivers in the Canadian West is already fully if not over-allocated. Further population and economic growth, greater pressure to increase agricultural productivity to meet rising global food demands and climate change impacts on water supply could in tandem cause some prairie rivers to cease flowing year round, creating situations that could bear resemblance to what is presently happening in the Great Ruaha Basin in Tanzania. In order that Canadians stay ahead of such potentially devastating developments, policy makers in Canada may wish to pay close attention to what Dr. Bahri and her colleagues learned in their analysis of the public policy options left open to decision-makers responsible for reversing the cascading environmental-cum-economic effects over-allocation of water resources to agriculture caused in the Great Ruaha Basin.

Using hydrological and water resource models the Tanzanian study found that the downstream environmental flow requirements necessary to sustain Great Ruaha National Park amounted to 22% of the mean annual flow in the basin. A dry season flow of at least 0.5 cubic metres per second was critical to the maintenance of the park's ecosystems. It was determined that the maintenance of this absolute minimum dry season flow would require a 65% reduction in upstream dry season water withdrawals.

The study also found that though there was a significant potential to increase water-use efficiency in irrigation so as to free up water for wetland and downstream flow restoration, existing water management practices did not deliver on that promise. Although defined water rights and use fee systems were designed to provide economic incentives to reduce waste, they failed to do so. The reason for this was that mechanisms for monitoring actual water use and enforcing compliance were absent. The study found that some irrigation withdrawals were up to twice the legal limit and even where water rights were not exceeded considerable volumes of water were being wasted.

The economic valuation of comparative water use also arrived at some very interesting conclusions. The study valued water abstracted for rice paddy irrigation at \$0.01 per cubic metre and at \$0.04 per cubic metre when abstracted water was consumed in rice production as opposed to becoming part of return flows. The valuation of water utilized in hydro-power production was \$0.06 per cubic metre of gross allocation and \$0.21 per cubic metre in terms of the economic value of the final product. In other words, the economic value of water utilization in hydro-power generation was five times higher than the value of putting the same amount of water to work growing rice. If decisions were made solely on the basis of contemporary economic valuation of efficiency it would be logical to allocate water away from irrigation to downstream power generation. But decisions of this kind are never that simple. You can't eat hydro-power.

Rice production from the Usangu area of the basin alone contributes between 14% and 24% of the country's national food production. Irrigation agriculture supports some 30,000 agrarian families in the Usangu, providing them an average gross annual family income of about US\$ 912 per year. These people are among the poorest of the world's poor, and without their meager agricultural incomes they would have nothing. In such a context, water allocation involves highly charged political choices.

Though village-level water management is improving and conflicts over water use have been reduced agricultural abstractions remain largely uncontrolled. At present the only public policy options that appear practical include active water management in the wetland to reduce evaporation and a possible reduction in the size of the wetland so as to facilitate at least some of the dry season flow needs in the national park.

Without outside aid, it doesn't appear much progress can be made in the Great Ruaha Basin. Aid, however, has not been forthcoming. One of the reasons for that is that many developed countries are facing water problems of their own. Not all of the news from Africa is bad, however. Dr. Bahri and her colleagues also reported on the on-going development of legal instruments that have the power to encourage equitable and sustainable water management at the river basin level.

An example of progress that was cited is the Blue Nile which until recently was managed under the terms and conditions of fifteen different bilateral treaties signed between 1891 and 1991. All but one of these treaties – the Nile Water Agreement signed in 1959 – were negotiated on a strictly bilateral basis with Great Britain as a signatory. The problem with

these treaties – and the problem with many bilateral accords in general – is that they neglect the interests of others who depend on that same water and therefore remain unrecognized by one or more upstream or downstream neighbours. Another weakness in these kinds of agreements is that they seldom recognize the potential value of broader cooperation in matters related to the benefits that water can bring.

The results of recent efforts to quantify benefits of full cooperation among all of the countries that share the Nile are changing attitudes toward water resource management throughout the basin. Research indicated that basin-wide cooperative development of the Nile would generate US\$ 4.94 billion a year more in the region than the current system of bilateral agreements that stifle cooperation and breed antagonism between riparian neighbours. The resulting Nile Basin Initiative has already been the focus of Rosenberg Forum attention. An outline of its strengths and weaknesses was presented at Rosenberg IV in Turkey by Abdel Metawie of the Egyptian Ministry of Water, Martha Karua, who was then the Minister of Water Resources in Kenya and Patrick Kangohire, who represented Uganda on the Nile Basin Secretariat.¹³

The Nile is one of this planet's greatest assets. Its basin encompasses some 3,000,000 square kilometres, about 10% of Africa's total land mass. About 160,000,000 people live in the basin proper and about 300,000,000 live in the ten countries through which this great river flows. These countries include Burundi, the Democratic Republic of Congo, Egypt, Kenya, Rwanda, Sudan, Tanzania, Uganda, and now Eritrea.

Metawie, Karua and Kangohire confirmed that the transboundary nature of the Nile presents a huge challenge. That challenge centres around the imperative of achieving truly sustainable management of a river system whose development potential has raised conflicting aspirations and expectations of so many people living both within and beyond the basin. At the heart of this challenge is the urgent need to eradicate poverty. Sustainable development of the river can achieve this goal by providing enhanced food, power and water security and the enhancement of job creation. But this won't be easy. Most of the countries located in arid and semi-arid regions are facing water crises. For the Nile Basin countries, the problems are different but equally serious. They include wholesale climate change impacts, civil wars and political instability, economic and debt crises as well as population and other pressures. Many of these African nations have their backs against the wall. They are at the stage now that they cannot get anywhere without working together.

Cooperation in the Nile Basin in terms of transboundary water agreements dates back to the early twentieth century. The first bilateral treaty setting out the terms of utilization of the shared waters of the Nile was signed by Egypt and Sudan in 1959. Later cooperative efforts took a regional approach to involving countries sharing the basin. Three major regional initiatives have advanced both the level of cooperation and the promise of ultimately achieving sustainable development of the river. These initiatives include "Hydromet" between 1967 and 1993; TECCONILE between 1993 and 1999; and the Nile

¹³ See pages 100 to 104 of *Irrigating Eden, Journals From the Rosenberg Forum in Turkey* by R.W. Sandford, 2004

Basin Initiative which began in 1998. The three speakers were remarkably unified in their support for this last initiative which in their opinion provided a unique cooperative forum for each of the countries to realize tangible benefits and to build a solid basis of trust and confidence that would allow them to ultimately achieve a sustainable future.

The Nile Basin Initiative provided an important mechanism for institutional transition from isolated decision-making by individual states to productive cooperation on transboundary opportunities. By providing an agreed upon vision and a basin-wide framework for working together, this process has begun to facilitate substantial investment in the Nile Basin. Just as importantly, it represents a deep commitment by Nile riparian countries to foster cooperation and pursue jointly sustainable development of Nile water resources for all.

Important lessons have been learned by each nation from involvement in this form of cooperation. Of utmost importance in the process is allowing enough time to build trust. This requires positive results that support a “carry on” conviction among neighbouring riparian countries. The process also underscores the important role that the international community must play in bridging gaps in the cooperative process; the indispensibility of political will; the importance of investments; the significance of establishing and maintaining dialogue; the worth of bringing diverse interests together, the value of exchanging visits and the role of civil society organizations in boosting cooperation at a national level.

In 2004, the lessons derived for Canada focused mainly on the importance of long-term cooperation in the development of trans-boundary water agreements. This lesson was held to be relevant particularly within the context of the Columbia River Treaty which, as was pointed out in a separate case study, could be subject to reconsideration as early as 2014.

While the Nile example continues to serve as an important model for how transboundary water treaties should be crafted between sovereign nations in the future – in North America and elsewhere – its lessons should also be allowed to inform the intent and function of inter-provincial compacts within large countries like Canada. Presently the relationships between provinces and territories in Canada are largely defined by bilateral agreements of relatively limited scope. Most deal with how much water must cross provincial boundaries or with the management of specific projects such as dams and oil or resource developments. In western Canada at least there does not appear to be any effort being made to consider the environmental, ecological and economic benefits of cooperative approaches to integrating regional infrastructure, markets and trade. Despite the huge benefits demonstrated in basins such as the Nile, no similar analysis appears to exist in similar sized basins in Canada, such as the Mackenzie or the North and South Saskatchewan though each of these basins is crucially important to our country’s economic and environmental future.

The limits to the effectiveness of outdated bilateral water agreements have been well demonstrated on the Nile. British Columbia, Alberta, Saskatchewan and the Northwest

Territories may wish to learn from the Nile example and look for great benefits that can only derive from proactive and full transboundary cooperation with respect to integrated water resource management. Deliberations to this end should begin now before the signing of further bilateral agreements precludes cooperation toward more mutually beneficial ends or makes cooperation more difficult to achieve. We do not in Canada have to wait 5000 years as Egypt did to learn the benefits of cooperating in the shared management of our great rivers. We know that if we act now we will have less precedent to reverse and a longer period in which to enjoy the benefits of cooperation.

On Tensions Between Cities & Agriculture

In urban watersheds, competition between urban water demands and those for agriculture and industries is increasing due to urban expansion and political priority given to cities. Fast growth of cities in sub-Saharan Africa and rises in livelihoods standards are exerting more pressure on water and land resources. With the political and economic centers of gravity located in the cities, urban water use tends to be prioritized over other users and other regions. Northern Ghana and Burkina Faso stand in competition for water resources with the urbanized society of Southern Ghana.

Akissa Bahri et al
Integrated Watershed Management:
Towards Sustainable Solutions in Africa



Exposición Internacional
Zaragoza 2008

HONG YANG

Globalization of Water Resources Through Virtual Water Trade

Hong Yang is a colleague of Alexander Zehnder at the Swiss Federal Institute for Aquatic Science and Technology in Duebendorf, Switzerland with whom she authored the paper she presented. In the time he can spare from his research, Dr. Zehnder also happens to be the Director of the Alberta Water Research Institute in Edmonton. Hong Yang's paper and presentation explored the increasingly interesting important subject of globalization of water resource utilization through virtual water trade, or the trade of water in the form of food.

Dr. Yang began by quantifying virtual water flows. Virtual water content is defined as the amount of water required for the production of a unit of a given crop type, which usually expressed as cubic metres of water required per kilogram of crop production. In essence this calculation is the inverse of crop water productivity which is expressed in terms of kilograms of production per cubic metre of water employed. If you multiply the virtual water content of a crop by its trade quantity you arrive at the virtual water flow that results from the trade of that crop. A lot of water is shifted around the world in this way. As of the year 2000, about 1000 cubic kilometres of water were traded from nation to nation in the form of food. The volume of virtual water transported around the world in this way amounted to about 15% of the total amount used currently in food production. This, however, is not a straight-forward calculation.

Because the same crop may demand more water if grown in a water scarce arid or semi-arid region than in a cooler more water abundant area, there can be considerable savings in virtual water trade. Hong Yang is an expert in calculating such savings. The total amount of water exported in the form of food crops is in the order of 644 cubic kilometres a year. If the countries to which these crops were exported were forced to grow them themselves under local water availability and agricultural practice regimes, the volume of water required would have been 981 cubic kilometres a year. This suggests that virtual water trade currently reduces total global needs by some 337 cubic kilometres a year, which is a lot of water. At the global level this translates into about 34.3% of the water committed to food crops is saved as a result of traded food volume through virtual water export.

Dr. Yang also points out that the scale of virtual water export savings varies considerably depending on the crop. The trading of wheat and corn, for example, results in a 41% to 59% reduction in global water use respectively. As a result the trading of these two crops contributes significantly to total global water savings. Dr. Yang also indicated that the crop in which there appears the least potential for virtual water saving as a result of import is rice. The growing environment and water requirements for rice are similar wherever it is grown.

According to Dr. Yang, North and South America and Australia are the only places in the world that export virtual water benefit. All other regions are net importers of virtual water. The major destinations of virtual water include East Asia, Central America, North and West Africa and the Middle East. Some of these exports are seen to make a real difference in terms of water demands in the recipient countries. Because of crop water productivity, 73 cubic kilometres of virtual water exported from North America is worth the equivalent of 149 cubic kilometres of water when these crop products are imported into East Asia, which represents a doubling of effective value. While the volumes are smaller the percentage benefit of exporting to very dry places such as the Middle East is even greater. Here a volume of 17 cubic kilometres of virtual water exported from North America is worth 55 cubic kilometres locally, a near tripling of volume. There are, however, situations where the opposite is true. Because of its lower water productivity, virtual water exported from South America is worth less than it would be at home if exported to Europe. In such instances other values besides the amount of water used to produce agricultural products define their export and import value.

While growing water scarcity is at the heart of current interest in virtual water trade, other forms of scarcity have increasing influence on agricultural trade. Japan, for example, imports 75% of the cereals consumed domestically even though it is a relatively water abundant country relative to its total area. As the Japanese enjoy some 3380 cubic metres of water availability per person it is not scarcity of water but of land that drives the country's food import strategies.

As populations increase globally water use and food production policies will be shaped as much by scarcity of land as they will be by water scarcity. Many countries will choose to import water as food so as to free up water and land for higher economic productivity just as is happening today in Japan, Switzerland and Italy. Increasingly scarce blue water has many functions.

Agriculture yields the lowest relative economic value of all blue water functions.

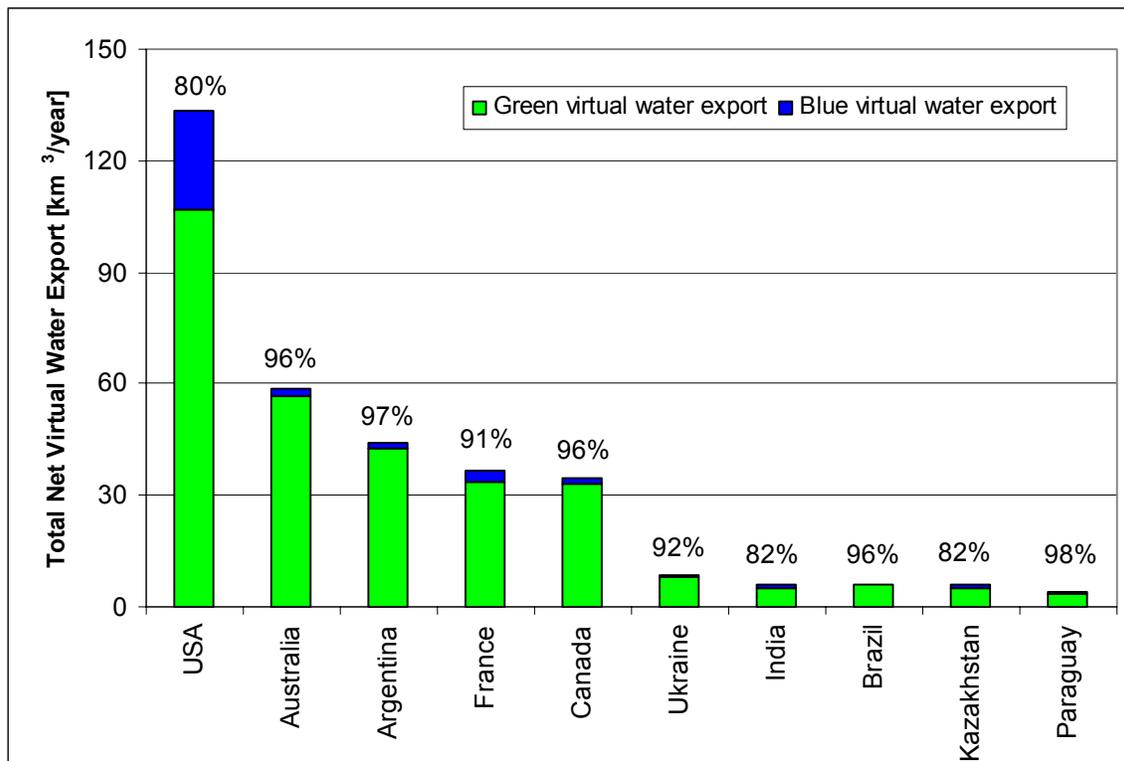
Dr. Hong Yang

In many circumstances irrigation often yields the lowest economic value among all the functions. Alberta, in particular, is beginning to face this realization and the many consequences that could flow from it. As the southern Alberta economy continues to grow, the irrigation community should expect challenges related to the level of economic benefit that is presently being derived from this high level of allocation to the production of low-yield economic value. If continued disproportionate allocations to irrigation agriculture lead to the limiting of higher value economic activities, irrigation districts

should expect challenges to the first-in-time, first-in-right water licensing system that has been in place in Alberta for more than a century.

This does not mean, however, that Alberta should be rushing to take water away from agriculture to put it to higher economic use. In many water-scarce countries the high opportunity cost of irrigation is often seen as a trade-off for other pressing concerns such as food security, rural employment and political stability. Rising food prices globally and threats to food production capacity caused by groundwater overdraft in other parts of the world are likely to make Canada's food-producing capacity central to the stability of international food supply.

It should also be noted that on a global scale, the amount of water we use in the Canadian West for irrigation is relatively small. Dr. Yang showed a graph illustrating the proportion of blue and green water use in the world's seven largest food exporting countries. These seven countries, the United States, Canada, Australia, France, Argentina, Thailand and Brazil account for about 80% of the total net global virtual water export.



It can be seen clearly in the graph that the proportion of exported blue virtual water in these countries is relatively small. In Canada, in fact, the amount of blue water used in agricultural production relative to green water is almost negligible. The reason for this is that the overwhelming majority of Canadian agricultural exports are produced not in irrigation areas but in rainfed circumstances that rely on green water not water withdrawn from streams and rivers. The only places where this is not true are in southern Alberta, southern Saskatchewan and in the dry southern interior of British Columbia.

This brings us back to the relative value of green and blue water and how we ought to decide how to use each for the most appropriate purpose. From 1976 to 2006 world food prices declined in real terms by about 50% allowing countries with water deficits to access virtual water at affordable or advantageous prices. But since 2006 food prices have been rising dramatically which has created a disincentive to food import. One of the developments responsible for rising food prices is the rapid expansion of biofuel production.

Future government policy with respect to energy production will continue to have direct impacts on food prices in major food exporting countries which will in turn change the formula that determines the economic feasibility of trade in virtual water. Taking more and more land out of agricultural production and requiring more and more water for non-agricultural purposes will create a vicious circle of food price increases that will make it more difficult if not impossible to meet future global food production needs.

There are other concerns related to agricultural practices. Presently heavy reliance in major food exporting countries like Canada on fertilizers, pesticides and upon hydrological stationarity pose a threat to the long-term sustainability of our agriculture.

Average fertilizer application in the United States is 140 kilograms per hectare. In developing countries it is about 100 kilograms per hectare. In many developing countries excessive application of fertilizers and pesticides is becoming an environmental hazard. We cannot tell in many major food exporting countries – including Canada – how much of the high crop water productivity is due to more efficient use of water and how much is due to what in the end may be non-sustainable agricultural practices.

Unless we manage our water more efficiently and diminish nutrient loading of our western rivers, we may not be able to take full advantage of our opportunity to serve the world by exporting water virtually to water-scarce countries elsewhere if only because we will have over-exploited many of our own rivers and aquifers causing the same serious regional water resource depletion and environmental degradation we have witnessed in parts of the central and western United States. It is hard to help others when you are in trouble yourself – something we want to avoid in Alberta and the rest of the Canadian West.

Hong Yang and Alexander Zehnder also reported that under business-as-usual scenarios it has been estimated that an increase of 17% in irrigation water supply would be necessary worldwide to meet global food demands in the next 25 years. While most of

this growth in irrigation is likely to occur in food importing countries an increase in irrigation could also occur in food exporting countries as a result of an increasing demand for their virtual water. Yang and Zehnder caution us to recognize that this increase in irrigation demand could, on one hand, aggravate regional water resource depletion and environmental degradation in food exporting countries, while increasing the cost of virtual water trade on the other. This could certainly be true in parts of Canada, especially in the irrigated regions of the West.

The Hong Yang – Alexander Zehnder analysis of the global virtual water trade makes a good case for important consideration of public policy with respect to agricultural practices and water management traditions in Canada. It is useful to raise public awareness of the importance of understanding the relationship between water use and the environmental impacts of food production as they can be viewed through the lens of the amount of virtual water embodied in the commodities we consume. In water-scarce countries, virtual water import plays an important role in alleviating local water availability issues. In water abundant countries, however, examining the usefulness of virtual water export from the perspective of water saving *per se* is of little practicality. What is important is to be able to recognize when high water productivity is being supported by high inputs of chemical fertilizers and pesticides which may over time be non-sustainable because these practices undermine the very water productivity they were meant to support.

Hong Yang and Alexander Zehnder also point out that the current global food trade is currently among countries with middle to high national incomes. Poor countries are not part of this trade because they cannot afford to purchase food on the international market when domestic supplies run low or fail. For this reason Yang and Zehnder caution us not to expect miracles from the virtual water trade in the context of what needs to be done to address food security problems in the world's poorest countries. Just as Southern Alberta beef producer John Kolk told me so clearly during a visit to his ranch in the spring of 2007, Canada does not produce food to export to the world's hungry. The reason for this is simple. They simply can't afford to buy it.

As many questions as lessons emerge out of this important paper – questions we ought to be asking ourselves in Canada and in particular in the agricultural West. Assessing real water efficiency as a consequence of our engagement in the global virtual water trade is a complex exercise. We need to know more about the real trade-offs in terms of measurable gains and losses. Such trade-offs will ultimately also have to be measured against a growing understanding of the water needs of natural systems as they relate to the maintenance of the biodiversity-based ecosystem service provision upon which our sustainability ultimately depends and for which we presently have few reliable measures.

We should not expect a “green” water revolution. We are, in fact, likely at the peak of our food production capacity without changes in our agricultural practices. What we decide to do about biofuel production especially where it conflicts with agricultural productivity and food pricing matters greatly and looms large in all future public policy deliberations with respect to virtual water export.

“Natural” and invasive species also compete with food crops for blue and green water. In this context invasive species and ecosystem disturbances that favor invasives can affect water availability.

Dr. Hong Yang

There are also some very tough questions we know we will have to face sooner rather than later. What happens when you discover that your circumstances have changed and that you have gone – as southern Alberta has – from having enough water to export great volumes of it elsewhere embodied in food to not having enough water to sustain agriculture and additional population and economic growth locally? What happens when areas in food exporting countries suddenly find themselves water scarce as has recently happened in Australia? At what point is it unwise to export precious local water resources as virtual water embodied in relative low-value food when you no longer have enough water for yourself?

This leads to a related question – one that is being asked ever more frequently in places like the Middle East. What do you do if you are caught between the hammer of rising food prices and declining per capita water supply?

Food security in an increasingly crowded world is going to be more and more difficult to assure. In the end we know we would pay anything for food just as a thirsty man will in the end pay almost anything for water. Fundamentally, food and water are virtually the same thing and given that we simply refuse to slow the increase in the numbers of people who need both we should not be surprised if the price of both goes up.

We have taken the ready availability of food and water for granted in Canada for two generations. In parts of the country at least, that era in our history may be coming to an end. If Hong Yang’s presentation didn’t make that clear then the next presentation on globalization and water most certainly did. Presented by Wendy Craik, it pointed to lessons that were learned in the Murray-Darling Basin in Australia during the recent prolonged drought. What she told the Forum was frightening.

WENDY CRAIK

Modern Agriculture Under Stress Lessons from the Murray-Darling

We know from what happened on the Great Plains of North America in the 1930s that it is very difficult to know at the time exactly when a drought has begun. Nor, because the environmental and economic impacts they cause can persist long after rains return, can we always exactly pinpoint when a drought has finally come to an end. In the early years of the new millennium, Australia experienced a drought that changed that country's national identity. History will record that this drought began in the austral spring of 1996 and then intensified before continuing through until 2005. Though the worst appears to be over at least for the moment, it remains unclear at the time of this writing whether the Australian drought has actually ended or, in fact, if it ever will.

If there are lessons about water management in circumstances similar to ours that have been painfully learned elsewhere in the world from which Canada could learn much, the Australian example should be front and centre. Current circumstances in Australia demonstrate what happens when you get a drought that is far longer and more intense than the drought of record upon which a nation has based its water storage infrastructure development, water allocation mechanisms and drought contingency plans. What is presently happening in Australia should engage our attention most fully and immediately, for it offers deep insight not just into how to manage a serious drought but into the kinds of difficulties Canada will inevitably have to address in the face of the more frequent, prolonged droughts that are projected to occur on the prairies under all current climate change scenarios.

Wendy Craik is the Chief Executive of the Murray-Darling Basin Commission. Her paper, submitted to the forum on behalf of co-author James Cleaver, was entitled *Modern Agriculture Under Stress: Lessons from the Murray-Darling*. In describing the system, Craik explained that the million square kilometre Murray-Darling River Basin covers roughly twice the area of Spain but covers only 14% of south-eastern Australia. The basin's two million residents rely on the combined river system for all their water supplies as do the 1.2 million residents of the city of Adelaide which is located on the south coast adjacent to the mouth of the basin. The Murray-Darling, Craik explained, is Australia's "food bowl". The 2% of the Murray-Darling Basin that is irrigated accounts for 70% of the value of Australia's irrigated agriculture output.

The similarities between the Murray-Darling system and the North and South Saskatchewan River basin in Canada are striking. At 420,000 square kilometres the Saskatchewan system covers roughly the same area as Spain but only half the area of the Murray-Darling. But the same number of people as rely on the Murray-Darling, about three million in three Canadian provinces, rely on the Saskatchewan for the water they need to live, to practice agricultural and to sustain industry. The flows of the Murray-Darling, like those of the Saskatchewan, are also highly regulated by more than 2 billion

dollars worth of expensive dam and water distribution infrastructure. As in Canada, the historically high reliability of inflows into the reservoirs created by the two major dams on the Murray-Darling system have allowed for the allocation of reliable irrigation water entitlements as well as for reliable urban and domestic water supplies throughout the basin. Like the Murray-Darling, the Saskatchewan is considered the “bread basket” of the vast nation in which it is located. Like Australia, Canada has developed significant irrigation capacity. While only 5% of Alberta’s farmland is irrigated, it produces close to 20% of the gross provincial agricultural production each year.

The Darling River region is very flat. Inflows in this system are unreliably tied to episodic rainfall events that lead to major flooding approximately every decade. In most years, however, most of the flows from the Darling are diminished by transmission losses and evaporation before reaching the Murray. Historically, the only reliable rainfall in the entire Murray-Darling system has occurred in the mountain regions of the Murray River. As is the case in so many watersheds including those in western Canada, the rest of the system relies heavily on the disproportionate amount of precipitation that falls in upland regions.

So reliable were flows in the Murray-Darling system that they were taken for granted in the economic development of the region. Water rights were granted to 99% of the long-term average annual river flows. When these highly reliable flows ceased, however, southeastern Australia found that while increasing agricultural and economic productivity to the full limits of its water supply made for great prosperity, it also left the region very vulnerable to the grief that drought and climate change have caused repeatedly throughout the entire history of settled human society. Rights had been granted for water that no longer existed. Huge investments had been made into infrastructure and businesses that could not exist without the water allocated to them. When the drought began it was possible to make due, but as it wore on the very institutions upon which the region depended for its integrity began to unravel under the weight of precedents that could no longer be honoured and governance structures that were not capable of meeting the demands of conditions far worse than those for which emergency drought plans existed.

A Drought Of Uncommon Intensity & Duration

The current Australian drought began quite innocently, like so many do, with diminished flows in important major rivers. During the early phase of the drought which began in 1996, the annual flows of the Murray-Darling system, though reduced, remained within the Murray-Darling Basin Commission’s planning minimums, which is to say they were well within the historic variability of the system as accepted at the time. As happens in such circumstances, those with “high reliability” water licenses barely noticed the drought as they had all the water to which they were entitled so that critical livestock, urban and domestic water supplies were assured. The bulk of early impacts of the drought were felt by irrigators with “lower reliability” water licenses whose allocations in some cases were cut by as much as 54% down from a long term average reliability of 80%. In the beginning most were able to manage their way through. It is important to note, however, that one valid customer that did not receive the water to which it was entitled

even at the beginning of the drought was the environment. As natural floodplain inundation had not occurred in the Murray Valley since 1993, widespread decline of floodplain ecosystems began at the very outset of the drought. This was to have serious implications later, implications that continue to this day.

Instead of letting up over time, as the historical record suggested it would, the drought lingered for ten years. Then it got worse. By 2006 conditions had severely deteriorated throughout the Murray-Darling Basin. But the worst was still to come. When the austral spring arrived in September of 2006, it became evident that the autumn, winter and spring flows had failed completely. It was as if the hydrological cycle has simply stopped. There was, quite literally, no water. The Murray-Darling Basin Commission forecast that water storage behind the Murray River dams would be drawn down to extreme low levels by the end of 2006-2007 growing season. Two months later allocations to even the most senior water license holders were reduced throughout southeastern Australia. Conservation efforts were re-doubled; neighbours began reporting one another for water use violations; jealousies over who was allocated water for what purpose led to conflicts; and suicide rates in rural agricultural areas began to rapidly rise.

By the end of the austral summer of 2006-2007 total Murray River annual reservoir inflows had dropped to approximately 60% below those recorded during the previous drought of record, which occurred in the austral summer of 1914-1915. But since then things have even gotten worse. Storage levels at the beginning of the austral summer 2007-2008 were very low. As a result opening allocations even to senior license holders fell to ZERO. As there was no stored water to offer to licensed water users, all allocations were made entirely dependent upon how much rainfall fell and was stored during the summer season. Just as we did during the southern Alberta drought of 2000 and 2001, Australian irrigators have traded water allocation rights in order to reduce the economic impact of the drought. Preliminary estimates indicate that approximately 30% of all available water has been traded during the extended period of the drought. Prior to 2006, when the drought intensified, "leased" water was traded at a maximum value of approximately \$200 Australian dollars. During the 2007-2008 growing season, however, the price of "leased" water was about \$1100 AUD, a price increase in only two years of 550%.

At the time Wendy Craik gave her presentation to the Rosenberg International Forum on Water Policy in June of 2008, annual Murray-Darling reservoir inflows remained in the bottom 5% of recorded years. In the entire 116 years during which instrumental records of streamflow have been kept in southeastern Australia, it has never been this dry.

The reader should be reminded that this has occurred after an earlier decade of less severe but still very harmful drought conditions. It should also be noted that there is nothing even remotely similar to a drought of this intensity and duration this in the modern settlement history of the Canadian West. This does not mean, however, that such droughts are not possible on the prairies or that they haven't occurred before. It is well known from tree-ring studies and other proxy records that droughts of this duration have occurred on the Great Plains of North America before Europeans were present to witness

them. The drought of record upon which the Canadian Prairie Provinces have established drought management plans was the six-years without rain that turned the plains into a dust bowl between 1930 and 1936. That drought, which was minor in comparison to what is presently happening in Australia, nearly wiped the Canadian West.

We do not have to wait for the drought in Australia to come to an end to derive valuable lessons in Canada. Given climate change and other factors, the climate and hydrological variability upon which we have built our Great Plains economy is very likely to be far more extreme than which we experienced during our established drought of record of the 1930s. What this suggests is that we have likely defined both our infrastructure standards and the often invisible institutional arrangements and economic instruments upon which we depend for our ultimate adaptability to such events on an inadequate baseline. We need to ask ourselves how we would deal with – not six years of moderate drought we experienced in the 1930s – but ten years of water scarcity followed by a drought that was half-again as severe as anything our prairie civilization has ever experienced before. It is extremely valuable for us to know what happened in Australia because that is exactly what has happened there.

It is useful from a public policy point of view to examine the Australian example with the goal of anticipating what we need to change now before we find ourselves in the midst of a drought – as Australia has – that could test our very capacity to live where and in the manner we presently do on the Canadian prairies.

Why Has The Australian Drought Been So Severe?

The Murray-Darling Basin Commission has examined very carefully all the factors that have contributed to the severity of the drought presently gripping southeastern Australia. The conclusions the Commission has drawn could be seen as nothing less than frightening when viewed in the context of our own growing vulnerability in Canada to the same array of extreme conditions that presently persist in Australia. Five factors are seen to have made the Australian drought worse than those that have occurred in the past.

1. Over-Allocation of Water Rights

The first thing the Murray-Darling Commission thinks Australia did wrong that led to intensification of the effects of current drought was to permit over-allocation of existing water resources. The Commission noted that the second half of the 20th century was significantly wetter than the first half. Wetter climate conditions in tandem with a forty year period of dam construction between the 1950s and 1990 allowed Australians to arrive at the accepted wisdom of the day which held that only a small percentage of new water entitlements would actually be utilized. With this logic as an underpinning, irrigation entitlements were allowed to expand so as to permit the appropriation of almost every drop of surface water that flowed in the Murray-Darling system. Unfortunately, expansion of water rights exceeded levels of environmentally sustainable extraction. The Australian example proves that even senior water rights can be meaningless if there is no water.

The over-allocation of water rights also had – and continues to have – and huge impact on ecosystem vitality in Australia. As Israeli ecologist Uriel Safriel has gone to such pains to illustrate, if we are to survive we must recognize “nature” as equal in importance to people in terms of water allocation. It is impossible at this time to say just how much the drought Australia has been experiencing has weakened its overall ecosystem health. There can be no question, however, that a great deal of systemic damage has already been done.

Even later caps on water use aimed at preventing further expansion of water diversions were unable to reverse the environmental damage caused by over-allocation or to lesson the economic impacts associated with investment in business activities that failed when it was no longer possible to access the water upon which these operations depended for their survival.

Just like southeastern Australia, we have over-allocated our southern Canadian rivers with no virtually no respect for in-stream flow needs or for the need to maintain other biodiversity-based ecosystem services up which we ultimately depend for the sustainability of our way of life on the Great Plains. We have done exactly what got Australia into trouble during a drought lasting longer than the established drought of record. They got caught. We haven't, at least not yet. We would be wise to learn from their example.

2. Atmospheric Temperatures in Australia Are Rising

Another factor in making the current Australian drought worse than those preceding it, is the fact that mean temperatures in southeastern Australian have been usually warm in recent years. According to the Australian Bureau of Meteorology, three of the last five hottest years on record in the Murray-Darling Basin has occurred in the last five years. The Commonwealth Scientific and Industrial Research Organization in Australia estimates that each 1°C increase in mean annual temperature in the basin ultimately reduced runoff by 15%. Wendy Craik and James Cleaver observed that the impact of higher temperatures and a drier catchment have been evident since 2007. Even though a La Niña event brought above average rainfall to most of the Murray catchment between September of 2007 and March of 2008, total inflows into the system remained very low. This suggests that the aridity generated as a consequence of the drought may in fact irreversible.

The Commonwealth Scientific and Industrial Research Organization in Australia also estimates that the largest impacts of climate change in the region will present themselves in the upland areas of the Murray River Basin. The capacity of the Murray River to supply water at levels based on historic averages is now permanently in question.

The lessons for Canada inherent in these Australian trends are obvious. Drought combined with the loss of environmental water flows can damage “natural” ecosystems to such an extent they are unable to provide normal adaptability to such extremes. As the

capacity of natural systems to moderate the effects of extreme weather events diminishes, temperatures can rise and in so doing increase evaporation rates from the soil surface and subsurface. High temperatures also affect other hydrological patterns.

Though we can only speculate on what the exact effects will be, rising temperatures are expected to increase rainfall during the winter and spring on the Canadian prairies. Summers, however, are expected to be longer and hotter. Just as has been witnessed in Australia, higher temperatures are expected to increase evaporation and to reduce soil moisture to such an extent that these factors will more than compensate for the small increase in rainfall that is projected in most climate change models. What we learn from the Australian example is that temperature and soil moisture changes projected by climate change models can be for real. What climate models have projected to happen in Australia is actually happening and one change invariably leads to another. If it is happening there, it could happen here.

