

## Canadian water strategies: past, present and future

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Thanks for inviting me to speak at your conference, etc.

I was asked to speak about Canadian water strategies. I will try to do that by looking back over the past century and a half and attempting to speculate a bit about the next half century. Over those two centuries, there have been and will be a lot of changes in water and water related issues, and lots of changes in our strategic responses to them. But one thing that has remained constant is the relentless growth in consumption of energy and materials, and ever more powerful technologies.

So, I would like to begin with just a little of that kind of context, and come back to it again when I speculate into the future.

In 1700, the world's population numbered 700 million; by 1800 it had increased to 950 million; and by 1900 to 1.6 billion. Today, we are approaching 7 billion. Those 7 billion humans are supported and impacted by essentially the same renewable water resource endowment as that which supported the 700 million in the year 1700.

And while the world's economy multiplied sevenfold in the latter half of the 20<sup>th</sup> century, the earth's natural support systems remained essentially the same.

Over the past half century, there has been much debate about "limits to growth". Many very credible thinkers have argued that human demands are approaching, or may have already surpassed the earth's carrying capacity. Other equally credible thinkers point out that as the world's population and economies have expanded exponentially, humankind now enjoys material wealth and lifespans that exceed even the most optimistic predictions of a century ago.

Both perspectives may be correct. Ecological degradation is not the same as resource scarcity. Through technological innovation, available materials and energy are constantly increasing and that will likely continue. While doomsday prophecies of resource scarcity may be misplaced or premature, the fear of ecological degradation is almost certainly well founded. The next century may very well see humans gaining control of a plethora of new materials and energy sources, while at the same time destroying what remains of the natural habitat and driving most other species to extinction.

Many fear a vicious cycle in which climate change, rising oceans and widespread chemical pollution may cause a spiraling race between human power and human-induced natural disasters. In such a scenario, should humans try to use their power to counter the forces of nature and subjugate ecosystems to their needs, possibly leading to a vicious cycle of ever more drastic and expensive manipulations of the ecosystem? Or is it possible that it may be in both our socio-economic and environmental interest to redirect more of our efforts to rebuilding resilience in those natural ecosystems ?

Some forms of water management have existed for thousands of years going back to the roman aqueducts, primitive irrigation schemes in the middle east, attempts to control flooding in Asia, and many others. But, it is only in the last century that Canadians and others have begun to consider water resources in a strategic way, as the resource development/ecological degradation

conundrum has become more and more apparent. Sometimes that conundrum has manifested itself through political or ideological debate, but more often and certainly more importantly it has been driven by shifting conventional wisdom and sometimes even voter rage among the population at large.

I will begin by examining the several phases of shifting conventional wisdom and resulting water strategies in Canada over the past century and a half. As I go through the various eras, I will also be mentioning typical interjurisdictional agreements in those eras, because those agreements tend to capture the national consensus at those points in time, even though a national consensus has never been formally articulated.

## First, the era of awakening (1880 – 1930)

Until late in the 19<sup>th</sup> century, there was little need for government intervention in water use or water protection. Water in its natural state was generally plentiful, clean and readily available. Most Canadians got their water from a shallow private or public well or buckets dipped into the nearest creek. For wastes there were outhouses. This was generally true, even for the minority of citizens living in urban areas.

But, two things changed late in that century. First, offensive odors and a growing recognition that pathogens carry diseases prompted some communities to begin developing community water supplies and burying their sewer streams underground.

In 1888, Vancouver began bringing drinking water from nearby mountains. The city of Montreal grew by nineteen times between 1883 and 1918 by providing sewer connections to suburbs that agreed to annexation. In 1912, Ontario began supervising water supplies and sewage treatment province-wide, which prompted most municipalities to introduce at least rudimentary water and wastewater systems. Other provinces eventually followed suit.

The second form of awakening was recognition of competition and the need for collaboration with our neighbors to the south. Competition arose initially in the dry foothills along the eastern slope of the Rocky Mountains where neighbors in Montana and Alberta proposed competing diversions that would essentially “steal” each other’s waters. The two national governments referred the matter to international negotiators. The outcome was the boundary waters treaty, signed in 1909, which allowed Montana to build its diversion but gave a greater share of the water to Alberta. The treaty also settled a separate disagreement about water for hydroelectricity in the Niagara river.

