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Paper for Policy Research Initiative
Government of Canada
October 2, 2007, Conference on Climate Change and Water
September 20, 2007

# By the Waters of Babylon:
# Social, Institutional and Policy Dimensions of North American Hydrological Security in a Warming World

**Paper prepared for Policy Research Initiative Workshop on Climate and Water, October 2, 2007, The Wilson Center for International Scholars, Washington, D.C.,**

**ABSTRACT:** Canada has an opportunity to provide bilateral (with the United States) and international leadership in probing the social and institutional as well as the environmental linkages between the emerging threats of human-induced climate change globally and growing water stress in North America. Just as global warming is likely to alter hydrological systems and exacerbate the challenge of assuring safe water and sanitation to all the world's people, the growth of

population and of income inequalities contribute in their own ways to climate change, to insecure water access, and to ecological risks stemming from water withdrawals. The climate-change-water nexus bridges from the global (climate change) to the national (policy in both arenas) to the highly local (watersheds and water bodies), and the nexus demands social and institutional responses at all these levels. Among the important factors to understand are population, the different purposes to which water is put and how these will be affected as the global climate warms (and the world responds), the way these two issues interact physically, and the importance of transparency, fairness and sustainability in addressing problems.These issues — climate, water, population, fairness, and global-to-local linkages — are locked together in an embrace that even "well watered" countries such as Canada and the United States world will be pondering and to which they will be responding throughout the 21st century and beyond.

**Introduction**

This paper assumes some familiarity with the concept "soft" water management (Brandes and Brooks 2007) and raises several emerging social and institutional points or topics related to it. These touch on the future of safe water supply, sanitation, industrial and agricultural uses of water in North America, under the working hypothesis that human-induced climate change is real and will gain force throughout the century. For the purposes of a paper supporting a short oral conference discussion, the points presented are intentionally provocative and to some extent risk-

taking rather than comprehensive, properly nuanced, or authoritative. My hope is that they will be productive for the purposes intended.

**Population**

No solution to water supply problems, whether hard or soft, can permanently sustain growing human populations — even if the population amounts only to Canada's 33 million (United Nations Population Division 2005; note that UN population estimates and projects are quite close to those of Statistics Canada) and its annual renewable fresh water supply to a generous-sounding 90,000 cubic meters per person (Population Action International, 2007). Water is life, water is health, and water is well-being. Water is also nature, the home of the vast living world of the oceans, estuaries, rivers, lakes and other terrestrial aquatic ecosystems. And water is finite. As Canadian journalist Marq de Villiers remarked, paraphrasing American humorist Will Rogers' famous remark on land, "they're not making any more of it." (Brandes and Brooks 2007.) Thus, more perhaps than in the case of any other natural resource, fresh water and its finiteness remind us that an end to human population growth is a certain part of our future.

There is today huge scope for squeezing out inefficiencies in water distribution and use. If, just as one example, we could somehow replace all water-based sanitation with safe and effective compost-based recycling of human waste for soil regeneration, we could greatly extend the lifetime of current water supply infrastructure — *and* reduce nitrogen and related pollution of our waterways, *and* improve forest soils and farmland while reducing artificial chemical inputs. Cultural

resistance to the idea would be significant — one among the many social and institutional barriers to long-term water security that this paper cannot fully address — but let me set this point aside for now for the sake of another one. Once this imagined shift from water-based to compost-based sanitation had been made, its huge water savings would never be available again — and population could still be growing, renewing the long-term trajectory of demographic stress on water supply.

Despite Canada's relatively high ratio of renewable water resources to its population, among the highest in the world, population and water linkages are already problematic in the southern tier of the country. In the United States, many or most large metropolitan areas are facing infrastructural and even natural water constraints due to population dynamics that are not well matched to freshwater supply. As human-induced climate change exacerbates the variation of the natural hydrologic cycle — potentially bringing "100-year" storms and droughts every decade or two, for example, or extending their extremities beyond historical precedent — more disruptive population-related stresses will be felt earlier and more acutely.