3. Rainfall Patterns Have Changed

Recent research clearly indicates that there has been a significant reduction in autumn rainfall over the Murray-Darling Basin. Researchers have indicated that the reason for this is the strengthening of a high pressure “subtropical ridge” over the basin during the summer months. The persistence of this high pressure ridge, which has been linked to climate change, results in the effective diversion of autumn storm systems to the south of the basin.

It is not known how long this weather condition will persist into the future.

We have witnessed similar changes in precipitation patterns and snowpack accumulation in the upland regions of the Saskatchewan River Basin. While there is no clear indication of what future changes might occur, presently snowfall is on average diminishing on the east slopes of the Rocky Mountains. While some years bear greater resemblance to established means, the trend appears to be toward more rain and less snow in the Rockies during winter, early peak snowmelt and longer drier summers. If this pattern continues we should expect lower average flows in prairie rivers and more tension over water rights and uses.

4. Extreme Low Stream In-Flows

Another factor that made the current drought different from what Australians have experienced in the past is that total Murray River system flow during 2006-2007 was approximately 60% below the previous record minimum. As of July in 2006, Dartmouth Dam, despite a decade of very dry conditions, was filled to approximately 65% of its storage capacity. By June of 2007, the dam held only 13% of its capacity. This was unprecedented in the history of settlement in the basin and almost completely exhausted the system’s main drought storage reservoir at Dartmouth Dam. As Wendy Craik and James Cleaver point out, the exhaustion of this reservoir has resulted in the need to allocate water almost entirely on the basis of real time inflows. Craik and Cleaver also

make it clear that even if normal rainfall conditions were immediately restored, it will still take years to restore former high water storage levels behind the Dartmouth Dam.

The lesson for us in Canada is that it can take a very long time to recover from severe drought, especially if that drought is of an intensity or duration that exceeds the baseline conditions to which drought protection infrastructure was meant to respond. The Australian example suggests that we need to revisit the standards to which we build and operate our water-related infrastructure so that we can be prepared for droughts of much longer duration than those upon which our drought protection strategies have been established.

5. Extremely Dry Years, One After Another

Another thing that makes the current drought in Australia different from any that have preceded it is that it has violated all past established drought patterns. Never before in the recorded history of the Murray-Darling Basin, has one extremely dry year been followed immediately by another that has been just as dry. It just hasn't happened before.

Prior to the back-to-back dry years of 2006-2007 and 2007-2008, every extremely dry year in the meteorological record of southeastern Australia was followed by significantly wetter years. Every one of the really dry years known to occur in the past which include 1902-1903, 1914-1915 and 1982-1983 all marked the end of drought periods. Australians know now, however, that they can no longer expect things to get better as a matter of course. If it is possible to have two extremely dry years in a row, why not three?

Current climate change impact models for Australia have projected that droughts of the current magnitude could become the norm by 2050 under business-as-usual global emissions scenarios. It is not something Australians want to come to pass.

A drought of the intensity of the one that is currently baking Australia leaves little room for speculation as to whether or not a warmer world might be more desirable than the one in which we presently live. The three million people who rely on the Murray-Darling Basin for the water they need to live have glimpsed what climate change might mean on their continent in their time. Climate change is not something that is happening somewhere else to someone else. It is happening to them. Many Australians are frightened by what the future might bring in an even warmer world than the one in which we live today. This, ultimately, will have political implications.

The lesson for Canada is that the past is no longer a guide to the future. What we took for granted about our climate patterns is no longer a reliable indication of what may happen in an era defined by a warmer and therefore more energetic atmosphere.

We are already seeing this in Canada with the increase in tornadoes, the rising frequency and intensity of extreme rainfall and snowfall events and in rising night-time and winter temperatures.

What Australia Did About the Drought Crisis

In November of 2006, extremely low storage levels, rising concerns that the dry conditions might persist and growing water availability problems throughout the Murray-Darling Basin forced Australian Prime Minister John Howard to convene a drought summit with the Premiers of the Basin states. The Prime Minister and Premiers organized a contingency planning group whose function it would be to ensure water delivery for critical human activities in the basin during the following year. The Murray-Darling Basin Commission was part of this group.

As Wendy Craik reported at the Rosenberg International Forum on Water Policy, partner governments responded to the unprecedented circumstances that existed during the 2006 to 2008 period by developing and implementing a range of strategies aimed at reducing the impact of the drought on the irrigation community and on towns and cities in the basin.

1. The Introduction of Allocation Carry-Over Privileges

One of the first things the Australians did was to alleviate as much as possible the stress on particularly hard-hit irrigators by allowing them to carry over part of their water allocation from one season to the next. This emergency measure served to better clarify the risks individual farmers might be prepared to take from one year to the next.

2. The Development of Effective Emergency Water Conservation Measures

In association with other members of the contingency planning group, the Murray-Darling Basin Commission developed a series of water saving measures in order to secure critical minimum water supplies for urban, domestic and livestock needs in areas most seriously affected by the drought. Some of these measures, such as the disconnecting of wetlands to their outlets and reducing minimum winter flow releases from the two main dams in the basin, were by necessity difficult trade-offs to make. Much was learned through this process, however, that will be of inestimable value should the Murray-Darling face similar drought extremes in the future.

3. Changes To Historic River Management Operating Rules

As happens in Canada during dry periods, all water demands in the Murray-Darling Basin during the drought had to be managed by way of planned releases from the two major headwater dams. The unprecedented duration of the dry conditions made it necessary to change historical river operation strategies in order to minimize losses and maximize water availability wherever possible.

While crucial to addressing serious water scarcity problems, changes in the operating rules of dams and other storage systems could not but further impact the health of natural systems that were already starved of water. Changes in dam release regimes also affected recreation.

4. Changes To Planning Regimes

The drought forced the Murray-Darling Basin Commission and State governments to re-evaluate how critical water supply requirements are guaranteed. This demanded an on-going re-calibration of all planning minimums and crisis management criteria around the new and far more demanding parameters that suddenly came into existence with the current drought.

5. Encouragement of Water Markets

It was clearly demonstrated, as it has been in Canada, that the opportunity to buy or sell water allows individual irrigators greater flexibility to meet the challenges imposed by drought. Preliminary estimates offered by Wendy Craik and James Cleaver suggest that up to 35% of all allocations were traded during the austral summer of 2007-2008.

Problems That Have Yet To Be Solved

The worst appears to be over in the Murray-Darling Basin, at least for the moment. Critical water requirements for the austral summer of 2008-2009 appear to have been reasonably well secured, a number of contingency measure have already been implemented and a successful water market appears poised to reduce the economic costs of further drought. There are, however, a number of issues that won't go away until the dry conditions that still prevail in the Murray-Darling come to an end.

Acidic Sulphate Soil Problems

As happens everywhere when wetlands are drained or allowed to dry out, the re-wetting of dried acid-sulphate sediments in exposed wetlands is leading to heavy metal mobilization in some areas of the basin. Rehabilitation of wetlands that have been drained or allowed to dry out as a consequence of not supplying enough water to nature are going to be expensive and will take a long time to rehabilitate.

On-Going Environmental Impacts

The decision to optimize irrigation water supply at the expense of natural environments has come home to roost in the Murray-Darling system. The total amount of water made available to sustain environmental functions such natural aquatic and riparian ecosystem health in the basin between 2006 and 2008 was only 1% of the water that was made available to irrigators. Under natural conditions, significant inundation of floodplain ecosystems occurs approximately every six years. Had irrigation not demanded almost all of the available Murray-Darling water, significant flood inundation would have taken place in 2001. It didn't. At the time of this writing there had been virtually no floodplain inundation in the Murray-Darling system for more than 16 years. In other words, the dedication of almost all water resources to human purposes exacerbated the effect of the drought on natural systems which may have, in part, exacerbated the intensity and

contributed to the extended duration of dry conditions that were at the heart of the drought.

Although floodplain ecosystems are well adapted to climatic variability, the combined impact of habitat fragmentation and loss, severe, on-going drought conditions and over-allocation to agriculture exceeds ecosystem capacity to survive. The Murray-Darling system stands to lose important bio-diversity based ecosystem products and services that in the end may prove just as important to the people who live in Australia as the provision of water for food production. The hard choices Australians were forced to make as a consequence of over-allocating their water resources are likely to result in the diminishment of the overall ecological vitality of their continent forever with unforeseen consequences to be borne by future generations. These are the kinds of choices Canadians would be wise to avoid having to make.

Reservoir Storage Levels

Historically, “wet years” are required to restore reservoir levels after a lengthy drought. Under average inflow conditions – which do not yet exist – and under existing water allocation policy, it is anticipated that it would take seven years for the reservoir behind the Dartmouth Dam to refill. Given that in dry and even average years, water allocation levels are such that there is little net change to storage levels, continuing dry conditions will slow or even halt the recovery of reservoir levels. This translates into continuing system vulnerability to droughts that may occur in the near future.

Continuing record low inflows are likely to result in very low storage levels in the coming year. What will happen after that is impossible to guess. The lesson for Canada is that once reservoir levels are depleted, a society has very little room to move in terms of water allocation choices until normal precipitation patterns are restored. If patterns related to the timing and extent of precipitation are interrupted or altered by climate change or other impacts, however, even the most expensive infrastructure may no longer be of much use in adapting to drought circumstances. Reservoirs are not of much use if over the long term there is not enough rain to fill them or if annual withdrawals are so great they can never collect enough water to be of use when scarcity can only be addressed through long-term storage.

Can Agriculture In The Murray-Darling Basin Survive?

Wendy Craik and James Cleaver conclude their paper with an interesting discussion about whether or not existing agricultural systems in the Murray-Darling Basin are adaptable enough to survive in a “high impact” climate change scenario of the kind that has been projected for that region of Australia.

The Australian example suggests that you can do well if you have water to sell as exemplified by dairy operations that were able to grow in size during the drought by selling excess water at the higher prices that increasing scarcity creates.

On the other hand, the Australian example also puts into clear relief the impact that prolonged drought can have on water-intensive operations for which no substitute exists for water. Rice production in the Murray-Darling Basin fell by 83% during the drought. Some citrus crops simply ceased to be grown. There were, however, some surprising turns of events. Though grape production fell by 1/3 vintners in possession of only 32% of their average annual water allocations still managed to produce outstanding wines. Highly valued in the marketplace, prices for these wines rose compensating to some extent for the impacts associated with having less water available for production.

If you look at agricultural productivity only – and do not contaminate the argument with concerns about expanded regional ecosystem health – the case can be made that irrigation agro-ecosystems in the Murray-Darling Basin may possess the adaptability necessary to survive persistent drought conditions. One study conducted by the Australian Bureau of Agricultural and Resource Economics suggested that the country's farmers were resilient. The model upon which the study was conducted suggested that a 20% reduction in water availability as a result of climate change would reduce farm profit by only 1.6% to 6.8%. This, however, does not take into account the cost externalities associated with providing water exclusively to agricultural ecosystems over the long term without regard to the water needs of other service providing ecosystem functions. Such an argument can only be made if no thought is given to the damage that focusing entirely on the maintenance of irrigation agriculture at the expense of the ecosystems that surround them will cause in the long term.

In the wake of recent drought-related developments in Australia, three important areas of consideration remain entirely unresolved. The first is the security of existing water entitlements in an age when there may well be less water available regionally on a permanent basis. The second unresolved issue centres around how much water needs to be allocated to the environment and how that water will be freed in a time of much reduced water supply for such purposes. This concern demands that a full disclosure be made with respect to just how much water the environment needs to function sustainably in Australia and what kind of storage may be necessary in the future to supply water not just for people but for all the environmental processes that together allow the life support functions of this planet to operate to the level necessary to make human life not only possible but meaningful.

Finally, many issues related to water trade have yet to be clarified. Temporary and permanent water trade had significantly reduced the impact of drought at least for the moment. The system, however, is far from perfect. The length of time required to process a trade and restrictions to the amount of water than can be traded from an irrigation district and the purposes to which it can be permanent put remain unresolved. Trade in water rights can also have unintended consequences for the environment. Water trade can result in externalities in such diverse areas as river salinity, aquatic and riparian ecosystem health, water quality, river channel capacity, water delivery infrastructure and dam operations. All these considerations must be brought to bear in the water trade approval process.

The Affect of Water Trading on Existing & Future Transboundary Water Agreements

Water trading also has implications for transboundary agreements. Water sharing accords within Australia, not unlike Canada, are essentially bilateral arrangements that define the terms and conditions of water sharing agreements based on formulas that allow allocation of monthly flows between states and regions. Many of these agreements are predicated on a need to maintain river navigability. Strict adherence to bilateral water sharing protocols tied to singular practical interests may in the circumstances created by climate change stand in the way of public policy development that optimizes adaptability to the broadest range of emerging water availability and quality circumstances. Never before has it been more important to transcend the limitations of narrowly focused bilateral arrangements and move toward agreements that respond to the broader benefits that can only accrue through

While the Nile example continues to serve as an important model for how trans-boundary agreements should be crafted between sovereign nations in the future its lessons should also inform the intent and function of inter-provincial compacts within large countries like Australia and Canada. Presently relationships between provinces and territories in both of these countries appear have been defined by bilateral agreements of relatively limited scope. Many deal with how much water must cross provincial or state boundaries or with the management of the impacts of specific projects such as dams. In Western Canada just as in the Murray-Darling, there does not appear to be any effort being made to consider the environmental, ecological and economic benefits of cooperative approaches to integrating regional infrastructure, markets and trade. Despite the huge benefits demonstrated in basins such as the Nile, no similar analyses appear to exist in similar sized basins in either Australia or Canada in river basins that are just as critical in their respective national circumstances as the Nile is to Egypt.

The limits to the effectiveness of outdated bilateral water agreements have been well demonstrated on the Nile. Australian states and Canadian provinces may wish to learn from the Nile example and look for greater mutual benefit that can only be derived from full transboundary cooperation with respect to integrated water resource management.

We know that if we act now we will have less precedent to reverse and a longer period in which to enjoy the benefits of cooperation. With the Nile example in mind, it may be wise to consider beginning deliberations to this end before the signing of further bilateral agreements makes cooperation toward mutually beneficial outcomes more difficult or even impossible to achieve in the future.

In Conclusion

Wendy Craik and James Cleaver conclude their paper in a back-handedly positive way by suggesting that the Murray-Darling Basin may not need to wait until 2050 to experience severe impacts of climate change. The positive element of their message is that even severe climate change impacts need not necessarily result in a dramatic reduction of agricultural productivity in even the most severely affected regions of Australia. Numerous adaptive measures exist that can help farmers respond to severe water shortages. Public and private carry-over of water allocations, uniquely adaptive water sharing arrangements and drought contingency measures are short-term strategies that can be employed to deal with even the most extreme drought conditions. The real challenge, however, will be to create a public policy framework which will accommodate both “wet” and “dry” conditions.

As I read the paper Wendy Craik and James Cleaver presented and heard the presentation she made before the Rosenberg International Forum on Water Policy I was left with a slightly different view of the main lesson Australia offered to the world as a consequence of that country’s agonizing experience with the intensity of extreme drought. It occurred to me that many parts of the world, including Canada, can expect to experience many of the same kinds of conditions under even moderate climate change projections. While a great deal of future climate change impact can be minimized through proactive planning and adaptation, long-term adaptation cannot be achieved by short-term incremental public policy adjustments to climate change impacts like those implemented in Australia. What is needed is a fundamental shift in public policy that establishes water sharing arrangements not just for irrigation and other consumptive water uses but for environmental protection over the broadest range of climate change scenarios over the longest possible time frames. You have to be ahead of the problem to create such policies.

Once again I draw attention to the ordering of the presentations at the Rosenberg International Forum on Water Policy. Had Uriel Safriel been able to give his paper at the beginning of the forum rather than on the second day, it would have been impossible for the short-sightedness of Australia’s response to their current drought malaise to have escaped the full attention of the participants of the forum. If you believe that “natural” biodiversity-based ecosystems not only deserve equal access to water but that the prospects of human sustainability will be diminished in direct proportion to our failure to supply water to nature so that it can continue to supply life-support services to us then you will be unable to accept as reasonable Australia’s self-serving decision to provide water to irrigation agriculture at any cost to natural ecosystem function. If you accept Safriel’s wisdom with respect to the value of natural ecosystem function, you will not allow a country like Canada to use Australia’s response to its recent drought crisis as a basis for defining public policy responses to like threats in this country.

In the face of ecological collapse, Australia chose to save its irrigation community, if only because they had the greatest immediate political influence of the decision-making process at senior levels of government. If there is a real lesson for Canada it may be that

in the end saving your irrigated agricultural may not be the best choice especially if that is the only one you make. In a perfect storm you need to save the ship you are sailing on in order to save the sailors. Save your farmers at the expense of natural ecosystem health and all you may get is farmers and more drought. Save your natural ecosystems – especially the highly productive ones that clean and regulate water and climate – and just maybe they will save you, and the farmers, too.

Lessons For Canada & Alberta

So in summary, lessons for Canada and Alberta from this very important Australian public policy synopsis might be as follows:

1. There Are Many Similarities Between Australia & Canada

The similarities between the Murray-Darling system and the North and South Saskatchewan River basin in Canada are striking. The same number of people as rely on the Murray-Darling, about three million in three Canadian provinces, rely on the Saskatchewan for the water they need to live, to practice agricultural and to sustain industry. Like the Murray-Darling, the Saskatchewan is considered the “bread basket” of the vast nation in which it is located. Like Australia, Canada has developed significant irrigation capacity. Historically, the only reliable rainfall in the entire Murray-Darling system has occurred in the mountain regions of the Murray River. As is the case in so many watersheds including those in western Canada, the rest of the system relies heavily on the disproportionate amount of precipitation that falls in upland regions.

2. New Conditions Are Emerging That Will Make Drought More Severe in Both Countries

The drought in southeastern Australia was unlike any before it largely because of over-allocation of water rights in the past fifty years. The impacts associated with over-allocation were exacerbated by a measurable rise of atmospheric temperatures, changes in rainfall patterns, record low inflows and an historically unprecedented number of record dry years one after another. There are concerns that these conditions will persist or even become the norm under more extreme climate change scenarios.

What is presently happening in Australia offers insight into the kinds of difficulties Canada will inevitably have to address in the face of the more frequent, prolonged droughts that are projected to occur on the prairies under all current climate change scenarios.

3. The Immediate Past Is No Longer An Adequate Guide To the Future

What happened in Australia suggests that we have likely defined both our infrastructure standards and the often invisible institutional arrangements and economic instruments upon which we depend for our ultimate adaptability to prolonged drought on an inadequate baseline. We need to ask ourselves how we would deal with – not six years of

moderate drought we experienced in the 1930s – but ten years of water scarcity followed by a drought that was half-again as severe as anything our prairie civilization has ever experienced before.

4. Water Markets Can Alleviate Some of the Economic Hardship of Drought & Conservation Can Help But Neither Are A Panacea

Just as we did during the southern Alberta drought of 2000 and 2001, Australian irrigators successfully traded water allocation rights in order to reduce the economic impact of lost production. In addition to encouraging water markets, governments at all levels contributed to public policy that permitted the carrying-over of allocation privileges from one season to the next, altered operating rules for dams and related water storage systems, changed emergency measures parameters and involved everyone in the basin in strictly enforced water conservation programs. Many of these programs have now become the norm rather than the exception. But while all of these efforts combined did allow adequate water sharing to meet human needs, they ignored or failed to address nature's need for equitable access to water supply.

5. Expect Sustainability-Threatening Permanent Ecosystem Damage If Water Is Not Also Supplied Adequately To Nature

While southeast Australia has survived the drought it did not happen without long-term or even permanent damage to natural ecosystems. The dedication of almost all water resources to human purposes intensified the effect of the drought on natural systems which may have, in part, exacerbated the intensity and contributed to the extended duration of dry conditions that caused the drought to persist. Damage to aquatic and riparian ecosystems in the basin may be permanent which will reduce natural adaptive capacity in the face of future droughts thereby threatening long-term sustainability.

Given the recognized adaptive value of natural ecosystem function, a country like Canada may not wish to emulate Australia's public policy response to its recent drought crisis in the event of a similar threat on the Great Plains. But given that Alberta has already over-allocated much of its water resources, we may not have any choice but to respond in a manner similar to what Australia did, which would result in similar broader ecosystem damage and a consequent diminishment of the broader ecosystem health upon which our long-term sustainability ultimately depends.

6. It Takes A Long Time To Recover From Extended Drought

The impacts of prolonged drought persist long after rains return. Even if normal precipitation patterns are restored, it will take years for storage levels in basin dams to return to levels that will permit reliable water supply during dry years. In the absence of adequate storage the region will remain vulnerable to further drought conditions. Even after precipitation patterns return to normal, if indeed they do, damage to broader ecosystem function will continue if all water resources remain committed to human purposes and not enough water is made available to nature.

Ecological circumstances may never be the same again after a prolonged drought. Inappropriate response to drought can put on region on the slippery slope that leads toward ecosystem decline and gradual desertification.

7. Simply Doing More of the Same Will Not Allow For Adaptability To Long-Term Drought

Over-allocation of water resources to human purposes is a serious mistake that can make entire societies and the natural systems upon which they depend vulnerable to persistent water scarcity. As Australia discovered, a fundamental shift in public policy framework is required that establishes water sharing arrangements not just for irrigation and other consumptive water uses but for environmental protection over the broadest range of climate change scenarios over the longest possible time frames. Without such protection, broader adaptability to drought conditions cannot be maintained.

If there is a real lesson for Canada it may be that in the end saving your irrigation agricultural may not be the best choice if that is the only one you make. In a perfect storm you need to save the ship you are sailing on in order to save the sailors. Save your farmers at the expense of natural ecosystem health and all you may get is farmers and more drought. Save your natural ecosystems – especially the highly productive ones that capture, store, clean and regulate water and moderate climate – and just maybe they will save you, and the farmers, too.

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Even with the conclusion of formal presentations, our day was far from over. One of the great attractions of the Rosenberg program was that it also offered an opportunity for participants to visit the World's Fair site in Zaragoza, which was themed around the importance of water to human well-being.

At 6:00 PM, we boarded a bus at the hotel which took us to a special entrance gate at the Fair where we were cut loose to be on our own until the fair closed at 3:00 AM if we so desired. Though many of the pavilions seemed dedicated more to promoting tourism in their respective countries, some – usually the ones with the long lines – did commit themselves to a broader understanding of global water issues.

It did not take me long to find the official bookstore of the World's Fair which offered in English, French and Spanish a wide array of books meant to inspire greater public interest in water supply and quality concerns.

As it happened, however, I was called away in the midst of my bookstore deliberations by Kindy Gosal and Craig Richards who were with our Turkish friends, Ambassador Oktay Aksoy and Yuksel Inan. The playoffs of the European Soccer Championship were on and Turkey was about to play Germany. Could I join them for the game? Of course!

We gathered all of us at the restaurant in the Belgian Pavilion where we started out drinking the excellent beer from that country and watching the game with the rest of the assembled on a flat screen monitor that hung from the corner of the bar. Germany scored first but then Turkey scored twice before we realized that the tiny food portions and small beer glasses offered in the restaurant were so over-priced that our table was positioning itself to pay for Belgium's World's Fair presence if we didn't leave soon. We took taxis back to the outdoor bar near our hotel at which many of us had congregated after the formal opening ceremonies at the Edificio Pignatelli. Though we cheered wildly for the Turks they were unable, with the number of injuries they bore into the game from past matches, to hold off the disciplined and relentless Germans.



The Exposición Internacional at Sunset
Zaragoza 2008

Elias Fereres

Optimizing Water Productivity In Food Production

Elias Fereres is a professor at the Instituto de Agricultura Sostenible at the University of Cordoba in Cordoba, Spain. Like so many other Spanish water scholars Fereres studied in the United States where he became a good friend and respected colleague of Henry Vaux. His is an excellent speaker and an honest commentator on the current status of agriculture globally.

Fereres began by explaining that the “road map” leading to higher agricultural productivity globally has been widely known for several decades. Though not everyone liked to hear it, genetically improved seeds planted at the right time are now able to generate canopies which when supplied with enough water and nutrients and protected from pests, disease and weeds by agro-chemicals, accumulate bio-mass at high rates and produce high economic yields. Combined improvements in plant breeding and agronomy have led to a consistent and systematic increase in global crop productivity over the past 40 years. Since the turn of the Millennium, however, there has been a clear slowdown in the rate of productivity increase globally especially in the average yields of main crops. It is clear now, Fereres said, that the world is genuinely facing the risk of a food crisis.

Fereres argued that experts have for years been pointing out that the situation we face now would undoubtedly arise if governments and international organizations didn't react in the right way to emerging agricultural realities. Fereres cited the contents of a presentation he himself gave at Rosenberg II nine years ago when he put forward in conclusion that there appeared to be considerable uncertainty that the growing world food demand would be met in the next twenty years and that even greater uncertainty existed that the world would be able to meet its goal of eradicating or reducing the hunger that at the time of Fereres' presentation affected more than 800 million people worldwide.

The reasons global food productivity has been slowing over the past two decades are of great interest to Fereres. Fereres attributes the decline in the growth of agricultural productivity to a number of factors. The first is the success of the agricultural revolution in its own right. At present the yield gap which is defined as the difference between maximum potential and current average yields is much more difficult to close when actual yields approach potential values. Progress toward potential values was easy at first but as time passed progress slowed as more marginal soils went into production under less favourable climatic conditions.

Fereres was also blunt in arguing that another reason for slowing global food production increases was the short-sightedness of Europe and the United States in shifting agricultural subsidies away from productivity enhancement because of over-production concerns that were, in Fereres' opinion, only a short-term concern.

Another factor in the slowing of agricultural productivity gains globally is the lack of knowledge about the maintenance of long-term soil fertility and general ignorance of how to make agriculture more sustainable.

Finally, Fereres pointed out that innovation in the agricultural sector has slowed down, as Margaret Catley-Carlson pointed out in her keynote address, because of most if not all governments have reduced their investment in agricultural research and extension over the past 20 to 30 years. One of the reasons for this is that governments expected that plant biotechnologies were going to deliver huge increases in yield potential as well as in abiotic stress tolerance. These gains, however, have yet to be realized.

Why Agriculture Needs So Much Water

The water vapor pressure gradient between the interior of a leaf and the atmosphere is such that **for every molecule of CO₂ taken up in photosynthesis, between 50 and 100 molecules of H₂O are lost.** Thus, the use of large amounts of water by crops is dictated by the evaporative demand of the environment and is tightly associated with biomass production and yield. Thus production of food requires large volumes of water, as indicated by the well-known fact that 70% of all the water diverted by our civilization is used in agriculture.

Fereres has not given up on the possibility of further crop productivity gains, which he believes must come from further attention to two critical domains, efficiency and maintenance. In terms of efficiency Fereres argued that we must do everything possible to increase the precision with which we manage inputs such as fertilizers, agrochemicals, water and energy so as to maximize production but also to minimize waste and pollution. Without attention to both of these aspects of efficiency modern agriculture will not be sustainable. Maintenance of agricultural ecosystems, Fereres maintained, also needed more attention if agricultural productivity increases were to have any hope of catching up to global food demands. Fereres argued that such maintenance has been widely neglected in recent years. Dr. Fereres cited a number of areas of concern including the maintenance of soil fertility, our failure to continually upgrade the resistance of major crop types to new races of disease through selective breeding as well as the maintenance of proper agricultural water balances. Fereres concluded by suggesting that efficiency and maintenance concerns were possible to address by simply examining past successes in which effective plant breeding went hand-in-hand with agronomic improvements to make continual productivity gains possible.

Fereres also went on to point out that current converging concerns related to growing global water scarcity and simultaneous declines in agricultural productivity only served to emphasize the urgency of increasing the efficiency of water use in agricultural production, a point that needs to be made again and again in the context of emerging issues of water scarcity in the Canadian West. In order to avoid both a water and a simultaneous food crisis we need to do everything we can to improve agricultural water productivity. Fereres does not believe we are investing enough in research to do that.

Fereres does, however, believe that it is possible to improve water productivity at least incrementally in agriculture. Though he does not believe it possible to significantly alter the photosynthetic process in order to reduce the amount of water plants actually needed to generate biomass, he does believe that water productivity can be enhanced by changing crop species or cultivars, changing the physical growing environment and/or by changing water management regimes.

Fereres pointed to the success that genetic engineering and plant biotechnology have had in generating new genetically modified cultivars that possess resistance to both pests and herbicides. This success, Fereres explained, has led to expectations that similar breakthroughs could be possible for the improvement of water productivity. Some progress in this area has been made under the aegis of what is usually described as drought resistance which properly refers to improving production when water is in short supply. Most of the advances so far, Fereres explained, were focused on plant survival under extreme water deficits, which represents only one variable in the water productivity formula. Fereres predicted that advances in biotechnology will continue to improve yields by improving crop response to hostile environments but that these improvements will occur incrementally at moderate rates.

Another way to improve water productivity is to modify the growing environment. The option that possesses the best potential to improve water productivity through environmental manipulation, in Fereres' estimation, is to grow crops at times of lowest evaporative demand. Fereres himself was involved in research that simulated the seasonal water requirements necessary to produce one ton of alfalfa in a semi-arid environment. The research proved that consumptive use of water in spring or fall was about half of what it was in summer. While similar gains appear to be possible with other crops like sunflowers, the limit to improving water productivity by changing the growing season was the fact that low evaporative demand is often associated with low solar radiation and low temperatures which slow down and even halt crop growth. Breeding tolerance to low temperatures could therefore, Fereres offered, be a worthy objective for further research into genetic improvements of crop types. The same effect, of course, can be achieved by growing crops in greenhouse conditions.

In the end, however, improvements in water productivity are not going to be achieved by simply influencing the growing environment. Measurable improvement will only be possible through the manipulation of all the factors that influence crop performance in both dryland and irrigated systems. By far the most environmental factor that has to be

better controlled is advanced knowledge of the available level of water supply in the face of seasonal scarcity. Fereres complained that with all of the investments made recently in climate change-related research it should not be unreasonable to expect far more reliable seasonal water availability predictions.

This expectation, however, is not being met which in itself points to a lesson for Canada and particularly for Alberta. Everyone in the water-stressed world is calling for improved seasonal water availability forecasts but very little money is being invested in the monitoring, data collection and interpretation that are necessary to make improvements in this kind of forecasting possible. But, according to Fereres, there is more. Coupled with the uncertainty of seasonal water availability forecasts is conservatism within water management agencies that makes them reluctant to include multi-year water storage in their water planning scenarios. The result is that almost worldwide growers do not have adequate information to plan ahead even though the capacity actually exists to use simulation models coupled with long-term weather records to reduce uncertainty and risk when deciding how much water to allocate to different crops at the outset of any given growing season.

Fereres referred at length to the value of models that simulated a broad range of important parameters starting at the water content of the crop root zone which have been used widely in the attempt to develop better water balance models. Fereres referred specifically to the usefulness of a modelling suite named AquaCrop which is used widely in the United States to simulate attainable yields based on current projections of water availability.

The model, Fereres explained, simulates the water content of crop root zones over time using a water balance model. Fereres proposed that the coupling of the AquaCrop tool with economic optimization models would allow the development of decision-making support systems that would work over time. These systems, he said, must be made to respond to more than just the water availability needs of crops but to the needs of ecosystems in which the crops are grown. In other words, the advancement of aquatic ecosystem health is gradually becoming more important in our assessment of adaptation and in our analysis of what separates sustainability from its opposite.

Models suddenly matter, especially if they can help you imagine a future you want as opposed to a future you might inherit as a consequence of neglect. Analyses of what we might become have placed the importance of long-term natural history observations into relief. We need better monitoring and we to employ the kinds of models that good data can make available to us. Given the serious obstacles we have faced in even having the opportunity to pilot the Oasis-based South Saskatchewan River Basin Model, the growing international focus on the usefulness of such models should put the Province of Alberta on notice that far more progressive institutional cooperation is going to be necessary if we are to achieve the water management finesse to which we aspire in the Canadian West.

We cannot expect to be successful in managing our water resources over the long-term if we reject outright valuable new tools simply because they conflict with inferior traditional mechanisms by which water resources were managed in order to satisfy single industry interests without consideration of the common good.

Fereres concluded his paper and his presentation with a discussion of recent advances in real-time remote sensing of field water use at a level of precision sufficient to permit improvements in water productivity. Fereres pointed to new research that combined satellite imagery with land-surface energy balance calculations that resulted in more accurate accounting of field-level evapotranspiration. The current weakness in this approach, Fereres explained, was that the 14 day interval between satellite observations was too long and the resulting image pixel sizes too large to be useful in advising individual farmers on how best to manage water.

Fereres then demonstrated how these obstacles are being overcome through the development of unmanned aerial drones carrying sensors that can fly daily or even several times a day over any given field collecting thermal and multi-spectral images that once processed and interpreted are detailed enough to perhaps herald a new era in improved irrigation management and thus a breakthrough in increased water productivity in crop production.

In addition to the contents of his paper, Fereres made some very interesting asides in his presentation that are worthy of note. One of the most important observations he made was that we have been far more successful in increasing yield than in decreasing water use, which suggested to him that we have only gone half way in meeting the global food production and water supply challenge. We are already using almost all the water available to us to grow food in many parts of the world, and already we are falling behind in our efforts to grow enough to keep up with the needs of our ever-expanding global population. This has become a Catch-22. We can't grow more food unless we improve our water productivity so that we can free up more water to grow food. But that is not what we are doing. We are 40% - 50% more efficient with respect to agricultural production but we are using every last drop. Water is not being freed up to support the maintenance of the biodiversity-based ecosystem provision Uriel Safriel is arguing is so important to the planetary life-support function upon which the sustainability of both "natural" and agricultural ecosystem health ultimately depend. "Instead of water policy," Fereres quipped, "what we really need is water police."

Instead of water policy, what we really need is water police.

Elias Fereres

Fereres also commented on the importance of understanding the progress that has been made through bio-engineering on the development of crop types that require fewer

pesticides. In his estimation it was unfortunate that these advances were not being recognized as they should be because of general public resistance to genetically modified food crops. Fereres argued that this resistance is not rational. "Why," Fereres questioned, "don't the Greens accept genetically modified foods? Is it because they don't like the corporations that developed them?" Not a bad point, Dr. Fereres.

The last remark Dr. Fereres made is one that is worthy of further investigation in the context of the lesson it may offer policy-makers responsible for the agricultural future of the Canadian West. Fereres put forward that we are presently in an era of great changes in irrigation technology. Fereres made the comment that superior drip irrigation systems are now being employed far more widely and are scheduled to replace surface systems as the dominant technology by 2070. This development could have real bearing on water management and the future of agriculture in the Canadian West.

When I asked David Hill, who was at the time Executive Director of the Alberta Irrigation Projects Association, why drip technology was not being employed in irrigation in Alberta he responded by stating that the technology was too expensive and that irrigators had already too much invested in the technology they were presently using. The second reason he offered was that the geographical area being irrigated presently is simply too vast to even consider using drip technology even if it was far more efficient. This situation, however, may have changed.

There may be a way of resolving or at least alleviating southern Alberta's intensifying water crisis by thinking about the kind of future Fereres was predicting would soon come into existence and how that future might be made to serve us. Presently there is a moratorium on the issuance of further water licenses which means you can't simply apply for more river water for new developments or emerging uses no matter how economically important they might potentially be. If you want water for purposes for which no current allocation exists you have to buy the right to use the water you need from someone who already possesses that right. Such rights have been granted in Alberta on a seniority basis which gives license holders access to water first and the right to take all to which they are entitled before more junior users can take a drop. Almost all of the senior water rights in southern Alberta are held by irrigation farmers who are permitted by the seniority of their licenses to take all the water to which they are entitled and put it to whatever agricultural purposes to which they desire for as long as they like before towns, cities and industries which came into existence after agriculture established this rights hierarchy are entitled to water for their purposes.

