Freshwater Issues in the United States

By Erica Gies

In the United States, most people turn on their taps and receive inexpensive, clean water. It's easy to think that issues pertaining to water health and delivery were solved about 100 years ago when most municipalities installed water systems, or 35 years ago when federal clean water legislation was passed.

But demand, infrastructure, and pollutants are not static. The water challenges we face today are not being addressed. Instead, the United States is poised on the brink of a quiet crisis in freshwater management, a crisis that will become much more dire in the coming years and decades if we don't work together now to confront them.

Areas of concern include shortages, pollution, and mismanagement. Each has environmental, economic, and social challenges that we must overcome if we are to continue to enjoy affordable, clean water from our taps while maintaining the health of ecosystems that support us in myriad ways. By clearly identifying these problems we hope to both educate and win the commitment of the media, policy makers and others to work toward solutions. The Johnson Foundation at Wingspread believes that we need a cohesive national strategy, clear goals, and strong leadership.

SHORTAGES

Today the epic water battles fought in the arid West are moving east, as new pressures on water availability emerge. At least 36 states expect water shortages by 2013.[1] The reasons for current and projected water shortages are multiple and include population growth, climate change, failing infrastructure, misallocation, and inefficient use.

Regional and local water shortages create competition among users that leads to economic and political turmoil. We have already seen this play out in the Klamath basin in California and Oregon, where farmers have squared off against Native Americans who are concerned with the decline of their traditional fisheries. That conflict crossed over into violence.[2] Georgia, Florida, and Alabama fought a fierce court battle, concluded in 2009, over the waters of Lake Lanier.[3] Even without serious conflict, water shortages can constrain economic growth, forcing farmers to reduce planting area and developers to rethink where they will build. In California, water limitation is dictating which types of energy plants will be built.[4]

Population

Our nation's population is increasing steadily, yet the hydrologic cycle has a fixed amount of freshwater that we can use – less than 1 percent of the water available on Earth. That means the amount of water available to each person is declining. The fastest population growth is happening in the Southwest and Southeast,[5] areas that have increasing water scarcity. The nation's population is

---

[1] U.S. General Accounting Office, *Freshwater Supply: States' View of How Federal Agencies Could Help Them Meet the Challenges of Expected Shortages*, GAO-03-514, Jul. 2003, p. 5.
[2] "3 Accused of Shooting Up Oregon Town; Water Dispute Cited," *New York Times*, Dec. 21, 2001.
[3] Shaila Dewan, "River Basin Fit Pits Atlanta Against Neighbors," *New York Times*, Aug. 16, 2009.
[4] Erica Gies, "Water Adds New Constraints to Power," *New York Times*, May 17, 2010.
[5] CensusScope, Social Science Data Analysis Network, University of Michigan, www.censusscope.org/us/print_rank_popl_growth.html, viewed 5/22/2010.

projected to increase to 392 million by 2050[6] — a 27 percent increase the current figure of around 307 million.[7]

Trends in water consumption show that, as our population has grown, the amount of water required for public supply — domestic, commercial, and industrial purposes, public services — has increased as well. Between 1950 and 2005, our population doubled and our water use for public supply tripled. However, as we have begun conservation measures, this gap is closing; in the last five years, our population increased 5 percent while public supply withdrawals increased by just 2 percent. Meanwhile, we've seen a stabilization or slight decrease in demand from our largest water users: energy production and irrigated agriculture.[8] Of course, our growing population will need more energy and food as well, so these sectors will have to ramp up their efficiency efforts to maintain or decrease stable withdrawals. Increasing competition for water from urban areas might force their hand.

On a local scale, most cities' zoning laws do not require developers to prove long-term water security before building new development. In 2001, California passed a law that makes project approval dependent upon whether developers can provide at least 20 years' worth of water for their projects.[9] Other areas need to follow suit to ensure that future growth won't be left high and dry. In the Great Lakes region, falling lake levels led to the Great Lakes Compact of 2008 that outlawed most water transfers out of the eight-state region. Area governments wanted to ensure they have enough water for their own future growth. Given that the Great Lakes hold 84 percent of North America's surface freshwater,[10] this approach might seem greedy to thirstier states. But perhaps it is only common sense to encourage future growth in areas that have natural water. The population explosions in dry Phoenix and Las Vegas over the past 20 years can't continue indefinitely and may not even prove sustainable at their currents numbers.

Climate change

"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level," wrote the International Panel on Climate Change in its 2007 report.[11]

In response to ongoing efforts by vested interests to discredit the science, in May this year, 255 members of the National Academy of Sciences declared that climate evidence is "compelling, comprehensive, and consistent."[12]

While climate models are nearly as complex as the natural systems they attempt to interpret, they all indicate a future with increasing variability in precipitation. The Southwest is likely to experience widespread, prolonged drought, while the Southeast will likely see more precipitation in shorter bursts, spurring floods. In the Northeast, summers are expected to be longer and hotter, putting a

---

[6] U.S. Census Bureau, Population Profile of the United States, web site, www.census.gov/population/www/pop-profile/natproj.html, viewed 5/22/10.
[7] U.S. Census Bureau, Population Estimates, web site, www.census.gov/popest/states/NST-ann-est.html, viewed 5/22/10.
[8] Joan F. Kenny, Nancy L. Barber, Susan S. Hutson, Kristin S. Linsey, John K. Lovelace, and Molly A. Maupin, *Estimated Use of Water in the United States in 2005*, U.S. Geological Survey, 2009, P. 43.
[9] Jennifer Steinhauer, "Water-Starved California Slows Development," *New York Times*, Jun. 7, 2008.
[10] Great Lakes, Basic Information, EPA, www.epa.gov/glnpo/basicinfo.html, viewed 5/22/10.
[11] Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis*, Geneva, Switzerland, 2007.
[12] 255 members of the National Academy of Sciences, "Climate Change and the Integrity of Science," lead letter, *Science*, May 7, 2010.

greater strain on water and electricity.[13] Studies predict greater fluctuations in watershed flows, less snowfall, earlier snow melt, rising temperatures in water bodies, altered stream channels and floodplains, and saltwater intrusion.

[Insert water flow change 2040-2060, US Climate Change Science Program from pg. 2 Beckman report]

We are already seeing changes to the hydrologic cycle. No single drought, flood, or storm can be linked definitively to climate change because weather is not climate; rather, climate is mapped over a period of time. But we have already seen decreasing snowpack in the West. More precipitation is falling as rain, rather than snow. And earlier, warmer springs are melting snowpack sooner. In several western states, water managers have traditionally relied upon mountain snowpack to melt throughout the spring and summer to supply water during the dry season. These snowpacks have been the region's largest reservoirs, providing nearly three-quarters of the West's water, according to Brad Udall, director of the CU-NOAA Western Water Assessment.

But in a 2005 study researchers showed that streamflow from snow runoff in the Colorado River decreased 2 percent during the twentieth century. The authors predict a 10 to 20 percent reduction by 2050.[14] Several other studies show reductions in a similar range. In a region where watersheds are already overallocated, this trend is likely to heighten tensions among farmers, cities, tribes, environmentalists, and industry. Already Lake Mead — created by the Hoover Dam on the Colorado River — is losing 1.2 million acre feet a year, according to the Bureau of Reclamation. (NOTE) If depletion continues at this pace, in about six years, it will fall below 1,000 feet, the site of the lowest water intake for Las Vegas. Researchers found a 50 percent probability of this happening by 2017.[15] Without alternative action this city of a half-million people will have no water.

During the twentieth century, water managers planned for the future based upon the amount of water natural systems have provided in the past. But with climate change, that approach will no longer work; we don't yet know the full range of water fluctuation to come. However, there is a management solution: resilience. Whether experiencing drought or flood, an effective system of the future will be designed to accommodate soft failure; will bend rather than break. In some cases it may be more costly to build such systems up front, but long term they will be cheaper because we will have fewer disasters.

Failing infrastructure

In May, a water main near Boston sprung a leak, dumping eight million gallons of water per hour into the Charles River. Gov. Deval Patrick declared a state of emergency and issued a "boil-water" order for Boston and 30 nearby communities that lasted for three days.[16] Unfortunately, this was not an isolated incident.

Santa Ana, Calif.;[17] Saginaw County, Mich.;[18] Kissimmee, Fla.;[19] Owings Mills, Md.;[20] Colorado Springs,

---

[13] N. S. Diffenbaugh, J. S. Pal, R. J. Trapp, and F. Giorgi, "Fine-Scale Processes Regulate the Response of Extreme Events to Global Climate Change," *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 102, No. 44, 2005, p. 15,774–15,778.