The details and prospects of policies that could slow North American population growth through lower birth and/or immigration rates are beyond the scope of this paper. (Not to mention their political feasibility. In an effort to boost provincial population in Newfoundland and Labrador, for example, provincial premier Danny Williams proposes to pay parents Canadian $1,000 per new baby born. (Brautigam 2007.)) But policies based on such common North American values as fairness, respect for individual decisionmaking about reproduction, and access to affordable health care are effective in slowing growth. My point in raising population here,

however, is merely to signal its close connection to water supply — at any level of natural availability, use efficiency, or "soft management" — and to note that governments and water utilities at all levels will increasingly face discussions of population growth and distribution in thinking about future water supply.

**Renewable, Non-renewable, or Both?**

A related point to those above is that, despite hydrologists' division of water resources into "renewable" (i.e., originating in ongoing precipitation) or "non-renewable" (derived from ancient deposits underground or in stable glaciers and not subject to recharge), in the new hydrologic environment of the 21st century neither of these terms is really fixed. Water is either renewable or non-renewable in proportion to the sustainability of its human uses. The Ogallala aquifer under much of the U.S. Midwest, for example, is arguably a mix of renewable and non-renewable water assets. Much of it is indeed recharged, albeit slowly, by current rainfall. But at the high scales of irrigation to which the aquifer is being placed by contemporary U.S. agriculture, only a small proportion of the aquifer is maintaining a constant depth from the surface. (Opie 2000.)

In Africa, Lake Chad is today one-tenth the size it was a few decades ago. (Ban Ki-moon 2007.) Hydrologists debate whether this relates more to the impact of recent global or regional climate change on the supply of water to the lake or withdrawals for nearby irrigated farming, but none dispute the long-term drying trend or the role of one or more human causes for this. Is the water in Lake Chad thus renewable or non-renewable? Along the same lines, and relevant both to climate

change and Canada, what are we to call water from melting glaciers that had been frozen since the Pleistocene?

The ambivalence of water characterizations by renewability thus brings into sharp relief the human interaction with water. And it reminds hydrological engineers and policymakers alike that institutions must adjust to the social factors that drive net water demand and its component parts in planning for the future of water supply. A mere two decades ago, few policymakers understood the difference between renewable and non-renewable water supplies. Understanding has grown, but some policymakers (along with journalists and the public) now confuse “renewable” with “infinite.” The subtleties of how long- versus short-term hydrological cycles operate continue to elude most people, a point to which I will return below.

**Implications for Energy and Agriculture**

What comes to mind first when thinking about hydrology and energy together is hydropower, and climate change may well introduce new uncertainties into the production of electricity by moving water. Again, however, the changes wrought by climate change may be hard to separate from those wrought by increasing demand upstream from the dams and turbines. Institutions will need to become more sophisticated and measurement more exact in teasing apart supply and demand dynamics and long-term trends from short-term fluctuations.

A new energy-water interaction may come from growing production of biofuels in either or both countries. Growing corn for ethanol production is not only water-intensive, it is nutrient- and chemical-intensive in ways that inevitably pollute local

waterways. Once again we see that water supply and climate change (potentially boosting biofuels production by forcing the need for reductions in greenhouse gas emissions from fossil fuels) mutually influence each other. They are tied as well into other issues such as food prices and security (yet another tradeoff in biofuels production), water pollution and overall ecosystem health.

Farm and other food-related industries will feel the effects of climate change most acutely as water regimes shift with warmer temperatures and changing precipitation patterns. These shifts are likely to shake up these industries and farm families in unprecedented ways. These groups will pressure governments for assistance in making needed adjustments. Given the historical political clout of agricultural interests in both countries, such pressure will add to the competing demands governments face as climate change proceeds.