While this system has worked acceptably well during periods of normal river flow and smaller populations, it breaks down in periods of prolonged drought. It is also coming under greater and greater scrutiny as southern Alberta communities grow and the regional economy expands placing more pressure on limited available water resources. With climate change effects expected to reduce the amount of water available as a whole, we should expect that soon the weaknesses and inconsistencies inherent in the first-in-time, first-in-right water allocation tradition will be put into what might be very public relief.

Currently, the Government of Alberta appears to be favoring a market-based solution to this problem in which markets will be encouraged so that existing allocation rights will gravitate toward economically higher uses as water becomes more scarce and its value rises. There are two recognized problems associated with this approach. The first is that it does not guarantee more water for nature. Even if, as the government has proposed, a hold-back for nature of say 10% of the allocated is clawed back as part of each major market transaction, increased utilization of full license allocation demanded by the rising cost of water will likely mean less water in the river because license holders will have greater economic incentive to use all of the water to which they are entitled which seldom happens under current allocation regimes in which water is provided at very little cost especially to irrigators. The second problem widely associated with the market approach is that current license holders are the beneficiaries of the growing value of water and the higher trading prices for licenses. Invariably this leads to hoarding and speculation and to growing tension over who gets water for what purpose; issues that end up having to be resolved more and more in the courts.

What we are presently heading toward is the American system of water market opportunism that for decades we have declared we want to avoid. So what is it that Elias Fereres said that suggested a different possible future circumstance that the one toward which we appear almost certainly to be headed? What he said is that we are in the midst of an irrigation technology revolution that could dramatically improve water productivity in Alberta. Initially at least that technology is going to be expensive far beyond what irrigators today can afford. And herein resides, in Alberta at least, a potential opportunity. We could explore how much less water would be required to maintain current irrigated agricultural production with drip as opposed to today's far less efficient spray pivot irrigation technology. Let's say for the purposes of discussion only that the water productivity savings would be 50% and that the cost of buying and installing drip systems over the 1.3 million acres of southern Alberta already under irrigation was reduced through technological innovation to \$5000 an acre. If this were the case then you could free up half of the 70% of the water presently allocated to irrigation in the South Saskatchewan River Basin in Alberta for about \$6.5 billion without diminishing production. This would leave more water for aquatic ecosystem health, for expansion of irrigated agriculture and for other economic uses while at the same time upgrading the province's food production capacity to the very best that exists in the world.

In exchange for this level of public support irrigation districts would have to give up – not their licenses – but the first-in-time, first-in-right condition that currently stands in the way of the success of Alberta's progressive Water for Life strategy direction. Everybody wins for such a proposal. Water is freed up for nature and for further economic development, agricultural capacity is enhanced and long-term agricultural sustainability assured, adaptability to climate change effects is strengthened, and the people of the Province of Alberta are presented with the opportunity to create a water management regime that respects the value of water as a public good and environmental benefit. The Province of Alberta finally becomes the envy and an example for the rest of the world in terms of the way it manages water.



The Parbelló Iniciativas Cuidadas with the Plaza Temática Sed in the foreground.

Shawki Barghouti

Water Productivity: Challenges Facing Agricultural Development

Though Shawki Barghouti was not present to give his paper at the Forum, there were a number of points he made about modern agriculture as seen from an Arab perspective that many found compelling. The Director General of the International Centre for Biosaline Agriculture and a member of the Arab Water Academy in the United Arab Emirates, Dr. Barghouti knows a great deal about irrigation agriculture. In his paper on water productivity challenges facing agricultural development, Dr. Barghouti observed that a slowing of yield growth in Asia was due to a reduction in the level of investment in infrastructure and research, a shift toward more profitable crops, the reaching of productivity limits made possible by application of fertilizers and pesticides and resource and environmental limitations and constraints imposed on further agricultural productivity by ineffective or inappropriate public policy.

He then went on to point out that more open trading regimes and declining water supplies in many regions of the world could as forecasted by Hong Yang make grain imports more attractive than local production. He pointed out that, on the other hand, upward trends in grain prices could have the opposite effect. Public investment in agriculture even in water-scarce areas could grow as the pressure to provide affordable wheat and rice to millions of poor households in places like South and East Asia increases. Dr. Barghouti also noted that subsidies aimed at diverting more crops to biofuel production could also have a significant impact on attitudes toward the need to achieve greater national food supply security worldwide.

In thinking about what Dr. Barghouti said, one wonders if current Canadian agricultural policy might not be making us doubly vulnerable. Rising crop prices make our agricultural products more expensive on the world market forcing many countries to grow their own wheat instead of buying it from us. Our misplaced commitment to biofuel production at the expense of food crops will continue to put upward pressure on cereal prices creating a vicious circle into which other nations may not wish to be drawn through trade with Canada.

Dr. Barghouti went on to say what Uriel Safriel, Pete Loucks, Malin Falkenmark and Margaret Catley-Carlson said about the growing threat unsustainable agricultural practices were beginning to pose in terms of their impact on the global natural resource base. Barghouti then pointed to the fact that approximately 16% of agricultural soils are currently degraded with significant impacts on food production, rural incomes and national economies. He noted that the potential to expand the global cultivated land area is nearly exhausted demanding that available water resources be used more efficiently, especially given that global fish stocks are also in decline. After claiming that agriculture was the planet's greatest user and abuser of our natural resource base, Barghouti underscored his point that agriculture has reached the limits of available natural resources by illustrating declining per capita water availability worldwide.

Barghouti's central point is that measuring the productivity of the water sector in terms of its short-term contribution to economic growth and national food security is different from measuring water productivity in real terms at the field level. We may increase water productivity at the field level through improvement of on-farm water management, better crop husbandry and advances in irrigation technology but these measures are meaningless if they do not take into account the adverse impacts these approaches may have on water quality or the degradation of aquatic ecosystems.

Barghouti is concerned that when we talk about water conservation in agriculture we may be deluding ourselves. Barghouti does not believe we are talking about actual water conservation in agriculture if water freed up through conservation measures is not contributed directly to the provision of environmental services. In other words, freeing up water through improved efficiency and then simply committing it to further agricultural expansion is not water conservation because even though it may contribute on the short-term to economic growth or national food security it continues to rob biodiversity-based ecosystem functions of the water needed to supply services that will prove ultimately to be every bit as valuable and important to people as food production.

Barghouti notes that we are already at the limits of water availability in many parts of the world. He also observes that we are also heading for declines in food production in many places. For this reason many countries are exploring non-conventional sources of water. These include deep water aquifers, which can only be exploited at high pumping and transportation costs, and investment in sea water desalination. Barghouti mirrored the views of many others in suggesting that the pressure to reallocate water among different users is likely to intensify worldwide in the next decade. He then pointed out that since agriculture is the main user of scarce water resources, pressure is mounting in places like the United States, the Middle East, North Africa and South Asia to reconsider how much water should justifiably go to agriculture.

Around the world, formal justification of water allocation has increasingly been pressed to include expanded considerations of the needs of growing urban populations and new industries. In addition it is gradually being accepted that more water globally has to be allocated to address serious impacts on ecosystem service provision caused by short-sighted investments in previous years in water management regimes that ignored the need

to allocate water for environmental protection. Barghouti then committed what would be the ultimate heresy in southern Alberta. He observed that an important question is being asked more and more frequently around the world and then asked it. Does agriculture do enough for the economy and are its impacts on surrounding environments neutral enough to justify agriculture's disproportionate water allocation?

In Alberta the irrigation community has aggressively acted to prevent this question from being asked with any seriousness by stressing its own efforts to increase water productivity as measured by such standards as "crop per drop" and "cash per drop" which reinforce the notion of responsible farm families practicing the highest level of land stewardship. While it would almost be unpatriotic to suggest that agriculture isn't committed to the highest standards of stewardship the fact remains that prairie irrigators measure their success by self-serving productivity standards that in no way account for the impacts this water-intensive form of agriculture has on the production of goods and services of equal long-term value that are no longer functioning for want of water or because the water that is returned to nature after it has been used by agriculture is of poor quality or has been contaminated to such an extent that it can no longer contribute in the way it once did to enhancing aquatic or terrestrial ecosystem vitality.

The fact is that this form of agriculture is not practically or environmentally sustainable has escaped broader public notice for generations. Now that water has become scarce on the Canadian prairies, however, agricultural water use will not escape the attention of a growing urban population. Our society is no longer in the thrall of the myth of the family farm and farmers committed from birth to the best thing for the preservation of the land at all costs. In the public imagination, agriculture is on the way to being viewed as just one more industry and its ultimate motives and impacts no less suspect than those of the oil industry. While the agriculture industry's confidence in its own public relations remains high, it will be increasingly difficult for agriculture to prevent long-established myths from coming under closer scrutiny once public attention is focused on the growing global and national environmental impacts that are being caused by non-sustainable agricultural practices.

The public is unlikely to know who to believe or what public policy direction should be followed when it becomes clear that agricultural allocations are robbing nature of the water it needs to do things for us and for the world that may ultimately be as important in the long-term as agricultural production is on the short-term. It would seem likely that initially agricultural will not countenance any suggestion of its lack of sustainability. Nor is it as an industry willingly going to grant more water for nature when there are so many people who rely on agriculture for their livelihood and so many people who need to be fed.

As a society we may have painted ourselves into a corner. There are too many of us and our diverse business and religious traditions and a fear of being overwhelmed by culturally different others will not permit us to reduce our numbers. Our agriculture and resource needs have become so substantial that they are shutting down other life-support processes upon which the entire global system depends for stability and sustainability.

We can see clearly what is happening but we can't do anything because no one wants to make compromises or sacrifices for fear that those who won't make those same sacrifices will triumph over them economically or politically. If there was ever an area of social science research that needs urgent attention it is this form of environmental *cum* economic brinksmanship that ignores the obvious impacts of rapid population growth, encourages agricultural practices globally that we know are non-sustainable, acknowledges that biodiversity losses are compromising the state of our global life-support systems and yet takes only token steps toward preventing such loss; and knowingly starves nature of the water it needs to provide services to people that we cannot afford or do not know how to supply for ourselves. While many describe this madness as strategic or calculated brinksmanship, in the end it may prove to be only a form of collective delusion.

The social science research we need to undertake must explore elements of our nature that would allow us to make apparently rational choices that support the constant pushing of every environmental constraint and limit until the system breaks down and has to be replaced by costly but inferior artificial solutions that we in turn push to the limits of failure. We may not be able to get much further as a society until we know what it is in our collective character that permits us to act in such a dangerous manner on one hand, and how it is that we have almost universally come to accept the consequences of such behaviour on the other. It may be that until we can understand why we are like this that more research into the damage we are doing to ourselves by what we are doing to the world will not yield meaningful results in the form of changed habits or effective action.

There are a great many people who believe that the marketplace will take care of this problem. Returning to Shawki Barghouti we are offered a glimpse of how market forces have already begun to dramatically influence attitudes toward common pool resources. In his paper, Dr. Barghouti cited a recent study conducted by the Asian Development Bank which estimated that the average price charged to urban customers by water utilities in 38 large Asian cities rose 88% in the four years between 1993 and 1997. While it would be interesting to know what happened since, Barghouti's point is very clear. Water supply in urban areas in many parts of the world is becoming more expensive to assure. The reasons for this include higher costs to develop more distant sources, more complex and therefore more expensive source development, the greater need for higher-cost treatment facilities and the lack of flexibility of other users of low-cost water. In mentioning the lack of flexibility of other users of low cost water, Barghouti was talking about irrigation farmers.

This general lack of flexibility within the global irrigation agriculture community with respect to the sharing of low-cost water with cities should be of interest to policy-makers in Alberta, especially given that the province's two major cities may be facing challenges, in one case, to how much water to which they have entitled; and in the other case to the amount of water available for future growth and development. As in much of Asia, Alberta also possesses an irrigation constituency. This constituency has strong views about the primacy of agriculture and powerful political connections it is not the least reluctant to call upon the moment challenges to historical water rights emerge. One

wonders, however, what would happen if the unit cost of water in Alberta's cities doubled or tripled because of the need to expand supplies as has happened in increasingly water-scarce parts of Asia. Could irrigators continue to assert their claims with the same effect in the court of public opinion as they have in the past? Probably not.

Barghouti cites a World Bank Evaluation Group Study in 2006 which in combination with studies by the UN's Food and Agricultural Organization and others provides interesting insight into irrigation investment. The report reviewed irrigation investment between 1994 and 2004 and found that the average cost of irrigating one hectare of land during the period of 1967 to 2003 was about US\$ 5021, ranging from \$6590 for new construction to \$2882 for rehabilitation. Not surprisingly, the study also noted there were significant diseconomies of scale as projects got smaller. In sub-Saharan Africa, where farms are small, the cost of new irrigation developments rose to between \$6500 and \$8500 per hectare. Barghouti noted that in Africa the cost-benefit of irrigated crops, especially low-value coarse grains such as sorghum and millet and even corn would not justify costly investment in irrigation in today's real markets. The cost-benefit of irrigation investment might, of course, all change with the current trend toward rising food prices. But even as that happens the rising value of water for purposes other than agriculture will continue to call into question whether such large allocations to growers can be justified economically.

A recent review by the World Bank concluded that the price change for municipal water supply was on average somewhere around 35% of the actual cost of supply, and that charges for water in many irrigation districts were even lower. The impacts of cheap water supply to irrigation, Dr. Barghouti pointed out, could no longer be ignored. Irrigation productivity rose dramatically over the past 40 years as a result of the Green Revolution. But, even if we disregard the environmental impacts caused by that revolution, we are no nearer to achieving global food security that we were 40 years ago because every time we come close to filling the food production gap population growth and ecosystem decline associated with water diversions to human purposes set us back. Barghouti pointed to analyses that suggest another 29% increase in irrigation area is needed by 2025 to meet the United Nations Millennium Goals for hunger reduction. Meanwhile, the environmental community which is concerned about larger ecosystem function would like to see irrigation decrease by 8% during the same period to reduce damage to natural ecosystem productivity.

These observations, of course, lead to a number of questions we should be asking ourselves in Canada and especially Alberta. What would the doubling of the unit cost of water do to agriculture on the Canadian prairies? What crops would you grow if the cost of water doubled?

After the initial smoke cleared, the agricultural community on the Canadian prairies would likely react to these questions with a great deal of soul-searching over the ultimate value of that to which water is presently allocated. As Shawki Barghouti points out in his paper, humans on average eat some 70 times more water than we drink. Food production is not only important in the context of nutrition but also in the context of hydration.

In response to such questions we should also expect the usual reflexive howl of bitter recrimination agriculture holds in ready reserve to aim at anyone who might so much as look sideways at the Holy Grail that is the family farm, though the non-sustainable agricultural practices that are diminishing natural ecosystem productivity are in the end just as threatening to traditional farming as they are to the environment.

The grim fact remains that we may be facing widespread global famine even before we deal with the challenge of allocating more water from agriculture to nature. As Shawki Barghouti pointed out the challenge to agricultural productivity is no more starkly evident than in the fact that per capita area for food production will decline from 0.44 hectares per person in 1961 to a projected 0.15 hectares per person in 2050. This represents a reduction of two-thirds in the area available on the planet to grow the food that each person alive will need to survive. Per capita food production per hectare must rise commensurately if we are to avoid mass famine among the rapidly growing populations of the developing world.

We are already putting a great deal of faith globally in an already stressed and demonstratively non-sustainable agriculture. Add the requirement of having to free up water for nature and what you have done is make a Sophie's Choice out of the future. Either you do everything you can to produce enough food to feed our teeming populations and risk bringing down the "natural" productivity that provides the stability and resilience upon which we depend for our long-term survival; or we give water to nature at the risk of condemning hundreds of millions of people to death by starvation. Name a politician that is prepared to make that choice.

Shawki Barghouti would argue that we have a few more cards to play before we are faced with such a terrible choice. In the Middle East the new paradigm for increasing water productivity revolves around the capacity to use water of marginal quality for food production. Barghouti puts forward that in most countries drinking water supplies in cities and towns account for only 10% to 15% of all water consumption. In contrast to agriculture where consumptive losses in the form of evapotranspiration and losses to non-recoverable sinks average around 50% at the field level, municipalities generally only consume 10% to 20% of their water. This, Barghouti suggests, means that 80% to 90% of municipal wastewater either becomes a disposal problem or is available for re-use nominally for agriculture.

At present only about 2% of current water use, in the Middle East at least, comes from treated wastewater, while some 50% of municipal water is released untreated. Barghouti

believes that municipal wastewater could become an important water resource in the Gulf State region if economically efficient and environmentally safe ways are found to re-use it. But this of course is not without its own problems. While the notion of water re-use has been touted so widely for so long it is beginning to sound like conventional wisdom, it may not be wise at all especially given the growing global problem that has emerged around food quality assurance. Concerns have also been widely expressed over the potential impacts of wastewater contaminants on soil structure and water infiltration, as well as on salinity and groundwater quality.

While Barghouti concluded the paper he was unable to be in Zaragoza to give with much on the importance of decentralizing the management of water down to the basin and community level that Helen Ingram and Margaret Wilder could explore in much great detail in their papers, participants at the Forum appeared to favour the treatment of municipal wastewater to the highest possible level affordable, preferring to stay away as much as possible from using untreated or partially treated wastewater to grow our food.



Exposición Internacional
Zaragoza 2008

Alberto Garrido

Lessons for Spain:
A Critical Assessment of the Role
Of Science & Society

Consuelo Varela-Ortega

Water Policies in Spain:
Balancing Water for Food
& Water for Nature

One of the most important sessions at the Sixth Rosenberg International Forum on Water Policy concerned itself with how the main themes that were explored in all of the other sessions manifested themselves in the water policy circumstances of our host country, Spain. It was chaired in his usual masterful way by Henry Vaux and powered by two complementary papers by renowned Spanish water scholars Alberto Garrido and Consuelo Verela-Orega.

As the content of these two papers overlapped with such an abundance of lessons for Canada and for Alberta I was compelled to meld the papers together with the extensive observations I made while examining this session's content before leaving for Spain. In so doing I discovered that what was happening in Spain was perhaps even more instructive to Canadians than what was happening in California.

A Very Long Road To Change What Canada and Alberta Can Learn From Spain

As the world becomes more crowded and we begin to reach limits in the availability of fundamental resources necessary to sustain our populations at desired levels of material expectation, public policy issues are emerging that we have never faced before. It appears we may be entering an era characterized by the most complex and difficult public policy choices that have ever had to be made in the history of human civilization. Some of the most difficult choices we will have to make will involve fresh water.

While droughts have always been serious threats to societal stability, there has never been a time in human history when cities began to compete with agriculture for water on such an expanded geographical scale. In many places in the world there is no longer enough water to grow food and to supply water for cities and for other uses. For the first time ever, human populations are beginning to compete not just with agriculture for water but to compete with nature itself for water supplies.

In Spain – as in many other parts of the world – tensions are rising over how water should be managed to ensure there is enough available to produce food, to meet growing urban needs and to ensure that adequate supplies of high enough quality water are available to

perpetuate essential natural ecosystem function. These growing tensions have led to dramatically increased public pressure to find ways to free up water currently perceived to be used for low productivity purposes by the agricultural sector so it can be used in other functions including ecosystem protection without at the same time severely damaging food production capacity and rural livelihoods.

As such tensions are likely to become universal as human populations grow and water scarcity becomes a greater problem world-wide, lessons Spain can offer in terms of public policy example may be of great value to nations and regions that presently face or will face similar public policy choices in the future. What Spain teaches others is that it is possible to downscale the global principles of sustainable water and agricultural policy to address regional water management practices. But as the Spanish example indicates, you may not get what you want at first, but with persistence it can be done.

Introduction: Water & Agriculture In Spain

According to Dr. Alberto Garrido, of the Technical University of Madrid, irrigation in Spain has been evolving for over 12 centuries. Over the course of development in the past century, irrigation agriculture expansion was founded upon supply-side policies that relied upon the construction of large-scale publicly funded water infrastructure such as dams, reservoirs and water distribution networks. Surface water was delivered at subsidized costs and irrigators were granted extensive water allocation concessions which in effect transferred water rights from public ownership into private hands.

The past 50 years, however, Spain has witnessed a great number innovations and improvements in irrigation agriculture productivity. Because of effective irrigation management during the last half century, there has been a silent explosion of population in arid lands that would otherwise not support many people. Breakthroughs in well drilling and pumping technologies also allowed for a silent explosion in groundwater utilization. All of these developments were encouraged through favourable domestic agricultural policies.

Following Spain's entry into the European Union in 1986, EU Common Agricultural Policy programs based on production-related subsidies further encouraged irrigation expansion. This led to positive development particularly in economic and socially stagnated parts of Spain. Irrigation became the main driver of prosperity and helped address many of the country's endemic drought problems. Unfortunately, the focus on irrigation development lead also to excessive groundwater mining and over exploitation of the La Mancha aquifer and subsequent degradation of important wetland areas. As the situation worsened, unlicensed expanded annual water withdrawals greatly exceeding the aquifer's natural recharge rate. By 1991, the aquifer was in serious trouble.

With the aim of reversing this potentially devastating ecological damage, two new policy structures were put in place. The local Guadiana River Basin Authority adopted a strict Water Abstraction Plan that imposed quotas on withdrawals which reduced entitled water

volumes to irrigators by almost half. Farmers strongly opposed the restrictions. Social unrest grew until the river basin authority found itself incapable of enforcing the policy or of controlling the actions of the irrigators.

In 1993, a parallel EU Common Agricultural Policy directive emerged as a result of broader EU agricultural reform. This new program's objective was to recover the damaged Guadiana wetlands by way of compensation to irrigators that voluntarily joined the effort to maintain the thriving agricultural economy of the region. Hard pressed by a five-year drought, an overwhelming majority of the region's farmers participated in the program. Though the program was extended for five years, its high cost and low-cost effectiveness led to its modification in 2003 when for the first time water use limitations were tied to both EU water management targets and to the national Spanish Water Plan.

In the meantime, Spain committed to its own very aggressive national irrigation improvement program. Since then adoption of modern irrigation technologies as well as better conveyance and management systems right from the reservoir to the farm gate have played a significant role in improving irrigation efficiency. At present, 35% of irrigated territories in Spain still employ traditional gravity irrigation. These areas are in the relatively water abundant regions of Castilla y León and Aragón. Modern pressurized irrigation systems cover 65% of total irrigated surface of Spain. Water scarcity and the resulting need for increased precision in water application has led to the expansion of drip irrigation for high value olive, vineyard and fruit crops, especially in the dry southern regions of Spain. Some 42% of the 65% of irrigated farmland served by pressurized systems is under drip irrigation. This means that 27% of all of the irrigated land in Spain is presently employing highly efficient drip irrigation technology.

Coming to terms with the need to balance the environmental impacts of agriculture with economic realities has not been easy, in Spain or anywhere else for that matter. Because of its Mediterranean climate, Spain's water problems are particularly acute. This is a view shared by Dr. Consuelo Varela-Ortega also of the Technical University of Madrid, who explained in her presentation that irrigated agriculture in Spain now occupies a mere 15% of all farmland but accounts for almost two-thirds of the nation's agricultural production value and for more than 80% of all farm exports. Productivity of irrigated crops, as measured by net margin per hectare on a national basis, is about 4.5 greater than that of rainfed crops. The value of production can be nine times higher in irrigation farming and is as much as 20 times higher in some southern regions. This productivity, however, does not come without costs. As in parts of Canada, irrigation agriculture in Spain consumes more than two-thirds of the entire country's water resources. It has reshaped the Spanish landscape which has caused considerable damage to river systems, aquatic ecosystems and to biodiversity.

Increased environmental damage, unacceptably high water losses in conveyance systems and increasing competition for water resources from other sectors and from growing urban areas made it necessary to launch an expensive nation-wide irrigation modernization program in 2003. But despite huge investments in improved irrigation efficiency Spain still does not have any more water to spare. Moreover actual total farm

productivity has not increased. While rapid evolution of new policies have resulted in changes in the crop types some growers now cultivate, farmers have proven themselves unwilling to give back the water they save so that it can be used for other purposes. Water savings go to more food production not to nature. According to Dr. Garrido, the non-agricultural academic community and the media have ignored both reforms and progress toward greater agricultural efficiency at lower environmental cost and focused unfairly on the failure of the sector to deliver up water savings. As a consequence, the Spanish public sees the irrigation community in an unprogressive and negative light. With some reason perhaps as we shall see. But no one has given up on a better future. The Spanish lesson tells us a great deal about how persistent public policy will have to be to balance the need to grow food with the urgency of sustaining vital ecosystem function.

From The Top: The European Union Common Agricultural Policy

There are two main public policy bodies that directly and indirectly affect water consumption in Spain and in other European Union States. The first of these is the European Union's Common Agricultural Policy or CAP. Through this program, which was initiated in the 1980s, irrigation expansion and increased water use was encouraged through higher-production subsidies that were granted for irrigated crops. This plan has clear benefits for farmers but stimulated overuse of irrigation water and undesirable impacts on aquatic and other ecosystems. As a consequence Common Agricultural Policy programs are progressively including new environmental regulations that support natural ecosystem protection.

The European Union Common Agricultural Policy reform of 2003, which is currently in force in all EU countries, no longer ties subsidies to farm-level agricultural productivity. Single farm payment subsidies are instead tied to a mandatory "cross compliance" scheme by which all farmers are required to comply with specific environmental and other regulations to qualify for receiving subsidies for specific crops. These regulations relate to soil-conservation tillage practices, use of fertilizers and chemicals and to the protection of flora and fauna. The Common Agricultural Policy reforms also demand more efficient water management measures to protect watercourses and climate change adaptation considerations.

Recent studies have argued that while these environmentally focused programs have contributed to better enforcement of ecosystem protection regulations throughout the EU, farmers in Spain are having difficulty in meeting environmental requirements. It has also been found that enforcement, control and follow-up of the many measures demanded by EU regulations entail burdensome costs for the regional administrations responsible for the implementation of these programs.

The 2005 iteration of the Common Agricultural Policy seeks to promote nothing less than a multifunctional environmentally-oriented sustainable agriculture. The foundation for this proposed new sustainability is the dual objective of increased agricultural production and water resources conservation on irrigated lands. The main thrust of this new policy is

shift away from intensively irrigated crops such as maize and legumes, in favour of other low water consumption crops such as winter cereals. As of 2008, maize had lost its comparative advantage as farmers producing it no longer benefitted from the higher yield-based subsidies that were part of previous EU Common Agricultural Policy. Low water demanding crops such as winter cereals now enjoy an equivalent subsidy under the new CAP rules. As a result land cropped for maize dropped by 22% while at the same time the area of land under cultivation for winter cereals increased by 13%. At the same time there was a parallel increase in the amount of irrigated land under olives and vineyards. The expansion of these crops demonstrated that higher profits could be obtained by specialized farming that took full advantage of modern drip irrigation technology and market opportunities to reduce demands on water resources. In actual fact, however, reductions in water use were small if they occurred at all.

The extent to which crop changes in Spain actually translated into a reduction in the area of irrigated lands and water use remains unclear. What is clear is that the water savings brought about through change in Common Agricultural Policy subsidies were not returned to nature or to river basin authorities for allocation to other users. Instead the water savings were invested in increases in the area irrigated lands that could be cultivated in high-value olives, vineyard and other products. In other words, actual water savings didn't materialize because water meant to be conserved through subsidies paid to farmers is simply being used to grow more crops. In the eyes of many observers, Spanish farmers managed to get their cake and eat it, too.

Despite the imposition of more environmental considerations, the principal goals of the EU Common Agricultural Program remain at odds with another European Union policy directive that seeks to measurably improve water quality in river basins in member states. This policy structure, which is the second major public policy structure that influences Spanish water use, is the European Union Water Framework Directive or WFD. Among other things, the Water Framework Directive employs water demand instruments and water pricing schemes to attain full cost recovery for all water services. If fully implemented, the WFD will have enormous impacts on irrigation agriculture in Spain and elsewhere.

The European Water Framework Directive

Possibly the single most important environmental legislation created since the inception of the European Union, the EU Water Framework Directive was enacted in 2000 with the goal of full Member State implementation by 2012. The Water Framework Directive is part of a wider public policy framework that has inspired the creation of the EU Sustainable Development Strategy which aims to promote a sustainable link between economic growth and the protection of natural ecosystem function and productivity.

The key objective of the Water Framework Directive is to achieve good ecological status of all water bodies in the European Union by 2010 and to promote sustainable water use over the long-term.

To these ends, the EU established that each Member State should carry out for all its river basins the following research:

1. analysis of each basin's characteristics
2. a review of the current and projected impacts of all human activities on the status of surface and on groundwater
3. a thorough economic analysis of water use

These requirements resulted in the completion of massive studies for each country in the European Union. Though some regional governments in Spain – including Catalonia – opted to exempt the farming sector from higher water tariffs demanded by the EU Water Framework Directive, every part of the country was subject to a thorough re-examination of the state of its water resources. This resulted in a complete overhaul of the inherited criteria by which all water monitoring was conducted and how data were recorded, interpreted and shared – something that desperately needed to be done in Spain and but also needs to be done in Canada if we are to aspire to more holistic management our of water resources.

The European Union Water Framework Directive calls for more efficient use of water resources. To achieve this, the framework calls for the application of economic instruments such as higher water tariffs to recover the costs of water services, including environmental as well as resources costs in accordance with the “Polluter Pays” principle. The Water Framework Directive also demands that water pricing policies must recognize the specific climatic and geographical circumstances and be respectful of the social, economic and environmental impacts of each EU region. In Spain it is not yet clear how principles of cost recovery will finally be applied.

It is widely held that in some parts of Spain at least, water consumption is not expected to decrease sharply when the cost of water increases to full-cost recovery levels because of inelastic demand related to already existing water scarcity deriving from existing climate conditions. It has been calculated by Consuelo Varela-Ortega and others that if the European Union Water Framework Directive is applied to the full cost recovery of water in Spain that farm incomes will be reduced two-fold in most of the river basins in which irrigation utilizes surface water without supplemental groundwater availability. Economic and social devastation in these areas will lead to irrigation abandonment and social conflict. Some places will be hit particularly hard. According to Dr. Varela-Ortega the full implementation of the EU Water Framework Directive will have especially devastating social and economic impacts on irrigation farms in Spain's less fertile inland regions. In other words, it will be farms on marginal lands that will be economically hurt.

Full implementation of the EU Water Framework Directive will also impact irrigators who enjoy the benefit of groundwater use. Groundwater irrigators already incur the full costs of irrigation operations. If, for example, irrigators utilizing the Western La Mancha aquifer were in fact required to recover environmental costs related to maintaining aquifer sustainability, tariffs would have to increase to the 0.54 Euros per cubic metre of withdrawal calculated to be necessary to stimulate a the 30% reduction in aquifer

withdrawals presently required to bring on recharge of the aquifer. This would reduce farm incomes in this area by 20%, unless farmers were able to change their crop types.

This is not how others see it. The EU argues that social, environmental and economic impacts can be reduced to tolerable levels if farmers on marginal agricultural lands invest in modern irrigation technologies and cultivate market-oriented, high value-added crops like vegetables and vineyard products. It has also been put forward that if farmers adjust their cropping mix to reduce water consumption, it will be possible to attain aquifer recharge targets that comply with Water Framework Directive requirements at tolerable social cost. Efforts are being made to move in exactly this direction but there remains a great deal of tension and doubt surrounding the achievability of these goals.

A microcosm of the world, there is tension even in the European Union over the tradeoffs that need to be made between the water quality and ecosystem integrity demands of the Water Framework Directive and the agricultural productivity and economic well-being expectations to which the Common Agricultural Policy aspires. The main battleground of these conflicting policies is the dry Mediterranean region of southern Spain. In Spain the European Union policy frameworks are not only to some extent at odds with one another they are also at odds with Spanish national legislation that assures water services to all users in all the country's river basins.

Spain's National Irrigation Rehabilitation Project

In 2000, the Spanish government embarked on a massive irrigation rehabilitation project that sought to modernize all of the irrigated regions in the country, which at the time still relied mostly on 19th century irrigation technology. The cornerstone of this modernization of existing irrigation technology is the goal of achieving total national average annual savings of 1,300 million cubic metres of water. Presently covering a surface area of 1.4 million hectares, or about 40% of all of Spain's irrigated lands, the plan aims to guarantee water demand to irrigators while at the same time reducing the impact of climate variability, mitigating drought effects, increasing farms competitiveness and crop diversification, encouraging expansion of irrigation-related industries and services, expanding employment opportunities and promoting population stability. Complementary ecological measures include better soil use and the reduction of contamination of rivers from agro-chemical residues.

About 80% of the 6 billion Euro budget was committed to modernization of existing networks. The average investment for modernization projects covered by the four Public agencies responsible for funding the National Irrigation Plan ranged between 4000 Euros and 5000 Euros per hectare, a high figure by international standards but not unreasonable given the degree of sophistication of the new pressurized and computer managed systems.

About 50% of the 6 billion Euro budget was financed by public funds. The other 50% of the project's cost is paid for by EU funds and by the irrigators who benefit from the program. The EU funds finances about 24% of the cost in low income areas and 17% in

other areas. Irrigators pay the rest but were permitted low interest loans of up to 50 years to minimize the hardship. But even with irrigators paying only 26% to 33% of the costs of modernization, it is a big load for an industry to carry. Though loans were of long duration, increasing capitalization in agriculture has dramatically increased farm debt. Outstanding farm debt increased from 1.5.8 billion Euros in 2004 to 21 billion Euros in 2006, making outstanding debt the equivalent of the entire agricultural sector's net income.

All 1.4 million hectares of the targeted irrigated areas Spain were re-planned and completely refurbished from scratch between 2000 and 2008. It was noted by Alberto Garrido that this expensive but urgently needed irrigation renewal program enjoyed bipartisan political support and continued uninterrupted through the terms of two different national governments. The program was, in fact, reenergized through the new "Priority Plan" which invested an additional 2.4 billion Euros in improvements to an additional 868,000 hectares between 2007 and 2009. Garrido further notes that since this national irrigation revitalization program began in 2000, it has met 100% of its objectives. This claim, however, seems somewhat at odds with the fact that the irrigation revitalization plan has yet to release water from agriculture to other purposes.

According to Alberto Garrido, evidence to support the beneficial effects of innovative irrigation management and improvements in technology is overwhelming. Water savings as a result of better management of application schedules of 30% to 40% without yield reduction have been reported. Technology shifts at both the on-farm and district level have demonstrated that effective water conservation makes solid economic sense. Control of key factors such as soil moisture has been found to contribute significantly to water consumption reductions. It has also been discovered that the most efficient irrigation schedule may not be the one that yields maximum production. The change in irrigation technologies is most evident where farmers are growing typical Mediterranean crops such as wine grapes and olives. By 2005, drip technologies well adapted to these particular crops became the dominant form of irrigation technology in the country. Some 1.3 million hectares of Spain are now efficiently irrigated by drip technology which is more than the area of land under irrigation in all of Canada.