[14] P. C. D. Milly, K. A. Dunne, and A. V. Vecchia, "Global Pattern of Trends in Streamflow and Water Availability in a Changing Climate," *Nature,* 438, Nov. 17, 2005, p. 347–350.

[15] Tim P. Barnett, David W. Pierce, "When will Lake Mead go dry?" *Water Resources Research*, Vol. 44, Mar. 29, 2008.

[16] Martin Finucane, et al., "'Boil water' ordered for nearly 2 million in Mass.," *Boston Globe*, May 1, 2010.

[17] Denise Salazar and Robert Whitfield, "Water main break leaves businesses without water," *The Orange County Reigster*, Feb. 19, 2010.

[18] WNEM.com, "Residents without water after water main break," Apr. 23, 2010, web site, www.wnem.com/news/23247935/detail.html, viewed 4-30-10.

Colo.;[21] and West Lafayette, Ind.,[22] are just a few of the towns that experienced similar breaks in the last few months, flooding and closing streets, interrupting water service, and requiring residents to boil water for safety. In fact, nationwide, 250,000 water lines burst a year, or about one every two minutes.[23] [24]

U.S. cities currently lose one-fifth of their water to leaks and suffer 1.2 trillion gallons of wastewater spills each year.[25] Our nation's drinking water and sewer infrastructure spans almost 1.5 million miles of piping,[26] and this infrastructure is aging. It is clear we need to repair our water systems, but the financial burden is huge: more than $600 billion by 2019.[27]

Allocation

Citizens who live in drought-prone areas are familiar with campaigns to conserve water around the house, from installing low-flow showerhead and toilets to planting natives instead of thirsty lawns. But most of our water doesn't flow to our houses; just 11 percent goes to public supply, which includes not just houses by also commercial and industrial use and public services.[28]

In the United States, thermoelectric power generation — primarily coal, nuclear, and natural gas — accounted for 41 percent of U.S. freshwater withdrawals in 2005. Irrigated agriculture took 37 percent.[29]

As our urban areas grow and demand more water, we are going to have to find new ways to conserve in these large sectors, using both new technology and new policy. Allocations for ecosystems will likely need to increase as well, as our understanding of their function and services deepens.

Groundwater is an important part of our supply in many regions, such as the Great Plains and New Hampshire.[30] But unsustainable extraction is common. In some areas atop the Ogallala aquifer under the Great Plains, farmers withdraw four to six feet of water a year, while natural systems replace only a half-inch.[31] Because groundwater and surface water are linked, streams in the area are changing from their historic pattern of gaining water as they cross the Ogallala to losing water.

In coastal areas, overdraft of aquifers can lead to saltwater intrusion or destroy wetlands, which require high water tables. Excessive withdrawals from the Colorado River have dried up wetlands,

---

[19] WFTV.com, "45,000 affected by water main break," Jan. 28, 2010, web site, www.wftv.com/news/22366499/detail.html, viewed 4-30-10.
[20] Sherrie Johnson, "Water outage hits local businesses," abc2news.com, www.abc2news.com/mostpopular/story/Water-Main-Break-Located/OT7UVj2omkOYjgjKBhoiNQ.cspx, viewed 5-23-2010.
[21] Jakob Rodgers, "Water main break floods basement of Penrose Hospital," *The (Colorado Springs, Colo.) Gazette*, May 23, 2010.
[22] "West Lafayette water main break prompts boil advisory," Lafayette Online, May 19, 2010, www.lafayette-online.com/community/2010/05/west-lafayette-water-main-break-boil-advisory/, viewed 5-23-2010.
[23] Marianne Lavelle, "Water Woes," U.S. News & World Report, May 27, 2007.
[24] Charles Duhigg, "Saving U.S. Water and Sewer Systems Would Be Costly," *New York Times*, Mar. 14, 2010.
[25] U.S. General Accounting Office, *Water Infrastructure: Information on Financing, Capital Planning, and Privatization*, GAO-02-764, Aug. 2002.
[26] Ibid.
[27] U.S. EPA, *The Clean Water and Drinking Water Infrastructure Gap Analysis*, EPA-816-R-02-020, Sept. 2002.
[28] J. F. Kenny, N. L. Barber, S. S. Hutson, K. S. Linsey, J. K. Lovelace, and M. A. Maupin, *Estimated Use of Water in the United States in 2005*, U.S. Geological Survey Circular 1344, 2009, p. 43.
[29] Ibid.
[30] Sarah Pillsbury, et al. (eds.) New Hampshire Department of Environmental Services, *New Hampshire Water Resources Primer*, R-WD-08-23, Dec. 2008, p. 4-2.
[31] Jane Braxton Little, "The Ogallala Aquifer: Saving a Vital U.S. Water Source," *Scientific American*, Mar. 2009.

killing fish and destroying habitat for birds and other species.[32] Depleting reservoirs and groundwater can also harm environmental and human health because lower water levels concentrate natural or human pollutants.

Water-energy interface

In last decade, water availability has begun to impact the reliability of power. Droughts have forced the temporary closure of nuclear plants in France, Germany, Spain, Romania, and Australia. Similar shutdowns have been threatened in the United States as well.[33] [34]

The type of cooling technology used by a thermoelectric plant — coal, natural gas, nuclear, biomass, solar thermal — is the biggest factor in the amount of water it uses.

Once-through cooling sucks up huge quantities of water from a nearby river, lake, or ocean. A typical 500-megawatt power plant takes in almost 19 million gallons an hour.[35] The water is run through the plant and then most of it is deposited back into the water body a few minutes later, warmer and potentially polluted. New once-through cooling plants are rarely built anymore, but existing plants still account for 92 percent of water withdrawals.[36]

Once-through is being replaced by wet cooling, an evaporative method that withdraws just 3 percent of the water needed for once-through but loses 90 percent of that to vapor.[37] Wet cooling can also use alternative supplies, such as wastewater or mine pool water. A newer process called dry cooling uses fans to push waste heat into the atmosphere instead of into water.

California created a policy in 2003[38] that discourages the use of freshwater for power plant cooling. New power plant developers are responding by proposing wet or dry cooling for their projects.

Non-thermoelectric renewable energy — hydro, solar PV, wind, ethanol for transportation — have very different water footprints. Hydropower consumes many times more water than thermoelectric generation, primarily because of evaporation from the lake created behind the dam. And, depending upon irrigation, corn ethanol consumes 2 to 200 times the water that gasoline production does. (NOTE, Bevan. Verify?) On the other hand, wind and solar photovoltaics use almost no water, according to Peter Gleick, president of the Pacific Institute, a water research organization.

In 2009, prompted by climate change, the U.S. federal government began to draft policy about the water-energy nexus. These include the WaterSMART initiative, a strategy that would map and conserve water and measure the water footprint of various types of energy. The Energy and Water Research Integration Act, currently in the Senate, would direct the Secretary of Energy and relevant federal agencies to improve energy and water resource data collection, reporting, and technological innovation.

Food security

---

[32] J. I. Morrison, S. L. Postel, and P. H. Gleick. *The Sustainable Use of Water in the Colorado River Basin*, Pacific Institute/United Nations Environment Program: Oakland, Calif., 1996.
[33] Mitch Weiss, "Drought could force nuke-plant shutdowns," *USA Today*, Jan. 25, 2008.
[34] Mary Moss, "Nuclear power plants in the Southeastern United States may need to shut down," Associated Content, Jan. 23, 2008, Associated Content web site, www.associatedcontent.com/article/560407/nuclear_power_plants_in_the_southeastern.html, viewed 5-23-2010.
[35] DOE (FIND)
[36] J. F. Kenny, N. L. Barber, S. S. Hutson, K. S. Linsey, J. K. Lovelace, and M. A. Maupin, *Estimated Use of Water in the United States in 2005*, U.S. Geological Survey Circular 1344, 2009, p. 38.
[37] DOE
[38] Susan Bakker, Rick Buckingham, Melissa Jones, Rosella Shapiro, Michael Smith, Scott Tomashefsky, Chris Tooker, *2003 Integrated Energy Policy Report*, California Energy Commission, 2003.

We are beginning to bump up against water limitations in agriculture as well. Our ability to produce food for our population is threatened by unsustainable water withdrawals and land use practices, which affect surface and groundwater levels and water quality. These impacts are obvious in the West, where the San Joaquin and Colorado rivers run dry before reaching their outlets. (NOTE, CHECK)

[Insert satellite photo]

Ways to improve water efficiency in agriculture include shifting lower-value, thirsty crops to higher-value, water-efficient crops; scheduling irrigation to meet crop needs precisely; using advanced management tools, such as regulated deficit irrigation that withholds full water from plants at strategic times; and shifting some flood-irrigated crops to sprinkler and drip systems. Some of these strategies require significant investment, but policy makers could offer farmers incentives.[39]

Some current policies offer perverse incentives. For example, commodity-support programs subsidize thirsty crops such as alfalfa, rice, and cotton. These programs should be refocused with the goal of saving water.