Perhaps as a precursor of things to come, in 1912, in one of the earliest references to the international joint commission, which was created under the treaty, dealt with the extent and sources of great lakes pollution.

In its 1916 report, the IJC provided damning testimony of how a mere quarter century of industrialization had seriously degraded the continent’s largest bodies of freshwater. But strikingly, the investigators concluded that the centers of the lakes were remarkably pure, and that dilution may well be enough to neutralize pollution.

I would be remiss if I did not recognize the remarkable foresight of our early water science community, which initiated a formal approach to defining the extent of the nation’s water resources long before there was a generally recognized need. For example, the predecessor to the

national hydrologic service can be traced back to at least 1908, and the collection of weather and climate data began even earlier.

## Second, the era of unfettered development (1930 – 1965)

After the “awakening”, and generally satisfied that their drinking water and wastewater situations, and interjurisdictional water conflicts were mostly in hand, Canadians set their engineers to work to dam, divert and otherwise modify much of our natural plumbing system, with the single minded purpose of economic development.

By the end of this period, we had completed or initiated work on over 100 reservoirs with storage capacities exceeding 100 million cubic meters, and over 50 exceeding 1 billion cubic meters. Over 80 of these large dams are in support of hydro development, about 7% are for irrigation purposes and the rest are either flood control or multi-purpose projects.

We also undertook over 50 major interbasin transfer projects. Some of the larger ones include the Long Lac and Ogoki diversions in northern Ontario, the Nechako-Kemano diversion in central British Columbia, the Churchill Nelson diversion in northern Manitoba and the La Grande (James Bay) diversion in Quebec. Interestingly, the total flow in Canadian diversions exceeds the total of water in the next two leading countries, the United States and Russia combined. 96% of our total water diversion can be attributable to hydroelectric projects.

Some of our southern water mega projects were in fact projects of mutual advantage to Canada and the United States. Examples included hydro projects under the Columbia river treaty and the St. Lawrence seaway. But what may be less well known is that many if not most of our more northern water megaprojects were built to serve American energy demands long before the demand fully developed in Canada. Some argue that such a pre-build policy was fully justified in the national interest and on economic grounds.

On the other hand, others argue that it represented a colonial practice by established economic and political powers in both countries to exploit the hinterland and its scattered populations.

What is undisputable is the fact that the burden of adjusting to the era of mega dams and diversions fell on our indigenous populations more than on any other group. In many cases they were forced to relocate to distant communities and different ways of life. And horror stories about being flooded out, dried out and contaminated with mercury from hydroelectric reservoirs are common. Their well-founded determination to look after their own welfare through confrontation and court action, along with a better understanding among the general population of the sometimes questionable economic benefits and huge environmental costs will almost surely prevent a similar era from reoccurring in the foreseeable future.

As would be expected, rapid development of large-scale storage projects in the water-short prairie region led to fears of water depletion in the downstream jurisdictions. Those fears in turn led to the prairie provinces water board and related water apportionment agreements, as well as to several basin-specific water apportionment arrangements between Canada and the United States.

But, it is important to note that those arrangements were not comprehensive, and did not respect ecological integrity in the same way as do some of the more recent transboundary agreements, for example in the great lakes and Mackenzie basins.

With respect to flooding, the engineering profession, which dominated water management at the time, had a similar preference for large scale and very expensive physical works. Large-scale flood

control works, partially funded by the federal government followed hurricane hazel in southern Ontario, and unprecedented flooding in the Winnipeg and lower Fraser regions. But, one very promising sign of things to come was the willingness and capability in Ontario, mainly through its conservation authorities to begin controlling and in some instances even evacuating development from the most vulnerable flood plains.

The construction of water and water impacting megaprojects did not of course come to an abrupt end in the mid 19960s. But, after that time the pace of development slowed and the development could no longer be characterized as largely unfettered. Reckless spending on often questionable investments began to receive more scrutiny as government deficits started to balloon.