If this was the end of the story, there would be no tension between agriculture and other water interests in Spain. Unfortunately, not all of Spain's water use is committed to high value crops. While modernization has made Spanish irrigation more efficient most of the water used in irrigation is still used mainly for low productivity farming. A comparison of water use, crop productivity and gross value-added, yields the realization that two-thirds of all water used in agriculture in Spain is utilized for crops with productivity ranges of less than 0.4 Euros per cubic metre. In other words, two-thirds of water employed in Spanish irrigation is utilized to produce only 16% of the gross value-added through that use. Only 4% of Spain's agricultural water allocation is used to high productivity crops which are defined as those that generate a value of 1 to 3 Euros or more of value for each cubic metre of water applied in production. But production of low value crops is only the beginning of the problem that is emerging in Spain. The real problem is that – even though billions were spent in improving irrigation technology at

the farm level, irrigators will not give any of their water saving back so that they can be used for other purposes.

In spite of all efforts to improve the efficiency of irrigation technology and the long-standing socio-economic benefits that accrued to irrigation farmers and rural communities, it is now questionable whether Spain's National Irrigation Program will achieve its water saving goals. The main reason for this is that in 80% of all systems water continues to be priced, not by volume of use as it was meant to be under current reforms, but at a low unit price tied to the surface area in irrigation. In other words there is not yet any incentive for farmers to use less water. In fact, reduction of conveyance losses has increased on-farm use of existing allocations and diminished return flows much to the detriment, in many cases, of already stressed surrounding natural aquatic systems. Spanish farmers are now, in many cases, using most if not all of their allocations and even less is going back to maintain natural system productivity that did before billions were invested in irrigation improvements. Out of this circumstance has emerged general public distrust of the selfish motives of the agriculture sector.

In 2007 the Ministry of Agriculture in Spain enacted a new law aimed at sustainable development of the rural environment. In accordance with the principles of "good ecological status of all water bodies" outlined in the EU Water Framework Directive, the law established regulations relating to environmental flows and recovery of over-drafted aquifers. As per the EU Water Framework Directive, the law also reinforced the use of economic instruments for the temporary or permanent purchase of water rights. In passing this legislation Spain made it clear it was serious about integrating EU and national policies with respect to water resources management through the coordination of the action plans of its own national water, environment and agriculture administrations. The key lesson here is that public policy has to respond to each new obstacle to achieve some kind of practical, functioning harmony between internal interests. This must be done first at the national level before it can inform regional policy synchronization and reshape the activities of private interests.

The Role of River Basin Authorities & Irrigation Associations in Spain

Spain has a long historical tradition of managing water resources on a watershed basis. The first single integrated basin management unit with competence in managing both surface and groundwater resources for all purposes and uses was created in the Ebro Basin in 1926. This was some 75 years before anything similar came into existence in Alberta.

Since that time some 15 River Basin Authorities (RBAs) have been created in Spain, each with considerable organizational, functional and economic autonomy. The national Water Act of 1985 enlarged the powers of country's river basin authorities as unified planning and management units. The act also introduced new environmental protection goals and gave additional powers to users at the decision-making level.

In addition to the 15 River Basin Authorities there are also some 7000 irrigation associations in Spain. These associations are collectively responsible for the management of more than 90% of all the irrigated lands in the country. Spanish irrigation associations have powers similar to those possessed by irrigation districts in Alberta. They are responsible for regulation of water distribution, the setting of water use tariffs, conflict resolution between users and input into basin watershed management plans. Because of the amount of water irrigators demand and the extent of the area of the land they cultivate, irrigation associations are key stakeholders in water management processes.

The Spanish experience suggests that River Basin Authorities as structured in Spain at least are well positioned – in principle at least – to respond effectively to the European Union Water Framework Directive requirements that demand a single unit management structure and public participation in the elaboration of water management plans. According to Consuelo Varela-Ortega, river basin authorities in Spain capably deal with supply and demand variability, climate change impacts and changes in water demand that have emerged as a consequence of agricultural policy reforms. River Basin Authorities throughout the country have also established participatory boards that invite direct, on-going input on water management decisions by irrigation associations and other water users. The EU Water Framework Directive, however, requires a more complex ecosystem-based vision of water resource management than is currently practiced at the river basin authority level in Spain. The EU framework seeks better integration of hydrological, technical, socio-economic and institutional factors. The other main pillars of the Water Framework Directive are transparency in data and information collection, greater public participation in management decisions and expanded stakeholder involvement, all of which have required further action on behalf of the river basin authorities. Most of the River Basin Authorities are responding to these challenges and prospects of success are favourable particularly in the more active basins. Adaptation to change, however, takes time.

Water Markets

Economic analysis of water use led to a reform of Spain's national Water Act in 1999 which permitted the revision of water concession rights to make transfers more flexible, which in turn stimulated the creation of formal water markets. Tailored specifically to issues of water availability and competition for water resources, a number of Spanish River Basin Authorities have established water exchange contracts, public tenders for purchasing water rights and Water Rights Exchange Centres. Among water users irrigators have been most active in exchanging water rights. Most are inter-basin exchanges that permit the transfer of water from the country's central basins to water scarce areas in southeastern Spain. These southward bound exchanges of water are expected to continue as long as they remain profitable for the exporting central regions. This, of course, will depend on the cost of water.

Because of the deeply entrenched system that existed at the time these new regulations took effect, it took seven years for these markets to begin to function as they were designed. The reforms opened up two avenues to enable rights-holders to lease out their

allocations either to basin authorities or to other users. The very simplest of these exchanges required only the agreement of two rights-holders and a formal application to exchange rights. In order to facilitate such exchanges, basin agencies were required to respond within 30 days. Unless major technical, environmental or third-party difficulties are encountered, applicants can expect rapid approval.

The second avenue open to those wishing to exchange water rights came into existence through the creation of water banks or exchange centres. Water banks in Spain are not independent organizations. In order to ensure transparency and to avoid third-party conflicts, Spanish water banks are hosted, operated and located within the basin agencies themselves. They appear to work, however, as farmers are now leasing out their full allotments from headwater resources that previously had been leased very inefficiently to other users who were not always located in the same basin.

Markets work both ways. Water rights can be sold and they can be bought back. In areas where aquifers have been overexploited, river basin authorities have resorted to public tenders for repurchasing water rights on either a temporary or permanent basis. The aim of these purchases is to reduce water over-pumping and to restore aquifers to sustainable levels. Some Water Rights Exchange Centres have been created almost solely with the aim of repurchasing groundwater from irrigators.

In some basins, groundwater is also repurchased so that it can be used to maintain and restore natural ecosystem function. Protection of the internationally recognized “Las Tablas de Daimiel” wetlands, for example, has been identified as central to the watershed management goals in the Upper Guadiana river basin.

Such programs have just been initiated in Spain. At the time the Rosenberg was held in Zaragoza in 2008, prices offered to irrigators to sell their rights permanently and to return to rainfed farming have not been high enough to attract sellers. It is clear that while such markets do offer a vehicle for adapting to the requirements of the European Union Water Framework Directive, the costs associated with buying back precious water resources is likely going to be very high. The cost for permanent water rights buy-back in Spain has averaged between 3000 Euros and 10,000 Euros per hectare, but even at these prices buy-back will only work if enough irrigators sell. That has yet to happen.

From this we begin to understand how the myth of the humble and kindly family farmer was dispelled in Spain and why there so much ill-will is currently directed toward to the country’s irrigation sector. Though it provides products that are essential to human existence, agriculture at the scale practiced in Spain is industrial in purpose and function. There is little that is altruistic about this kind of agriculture. Farmers in Spain, just like the farmers in Western Canada, are no strangers to hard times. They do not seek to feed a starving world. Spain is in possession of full understanding of blue and green water realities and the complexities of virtual water trade. Spanish farmers carefully choose the crops they grow on the basis of market price and seek the highest profit possible at the lowest possible cost of production, even if that sometimes means ignoring the long-term cost of environmental impacts. The Spanish agricultural sector sells food to people who

can afford to buy it. The markets for their products are generally countries in which average incomes are at or above the level they are in Spain.

The increasingly industrial and commercial character of modern European agriculture has resulted in a changing public perception of how much farmers should pay for water. Currently farmers in most regions of Spain benefit from water costs that are so low that they barely reflect the cost of operating and maintaining the systems that deliver it to their farms. Water scarcity, however, invariably attracts public attention to heavy water users. In the last decade the notion that farmers use excessive amounts of water because it is sold to them so cheaply that there is no incentive to use it more sparingly has become deeply ingrained in the public imagination. While irrigation associations in Spain continue to vigorously promote the industry's important historical contribution to Spanish stability and prosperity, commitment to efficient water use and the benefits of maintaining irrigated farms in rural areas, these arguments have lost some of their force. According to Alberta Garrido, irrigation sector pronouncements are too often seen in influential circles as mere public relations.

While few would disagree that the evolution of the Spanish irrigation system depends utterly upon the ability of the public and private sector to arrive at a unified vision of the future of the country, distrust of self-interest continues to stand in the way of progress. This is most unfortunate given how many millions of Euros having been spent on agricultural reform and improvement of irrigation technology.

Dr. Garrido goes on to point out that while this debate continues the importance and practical usefulness of the country's increasingly efficient irrigation system is being under-valued. The example Garrido puts forward is highly instructive. He notes that recently while Spain's second largest city, Barcelona, was facing serious water scarcity issues, few commentators or academics noted the fundamental "buffer" value that the irrigation sector can provide to urban areas. Garrido observes that because there was hardly any irrigation agriculture in the basin in which Barcelona's water supply originates, the city of five million people is less prepared for drought than other cities in arid Mediterranean environments because it lacks the capacity that can only be provided by irrigation districts to option upstream water rights. This, however, may be more of an argument for better drought preparedness than for further irrigation development.

Water Scarcity, Drought & Climate Change

Water withdrawals in Spain increased on average by 2% a year between 1997 and 2001 which represents a larger annual increase in water use than in any other southern European Union country. This heavy use makes Spain one of the greatest water using countries in the Mediterranean region. Projections indicate that Spain is expected to increase its total water demand by 0.3 % annually from 2000 until 2025. By this time water withdrawals in Spain are expected to be close or to surpass the average annual renewable volume of natural water resources. Parts of Spain are already using as much water as is available to them. Where additional water resources will come from after 2025 remains unclear.

Even under adequate rainfall circumstances and conditions many areas of Spain face significant challenges due to the unequal distribution of water resources which inevitably leads to conflicts among users and between regions. Recurrent droughts lead to the intensification of these problems adding greatly to the complexity of water management. Moreover, droughts have become frequent in Spain after 1970 with economic and social impacts growing with each successive drought event. Droughts do not just affect surface water flows. Not surprisingly, groundwater overdraft during drought episodes in Spain has contributed to the degradation of groundwater quality. In addition, important remaining wetland areas are affected during droughts by irrigation withdrawals once again highlighting the difficulty of providing enough water to nature to maintain important biodiversity-based ecosystem productivity that over the long term may be as important to sustainability as surviving drought.

What is worrying is that commitment to bold water management reform threatens to break down in the face of more and persistent drought; which is expected to occur even more often as a consequent of climate impacts on the entire Mediterranean region. Unfortunately, climate change projections particularly in southern Spain do not suggest that the water availability situation is going to be better in the future.

According to Dr. Alberto Garrido, climate change projections derived from global climate models project an increase in temperature of from 1.5°C to 3.6°C and a decrease in precipitation of from 5% to 14% by 2030 and from 10% to 20% depending on season by the 2050s. In critical semi-arid areas, such as the south Mediterranean basins and the arid hinterland and island basins, water availability may be reduced as much as 50%. Seasonal variability will be even more acute. Under these scenarios evapotranspiration water demand in agriculture in all the river basins in Spain is predicted to increase by between 5% and 10%, which could reduce average water resources by 17%.

Climate change projections indicate a greater and more intense variability of precipitation as well as an increased likelihood of drought. Both of these projections, if they come to pass, will directly influence water availability in many parts of Spain. The combination of greater warmer average temperatures, greater extremes and more frequent droughts is also expected to have huge impacts on water demands which will directly impact Spain's capacity to supply water for the maintenance of other ecosystem services.

Under every climate change scenario, water supplies decrease and irrigation demands increase in Spain, just as the models suggest they will on the Canadian prairies. The capacity of the irrigation sector to adapt to these changes is particularly constrained in Spain by the fact that climate change is occurring in tandem with high development pressures in both the country's most productive agricultural regions and in sub-optimal agricultural regions in which other economic alternatives do not exist for rural populations.

Droughts that have persisted through the 1990s to the present are already testing the limits of adaptation of socio-economic and agricultural systems in Spain. Some

irrigation-dependent areas have simply ceased production. The fact that differences between the wide range of stakeholders with interests in water are only partially resolved has become a matter of wide public concern. Many now believe that drought and climate change issues are among the most pressing problems presently facing Spanish society. Many worry that despite huge efforts at reform, weak cooperation and the fragmented and often competing mandates of government departments, administrative regions and basin authorities result too often in conflicts and impediments to the implementation of existing legislation and agreed-upon innovations and management actions.

The overarching concern is that these impediments will limit the adaptive capacity of the Spanish irrigation sector with respect to managing water supply and demand which in turn will have huge implications for the nation's capacity to adapt to emerging climate circumstances and to the economic implications that will undoubtedly present themselves the wake of further warming.

It is interesting to observe that these are exactly the kinds of problems parts of southern Canada are expected to experience under all projected population growth and climate change scenarios.

Lessons For Canada

Public Awareness of Water Issues Is Growing

Balancing the trade-offs between water for food and water for nature is rapidly becoming one of the major challenges facing policy makers, national and regional administrations and stakeholders in Spain and around the world. If what is happening in Spain is any indication of our future, we could be facing difficult circumstances for which we ought to prepare.

Societal awareness of environmental and water problems is increasing in Spain. The Spanish public has begun to demand greater transparency in decision-making and more accountability in the management of the country's water resources. This mirrors what is happening in Canada generally and is highly emblematic of current developments in Alberta. It is as if water issues have suddenly been discovered by an astounded Canadian public.

Nowhere is Canadian attention on water more focused than on the Great Plains where a growing number of interests are competing for a suddenly very limited water supply.

The Importance of Integrating National and Regional Policy Direction

The Spanish case study offered at Rosenberg VI in Zaragoza points out how important it is to have all levels of government starting continentally then moving to national, regional and local levels working clearly toward the same goals. Trying to match the national objective of assuring water services to all users while at the same time complying with EU Water Directive Framework requirements of achieving "good

ecological status of all waters” proved and continues to prove to be a difficult task even for well-established and highly effective River Basin Authorities. It is not an easy job. Nor is the level of public participation required by the EU. Active involvement of stakeholders, however, is obviously central to successful implementation of such demanding policies.

The Importance of Integrating Water and Agricultural Policy

From the Spanish example we also learn that in major food-producing countries water policies must be viewed as inseparable from agricultural policies. The key to balancing the trade-off between agricultural water use and water availability for other needs requires the transparent well coordinated collaborative design and implementation of integrated water management and agricultural policies at both national and regional levels.

The Spanish example also suggests that in countries where irrigation is the key sector supporting rural economic prosperity, the parallel, coordinated, integrated design and simultaneous implementation of agricultural and water policies is central to solution of water availability and quality conflicts.

This integration can only take place through transparent stakeholder participation, avoidance of policy contradiction and through support for synergies that reinforce common objectives.

In addition, it must also be recognized that the social and economic burdens associated with the implementation of water conservation programming must be managed through the parallel evolution of integrated rural and social development programs.

The integration of such wide-ranging elements within the larger framework of policy response to increasing water scarcity is presently the greatest challenge facing regional administrations in Spain responsible for the simultaneous implementation of both EU and national agricultural development and water management policies.

The Spanish example also demonstrates that such joint policy integration is not easy to achieve. Each new policy is likely to create a new and different set of problems that will have to be addressed by further policy innovation. While the process is clumsy, costly and time consuming it is the only avenue presently available to prevent conflict between the agriculture sector and the people it exists to feed in cities over water quality, allocation and use.

Basin Authorities and Councils Have a Role to Play

In Spain, the Ministry of the Environment is the national authority responsible for the management of water resources. Just as in Canada, however, autonomous regional governments are also involved in matters related to water resource management such as land use planning, agricultural policy, forestry operation and environmental standards.

Water institutions in Spain are, in principle, well positioned to adjust to the new policy setting and management expectations created by the European Water Framework Directive and by river basin management plans. Each River Basin Authority possesses considerable technical capacity and many have demonstrated measurable success in the development of effective participatory processes that ensure collaboration with water users and interests. Just as in Canada, however, some River Basin Authorities are more active than others. The active authorities are working effectively. The less active ones need to concentrate on increased transparency, on improving data collection and on increasing the effectiveness of information sharing networks.

River Basin Authorities in Spain are becoming successful at encouraging more flexible distributions of water allocations among farmers and other users. These exchanges of rights, or, in the case of overexploited aquifers, the public purchase of water right for environmental purposes are central to creating sustainable water use practices. The Spanish example suggests that such demand-side solutions can be helpful in facilitating the adaptation process necessary for creation of the kind of policy-setting environment that will be necessary if water and agricultural policy is to be effectively integrated on a national or continental scale.

Emulating the European Union Water Framework Directive

One immediately wonders if it might not be worthwhile considering implementing programs in Canada similar to those undertaken by the European Union and its Member States under the aegis of the Water Framework Directive. Certainly, if the European Union with its 27 member states and a population of 500 million people covering an area of 4,324,782 square kilometres, less than half of that of Canada's but encompassing a 23 different official languages can create a continental water framework it is conceivable that a single 9,984,670 square kilometres country with only 33 million people spread through 10 provinces and three territories with two official language should be able to do something comparable. Without question we have the capacity to create a similar groundswell of change. All we have to do is want to.

A national – not federal – watershed basin accounting, a thorough analysis of the impacts of all human activities and a thorough economic analysis of water use might prove very valuable in clarifying the true state of Canada's water resources and would prove a valuable baseline as climate change impacts further alter the timing and extent of precipitation in many parts of the country.

The Blue Plan for the Mediterranean, and the Mediterranean Action Plan created by the United Nations Development Program have both examined pressures on natural water resources in the Mediterranean catchment basin by way of a "Water Exploitation Index". This index, which is expressed as a percentage, is defined as the ratio of withdrawals from renewable water resources to the average volume of renewable water resources. Might we in Canada wish to employ a similar measure?

Agriculture Everywhere Faces Similar Problems

Agriculture everywhere in the world is at odds with itself to the extent that the need to increase agricultural production to meet growing world food demands must be balanced with economic and environmental realities. The principal determinants of profitability in the irrigation agriculture sector in Spain are much the same as they are in Canada. They include the availability of markets, availability and cost of water; the price of other inputs such as labour, capital, fertilizers, pesticides and energy; the cost of complying with environmental standards and how favourable the public policy climate might be to stability over time. Like many other countries, including Canada, Spain has a big problem with nutrient loading in its major rivers which results eutrophication of its lakes.

The weak real growth of land productivity in Spain between 1995 and 2005 can be attributed principally to the fact that yields have grown only slightly during that period while crop prices remained low. As in many parts of the world, however, corn and alfalfa production increased as farmers moved to produce more livestock. This will put further pressure on water resources and likely make the agriculture sector even more reluctant to free up water through conservation efforts simply to give it away for environmental or other uses.

The Irrigation Community in Canada May Wish To Avoid What Happened In Spain

The irrigation community in Canada, and particularly in Alberta, would be wise to pay close attention to what is happening in Spain. After 12 centuries of irrigation production, the Spanish public no longer believes that irrigation is a given or that the dedication of the substantial amount of water currently supplied to agriculture is either efficient or equitable. Despite massive progressive public policy reform in Spain, it remains unclear where this public perception will lead next in terms of policy direction.

In Canada, and particularly in Alberta where public policy with respect to irrigation water allocation has not been altered significantly in a century, similar pressure for change is likely to emerge as water scarcity attracts greater urban attention.

Irrigators in Alberta and elsewhere in Canada should expect to be challenged on the price they pay for water and on their environment impacts; and everyone in the Prairie West should expect longer and more regular drought conditions.

Despite genuine collaborative progress in Spain, antipathy between environmentalists and irrigators makes it difficult if not impossible to build further on hard-won public policy improvements in water management. This is a situation we should do everything we can in Canada to proactively avoid.

Charging the Real Cost of Water Will Create Conflict

We should expect the exactly the same tensions should we decide in Canada to charge the real cost of water as it is supplied to agriculture. The mere notion of charging the agriculture industry the real cost of water would likely evoke an incendiary response from Western Canadian irrigators.

Certain kinds of farming would no longer be possible if you forced farmers to pay the actual environmental and other costs associated not just with water supply but with the impacts associated with agricultural practices. But only when environmentally non-sustainable agriculture becomes economically non-sustainable agriculture do new possibilities emerge.

At the moment at least, the Spanish example suggests that even the sincere cooperation of the agriculture sector in the development of enlightened new approaches to the sharing of water resources nationally may not be adequate to stave off growing criticism regarding the disproportionate amount of water allocated to irrigation. Just as occurred in Spain, the irrigation community in Canada could be harshly judged in the court of public opinion if it cannot convince urban neighbours that it is not only improving water productivity and reducing pollution but is measurably reducing total water consumption – and most importantly that water freed through conservation is actually being put to use for environmental and other purposes.

It Might Be Wise To Consider Further Irrigation and Agricultural Renewal But With Some Reservations

If it is possible to free up enough water to prevent the limiting of social and economic development in a dry country like Spain by simply improving the efficiency of irrigation agriculture then surely the same must be true in Canada. The Spanish example clearly suggests that Spain experienced the same stubborn resistance to change in its agricultural community that we can expect in Canada. It follows, then, that the same solution that would work to address the problem of water supply in the dry regions of Alberta would also work in Spain, and vice versa. But what was the solution?

One wonders if a similar kind of program to the irrigation renewal initiative undertaken in Spain might be worth considering in Canada, or at least in Alberta. If you take 1 acre to be about 0.4 hectares, our 1.3 million acres of irrigated land in Alberta works out to only about 520,000 hectares. In other words, Spain spent about CDN \$ 9 billion to improve irrigation technology in an area roughly two-and-a-half times that which is currently under irrigation in Alberta.

That means it might cost somewhere around CDN \$ 3 billion to orchestrate similar improvements in irrigation technology in Alberta and that is without taking into account the fact that some irrigation technology improvements have already been undertaken in parts of the province's southern irrigation districts.

The National Irrigation Plan in Spain has increased water productivity through an expensive nation-wide irrigation modernization program. The plan has contributed to the reduction in environmental pressures on water courses and has encouraged the integration of expanded data sets into River Basin Authority information networks. But despite its successes, the plan has not achieved its water savings goals in that water freed up for other uses is generally channeled toward guaranteeing water availability for irrigation and to a lesser extent to responding to the European Union Water Framework Directive goals of enhancing ecosystem protection.

In other words, the technology made available to irrigation to reduce water use was available but what wasn't created was the institutional wherewithal to ensure that the technology was productively married to demand-management incentives such as the revision of water rights, volumetric pricing and simple mechanisms by which water rights could be exchanged in a timely manner.

Non-sustainable agriculture can become sustainable. The transition between the former and the latter, however, can be painful even when it is driven by good public policy and government support. Without carefully considered public policy and timely and adequate support for the agricultural sector, the impacts on people and local economies could be utterly devastating.

The lesson from Spain is that policy makers must be tireless in their efforts to coordinate the parallel implementation of both EU and national policy directions actual save water so that it can be put to use for environmental and other purposes.

Policy makers must be very clear on final objectives. The decoupling of the EU's Common Agricultural Policy subsidies from production increases has not reduced the overall irrigated surface in Spain. It has produced a crop shift away from water-intensive crops such as maize in favour of less water dependent crops like cereals, olives and vineyard products but it has not reduced overall agricultural water use in Spain.

Linking Agricultural Development Goals To Water Availability Realities

The question the Spanish example begs is how policy makers can make the all important next step from the creation of their much improved agricultural system toward actual water savings that can put to environmental and other uses. It struck me that part of the answer to this question had already been formulated in Australia. In June of 2006, Paul Perkins from Australia shared a paper he had written on addressing the world water crisis through agricultural reform. As Australia was already facing serious water scarcity, he was beginning to think seriously about how to reframe current resistance to change so that unproductive hand-wringing could be translated into effective action.

Perkins looked at the problem from a different perspective. His goal was to create a different scenario than the one in which Australia found itself so deeply entrenched. His logic in the end was very simple: Given the World Bank's assessment of population growth and climate change impacts on world food production which sees half the world's

population water deprived by 2030, but also sees Australia as one of the few regions (along with Canada, the United States, Europe and parts of South America) capable at that time of “water export in the form of cereal grain, meat etc.”, would Australia not be more productively engaged if it asked the question: “How can Australia develop methods to produce twice as much food over 25 years, using say half the water?”

The situation in Canada is different from that which exists in Australia. Climate change impacts, while likely causing dramatic drying on what are now the Great Plains, are likely to improve mid-latitude agricultural productivity. But even so limits to water supply could hamper this development. So the question that Canada might ask might be something like this:

How can Canada develop methods to produce four times as much food for export over the next 25 years, without increasing domestic food prices unreasonably, and without upland watershed decline, while still ensuring enough water for environmental services, population growth and proportional industrial and technological development?

Reflecting on Paul Perkins’ question it could be proposed that part of the answer to how such a solution might emerge is through substantial Alberta investment of oil royalties in greater agricultural efficiency that does not simply rely on upstream storage development.

This investment will be necessary to ensure that individual farmers do not have to cut into already tight margins to restructure improve irrigation practices in ways that will make them more efficient.

This investment also ensures that leading-edge irrigation technology and practices emerge that will allow the freeing up of large volumes of water from the agricultural sector that can be employed in specifically directed ways to ensure that water scarcity does not limit the social or economic development of the Canadian West now or in the future. If we undertook an approach like this, there would also be another advantage. We could export our knowledge and expertise to Spain, Australia, the United States and to all the other places that face the same challenge.

The Pressing Need for Improved Conflict Resolution Tools

One lesson that the Spanish example clearly provided was that drip irrigation technology is coming. The most useful technological innovations, however, will not just be those that enhance the capacity of farmers to respond to more expensive or more precious water. As in Spain, the future of the irrigation sector in Alberta will depend on institutions that influence the allocation of scarce water supplies among competing users. The societal values affecting these decisions, however, are changing. We should expect the management of irrigation to be integrated, as it has in Europe, in a larger framework of common resource management. The shift toward integration will be accompanied by renewed emphasis on the need to reverse the damage to aquatic ecosystem health caused by unsustainable agricultural practices. This shift will also be accompanied by a growing focus on the protection and restoration of natural ecosystem productivity and function.

While better and different kinds of monitoring and constantly improving irrigation technology will be important, other technology will also become useful. The most important technology in which we may wish to invest at this time is already proven and available. Real-time, computer-based collaboration models that will enhance our ability to anticipate and resolve actual and potential conflicts over water allocation and use should be employed as soon as possible to establish the cooperative foundation that will undoubtedly be need to face the challenges ahead.

It Is Important To Factor Climate Change in Evolving Public Policy

The Spanish example also underscores the crucial significance of drought management planning. Even in Spain, however, drought plans do not yet embrace long-term climate forecasts or the ecological needs of natural ecosystems. Like the Prairies in Canada, Spain finds itself outside the range of adaptation to climate change impacts. Even with improved water management policy, there are high profile conflicts over how much water agriculture should get during ever more frequent and intense drought that the public already perceives will occur as a consequence of global warming. This has put weak cooperation among fragmented institutions into relief and calls into question the success of even the most progressive water reforms.

In Summary

If we want to avoid the kinds of problems other semi-arid regions like Spain are facing, massive reform is no longer an option. It is an urgent necessity.

Expect public policy to be difficult and time-consuming to develop and hard to implement.

Expect such processes to take a great deal of collaboration and to take years to generate lasting results.

No single management action, legislative package or policy framework can respond to all of the problems that are presently converging around water availability conflicts especially as they relate to the disproportionate amount of water demanded by irrigation agriculture in parts of Canada.

National and regional policies must be integrated and water strategies must somehow be integrated into agricultural policies if water scarcity challenges are to be fairly and equitably resolved now and in the future.

Expect to have to manage conflict over allocation and water use priorities.

Expect the shutdown of entire processes during droughts.

Expect to have to keep refining policies and management directives in the face of the emergence of unexpected new developments and challenges.

Expect this to go on for generations because the problems are likely to become more and more complicated as they converge around increasing global populations and climate change.



Exposición Internacional
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Helen Ingram

Beyond Universal Remedies For Good Water Governance: A Political & Contextual Approach

We have not yet established in the public imagination the link between sustainability and democracy. Like many others at this forum I am beginning to see sustainability as a dauntingly fundamental human value as important to fight for as democracy and as central to who we are or must be as the right to life itself. It is also a struggle that like democracy will be one we never entirely win and that once achieved will have to be diligently protected and defended. Moreover, sustainability may well prove to be central to the perpetuation of democracy itself for when and wherever ecosystem health declines to the point that economic prosperity is no longer possible is when human despair creates circumstances antithetical to human rights and dignity and tyranny establishes itself and becomes lodged in our most important institutions. In considering the content of the presentations at Rosenberg VI in the context of the governance issues put forward by Helen Ingram and Margaret Wilder it was not clear if our democratic institutions are ready yet to contemplate that link.

If Helen Ingram is right our clumsy, time-consuming public processes can barely comprehend environmental decline let alone turn that decline around in an effort to achieve any meaningful level of sustainability. What Dr. Ingram suggests is that we are going to have to work simultaneously to improve our fundamental institutions while at the same time pressing at every opportunity for greater clarity in our definitions related to what sustainability actually means in the context of being human. Decades of work must be committed to understanding our impacts on our own life-support systems and in creating mechanisms for responding to those impacts by changing our habits, adjusting our expectations and improving our technologies.

This clearly is “The Great Work” of our generation as Thomas Berry¹⁴ called it and of every subsequent generation that wants to possess anything close to the prosperity we have enjoyed. Unfortunately, it is not likely to be the kind of work that will create Hollywood-type heroes. This work will take place in town and city council chambers, in meeting rooms and in endless dialogue aimed at arriving at a more durable consensus about the future than exists today. For the most part it will be done by faceless volunteers.

In my introduction to the session on the Revitalization of Water Governance in which Helen Ingram and Margaret Wilder made their presentations I began by suggesting that if there is one thing we might learn from the keynotes addresses and from the Rosenberg presentations and highly charged discussions that followed it might be that the management of water resources in the context of both food production and ecosystem protection is becoming more and more complicated. It would be easy to believe, I said, that with each passing forum, more and more challenges appear to be converging on

¹⁴ See *The Great Work*, by Thomas Berry, Harmony/Bell Tower, 2000.

some not-too-distant future date when our system seems certain to break down from the sheer weight of so many conflicting demands. Clearly, I argued, it was the purpose of forums like the Rosenberg to prevent that from happening.

We have seen that development can clearly improve the lives and circumstances of people in poor countries and can do much in some cases to simultaneously improve general ecosystem health and agricultural productivity. It seems, however, that once we reach a certain level of development, we often start moving again in a direction away from sustainability – whatever one takes sustainability to be.

Listening to earlier speakers I wondered if we haven't adopted by default a consensus view of what we want sustainability to be like that doesn't reflect reality. It is rather like the Spanish farmers who want to have their cake and eat it, too – who want huge public support for revitalizing irrigation infrastructure but are unwilling in return to give any of the water that revitalization saved back so that even a drop can be used for other purposes such as the restoration of aquatic ecosystem health. Such circumstances appear part of the unreality we have created.

Too many of us appear to believe that someone else has to make the sacrifices for the environment but not us. The only impetus that appears to inspire real and timely change is crisis, but even crises do not always carry us across the threshold to new ways of thinking and acting. We so very often go right to or even over the threshold of change but turn back the moment the crisis is over. We know there are limits but we just keep pushing them. The moment we achieve even a modest sustainability gain we cancel it out or create new problems for ourselves through further population or economic growth.

We seem capable of rationalizing anything and appear against all evidence willing to believe anyone who will tell us everything will be all right.

If I were to simply summarize what Helen Ingram and Margaret Wilder had to say about governance it would be that changes in the agreed-upon frameworks by which we govern our collective actions are urgently necessary if we want to achieve any semblance of true sustainability. In the session on the revitalization of governance Ingram and Wilder told us we need to:

- continue the on-going project of constant reform of our governance structures;
- recognize the crucial importance of leadership;
- recognize that equity is becoming increasingly important in decision-making;
- design solutions for real world situations;
- and most importantly we have to cross the line that separates intention from action – and we have to stay there after we have crossed this line.

A great deal of territory has already been staked and a great deal of ecosystem function and appropriated. Getting that territory back for life-support function may be one of the most important challenges we will face as a civilization.

We have to cross the line that separates intention from action – and we have to stay there after we have crossed this line.

**Revitalized Water Governance:
Filling the Gap Between Promise & Practice
The Background**

I had few comments and no influence whatsoever in the choice of content in Helen Ingram's paper for fear that her descriptions of our failures and successes in water management – which so accurately describe the circumstances we presently face in Canada – might be seen to have originated with me. They most certainly didn't.

Characteristically, Helen Ingram did not waste any time getting to the point of her paper. Nor did she pull any punches. She started rolling with her first sentence in which she pointed out that the water resources research community and practitioners of water resource management excel at the development of innovative ideas and blueprints with which to replace existing flawed water management institutions. Unfortunately, she claimed, history is littered with failed formulas that were at one time embraced by both scholars and practitioners. In turn each of these seemingly really good ideas failed to take hold or when implemented failed to live up to their promise.

The list of these innovations is long. Breakthroughs that had their day in the sun include revitalized water management principles and standards, centralization of decision-making, devolution and de-centralization of decision-making, multi-objective planning, coordinated river basin planning and management, watershed management, privatization of water services and the reliance on newly created water markets. It should not be said that these efforts have been outright failures. These ideas often corrected errors and made things better in some areas, but each in turn proved to be no panacea for the problems associated with water governance in other broader contexts.

Our current hope, of course, is integrated watershed management and adaptive management, which envision more collaborative governance and a more flexible and engaged role for science. Dr. Ingram offered, however, that there was a lot of old wine in these bottles. Her key point, though, was that as we move toward these new ideals two things had to be kept clearly in mind. The first was that innovations had to respect the realities of governance on the ground in ways that ensured the remedies were designed for the context into which they were to be imposed. The second requirement Dr. Ingram proposed was that the remedies must actually be implemented.

Failures of Governance

Dr. Ingram's concerns were very clear. There are many exciting new ideas in the field of water management but we are failing to act upon them. This failure takes a number of forms. Among the critical shortcomings in contemporary water politics are:

1. the failure to properly contextualize water issues in ways that take into account local history, culture and sense of place;
2. an inability or unwillingness to frame issues in ways that will attract and sustain public attention;
3. the inability to engage in a new water ethic;
4. an unwillingness to address deep-seated inequities in the way water is allocated and managed;
5. the failure to recruit and inspire leaders and, finally;
6. an inability to create, foster and cultivate the level of political will over the duration required to ensure proper and lasting implementation.

Dr. Ingram then went on to point out by way of example that though the United States has long been a leading exporter of river basin planning approaches to countries around the world, it has been unable to sustain the programs it exports at home. Even in developed countries like the United States, Ingram indicated, reforms appear to stall out most often at the critical stages of marshalling support for adoption and implementation. From this we learn that the failure to act upon innovative new water management ideals – that is to say the failure of governance – it is not just a problem in Alberta, or in Canada. It is a problem around the world.

Why Watershed Basin Councils Achieve Only Partial Success

Dr. Ingram is very concerned about the effectiveness and viability of watershed-based institutions like basin councils and trusts. She pointed out that problems associated with watershed governance have plagued such organizations right from their inception. Gaps exist between watersheds leaving some problems unattended. Watersheds by their very nature are highly vulnerable to problems that have their origins outside their boundaries. Without some overarching umbrella institutions at the river basin level or higher, clashes over management choices can inevitably expected to occur. Further, the success of any given watershed basin group is highly dependent upon the reliable possession of enough resources and the extent to which sufficient scientific, technical know-how and leadership come together a happy convergence. This, Ingram noted, was a fairly uncommon circumstance.