As world population grows, food insecurity grows more acute in the poorest and least food-sufficient developing countries, with an estimate 850 million now malnourished. The United Nations Food and Agriculture Organization attributes the fact that little progress is being made to shrink this number in part to the loss of upland water supplies in Africa and Asia due to global warming. (Food and Agriculture Organization, 2002.) The risk of continuing water and crop losses is exacerbated by past fossil-fuel combustion that has occurred on much larger per capita scales in Canada and the United States than in the developing countries themselves. This adds a strong moral argument, so far generally unrecognized, to the growing pressure on North America to act as the world’s breadbasket, especially for basic grains. This, too, will raise the need for irrigation, and thus the competition for fresh water. Greater public education on these

tradeoffs and interconnections may help democratic governments allocate water. One reason for the power of agriculture in the U.S. Congress and the Canadian Parliament has been the non-farm public's relative lack of interest in farm issues. With the strong likelihood that food prices will rise generally (given increased demand, finite water and land, and higher prices and/or taxes for fossil fuels), it seems likely, and indeed helpful, that public interest in farm issues will grow.

**Nature's Claim to Water**

A strictly hydrological accounting of renewable freshwater supplies can imply that nations have considerable renewable accounts to draw from. But of course most of the renewable water that is useable for withdrawals moves in rivers and nourishes ecosystems that are not only wondrous in and of themselves but are closely connected to such human needs as recreation, food supply, and mental health. Some argue that ecosystem claims for water in an increasingly crowded human would should be based on existential rights of non-human living beings, but any such rights are neither institutionally defined in North America (or anywhere else) nor a topic of public discussion.

Precedent — such as the second Bush Administration's decision in 2002 favoring in Oregon and California farmers over salmon in the Klamath River (Egan 2002) — suggests that natural ecosystems lose when their integrity competes directly with urgent human demands for water. Changing such dynamics will require much greater public education about the value of natural ecosystems, potentially leading to an increase in public pressure for their defense as human water needs grow.

**The Future's Claim to Water**

Even more difficult to weigh than nature's water rights are those of future inhabitants of Canada and the United States. Who represents the interests of future generations in having secure, unpolluted water supplies? Here, too, education and open public discussion are critical, but there's even less basis than in the case of nature for estimating how — or if — governments and other institutions will weigh hydrological sustainability in allocating water supplies in the present and constructing infrastructure for the needs of today.

**Dividing the Waters**

International water law is well behind the needs of today, let alone tomorrow. Who owns aquifers or static or flowing surface water — or water that is flowing underground, which is often the case? What happens when water flows across political boundaries? Our political institutions evolved when abundantly flowing water was mostly a given. Even in the arid U.S. Southwest, population densities were low enough that conflicts over water were generally resolvable through fairly simple "first-beneficial-user" principles. No longer.

Among the most difficult U.S. water disputes are evolving with Mexico. In one case Mexico is unable to honor a past commitment to limit its withdrawals from the Rio Grande River. In another Mexico was promised continuous flow of the Colorado River, which upstream U.S. overuse now makes impossible. More hypothetically, what would happen to Canadian-U.S. relations if the latter country took advantage of perceived rights

to use “U.S.” water by building a giant pipeline to move Great Lakes water (from the U.S. side, of course) to the demographically growing region of southern California and Nevada?

Again, existing legal and governmental institutions are largely inadequate to the task of permanently resolving such conflicts, which fester as a result. This, too, will require more discussion and a better-educated public before progress is likely.

**Wealthy and Wet, Poor and Parched**

As these questions illustrate, questions of equity and justice are deeply embedded in decisions on water allocation, and indeed even more so in climate change. In the latter case, it is the wealthy who emit the most greenhouse gases, the poor who suffer the greatest impacts of human-induced climate change with the fewest resources for adapting to it. Such issues are especially hard for North Americans to grapple with, committed as we are to democracy and the democratic principle of “one man [and presumably woman], one vote,” yet unable so far to apply such principles to the global atmosphere or the fresh water necessary for health and life. Yet as climate change, population growth and water stress increase, publics and policymakers at all levels will increasingly be forced to ask the questions: What is fair? What is right?