More broadly, federal and state governments have invested substantially in irrigation systems as an incentive to populate the West. By creating an artificially inexpensive supply of water, these indirect water subsidies provide a disincentive for water conservation and efficiency improvements. Western water law still has the "use it or lose it" provision, whereby long-term landowners have first right to water. If farmers don't "beneficially use" their allocation, they lose it — encouraging farmers to waste water.

Recently, some water rights holders have been able to transfer their water rights temporarily to avoid its permanent loss. After a court reversed a ban on short-term water agreements, the town of Aurora, Colorado, began to lease water rights from farmers to serve its growing population. Under the agreements farmers can sell part of their water for a single year (essentially a lease because they are using their water and maintaining their right to it for the next year) and continue farming with the rest.

Previously Aurora had bought outright water rights from farmers, who usually retired because their land was not arable without water. The Arkansas River Valley, where they used to farm, is reverting to grassland, dependent industries such as tractor and seed dealers have gone out of business, and rural towns have been depopulated. But water leasing isn't necessarily a cure-all. Farmers who lease their water are still growing less, which still harms dependent businesses and communities. Farming advocates wonder how long this precarious economic balance can last.[40]

With our growing population, how can we sustain — much less increase — food production with less water? "Food security might mean we'll be eating different things," said Reagan Waskom, director of the Colorado Water Institute at Colorado State University. He said much of our farmland grows grain and hay for livestock.

For that reason, it takes eight times more water to produce 500 calories of meat than the same amount of plant-based food.[41] Processed foods like soda and chips are also water intensive. A sustainable diet of the future might mean eating less meat and more fresh food. Drinking municipal water from a refillable container rather than buying bottled is also preferable from a water

---

[39] Heather Cooley, Juliet Christian-Smith, Peter H. Gleick, *More with Less: Agricultural Water Conservation and Efficiency in California*, Pacific Institute, Oakland, Calif., Sept. 2008, p. 21–22.
[40] Amy Kimball, "Selling Water Instead of Watermelons," *Next American City*, Apr. 2005.
[41] J. Lundqvist, C. de Fraiture and D. Molden. *Saving Water: From Field to Fork — Curbing Losses and Wastage in the Food Chain*, SIWI Policy Brief. SIWI, 2008, p. 11.

perspective, as it takes about three liters of water to produce a one-liter plastic bottle.[42] (NOTE)

Water for ecosystems

Western water managers in the mid-twentieth century believed freshwater that makes it to the ocean is wasted. We have since learned that overextraction of water harms ecosystems, and healthy ecosystems provide many things we value, such as natural flood control, water cleaning and storage, rich soil to grow our food, habitat for fish and waterfowl, and space for recreation and water-based transportation. Many people also consider it a moral matter to protect ecosystem health for the species who live there.

Dams cause dramatic changes to ecosystems. They cause flooding behind the impoundment, which warms and slows rivers. They speed evaporation. They decrease floodplain fertility by reducing or eliminating nourishing floods. They impede fish migration and reproduction. Ironically, they also lead to increased erosion and flooding by reducing the flexibility of a natural hydrological system.

According to the University of Michigan's Global Change Program most major rivers of the Northern Hemisphere are dammed, usually at multiple sites, resulting in major fragmentation of river habitat.[43]

Because water managers don't always leave adequate water in ecosystems, sometimes courts step in on behalf of endangered species. In 2007, Central Valley farmers saw their allocations from the San Francisco Bay Delta reduced to protect the delta smelt, an endangered fish.[44] The reduced allocation cost farmers income. If agriculture improved its efficiency now and if water managers allowed a greater buffer when planning, such conflicts could be avoided.

Efficiency/Conservation

When faced with water shortages, water managers have historically tried to get more water. But that's not always possible or affordable. A hunt for more water means higher taxes for new infrastructure such as longer pipelines or new desalination plants. That makes conservation the best bargain going.

As we've seen, energy generation and agriculture are our biggest consumers of water, and those industries are working on conservation. Cities are also getting into the act, implementing green building standards. Last year San Francisco passed an ordinance to retrofit all residential and commercial properties with water-efficient plumbing fixtures upon resale, which could save the city four million gallons daily.[45] Los Angeles, Dallas, New York City, and Annapolis, Md., are among the cities that have water use ordinances for new buildings.[46] (NOTE)

Pinellas County Utilities in Clearwater, Florida, increased its water efficiency by more than 40 percent between 1991 and 2008. Its comprehensive approach includes using reclaimed water and

---

42

43 University of Michigan's Global Change Program web site, Dams and Rivers: Human and Ecological Consequences www.globalchange.umich.edu/globalchange2/current/lectures/dams/dams.html, viewed 5/23/10.

44 U.S. District Court, Eastern District of California, *Natural Resources Defense Council et al. v. Dirk Kempthorne*. Dec. 14, 2007.

45 San Francisco Public Utilities Commission, New Retrofit Legislation Will Save Millions of Gallons of Water for San Francisco, Jul. 14, 2009, SFPUC web site, sfwater.org/detail.cfm/MC_ID/13/MSC_ID/168/MTO_ID/357/C_ID/4642/Keyword/retrofit%20on%20resale, viewed 5-23-10.

46

offering rebates and technical assistance for water efficiency across all sectors.[47] One way utilities inspire conservation is by instituting a tiered pricing structure: if you use more, you pay more. Cities that have tiered pricing include Raleigh, N.C.; Tucson, Ariz.; and Amarillo, Texas.[48] (NOTE)

Corporations can also achieve big savings. Intel cut its annual water use by three billion gallons, or 40 percent of its 2008 consumption, by investing $100 million in conservation practices, according to a company spokeswoman, Suzanne Fallender.

Individuals can play a role too. The average American uses nearly 1,795 gallons of water per day, a figure includes the virtual water used to produce the food eaten, products bought, and energy consumed. The global average is 897. Chinese are on the low end, at 507. Germans use 1,118.[49] We have room to conserve without compromising a comfortable life.

EPA's online WaterSense program lists ways for homeowners to save water: low-flow toilets, washing machines, dishwashers, and more. In 2008 WaterSense saved 9.3 billion gallons of water and helped consumers save more than $55 million in water and sewer bills.[50]

Outdoor water use accounts for 30 percent of residential demand nationwide, and 80 percent in the arid West, according to Mary Ann Dickinson, president of the Alliance for Water Efficiency.[51] Reducing lawn size and planting native plants, which can thrive on rain alone and can a big difference.

Water conservation also saves energy. Water cleaning and delivery accounts for 13 percent of energy consumption in the United States.[52] Conserving water postpones the need to develop new sources that require a lot of energy, such as distant water or a desalination plant. Because conserving water conserves energy, water conservation also reduces greenhouse gas production. Saving water is therefore part of the climate solution, not just an adaptation to the water uncertainty brought by climate change.

An efficiency leader is the Santa Clara Valley Water District, which serves 1.8 million residents in the southern San Francisco Bay Area. Between 1992 and 2006, the district saved approximately 1.42 billion kilowatt hours of energy, equivalent to the annual electricity required for 207,000 households, and a financial savings of approximately $183 million. This energy savings represents the avoidance of 335,000 metric tons of carbon dioxide emissions.[53]

POLLUTION

The Clean Water Act and Safe Drinking Water Act have worked to reduce blatant pollution, but now, thanks to better testing methods and an increase in the amount of chemicals in use, scientists are finding dangerous pollutants in our water that are invisible to the naked eye. Fifty percent of our rivers and streams are impaired for some uses, including fishing and swimming; 66 percent of our

---

[47] U.S. EPA, Water Efficiency Leader Awards, 2008, EPA web site, www.epa.gov/water/wel/, viewed 5/3/10.

[48]

[49] A. Y. Hoekstra and A. K. Chapagain, "Water footprints of nations: Water use by people as a function of their consumption pattern," *Water Resource Management*, 2007, 21:35–48.

[50] U.S. EPA, 2008 Program Accomplishments, WaterSense, EPA web site, www.epa.gov/watersense/about_us/program_accomplishments.html, viewed 5/23/10.

[51] Mary Ann Dickinson, interview with author, Mar. 8, 2010.