In her estimation longstanding problems associated with these institutions have yet to be satisfactorily overcome. She pointed to the reasons. Geographically based institutions whose boundaries do not match political boundaries have trouble establishing stable funding streams since joint funding always presents difficulties of collaboration. This is because political leaders whose constituencies have little relation to river basin

institution's boundaries often feel estranged from basin institutions that are not directly accountable to them. Similarly, established agencies are threatened by new institutions with whom they are supposed to collaborate, but who may compete with them for both political and financial support.

Ingram claimed that what she called "goal deflation" appeared to be plaguing many of the newly formed basin-based institutions with which she had had recent experience. Her observations were very relevant in the Canadian context as well. Basin councils gain initial support through promises to improve a wide variety of water-based problems such as the recovery of habitat and support for endangered species, improved water quality, more secure water supply and more open and secure decision-making. Once they are up and running, however, such institutions find themselves unable to provide evidence of improvement in the problem areas they were created to address. In examining the reasons for their failure they discover that many of these problems were decades in the making and governed by forces that were in fact outside the basin council's control. Moreover, they discover that a great deal more of their effort than they expect must be expended in the unwieldy business coordination and collaboration among far flung participants whose main concerns and loyalties are elsewhere. When such beleaguered councils are pressed to defend their records in battles over resources, they are often reduced to showcasing localized examples of progress that are both limited and localized which hardly seem to justify the large overall expenditures.

Dr. Ingram pointed out that thousands of watershed institutions exist in the United States alone, and that they display an enormous diversity of orientation, purpose, extent of public involvement and degree of government support. This basin council model, with the encouragement of both scholars and practitioners, has also been diffused around the world. Ingram holds that from the perspective of extent of adoption of bottom-up participation watershed-based governance arrangements are unquestionably successful. If the measure of success of watershed institutions is based on whether they lead to more implementable policies and practices many fare very well. There is no question that legitimate processes of participatory decision-making helps to resolve to prevent and resolve conflicts, increases trust among participants, builds social capital and leads to consensus over water management options. Ingram observed that perceived fairness of the basic basin council structure correlates highly with the acceptance in studies that researched the effectiveness of collaborative governance in both North America and Europe. Measured in other terms, however, the verdict, according to Ingram, is less certain.

Ingram points out that one of the reasons the verdict is out on the ultimate real success of basin councils is that participation in these institutions is only weakly associated with positive results for water management with respect to a number of other important measures. Ingram pointed to studies involving 35 basin-basin organizations in the United States and Europe which suggested that in only one-third of all cases did the new perspectives that were put forward, the information generated and social marketing campaigns developed actually lead to better consideration of environmental concerns in completed final agreements.

A similar large study of watershed management successes in the United States arrived at the conclusion that collaborative institutions are expensive to implement and maintain and are often time-consuming. The report argued that it took such institutions as long as four years to achieve effectiveness in dealing with any given issue. The authors of this study concluded their report with the recommendation that the collaborative approach to watershed management is effectively used "... only when there are high stakes, social distrust, high government distrust and high knowledge uncertainty". In essence, the authors recommended that collaborative processes should only be employed as a last resort when more straight-forward governance is impossible, simply not present or when trust between interests, or in the government was so low that this was the only mechanism that could be employed to come to resolution on a high-stakes water-related issue.

Unfortunately, the situations under which straight-forward forms of governance exist and are capable of managing increasingly complicated and pressing water issues appear to be becoming less common worldwide. This unhappy circumstance is likely to be even more common as populations continue to grow, greater pressure is applied on existing water supplies and as climate change impacts the timing and extent of precipitation over large parts of the globe. The suggestion here, then, is that as unwieldy as they may often be, collaborative watershed basin management processes are going to be needed more than ever in the future to address issues of trust and to create a forum in which areas of concern and potential conflict can be forecast and the possibility at least of preemptive resolution outside the courts preserved.

The widespread challenges associated with watershed governance, Ingram offered, is going to be made even more difficult by the fact that new energy production processes are taking up ever greater volumes of water in many parts of the food-producing world. This, in tandem with growing concerns about the need to share a great deal more of the water we presently use with nature so as to maintain other critical biodiversity-based ecosystem functions makes much of the current news about future water availability less than encouraging.

Growing concerns over water availability globally underscores even more the critical trust-building role that watershed basin councils and trusts can play in building consensus about how to manage water resources in the future. But simply creating a forum for trust-building will not be enough to allow watershed basin councils and trusts to win enduring public and political support. It is absolutely essential that every avenue available for making basin councils more effective in the actual final implementation of better policies and practices be urgently explored. This perhaps represents the most important lesson that Canada and particularly Alberta should learn from the proceedings of the Rosenberg International Forum on Water Policy with respect to the revitalization of governance.

It is not enough to simply collaborate on the subject of possible public policy evolution and changes in practice. Talk generated within the collaborative framework created by any given watershed basin council has to be translated into action if it is going to mean

anything over the long term. In order to ensure that our recent investments in the development of watershed basin councils throughout the province of Alberta are not wasted, we have to acknowledge the substantial gap that presently exists between promise and practice; and move immediately to fill that gap. This demands careful, honest evaluation of why recommendations of basin councils and trusts are not acted upon in a timely manner by government, agriculture or industry and clear indication of what must be done to remove current obstacles to measurable progress. This may mean deep and perhaps uncomfortable examination of gaps or conflicts in jurisdictional accountabilities and identification and naming conflicting outside interests and political influences as well as difficult questions having to be asked about the ultimate motives of representative interests participating in basin activities. Such an evaluation should not be undertaken, however, without a commitment to undertaking the final difficult but crucially important step of cultivating political will required to break out of current bureaucratic and political constraints that stand in the way of the ultimate success of the basin councils in achieving their established goals.

While this may appear a painful step to have to take, the consequences of failing to properly and truthfully evaluate the reasons for less than expected performance of watershed basin councils in terms of actually changing water policy and practice could be even more painful. If the gap between promise and practice is not filled, enthusiasm currently generated by the creation of new watershed basin councils throughout the province will wane, volunteers within these organizations will become disillusioned, burn out or lose faith and the public may abandon trust in the Government of Alberta's capacity to fill the gap between practice and the great promise that was made by the Water for Life strategy.

If, on the other hand, the Government of Alberta is able to break through what appears to be a barrier that exists globally between collaboration and action on water issues at the watershed level by carefully cultivating truly effective basin-based institutions, it will not only have its own success, it will have something very significant to showcase and share on the world water resource management stage.

It is clear from the Spanish example that the European Union Water Framework Directive both legitimized and facilitated the implementation of regional water conservation policies. Without higher level credence and support, it would have been impossible for regions to continue advancing and enforcing important new policy directions in the face of opposition based on perceived high local social costs. The entire weight of the European Union itself was required to ensure that new and sometimes locally unpopular policies had enough weight to overcome local resistance to change.

The Spanish example supports Dr Ingram's assertion that appropriate downscaling of national policy decisions to the regional and local level is an important step toward effective implementation of new policy directives. As Consuelo Varela-Ortega pointed out in her case study, some Spanish basins are already launching region-specific programs to conserve water resources in order to protect aquatic ecosystems while maintaining rural economies. Though the results are uncertain, it is already clear that

political will and stakeholder involvement, particularly as they relate to legitimization of process and the commitment to balancing environmental goals, are key to the successful implementation of new policies.

Dr. Ingram's presentation was the only one to explore not just what should, could or must be done but why the right reforms are seldom implemented. "Politics is usually blamed for defeats and short-comings of various reforms," she said, "as if the failure to pass political muster was not a fundamental requisite of any water resources governance arrangement." Politics, Ingram points out, is a means by which values are assigned and allocated. Conflicts have to be expected and to simply give up on reform because of the threat of potential conflict is to fail before you get started. Moreover, if badly needed reforms are delayed because they fail to pass the muster of the politics of the day they can produce tensions that will in the end create conflict until they are resolved.

Ingram explained that conflicts are certain to happen in situations where past climate is a poor prediction of the future; where wetlands that purify water are being degraded or destroyed; where safe drinking water is increasingly unavailable even the developed world; where coastal areas are vulnerable to sea level rise; where the risk of extreme weather events threatens lives and agricultural productivity; and where processes of energy production place additional demands on water resources.

With the exception of the threat of sea level rise, Ingram's list of places where we might expect conflict over water resources perfectly describes the Canadian prairies and in particular southern Alberta. Here politics threaten to prevent important reforms relating to water allocation from being considered for fear of agitating irrigation farmers; the climate of the last century has been identified as a poor indication of what we should expect in the future; wetlands are being degraded and destroyed; water availability is already a growing issue; drought remains a constant threat to agricultural productivity and oil and gas activities are placing additional stress on water resources. By Ingram's criteria, we are on our way toward conflict.

Dr. Ingram went on to explain that water resources inherently involve value conflicts because water has a very different meaning to different people. For some people – the majority it appears of those presently working in water – view water as a product of engineering systems. Others view it principally as an economic good that should be reallocated through markets. Some – and this is true of many southern Alberta farmers – see water as a property right. Finally there are others who view water as a common good to which access must remain a fundamental human right.

Ingram also points out why water policy decisions matter in a crowded world. Water resources and political power are inextricably connected if only because there are winners and losers in most water decisions. Ingram points out something that most Canadians have yet to fully grasp which is the fact that politically powerful interests have always benefitted from privileged access to water resources decision-making. As a result it would be naïve to believe that vested interests are going to step aside in the face of reform without conflict.

Ingram also correctly points out that participation in itself is no panacea for water conflicts as decisions as to who can participate in any given collaboration is also a highly political process as are the rules of engagement that define such processes. Ingram goes on to point out that even open and transparent forums often do not make up for power differentials among participants. Some interests will invariably have more clout than others. In addition there will be significant barriers to full participation for some interests related to resources, skills and cultural orientation.

As we have seen so often in Canada only interests with the money to pay for professional representation in policy collaborations can afford to be well enough informed and organized to persistently press for their policy preferences. This, in combination with the power such interests may have in defining the structure of such processes and in determining the politics of participant selection may be the death knell for effective and meaningful involvement of opponents in the advancement of policy direction. Vested interests know this which means that a very quiet but deadly serious form of hardball gets played every time public input becomes necessary to address the need for public policy reform.

Helen Ingram goes on to point out that in addition to the governance issues listed above public policy collaborations can be defined as much by what is left out of discussion as by what is included. Among the central issues most often absent from discussion of public policy reform are those associated with the mechanisms and actions necessary to move ideas to action and measurable results. Ingram puts forward four questions related to the translation of water-related policy ideal into action which are seldom asked if only because solidification of support for even the best scientific research outcomes is seldom linked to funding necessary to bring these outcomes to public light. The translation of science into public policy rarely considers how to gain public support for new ways of thinking except as an afterthought. Ingram, however, urges scientists and those who seek reform of water policy to include broader questions in policy debates and to ensure adequate time and funding exist to ensure they are adequately answered and that resources exist to ensure they stay answered in service of moving from dialogue to meaningful action.

How can issues be framed so as to engage the imagination and public support necessary to cause change?

How can social movements be mobilized to place water issues higher on the public agenda of matters that must be addressed?

How can leadership be attracted to take up water issues that have long been the province of experts?

How can water agencies bound by conservative bureaucratic cultures be encouraged to take risks by adopting new ideas and approaches?

The contemporary language of water resources tends to be rather bloodless and politically tone-deaf.

Helen Ingram

Ingram explained that any meaningful change is likely to be accompanied by a good deal of resistance and strategic maneuvering. Few would disagree with her assertion that it is far easier to continue to do things in the same way than to make fundamental changes. Policy stability characterizes most domains and in Ingram's estimation particularly characterizes water resource management. For this reason the issue of water has to be placed higher on the public agenda if it is to receive the attention it deserves. This may not be as easy as it sounds.

Ingram observed that half a century ago crises such as floods and drought were galvanizing influences that advanced public policy with respect to water management. During that period disasters became immediate opportunities to promote the backlog of construction projects that could be brought forward as "solutions" the moment public attention focused on the crisis. Ingram observed that while present day disasters are every bit as severe and costly as they were in the past our current generation of water managers seems unable to translate public concern into the kinds of actions that will lead to better protection of our water resources. Ingram argues that instead of capitalizing on public attention over water issues that public focus is in fact an anathema to many water managers in agencies and utilities that fear that illumination of concerns over its state or management will bring only approbation and blame upon those who are charged with providing its supply and quality. Ingram maintains that we cannot afford to ignore these other dimensions simply because we don't want to offend those who view water issue only in the light of their own responsibility to provide a public service.

What our water is telling us goes far beyond its function in power generation and municipal and agricultural use. Water invariably figures centrally in crucial contemporary issues such as wildfires, climate change, drought and food security and the public needs to know that. The connection between water and these crises should be made apparent to the public as a means of consolidating support for policy advance related to water management. We need to create signature measures that underscore the worsening state of the planet's waters in the same way climate scientists have employed extreme climate variability as a focus for new public interest in global warming. Whatever the technical flaws in the concept the notion of a "carbon footprint" has been ingrained in the popular imagination. The urgency of making our individual carbon footprint smaller has somehow gained public currency in a way that conserving water and protecting ecosystem integrity has not.

Helen Ingram believes we need to develop similarly intuitive and understandable yardsticks by which people can measure what is happening to water as well as to provide a means by which the public may choose to mobilize against damaging new energy, agriculture and land-use practices and technologies. We know already from climate change that such yardsticks promote individual habit change and broad support for public policy reform. In summarizing this point, Dr. Ingram made a statement that almost escaped notice but that is so crucially apparent that one's heart aches to read it. Because water flows through everything, Ingram wrote, it can provide a very accurate barometer of un-sustainable practice. Moreover, water touches the emotions and evokes far more primal responses relating to human survival than does carbon dioxide, methane or other greenhouse gases, and yet we fail to attract the necessary level of public attention to ensure that innovations in water policy are actually implemented.

One of the reasons for this – though Dr. Ingram didn't mention it – is that the management of water resources is dominated by engineers. She does say, though, that water resources needs to add a broader range of inter-disciplinary skills especially in the area of the humanities and the arts so that cultural values can be mobilized in service of a commitment to water policy reform and implementation.

Ingram notes that imagery can play a huge role in shaping public consciousness. She observes that photographs of melting glaciers and polar sea ice have done more to raise the profile of global warming than years of endless discussion about the structure of the Kyoto Protocol. Ingram proposed we need an image-maker to do for water what Ansel Adams did for the national parks system in the United States.

Ingram believes that the best way to reach the public is through engagement of community and sense of place. She observes that people with widely divergent interest in far-flung places are responding similarly to feelings of risk and insecurity generated by “impenetrable and unaccountable” water resource decisions that appear to be made elsewhere by expert others, through market forces they did not know existed, or in response to interests or circumstances they do not know anything about. What Ingram is saying is that this is no longer a scientists or policy-makers game. Citizens with a sense of place are becoming involved in the recovery and restoration of riparian habitats. Greater concern over the equity of water resources decisions is leading to a quiet groundswell that seeks to transcend the engineering focus on “doing things right” toward a broader focus on “doing the right thing” in evaluating water resource options.

In Ingram's estimation issues of equity, fairness and justice are currently too often treated as indirect and third-party effects in the decision-making process. Ingram believes that ethical issues have to be elevated to primary concerns if we wish to arrive at equity in water resources policy development. She claims this is happening in scholarship and in practices in some processes but needs to be advanced.

It may be useful to stop in the midst of this breathtaking discourse to contemplate what Helen Ingram has put forward in the context of lessons we might learn from her observations in Canada and in particular in the Canadian West.

The first thing to which we may wish to pay heed is the growing global public concern over what is happening to the planet's fresh water resources. Even though Canadians have never been forced as a people to trouble themselves with water availability concerns, population and economic growth in southern Canada is beginning to press up against ready supply. While a great deal of water can be made available by taking up slack in inefficient systems and through conservation programs that appeal to the public to change wasteful habits, the fact remains that water security in the future in many parts of the country is going to demand far more public engagement in water resources decision-making if only because their participation will be required to affect and pay for change.

At present water resources decisions are in fact being made outside of the regions they affect just as Dr. Ingram indicates. This is a function of centralization which most citizens would understand and accept. Canadians in many parts of the country, however, may not be satisfied with the lack of transparency in decision-making that currently exists or be happy with the degree to which market forces they did not know existed shape public policy with respect to water resources management. When the public discovers that water is being poorly managed where they live they may wish political retribution against governments that have failed over the long term to act in the interest of the common good. When, as is the case in many parts of the country, the public discovers that water has been managed in the same manner as timber and oil – only less effectively – we may see a sea change in Canadian consciousness.

I think of Dr. Ingram's admonition that those concerned about our failure to raise the profile of water issues ought to explore ways of taking full advantage of the growing number of water-related climate crises to advance public policy reform. I think of her example of engineers pulling fully developed plans off the shelf after floods and other disasters and gaining immediate support for them and I realize that those who want reform of Canadian water policy have nothing to pull off the shelf. All the water emergencies and crises in the world are going to lead to meaningful reform without an ethic to which we would aspire. Right now all people like me know is what we don't want. We know we don't want biodiversity or ecosystem decline, commodification of water resources, the creation of markets that don't free up enough water for nature or that don't respond to equity needs or profiteering based on water pricing that comes into force by way of decisions made elsewhere by experts whose focus is mainly on engineering for profit or finance. I don't want the agricultural community to have disproportionate influence on mechanisms that we decide to employ to determine future mechanisms of water allocation and use in southern Alberta.

In order to establish a proactive rather than reactive stance on water policy reform, I think we should advance Oliver Brandes' proposal to hold a series of conferences that will allow articulation of a broad national water ethic tied to more specific regional ethics that can help us connect what we know we don't like about our current system to what we want in the future. In this effort we should judiciously avoid reference to the term "federal" as this will antagonize provincial governments who feel it is their duty to

jealously protect hard-won independent powers related to the management of their own water resources. We would be wise also to avoid the term “national”. What we should be seeking is a “Canadian” water ethic. The goal, however, ought to be very clear. A new Canadian water ethic has to inform reform of both federal and provincial water legislation and practice.

Helen Ingram goes on to point out that integrated water resource management in combination with adaptive management has become the *lingua franca* among water resource scholars and practitioners. She points out that IWRM was endorsed globally by the 2000 Summit on Sustainability in Johannesburg and by the 3rd World Water Forum in Tokyo in 2003.

Integrated Water Resource Management embraces a number of concepts including:

- recognition of the full range of uses, sociological, ecological, agricultural and industrial of water
- integrated planning and practices across the full range of water users; including in-stream uses and needs
- the need to coordinate water management at a range of scales
- flexible allocation of water entitlements

Ingram argues that despite the high hopes and expectations of the academic and professional water community with respect to Integrated Water Resource Management and the Adaptive Management practices associated with it, the actual prospects for the delivery of purported benefits are no better than fair. IWRM and Adaptive Management have great appeal to specialists but actually delivering on these ideas presents a number of political, institutional and equity issues. A big part of the difficulty of Integrated Water Resource Management is that the scope and scale of its ambitions may be too great to achieve. If each of the single elements that have composed IWRM ambitions in the past were hard to achieve individually then all of the other components in combination – which include recognition of the full range of uses of water, the recognition of in-stream flow needs, the desire to integrate water and land-use policy and the flexible, equitable allocation of water rights – pose an almost insurmountable implementation challenge. When you can’t even do one of these things well enough to ensure sustainability, how are you going to reform entire water management systems in ways that will permit implementation of all of these elements simultaneously?

The risk of failure is compounded with each additional element that is added to the combination of reforms meant to be implemented. Attempting to resolve so many shortcomings at once can impose demands on human resources, organizational capacity and financial availability that are simply overwhelming.¹⁵ Ingram points out that even in

¹⁵ This was written before the economic collapse that occurred later in 2008 and suggests that any hope of achieving Integrated Water Resource Management in the Canadian context, if there really was any hope at all given already existing budgetary limitations, has been set back for at least the duration of the current recession and perhaps longer. It seems that when times are prosperous we are too busy to undertake environmental reform, and when things are tough economically we say we can’t afford it.

prosperous times the integration or reconciliation of water resources goals and objectives seldom occurs. Once again the reason for this is that Integrated Water Resource Management and Adaptive Management are far too often disconnected from politics and implementation processes and analyses that can initiate real change.

Ingram maintains – quite rightly I think – that the real difficulties of implementation are almost always greatly underestimated. To achieve the true sustainability promise of integrated water resource management, substantial changes in water entitlements are required. Even more daunting is the change demanded in bureaucratic cultures and missions. In addition public attitudes and behaviour have to change, on massive scales and in timely concert with other changes.

Ingram, who has witnessed many IWRM efforts observes that such initiatives are begun with great fanfare involving the expenditure of large sums of money and the engagement of significant scientific expertise. Yet carefully constructed arrangements fall apart the moment problems such as economic reversals or political conflicts arise or when drought occurs. When things begin to go wrong participants are often unwilling to wait long enough for new arrangements to take hold or for additional scientific research to be completed. The divided loyalties of those participating in any given collaborative process make it difficult if not impossible that new champions will emerge to keep faltering institutions going once they are in trouble. It is for this reason that leaders do not attach themselves to collaborative processes until outcomes are assured.

As Helen Ingram notes, leaders are not attracted to public policy concerns unless there is potential for public support that goes beyond experts and professionals.

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Helen Ingram

**Revitalized Water Governance:
Filling the Gap Between Promise & Practice
The Role of Leadership**

Ingram reminds us that the multiple and complex ways in which humans relate to water suggests that individuals and groups can be moved to change behavior or take action as a result of impulses and motivations that transcend simple self interest. She points out that while analysis of water politics in the past has tended to be viewed as a struggle among different user groups to obtain specific advantage, issues of identity, moral grounding, and fairness can in certain instances be more persuasive than appeals to self interested

rationality in changing orientations and allegiances. There are examples from all over the world that suggest that out of the shared experience of loss of opportunity, security, and control over water resources, powerful forces can emerge to change water governance. Ingram points out that the collective “sense of we” can animate and mobilize ordinary people cognitively, emotionally, and even morally to take common action. This seldom happens, however, without some form of leadership.

Getting things done in politics requires effective leadership, and in virtually all cases where real change occurs in water resources, success can be traced to the involvement of people skilled in politics. It is important to note that Ingram identifies the need to involve political operatives, not just politicians. As former Alberta Environment Minister Lorne Taylor has indicated many times, changing the way we value and manage water will simply not happen in Alberta or anywhere else in Canada without full, productive and on-going political engagement.

Those who would seek to reform public policy with respect to water management must clearly understand that leaders are not attracted to policy areas unless there is a potential for public support beyond just the experts and professionals. That means that they must be connected to people in the larger water community whom they trust for advice and support. Lorne Taylor agrees with Helen Ingram that political leaders need access to new ideas, especially if public support for change prompted by water-related crises is not to be satisfied through time-worn solutions such as large scale dams and diversions that were offered up as a panacea every time water becomes scarce.

Political operatives are those who can engage politicians in meaningful dialogue about the policy options that might be explored in order to ensure orderly change. Real leaders, as Ingram indicates, do not stop with simply exploring public policy choices. They make the leap from promise to practice. In other words, they cross the line from concept to effective implementation.

The lesson here is that the real leaders in water resources management are not just those with power but those with the ability to influence power. Being in that position, however, requires clear focus on larger long term goals; careful attention to detail and accuracy; and a strong sense of political reality, possibility and opportunity.

With each passing year governments around the world are becoming more and more paralyzed by the cumulative weight of past decisions, commitments and loyalties. Our society’s ability to move around inside the straightjacket of established precedent is constantly decreasing. Already we can see that the past mechanisms of breaking out of political straightjackets through acts such as territorial expansion and war only make things worse. Every problem we face comes back to one single issue. As a species, we are running out of space and resources and we are unavoidably, as a consequence, on our way to global environmental and economic decline.

At present it takes real genius and huge energy to affect meaningful public policy change. That is why such change occurs so seldom. As our ever more populated world converges

on trade-offs that will have to be made between our way of life and our survival, we should expect it to become even more difficult and even more time consuming to positively affect public policy reform. Support for effective leadership will no longer be optional. It may be our only hope.

Helen Ingram goes on to detail some of the obstacles and pitfalls associated with activating political support for water reform. It isn't pretty but it does demonstrate how things work in a democracy. Ingram points out that speaking truth to power is never an easy matter. While sensitivity to the stakes of political leaders is required, telling only those things that leaders want to hear is not. Leaders need to hear about the full urgency of problems and risks of doing too little too late. She offers a telling example.

In the American Southwest, overexploitation of water resources may be close to the "tipping point". According to the Arizona Auditor General, the three most populous management areas will not reach water safe yield by 2025, even though that was the specific goal of the highly touted Arizona Groundwater Management Act. Even so, widely respected water commentators in the state write that the Act is a success largely because of its innovative water banking provisions that make full use of Arizona's legal entitlement to the already overstressed Colorado River. Ingram completely disagrees. She points out as a matter of fact that while such water banking actions reduces groundwater overdraft for about 15 years, the aquifer depletion problem escalates after that because of relentless population growth. She also points out that resistance to conservation regulations remains common; that many wells are exempt wells and that drought continues to contribute to dwindling surface water supplies. From this it can be seen that exemptions from regulations, lack of enforcement of existing laws and drought make the terms and conditions of Arizona Groundwater Act impossible to fulfill. In Dr. Ingram's opinion, all the public relations spin in the world is not going to change that fact.

In Helen Ingram's estimation, it is important that water policy scholars and practitioners consider the Arizona experience as a cautionary tale. The visionary language of contemporary reforms is not the same as performance. The Arizona system is biased toward business as usual, and only if political leaders see either threats or opportunities in current failed circumstances are real changes likely to occur.

The lesson for Canada and particularly for Alberta is that we may wish to examine what worked and didn't work in the Arizona circumstance so that we can avoid spending billions of dollars on public policy actions that appear to reform water resource management habits but in fact only perpetuate current circumstances while worsening the water scarcity situation in the future.

Ingram also had much to say about the importance of context in the appropriate design of water resource governance. Ingram contends that prescriptions to water resource problems need to fit the context in which they problems have emerged. The notion of context, Ingram suggests, should be used to signify the numbers of complex characteristics that distinguish one geographic and temporal place from another. Just as ecologists see the interrelationships among numbers of physical things and living

organisms as making up a particular ecology, context signifies the nexus of physical, natural, political, cultural, social, and economic phenomena that make one place distinct from another. Context also has a temporal dimension. The context of a place depends upon what has happened in the past in terms of the development of cultural traditions, the kinds of technologies that are in common use and the nature and function of local institutions. Context clearly incorporates the presence or lack of justice, fairness, and opportunity. Context also includes whether or not a place has reached some threshold that is favorable to innovation.

Ingram notes that warnings against the adoption of standardized solutions to public problems regardless of settings abound both in the general literature on public policy and practice and in particular reference to water resources. She points out that values, goals, and other elements of policy designs and processes depend upon context and that concrete settings determine what is feasible. She argues that this advice has been largely ignored in water management.

Ingram points to scholarly evidence that suggests that each of the institutional arrangements that has been presented as panaceas to improve water management over the past 50 years has failed to live up to expectations, largely because the variability of local situations did not favour the ready transplanting of water governance institutions from one place to another. Ingram argues that standardized solutions often embrace only one perspective on problems. While it is true that where that perspective is presently lacking in a given context, such reform may be quite helpful but it is equally true that a uniform one-size-fits-all approach to a subject as complex and disputed as water is a recipe for failure.

In exemplifying this problem Ingram draws our attention to the singularity of most water policy reforms. In Ingram's opinion such singularity demonstrates the great weakness inherent in standardized solutions that embrace only one perspective on how a problem should be addressed. Ingram argues that the contested terrain of water requires not water for nature or people, but both; not expertise or grass roots knowledge, but both; not centralization or decentralization, but both; not government or markets, but both; not public or private water enterprises, but both; not river basin or watershed institutions, but both. She points out that depending upon context this list could go on and on.

Ingram tells us that a contextual approach to water resources requires not just a close study of the elements of water resources management that are present in a context, but also what is absent. In situations of excessive bureaucratic control, designs with greater transparency and public participation are appropriate. However, transparency and openness are not by themselves useful in contexts of great economic and social inequity where the resources necessary to participate are out of reach to the disenfranchised. In such cases other outreach strategies and capacity building are required.

Markets and privatization may well spur necessary innovation in contexts where entrenched public bureaucracy are slow and inefficient, and where entrenched interests have captured public subsidies, but they hardly make up for lack of long term focus on

water sustainability and intergenerational equity. Ingram is very clear in telling us that markets cannot make up for failures of governments. Well operating markets in fact depend upon a strong regulatory framework and functioning oversight.

Ingram also points out that emotional appeals to conscientious stewardship of irreplaceable ecological services provided by water have the power to spur the development of social movements and change public priorities. It must be noted, however, that such appeals, no matter how well intended, may not be enough to overcome the habit of waste that cheap or free water encourages. In the end, only through the appropriate valuing of water do conservation measures have a hope of achieving sustainability goals. A contextual approach also suggests that there are no policy designs or institutions that once put in place can just run on their own without continual vigilance. There is little hope for panaceas. Good water governance is a matter of diligence and persistence.

Ingram offers a list of suggestions and advice that needs to be considered when evaluating whether any sort of reform might fit a particular context. Each of these points relates in one way or another to the problems outlined in each of the papers presented in Zaragoza. Each of these points also has relevance for both Canada and for Alberta. More work need to be done to derive these lessons following the forum.

- **The perfect can be the enemy of the good.** There are a number of examples where natural resources management has been muddling along doing a fairly good job only to be replaced by some “best practices” preferred by international networks of experts that resulted in decidedly worse performance.
- It should be remembered that administrative **reorganization within water institutions often sacrifices many years of possible progress to time spent in restructuring and readjustment that does not always produced desired results.** In Ingram’s experience, which is similar to what we have seen both federally and provincially in Canada, is that years of necessary reorganization may not in the end alter the ability of many agencies or institutions to address the issues at hand. While it is important to reform our major water institutions, the simple act of organization may not arrive at desired results. Instances abound both in Canada and the United States where reorganization may merely compounded agency posturing and ineffectiveness, inter-agency differences and infighting.
- **The fundamental needs of the poorest of the poor must be kept in mind** in designing governmental and market institutions. Where there are already large economic, social and political inequalities, it is important to carefully consider whether reforms help to level the differences among users or will further empower already advantaged water users.
- Where past water policies are generally inequitable, **it is not good enough to simply increase efficiency of a given water system without considering the fullest range of water needs.** Increasing efficiency through markets may actually

cancel out equity by making it less likely that decision-makers will worry about distribution or non-market captured benefits such as those associated with the crucial supply of water to nature. Equitable water policies respect and honour in-stream flow needs, the need to perpetuate the delivery of biodiversity-based ecosystem products and cultural needs such as the importance of sustaining indigenous fisheries.

- **It is best to mix and match policy tools to get people to do what they otherwise would not do.** Policy tools such as capacity building – including the building up of civil society, incentives, sanctions, regulations, charges, symbolic appeals and the like are all based on different theories of how desired action can be motivated. Different people and groups are open to very different kinds of appeals, and depending on who needs to change to reach some water related objective, one or another tool can be usefully employed.
- **Scientific research has an intrinsic value, but more science may or may not help water governance in particular contexts.** Before recommending large investments in research, it is best to consider the range of possible findings and whether such information would be likely to change the attitudes and behavior of any actor(s). It may also be germane to consider the specific questions scientists are being asked to address – and what would constitute a satisfactory answer (e.g., do policymakers need exactitude or probability; are scientists being asked to help determine a single choice, or to compare and evaluate the effectiveness of two or more choices?) If additional problem oriented science is likely to be helpful, the investigatory process needs to be designed in such a way that knowledge is credible, trusted, and legitimate.
- Whether or not to set up new hydrologic based management institutions is a question of whether new arenas can make a difference in access and outcome in what may be an already crowded institutional context. **Hydrologic based institutions like watersheds and river basins are not the magic bullet in water management some reformers insist them to be.** While it is very often helpful to try to draw institutional boundaries to include upstream and downstream problems and other kinds of externalities, there are other considerations. National and sub-national political boundaries are usually drawn on bases different from hydrology, and mismatches create serious conflicts over standing, authority and resources. There are always spaces between hydrological boundary lines however they are drawn that are outside governance boundaries but still require attention. Further, there is the issue of whether decision-makers across jurisdictions are provided with incentives to build trust, enhance confidence, share information, and collaborate on outcomes.
- **Culture and place are very important in understanding why water institutions are the way they are and the extent to which there are opportunities for change.** Institutions may be path dependent, set in motion long ago, and still operating even though they no longer fit existing values and

circumstances. Opportunities for change can be enhanced by the respectful creation of a narrative that explains how institutions that once served useful purposes no longer do so – and that engage local cultures and communities in discussion. It should be remembered that – as pointed out above – reorganization should not be contemplated without considerable reflection as it often leads to sacrificing many years of possible progress to time spent in restructuring and readjustment.

- **Changing policies does not necessarily solve problems of implementation.** As has been witnessed widely, new policies may be ignored. There is ample evidence that privatized water utilities often inherit customers used to not paying their water bills and will continue to ignore bills even when they are sent by a different agency. Some reforms aggravate implementation problems. The more complex the policy chain the more numerous are the veto points where policies can fail.
- **Privatization and market mechanisms cannot substitute for inept government and corrupt institutions.** Both require continual monitoring and oversight by governmental and political institutions with capacity to perform such demanding roles. Such reforms should be undertaken only within a transparent, accountable framework that has the capacity to protect public values.
- **Strategies that can project credible alternative scenarios of water availability and cost for future generations in particular places can help develop concern for intergenerational equity.** In the many contexts where unsustainable practices are being pursued, groundwater is being mined, rare and endangered species are being harmed, and water quality is becoming degraded, stewardship needs to be actively cultivated.
- **Water management always faces multiple challenges, but maintaining public confidence and support is essential.** Credibility and trust, once lost, are enormously difficult to recover. In the context of climate change and increasing risk of extreme events, it is essential that water agencies accurately portray risks, explain the differences between preparedness and prevention, and engage the public in plans for equitable sharing of unavoidable burdens.

The term “hydrosolidarity” was coined by Malin Falkenmark to characterize the opposite of what she called “hydroegoism”, or a narrow self-interested view of water. In its broadest sense “hydrosolidarity” is a deliberate attempt to inject mutual understanding, ethics and a desire to achieve the common good in relation to the management of common waters.

Conclusions & Lessons for Canada & Alberta

Close consideration of many of the ideas promoted in contemporary water networks of researchers and practitioners reveals that some have a long history of failure in many places and only partial success in others. There is little new evidence that the fundamentals that caused past failures have changed.

While we have been managing water for more than a century in Canada, our major institutions have not changed in structure or focus for decades. While we continue to undertake excellent research and demonstrate considerable engineering finesse in the management of water resources, the overarching principles that form the foundation of our purpose and approach to water are outdated and have been proven elsewhere to be unsound as populations and economies grow and water becomes scarce because there isn't enough to meet human needs or because we do not have as much as we want to use when we want to use it.

While there is much to celebrate about recent discourse and activity around Integrated Water Resources Management including greater involvement of the social sciences in applied research and a general commitment to participation and openness, there simply are no universal remedies for good water governance. Moreover, there will always be stress among the multiple values underlying water problems.