But even more importantly, conventional wisdom had shifted. The citizenry, led by the environmental movement and indigenous leaders began insisting that less disruptive and less expensive options at least be given more serious consideration.

### Third, the environmental era (1965 – 1985)

Although it was by no means the largest of its kind, the 1969 Cuyahoga river fire created a political spark in the u.s., fanned by the media and public mood that ultimately reached the feet of the US congress. That spark, combined with a widespread belief that the algae-laden lake erie was “dying” and the subsequent realization that many northeastern lakes were being acidified created enough voter rage to spring politicians into action. By December of 1974, a trio of very strong US acts – the clean air act, the clean water act and the safe drinking water act were in place and being vigorously enforced by the new environmental protection agency.

Canadian politicians faced and reacted to similar voter rage. As a result, water pollution was a prominent part of the agenda of the 1969 first minister’s conference. First ministers directed the Canadian council of resource ministers to develop proposals to accelerate the formulation of uniform national standards and common approaches to pollution.

The following year, first ministers received a council recommendation that each government create a single agency or department responsible for environmental protection.

By the early 1970s, environmental agencies were created, and a plethora of environmental laws and programs were put in place at both the federal and provincial levels. These included the Canada water act, and dozens of federal-provincial agreements in areas like comprehensive river basin planning, flood damage reduction, and boundary water management. The changes also included amendments to the federal fisheries act to facilitate industry-based water pollution regulations, passage of the environmental contaminants act, the precursor to the Canadian environmentally protection act, and the launching of both federal and provincial environmental assessment and review processes. At the provincial level, many new laws were passed to deal with, among other things, water allocation and water quality management.

At least initially, the first wave of environmentalism produced very real results. Canada and the US signed the great lakes water quality agreement in 1972, and made remarkable early progress in addressing the eutrophication problem. While this agreement initially focused on nutrient over enrichment, subsequent amendments have made it much more comprehensive, dealing with toxic substances, areas of concern, groundwater and even climate change.

We also initiated over 20 other federal-provincial river basin planning studies under the Canada water act in those days. Just a few examples included: the saint john, Okanagan, Qu’Appelle, St.

Lawrence, and Souris basin comprehensive basin studies; the lake Winnipeg, Churchill and Nelson rivers and the Peace Athabasca delta studies with an emphasis on environmental impact; and the Ottawa river, Fraser river, Metro Toronto, and Montreal region flood studies.

During this era, considerable capacity was also built right across the country under the many Canada Water Act agreements. Both federal and provincial governments made measurable progress in arresting point source pollution and improving flow regulation. And, based to a large extent on world class science at Canada's two new research establishments, we began to identify root causes and potential solutions to a myriad of problems ranging from contaminants in fish and wildlife, to groundwater depletion, acid rain and destruction of the ozone layer.

But, the national consensus began to unravel in a hurry by the mid 1980s. The inevitable phenomenon of "agency capture" began to weaken the resolve of regulators, and all across the western world, there was widespread deregulation, privatization and tax leakage. With everything viewed through the lens of international economics, and with ballooning budgetary deficits, public good issues like health, education and the environment suffered severe budgetary cutbacks.

Citizens and non-governmental organizations began to question the motives of their governments, and some even started to drag them into the courts for violating their own laws. Water examples included very messy legal battles over the Raftery and Alameda dams in Saskatchewan and the Oldman river dam in Alberta.

Despite the crumbling consensus in the mid to late 1980s, we are fortunately still left with much of the progress achieved during the first wave of enthusiastic environmentalism, and much of the knowledge that it generated. It also provided a solid foundation for the next era – an era founded on the optimistic notion of sustainability.

#### Fourth, the sustainable development era (1990 – present)

In 1987, the Brundtland Commission published its landmark document "Our Common Future". The entire report was based on the assumption that "humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs".

What made the Brundtland concept different from previous theories was the added assumption that limits themselves can be expanded through improved technology and social organization. In other words, the biosphere could absorb increased volumes of human activity through technological and institutional advances.

