Water Security in a Changing World

John Briscoe

Abstract: This essay defines the concept of water security and explores the implications of the eternal pursuit of it. I will describe how water security is perceived by wealthy and by poorer nations, the tensions that arise from these differing views, and how these tensions are being resolved in a world in which the geography of economics and power is changing rapidly. I outline a few iconic cases of how societies have built institutions and infrastructure to deal with both floods and droughts. The essay assesses the effects of changes in climate and land use systems, and the differing reactions to the new perception of "nonstationarity": the idea that these systems are less predictable than they have historically been. The essay concludes with some reflections on the challenges of educating young people seized with passion for the issues of their generation but who may have difficulty taking a long view of water security. Many have been taught about the environmental ravages wrought by water infrastructure, but few understand how these same infrastructure and institutions underpin the water security that the United States has achieved.[1] Similarly, we teach the next generation too little about the remarkable contributions of "thinking practitioners": experts who are also involved in policy-making and planning – whose work underpins the food, water, and energy security of their societies.

JOHN BRISCOE was the Gordon McKay Professor of the Practice of Environmental Engineering and Environmental Health at Harvard University and Director of the Harvard Water Security Initiative. Previously, he worked as an engineer in the state water agencies of South Africa and Mozambique and at the World Bank for twenty years as the Senior Water Adviser and as Director for the World Bank in Brazil. He was the 2014 Stockholm Water Prize Laureate. His books and publications include *Pakistan's Water Economy: Running Dry* (with Usman Qamar, 2005), *India's Water Economy: Bracing for a Turbulent Future* (2005), and *Water Resources Sector Strategy* (2004). He passed away on November 18, 2014.

The relationship of people to water is and has always been complex and contradictory. Ancient civilizations developed alongside rivers because of the services abundant and easily accessible water provided (such as irrigation, potable water, and transportation). Yet proximity to fickle rivers also meant that these civilizations were vulnerable to floods, droughts, and changing river courses. The challenge for civilizations both ancient and contemporary has been to confront this Faustian bargain and find balance – between too little and too much water on the one hand and between the financial and environmental costs and benefits of manipulating rivers, lakes, and aquifers on the other.

This essay addresses three contemporary aspects of this age-old quest. First, it describes what is meant by water security and outlines which aspects of water security keep forward-looking leaders awake at night. Second, the essay describes some successful efforts to manage the two ends of the water-security

© 2015 by the John Briscoe Estate
doi:10.1162/DAED_a_00339

Downloaded from http://direct.mit.edu/daed/article-pdf/144/3/27/1830640/daed_a_00339.pdf by guest on 24 May 2024

spectrum: droughts and floods. The essay concludes with some observations on the challenges that face policy-makers, scientists, and citizens in moving forward.

There are a few major concepts implicit in the idea of water security and its implementation challenges. First, water security is rooted in water's contribution to the "good life." An adequate supply of water of reasonable reliability and quality – for people, industry, agriculture, and energy – is essential for the well-being of societies. Second is the "Goldilocks" concept: that is, societies need just the right amount of water – not too little (few periods of scarcity) or too much (few periods of inundation). Third is the concept that building the institutions and infrastructure to provide water security involves financial and environmental tradeoffs. Fourth and finally is the idea that context matters: people and governments choose to situate themselves at different points on the "risk/cost curve" depending on levels of development and social values.

According to the vast outpourings of the catastrophe-prediction industry, there is no end to the list of risks that threaten civilization and society today. However, issues of water security have moved up the priority lists for even the most sober prognosticators; three examples are worth mentioning.

The first is the national security establishment. One decade ago, the cogitations of national security bodies were largely concerned with two issues: nuclear proliferation and terrorism. Today, there is broad agreement that a range of environmental issues constitutes a third strand and that water looms large in these concerns. For example, in 2012, the U.S. National Intelligence Council produced a major report on the global trends that would frame "the alternative worlds of 2030."[2] One of these four dominant global trends was the water-energy-food nexus, and the Council suggested that "water may become a more significant source of contention than energy or minerals . . . at both the intrastate and interstate levels."