The principles of Integrated Watershed Management offer promise for future water management success. This promise, however, cannot be fulfilled unless we exhibit the political courage to effectively integrate water management and land-use policy on a basin and regional scale. Until a breakthrough occurs in this crucial area of public policy development, contemporary water management traditions in many parts of Canada are likely to make water allocation, quality and use issues more complicated, less efficient and more contentious in the future.

Even when policy designs fit and work well in a particular context, continual readjustments are likely to be necessary to deal with both emerging problems of a changing and increasingly variable climate and shifts among contending values.

We have reached a threshold in population and economic growth in parts of Southern Canada, and in particular in Alberta, where it will no longer be simple, easy or cheap to successfully manage our water resources. While water resources in many parts of Canada largely managed themselves, that era in our frontier history is over.

Unless strong leadership emerges in public policy reform, we can expect more conflict over who gets to use water for what purpose in Alberta and we should expect to spend a great deal more time and money deciding how to best manage what has suddenly become a potentially limiting factor in the economic and social development of the province.

While contemporary water resources research and practice provides a lively smorgasbord of ideas, often misleadingly swept together as “integrated”, far too little attention has been directed towards the politics of water. Politics is often viewed as an impediment by the water researchers and managers, perhaps as an outgrowth of their generally technical orientation.

The mainstream of the water research and practice community prefers commitment to ideals that can somehow be adopted and implemented by “collaboration”. Politics is the means through which societies contend with differences among multiple values and perceptions and the gaps between desires and resources.

Presently truly integrated watershed management is still a dream in Canada. Water scholars and practitioners can imagine whatever future they may desire but without political engagement, nothing much is likely to change. While many who would wish to see reform of public policy with respect to water often dismiss contemporary political process as a waste of time, politics cannot be avoided if change is to occur. Imperfect as it may be, the political process is the foundation of democracy and as such it is the established and only vehicle through which orderly public policy reform is possible. Watershed interests must not only engage in the political process but must take an active interest in how it functions in order to raise the profile of water issues to the level of priority at all political levels.

Collaboration, along with persuasion, conflict, bargaining, negotiation, discourse, and force are all political processes that may be more or less appropriate in various contexts. Research suggests, however, that collaboration is a lengthy process that may not result in sufficiently timely or innovative solutions.

Watershed basin councils and trusts are not the total solution to the challenge of managing water in a more completely sustainable way anywhere in Canada. We should recognize collaborative processes impose limitations by their very design on the results that can be expected from them. We should also respect them for the doors they leave open to dialogue and future possibilities.

Adequate responses to what are bound to be mounting water problems will take more radical political action and substantial change in “business as usual”. While water tends to be a path dependent issue area, which is subject to only small and sometimes inadequate change, opportunities for dramatic and transformative change do occur. Such opportunities may be triggered by external events like floods or drought, but to ignite change, events must be accompanied by new issue definitions, public mobilization, and committed leadership.

Catastrophe has a way of rapidly opening doors to change. More extreme weather events associated with global warming; the likelihood of more frequent and intense forest fires and a longer annual fire season; the possibility of changes in the timing and extent of precipitation; glacial recession and changes in snow cover and snow

pack; and the spectre of longer, more frequent droughts particularly in Alberta should logically inspire a desire for sweeping public policy reform with respect to water governance.

If such events do not in themselves create a sense of urgency in government then it will be up to the public to use these circumstances as a vehicle for pushing for action. Simply demanding change, however, will not be enough. Those interested in reform of water governance will need to know what they want, have credible plans for reform ready to propose and be persistent in following new legislation through to implementation. They must also be on guard against push-back against implementation and the gradual erosion of regulation and enforcement of new policies and directives.

Water researchers and practitioners need to attend to political opportunity structures and the cultivation of leadership through strategic and timely insertion of ideas, perspectives, relevant science, and accumulated wisdom. There will be growing opportunity to link water with other critical subjects of heightened public concern, like energy and agriculture to raise the visibility of water and to bring in a broader, more energized movements and networks.

A daunting backlog of knowledge generated through already completed research remains to be incorporated into contemporary decision-making processes. A far better bridge has to be built between scientific research outputs and public policy inputs. This suggests that a great deal more work must be done to translate research outcomes into language the public can understand and legislators can act upon.

Further inter-disciplinary research is critical to the level of integration of public policy that is required to come anywhere close to sustainability. Water governance reform cannot occur in isolation from changes in public policy in other sectors such as agricultural and energy.

Equity and fairness have powerful generative force in water politics and water reforms that do not appear just and fair are unlikely to be politically infeasible.

In Canada we think we are by nature equitable and fair in the way we treat one another. This, however, is not always borne out in the way in which public policy unfolds especially in terms of how we manage common pool resources. First Nations would be the first to argue that we have neither been fair, forthright or equitable in fulfilling the contract they have with the federal government that guarantees the supply of clean fresh water on the country's Indian Reserves.

Many First Nations are also concerned that federal, provincial and regional jurisdictions in many parts of the country no longer honour their promise of retaining water quantity or quality sufficient to meet conditions that would permit cultural traditions to be perpetuated as promised. But it is not just Aboriginals who are concerned about equity as it relates to water governance.

It is not unreasonable to suggest that public policy with respect to governance of water resources in Canada has largely been defined by special interests which have quietly but vigorously done their utmost to limit the influence of expanded public dialogue on how water might be managed in the future. That, in final analysis is neither equitable nor fair.

Urban centres, the oil and gas industry and agriculture have each sought to define public policy reform with respect to water in their own interest. Each brings a singular perspective to future needs that does not allow for the fullest accommodation of all the needs represented by society and by natural ecosystems.

The greatest and perhaps ultimately the most dangerous area of inequity related to water resources resides in the fact that nature has no voice in the evolution of public policy reform. The provision of water to nature is most often an afterthought and is only considered when water is available in abundance. Until these inequalities are addressed, Canada's water management policies will be neither equitable nor sustainable over the long term.

Attempts to design improved water resources management and institutions must attend to context. Standardized reforms have failed time after time because of a lack of understanding of the cultural and political logic of existing arrangements and/or because prescriptions worsened imbalances among competing perspectives in particular context.

Attachments to the purity of particular approaches with broad labels like "markets", "privatization", "watershed governance" or the like leads to overemphasis of some values and blindness to others. In general, clumsy solutions that embrace multiple perspectives and appeal to different kinds of logic are preferable. It is a mistake to believe that all people and groups are motivated the same way. Mixed strategies that appeal to different ways of knowing are more likely to be effective.

Creating public policy is not the same as implementing it. Much water-related policy reform put before the public in Canada is never meant to work. It is meant only to give the appearance of working while the government pursues other higher priorities such as energy and resource development. Advancements in these domains invariably cancel out or defeat any advances toward sustainability in water resource development.

Most water policy put forward in Canada can't work as effectively as it should simply because not enough energy or resources are committed to implementation. Even when implemented, policy reforms will continue to affect change only so long as champions of that change continue oversight and fight fiercely to ensure that regulations are in fact being followed and that meaningful enforcement of new policies occurs.

Finally, the water researchers and practitioners must give up the pursuit of one size fits all water institutions that, once set in motion, persist on their own by adaptively respond to changing circumstances. What is needed is a renewed appreciation for the pluralism of good ideas and a realization that no single idea can ever be the panacea. Universal remedies are a mirage, momentarily exhilarating but ultimately disappointing.

Simple broad brush public policy solutions that appear to work on the surface too often stall on the ground because they do not respect local circumstances and traditions. Effective water policy must offer specific direction on the larger scale but be flexible at the local level where it succeeds by way of adoption by credible people who believe they are doing the right thing and through example influence others.

Thus we see that the great challenge of sustainable water management in Canada is to create unity in purpose and in action that links what the country has, what provinces want, what regions are doing and what individuals need and desire in terms of sustainable water resource policy. Unfortunately, because we still live under the myth of limitless water abundance and because accountability for the management of water resources is dispersed and atomized through an unwieldy array of fragmented jurisdictions, we cannot get there from here.

Ultimately, anything even close to sustainability can only be achieved through the development, adoption and implementation of a new shared Canadian water ethic that defines how water ought to serve us and nature in the future. Until such an ethic exists we are doomed to rely more and more on expensive but comparatively inferior technological solutions to perform services nature used to provide on its and our behalf for free.

The integration of water management and land use policy is particularly important. The destruction of the aquatic ecosystem health of our rivers and streams through poorly considered land-use policy is the landscape equivalent of wiping out the immunological capacity of your own blood stream. When you destroy terrestrial and aquatic ecosystem health you wipe out the self-purifying capacity of natural systems, the very capacity upon which we rely to supply us with the water we need for drinking, for life and for everything we do and make. In the absence of ecosystem health all we left have are engineering solutions that are the equivalent of putting all of nature and all of humanity on dialysis.

Unless the public truly understands and can act upon how these problems have emerged and the directions they are taking us, we will never be able to keep up with the difficulties we are creating for ourselves in terms of water security, ecosystem integrity or climatic stability. Only by building a better bridge between science and public understanding that leads to policy action can we break out of this vicious circle. Only by breaking out of this vicious circle will the work we do in our generation be meaningful in any enduring way in the lifetimes of our children.



Exposición Internacional
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(*Photograph courtesy of Peter Gleick*)

Margaret Wilder

Promises Under Construction: The Evolving Paradigm for Water Governance And the Case of Northern Mexico

Helen Ingram's thoughtful presentation was followed by a compelling paper on water governance reform in Mexico which made concrete many of the points Helen made. In her presentation Dr. Margaret Wilder's made three three key points.

1. The wedding of marketization of water decentralization of governance in Mexico has resulted in an uneasy marriage that in Wilder's opinion must be constantly mediated and continuously negotiated if Mexico is serious in its desire to achieve water use efficiency in tandem with equity, sustainability and full participation of the widest range of interests.

It is likely we are entering the same kind of uneasy marriage in Alberta with the advent of markets and the move toward decentralization of some governance responsibilities to watershed basin councils. As Mexico, perhaps surprisingly, is well ahead of Alberta in implementing watershed-based governance processes it will be very interesting to examine how well their system is working. It will also be interesting to compare what is happening in Mexico with what we have learned about how Spain approached similar governance challenges under the combined influence of the European Union Water Framework Directive and Spain's own evolving national water policy reforms.

2. Second, Mexico's democratic transition has, paradoxically, led to more fragmented national and regional politics – especially party politics – which has made it more difficult to push a unified decentralization and sustainability agenda forward.

It is interesting to observe what Spain did differently than Mexico to ensure the country's national water policy remained intact through the terms of several governments composed of sometimes rival political parties. The difference seems quite clear. In Spain, successive governments were held in check by their country's commitment as a member of the European Union to honour the EU's Water Framework Directive and water-related clauses in the EU's Common Agricultural Policy. A desire to meet with the European Union's requirements was reflected in the country's own domestic policies. It also allowed initiatives to be advanced regardless of which party was in power. In Mexico, the foundation of water governance reform was the North American Free Trade Agreement which imposed many conditions that remain unpopular in parts of Mexico. As the issues associated with being bound by the conditions of NAFTA has yet to be adequately resolved, governance issues related to water remain politicized.

It may be that the North American Free Trade Agreement – like any other market-based solution that focuses primarily upon market productivity without paying equal attention to equity and sustainability is an inadequate public policy vehicle for addressing water issues either continentally or nationally. Trade agreements of such limited focus may in fact make it impossible to manage water in an integrated and effective way because they unilaterally tie all regions within signatory nations to narrow definitions of economic progress that exclude meaningful attention to the sustainable use of local water resources or inter-generational responsibility to the maintenance of the biodiversity-based systems upon which local hydrological regimes depend for their stability. They do this by making it uncompetitive at least on the short-term to do the right thing in terms of sustainability of water resource or related-land use.

The lesson for Canada is that there may only be two effective ways in which to approach the effective and enduring reform of water policy on any level in this country. The first might be to create a European Union style North American Water Framework Directive that bound Canada, the United States and Mexico to the same water resource quality and management goals while offering funding and support that would allow each state or province in each country to find the most appropriate means to achieving those goals within reasonable time frames. Such a framework would by necessity require adjustments to the North American Free Trade Agreement.

The second option is a more localized national approach which Canada could undertake on its own without the involvement of its North American Free Trade Agreement partners. This option is far less desirable, however, if only because Canada shares so much of its water resources with its southern neighbour. This option does, however, recognize that it will be very difficult if not impossible to revitalize water policy on a national basis in Canada without the full and complete support of the provinces. Such support will likely demand an appeal to higher reason for cooperation. This appeal would have to be sufficiently motivating to encourage provincial commitment that would drive non-partisan support for an overarching inter-generational sustainability goal not dissimilar to the one that powers the European Union's Water Framework Directive.

A uniquely Canadian framework would have to be compelling enough in its intention to bring the entire nation together over water. The only thing that might have the power to do that may be the threat of climate change.

3. Wilder's third key point is that we can learn much as Mexico's experiment with marketization and decentralization enters a more mature phase, about the challenges other countries will likely face in making a major transition in water governance. At present we learn from Mexico that it likely to be more difficult to sustain multi-faceted governance transition over decades and across regions than to launch the transition in the first place.

The lesson we may learn from both Spain and Mexico is that necessary water policy reform is a multi-generational project. Starting the reform is the easy part. Completing it is more difficult. In starting out it is important to accept that it may be more difficult to sustain a multi-faceted transition of water governance over decades and across vast regions than to launch the transition in the first place.

Wilder goes on to point out that since market mechanisms are notoriously poor at addressing social or distributional inequalities, it is critically important particularly in developing countries like Mexico to get the balance between marketization and decentralization right at the start. What she is saying is that it is critically important to develop decentralized management and sustainable processes and practices not only as a counter to the excesses of the market, but as a means of making a substantive and fundamental democratizing shift in social relations of power and control over water.

The fundamental question in Margaret Wilder's mind at the moment is whether Mexico – and especially the Mexican state – has the will and the capacity to fulfill these “promises under construction” as she calls them, or if the *status quo* with respect to power and equity will prevail. In my estimation, Margaret Wilder has pretty much answered her own question. The democratization of Mexico's water legislation began with criteria defined by the North American Free Trade Agreement and encouraged by the World Bank. The requirement of responding to these criteria resulted in massive shifts in terms of economic restructuring which included privatization of state-owned water utilities, elimination of subsidies, initiation of market reforms and the reduction in the size and capacity of government. The World Bank-endorsed reforms were to be counterbalanced by Earth Summit and the Dublin Principles of water stewardship¹⁶. These principles were expressed through Mexico's National Water Law which was passed in 1992 and then modified in 1994.¹⁷

¹⁶ In a related paper entitled *Water, Equity in a Changing Climate* (published in *Water, Place & Equity*, MIT Press, 2000) Helen Ingram outlines the range of meanings water has to people and why each has a claim to legitimacy. She also argues that while general concepts such as the Dublin Principles contribute usefully to discourse and discussion they are not a practical list of rules that can be applied in real-world situations. Ingram argues that while access to sufficient water to sustain life should probably be considered a basic human right, the fact still remains that water still has to be delivered from one place to another through infrastructure that has economic and social costs. Ingram goes on to point out that, in order to be effective, the broad range of often conflicting water resource management ideals must be implemented in ways that embrace both the needs of watersheds and the demands of democratic theory. If they don't, Ingram argues, they will fail.

The fact that universal pronouncements fail on this ground suggests why major global gatherings such as the World Water Forum are not necessarily worth attending if practical local solutions are what you seek. Covenants such as the Dublin Principles create change. The moment they do, however, corporate and other vested interests exploit that change and attempt to halt it at the point at which change brings the greatest advantage to them.

¹⁷ These reforms, then, were implemented 14 to 16 years before the time of this writing which suggests that Mexico was well ahead of Canada in terms of contemplating national water reforms based on these new global principles.

Seven major elements were enshrined in Mexico's national water reforms, all of which were overseen by the National Water Commission:

- Public registry of water rights
- Establishment of formal markets for trading surpluses
- Reduction or elimination of subsidies
- Transference of the country's irrigation districts to water user associations
- Municipal and state responsibility for water and sanitation management
- Allowance of private sector management
- Creation of a network of watershed basin councils

But just as happened later in Canada and particularly in Alberta decentralization of power to basin councils has been slow, if indeed it has occurred at all, leading to legal and philosophical limbo.

Water policy reform in Mexico has put into relief the fact that all but the largest municipalities lack training and know-how to improve system performance, utilize new tools, create and improve protocols for sustainability and to establish more accountable processes. Some would argue that the same is also true in Canada.

Mexico, like Canada, has enough water but it is not evenly distributed. In a situation very similar to what exists in southern Alberta, the densely populated centre and north has 77% of Mexico's population but only 31% of the country's natural water supply. The wealthy southern part of Mexico, however, has 23% of the population but 69% of the water supply. Mexico uses 77% of its current water supply for agriculture. Of the water allocated to agriculture 85% goes to commercial irrigation and 15% to smaller irrigation operations. Like parts of Canada, northern Mexico faces increasing water demand, competition among water users and decline in water quality due to intensified demand and climate change.

As in many parts of the world where governments have been downsized, responsibility for broken water management infrastructure is downloaded to municipalities without the financial and technical resources to ensure repair, improvement and extension of urban water systems. This, of course, is an invitation to private sector involvement in municipal water supply.

While public participation in decision-making has yet to be fully optimized successful transformation of irrigation districts was accomplished through very effective government oversight. By law, however, National Water Commission regional directors are required to be the presidents of each of the river basin councils. As a result these councils have very little autonomy and lack jurisdiction to make major decisions. This has proven to be good for irrigation districts but bad for the integrity and perceived autonomy of the basin councils.

The dynamics within the irrigation community have also been interesting. Irrigation districts are now being touted as “successful new globalizers”; and 76 of 81 major irrigation districts have become water user associations as per the direction of the National Water Commission. It is difficult to say what this means in the Canadian context, except that there has already been resistance in southern Alberta to irrigation districts assuming the broader role of water utilities in the regions they serve. It should be noted, though, that indigenous irrigation districts have not bought into the Mexican water framework directive which will be of interest in Canada should similar strategies be developed to transform irrigation districts into regional water user associations.

In Wilder’s estimation privatized water services on the whole have not generated greater water efficiencies even in North America. Nor have there been measurable sustainability gains. Just as Helen Ingram suggested, the key lesson here is that neither decentralization nor privatization options appear to work without strong state oversight. This suggests that cutting the size and reducing the role of government – which is a Conservative panacea in North America – and then expecting markets and privatization to not only take up the slack but to actually move water governance toward long-term sustainability is unachievable.

Markets and decentralization can only function effectively in the presence of competent and persistent government oversight of regulations, effective enforcement and integrated planning. You can privatize and decentralize all you want but unless there is enough of the right kind of government oversight in the form of competent and inspired regulators you are not likely to succeed in achieving the goals to which reforms of this kind claim to aspire. A high level of oversight is critical if only because privatization is limited in its ability and capacity – as has been so clearly demonstrated in Mexico to resolve politically charged issues such as water scarcity, redistribution of water rights or issues of environmental sustainability. Nor can private corporations address urban water needs within the broader socio-cultural context of community, a point Wilder makes in her analysis of current water-related problems in Mexico City which she appended as a footnote in her paper.

In attempting large scale water reform, Wilder urges proponents to count on entrenched and vested interests to impede change from within. Noting that some of the district basin council presidents became the protégés of large landowners, Wilder worries that real participation in the process of decision-making regarding water resources management has not expanded in the Mexican model. Reforms in laws in 2004 may lead to increased

participation over time but as Wilder points out, this remains yet another “promise under construction”.¹⁸

The biggest concerns relating to the success of governance reform in Mexico relate to sustainability. It is in this domain that Mexico’s water reform appears to have made the least progress. Existing problems such as unplanned growth received no more attention under the new legislation. Nor were issues of groundwater overdraft addressed. This was highlighted, just as it was in Spain and recently in Australia during a decade-long drought during which irrigators shared water successfully with the aim of sustaining high value agricultural production. It soon became apparent that the water conserving practices of districts were often self-serving in terms of focusing on monetary generation that had little to do with sustainability. While this may have been necessary during a short-term crisis like a drought, it becomes a serious long-term problem when drought is prolonged or becomes a persistent feature of regional climate. What would have in earlier circumstances been an emergency measure gradually becomes the norm which means that surviving economically becomes more important than sustainability as a matter of course, which throughout the history of human civilization has been the fundamental condition of societal collapse.

What Margaret Wilder and many other presenters at Rosenberg VI are saying is that unsustainable agricultural practices are becoming the norm as a result of persistent drought conditions in the Middle East, North Africa, Spain, Mexico and Australia. It is no longer just our numbers that constitute a danger to the our future; our planetary life-support system may well collapse not just as a direct consequence of our populations but as a consequence of the way we have decided to meet our food production needs.

Who would have ever guessed that such a circumstance would arise? Our cities are now so large that they are cutting into the amount of land and water we need to feed ourselves; and the amount of land and water we increasingly need to feed ourselves is now cutting into the biodiversity-based ecological functions that make life possible and meaningful on this planet and that created the very climatic stability that made the rise of our civilization possible. Our hope of preventing the convergence of these dangerous circumstances has resided in our faith in innovation, science and technology. But in the dry regions of the world such as the Middle East, Africa, Spain and Mexico – and in new regions made permanently drought-prone such as Australia and parts of the American West engineering and technology have only been successful in creating short-term stop-gap solutions that only lead to greater ultimate vulnerability as populations continue to grow and material expectations rise.

What we learn from these examples is that while engineering and technological innovation will always be important, the area in which we may need to concentrate most

¹⁸ In later conversation with Henry Vaux on matters of governance, he suggested that the absence of good governance in Mexico is a significant problem that was not touched upon in the Forum. It was Vaux’s opinion that the lack of good governance in Mexico represents a major barrier to the implementation of a sensible national water strategy which would include many of the recommendations put forward in Margaret Wilder’s analysis.

in the management of our water resources is on sustainability of use which suggests our central focus should be on governance for it is in this broad and universal domain that our collective ineffectiveness is likely to produce the greatest potential for conflict which can only occur at the cost of any future hope of achieving sustainability.

As Margaret Wilder points out, the central fictions in Mexico are similar to those we face in Alberta. In both systems there is no formal representation for the environment itself and no effective way to advocate for nature's own need for water so as to perpetuate ecological productivity that is as important to our survival as a species over the long term as surviving drought is on the short-term.

Wilder also added another dimension to this argument to which other speakers also alluded. In addition to the tensions between cities and agriculture and agriculture and sustainable global ecosystem function there is a new kid on the block who threatens to blow the neighbourhood apart. That kid goes by the name of biofuel production. It is worth quoting how Margaret Wilder frames her concerns about what is happening in the global neighbourhood of Mexico:

As we confront the certain challenges of the future—climate change, sectoral and regional conflicts over shrinking water supplies, increased demand related to growth and development, and changing technologies such as biofuels and desalinization that are redirecting water supply or making available new sources—how can this array of fragile relationships among citizens, states, markets, and the environment itself be made to work, even to thrive, so that water policies especially in the developing world can be made more democratic and sustainable? Mexico's visionary agenda about democracy and participation is wedded to a strange partner, the market—and frankly, these two co-exist in an uneasy relationship that must constantly be mediated and negotiated. Each of these partners do some things very well, but each tends to overstep the boundaries of the other. Each has a tendency to absorb all the oxygen in the room and to leave insufficient space for the other partner. The literature suggests that new relationships can lead to context specific solutions—for example, pairing of community with markets (private-social participation model) or co-management models (state and community management) (Lemos and Agrawal 2006). One of the pressing challenges ahead, then, is to sort out the fundamental relationships among the state, the market, and citizens. Mexican policymakers need to ask themselves the fundamental question: what is our water policy really about—market efficiency? decentralization and local participation? equity and sustainability? Respected former environment ministers such as Julia Carabias and Victor Lichtinger maintain that markets, the private sector and efficiency gains must be part of the solution of moving toward a more sustainable, secure water future. Prominent advocates of more sustainable water governance such as Gleick et al. agree that private management of water has long been an aspect of water governance and is likely to continue to play a role in the future (Gleick et al. 2002). Helen Ingram precisely frames the challenge facing Mexico and other developing nations, when she writes: “The contested terrain of water requires not government or markets, but both; not public or private water enterprises, but both; not water for nature or people, but both; not centralization or decentralization, but both; not river basin or watershed institutions, but

both...” (Ingram 2008). At the end, we return to the politics of water. Regardless of the party in charge, only a strong Mexican state that is committed to achieving not just one end of this equation—markets and efficiency—but the other end as well—equity and sustainability—will be able to implement a sustained program of transition to achieve these desired ends. Mexico’s democratic transition is embodied within and being realized through its water policy transition, and the promises imagined in the emerging water governance paradigm are still under construction. Mexico’s citizens—the water drinkers, the farmers, the colonia dwellers, the indigenous tribes, the housewives, the children—will stand for nothing less.

There is much that is happening in the rest of the world that should be of interest to Canadians. Mexico, for example, is attempting to do a great deal all at once with its national water strategy. It is trying to confront well identified future challenges such as sectoral and regional conflicts over shrinking water supplies, increased demand related to growth and development, climate change, and a changing economic focus on energy production that has brought about new demands on water through the growth of energy options like biofuels. At the same time a fragile new arrangement of citizens, states and markets is trying to create water policies that not only make the country more democratic but that will advance Mexico toward the ideal of sustainability. Margaret Wilder wonders if the notions of greater democracy and expanded public participation in decision-making on water issues isn’t at odds with the market-based approach Mexico is taking with respect to water policy reform. Certainly, it is a marriage that is not going to work without a great deal of counseling in the form of government oversight.

As quoted above, Wilder offers an interesting metaphor for the tension that exists between markets and democracy. She argues that each does some things very well but that each tends to overstep the boundaries of the other. Each, as Wilder points out, has a tendency to absorb all the air in the room leaving insufficient breathing room for the other.

One lesson Canada may wish to derive from the Mexican experience relates to the fundamental goals of any significant water policy reform. Canadian policy-makers need to ask the same fundamental questions that continue to be asked in Mexico and around the increasingly water-scarce world. What is our water policy really about? Is it about market efficiency? Is it about decentralization and local participation? Or is it about sustainability? Or is it about all of these ideals? Unfortunately solving one of these problems is not enough. Creating markets and market efficiency without achieving equity and sustainability changes the circumstances but does not solve the problem. Nothing less than sustainability will do. Anything less is nothing more than just one more “promise under construction” that will not help us meet long-term needs. The Mexican example suggests that regardless of the party in power only a very strong government committed to achieving all of these goals and not just one end of the spectrum will be able to implement a sustained program of policy transition capable of achieving all of these interlocking goals.

Though Canadians have yet to realize it, market-based approaches in themselves don't always work to define the most desirable future. Some things are simply too important to leave solely up to the market place to work out. The future of our country's freshwater resources is one of those things. We have to be careful in Alberta that we are not forcing an arranged marriage between two very different interests. We need to ask how long we can expect a peaceful marriage between public participation in water policy reform through newly created watershed basin councils and market-based solutions to water availability issues. Can democratic participation in water policy reform and market-based solutions live together in the same house; or is this a balance that will favour one but leave the other unfulfilled putting sustainability forever out of reach?

In a related paper entitled *Water, Equity in a Changing Climate* (published in *Water, Place & Equity*, MIT Press, 2000) Helen Ingram makes the point that in Western societies in particular (as reflected in the politics of both developed nations and in the corporations, NGOs, and international aid organizations they support, there is a bias toward defending policy decisions on the basis of rational or enlightened self-interest. In Ingram's opinion, this bias inhibits public interest-based solutions to environmental and resource issues because it assumes that individual economic gain is in itself a virtue. It rejects civic republicanism, which can be defined as the conviction that citizens have an obligation to serve the needs of the larger community and of future generations. Ingram points out that it is difficult, at best, to achieve clear and transparent policy objectives that are ethical as well as practical through a political process characterized by interest group negotiation, bargaining and brokered compromise. Ethical discourse, Ingram explains, is concerned with defining right and wrong. Political discourse is about who gets what and when. Figuring out how to use power to achieve one's desired ends the foundation of politics. Determining how to use power justly is a secondary concern – or worse is ignored completely. For these reasons we should not expect ethical panaceas to emerge in service of the creation of just environmental policy.

It appears from the discussion of how to revitalize governance that we may need to transcend the current objectives, goals and practices of contemporary politics. It may no longer be enough to manage opposite interests and political dichotomies based on the tradition of negotiated compromise. We appear to have approached a point in our history where the thing that matters most is sustainability. The issue of sustainability may already be so urgent that we have to overlook the fact that the term has been appropriated and made meaningless through manipulation of its terms in corporate and political circles. We have to wrest the term back rather than wasting years creating and putting forward a new term that means the same thing. We may need to insist on firm local and contextual definitions and meanings and be on high alert in preventing weasel words sidling up to the pure concept and robbing it of its forcefulness and integrity. As public relations interests will inevitably try to cast a net over its pure meaning it will be necessary to be uncompromisingly persistent in defending sustainability's highest ideal from those who would torque its meaning out of shape in service of their own interests.

It often appears that governance in our time has either lost its focus or has spread its focus over too many often contradictory or self-cancelling interests. Governance can be

revitalized by focusing on a single unifying urgency. That urgency is not the marketplace which tends to take care of itself, often sucking so much air out of the room by doing so that there is no breathing space for anything else. The urgency to which our major institutions must respond has emerged, in fact, as a result of too much focus on markets and not enough oversight concerning the incentives markets create. The urgency we must address is sustainability and only by addressing it can markets be brought into line with any hope of creating an equitable and desirable future for those who will occupy the planet after we were gone.



(Photograph by R.W. Sandford)



Exposición Internacional
Zaragoza 2008
(Photograph courtesy of Peter Gleick)

Peter Gleick

Synthesis, Lessons, Conclusions Water for Food In A Changing World

The close of the Rosenberg Forum in Zaragoza was dignified by summarizing remarks presented by no less an expert than Peter Gleick of the Pacific Institute. As he did in Forum V in Banff, Dr. Gleick offered a most thoughtful analysis of the proceedings. Gleick began by offering that the challenges associated with growing food are increasing because of intensifying constraints on water, land and other resources. Gleick noted that considerable progress has been made in domains such as the expansion of irrigated land and the improvement of yields, but progress has been slowing as we reach the limits of the revolution and must speed up if we are to meet continually expanding food production needs demanded by population growth. As he pointed out at the close of Rosenberg V in Banff, two challenges continue to confront us. The first is to find new ways to tackle old problems. The second is to understand and address new problems.

Dr. Gleick then outlined the major problems we face on a global basis. Foremost among these was that water needs for food production are growing substantially and will continue to grow without improvements in efficiency or changes in diet, food demand and population size. As a result we can expect growing competition and more conflict over water for agriculture and urban use and water needs related to the perpetuation of ecosystem health.

Traditional sources of water supply are increasingly constrained in most of the world's highly populated areas. River basins are being closed to new withdrawal licenses and uses, most of the best dam sites have already been developed and unsustainable groundwater withdrawals are occurring in many regions. New investments in irrigation are falling or are misdirected. Climate change has become a reality.

In synthesizing the outcomes of the forum, Gleick identified five themes relating to further advancement of public policy with respect to water resources.

1. Ignore Ideology; Expand Thinking

Gleick offered that the proceedings of the forum suggested that while ideological debates were often interesting and even fun, they are not necessarily productive. The kinds of ideological debates he put into this category included arguments over infrastructure; the debate pitting markets and privatization against water as a human right; and the debate over genetically modified organisms. These debates – at least at far as Gleick had observed in the proceedings of the forum – were not helpful in advancing dialogue over how to address the growing global fresh water crisis. What is important now is to expand our thinking rather than contracting it around unproductive wrangling.

What was important, in Gleick's estimation, was to realize how easy it is to get technologies right but the institutions wrong. It is also important to realize that what might work in one place, for small landholders in Africa for example, may look different from solutions that may work in larger-scale systems, say in Asia. What was really important at this time was to challenge fundamental assumptions such as the stationarity of climate and water availability and our deep-rooted belief in singular, silver bullet solutions.

2. Integrate; Do Not Isolate

Dr. Gleick underscored the need for less isolation in the evolution of water resources policy through the presentation of a number of examples where undue focus on only one element or benefit has resulted in damage to entire hydrological systems. While I had worried throughout the forum that not enough attention had been given to energy industry competition for agricultural water, Gleick summarized the problem in a single sentence. Current biofuel policy, in Gleick's estimation, was an excellent example of how to do the wrong thing with enthusiasm and of the failure to integrate public policy across linked domains of water supply, land-use policy, energy security and food production.

Current biofuel policy is an excellent example of how to do the wrong thing with enthusiasm and of the failure to integrate public policy across linked domains of water supply, land-use policy, energy security and food production.

Peter Gleick

Gleick also observed that isolated public policy failures were apparent where increased water use in one sector traditionally comes at the expense of other users and especially the environment. Gleick pointed out how unwise it was to permit any activity that led to groundwater pollution or increased salinity. Such impacts made it impossible to use water for any other purpose than the one that led to its contamination.

Gleick also pointed to the isolated goals of many 20th century water projects which focused on a narrow set of benefits which, when realized, made other potential benefits impossible to achieve. Citing hydropower, flood protection, irrigation and recreation projects in particular, Gleick noted that limited purpose projects served isolated functions if they do not integrate impacts on ecosystems, local communities and local cultures into the way they are designed and operated. Water resources policy had to integrate the widest range of purposes and interests into evolving management approaches including an acceptance of nature's equal right to water to perpetuate ecosystem function.

Gleick points out that sustainable water solutions inevitably come from a merging of solutions which suggests that engineering solutions on their own are not likely enough. Technology has to be tied to non-structural solutions, which include utilization of non-traditional sources of water as pointed out in presentation by Holger Hoff, Malin Falkenmark and Ramón Llamas. These solutions also have to be tied to a more comprehensive view of the food system as a food chain that leads “from field to fork” as Holger Hoff and Shawki Barghouti proposed. Broader integration of water solutions also means embracing expanded conceptions of trade such as those implicit in notions related to virtual water export.

3. Innovate

Innovation also requires the rethinking of water supply which means looking at both blue and green water as potential sources. Innovation means using the concept of virtual water as a planning tool. Innovation also means the continuing evaluation of “non-traditional” water sources such as rainwater harvesting, conjunctive use of groundwater, treated wastewater and desalination. Innovation also requires consideration of how to match the quality of water needed with the quality of the water available. Innovation also means not forgetting or dismissing ecosystem needs and recognizing that true sustainability means meeting human environmental needs together. Innovation does not mean abandoning traditional supply infrastructure but building it only where and when it is needed at new standards.

Innovation also means rethinking water “demand”. It means moving away from the idea of “using” water toward the idea of optimizing “benefits” that water provides. Gleick pointed to examples such as improving yields while reducing water use per unit of production.

Gleick also argued that innovation also meant rethinking water “institutions” and “management”. This suggests the need to bring the natural sciences, social sciences, politics and water more effectively together. In this, Gleick pointed out, equity had to be a central not peripheral requirement. Gleick pointed, however, that as desirable as participation and collaboration were, they did not always deliver desired results within useful time frames. He noted that while trading of water rights was key that water markets were only effective over the long-term if governments exercised constant oversight of the results. Sustainability, once again, was not just markets; not just collaboration; not just productivity and profit; not just enough water for nature; but all of these together.

Sustainability is not just markets; not just collaboration; not just productivity and profit; not just enough water for nature; but all of these together.