Also in 1987, the federal government tabled its first ever federal water policy in parliament, and most provinces followed suit with provincial policies within a few years. Those policies were all conceptually similar, and all at least marginally advanced notions of sustainability. For example, with respect to water use, we have traditionally met our needs building dams and drilling wells, in other words almost exclusively through supply management. Throughout the sustainability era, we have been placing much a greater emphasis on demand management through, for example more realistic pricing.

More realistic pricing makes users more conscious of the real value of the resource and delivery systems, which in turn reduces demands on those systems. It also encourages efficiencies through improved technology, and reduces pressures for costly system expansion. Although some municipalities still have no or inappropriate pricing policies, this has represented a real success

story. For example, a recent IJC review concluded that water use has essentially stabilized in the great lakes basin since the turn of the century.

With respect to pollution, the emphasis during the environmental eras was almost exclusively on end-of-the-pipe regulation. We now realize that approach, while necessary, is not sufficient, and that a sustainable approach must be more anticipatory and preventative. And we must deal with chemicals through their entire life cycle, that is, from development through manufacture, transport, distribution, use and storage. The federal government adopted this approach in its 1987 Canadian environmental protection act and subsequent amendments, and provinces have been cooperating during implementation.

Unfortunately, even though the concept does move us in a more sustainable direction, we have not yet executed as well as, for example the Europeans. We still examine chemicals one at a time and put the onus on government. The Europeans, under their reach program do them all at once, and put the onus on the manufacturer or importer. 30 years after passage of the legislation, the federal government has addressed only 3160 of the 4300 substances on its priority list. But with over 100,000 substances in commercial use, perhaps 1000 new ones added each year, and evidence of health impacts mounting, our leisurely one-at-a-time approach is unlikely to provide a sustainable outcome. A recently completed two year federal policy review has resulted in a decision to extend the review for two more years.

Yet another move in the direction of sustainability relates to flooding. There is a reasonably broad consensus that the only sustainable solution is keeping people off floodplains. During the environmental era we still built some physical flood control works, but appropriately began to shift the emphasis to flood risk mapping. Under a variety of federal, provincial and federal-provincial programs, over 1000 communities were mapped up to 1990. Since 1990, the emphasis has shifted to implementation, mostly at a local and river basin level.

Some of these programs are now quite effective, for example in Ontario's conservation authorities. But, they are not yet perfect – for example few flood risk maps take climate change into account. There is also renewed interest within the federal government and the insurance industry to advance flood damage reduction policies even further in light of rapidly escalating flood risk associated with climate change.

Without question, the most critical newer environmental, and by extension water issue is climate change, and its potential impacts on floods, drought and ecological integrity. Although success in adapting to this reality has been mixed, at least one strategy does stand out as a Canadian success story. In its year 2000 report on “protection of the great lakes”, the IJC suggested that, in light of uncertainty about future water availability, there should be a bias in favor of keeping water in its natural drainage basins.

In the subsequent agreement negotiated by the eight great lakes states and two great lakes provinces, the maintenance of ecological integrity was the key objective, and a prohibition on removals of water from the basin, with minor and well-defined exceptions, was the key provision. A similar philosophy guided a federal water export ban passed unanimously by parliament in 2013.

## Fifth, the immediate future: the era of reconciliation

Clearly from the foregoing, we have had many strategic successes from which to build. But, the issues continue to evolve much faster than our strategies. Our current prime minister often contends that we can have both a strong economy and a healthy economy – that we do not have

to choose one or the other. Perhaps he is correct. But, for that to come to pass, we will have to get a lot better at reconciling the societal goals of not only prosperity and sustainability, but also of a third societal goal – equity.

Globally, some of the most pessimistic scenarios suggest Canada in a world ravaged by climate change and environmental degradation in which markets become highly unstable and there are high risks of widespread conflicts and Canada having to cope with millions of environmental refugees. In that context, preserving water security on a global scale is clearly a lynchpin to an equitable, prosperous and sustainable future for all mankind.