The business community also expresses growing concern about water-related issues. Again, a decade ago, water would have been barely mentioned in the halls of Davos, the home of the World Economic Forum (WEF). The most recent WEF survey of global business leaders, however, shows that of the hundreds of identified risks to the global economy, not one has a higher combination of "likelihood" and "impact" than water.[3]

The third group expressing concern is citizens, as revealed in Globescan's annual surveys of citizens in Brazil, Canada, China, France, Germany, India, Indonesia, Mexico, Nigeria, Turkey, the United Kingdom, and the United States. For every year since 2008, "shortages of freshwater" have been the highest-ranked environmental concern, above water pollution, depletion of natural resources, air pollution, loss of biodiversity, climate change, and automobile emissions (in descending order according to the most recent poll).[4]

Perceptions about challenges are strikingly different among different groups of experts. As a former World Bank employee and as a university professor, I have been exposed to the perspective of elites in the most prosperous countries in the world (a group that economist Thomas Sowell has tellingly called "the anointed").[5] As part of the many talks I am privileged to give on water, I often give the (mostly highly educated and rich) audience members "clickers" to gauge their views on water-related problems and their solutions. These polls produce some telling results. People in rich countries believe that about 70 percent of people in the world do not have access to an adequate supply of drinking water, but

Downloaded from http://direct.mit.edu/daed/article-pdf/144/3/27/1830640/daed_a_00339.pdf by guest on 24 May 2024

in fact the proportion (as shown in the latest global survey conducted by UNICEF and the World Health Organization) is only 11 percent.[6] In terms of solutions, the vast majority of aid money going to water-related causes (from philanthropies including the Gates Foundation and thousands of smaller charities, and from aid agencies such as the World Bank and USAID) is used to "provide water to the unserved."[7]

While leaders in the developed world tend to view water as a matter of charity and an issue to be addressed only when it reaches the status of an emergency, leaders in the developing world have a sharply differing perspective. It is these leaders of the major "emerging markets" (such as China, Indonesia, India, Mexico, and Brazil) who have been responsible for the remarkable decline in poverty over the past twenty years (from global levels of over 50 percent to under 20 percent). As part of this broad-based progress, water services to the poor have improved dramatically. According to UNICEF/WHO figures, every day for the past twenty years over 280,000 people on average moved from "unserved" to "served."[8] While the leaders of the rapidly growing emerging-market countries are responsible for most of the global success in improved access to water, they see "water supply for the poor" as one element of a broad-based economic advancement program. They do not treat the social problem (as do "the anointed" in rich countries); they search for underlying economic solutions.

What challenges do developing countries face in providing reasonable levels of water security to their populations? First is the simple fact of the hydrological starting point. In the United States, for example, development started in the Northeast, where hydrology was favorable: not too much or too little rain; and abundant water for supply to factories and people, to dilute wastes, to generate cheap hydropower, and to transport goods to market cheaply via shipment on boats. Under such circumstances it was easy and cheap to build a water platform for economic and social growth. The financial capital accrued through this "easy hydrology" was subsequently used to finance the major works (such as the Hoover Dam) necessary to serve the parts of the country where hydrology was much less favorable. Similar processes drove the developmental history of most wealthy nations; a few figures give the general picture. Wealthy countries have developed over 80 percent of their economically viable hydroelectric potential; in arid areas (such as the Colorado River basin in the United States or Murray-Darling Basin in Australia) they have built reservoirs that can store about a thousand days of average flow to generate electricity and act as buffers against floods and droughts.[9]