Peter Gleick

4. Improve Information

Not surprisingly the issue of effective monitoring, data collection and interpretation surfaced in Dr. Gleick's summary of the central themes of Rosenberg VI. It is the role of science to collect key data without which it is impossible to make good decisions. Scientists also have to communicate better with policy-makers just as policy-makers have to communicate far better with scientists. And everybody – Gleick proposed – has to communicate better with the public.

Gleick reserved his most poignant summary observations, however, for a theme that could not be ignored at any time during the forum: the urgency of effective action.

5. Initiate and Implement

In conclusion Dr. Gleick synthesized the proceedings of the forum with respect to priorities related to water and food in a changing world. He ordered the priorities in the following order:

- Meet the needs of the poorest, but especially of Africa
- Don't ignore the population growth program and the growing number of problems converging around the challenge of feeding more and more people at the expense of the planet's ecosystems.
- Continue to strive toward higher water efficiency and productivity
- Continue to focus on investment in improved technology and practices
- Continue also to improve governance and management

Gleick pointed out that successful solutions to water problems are available and being implemented every day and that we should build on successes and learn from our failures. Gleick offered that the forum demonstrated that successful solutions will be those that move beyond ideology; integrate concepts; communicate new information in new ways; and that lead to action.

Gleick's last remarks were suggestions for further forums. Future Rosenberg Forums, he proposed, should emphasize solutions and success stories and not just problems. They should explore ideas related to integration and highly useful inter-disciplinary tools. They should explore – and this was of particular interest to me – ideas for better communication ways forward and the continued integration of science and policy.

Finally, more policy-makers should be invited to future forums.



Henry Vaux

Closing Remarks Water for Food In A Changing World

After Peter Gleick completed his summary, Henry Vaux made his parting remarks thanking especially the sponsors and hosts of the forum. The forum concluded with everyone in attendance standing up to applaud its success. No one seemed to want the conversation to end. Knots of participants hung around talking, trading business cards and making plans to meet again.

Then, as if there had never been anyone in the room, everyone was gone dispersed to the farthest corners of the globe. The Rosenberg pebble had dropped into the water and now the ripples were radiating outward into the world.



Photographs courtesy of Dr. Peter Gleick

The Rosenberg Gala

The gala concluding dinner at the Rosenberg International Forum on Water Policy is always a memorable event, and the Zaragoza gala held at the Gran Hotel a 5 Calle Joaquin Costa was no exception. Sponsored by the Agbar Foundation and the Museu Agbar de les Aigües it was a beautifully orchestrated event at which we could not fail to celebrate our good fortune of being together in Spain and reflect on the urgency of our collective purpose in being there.

This gala, however, was special in a sense that it had to be scheduled in the end around Spain's national obsession with the European soccer championship. An important play-off game in the lead-up to the 2008 European Cup was being played tonight. Spain was playing Russia for a place in the final championship game. We had to begin the gala at a different time as it was clearly understood that no service staff would be available once the match had begun.

We had already seen that the entire country appears to shut down when Spain's national team takes the field, so we were under no illusions about what would happen if the game got started before we were finished dinner. But it wasn't just the service staff we worried about. We had a strong sense that even our Spanish hosts might abandon us along with the hotel staff if we persisted too long and game was close. As it happened we were finished early enough to collect later in a bar not far from our hotel which had been transformed into a sports centre for the game. We watched Spain systematically frustrate Russia to win the European Cup play-off game 3 – 0. All of Zaragoza went wild.

As is so often the case at forums such as these, a great deal was happening in the undercurrent of discussion that led to important directions being established even though on the surface it appeared that everyone's attention was focused on having a good time at dinner and talking about how well Spain might ultimately do in the European Cup series. By the end of the evening, however, Sylvia Rafielli was already touting South America as the site of the next Rosenberg Forum. In her enthusiasm she even went so far as to suggest that we would all be seeing each other again on the austral equinox, September 21st, 2010. She even named the hour, 9:00 PM, which she proclaimed a sensible time to have dinner.

In later conversations with Henry Vaux, it appeared that Dr. Rafielli may not be that far off in her prediction. There were gestures, he said, to suggest that the next forum might indeed be held in South America, and that Brazil or Argentina might be the venue.





A Meditation on Population

Imagine yourself in a stunningly beautiful open-air restaurant which you discover to your utter astonishment comfortably seats three billion people. It is so amazing that it is impossible not to reflect upon how lucky you are to be able to dine there. You know that no one is naturally entitled to live this well which adds to your feeling of good fortune. But then six billion more people suddenly show up at the already comfortably full restaurant. It does not take long before there is little room to move. Most of the new customers can't even sit down. There are not enough servers so most have to wait. In the end not everyone gets served and soon it becomes apparent there isn't enough to eat. Many don't even get a drink of water.

We soon notice that the beautiful furniture, appointments and natural surroundings are being destroyed or stolen. The washrooms are overwhelmed and toilets overflow. People start fighting with one another because they are hungry, confused and because there is no one with any credibility that can tell them what they should do. Soon the magnificent restaurant is in ruins and everyone is on their own to fend for themselves. The kitchen is looted is for what is left and now there is nothing for anyone to eat except for what they can find in what remains of the landscape that surrounds them.

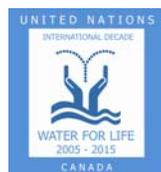
It doesn't take long to realize that such a restaurant is not likely to exist again for some time for the climate in which it was created – environmentally, socially, economically and demographically – has been altered beyond recognition and may not appear again for some time unless we exercise uncommon restraint now and for many generations to come.



Lessons From Rosenberg VI

Part Five

Rosenberg VI: Afterthoughts



Robert Sandford

Afterthoughts: Deriving Meaning & Value From the Forum

After connecting again with my family, who had spent the time I was at the forum in Madrid before joining me in Zaragoza, we travelled to meet Henry Vaux for follow-up discussions on how to best derive lasting value from incredible amount of information presented as part of the proceedings.

The train to Barcelona departed with Swiss-like precision at 6:35 PM and within minutes we were travelling at 300 kilometres an hour toward the Mediterranean coast. As we raced toward Catalonia we passed through the agricultural countryside that had been the object of so much discussion at the forum. As we danced past the irrigated farmland it occurred to me that my summary of the forum would, in addition to what Peter Gleick outlined, include a profound observation made by Henry Vaux after Uriel Safriel's presentation the forum that caused the room to go silent.

Converging Global Trade-offs: Water, Agriculture and Cities

Currently, global human population growth is the highest in places where there is the least water. About 40% of the surface of the solid Earth receives so little precipitation that natural ecosystem function is limited by water availability. Thus we find that globally a third of humanity is now competing directly with nature for water. More water resource development, especially in semi-arid and arid regions of the globe will lead to great damage to both freshwater and non-aquatic ecosystems which will lead directly to the decline of our global life support capacity and ultimately to diminishment of human well-being. That, however, is the direction we appear headed.

It is estimated that to meet the food demands that are projected to exist in the world in 2025, we will need to put an additional 2000 cubic kilometres of water into irrigation. This amount is roughly equivalent to 24 times the average flow of the Nile. Given current water use patterns, the population that is projected to exist on the planet in 2050 will require 3800 cubic kilometres of water a year, which is close to all the fresh water that can presently be withdrawn on Earth. This would mean that the world would lose most of the important environmental services aquatic ecosystems presently provide on our behalf. Clearly, that is just not going to happen. Something has to give.

We are also beginning to observe that rapidly expanding urban centres have begun to compete with agriculture for both land and water on a global basis. Agriculture has, in turn, begun to compete with nature for land and water. We are increasingly concerned that we cannot meet both agricultural and urban needs while at the same time providing enough water to ensure the perpetuation of natural ecosystem function.

As a consequence of growing populations and increased competition for land and water, humanity is converging upon the need to make uncommonly difficult public policy trade-offs that have never had to be made on a global scale before. As Henry Vaux so succinctly pointed out, we are increasingly faced with only two choices. If we provide to nature the water it needs to perpetuate our life planetary life support system then much of that water will have to come at the expense of agriculture which means that many people will have to starve to meet ecosystem protection goals. If, on the other hand, we provide agriculture all the water it needs to have any hope of feeding the populations that are projected to exist even in 2025 then we must expect on-going deterioration of the biodiversity based ecosystem function that has generated the Earthly conditions upon which our society depends both for its stability and sustainability. What Henry Vaux is saying is that we are painting ourselves into a terrible corner. Either we save our life-support system at the cost of the starvation of millions of people; or we feed our growing billions at the risk of denying nature enough water to keep fundamental earth system processes intact.

While technological and governance solutions presented at the forum suggest there are ways to move forward in the management of water resources in either eventuality we do not know which tools will be the most helpful until we decide which of the two trade-offs we will make. If on the other hand we do nothing it is entirely possible we will fail on both counts for there was no compelling evidence put forward at the forum to suggest that if we continue population growth at rates already predicted and continue to demand the diets to which we have become accustomed we will fail to feed ourselves and bring ecosystem decline down upon ourselves on a global scale at the same time.

Another lesson we might learn from the Rosenberg Forum is that by not making a distinct choice between water supply for nature as well as water for people, we have actually chosen to risk compromising both agricultural and natural systems. Instead of arguing how to use “green” water management as a means of increasing water productivity in agriculture by 1% or 2% we should concern ourselves especially in dry areas of the world with slowing or even halting our relentless growth until we figure out how to make sure we have enough water for agriculture and for nature and so that our cities don’t ruin both before we come to terms with what sustainability ought to mean in our time and in the changed climate will should expect in the future.

In any event, water in Canada will become more important to us and to the world. To be useful to others, however, we have to get our own house in order. There are at least ten major problem areas that need to be addressed in Canada if we are to achieve anything close to level of sustainable water resource management that will allow us to help the world.

Our future economy will to increasing measure be defined by:

- our ability to dispel our own myths of limitless abundance;
- how well we improve the monitoring of surface and groundwater quality and quality;

- how well we understand and protect the ecosystems and ecosystem functions that generate clean water;
- our success in solving our own water availability and quality challenges related to agricultural practices;
- the extent to which we reverse the growing eutrophication of our lakes, watercourses and estuaries;
- our willingness to reassess policies with respect to biofuel production in the context of its impact on water supply, land-use and the future availability of productive farmland;
- our effectiveness in anticipating and managing the growing likelihood of prolonged drought;
- how well the markets we create to manage water allocation reflect not just the opportunity to make money but respect inter-generational equity and the need to achieve sustainability
- and our willingness to anticipate climate change impacts on both water supply and quality;
- if we can summons the courage to reform our nation's administratively fragmented and jurisdictionally territorial water governance structures in service of these goals.



Construction continues on the Sagrada Familia in Barcelona

A World Phone Book

Rosenberg VI
&
Its Names

The names of the water scholars and water resource professionals attending the Rosenberg International Forum on Water Policy in Zaragoza, Spain are poetry in their own right for they situate the importance of water everywhere there is life. This is just a partial list of the names of those who attended.

Henry Vaux
Helen Ingram
Sihem Benabdellah
Prachoom Chomchai
Antonio Embid Irujo
Ramón Llamas
Abdel Fattah Metawie
Sayad-Farhad Mousavi
Silvia Rafielli
Ariel Dinar
Alberto Garrido
Wang Xi
Yuksel Inan
Malin Falkenmark
Elias Fereres
Hong Yang
Shawki Barghouti
Lorne Taylor
David Hill

The names of the participants create a unique narrative of why water is important to where and how we live, no matter where that might be in the world.

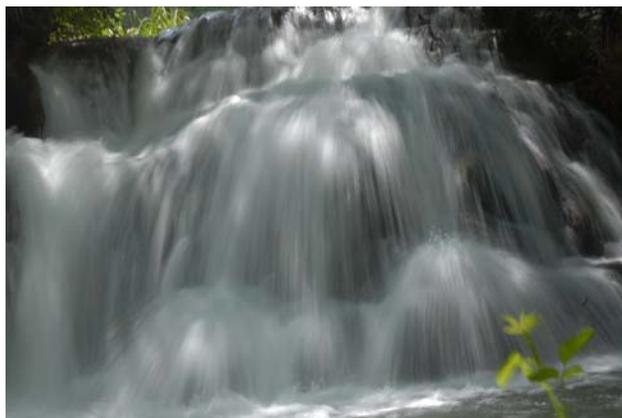




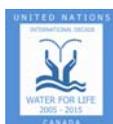
Converging Global Food & Water Trade-offs

International Lessons Derived From the Rosenberg International Forum on Water Policy

Zaragoza, Spain
June 24 – 27, 2008



A Report for the Max Bell Foundation
Prepared By
R.W. Sandford





Converging Global Food & Water Trade-offs

Water for Food in a Changing World

Author's Note

The following report represents the observations of just one of the participants of the Rosenberg International Forum on Water Policy held in Zaragoza, Spain in June of 2008. It should be noted that, while reviewed by the Chair of the Forum, Dr. Henry Vaux, other participants were not called upon to make observations on the meaning and value of the proceedings or their outcomes after the forum and may have varying views on its significance in the context of their own work and situations.

It should also be noted that there are some materials and sources to which reference is made in this report that were not part of the Rosenberg VI proceedings. They have been included because they are held to be directly relevant to the wide ranging issues the forum examined.

Readers or researchers with specific interests in the proceedings of this forum are invited to view all of the papers that were presented in Zaragoza and at other forums on the Rosenberg International Forum on Water Policy website <http://rosenberg.ucanr.org/>.

A 244 page illustrated day-by-day report on the forum, including full analysis of each of the papers presented and discussions that took place at pre- and post-forum events is available through the author at sandford@telusplanet.net.

The author wishes to acknowledge the support of the Max Bell Foundation in Canada for making this rich analysis possible.

Bob Sandford
Chair
Canadian Partnership Initiative
United Nations
Water for Life Decade
&
Advisory Board Member
Rosenberg International Forum
On Water Policy



Converging Global Food & Water Trade-offs

Water for Food in a Changing World

The Global Fresh Water Supply Picture Is Not Rosy

An understanding of the current state of our civilization can be derived from the condition of the planet's fresh water resources. In developing countries – where the bulk of the population of the world lives - more than 90% of all sewage and 70% of industrial wastewater is dumped untreated into surface water.

Even if we were able to keep it clean, however, there is not enough water globally for all the things humans need and want water to do for us. Water supply bubbles are bursting in China, the Middle East and India with potentially serious implications for the global economy and for political stability. Even the United States is depleting groundwater on average 25% faster than it is being replenished.

Our thirst for water grows with our population, but the amount of fresh water available on Earth is fixed. If we assume “business as usual” by 2050 about 40% of the projected global population of 9.4 billion is expected to be facing water stress or scarcity.

With increasing climate variability being predicted by global climate models, we are likely also to have more people without adequate water more of the time, even in water rich regions.

The Amount of Water We Have Will Limit the Amount of Food We Can Grow

Abundant water is not only essential to the photosynthetic process by which plants manufacture the carbohydrates that are the foundation of our food supply, it is also an important structural element in our food products. There is a lot of water in the food we consume. It has been estimated that we eat 70 times more water than we drink. World water demand is directly influenced how many of us there are and what we want to eat.

Increasingly, the response to global water scarcity will not be defined direct transfers of liquid water between regions and countries, but by how much water is traded among nations in the form of water embodied in food.

Unfortunately, there are now so many of us, and our dietary expectations have risen so dramatically in the past fifty years, that we are approaching the limits of the water available to grow all the food we want. We should not worry just about running out of oil. We may not make it to the projected global population of 9.4 billion by 2050. There may not be enough water.

Cities are Now Competing with Agriculture and Nature for Water

Currently, global human population growth is the highest in places where there is the least water. About 40 percent of the surface of the solid Earth receives so little precipitation that natural ecosystem function is limited by water availability.

Thus we find that globally a third of humanity is now competing directly with nature for water. More water resource development, especially in semi-arid and arid regions of the globe, will lead to greater damage to both freshwater and non-aquatic ecosystems, which will lead directly to the decline of our global life-support capacity and ultimately to diminishment of human well-being. That, however, is the direction in which we appear to be headed.

It is estimated that to meet the food demands that are projected to exist in the world in 2025, we will need to put an additional 2,000 cubic kilometres of water into irrigation. This amount is roughly equivalent to 24 times the average flow of the Nile.

Given current water-use patterns, the population that is projected to exist on the planet in 2050 will require 3,800 cubic kilometres of water per year, which is close to all the freshwater that can presently be withdrawn from the surface on Earth.

This would mean that the world would lose most of the important environmental services that aquatic ecosystems presently provide on our behalf. Clearly, that is just not going to happen. Something would give first, either the environment itself or, perhaps more likely, our social order. Both are already under stress.

We are already beginning to observe that rapidly expanding urban centres have begun to compete with agriculture for both land and water on a global basis. Agriculture has, in turn, begun to compete with nature for land and water. We are increasingly concerned that we cannot meet both agricultural and urban needs while at the same time providing enough water to ensure the perpetuation of natural ecosystem functions central to the maintenance of our planetary life-support system.

Humanity is Converging upon the Need Globally to Make Uncommonly Difficult Public Policy Trade-offs

As a consequence of growing populations and increased competition for land and water, humanity is converging upon the need to make uncommonly difficult public policy trade-offs. These are trade-offs that have never had to be made on a global scale before.

We are already putting a great deal of faith globally in a stressed and demonstratively non-sustainable agriculture. If we provide to nature the water it needs to perpetuate our planetary life-support system, then much of that water will have to come at the expense of agriculture, which means that many people will have to starve to meet ecosystem protection goals.

If, on the other hand, we provide agriculture all the water it needs to have any hope of feeding the populations that are projected to exist even in 2025, then we must expect ongoing deterioration of the biodiversity-based ecosystem function that has generated Earth's conditions upon which our society depends both for its stability and sustainability.

Our hope of preventing the convergence of these dangerous circumstances has resided in our faith in innovation, science and technology. But in the dry regions of the world such as the Middle East, Africa, Spain and Mexico – and in new regions made permanently drought-prone such as Australia and parts of the American West engineering and technology have only been successful in creating short-term stop-gap solutions that often lead to greater ultimate vulnerability as populations continue to grow and material expectations rise.

Confronting Nature's Need for Water

Irrigation productivity rose dramatically over the past 40 years as a result of the Green Revolution. But, even if we disregard the environmental impacts caused by that revolution, we are no nearer to achieving global food security than we were 40 years ago because every time we come close to filling the food production gap population growth and ecosystem decline associated with water diversions to human purposes set us back. Our natural and agricultural ecosystems are trying to tell us something.

Recent ground-breaking research reported by Uriel Safriel in his Rosenberg Forum paper, indicates that natural ecosystems may be far more important to our global economy by way of water supply than many of us may have appreciated. The hydro-ecological principle at the core of this insight is breathtakingly simple:

Nature has survival value to people and much of that survival value is defined by the fact that nature is our only provider of water. In order to provide water and other critical benefits to people, nature, however, needs water, too. We need water to prime the pump – so to speak – and the hydrological cycle is a very large pump.

From this it becomes clear that if we want it to continue to receive valuable ecosystem services on a free basis, nature must be regarded in the context of water resources management decision-making as a legitimate water customer in its own right. But in many places it isn't.

Taking Nature's Need for Water Seriously as a Means for Making More Water Available for People

A recent study of the estimated value of 17 ecosystem services provided by 16 worldwide ecosystem types was estimated at an average of US\$ 33 trillion a year which is nearly twice the global gross national product which is currently estimated at \$18 trillion per year.

It is interesting to note that the highest value of ecosystem service provided by nature was nutrient cycling. The overall planetary value of nutrient cycling was estimated at about \$17 trillion a year, nearly half of the total value of all the services provided free to us by our planet's functioning ecosystems. Nutrient cycling is largely a service provided by water.

From this it becomes evident that, while all services are essential, water-regulating functions are more valuable than other regulating services. While one might not agree with the value attached to these services or even with dollar accounting for what nature does in service of making life on this planet possible, an important point is put into relief through this kind of audit.

Despite their small area globally, aquatic ecosystems are found to be of extraordinary actual and relative value. Coastal estuaries were deemed the most productive of all freshwater ecosystems followed by inland wetlands. More striking, perhaps, is the comparative value of global freshwater ecosystems to terrestrial ecosystems.

Current eco-hydrological research underscores much of what humans have known intuitively for generations. Healthy aquatic ecosystems contribute far more than we ever understood to the production of water through the hydrological cycle as well as to the self-purifying power of healthy wetlands, lakes, and rivers. Intact aquatic ecosystems function synergistically with neighbouring terrestrial complexes to provide regulating services such as those that control rainwater capture, enhance the storage of water in ecosystems, and facilitate the gradual release of the water that perpetuates stream flow throughout the year.

While all freshwater ecosystems together comprise on 2.4% of all non-marine ecosystems they provide 40% of the value of all of these ecosystems combined. The average annual value of services per hectare of a freshwater ecosystem is 16.8 times that of an average hectare of a non-marine system.

Natural ecosystem function is also the foundation of the ecological diversity that makes agricultural food production for our growing populations possible. But natural systems are not the only ones capable of contributing to planetary life-support function. To a lesser but not unimportant extent, human-altered systems can do this, too.

Researchers in the Middle East have demonstrated that managing natural and human-altered ecosystems in tandem can create more water for both people and nature.

In Israel in 1993, scientists calculated that the potential water yield of that country's natural Mediterranean scrubland – that is to say the volume of rain falling during a given year on a given surface minus the volume of water returned to the atmosphere from the same area in the same year – is about 1590 cubic kilometres a year.

In little more than a decade scientists experimenting with diverse arrays of agricultural plant species were able to increase the potential water yield of this region by some 16% to 1846 cubic kilometres a year by transforming it into an optimally diverse cultivated ecosystem.

This improvement was accomplished by enhancing the water provision function of the “natural” Mediterranean scrubland ecosystem so as to reduce the amount of soil moisture that was evaporating. This demonstrates that human landscape transformations undertaken with the aim of enhancing the water regulation function of a given ecosystem can result in increased soil water content being available for both agriculture and nature.

The great breakthrough here is that millennium definitions of “ecosystem” include both cultivated and urban ecosystems. Agricultural and urban ecosystems suddenly become part of a global ecological whole.

The new construct recognizes that actively managed ecosystems now constitute more than half of the ice-free Earth, and that 11% of these are cultivated. It recognizes that it is not just pristine ecosystems that provide marketable goods and generate priceless services such as water purification, aquifer recharge, soil development and – until recently – relative climatic stability.

Beyond Engineering: An Eco-Hydrological Frontier

It is important to pay attention to the fact that natural systems perform many functions, and when natural ecosystems are diminished or disappear these functions must be reproduced or enhanced elsewhere if our planetary life-support system is to continue functioning in the manner in which we have come to rely. If eco-hydrological research tells us anything it is that that is clearly not happening.

Historically, it has been a given that when humans impair the provision of goods and services by either natural or passively managed ecosystems these must be replaced by artificial means. What we have discovered, however, is that artificial technology replacements for naturally or passively managed ecosystem function invariably turn out to be expensive and inferior to goods and services provided by “natural” ecosystem function. This is a fact we need to explore if we want to solve the global water availability problem.

All over the world, complex natural systems are being simplified in order to concentrate specific benefits in human hands. The cumulative effects of our global engineering efforts on our planet’s life support function are becoming increasingly measurable.

This should not be seen as a criticism of engineering. The point that evolving eco-hydrological perspectives put into relief is not that we should stop relying on engineering solutions. We can’t go back now. If anything we need solid engineering solutions more than ever. But we do need to know more about how urban and agricultural ecosystems can contribute more to both water supply and quality.

We need to improve our understanding not just of fundamental eco-hydrological function, but of the expanded services that our natural, agricultural and urban ecosystems might together be able to provide in the future and engineer toward the realization of that potential.

But here's the kicker. We then have to reserve enough water through our management mechanisms to make sure these ecosystems have the water they need to perform these functions under current circumstances and in the altered circumstances in which we may have to live as a consequence of higher mean global temperatures. We may not be able to do this if our population continues to mock our every technological advance and undermine our best efforts to achieve sustainability.

What we learn from these examples is that while engineering and technological innovation will always be important, the area in which we may need to concentrate most in the management of our water resources is on sustainability of use which suggests our central focus should be on governance for it is in this broad and universal domain that our collective ineffectiveness is likely to produce the greatest potential for conflict which can only occur at the cost of achieving sustainability in the future.

Failures of Governance

As many water policy scholars have pointed out, there are many exciting new ideas in the field of water management but we unfortunately failing to act upon them. This failure takes a number of forms.

Shortcomings in contemporary water politics globally are marked by the failure to properly contextualize water issues in ways that take into account local history, culture and relationship to place. This is in part least connected to an unwillingness to address deep-seated inequities in the way water is allocated and managed in many places in the world.

This unwillingness to address equity injustices makes it difficult to frame issues in ways that will attract and sustain public attention which in turn makes it difficult to recruit and inspire leaders capable of the sustained effort required to bring about long-term water policy reform.

Without forceful leadership it is impossible to create, foster and cultivate the level of political will over the duration of time required to ensure proper and lasting implementation of improved policy leading to changed practices and different results.

What is needed is a new global water ethic. That ethic could have its origins in the first principles that define the relationship between ecosystems and water supply.

Solutions Exist: We Need To Know Why We Don't Implement Them

As a society we are painting ourselves into a difficult corner. There are too many of us and our diverse business and religious traditions and a fear of being overwhelmed by culturally different others will not permit us to reduce our numbers. Our agriculture and resource needs have become so substantial that they are shutting down other life-support processes upon which the entire global system depends for stability and sustainability.

We can see clearly what is happening but we can't do anything in part because no one wants to be the first to make compromises or sacrifices for fear that those who won't make those same sacrifices will triumph over them economically or politically.

If there was ever an area of social science research that needs urgent attention it is the form of environmental *cum* economic brinksmanship we practice that ignores the obvious impacts of rapid population growth, encourages agricultural practices globally that we know are non-sustainable, acknowledges that biodiversity losses are compromising the state of our global life-support systems and yet takes only token steps toward preventing such loss; and knowingly starves nature of the water it needs to provide services to people that we cannot afford or do not know how to supply for ourselves.

The social science research we need to undertake must explore elements of our nature that would allow us to make apparently rational choices that support the constant pushing of every environmental constraint and limit until the system breaks down and has to be replaced by costly but ultimately inferior artificial solutions that we in turn push to the limits of failure through relentless population and economic growth.

As water resources expert Margaret Catley-Carlson pointed out, we focus too much on what should be done and not enough on why it isn't done. As a civilization, it may be a good time to look in the mirror. We should not just look at ourselves but at what is coming up fast behind us in the form of converging problems that together may be more difficult to address than we can imagine or afford. Global economic analysis indicates that the greatest new scarcity to appear in our time relates to limitations on the environment's capacity to absorb and neutralize the unprecedented waste streams humanity looses upon it. Nature is not likely to turn against us, but we are turning nature into might.

What Are The Solutions?

In his synthesis of the outcomes of the Sixth Biennial Rosenberg International Forum on Water Policy in Zaragoza, Spain, renowned water resources expert Peter Gleick identified five avenues of potential public policy advancement that will serve humanity in our efforts to address the current global water crisis.

1.
Ignore Ideology; Expand Thinking

Gleick offered firstly that while ideological debates were often interesting and even enjoyable, they are not necessarily productive. The kinds of ideological debates he put into this category included arguments over infrastructure; the debate pitting markets and privatization against water as a human right; and the debate over whether or not genetically modified organisms should be accepted as part of the future of agriculture.

Given how advanced the water crisis has become - we may no longer have the luxury of debating such matters. What is important now is to expand our thinking rather than contracting it around unproductive wrangling.

We need to realize how easy it is to get technologies right but the institutions wrong. It is also important to realize that what might work in one place, for small landholders in Africa for example, may look different from solutions that may work in larger-scale systems, say in Asia.

But what is really important at this time is to challenge some of our most cherished assumptions. These include the stationarity of climate and water availability and our deep-rooted belief in singular, silver bullet solutions.

2.
Integrate; Do Not Isolate

There is an urgent need for less isolation in the evolution of water resources policy. While there are examples from around the world of where undue focus on only one element or benefit has resulted in damage to entire hydrological systems the most compelling example of public policy failure in this area is the current biofuel issue and its impact on global food prices.

From 1976 to 2006 world food prices declined in real terms by about 50% allowing countries with water deficits to access virtual water at affordable or advantageous prices. But since 2006 food prices have been rising dramatically which has created a disincentive to food import. One of the developments responsible for rising food prices is the rapid expansion of biofuel production.

Taking more and more land out of agricultural production and requiring more and more water for non-agricultural purposes will create a vicious circle of food price increases that will make it more difficult if not impossible to meet future global food production needs.

Current biofuel policy is widely seen as an excellent example of how to do the wrong thing with enthusiasm not because of its intentions, but because of its failure to integrate public policy across linked domains of water supply, land-use policy, energy security and food production. Future biofuel policy has to respond to these linked domains.

Isolated public policy failures become apparent where increased water use in one sector traditionally comes at the expense of other users and especially the environment. We have also learned at great expense that it is unwise to permit any activity that leads to groundwater pollution or increased salinity. Such impacts make it impossible to use water for any other purpose than the one that led to its contamination.

We can see now that the isolated goals of many 20th century water projects focused on a narrow set of benefits which, when realized, made other potential benefits impossible to achieve. Hydropower, flood protection, irrigation and recreation projects ultimately serve isolated functions if they do not integrate impacts on ecosystems, local communities and local cultures into the way they are designed and operated.

Water resources policy has to integrate the widest range of purposes and interests into evolving management approaches including an acceptance of nature's equal right to water to perpetuate ecosystem function.

Broader integration of water solutions must also mean embracing expanded conceptions of international trade such as those implicit in notions related to virtual water export in the form of food.

3. Innovate

We need to explore new ways of thinking about the water we use and need. We shouldn't just think about the "blue" water that flows in streams and rivers. We should think about the "green" water that falls as precipitation, is absorbed into the soil and evaporated from the earth and evapo-transpired through plants as a second vital and almost untapped water resource.

The management of these two water sources in tandem will allow further expansion of our global food production capacity while at the same time allowing more water to be reliably available for a variety of environmental requirements including in-stream aquatic ecosystem flow needs.

Innovation means using the concept of virtual water as a planning tool. Innovation also means the continuing evaluation of "non-traditional" water sources such as rainwater harvesting, conjunctive use of groundwater, treated wastewater and desalination, even in places that were once seen as possessing relatively abundant water supply.

Innovation also means rethinking water "demand". It means moving away from the idea of "using" water toward the idea of optimizing "benefits" that water provides. Significant innovation is required in areas such as improving yields while reducing water use per unit of production.

Innovation also means rethinking water "institutions" and "management" and the need to bring the natural sciences, social sciences, politics and water more effectively together.

4. Improve Information

By far the most urgently needed science relates to improving our ability to cope with seasonal water scarcity.

Agricultural researchers around the world are arguing that with all of the investments made recently in climate change-related research it should not be unreasonable to expect far more reliable seasonal water availability predictions.

It was also noted that while more and more voices in the water-stressed world are calling for improved seasonal water availability forecasts, very little money is being invested in the monitoring, data collection and interpretation that are necessary to make improvements in this kind of forecasting possible.

In the end, improvements in monitoring and remote sensing necessary for future improvements in water productivity are not going to be achieved by simply influencing the growing environment.

Scientists need to communicate better with policy-makers just as policy-makers have to communicate far better with scientists. And everybody has to communicate better with the public. We cannot ignore the urgency of effective action.

5. Initiate and Implement

We may wish to order our water resources policy priorities in the following way:

- Meet the needs of the poorest, but especially of Africa
- Don't ignore the population growth issue and the growing number of problems converging around the challenge of feeding more and more people at the expense of the planet's ecosystems.
- Continue to strive toward higher water efficiency and productivity
- Continue to focus on investment in improved technology and practices
- Continue also to improve governance and management

Successful solutions to water problems are available and being implemented every day. We should build on successes and learn from our failures.

The most successful solutions in the future will be those that move beyond ideology; integrate concepts; communicate new information in new ways; and that lead to action.

So, In Conclusion

By way of encouraging one another toward success in dealing with the global water crisis, or the piece of it that is ours to address, we should do our best – all of us – to emphasize solutions and success stories and not just problems.

We should continue to explore ideas related to integration and methods that embrace inter-disciplinary tools.

We should be relentless in our pursuit of better ways to communicate with one another and the public.

We should do all we can to make what we know intelligible to decision-makers who will help us translate scientific research outcomes into timely, effective and durable public policy..

And whatever we do should not lose our sense of humour or our passion for the very important work in which we are engaged.





Water for Food In a Changing World

*Strategic Lessons & Opportunities for
Alberta & Canada*

**Derived From the Rosenberg
International Forum on Water Policy**

Zaragoza, Spain
June 24 – 27, 2008



A Report for the Max Bell Foundation
Prepared By
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Author's Note

The following report represents the observations of just one of the participants of the Rosenberg International Forum on Water Policy held in Zaragoza, Spain in June of 2008. It should be noted that, while reviewed by the Chair of the Forum, Dr. Henry Vaux, other participants were not called upon to make observations on the meaning and value of the proceedings or their outcomes in a specifically Canadian context and may have different views based on their experience abroad.

It should also be noted that there are some materials and sources to which reference is made in this report that were not part of the Rosenberg VI proceedings. They have been included because they are held to be directly relevant to the issues we face with respect to water resource management particularly in the Canadian West.

Readers or researchers with specific interests in the proceedings of this forum are invited to view all of the papers that were presented in Zaragoza and at other forums on the Rosenberg International Forum on Water Policy website <http://rosenberg.ucanr.org/>.

A 244 page illustrated day-by-day report on the forum, including full analysis of each of the papers presented as well as in-depth consideration of the lessons learned elsewhere that may have application in the Canadian context is available through the author at sandford@telusplanet.net.

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Lessons For Canada & Alberta from Rosenberg VI

Executive Summary

Globally, we are converging simultaneously on both food shortages and water scarcity. These two trends will in tandem have huge implications for the economy of Canada and the way of life of Canadians.

The first implication is that we should expect the same kinds of water supply and quality issues that are appearing elsewhere to make their presence known in Canada. We should recognize that serious problems with respect to water supply can develop even in the absence of drought if population pressures on limited water resources are not exacerbated by climate change. Population growth in southern Alberta will put pressure on local water resources just as surely as they have in southern Spain. Global warming could just as easily and suddenly reduce the amount of water available on the prairies as it has in Australia and in the Mediterranean.

As the Australian example clearly indicates, climate is variable and that variability can affect every sector of a national economy immediately. Climate change impacts can also extend rapidly far beyond known ranges of variability and can also become permanent. If there is a lesson for Canada in this it may be that we should take neither water demand nor hydrological stationarity for granted.

Lessons from elsewhere suggest we should be preparing now for water scarcity in parts of the country while at the same time ensuring we know as much as we can about the potential impacts of this scarcity on those places that remain relatively water abundant.

We should expect growing tension between big urban centres and the agricultural community as more demands are placed on limited water resources and as the threat of prolonged drought increases as a consequence of climate change.

The second implication of converging global food shortages and water scarcity relates to the role Canada already plays in producing the world's food. Groundwater overdraft and climate change are already affecting many established food growing regions such as China, India and the United States. This will put greater pressure on remaining food producing countries to increase productivity. Increasingly, the response to global water scarcity will not be defined direct transfers of liquid water between regions and countries, but by how much water is traded among nations in the form of water embodied in food. The favouring of virtual water exchanges could greatly advantage Canada's agricultural sector, but only if it is able to address its own serious issues relating to the sustainability of agricultural practices especially as they relate to impacts on water quality and quantity.