[52] Bevan Griffiths-Sattenspiel and Wendy Wilson, *The Carbon Footprint of Water*, Portland, Ore.: River Network, May 2009, p. 1.

[53] Santa Clara Valley Water District, *From Watts to Water*, Jun. 2007, p. iii.

lakes, reservoirs, and ponds; 64 percent of our bays and estuaries; and 36 percent of our wetlands.[54] Existing laws monitor pollution from specific sources, but as development spreads, so does nonpoint source pollution, such as excess fertilizer from lawns and agriculture and oil that runs off pavement during storms.

Water pollution comes from all facets of our lives. Failing infrastructure spills untreated sewage. Even treated sewage releases pollution in the form of dechlorinated byproducts. Groundwater contamination is on the rise, in part because, since its inception, the Clean Water Act has exempted agriculture from regulation. The rise of confined animal feeding operations (CAFOs) has created vast pools of waste that leak into rivers and streams or seep into groundwater. As a result we are seeing new water-borne pathogens such as *Pfiesteria piscicida*. Many chemicals in use are not regulated. Endocrine-disruptive chemicals in drinking water supplies are affecting the reproductive health of a wide range of animals, including humans.[55] (NOTE) The rise in pharmaceutical use is now measureable in our water because our bodies cannot absorb all the medication and water treatment systems cannot filter them out. Energy generation also causes water pollution, particularly coal production. The vast majority of these pollutants are not regulated in drinking water, and even for those that are, enforcement is lax.

Failing infrastructure, wastewater

U.S. cities suffer 1.2 trillion gallons of wastewater spills each year.[56] Combined wastewater and stormwater overflows cause much of this pollution.[57]

When storm water runs directly into water bodies, it takes with it runoff: petroleum residues, pesticides, nutrients, and other pollutants. In an effort to clean this water before its release, many cities, mostly around the Great Lakes and in the Northeast, combine their stormwater treatment and sewage treatment facilities. But the same paved surfaces that accumulate pollution also block the land's natural ability to clean and absorb water. Big storms inundate these systems, and water must be released before it's treated so that sewage doesn't flood the streets. Instead, up to 75,000 times a year, these combined sewer overflows expel untreated sewage and stormwater runoff into nearby waters.[58]

[INSERT MAP: Joel Schraga, EPA, p 6 combined sewer systems map and overflows, (Source, National Climactic Data Center/NESDIS/NOAA]

In general, wastewater treatment has made great strides since the 1970s, when most systems used just primary treatment to sift out solids. Most utilities now provide secondary treatment, which introduces bacteria to break down the waste, then chlorine to disinfect the bacteria.[59] This method protects people who are swimming or fishing near discharge locations from cholera, E. coli infection, Legionnaires' disease, and other illnesses.

However, the toxicity of chlorine that kills harmful bacteria also hurts other life. It harms fish and can kill aquatic invertebrates, affecting the entire food web. To avoid chlorine pollution, the EPA requires

---

[54] U.S. EPA, Summary of Water Quality Assessments for Each Waterbody Type, Watershed Assessment, Tracking, and Environmental Results, EPA web site, iaspub.epa.gov/waters10/attains_nation_cy.control, viewed 5/23/10.
[55]
[56] U.S. General Accounting Office, *Water Infrastructure: Information on Financing, Capital Planning, and Privatization*, GAO-02-764, Aug. 2002, p. 8.
[57] Congressional Budget Office, *Future Investment in Drinking Water and Wastewater Infrastructure*, Nov. 2002, p. ix.
[58] U.S. EPA, Basic Information, Aging Water Infrastructure Research, EPA web site, www.epa.gov/awi/basic1.html, viewed 4/28/10.
[59] U.S. EPA, *Progress in Water Quality, An Evaluation of the National Investment in Municipal Wastewater Treatment*, EPA-832-R-00-008, June 2000.

treatment plants to dechlorinate before releasing treated wastewater, but the effluent contains dechlorinated byproducts, which are considered carcinogenic. Chlorine is the most widely used disinfectant nationwide, but some treatment facilities are moving to other options, including ultraviolet light, ozonation, membranes, and peracetic acid or bromine.[60]

About 25 percent of all households in the United States have on-site wastewater treatment systems, such as septic tanks.[61] Most states and communities have not established adequate management programs to ensure they are working properly.

Some communities have taken an unconventional approach to sewage treatment. In the 1970s, Arcata, a small town in Northern California, was required to upgrade its sewer treatment to meet new water quality standards. The community could have bought in to a proposed $25 million regional sewage plant. But residents believed this investment would lead to sprawl and change the tenor of the community.

Arcata opted instead to build a marsh on an old brownfield to treat its municipal sewage. Wastewater piped from homes and buildings moves through the 154 acres of fresh and saltwater marshes, tidal mudflats, and grasslands, as natural processes purify the water. Chlorination brings it up to state standards before its release into Humboldt Bay. It opened in 1986, and today the town's 17,000 people use the Arcata Marsh and Wildlife Sanctuary for recreation and consider it a point of community pride.[62]

Nonpoint Source Pollution

When precipitation or irrigation runs over land or through the ground, it picks up pollutants and deposits them into water bodies or groundwater. This nonpoint source pollution (NPS) — meaning it does not come from an obvious source, like a factory or sewage treatment plant — is the nation's largest water quality problem.[63]

In rivers and lakes, the primary cause is agriculture. Urban runoff is the main culprit in estuaries. Concentrated animal-feeding operations (CAFOs) and construction sites also contribute.[64]

The most common NPS pollutants are sediment and nutrients from fertilizer or animal or human waste. Other common NPS pollutants include pesticides, pathogens, salt, oil, grease, toxic chemicals, and heavy metals. NPS pollutants close beaches, destroy habitat, taint drinking water, kill fish, and cause many other severe environmental and human health problems. Because no polluter can be identified, the United States government spends millions of dollars annually to mitigate the damage.[65]

Agriculture exempted from Clean Water Act

One of the reasons irrigated agriculture is such a large contributor to NPS pollution is because the federal Clean Water Act has exempted it from regulation since its inception.

Pesticides and herbicides contain persistent organic pollutants (POPs), which become concentrated

---

[60] Erica Gies, "Chlorine Treatment Seen as Risky," Wired News, Mar. 15, 2005.
[61] U.S. EPA, *The Clean Water and Drinking Water Infrastructure Gap Analysis*, EPA-816-R-02-020, Sept. 2002, p. 9.
[62] Amanda Suutari and Gerald Marten, "Eco Tipping Points: How a vicious cycle can become virtuous," *Earth Island Journal*, Summer 2007.
[63] U.S. EPA, Nonpoint Source Pollution: The Nation's Largest Water Quality Problem, EPA web site, www.epa.gov/nps/facts/point1.htm, viewed 5.4.10.
[64] Ibid.
[65] Ibid.

in people and other top predators, causing reproductive and developmental abnormalities.[66] Fertilizers also cause problems. Farmers apply much more nitrogen and phosphorous than crops can absorb. Excess nitrogen percolates into shallow groundwater in the form of nitrates. In the United States, 22 percent of wells in agricultural areas contain nitrate levels in excess of the federal limit.[67] More than 1.3 million people in California's San Joaquin Valley can't drink their tap water because it is polluted with nitrates, according to Eli Moore, a senior research associate at the Pacific Institute who is analyzing the public costs of nitrate contamination of drinking water.

Seville, California, suffers from this pollution. A small town of about 500 farm workers in the Central Valley, it gets all its water from a well, which tested positive for nitrates in 2008. Nitrate is an acute contaminant, which means it can harm a person in days. The most common health impact affects pregnant women and babies. Called blue baby syndrome, or methemoglobinemia, it inhibits children's ability to absorb oxygen in their blood, and they can suffocate to death. Residents complain of skin problems and stomach upset. It's also been linked to cancer and to spleen and kidney disease.

Because the average annual income in Seville is $13,000 per family, most residents don't have the means to buy bottled water and instead must drink the tainted water. [68] Nationwide, 15 percent of households rely on drinking water from private wells.[69] This is particularly the case in rural areas, which are often farming communities. Nitrates linger in groundwater for decades and are very hard to remove.