**Climate Change, Water, and the Knot of Social and Institutional Change**

From this reasoning, it becomes clear that we are embarking on interesting times indeed. Hydrological specialists will be increasingly valued, but good generalists are even more needed to unravel how the natural cycles of polyatomic (i.e. greenhouse)

gases, carbon, climate and water relate not only to each other, but to representative democracies that differ across the U.S.-Canadian border and embrace multiple levels of government. Not the least in the challenges involved in institutional responses to water stresses is the simple fact that among all 50 states and 10 provinces, plus territories, of the United States and Canada, not one is perfectly aligned with a watershed, major or minor. That disconnect is a geographical illustration of the larger disconnect between the ecology of natural resources and climate, on the one hand, and human social and political institutions on the other. Given the near certainty of both continued population growth and global climate change, institutional and social realignment toward the interface between human affairs and natural systems is all but certain to proceed over the coming decades — perhaps rapidly and fitfully.

**Policy Implications**

All this suggests a few likely principles, values and trends for addressing the coming transformations in water supply and allocation:

**Water education:** Until recently, water for most policymakers was something that came out of a drinking fountain in the halls of power. Assuming continuation of current demographic, climatic and hydrological trends, almost all nations will begin in some ways to resemble desert kingdoms. Water will be valued, and so will understanding about how it works — the hydrological cycle, water renewability, precipitation patterns, the links between climate and water. The number of water specialists will grow, and so will the need to educate university students, schoolchildren and the public generally.

Hydrology 101 may — and should — become a common course in universities and even liberal arts colleges.

**Engagement:** We need to move water supply and climate change as rapidly as possible up the attention scale of institutions of all kinds, not just governments at national and local levels, but those in industry, housing, and agriculture. These issues will force their way up in any event as problems become more acute. Adaptive and successful institutions will be those able to learn about these issues, plan ahead, make flexible and changeable forecasts with reasonable uncertainty boundaries, and build their capacity and resilience as early as possible.

**Transparency:** One value or ethic that will become especially important in addressing water stresses in a changing climate will be openness in policymaking and program development. Everyone has a critical, indeed life-supporting, stake in decisions that are made relating to the availability, reliability, safety and cleanliness of water. As problems become more acute, anger will arise from failures to disclose the inner workings of how and why decisions are made. Sunshine in decisionmaking will at least raise the prospects for positive public responses.

**Fairness:** Closely linked to this point is a growing recognition of the importance of rights in addressing both climate change and natural resource availability. While there is little precedent in national or international law or bilateral agreements for precision on what amount to environmental rights, publics are increasingly unlikely to accept that some individuals or groups are more entitled than others to emit greater volumes of greenhouse gases or gain access to more water. Policymakers can ignore this problem now, because few even in the news media and among policy elites have fully understood

the logical connections between resource availability and equity. But the wisest policymakers — especially those in mature and well-functioning democracies — will prepare now for a public awakening on these connections that may arrive sooner than anyone expects.

**Sustainability:** Both climate change and population growth, which together will drive much of this century's water supply challenges, are phenomena with huge reserves of momentum. As a result, they operate with long lead times and frustrate quick responses to threats as they are recognized. The problem often is compared to that of the Titanic as its crew saw an iceberg rise out of the darkness dead ahead. The 21st century will be a time in which publics and their governments grapple with a question difficult even to conceptualize: How do we adapt to the climate change we are too late to prevent, while still working to prevent the future climate change we still can? A test of all policy decisions related to these problems will be how much they contribute to *both* processes, making societies both more resilient and at the same time less environmentally damaging. Given the potential for significant and possibly catastrophic human-induced climate change, and assuming that Canadian and U.S. societies and institutions weather coming crises successfully and function effectively, the current generation's legacy to future ones will become paramount in public and policy debates.

Ancient Babylon, many historians now believe, fell in part because, like many of its predecessor civilizations in the once-Fertile Crescent, it overused and misused its renewable water, over-irrigating and salinizing its cropland as its population grew and became more affluent. It may well be that conferences comparable to the one we in which we participate in Washington in the autumn of 2007 occurred near the famed hanging

gardens around 600 B.C. In calling for this discussion, the government of Canada has an opportunity to be a pioneer among nations. Perhaps we can learn from history, adapt to the climatic and hydrologic challenges that are rapidly approaching us, and sustain the future. But we need to act fast and with courage and determination.

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