The situation in developing countries is quite different. As a group, they often face far more challenging hydrological conditions than do now-wealthy countries: greater intra- and interannual variability and either too much or too little water.[10] And developing countries have invested far less in the water platform for growth. Compared to the 80-percent level of rich countries, Asia and Latin America have developed 30 percent of their viable hydropower respectively, and Africa has developed 10 percent. And compared to the thousand days' worth of water stored on the Colorado or Murray-Darling rivers, the reserves of water available in developing countries are much more paltry; for example, there is only a thirty-day supply of water stored on the Indus River in arid Pakistan.[11]

Fifty years ago, the primary mission of multilateral and bilateral aid agencies was to help poor countries build the water (and other) infrastructure deemed essential for growth. The rise of the environmental movement in rich countries, however, was

Downloaded from http://direct.mit.edu/daed/article-pdf/144/3/27/1830640/daed_a_00339.pdf by guest on 24 May 2024

accompanied by a rise in activism against the sorts of investments that had made rich countries rich. This was due in part to legitimate and important concerns with social and environmental impacts of large infrastructure projects. But it was also fueled by an ahistorical paradigm that scorned the same types of investments that had been necessary to bring about the privilege those critics enjoyed. Activist NGOs in the Northern hemisphere focused heavily and productively on the otherwise largely ignored business of aid. By the late 1990s, however, most of the agencies that had once funded water and other infrastructure in developing countries (including the World Bank and the bilateral agencies of the Unites States, Canada, and Europe) had withdrawn from this business.

This change created much tension on the boards of institutions like the World Bank, where emerging and poor countries protested about the hypocrisy of those who came to have water, food, and energy security in part because of major infrastructure and yet deny similar opportunities to countries in need. But as global economic geography has changed, so too have the politics of multilateral agencies and the suite of countries offering financial assistance. In 2003, the politics of withdrawal at the World Bank came to a head: a concerted effort led by China, Brazil, and India led to a turnaround in the form of a new World Bank water policy recognizing the strongly expressed needs of developing countries and committing itself to reengagement with "high-risk/high-reward" infrastructure.[12] Simultaneously, middle-income countries not only continued to invest heavily in their own major infrastructure, but became major funders of such infrastructure in the poorer parts of the developing world. The World Bank – even with the new policy and with increasing lending for infrastructure – finances just a handful of large dams around the world, whereas China finances hundreds outside its borders.

There is, then, a yawning gap between the understanding of the anointed in wealthy countries (who prescribe what others should do) and leaders in developing countries (who have to live with the consequences). While the former worry about the (rapidly declining) problem of the unserved poor and shy away from high-risk infrastructure projects, the latter focus on longer-term solutions: namely, building infrastructure and institutions for dealing with their (generally) difficult hydrology and the still-unconquered problem of national water security. Wen Jiabao, former Premier of China, worried that "water shortages . . . threaten the very survival of the Chinese nation," and Montek Ahluwalia, Minister of Planning for India, suggested that "India can envisage a solution to the energy problem, but we do not know how to solve the problem of providing the water we need for people, industry, and agriculture."

All successful efforts to enhance water security involve the simultaneous and integrated development of infrastructure and institutions, as the following two examples illustrate. The iconic contemporary case for addressing water scarcity is that of the Murray-Darling Basin in Southeast Australia. The core infrastructural foundation was built throughout the twentieth century, the end result being a system that used almost all of the available hydropower potential, and whose reservoirs could hold several years of water in storage. The core institutional foundation was laid in the 1980s as part of a more general push to restructure the Australian economy around the principle of competition. A core element of this restructuring was the separation of water rights from land rights, the conversion of existing water licenses into tradable rights, and the creation of a

Downloaded from http://direct.mit.edu/daed/article-pdf/144/3/27/1830640/daed_a_00339.pdf by guest on 24 May 2024

strong set of incentives to facilitate trade both within and between states. This system was put through a severe stress test by an unprecedented eight-year drought at the beginning of the new millennium, and it performed extraordinarily well. The core driver of this success was that water had quite different value in different end uses (low for rice, high for grapes and fruits, and high for cities and industry). As the supply of water fell, prices rose. For a rice farmer, it was now far more profitable to lease his water for a year to a high-water-value project than it was to grow rice in a drought. There were therefore massive, voluntary transfers between low-value and high-value agriculture and from the country to the city. Remarkably, the bottom line was that there was very little impact of gross value added in agriculture (let alone the economy as a whole) from a 70-percent reduction in water availability.[13] Several other promising examples of the use of markets in the Western United States are discussed in Terry Anderson's essay in this issue.[14]