In recent years, prices increases for fertilizer have reduced use. In Nebraska, farmers have been working to manage nitrogen application and irrigation times for 20 years. Best practices vary depending upon crop, soil, and watershed, but even with perfect application, plants will still fail to absorb some 50 percent, according to Dr. Deanna Osmond at the Department of Soil Science at North Carolina State University. [TO WHAT EFFECT? Roy Spalding] She said riparian buffers are key to absorbing and breaking down excess nitrogen.[70]

Water removal for irrigation can also increase salinity. In arid areas, evapotranspiration increases sodium and calcium concentrations in surface waters. The Colorado and Rio Grande rivers are among those that are prone to this problem.[71]

Concentrated Animal Feeding Operations (CAFOs)

In the 1990s, fishermen in rivers along the mid-Atlantic Coast started seeing vast kills of dead, floating fish with bloody lesions all over their bodies. Then they started getting sick. Their skin burned, their lungs were irritated and they began to have problems with concentration and short-term memory.

It turned out the culprit was a naturally occurring microscopic organism called *Pfiesteria piscicida*. North Carolina experienced at least 48 outbreaks between 1991 and 1997.[72] A 30-year absence of hurricanes in the area had allowed *Pfiesteria*'s population to boom. With the addition of high nutrient levels from animal and human waste, *Pfiesteria* turned lethal to fish. [73]

---

[66] P. H. Gleick, A. Singh, and H. Shi., *Emerging Threats to the World's Freshwater Resources. A Report of the Pacific Institute for Studies in Development, Environment, and Security*, Oakland, California, 2001, p. 23.
[67] Ibid.
[68] Erica Gies, "The Central Valley's Tainted Water Legacy," *Crosscurrents*, KALW, aired Mar. 24, 2010.
[69] U.S. EPA, *The Clean Water and Drinking Water Infrastructure Gap Analysis*, EPA-816-R-02-020, Sept. 2002.
[70] Deanna Osmond, interview with the author, May 24, 2010.
[71] P. H. Gleick, A. Singh, and H. Shi., *Emerging Threats to the World's Freshwater Resources. A Report of the Pacific Institute for Studies in Development, Environment, and Security*, Oakland, California, 2001, p. 37.
[72] JoAnn M. Burkholder and Howard B. Glasgow, "History of Toxic *Pfiesteria* in North Carolina Estuaries from 1991 to the Present," *BioScience*, Vol. 51, No. 10, Oct. 2001, p. 827.
[73] Ibid.

In the late 1980s and 1990s, many concentrated animal feeding operations (CAFOs) moved into the area. Research shows they polluted the water via atmospheric deposition and by direct spills.[74] *Pfiesteria* outbreaks happened in the late '80s and '90s. But then Hurricanes Floyd (1999) and Irene (1999) came along, reducing *Pfiesteria* populations, and thus, the risk of lethal outbreaks in the near term.[75]

CAFOs were created to meet consumer demand for large quantities of inexpensive meat and dairy products. Animal cultivation in the United States produces 133 million tons of excrement annually, 13 times the human waste. Chemical solvents are used to remove waste from the floors, and the liquid is channeled into huge open pits called lagoons. The waste contains feces, urine, antibiotics, pharmaceuticals, pesticides, pathogens, hormones, and carcass parts.[76] As it stagnates, it emits methane, ammonia and hydrogen sulfide.

CAFOs have come under fire not just for air and water pollution but also for health concerns about the products they produce, which are heavily treated with antibiotics, and for ethical issues surrounding the treatment of animals.

One way to reduce the effect of all types of nonpoint source pollution on water is to create buffer zones around water bodies. In cities, permeable pavement, parks, rain gardens, and bioswales can help. In rural areas, the U.S. Department of Agriculture's Conservation Reserve Program pays farmers to retire flood-prone or eroding cropland along the rivers, restoring natural buffer zones to prevent agricultural runoff from reaching the water. More than 30 million acres have been set aside for this use, and the Mississippi River Basin has been an area of special focus.

Chemicals and Pharmaceuticals

The Safe Drinking Water Act regulates just 91 contaminants, although tens of thousands are used in the United States.[77] Part of the problem is the Toxic Substances Control Act (TSCA) of 1976, which requires the EPA to meet a high burden of proof to show that a chemical is unsafe and should be regulated. New legislation aims to overhaul this law. The Safe Chemicals Act (SCA) would make industry, instead of government, responsible for proving the safety of chemicals.[78]

In fact, it's pretty clear these many of chemicals are not safe. Scientists have looked at thousands of the unregulated chemicals, identifying hundreds that, at small concentrations in drinking water, are linked to cancer, birth defects, and stomach irritation.[79]

Scientists are also finding pharmaceuticals in our water supply. In the 1990s, scientists began to notice that estrogen from birth control pills, present in water, was causing male fish to form androgynous sex organs. The EPA and World Health Organization tested for other drugs and found antidepressants, anticonvulsants, tranquilizers, antibacterials, antipsychotics, ACE inhibitors, nitroglycerin, steroids, ibuprofen, caffeine and more. It is impossible to remove the drugs from our water supply using current treatment methods.[80]

---

[74] JoAnn M. Burkholder, et al., "Impacts to a Coastal River and Estuary from Rupture of a Large Swine Waste Holding Lagoon," *Journal of Environmental Quality*, Vol. 26, No. 6, Nov.–Dec. 1997.
[75] JoAnn M. Burkholder, et al., "Comparative Impacts of Two Major Hurricane Seasons on the Neuse River and Western Pamlico Sound Ecosystems," *Proceedings of the National Academy of Science*, Jun. 22, 2004, Vol. 101, No. 25, p. 9291–9296.
[76] JoAnn Burkholder, et al. "Impacts of Waste from Concentrated Animal Feeding Operations on Water Quality," *Environmental Health Perspectives*, Vol. 115, No. 2, Feb. 2007.
[77] Charles Duhigg, "That Tap Water Is Legal but May Be Unhealthy," *New York Times*, Dec. 17, 2009.
[78] Jonathan Bardelline, "Chemical Reform Bill Would Shift Burden of Proof to Industry," GreenBiz.com, Apr. 15, 2010.
[79] Charles Duhigg, "That Tap Water Is Legal but May Be Unhealthy," *New York Times*, Dec. 17, 2009.
[80] Jeffrey Kluger, "Flushed Away," *Time*, Apr. 1, 2010.

In response to these problems the EPA announced in March that it is developing new strategies to protect public health from contaminants in drinking water. It plans to address contaminants as a group rather than one at a time, encourage the development of new water technologies that clean multiple contaminants, use the authority of several statutes to protect drinking water, and share pollution data with states.[81] It remains to be seen whether these changes will be effective.

Energy

Generating energy can pollute water directly. Plus, a common plant cooling method creates heat pollution in water.

Coal mining pollutes water in myriad ways. When mining companies seek coal via mountain-top removal, they blast hundreds of feet off the top of a mountain to access coal seams. The rubble is dumped into adjacent valleys, choking creeks and rivers and flooding downstream communities.

When the industry washes coal to remove impurities, sludge or slurry containing minerals and chemicals is left behind. Companies dump this waste in lagoons or inject it into abandoned mines. Near Charleston, W. Va., coal companies have injected more than 1.9 billion gallons of slurry into the ground since 2004. Residents were getting sick, so they tested their water and found it contained toxic amounts of lead, manganese, barium and other metals — the same pollutants injected into the ground. Thirty percent of local people surveyed have had their gallbladders removed, and half have tooth enamel damage, chronic stomach problems and other illnesses. These contaminants can also contribute to organ failure or developmental problems. However, justice for local people remains elusive because it is difficult to prove conclusively that pollution from one source caused illness, or which company was responsible for that pollution.[82]

Surface storage of slurry is dangerous as well. In December 2008, a dam near Harriman, Tennessee gave way, spilling an estimated 1 billion gallons of toxic coal ash into nearby streams, fields and homes.[83] The disaster revealed that there are no federal standards for coal-ash waste disposal or dam construction.[84] A report released in February from the Environmental Integrity Project and Earthjustice revealed 31 other sites around the country where coal-ash pollution has contaminated groundwater, wetlands, rivers and streams.[85]

In May 2010, the EPA announced it was proposing the first-ever national rules to ensure the safe disposal and management of slurry. But veteran Charleston Gazette reporter Ken Ward Jr. doubts its efficacy.[86]

Sometimes, environmental protections create unintended consequences. Scrubbers were installed on a coal-fired power plant in Masontown, Penn., to reduce air pollution. The technology sprays water and chemicals through the plant's chimneys. But now instead of polluting the air, the company dumps tens of thousands of gallons of wastewater into the Monongahela River, a drinking water source for people in the Pittsburgh area. This is not an isolated problem. Roughly 50 percent of coal-generated electricity in the United States is produced in plants that use scrubbers, yet no federal laws regulate these discharges.[87]

---

[81] Charles Duhigg, "U.S. Bolsters Chemical Restrictions for Water," *New York Times*, Mar. 22, 2010.
[82] Charles Duhigg, "Clean Water Laws Are Neglected, at a Cost in Suffering," *New York Times*, Sept. 13, 2009.
[83] Shaila Dewan, "Tennessee Ash Flood Larger Than Initial Estimate," *New York Times*, Dec. 27, 2008.
[84] Ken Ward Jr., "Tennessee Coal Ash Spill Highlights Broad Gaps in Government Oversight," *Charleston Gazette*, Dec. 30, 2008.
[85] Environmental Integrity Project and Earthjustice, *Out of Control: Mounting Damages from Coal Ash Waste Sites*, Feb. 24, 2010.
[86] Ken Ward Jr., "Obama EPA punts on coal ash regulations," *Charleston Gazette* blog Coal Tattoo, May 4, 2010.
[87] Charles Duhigg, "Cleansing the Air at the Expense of Waterways," New York Times, Oct. 13, 2009.