Given that the world will likely be relying upon us more heavily than ever to meet increasingly unattainable global food production goals, Canada's future economic success may well be defined by how carefully and productively we manage our water resources. We cannot, however, avoid the same kinds of problems other countries are facing with respect to water resources and at the same time increase our agricultural productivity unless we quickly get our own water management house in order. Canada's future economy will be defined in increasing measure by:

1. our ability to dispel our own myths of limitless abundance;
2. our willingness to integrate the management of ground and surface water;
3. how well we improve the monitoring of surface and groundwater quantity and quality and the extent to which enhanced monitoring leads to improved water availability forecasting and long-term climate change prediction;
4. our success in making the link between water and energy;
5. how quickly we can instil a conservation imperative into our society;
6. how quickly we embrace eco-hydrological realities and come to understand and protect ecosystems and ecosystem functions that generate clean water;
7. our success in solving our own water availability and quality challenges related to agricultural practices;
8. the extent to which we reverse the growing eutrophication of our lakes, watercourses and estuaries;
9. our willingness to reassess policies with respect to biofuel production in the context of its impact on water supply, land-use and the future availability of productive farmland;
10. our effectiveness in anticipating and managing the growing likelihood of prolonged drought;
11. our willingness to anticipate climate change impacts on both water supply and quality;
12. how well the markets we create to manage water allocation reflect not just the opportunity to make money but respect inter-generational equity and the need to achieve true sustainability;

Action in each of these linked domains hinges on the extent we can effectively summons the courage to reform our nation's administratively fragmented and jurisdictionally territorial water governance structures in service of these goals.



Lessons From Rosenberg VI

What Is the Rosenberg Forum?

The Rosenberg International Forum on Water Policy was created in 1996 by the Bank of America with an endowment gift to the University of California in honour of Richard Rosenberg upon the occasion of his retirement as Chairman of the Bank. The resources from this gift support the Rosenberg International Forum on Water Policy. The theme of the Forum is: Reducing Conflict in the Management of Transboundary Water Resources.

The Forum meets biennially at different locations around the globe. Past Forums have been held in San Francisco, CA, USA; Barcelona, Spain; Canberra, Australia; Ankara, Turkey and Banff, Canada. Attendance at the Forum is by invitational only and is restricted to 50 water scholars and senior water managers from around the world.

The Advisory Committee of the Rosenberg Forum wish to thank the Max Bell Foundation which supported the derivation of these lessons for Canada and Alberta from the proceedings of the Sixth Biennial Rosenberg International Forum on Water Policy which was held in Zaragoza, Spain in June of 2008.

Part One: Emerging Development & Issues

Converging Global Trade-offs

The underlying theme that emerged throughout this forum is that food shortages and water scarcity are simultaneously intensifying around the globe. These two trends will in tandem have huge implications for the economy of Canada and the way of life of Canadians.

The first implication is that we should expect the same kinds of water supply and quality issues that are appearing elsewhere to make their presence known in Canada. We should recognize that serious problems with respect to water supply can develop even in the absence of drought if population pressures on limited water resources are not exacerbated by climate change. Population growth in southern Alberta, for example, will put pressure on local water resources just as surely as it has in southern Spain. Global warming could just as easily and suddenly reduce the amount of water available on the prairies as it has in Australia and in the Mediterranean.

The second implication of converging global food shortages and water scarcity relates to the role Canada already plays in producing the world's food. What is happening at the nexus of food and water scarcity worldwide will affirm Canada's already important place in the global food and water economy.

Growing global food production and water supply troubles will back up into our purview from the outside. Worldwide approximately 16% of agricultural soils are currently degraded with significant impacts on food production, rural incomes and national economies. The potential to expand the global cultivated land area is nearly exhausted demanding that available water resources be used more efficiently, especially given that global fish stocks are also in decline.

In many areas of the world, persistent groundwater overdraft threatens accustomed supplies because a point will be reached when aquifers will be economically exhausted in that the cost of pumping will exceed the benefits of any use to which the water may be put. Groundwater overdraft and climate change are already affecting many established food growing regions such as China, India and the United States. This will put greater pressure on remaining food producing countries to increase productivity.

Instead of waiting for a crisis, Canadians may well wish to put lessons learned elsewhere by others into active relief. Given that the world will likely be relying upon us more heavily than ever to meet increasingly unattainable global food production goals, Canada's future economic success may well be defined by how carefully and productively we manage our water resources.

We cannot, however, avoid the same kinds of problems other countries are facing with respect to water resources and simultaneously increase our agricultural productivity unless we quickly get our own water management house in order.

Virtual Water Export

Increasingly, the response to global water scarcity will not be defined by direct transfers of liquid water between regions and countries, but by how much water is traded among nations in the form of water embodied in food. As of the year 2000, about 1000 cubic kilometres of water were traded from nation to nation in the form of food. The volume of virtual water transported around the world in this way amounted to about 15% of the total amount used currently in food production. This, however, is not a straight-forward calculation.

Assuming that crops grown for trade would also be grown in the absence of that trade, virtual water export savings will vary considerably depending on the crop. The trading of wheat and corn, for example, has resulted in an estimated 41% to 59% reduction in global water use respectively. As a result the trading of these two crops contributes significantly to total global water savings.

Because of crop water productivity, 73 cubic kilometres of virtual water exported from North America is worth the equivalent of 149 cubic kilometres of water when these crop products are imported into East Asia, which represents a doubling of effective value.

While the volumes are smaller the percentage benefit of exporting to very dry places such as the Middle East is even greater. Here a volume of 17 cubic kilometres of virtual water exported from North America is worth 55 cubic kilometres locally, a near tripling of volume.

North and South America and Australia are the only places in the world that export virtual water benefit. All other regions are net importers of virtual water. If, as models predict, some 53% of the population of the world in 2050 is facing one form or another of water scarcity, then countries that need to make up for inadequate water supply by having to import water virtually as food will require a virtual global transfer of 7500 cubic kilometres of virtual transfer a year.

Since present food trade is principally between the industrialized countries, this represents more than a doubling of food trade internationally between now and 2050, which is no minor proposition – especially for Canada. Some experts have predicted that as a result of that trade agriculture will ultimately become more important to the economy of Western Canada than oil and gas. To take advantage of this opportunity, however, we have to improve our agricultural practices especially relating to the management of water resources.

Cities & Agriculture Competing With One Another & Nature for Water

Water supply in urban areas in many parts of the world is becoming more expensive to assure. The reasons for this include higher costs to develop more distant sources, more complex and therefore more expensive source development, the greater need for higher-cost treatment facilities and the lack of flexibility of other users of low-cost water.

In discussing the lack of flexibility of other users of low cost water, participants in the Forum pointed to irrigation farmers.

The unwillingness of the irrigation agriculture community globally with respect to the sharing of low-cost water with cities should be of interest to policy-makers in Alberta. This is especially true given that the province's two major cities may be facing challenges, in one case, to how much water to which they have been entitled; and in the other case to the amount of water available for future growth and development.

If what is happening elsewhere in the world is any indication of what will happen as our populations grow it is reasonable to expect that in the future there will be tensions between cities and surrounding agricultural regions over water allocation and use.

As a result of this tension we should anticipate challenges to the existing first-in-time, first-in-right water allocation doctrine upon which current water rights have been established. This does not mean, however, that Alberta should be rushing to take water away from agriculture to put it to higher economic use.

As has already been pointed out, rising food prices globally and threats to food production capacity caused by groundwater overdraft in other parts of the world are likely to make Canada's food-producing capacity central to the stability of international food supply – provided, once again that agriculture can become sustainable.

The Small but Important Matter Of A Common Definition of Sustainability

The consensus of the Rosenberg Forum was that contemporary discussions about sustainability were largely irrelevant because we do not as a society act on a common vision of what sustainability means. Sustainability has been defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. That said, many expert participants lamented the substance-less manner in which the term “sustainability” had been appropriated by so many public and private interests today. There was a sense that, in the absence of a common understanding of the meaning of the term that we have adopted by default a consensus view of what we want sustainability to be like that doesn't reflect reality.

A number of participants in the forum were concerned that despite the high hopes and expectations of the academic and professional water community with respect to Integrated Water Resource Management and the Adaptive Management practices associated with it, the actual prospects for the delivery of purported benefits are no better than fair.

It was noted that while Integrated Water Resource Management and attendant Adaptive Management have great appeal to specialists, actually delivering on these ideas presents a number of political, institutional and equity issues. A big part of the difficulty of Integrated Water Resource Management is that the scope and scale of its ambitions may be too great to achieve. If each of the single elements that have composed Integrated Water Resource Management ambitions were in the past difficult to achieve individually then all of the other components in combination pose an almost insurmountable implementation challenge.

These include the recognition of the full range of uses of water; the recognition of in-stream flow needs; the desire to integrate water and land-use policy and the flexible, equitable allocation of water rights – all together. When you can't even do one of these things well enough to ensure achievement of whatever you define as sustainability, how are you going to reform entire water management systems in ways that will permit implementation of all of these elements simultaneously?

Seen in this light, a common definition of sustainability becomes the bedrock upon which all future possibility must be built. New understanding about how ecosystems generate and purify water will also become part of that foundation.

The Emerging World of Eco-hydrology Or Why Nature Needs Water

Rich biodiversity provides insurance against changes in ecosystem processes that may impair service provision. Differences in species responses to disturbances and environmental extremes make it unlikely that over time scales of decades or centuries there is much ecological redundancy in the species composition of a functioning ecosystem. In other words, biodiversity imparts resistance and resilience against disturbances that disrupt ecosystem function and that world in less diverse situations reduce or diminish the benefits it can provide to itself and to humans.

The problem in our time is that biodiversity is being irretrievably lost in many of our ecosystems before it's economic and survival value can be proved or evaluated. We are tearing apart a system that was designed by nature to deal with decades to centuries-long variability. In so doing we are exposing ourselves to huge adaptive vulnerability. Nowhere is this more so than in the domain of water supply.

What is different about the eco-hydrological approach to water resources management in the Canadian context at least is that it is arguing that the precautionary principle should be applied also to biodiversity concerns related to the provision of one specific ecosystem benefit – the supply of fresh water. The “precautionary principle”, an inconsistently applied dictum that holds that where there is a threat of significant reduction or loss of biodiversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat.

Emerging eco-hydrological principles associated with this emerging worldview demand that we ask what may well be the question of the century. The issue at stake, in this context, is not how much water we need to allocate for “nature” at the expense of people so that “nature” is somehow sustainably maintained. The really important question is how much water can be allocated for driving current trends of global population and economic growth without reducing and degrading ecosystem services to the point that they can no longer support either people or nature.

Nature is of survival value for people and much of its survival value is established through its provision of water.



In order to provide water and other critical benefits to people nature needs water, too.



It follows, hence, that nature should be considered a legitimate water customer.

What eco-hydrologists are claiming is that, in dryland areas at least, the sacrifice of important and valuable water supply, regulation, self-purification and biodiversity-enhancing ecosystem services to the single purpose of agricultural food production may have disastrous consequences.

Eco-hydrologists like Uriel Safriel are of the opinion that over-development of agriculture or urban infrastructure actually results in measurably less water availability for both people and nature. From an eco-hydrological point of view, agri-monocultures and urban monocultures do the same thing to water. Both reduce the amount that can be absorbed by soils and captured and made available to surrounding vegetation.

Agri- and urban-monocultures dry out adjacent areas by reducing the sponge capacity of once diverse plant communities that surrounded them. They suck up all the water for their needs which leaves less for surrounding areas which affects both water quality and quantity.

From this one can see that despite their small area globally, aquatic ecosystems are of extraordinary nominal and relative value. While all freshwater ecosystems on Earth together comprise only 2.4% of all non-marine ecosystems they provide 40% of the value of all of these ecosystems combined. The average annual value of services per hectare of a freshwater ecosystem is 16.8 times that of an average hectare of a non-marine system.

In direct association with the water cycle aquatic and terrestrial ecosystems also play a huge role in determining the nature and character of the Earth's atmosphere. As the service of climate regulation is principally provided on behalf by vegetation and since the growth of vegetation is determined in much of the world by water availability, a reduction in the allocation of "nature" would exacerbate global warming.

This suggests that the more water we take for ourselves at the expense of aquatic and terrestrial ecosystem health as defined by biodiversity the more we are contributing to global warming. Simplifying dryland ecosystems like the Canadian prairies has no less an effect than deforestation in more humid regions. The added effect of wetland drainage not only contributes to nutrient loading and pesticide and other contaminations of diminished prairies rivers it exacerbates climate change by creating a positive feedback to rising temperatures which will lead to desertification and even higher temperatures.

All this – eco-hydrologists say - because we have over-allocated water to such an extent we no longer have enough to give to "nature" so that it can provide the service of climate regulation on our behalf. This should not be seen as a criticism of engineering. The point that evolving eco-hydrological perspectives put into relief is not that we should stop relying on engineering solutions. We can't go back now even if we wanted to. If anything we need solid engineering solutions more than ever. But we do need to know more about how urban and agricultural ecosystems can be made to contribute more to both water supply and quality.

We need to improve our understanding not just of fundamental eco-hydrological function, but of the expanded services that our natural, agricultural and urban ecosystems might be able to provide in the future and engineer toward the realization of that potential. There is some urgency in this in that we are converging on some very difficult trade-offs.

We Are Converging On Difficult Trade-offs

About 40 percent of the surface of the solid Earth receives so little precipitation that natural ecosystem function is limited by water availability. Currently, global human population growth is the highest in places where there is the least water. Thus we find that globally a third of humanity is now competing directly with nature for water. More water resource development, especially in semi-arid and arid regions of the globe, will lead to greater damage to both freshwater and non-aquatic ecosystems, which will lead directly to the decline of our global life-support capacity and ultimately to diminishment of human well-being.

It is estimated that to meet the food demands that are projected to exist in the world in 2025, we will need to put an additional 2,000 cubic kilometres of water into irrigation. This amount is roughly equivalent to 24 times the average flow of the Nile. Given current water-use patterns, the population that is projected to exist on the planet in 2050 will require 3,800 cubic kilometres of water per year, which is close to all the freshwater that can presently be withdrawn from the surface on Earth. This would mean that the world would lose most of the important environmental services that aquatic ecosystems presently provide on our behalf. Clearly, that is just not going to happen. Something would give first, either the environment itself or, perhaps more likely, our social order. Both are already under stress.

We are already beginning to observe that rapidly expanding urban centres have begun to compete with agriculture for both land and water on a global basis. Agriculture has, in turn, begun to compete with nature for land and water. We are increasingly concerned that we cannot meet both agricultural and urban needs while at the same time providing enough water to ensure the perpetuation of natural ecosystem function.

As a consequence of growing populations and increased competition for land and water, humanity is converging upon the need to make uncommonly difficult public policy trade-offs that have never had to be made on a global scale before. If we provide to nature the water it needs to perpetuate our planetary life-support system, then much of that water will have to come at the expense of agriculture, which means that many people will have to starve to meet ecosystem protection goals. If, on the other hand, we provide agriculture all the water it needs to have any hope of feeding the populations that are projected to exist even in 2025, then we must expect ongoing deterioration of the biodiversity-based ecosystem function that has generated Earth's conditions upon which our society depends both for its stability and sustainability. These are difficult political choices.

Specific Implications for Alberta & The Prairie West

Thus we see the challenge before us of creating sustainable water management in Canada. By building a better bridge between science and public understanding that leads to policy action, it is still possible for us to create the West we want, but it will not be easy.

If we want to avoid the kinds of problems other semi-arid regions like Australia, Spain and the American Southwest are facing, massive reform is no longer an option. It is an urgent necessity.

We should expect public policy reform to be difficult and time-consuming. We should expect the change process to take a great deal of collaboration and to take years to generate lasting results.

No single management action, legislative package or policy framework can respond to all of the problems that are presently converging around water availability conflicts especially as they relate to the disproportionate amount of water demanded by irrigation agriculture in parts of Canada. National and regional policies must be integrated and water strategies must somehow be integrated into agricultural policies if water scarcity challenges are to be fairly and equitably resolved now and in the future.

We should expect to have to manage conflict over allocation and water use priorities as part of the process of change. We should expect change processes to go on for generations because the problems are likely to become more and more complicated as they converge around increasing global populations and climate change.

Part Two: Getting Our House in Order

The implications for Canada of our own water problems and of emerging eco-hydrological pressures elsewhere in the world are significant. Given that the world will likely be relying upon us more heavily than ever to meet increasingly unattainable food production goals, Canada's future economic success may well be defined by how carefully and productively we manage our water resources.

Before we can begin to realize opportunity in what is happening elsewhere, we need to get our own house in order. In the context of water resources management our future economy could be defined in increasing measure by continuing improvements in at least a dozen areas.

1.

Dispelling the Myth of Limitless Abundance

The first challenge may wish to address relates to self-perception. We have to dispel the myth of limitless water abundance in Canada or we will continue to make public policy choices based on false assumptions that could have undesirable ecological, social and political consequences in the future. We may have 20% of the world's fresh water resources, but much of that is water in the bank left after the last ice age. We have only 6.5% of the world's *renewable* water resources and most of that is found in the north.

We spend far too much time in this country worrying about water exports and not nearly enough time thinking about the damage caused by our own management choices. If the Americans want our water, or if we want more in the south, we are going to have to go north to get it, and that will be very, very expensive.

The lesson here is that we have to be careful not to make ourselves vulnerable by making political decisions based on false assumptions about how much water we actually have. We have to solve our own problems first, before we satisfy the thirsts of others.

Recommendation

We must continue and expand our efforts to educate Canadians about the extent, state and importance of our water resources.

2.

Integrating Management of Ground & Surface Water

The alarming state of our country's groundwater resources was put into relief in a report by the Council of Canadian Academies. This report evidences that while some groundwater situations in Canada, such as the Oak Ridges Moraine region in Ontario, are being managed sustainably, contamination of groundwater aquifers is widespread all over the country. We are even contaminating aquifers we share with the U.S. The panel composed of this country's best hydrologists also pointed to long-term problems we have created for ourselves by denying the seriousness of ground and surface water issues related to projects like the oil sands.

Recommendation

All of these problems can be resolved but not without much strengthened and better integrated public policy and much improved monitoring and predictive modelling.

3. Improving Monitoring, Forecasting & Long-Term Prediction

Everyone in the water-stressed world is calling for improved seasonal water availability forecasts but very little money is being invested in the monitoring, data collection and interpretation that are necessary to make improvements in this kind of forecasting possible.

While there is a considerable amount of monitoring being done at lower elevations in some areas of Canada, it was repeatedly noted that there is a crucial need for enhanced hydrological and meteorological observations and associated predictions in the high mountain headwaters of western Canada where there is currently little monitoring activity. This is critical because it is at these elevations that climate change impacts are expected to be felt first and where they are expected to be most pronounced in terms of their impacts on water supply.

The station densities at high elevations in Canada's mountain West are so small that the numbers are difficult to conceptualize. As Dr. John Pomeroy at the Centre for Hydrology at the University of Saskatchewan has pointed out, there are significant gaps in our monitoring of water resources. There are lots of stations at lower altitudes, but few at upper elevations where important changes may be taking place.

In lower elevations in the Rocky Mountain West there is a weather station for every 550 square kilometres which is double the World Meteorological Organization standard for precipitation stations. The story changes, however, above 1500 metres in elevation. At and above this elevation the area sampled for year-round precipitation averages 5500 square kilometres per station.

Above 1500 metres in elevation, the hydrometric station density is 5½ times lower and the precipitation station density is from 3 to 23½ times lower than World Meteorological Organization minimum standards for hydrological analysis in mountainous regions.

Recommendation

A foundation needs to be laid for determining where new monitoring capacity should be established at upper elevations in the western mountains, what new monitoring stations should be measuring, what new remote sensing technologies can be employed to do that monitoring and how collected data will be collected, stored and ultimately translated into useful information that can be shared in a timely manner among water users, water managers, policy-makers and the public.

More also needs to be done to derive meaning and optimal value out from the data that is already being collected and will be collected in the future and that to be of greater use such interpretations had to be shared more effectively between researchers, water management agencies, major water users and policy-makers.

4.
Making the Link Between Water & Energy

Most Canadians have yet to make the link between water use and energy costs. It takes a lot of water to produce energy and a lot of energy to move water. Water is heavy. It takes a great deal of energy to abstract, treat, distribute and re-treat it for further use. Leaving your tap run for 5 minutes costs the same as letting a 60 watt bulb burn for 14 hours. That calculation does not account for the downstream cost of greenhouse gas emissions.

Recommendation

A massive public education program will be necessary to change the water use habits of Canadians. This program should likely be tied into the education required to ensure we understand the actual and potential effects of climate change and how we can mitigate them and adapt to their impacts.

5.
Instilling a Conservation Imperative into Our Society

Is there a water crisis in Canada? No. But in parts of Canada – and especially in southern Alberta – we have all the makings of one.

Because our population is growing, there is greater pressure on our water resources from agricultural and industrial use and more of our water is unfit for other uses because we pollute it. We can avoid a water crisis, or put it off for decades while at the same time saving billions in infrastructure costs, if we make conservation a habit and concentrate fiercely on protecting the quality of our water resources.

Recommendation

In order to make room for the future and for those who will populate it, water conservation should not be an option anywhere in the dry West.

6.
Recognizing Nature's Need for Water

If we do not recognize nature's need for water, there will not in the end be enough water for cities, agriculture or nature.

Recommendation

We need a thorough reassessment of the role ecosystems play in water supply and quality in the Western Canadian context. We need to identify and quantify the services provided

by each regional ecosystem type. We also need to identify the optimal and minimal water required by each of these ecosystems for securing the sustainability the provision of their services.

We need to determine which of the ecosystem types within the landscape proposed for development play landscape-relevant keystone roles, and explore means to maintain ecosystem processes.

We need to identify species that are endangered or at risk of becoming endangered, assess the contribution of each to water-related as well as other ecosystem services.

We need to evaluate the amount of water lost through appropriation of different ecosystem types by agriculture and urban development, for generating guidelines to be followed in land use allocation in areas planned for future development.

We need to study the role of freshwater ecosystems in treating wastewater of various qualities; the degree to which freshwater allocated to natural ecosystems can be replaced by treated wastewater; and the technologies appropriate for this substitution.

7.

Improving Agricultural Practices

The first problem relates to agriculture's impact on water quality. Agricultural water use is becoming an issue globally because contemporary industrial-scale food production practices inevitably result in reduced return flows to nature of water of poor quality which diminished and often water-starved natural systems no longer have the capacity to purify.

The second issues relates to crucial role in agricultural productivity. Unless we manage our water more efficiently and diminish nutrient loading of our western rivers, we may not be able to take full advantage of our opportunity to serve the world by exporting water virtually to water-scarce countries elsewhere.

Recommendation

We need to accelerate the effectiveness of programs that encourage producers to create Environmental Farm Plans that reduce the impacts of agricultural practices on water quality and quantity. In order to ensure results such plans may have to become mandatory.

We need better monitoring of water quality; more enforcement of water quality standards, and further integration of agricultural policy with combined land-use regulation and water resources strategies. We need to move on this integration immediately.

8. Reversing Eutrophication

Many of our big agri-monocultures are drying out the landscapes around them by constraining and then altering the chemical, physical and biological properties of the landscapes they occupy resulting in changes that radiate outward from cultivated areas to untransformed surrounding regions. Just after the Rosenberg Forum, Ducks Unlimited Canada completed Phase I of a multiphase, multi-partner research project to determine the impacts of wetland loss and associated drainage activity in the Broughton's Creek watershed located north of Brandon in southwestern Manitoba.

The area was selected as a study watershed because the land use and wetland loss trends are representative of other agricultural watersheds across the Prairie Pothole Region of Canada. Results from the first phase determined that wetland loss since 1968 in the Broughton's Creek watershed has resulted in:

- a 31 per cent increase in area draining downstream (an additional 19 square kilometres)
- an 18 per cent increase in peak flow within the creek following rainfall
- a 30 per cent increase in stream flow
- a 31 per cent increase in nitrogen and phosphorus load from the watershed
- a 41 per cent increase in sediment loading
- the release of approximately 34,000 tonnes of carbon, equivalent to 125,000 tonnes of CO₂– the annual emissions from almost 23,200 cars
- an estimated 28 per cent decrease in annual waterfowl production

What this report suggests is that agriculture as it is presently being practiced in the Broughton Creek area of Manitoba is not only non-sustainable but self-terminating.

Around the same time the Broughton Creek report was released, David Schindler and John R. Vallentyne published a book called *The Algal Bowl: Overfertilization of the World's Freshwaters and Estuaries*. The title of the book is important in the context of what the book's famous authors want the reader to know about what is happening to our lakes and how changes that are already taking place will be exacerbated by global warming. The title is also a tribute to John R. Vallentyne who published the first edition of this book in 1974. Though he did not live to see this volume printed, the theme of his first edition persists throughout this landmark new work.

As Schindler explains in his preface, Vallentyne predicted 35 years ago that unless something was done to stop the cavalier way we are treating our lakes we would find ourselves in an Algal Bowl in the Canadian West that would be more destructive of our ecosystems and our economy than the Dust Bowl that preceded it. Unfortunately, Vallentyne's prediction has come true. Thousands of western Canadian lakes and watercourses are now suffering from varying degrees of eutrophication. This is a potentially dangerous trend.

Recommendation

We need to accelerate demonstrably successful initiatives like the *Cows and Fish* program which provides useful advice at the farm and ranch level on how to improve the health of riparian habitats and reduce nutrient loading on local streams and rivers through simple changes in agricultural practice.

Similar programs have to be expanded in rural communities, in lake-shore sub-divisions and in recreation areas.

Once again, we will not know if such programs are delivering on their promise without better monitoring of water quality; more enforcement of higher water quality standards, and further integration of agricultural policy with combined land-use regulation and water resources strategies that anticipate potential climate effects.

9. Resolving The Biofuel Issue

From 1976 to 2006 world food prices declined in real terms by about 50% allowing countries with water deficits to access virtual water at affordable or advantageous prices.

But since 2006 food prices have been rising dramatically which has created a disincentive to food import. One of the developments responsible for rising food prices is the rapid expansion of biofuel production.

Taking more and more land out of agricultural production and requiring more and more water for non-agricultural purposes will create a vicious circle of food price increases that will make it more difficult if not impossible to meet future global food production needs.

Current biofuel policy, as judged by the Forum's proceedings, was an excellent example of how to do the wrong thing with enthusiasm and of the failure to integrate public policy across linked domains of water supply, land-use policy, energy security and food production.

Recommendation

Biofuel and other energy policies cannot be developed in isolation from water supply policies or agricultural water use and practices policies. If they are, expect future conflict between sectors over water allocation.

10. Drought Preparedness

The current situation in Australia offers deep insight into the kinds of difficulties Canada will inevitably have to address in the face of the more frequent, prolonged droughts that are projected to occur on the prairies under all current climate change scenarios.

The similarities between the Murray-Darling system in Australia and the North and South Saskatchewan River basin in Canada are striking. The same number of people as rely on the Murray-Darling, about three million in three Canadian provinces, rely on the Saskatchewan for the water they need to live, to practice agricultural and to sustain industry.

Like the Murray-Darling, the Saskatchewan is considered the “bread basket” of the vast nation in which it is located. Like Australia, Canada has developed significant irrigation capacity.

If there is a real lesson for Canada it may be that in the end saving your irrigation agricultural may not be the best choice if that is the only one you make. In a perfect storm you need to save the ship you are sailing on in order to save the sailors.

Recommendation

The lesson for Canada is that the past is no longer a guide to the future. What we took for granted about our climate patterns is no longer a reliable indication of what may happen in an era defined by a warmer and therefore more energetic atmosphere.

We need to ask ourselves how we would deal with – not six years of moderate drought we experienced in the 1930s – but ten years of water scarcity followed by a drought that was half-again as severe as anything our prairie civilization has ever experienced before. And we need to be prepared as possible when that inevitable drought arrives.

11. Taking climate change seriously

On the Canadian prairies rising temperatures could quickly push our agricultural sector beyond its current capacity to adapt with devastating impacts on our regional environment and economy. Our institutional arrangements with respect to water resources management in Canada are presently as territorial and jurisdictionally fragmented as they were in Australia at the outset of the change in climatic circumstances that devastated the country’s agriculture.

Recommendation

We may wish to be proactive in the reform of our institutional arrangements so as to enhance our adaptability to climate change effects before unforeseen events make our society vulnerable to the same social and economic catastrophe that befell Australia.

12. **Establishing The Right Kind of Markets**

It was universally held at the Sixth Biennial Rosenberg Forum that markets and privatization can spur necessary innovation in contexts where entrenched public bureaucracy are slow and inefficient, and where entrenched interests have captured public subsidies. But it was also held that water trading markets do not always make up for lack of long term focus on water sustainability and intergenerational equity.

As water scholar Helen Ingram pointed out, water trading markets cannot make up for failures of governments. Privatization and market mechanisms cannot substitute for inept government and corrupt institutions. Well operating markets in fact depend upon a strong regulatory framework and functioning oversight. The same is true in the case of water utility privatization.

In many parts of the world where governments have been downsized, responsibility for broken water management infrastructure has downloaded to municipalities without the financial and technical resources to ensure repair, improvement and extension of urban water systems. This, of course, is an invitation to private sector involvement in municipal water supply. Such downloading, however, can only be successful over the long-term if it contributes effectively to sustainability and not just market productivity.

An important lesson Canada may wish to derive from the experience of others with respect to water markets relates to the fundamental goals of any significant water policy reform. Canadian policy-makers need to ask the same fundamental questions that continue to be asked around the increasingly water-scarce world. What is our water policy really about? Is it about market efficiency? Is it about decentralization and local participation? Or is it about sustainability? Or is it about all of these ideals?

Recommendation

The Canadian West should continue to learn from others about the best kinds of market instruments available and how they might be modified in service of our specific circumstances.

In this effort, programs such as the 2009 Alberta Water Research Institute-Alberta Water Council symposium exploring International Experience, Policy and Practice in Dealing With Water Scarcity, provide the foundation for the right kinds of choices in the future.

The Urgency of Water Governance Reform in Canada

There are real risks associated with not considering water policy reform at this point in time. Just as surely as water scarcity and decline in food production are converging toward the diminishment of the quality of human life in many other parts of the globe, it is not inconceivable the same problems could present themselves here.

Without policy reform we could very well reach a point where remediation of the damage we are doing to our own surface and groundwater water will be more expensive than we can afford, or beyond our technological capacity to address.

Without broader policy reform water quality and availability problems will very likely limit future economic and social development in part of Canada.

The failure to properly account for nature's need for water will further exacerbate water availability and quality issues making us more vulnerable to the impacts of landscape and climate change.

Without water policy reform, we risk waking up one morning to discover that we are no longer any different than the rest of the world. We will have all the same water problems our neighbours do.

What Canada needs is a new water ethic that harmonizes federal and provincial water resource management aspirations with the need to change the country's economic system so as to make true long-term sustainability possible. So why can't we create that ethic?

Why Attempts at Water Policy Reform Fail

In response to this question, the Chair of the Rosenberg International Forum on Water Policy, Dr. Henry Vaux, referred to the work of two scholars who examined the same problem in the United States.

Max Bazerman and Michael Watkins¹⁹ believe that crises related to issues such as water availability and quality qualify as "predictable surprises" in that leaders know in advance that problems exist and that they are likely to get worse over time.

Leaders also recognize that solving the problem will be expensive both politically and economically and that the prospects of receiving credit in the short-term are very small. Every experienced politician knows that such issues are fraught with dangerous risk.

As long as the system continues to limp along, there is nothing to catalyze action. Bazerman and Watkins further report that in such circumstances there always seems to be a small vocal minority that benefits from inaction and is motivated to subvert the actions of leaders for their own benefit. And that is how good systems get run into the ground.

Fortunately no one in Canada wants to wake up in the morning with a predictable surprise on their hands. There doesn't appear to be any reason why Alberta couldn't lead Canada out of the reform rut. This may be a good time to do so for two reasons. The first reason is that options for reform exist.

¹⁹ See *Predictable Surprises: The Disasters You Should Have Seen Coming and How To Prevent Them*, by M.H. Bazerman and M.D. Watkins, Harvard Business School, Boston, 2004.

Three Potential Avenues of Reform

There are at least three potential avenues of reform. We can revitalize the current system by activating unexercised jurisdiction and harmonizing federal, provincial and municipal oversight with respect to the management of our water resources. Revitalization of the existing system will demand improved monitoring, forecasting and prediction capacity tied to better enforcement of existing laws.

Revitalization will also demand the introduction of new regulations that protect water quality and recognize nature's need for water.

Alternatively, water policy reform in Canada could emerge from the example of others. The European Water Framework Directive is a model we may wish to examine in the Canadian context. We may even wish to apply it on a continental basis. In this framework, water quality standards and parameters of aquatic ecosystem health are defined by the European Union. Individual nations are then charged with meeting those standards by whatever means they feel will work best in local circumstances.

A third avenue of reform might be to allow regions to reform water policy on a large scale watershed basis. The Premiers of the western provinces and northern territories have created the Western Water Stewardship Council which aims to resolve potential conflicts in the management of all the river systems that have their origins in Canada's western mountains. Perhaps something similar might emerge in the St. Lawrence and Great Lakes areas and in Atlantic Canada.

Perhaps Alberta's Water for Life Strategy could be the model for a more integrated regional water policy design.

The second reason it may be a good time to press for water policy reform is that the public has begun to take an interest in water issues and may well support leaders who would press for change.

Canadians Are Ready for a Change

Early in 2009, a national Ipsos-Reid poll sponsored by Unilever and RBC explored for the second year in a row the attitudes of Canadians toward the value of our country's water resources. The poll found that Canadian concern about water has not diminished in the face of our current economic woes.

The poll also confirmed that the majority of Canadian consider water our most important natural resource; even more important to our future than oil. This is a heartening sign.

Unlike so many other places in the world, Canada still has room to move in terms of how we manage our water resources. If we can balance the water availability and quality needs of nature, agriculture and our cities, everything else we need to do to become sustainable, including addressing climate change, may very well fall into line.

Part Three: Learning From Others

There are a number of important lessons Canada can derive from what is happening elsewhere in the world:

- 1. It may be important to integrate national and regional water policy direction.**
- 2. Sustainability must be a foundation of water policy reform.**
- 3. Agriculture Everywhere Faces Similar Problems**
- 4. It is Important to Integrate Water and Agricultural Policy**
- 5. There is a Pressing Need for Improved Conflict Resolution Tools**
- 6. Basin Authorities and Councils Have a Role to Play**
- 7. There are Different Models Out There We Can Emulate**

We should look outward for solutions. One immediately wonders if it might not be worthwhile considering implementing programs in Canada similar to those undertaken by the European Union and its Member States under the aegis of the Water Framework Directive.

Certainly, if the European Union with its 27 member states and a population of 500 million people covering an area of more than 4 million square kilometres, encompassing a 23 different official languages can create a continental water framework, it is conceivable that a single 9.9 million square kilometre country with only 33 million people spread through 10 provinces and three territories with only two official languages should be able to do something comparable. We have the capacity to create a similar groundswell of change. All we have to do is want to.

Follow the Water

As offered by Dr. Peter Gleick at the close of the Rosenberg Forum in Spain there are a number of global perspectives that may be helpful in our efforts.

By way of encouraging one another toward success in dealing with the global water crisis, or the piece of it that is ours to address, we should do our best – all of us – to emphasize solutions and success stories and not just problems.

We should continue to explore ideas related to integration and methods that embrace inter-disciplinary tools.

We should be relentless in our pursuit of better ways to communicate with one another and the public.

We should do all we can to make what we know intelligible to decision-makers who will help us translate scientific research outcomes into timely, effective and durable public policy..

And whatever we do we should not lose our sense of humour or our passion for the very important work in which we are engaged.