And it is in Canada's interest to contribute substantially to that outcome. Canada already contributes to some extent through u.n. agencies, the interaction council, aid and development agencies, and a relatively active Canadian consulting fraternity. But we could be doing much more. For example, as our own ability to reconcile goals advances, we could encourage and participate in multi-country consortiums to advance strategic options in specific countries around the world.

And there is also a more immediate reason to think more globally in our own self interest. There is already a several trillion dollar per year global environmental services industry. Canadian industries capture considerably less than 1% of that lucrative market. We could be doing a lot better, and would if we were both doing a better job at home and playing a more active strategic role abroad.

Here at home, as water strategies moved from one era to another over the last century, we have seen convention wisdom align and drive prompt political action several times, only to crumble a few years later. We now face an ever increasing array of seemingly intractable challenges, ranging from escalating natural disasters related to climate change, to stalemates over algal pollution and chemicals management, to highly volatile battles over pipelines, shale gas fracking, and oil sands development.

Resolution of most if not all of those issues will require, among other things, a practical reconciliation of goals related to prosperity, equity and sustainability.

Throughout the first half of the last century water related decisions were driven mostly by the prosperity goal. More recently, sustainability gained some traction, with equity still largely an afterthought. Governments instinctively understand equity is important, but is also less quantifiable.

One of their responses has been to embrace a number of what have to date been largely symbolic "rights". For example, in 1993, the government of Ontario passed an environmental bill of rights. In 2010, the u.n. general assembly passed a resolution declaring water as basic human right, and in 2012, Canada joined that consensus. In 2007, the u.n. general assembly adopted the u.n. declaration on the rights of indigenous peoples (undrip), and in 2018, the Canadian parliament passed a private member's bill to ensure all Canadian policies and laws are in harmony with undrip. And in 1918, the federal government announced that it would give consideration to the right to a healthy environment possibly being enshrined in federal law and policy, as part of its ongoing review of chemicals management.

Fully implementing all these declarations from a water perspective would likely require something at least akin to US style public trust law.

However, due to legal, historical and cultural differences in the two countries, the challenges in that regard may simply be insurmountable at this time. But, implementation of UNDRIP commitments as they relate to water may be quite feasible. In fact, fresh water offers a unique opportunity to move beyond the current consultation and accommodation approach as laid out in section 35 of the constitution, to building real partnerships and forms of governance built around the notion of collaborative consent. Such collaborative consent has the potential of largely doing away with the courts as a way to resolve disputes or mediate a fraying relationship with indigenous peoples.

At least at the federal level, indigenous reconciliation is being taken very seriously. For example, ongoing fisheries act amendments require the minister to consider any traditional knowledge that has been provided in regulatory decisions. They also expand the minister's authority to enter into agreements with indigenous governing bodies, for example co-management arrangements, and expands the equivalency provision to include laws made by indigenous governing bodies.

There may also be potential for similar concepts more generally for dealing with pipelines and other potentially highly controversial projects. We now rely heavily on environmental assessment processes in these circumstances.

When we first introduced these processes almost 40 years ago, they were intended to be used primarily as planning tools. Instead they have evolved into quasi - regulatory decision aids, and at the same time degenerated into battlefields for divergent interests to air their grievances. Over the past two years the federal government has tried to make environmental assessment processes more palatable to competing interests by fine-tuning the rules. But, what may eventually be required is a more fundamental overhaul, an overhaul that returns them back closer to their original intent by more fulsome involvement and something akin to a collaborative consent approach much earlier in the decision process.

And we may need additional tools to solve many other what seem like intractable problems. For example, algal blooms in lake Winnipeg are considered one of the worst problems of its kind anywhere in the world. The causes are many including massive agricultural and municipal wastes from several upstream jurisdictions, the destruction of many critical wetlands, and climate change. Governments have thrown tens of millions of dollars at studying the problem, but that is little comfort to the 23000 shoreline residents, many of whom are in first nation or metis communities, or the 800 commercial fishers operating on the lake.

Traditional approaches to conflict resolution are not working. What may be needed is novel new approaches. One suggestion has been a process involving all major stakeholders, with the intent of defining a way forward that comes closest to reconciling the societal goals of prosperity, sustainability and equity.