Heat pollution from thermoelectric energy generation also harms ecosystems. The once-through cooling process used by many plants — coal, nuclear, natural gas, biomass, solar thermal — creates heat pollution in water bodies, killing fish. Intake can also kill wildlife and microorganisms, and the used water can contain pollutants. Once-through cooling plants are rarely given permits anymore due to awareness of these environmental impacts, but forty-three percent of U.S. thermoelectric generating capacity still uses once-through cooling.[88]

Enforcement

One big hurdle to achieving clean water is that existing laws are often not enforced. The Clean Water Act and Safe Drinking Water Act have done a lot to clean up our rivers, lakes, and estuaries. But pollutants of concern today are impossible to see or smell, and the public is often unaware of their presence. States' enforcement has grown lax, and EPA data shows the result: significant impairment of our water bodies.[89]

In 2009, the *New York Times* conducted an in-depth review of water pollution records for every state and the EPA and compiled a national database. It found that 40 percent of community water systems nationwide violated the Safe Drinking Water Act at least once in 2008, although some were clerical. Still, some of the most frequently detected contaminants have been linked to cancer, birth defects and neurological disorders.[90]

Since 2004, more than 23,000 companies and other facilities violated the Clean Water Act 506,000. But fewer than 3 percent of the violations were fined or punished by state officials. The EPA didn't prosecute polluters either or force states to strengthen their enforcement. The *Times* reported that weak enforcement was due to a lack of resources and lobbying from vested industries.[91]

SOLUTION BARRIERS

Water shortages and pollution are formidable challenges, and some management problems are creating additional hurdles. We don't know exactly how much water we have, which hinders our ability to manage it responsibly. We have no national strategy for water management, leaving us with multiple agencies that have overlapping jurisdictions or work at cross purposes. We have a cultural history of trying to pave nature into submission with hardscape, and we are now learning that soft path strategies have many advantages, most notably, resilience to unpredictable events. We waste time, money, and energy cleaning water to potable standards to use in toilets and gardens. To rectify these problems we need investment, leadership, and innovation in addition to public education.

Data shortage

Imagine running a business without knowing how much capital you have. It would be impossible to make savvy decisions, and the long-term health of your enterprise would be in jeopardy. That is just the challenge we face with our water budget. We are allocating it to various uses without knowing how much we actually have.

---

[88] J. F. Kenny, N. L. Barber, S. S. Hutson, K.S. Linsey, J. K. Lovelace, and M. A. Maupin, *Estimated Use of Water in the United States in 2005*, U.S. Geological Survey Circular 1344, 2009, p. 38?

[89] U.S. EPA, Summary of Water Quality Assessments for Each Waterbody Type, Watershed Assessment, Tracking, and Environmental Results, EPA web site, iaspub.epa.gov/waters10/attains_nation_cy.control, viewed 5/23/10.

[90] Charles Duhigg, Clean Water Laws Are Neglected, at a Cost in Suffering," *New York Times*, Sept. 13, 2009.

[91] Ibid.

Some water policies are based upon inaccurate data. A famous example of this problem is the 1922 compact that divided the Colorado River among seven western states. Planners calculated the river's hydrology using data from the previous 20 years, which were abnormally wet. To make matters worse, each state was awarded a specific volume of water, not a percentage of total annual flow. Today the Colorado River is overallocated.[92]

The U.S. Geological Survey's National Streamflow Information Program is a critical source of data about our surface water that helps managers across sectors make good decisions. However, the cost of this program is rising, and federal support has decreased, shifting the burden onto state and local governments. The data this program provides will only become more critical as flows grow more variable in response to climate change.

When it comes to groundwater — that which is stored underground in aquifers and water tables — we don't even have a baseline data about quantity, although we rely on it for 40 percent of our drinking and agricultural water supply.[93] (Gleick?) Groundwater is linked to surface water through hydrological systems. When we overextract it, we not only have to dig deeper wells. We also see rivers, lakes, streams, and wetlands dry up, and sinkholes appear on land.

Groundwater pumping to supply new suburban developments in Massachusetts dried up the Ipswich River.[94] Extraction in Florida harmed 143 of 153 lakes near Tampa Bay and caused low water levels in most of the region's 350 wetlands.[95]

But we don't actually know the extent of this problem nationwide because we lack comprehensive national data. The U.S. Geological Survey has begun work on groundwater mapping under its Groundwater Resources Program but lacks funding to make meaningful progress. Many states collect data on a local level, but efforts are inconsistent, and some states collect no data at all.[96] Even extraction rates are unknown in many places, in part because fifteen percent of U.S. residents get water from their own private wells.[97]

Without comprehensive scientific data, state water managers cannot make sound decisions about water allocation. That is why scientists, government agencies, and nongovernmental organizations are participating in a Subcommittee on Groundwater to advise Congress on national water policy. It has recommended that the federal government implement a National Groundwater Monitoring Network, which would allow the USGS to collect data on ground and surface water quantity and quality in order to manage both simultaneously.

In some places, falling water levels affect not just the quantity, but also the quality of groundwater. In Louisiana, groundwater pumping has caused saltwater intrusion into the aquifer that supplies Baton Rouge.[98] On New Jersey's coastal plain, people have had to abandon 100-year-old well fields due to saltwater intrusion.[99]

We are also inhibiting groundwater recharge as we build up urban and suburban areas. When we pave over lands with strip malls and parking lots, we prevent water from naturally filtering through

---

[92] John Hazlehurst, "Colorado River Compact Based on Leaky Logic," *Colorado Springs Business Journal*, Sept. 21, 2007.
[93] USGS 2005 (CHECK)
[94] Robert, Glennon, *Water Follies: Groundwater Pumping and the Fate of America's Fresh Waters*. Washington: Island Press, 2002, p. 99–111.
[95] Ibid., p. 75, 77.
[96] Food & Water Watch, *Unmeasured Danger: America's Hidden Groundwater Crisis*, San Francisco, July 2009.
[97] U.S. EPA, *The Clean Water and Drinking Water Infrastructure Gap Analysis*, EPA-816-R-02-020, Sept. 2002, p. 9.
[98] Charles Taylor and William Alley, *Ground-Water-Level Monitoring and the Importance of Long-Term Water-Level Data*, U.S. Geological Survey, 2001, p. 27.
[99] Ibid., p. 43.

the soil.

No national strategy

Today too many disparate agencies manage water rights, quality standards, and law in myriad ways. Government agencies, universities and professional associations are organized and funded in a way that reinforces isolation and inhibits the development of cooperative, creative solutions. Even federal agencies operate independently of each other to handle flood management, water supply, and pollution control. Water experts such as engineers, hydrologists, sociologists, and economists rarely share information with each other. Effective water management would integrate goals for transportation, public health, energy, open space and environmental quality, housing, and public works.

For example, the Great Lakes are managed by ten federal agencies, eight U.S. states, forty tribal nations, several major metropolitan areas, and numerous county and local governments. In an attempt to streamline that morass, President Bush created the Great Lakes Interagency Task Force in 2004 to provide direction on Great Lakes policy, priorities and programs. The EPA, the lead agency, works with state governors and mayors to obtain cleaner water and sustainable fisheries.[100]

In many states, different laws apply to groundwater and surface water, although they are linked hydrologically. As states learn this, they are moving toward managing groundwater and surface water together, under a system called conjunctive use. Vermont, Nevada, and Utah are among the early adopters of this policy.

Even enforcement of national water laws is not applied equally across the nation. For example, in 2004 the U.S. General Accounting Office found that the 38 district offices of the U.S. Army Corps of Engineers differ widely in how they determine which waters and wetlands are subject to the federal jurisdiction of the Clean Water Act.[101] The report focused on the Corps' actions after the 2001 Supreme Court ruling the *Solid Waste Agency of Northern Cook County (SWANCC) v. United States Army Corps of Engineers*, commonly known as the SWANCC decision. The outcome reduced wetlands protection, and the effect is more pronounced in Corps offices in developer-friendly areas, such as the Texas Gulf Coast.