An iconic case of addressing flooding comes from the lower Mississippi, where water collected over almost half of the land area of the United States is funneled down into the Gulf of Mexico through Mississippi and Louisiana. Following the founding of the Mississippi River Commission in 1879, there was a vigorous debate about how to avoid catastrophic flooding in the delta. Nature spoke in 1927 in the form of a huge flood. Once it became apparent that water could not be contained within the extensive levee system, dikes were breached to protect New Orleans (and other areas where privileged and influential people lived). The result was anarchy and widespread destruction, wreaked particularly on disenfranchised black communities.[15] This taught the United States some hard-learned lessons. Most fundamental, it was evident that in "the big flood" the Mississippi could not be contained within the levees, and so the philosophy of "making room for the river" was born. In a remarkable process of community consultation, engagement, and consensual decision-making, two special types of land areas were identified. *Floodways* function as alternative exits to the Gulf of Mexico when water volumes exceed the carrying capacity of the main stem of the river; and *backwaters* along the river can store water when the river is at a high stage, both replenishing aquifers and wetlands and catching and holding floodwaters, which are then released slowly after the flood crest has passed. Central to this process was 1) identifying areas that could occasionally be submerged without lasting economic or social impact (such as limiting development of infrastructure and housing in these areas); and 2) awarding ex-ante compensation to the owners of this land. The resulting Mississippi Rivers and Tributaries Project, financed by the federal government and managed by the U.S. Army Corps of Engineers, was built in an integrated fashion and largely completed over the subsequent eighty years. The great stress test came in 2011, when the valley experienced a flood of even greater magnitude than that of 1927. The outcome was an extraordinary triumph (all but ignored by the disaster-hungry media). All excess water went only to designated floodways and backwaters; the area flooded was 60 percent less than that of the flood of 1927; no major infrastructure was affected; and the implementation process was – with some exceptions – planned and consensual, thanks to often-brilliant consensus-building by the leadership of the Corps of Engineers.[16]

The broad lessons from these cases of drought and flood are similar: the need to walk on two legs (drawing on the support of both infrastructure and institutions); the importance of having a way to reveal

Downloaded from http://direct.mit.edu/daed/article-pdf/144/3/27/1830640/daed_a_00339.pdf by guest on 24 May 2024

the opportunity cost of a shortage or excess of water; the reliance on voluntary processes for reallocation of water; and the emphasis on avoiding government confiscation of land.

Finally, to those who live in the Murray-Darling or Mississippi basins, the above descriptions will appear to be Panglossian or naive despite these systems' success overall. In his study on the history of water and the state in Germany over four centuries, historian David Blackbourn shows how "final solutions" to the water problem are illusory: solutions are merely "provisional."[17] So it is, too, in the Murray-Darling and Mississippi, where major challenges continue to arise, either because they are actually new or because changed social values have given them new visibility. Australia is now negotiating a complex and much-contested process for determining an optimal balance between human benefit and environmental impact; and the Mississippi basin faces great challenges in maintaining an aging infrastructure while simultaneously addressing the challenges of coastal degradation (to which the dams and dikes contribute) and of the transport of phosphorus and other agrochemicals from the agricultural heartland into a large dead zone in the Gulf of Mexico.

