GLOBAL WARMING ASIDE, FRESH WATER DWINDLING

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According to a study published in the July 14, 2000, issue of *Science*, one-third of the world's population is water-stressed, with 8 percent classified as severely water-stressed, including the western United States and northern Mexico, South America, India, China, Africa surrounding the Sahara Desert, and southern Africa and Australia.

“Water stress” has profoundly different meanings in developed and developing countries. In Africa and many parts of Asia, it means inadequate water for drinking, sanitation and crops. In emerging economies such as India and China, it translates as an inability to meet the dietary and lifestyle aspirations of a growing middle class.

Water stress in richer nations, and in places such as Phoenix and Las Vegas, means an inability to sustain a growth economy and support lavish oasis-style lifestyles featuring irrigated lawns, outdoor swimming pools, artificial waterfalls and urban lakes.

Per capita water withdrawal and use vary widely according to a country's technological capacity and economic profile, but almost two-thirds of all water withdrawn from Earth's rivers and streams is used for agriculture. Agriculture accounts for 85 percent of "consumptive uses" overall: water that is evaporated, transpired by plants, incorporated into crops, or consumed by humans or livestock. Domestic households use an additional 10 percent, industry uses 20 percent, and nearly 4 percent is lost from evaporation at reservoirs.

The problem of water stress has other facets, as well, such as the often-overlooked environmental needs of plants, animals and natural landscapes, or the flow of “virtual water” contained in trade goods. It takes 57 gallons of water to produce a pound of corn and 855 gallons of water to produce a pound of corn-fed beef, meaning that exporting corn and beef is equivalent to exporting water. World trade can therefore be a mechanism to exacerbate or relieve water stress.

WATER STRESSORS

Future water demand, with or without climate change, will grow substantially.

According to the Population Reference Bureau, the world will grow by 6.6 million to 8 million by 2025, and by up to 9.3 million in 2050, with nearly all growth occurring in developing countries lacking capacity to increase water supplies or improve delivery.

The world is also rapidly urbanizing, creating additional stress by concentrating demand in small areas. Currently, the developed world is more than 70 percent urbanized, whereas less than 40 percent of the population of Africa and Asia is urban. However, 50 percent of Africans and Asians and 60 percent of the world will live in urban areas by 2030.

As needs grow, cities will intensify aquifer drawdown and divert more distant surface-water flows, leading to potential conflicts between sectors, people, regions and countries. One need only consider the approximately 2 million people displaced by China's Three Gorges Dam or the depleting aquifer that Israel currently shares with its neighbors to see the potential outcomes of such shifts.

The rising middle class in many developing countries also stresses water supplies by demanding better diets and urban lifestyles, although the overall relationship between economic development and water demand remains controversial because the efficiency associated with higher levels of development and technology can also reduce water use.

Climate change has the potential to alter both water supply and demand. According to the Intergovernmental Panel on Climate Change's Fourth Assessment report in 2007, increasing temperatures suggest increased evaporation and decreased stream flows, as well as rising seas that could contaminate freshwater estuaries and groundwater resources. Increasingly variable precipitation will likely mean more frequent high-intensity droughts and floods and less available rainfall in arid and semiarid regions, including Arizona.

THE ENERGY-WATER NEXUS

Water and energy are closely intertwined, a relationship that is often overlooked. Water provides the steam driving nuclear turbines. It cools thermal plants and powers hydroelectricity. Concurrently, loads of energy go toward desalinating, pumping and moving water. Producing 1 kilowatt of electricity requires an estimated 36 to 53 gallons of water, depending on whether fossil fuel or nuclear plants are used.

Large-scale desalination plants require substantial amounts of energy and specialized, expensive infrastructure, making them accessible for Middle Eastern countries with large energy reserves - Saudi Arabia's desalination plants account for about 24 percent of total world capacity - but non-viable for places that are poor, deep in the interior or at high elevation. Unfortunately, many of the world's most severe water problems occur in such places.

The water-energy relationship limits the usefulness of high-energy solutions in addressing climate-induced water shortages. It also significantly expands and alters the climate-change debate. We have long recognized that energy is a global resource, and it is now becoming clear that water, too, is global. Rich countries, trading virtual water and using energy to solve water-shortage problems, may accentuate global warming and water stress in poor countries.

POLITICS OF WATER

Water stress and competition are among the oldest causes of conflict in human history. The Los Angeles aqueduct/pipeline bombings from 1907 to 1913 (an effort to prevent diversions of water from the Owens Valley) and the Palestinian National Liberation Movement's attacks on Israeli diversion pumps in 1965 are but two modern examples.

Dams can lead to destabilizing population displacements, particularly among poor and indigenous populations, and international tensions. Ten million to 60 million people have been

displaced by dams in China, and, closer to home, damming the Colorado River has exacerbated water-management conflicts between Mexico and the United States.

Recent conflicts over water have focused on perceived inequities associated with water development, and for the 1 billion people who lack access to safe drinking water and the 2.4 billion who lack adequate sanitation, climate-induced water stress may well devolve into humanitarian crises and mass population displacements in the future.

FINAL THOUGHTS

Water resources are in crisis, with or without climate change, because, barring unforeseen technological advances in desalination, Earth's freshwater supply is limited and geographically variable.

Pressure upon it, already increasing over the past 50 years because of rapid population growth, urbanization, globalization, extreme poverty and woeful governance, will only increase with global climate change. Meanwhile, easy-fix technological solutions, with their high energy requirements, are not affordable for poor countries and may even exacerbate global warming.

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