The answer to improving water management cohesion on all fronts may lie in holistic management of the entire watershed. Watersheds flow through multiple towns, counties, and states. Many Native American tribes incorporated this natural reality into their water-use laws, limiting withdrawals and fish harvests to preserve resources for regeneration and people downstream. Today, watershed organizations that manage water supplies across borders can better control pollution and track water withdrawals. Working together, they can make farsighted decisions that will help avoid future conflict.

The Christina Basin Clean Water Partnership is an alliance of federal, state, local and nonprofit watershed organizations in Delaware and Pennsylvania. Since 1994 it has worked to restore the historically industrial, 565-square-mile watershed to potable, fishable and swimmable status.[102]

Although it relies on voluntary action, the partnership has successfully implemented a variety of soft path strategies, including helping farmers reforest riparian zones along streams, restoring wetlands to absorb stormwater, and encouraging residents to use rain barrels and native plants in

---

[100] U.S. EPA, Great Lakes, Basic Information, EPA web site, www.epa.gov/glnpo/basicinfo.html, viewed 5/22/10.
[101] U.S. General Accounting Office, *Waters and Wetlands: Corps of Engineers Needs to Evaluate Its District Office Practices in Determining Jurisdiction*, GAO-04-297, Feb. 2004.
[102] Christina Basin Water Quality Management Strategy web site, www.wr.udel.edu/cb/, viewed 5/23/10.

landscaping.[103] In 2003 the partnership received a $1 million grant from the EPA, which ranked it first among the 176 watershed groups considered.[104] [105]

Hardscape dominates

We have a several-decades-old tradition of engineering solutions to manage water. We've built hardscapes to stop flooding, generate hydropower, expand irrigated agriculture, and retain stormwater. Over the years we've seen that, while these methods often work in the short term, longer term they can fail, hurting the economy, water quality, and our health.

Soft path strategies, more compatible with nature's own rhythms, are more resilient to stress. Soft infrastructure can be less expensive to build, far less expensive to maintain, offer buffer against storms and sea level rise, and provide a host of ecosystem services such as water cleaning and storage, flood protection, stormwater absorption, and habitat for nurseries of game fish. Soft-path strategies often serve multiple functions, whereas hardscape is generally targeted to solve one problem. Examples of soft-path strategies include permeable pavement, urban agriculture, wetlands and stream restoration including tree replanting, and the building of parks rather than buildings in floodplains.

Houston's natural water regime has been disrupted by urban sprawl. Every other year or so, the area gets big rains of eight inches or more. Historically, its prairie pothole wetlands helped absorb the water. But as the city has expanded to cover 600 square miles, floods have become a regular occurrence.

Floodplain authorities require developers to build storm water detention facilities. But John Jacob, director of the Texas Coastal Watershed Program at Texas A&M, says they're not as effective as the wetlands.

"These stormwater detention ponds are just big holes in the ground. They don't have the water quality function that our local wetlands do," said Jacob. "Certainly we can engineer the stormwater function. We can engineer the water quality thing, but to think we can engineer everything and don't need these natural functions belies a lack of understanding. These wetlands are extremely complex."[106]

Philadelphia isn't know for sprawl, but it was interested in creating a sustainable, integrated water management program, in part to remedy its annual average of 166 combined sewage overflows[107] The Philadelphia Water Department Office of Watersheds, which manages the city's drinking water, wastewater, and stormwater, has been moving in a more sustainable direction for more than a decade. Last year it expanded its efforts with the Green City, Clean Water program and is awaiting final regulatory approval from the EPA. Philadelphia plans to absorb excess storm runoff by expanding the capacity of its wastewater treatment plants in combination with increasing on-site stormwater absorption. It will achieve the latter by replacing some pavement with permeable surfaces and by restoring streambanks and wetlands.[108] These green infrastructure improvements will serve multiple purposes, creating social, economic, and ecological benefits.

---

[103] U.S. EPA, *Christina River, EPA's Targeted Watersheds Grant Program*, EPA 840-F-04-002g, 2003.
[104] U.S. EPA, Targeted Watersheds Grant Program, EPA web site, www.epa.gov/owow/watershed/initiative/, viewed 5/23/10.
[105] University of Delaware PR, "Clean Water Partnership Receives $1 Million Grant," University of Delaware web site, www.udel.edu/PR/UDaily/2003/cleanwater062503.html, viewed 5/23/10.
[106] John Jacob, Interview with the author. Nov. 8, 2005.
[107] Neukrug, TK
[108] U.S. EPA, *Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices*, EPA 841-F-07-006, Dec. 2007.

Flood control is another area of water management that can benefit from the soft path approach. The Army Corps of Engineers spends more than $1 billion each year on levees and other infrastructure designed to control floods and repair flood destruction. Yet many of these projects actually increase repeated flooding, causing significant property damage.[109]

When we deepen rivers for boat traffic and narrow them with levees to develop floodplains, we close off space for water storage and conveyance, creating the higher flood levels that have been observed in recent years, according to Nicholas Pinter, a professor of geology at Southern Illinois University at Carbondale.

Pinter has studied rising flood levels over time around St. Louis, Mo., which he calls the "epicenter of floodplain encroachment nationwide." When St. Louis suffered an historic flood in 1993, experts called it a 100-year event. In response, the city constructed new "500-year-levees." Developers rushed to build on 1,400 acres of floodplain that so recently had been underwater.[110] [111]

Tulsa, Okla., on the Arkansas River, chose a different path. The city led the nation with nine federally declared flood disasters during the 1970s and 1980s. Two of these floods alone resulted in the deaths of 17 people and combined property damages of $214 million. Tulsa used local and federal funds, including flood insurance checks, to buy and remove approximately 500 flood-damaged homes and 375 vulnerable buildings. The reclaimed floodplain is now used for recreation, open space, and nature preserves.[112] Tulsa's flood insurance rates dropped 25 percent and are now among the lowest in the country.[113]

Allowing floodplains to absorb floods also reduces coastal dead zones because excess nutrients are processed and cleaned.

Right water for right use

Drinking water supplies are limited — acutely in some parts of the country — and demand continues to grow. But cleaning water to drinking level quality is energy intensive and not necessary for many uses, such as watering gardens, washing cars, flushing toilets, and industrial activities. Reusing or recycling water can provide additional supply. Some people consider reusing or recycling water distasteful, but communities in Arizona and Southern California have been using these practices safely for years.

"Some day in the not too distant future, our practice of flushing toilets with drinking water will be viewed as being as archaic as using pigeons to carry text messages, as wasteful as sending every bottle and can to the landfill, and as disgusting as dumping raw sewage into rivers and lakes," wrote Don Elder, former president of River Network.[114]

Out of necessity, some water-strapped areas are already exploiting these sources. Gilbert, Ariz., grew rapidly, from 5,800 residents in 1980 to 200,000 today. To meet increased demand, water managers designed a system to reclaim wastewater and move it through recharge ponds, where it percolates down into the aquifer for future use. Pond water is also used directly for irrigation and other

---

[109] Green Scissors, "Rotten to the Corps: Army Corps of Engineers Flood Control Construction $1.25 Billion," www.greenscissors.org/water/floodcontrol.htm. (EXPIRED. Will find another source.)
[110] K. C. Jaehnig, "Study: St. Louis Is the Epicenter of Flood Plain Encroachments," *Southern Illinois University Carbondale News*, April 7, 2005, p. 1.
[111] Nicholas Pinter, interview with the author. Nov. 8, 2005.
[112] City of Tulsa, Oklahoma, *From Harm's Way: Flood-Hazard Mitigation in Tulsa, Oklahoma*, 1993, www.smartcommunities.ncat. org/pubs/harmsway/index.shtml.
[113] Tawna Mertz, "Nature's Services: Ecosystems Are More Than Wildlife Habitat," the RAND Corporation web site, www.rand.org/scitech/stpi/ourfuture/NaturesServices/section1.html, viewed 5.23.10.
[114] Don Elder, Water Reuse, River Network web site, www.rivernetwork.org/water-reuse, viewed 2/24/10.

nonpotable uses, reducing demand on groundwater. Residents enjoy recreation around the ponds, which also provide critical riparian-style habitat for wildlife.[115] During summer's peak demand, Gilbert saves more than 131 million gallons of drinking water a day.[116]

Other places are using reclaimed water as well, including the cities of Chandler, Mesa, Phoenix, Scottsdale, Tempe, Peoria and Tucson in Arizona;[117] Clearwater and St. Petersburg in Florida; Clark County, Nev.; Austin, Texas; and San Diego, Orange and Contra Costa counties in California.