The primary challenge of water security is and always has been dealing with the tails of the hydrograph (droughts and floods). What of the bold claim of a group of hydrologists that climate change means "the end of stationarity," or the end of our ability to accurately anticipate water-related events?[18]

First, it is true that hydrologists have long used often quite short "historic records" as substitutes for longer-term records on which they would prefer to base their planning. But hydrologists have also been clear that short records are still the best basis for long-term projections, regardless of their limitations. From the few existing long-term records and from reconstructed records (often based on measurements of tree rings), however, it has long been clear that climate has never been stationary, but subject to short- and long-term variability. The Colorado River is one interesting study. In the early twentieth century, the Colorado Compact based its allocations on one half-century of records of river flows, which suggested that there were about seventeen million acre feet of water to allocate. Flows in recent decades have been only about thirteen million acre feet. Paleontological reconstruction of seven hundred years of records shows that there have been many shifts in runoff patterns, and that, in fact, the unusual period is not the last hundred years, but the unusually wet half-century before the signing of the Compact.

Second, it is important to recognize that climate models are just that – models – and not reality, despite the seemingly precise maps and graphs they produce. My own engagement with detailed climate models of the Amazon shows that even the most credible models seldom produce credible data on critical variables (including basic realities such as the timing and distribution of rainfall).

Third, many changes beyond the climate are affecting the stationarity of water. For example, work I was involved in in the Paraná River in Brazil showed that land-use changes in recent decades not only have a much bigger effect than climate change, but also induce changes in the opposite direction from precipitation changes.[19]

Fourth, a single-minded focus on climate becomes counterproductive when it crowds out attention to both known variability and other sources of nonstationarity. For example, I have in recent years worked extensively in Pakistan, where devastating floods have always alternated with devastating droughts.[20] There is much

Downloaded from http://direct.mit.edu/daed/article-pdf/144/3/27/1830640/daed_a_00339.pdf by guest on 24 May 2024

uncertainty about the effects of climate change on the Himalayas, with recent data (from the Gravity Recovery and Climate Experiment satellites, for instance[21]) showing a far more nuanced view than the IPCC's claim in 2007 that "the glaciers will be gone by 2035" – an error that the organization corrected soon after it was made, but which nonetheless continues to circulate in the media and in public discourse in South Asia.[22] Pakistan is swamped with foreign experts pushing their own climate models, but the obvious need is to walk before trying to run: Pakistan must build the infrastructure and institutions necessary to deal with variability, starting with known variability and eventually expanding to plan for new sources of natural and human-induced changes. If Pakistan and its development partners were to follow this course while keeping a watching brief on climate science, it might more quickly remedy its tragic water insecurity.

The water glass, then, is both half-full and half-empty. As one privileged to be educating the next generation, I see reasons for both pessimism and hope. On the downside, young people who have grown up in a society with established water security (and the associated health, energy, and food security) are inundated with the politically correct but, in my opinion, mostly erroneous view that all water management in the United States has been a disaster. When they are exposed both to the reasoning behind water management decisions (for example, on the Mississippi) and to the challenges the future poses to water management, their response is rarely to reject that view but rather to ask, "How come no one shared that perspective with us before?"[23] Indeed, when I am able to engage students with thinking practitioners – experts involved in water-management policy – the students are surprised that hands-on managers are often doing quite well in much more complex environments than those addressed by academics and advocacy groups! Pleased as I am with this, I still encounter large numbers of students who want to work on water and climate change but show little interest in the maintenance of the crumbling infrastructure that underpins their own water security.

In the meantime, as though on another planet, the emerging economies of the world are working on creating the knowledge, institutions, and infrastructure to enhance their still-precarious water security. Since they live in societies in which the consequences of insecurity of water, energy, and food reflect recent national experience, theirs is a more pragmatic and clear-eyed view. Perhaps, in this changing world, it will be they who are able to define a new, more balanced engagement with the great challenge of building a water-secure world.

ENDNOTES

1 John Briscoe, "The Practice and Teaching of American Water Management in a Changing World," *Journal of Water Resources Planning and Management* 136 (4) (2010): 409 – 411.

2 National Intelligence Council, *Global Trends 2030: Alternative Worlds* (Washington D.C.: National Intelligence Council, 2012), http://www.dni.gov/files/documents/GlobalTrends_2030.pdf.