Another potential set of tools for reconciling societal goals are economic instruments that in essence bring the value of ecosystem services directly into market decisions. For example, despite major obstacles, we are finally beginning to put a price on carbon to reduce greenhouse gas emissions. A variety of models in many countries are capitalizing on the market-based discipline that the private insurance industry can bring to bear on reducing flood damages. I understand the province of Quebec recently introduced legislation that will use economic incentives to protect critical wetlands. There is clearly enormous untapped potential in this area.

We should also recognize that, even though getting top-down strategies and the science right at the international, national and provincial levels, most water related decisions always have been,



and always will be made from the bottom up at a quite local level, often at the level of watersheds and municipalities.

In that regard, it is critical that we establish and maintain watershed conservation organizations, constructed around a sustainable funding model, with both an ecological intelligence capacity and a governance structure that is inclusive and can reconcile potentially conflicting societal goals. We already have a few good examples in Canada from which to build.

Earlier, I suggested that the natural tendency over time is for the production and use of more and more materials and energy, while at the same time degrading the ecosystem services that support us and other living species. Under those circumstances, we must continuously sustain enough ecosystem resiliency to leave space for the reconciliation of interests, and at the same time adapt to climate change and other inevitable future surprises.

For the past few years, I have been a member of the board of an Ontario conservation authority as well as a source water protection committee. I must say I am quite impressed by the progress some of these authorities have been making on activities like producing watershed health report cards, implementing comprehensive source water protection programs, preserving floodplains and critical wetlands, planting trees, renaturalizing shorelines, and even removing a few non-functional dams.

The interjurisdictional agreements that best demonstrate the reconciliation of prosperity, sustainability and equity are likely the recently negotiated transboundary agreements in the Mackenzie basin.

I played a small role in helping to negotiate these agreements, and would like to spend just a couple of minutes describing the Alberta – northwest territories one in a bit more detail, because I think it might provide a few useful lessons with respect to some of your work.

First the negotiating process itself, an interest based approach, was somewhat unique. Although all parties believed maintaining ecological integrity was important, I think it is fair to say the upstream party, Alberta, placed a high priority on the prosperity goal, and the downstream party, the NWT placed a high priority on the sustainability goal. To respect the equity goal and indigenous rights and lifestyles, NWT negotiators worked very closely with an aboriginal steering committee throughout, and used both western and traditional knowledge in its analysis. Because of these diverse interests, negotiators spent over a year articulating the interests of their stakeholders, and fully understanding all those interests before even attempting to define the content of the agreement.

A second unique feature is risk-informed management. There are some 50 transboundary water bodies in the Mackenzie basin, and clearly all cannot be given the same priority at all times. At any given time, each water body is assigned a classification according to the level of current or anticipated stress.

At level one, where there is little current or planned development or use, a watching brief is considered sufficient. At level 2, where there are early indicators of stress, the parties develop learning plans. At level 3, where there are significant stresses, the parties begin to develop transboundary objectives, which may include, but are not necessarily limited to measures of water quality, water quantity, groundwater and biological systems.

Class 4 waterbodies are those that do not meet the transboundary objectives, and where ecological integrity is not being maintained. In these cases, immediate action is required to move

the waters back into a class 3 state. In developing and applying objectives, it is important to note that surface and groundwater quantity, surface and groundwater quality and biological systems are all closely interrelated and that none can be considered in complete isolation from the others.

I might just say a few more words about water quality objectives because I assume that might be this group's primary interest. In the Mackenzie basin, it was found that national water quality guidelines for the protection of biota and human uses were of little or no value, so basin specific guidelines had to be developed. In addition to naturally occurring substances such as phosphorous, nitrogen and common metals, the agreement also addresses toxic, bioaccumulative and persistent substances that may be present in low levels, and which should be virtually eliminated.

I am sure you all recognize that simply developing and meeting water quality objectives may not be sufficient to avoid future water quality issues. For that reason, the parties have also agreed to set lower level triggers, or early warning signals, to identify, and if needed, begin to address water quality concerns well before the transboundary water quality objectives are reached.