Homeowners and businesses can create their own supplemental water supplies as well. Graywater from the shower and sink drains and rain harvested in barrels or cisterns can be used to flush toilets and water gardens. As with decentralized energy, on-site water supplies offer property owners increased water security, independence, efficiency, and environmental benefits.

To reroute graywater or rainwater back into the house or to use utility-delivered treated wastewater requires a dual plumbing system. A diverter valve allows people to choose potable water for some needs and alternative water for the rest. Dual plumbing systems could be phased in over time. Ed Mazria, founder of Architecture 2030, calculated that at our building rate prior to the recession, 75 percent of our building stock would be new by 2030.[118] Utilities could greatly speed installation of such infrastructure and reuse programs by redirecting some of the money they spend securing new supplies.

Investment, leadership, innovation

Economics rule most water decisions, and environmental and social effects are given short shrift. Decision makers tend to maintain the status quo because it is generally more affordable in the near-term. Innovative solutions that require up-front costs are politically difficult. But some soft solutions are actually economic boons. In 1989, the EPA ordered New York City to build a $6 billion water-filtration plant that would cost $300 million a year to operate. Instead, the city spent $1.2 billion to restore and protect its watersheds.[119]

But the economics of water are skewed. Often government or market incentives are not aligned with public goals to manage freshwater wisely. For instance, the Farm Bill encourages agricultural practices that deplete and pollute freshwater resources. Water utilities make greater profits by selling more water, which creates a disincentive to promote conservation.

Policy changes could switch the motives of powerful players. For example, in 1991, Irvine Ranch Water District in Orange County, Calif., instituted an allocation-based rate structure. Households that exceed their base allocation are penalized with rates up to eight times higher than the base. Thrifty households receive a discount. The result is low usage and low rates. To meet its revenue needs, the utility separated its fixed and volumetric charges and distributed operating costs across all customers. It also separated out capital costs and paid for them via property taxes and connection fees.[120]

---

[115] U.S. EPA, "*Cases in Water Conservation: How Efficiency Programs Help Water Utilities Save Water and AvoidCosts*," EPA832-B-02-003, July 2002, p. 17-18.
[116] Gilbert, Ariz., web site, Reclaimed Water, Water Conservation, www.ci.gilbert.az.us/water/popups/reclaimedwater.cfm, viewed 5/24/10.
[117] Ibid.
[118] Ed Mazria, interview with the author, Mar. 31, 2008.
[119] Caryn Ernst, *Protecting the Source: Land Conservation and the Future of America's Drinking Water,* San Francisco: Trust for Public Land, American Water Works Association, 2004, p. 21.
[120] Brett Walton, "U.S. Urban Residents Cut Water Usage; Utilities are Forced to Raise Prices," Circle of Blue web site, Apr. 19, 2010, www.circleofblue.org/waternews/2010/world/u-s-urban-residents-cut-water-usage-utilities-are-forced-to-raise-prices/, viewed 5/13/10.

To develop innovative solutions and to better monitor and enforce existing laws, we need new funding strategies. Since 2001, federal funding for drinking and wastewater utilities has declined 24 percent.[121] One way to pay for the infrastructure overhaul we need is to establish a clean water trust fund. In a 2009 study, the U.S. Government Accountability Office considered how to raise $10 billion annually for the fund and suggested that payment come from industries that profit from water or damage its quality, including those that make beverages, fertilizers and pesticides, flushable products, pharmaceuticals, water appliances and plumbing fixtures.[122]

An existing program, the Clean Water State Revolving Fund (CWSRF), provides loans for water quality improvement projects in the United States. The fund is administered by the EPA and state agencies. It supports municipal wastewater facilities, estuary protection projects, and nonpoint source pollution control. It has loaned more than $5 billion annually in recent years and continues to grow through interest earnings, principal repayments, and leveraging.[123]

Some people think we need more private investment. The proposed Sustainable Water Infrastructure Investment Act of 2010 would remove state volume caps on private bonds for water and wastewater projects. The bills sponsors say it will free up billions of dollars in private capital for the nation's water infrastructure.

Ecosystem services markets could also provide funding for water management. The premise behind these markets is that healthy ecosystems perform critical services for humans that have an economic value. These include recycling waste, pollinating food crops, and providing drinkable water, breathable air, food, a stable climate, physical buffers against storms and flooding, and space for recreation and tourism. Businesses have historically used these services for free. But as we degrade natural systems, they begin to fail. To understand how much an ecosystem service is worth, economists calculate how much it would cost to restore the natural system or to build mechanical systems to perform the same services.

For example, in Atlanta, heavy tree cover decreased from 48 percent to 26 percent between 1974 and 1996. Tree loss during that period increased stormwater runoff by 33 percent. For the city to build stormwater retention facilities to intercept the increase would cost $1.18 billion.[124]

Markets already exist for carbon, biodiversity, wetlands, and water quality. But because they are small and fragmented, they are not very effective. The U.S. Department of Agriculture's new Office of Ecosystem Markets and Services (OEMS), created last year, will ask government and private experts to develop a single standard for each market, then create a registry where carbon, wetlands, nutrient, biodiversity and other credits can be tracked to ensure the same benefits aren't being sold twice.[125] The Natural Capital Project — a partnership among Stanford University, The Nature Conservancy, and World Wildlife Fund — is also working to create effective policy and finance mechanisms through these markets. To retain confidence — and therefore value — in these markets, credits must be real, verifiable, additional, permanent, and enforceable.

---

121 Marianne Lavelle, "Water Woes: It's a special commodity everyone takes for granted. But supply is shrinking, pipes are aging, and few are willing to pay the price," *U.S. News & World Report*, May 27, 2007.
122 U.S. Government Accountability Office, *Clean Water Infrastructure: Design Issues and Funding Option for a Clean Water Trust Fund*, GAO-09-893T, Jul. 15, 2009.
123 U.S. EPA web site, Clean Water State Revolving Fund, www.epa.gov/owm/cwfinance/cwsrf/, viewed 5/24/10.
124 American Forests, *Projected Environmental Benefits of Community Tree Planting: A Multi-Site Model Urban Forest Project in Atlanta,* Washington, DC: American Forests, Oct. 2002, p. 9.
125 Alice Kenny, "How the U.S. Is Forging a National Ecosystem Marketplace," The Katoomba Group's Ecosystem Marketplace, www.ecosystemmarketplace.com/pages/dynamic/article.page.php?page_id=6908&section=newsletters&eod=1#close, viewed 5/24/10.

Steve Allbee, project director of the EPA's gap analysis that calculated the cost of our infrastructure needs, said that local municipalities or companies should continue to pay the bulk of infrastructure expenses. The large amount of federal funds invested in local infrastructures in the 1970s was a one-time boost, not meant to be ongoing, he said. "But the result was that an entire generation grew up not understanding the true cost of water." Allbee said water is undervalued by half and we need to educate the public about its true cost, including externalities such as harm to ecosystems, and then charge more for it.[126]

Public education

Most people take inexpensive, clean water for granted. That is, until they no longer have it. The communities who have faced temporary or permanent water service disruption span the country: Seville and nitrates, Boston and its water main break, West Virginia and coal pollutants. But ideally we wouldn't rely on emergencies to increase public awareness about how freshwater issues affect quality of life. Instead, effective education programs could help people understand the value of proactively investing to conserve and protect freshwater resources.

The goal is to help people be more willing to conserve, pursue rebates for new appliances, accept higher charges via tiered pricing structures, and consider lifestyle changes such as planting a native garden instead of a lawn.

"Customers need to understand what a utility does. They need to believe that it has value," said Allbee of the EPA. Some utilities use newsletter inserts with billing to deliver information, although they frequently go unread.

Public education via public service announcements could be a more effective tool to reach people. Information printed directly on bills is fairly unavoidable. Bills that show comparison data to neighbors' consumption or year-round patterns of use help customers understand which behaviors are most water intensive. Smart meters, like those being used for electricity, give immediate feedback to users and help utilities get a more nuanced picture of demand.

The emergence of ecosystem services markets will also help to educate the public about the many services that healthy water ecosystems provide.

Getting the nation on a path to sustainable water management requires all Americans to understand our water challenges and their own roles in helping to address those problems via personal action, cost acceptance, and support of related legislation and infrastructure repair.

[126] Steve Allbee, interview with the author, May 12, 2010.