3 World Economic Forum, *Global Risks*, 8th ed. (Davos, Switzerland: World Economic Forum, 2013), http://www3.weforum.org/docs/WEF_GlobalRisks_Report_2013.pdf.

4 Globescan, "Environmental Concerns at Record Low," Globescan Radar Survey 2013, http://www.globescan.com/images/images/pressreleases/2013-Enviro-Radar/globescan_press_release_enviroconcern_03-25-2013.pdf.

Downloaded from http://direct.mit.edu/daed/article-pdf/144/3/27/1830640/daed_a_00339.pdf by guest on 24 May 2024

[5] Thomas Sowell, *The Vision of the Anointed: Self-Congratulation as a Basis for Social Policy* (New York: Basic Books, 1996).

[6] UNICEF/WHO, Progress on Drinking Water and Sanitation, 2012 Update (New York: UNICEF, 2012), http://www.unicef.org/media/files/JMPreport2012.pdf.

[7] Ibid.

[8] Ibid.

[9] World Bank, *Water Resources Sector Strategy: Strategic Directions for World Bank Engagement* (Washington, D.C.: World Bank, 2003), http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2004/03/10/000090341_20040310154948/Rendered/PDF/281140PAPER0Water0Resources.pdf.

[10] Casey Brown and Upmanu Lall, "Water and Economic Development: The Role of Variability and a Framework for Resilience," *Natural Resources Forum* 30 (2006): 306–317.

[11] World Bank, *Water Resources Sector Strategy*.

[12] Sebastian Mallaby, *The World's Banker* (New York: Penguin, 2006).

[13] John Langford and John Briscoe, *The Australian Water Project: Crisis and Reform* (Melbourne: Committee for the Economic Development of Australia, 2011), http://www.ceda.com.au/media/154748/waterprojectdigital.pdf.

[14] See Terry L. Anderson, "Dynamic Markets for Dynamic Environments: The Case for Water Marketing" in this volume.

[15] John Barry, *Rising Tide: The Great Mississippi Flood of 1927 and How it Changed America* (New York: Simon and Schuster, 1998).

[16] Charles Camillo, *Divine Providence: The 2011 Flood in the Mississippi River and Tributaries Project* (Berkshire, United Kingdom: Books Express Publishing, 2012).

[17] David Blackbourn, *The Conquest of Nature: Water, Landscape, and the Making of Modern Germany* (New York: Norton, 2007).

[18] P. C. D. Milly, Julio Betancourt, Malin Falkenmark, Robert M. Hirsch, Zbigniew W. Kundzewicz, Dennis P. Lettenmaier, and Ronald J. Stouffer, "Stationarity is Dead: Whither Water Management?" *Science* 319 (1) (2008): 573–574.

[19] Angela Livino, John Briscoe, Eunjee Lee, Paul Moorcroft, and Jerson Kelman, "Climate Change as a Challenge to Decision-Makers in Brazilian Hydropower Systems Management," *International Journal of Hydropower and Dams* 4 (2014).

[20] John Briscoe and Usman Qamar, *Pakistan's Water Economy: Running Dry* (Karachi: Oxford University Press, 2005).

[21] Jonathan Bamber, "Climate Change: Shrinking Glaciers under Scrutiny," *Nature* 23 (2012): 482–483.

[22] Intergovernmental Panel on Climate Change, *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. Martin Parry, Osvaldo Canziani, Jean Palutikov, Paul van der Linden, and Clair Hanson (Cambridge: Cambridge University Press, 2007), http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter10.pdf.

[23] John Briscoe, ed., "The Harvard Water Federalism Project: Pedagogy and Substance," *Water Policy* 16 (Supplement 1) (2014): 1–10.

Downloaded from http://direct.mit.edu/daed/article-pdf/144/3/27/1830640/daed_a_00339.pdf by guest on 24 May 2024