On top of all the other considerations, climate change must also be a constant consideration. We know, for example, that the distribution of seasonal flow is markedly changing throughout the basin, and that melting permafrost is modifying both water quantity and water quality in significant ways. Negotiators recognized that, as climate change impacts accumulate, tipping points may be reached where aquatic ecosystems are seriously or permanently damaged. For that reason, all objectives will be set very conservatively, and be modified as necessary over time to account for climate related changes.

over the next decade or two, we will undoubtedly continue to improve policies and water related laws to better reconcile the societal goals of prosperity, sustainability and equity, and to better adapt to the water security challenges of climate change. And we will no doubt work hard at improving chemicals management, flood plain management, and the protection of wetlands. But, if history is any guide, that may not be enough, and changing conventional wisdom and/or voter rage may once again force more drastic strategic change.

## Sixth, the longer term future

I am now getting into purely speculative territory. But, going back to my original context setting, one can legitimately ask how long we can continue to get healthier and wealthier while at the same time running down the ecological services supporting our health and wealth. Or will we soon approach a cross-over point. Some will argue that climate change is already reducing our net wealth by decreasing the stability of our infrastructure, disrupting agricultural systems, worsening the impacts of already excessive pollution, and accelerating the loss of critical biodiversity and ecological integrity. And there is emerging evidence that environmental contaminants in air, water and food, along with other lifestyle factors may already be contributing to declining lifespans in north America.

Politically, a more obvious conundrum is the apparent Canadian environment-economy "stalemate" over pipelines, shale gas fracking and other large-scale energy and resource extraction and transportation projects. As governments inevitably fall captive to the industry they regulate, and that agency capture becomes increasingly apparent to citizens, governments and corporations are losing "social license" to make informed decisions, leading to a kind of stalemate that will benefit nobody.

I can't say for sure if and when it will happen, but if conventional wisdom ever concludes we are getting poorer and less healthy due to ecosystem degradation, citizens will demand and get another major strategy shift. Central to that strategy shift will likely be some healthier form of environmental democracy, including improved access to information, fuller public input in decision-making, and legal recourse for individuals or groups of individuals to seek environmental remedies – or in essence to force governments to meet their fiduciary duties.

Chris wood and I included a whole chapter on this topic in our book. The chapter was titled magna carta natura. Even the romans and the Greeks before them understood that certain natural resources – air, freshwater, the oceans and living things dependent on those resources – are central to our very existence. If our health and wealth are threatened by degradation of those resources, in the long run governments may have no choice but to accept a fiduciary duty to preserve the essence of those resources for the use and enjoyment of citizens, now and into the future.

A healthier form of environmental democracy could be based on five simple principles:

1. There must be a presumption against private ownership of renewable resources;
2. The crown must continuously assure the public's ability to use and enjoy such resources;
3. The crown may recognize and convey private proprietary interests in respect of those resources, provided the public interest is not "substantially" impaired;
4. The public must have a right to be informed about the state of those resources and to be involved in decisions that may impair their present or future uses; and
5. The public must have a right to hold the crown legally responsible for meeting its fiduciary duty in these regards.

## Living in a world of uncertainty

I would like to finish up with just a few words about uncertainty. When I started working on water in the early 1960s, I was told that human activity could never significantly impact the hydrologic cycle. I was also told that, for the most part dilution was the solution to pollution. Within a decade, we were into the environmental era.

When I worked on the federal water policy in the mid 1980s, nobody took either climate change or endocrine disruptors seriously. Arguably, those are now two of the most dominant water related issues.

The point is, neither you nor I know exactly what we will be dealing with a few decades into the future. I recently enquired about how management consultants deal with uncertainty. Apparently, they place much less emphasis on scenario-building these days. Scenarios must necessarily be finite and none are likely to be correct. Instead, many in the management consultant fraternity have now adopted the notion of "strategic agility" – building institutions that are agile enough to deal with any eventuality.

I would suggest that idea may be equally relevant for the scientific community. Yes, we need sound applied science to deal with the known. But, equally important is basic understanding of characteristics, cause and effect, interrelationships, and thresholds that will enable us to deal effectively with any future eventualities.

Thank you