Safeguarding our water

By Peter H. Gleick (Scientific American, Vol. 284, February 2001)

Throughout the first three quarters of the 20th century, the quantity of freshwater consumed per person doubled on average; in the U.S., water withdrawals increased 10-fold while the population quadrupled. But since 1980 the amount of water consumed per person has actually decreased, thanks to a range of new technologies that help to conserve water in homes and industry. In 1965, for instance, Japan used approximately 13 million gallons of water to produce $1 million of commercial output; by 1989 this had dropped to 3.5 million gallons (even accounting for inflation)--almost a quadrupling of water productivity. In the U.S., water withdrawals have fallen by more than 20 percent from their peak in 1980.

As the world's population continues to grow, dams, aqueducts and other kinds of infrastructure will still have to be built, particularly in developing countries where basic human needs have not been met. But such projects must be built to higher standards and with more accountability to local people and their environment than in the past. And even in regions where new projects seem warranted, we must find ways to meet demands with fewer resources, minimum ecological disruption and less money.

The fastest and cheapest solution is to expand the productive and efficient use of water. In many countries, 30 percent or more of the domestic water supply never reaches its intended destinations, disappearing from leaky pipes, faulty equipment or poorly maintained distribution systems. The quantity of water that Mexico City's supply system loses is enough to meet the needs of a city the size of Rome, according to recent estimates. Even in more modern systems, losses of 10 to 20 percent are common.

When water does reach consumers, it is often used wastefully. In homes, most water is literally flushed away. Before 1990 most toilets in the U.S. drew about six gallons of water for each flush. In 1992 the U.S. Congress passed a national standard mandating that all new residential toilets be low-flow models that require only 1.6 gallons per flush--a 70 percent improvement with a single change in technology. It will take time to replace all older toilets with the newer, better ones. A number of cities, however, have found the water conservation made possible by the new technology to be so significant--and the cost of saving that water to be so low--that they have established programs to speed up the transition to low-flow toilets.

Even in the developing world, technologies such as more efficient toilets have a role to play. Because of the difficulty of finding new water sources for Mexico City, city officials launched a water conservation program that involved replacing 350,000 old toilets. The replacements have already saved enough water to supply an additional 250,000 residents. And numerous other options for both industrial and nonindustrial nations are available as well, including better leak detection, less wasteful washing machines, drip irrigation and water-conserving plants in outdoor landscaping.

The amount of water needed for industrial applications depends on two factors: the mix of goods and services demanded by society and the processes chosen to generate them. For instance, producing a ton of steel before World War II required 60 to 100 tons of water. Current technology can make a ton of steel with less than six tons of water. Replacing old technology with new techniques reduces water needs by a factor of 10. Producing a ton of aluminum, however, requires only one and a half tons of water. Replacing the use of steel with aluminum, as has been happening for years in the automobile industry, can further lower water use. And telecommuting from home can save the hundreds of gallons of water required to produce, deliver and sell a gallon of gasoline, even accounting for the water required to manufacture our computers. The largest single consumer of water is agriculture--and this use is largely inefficient. Water is lost as it is distributed to farmers and applied to crops. Consequently, as much as half of all water diverted for agriculture never yields any food. Thus, even modest improvements in agricultural efficiency could free up huge quantities of water. Growing tomatoes with traditional irrigation systems may require 40 percent more water than growing tomatoes with drip systems. Even our diets have an effect on our overall water needs. Growing a pound of corn can take between 100 and 250 gallons of water, depending on soil and climate conditions and irrigation methods. But growing the grain to produce a pound of beef can require between 2,000 and 8,500 gallons. We can conserve water not only by altering how we choose to grow our food but also by changing what we choose to eat.

Shifting where people use water can also lead to tremendous gains in efficiency. Supporting 100,000 high-tech California jobs requires some 250 million gallons of water a year; the same amount of water used in the agricultural sector sustains fewer than 10 jobs--a stunning difference. Similar figures apply in many other countries. Ultimately these disparities will lead to more and more pressure to transfer water from agricultural uses to other economic sectors. Unless the agricultural community embraces water conservation efforts, conflicts between farmers and urban water users will worsen.

The idea that a planet with a surface covered mostly by water could be facing a water shortage seems incredible. Yet 97 percent of the world's water is too salty for human consumption or crops, and much of the rest is out of reach in deep groundwater or in glaciers and ice caps. Not surprisingly, researchers have investigated techniques for dipping into the immense supply of. water in the oceans. The technology to desalinate brackish water or saltwater is well developed, but it remains expensive and is currently an option only in wealthy but dry areas near the coast. Some regions, such as the Arabian Gulf, are highly dependent on desalination, but the process remains a minor contributor to overall water supplies, providing less than 0.2 percent of global withdrawals. With the process of converting saltwater to freshwater so expensive,' some companies have turned to another possibility: moving clean water in ships or even giant plastic bags from regions with an abundance of the resource to those places around the globe suffering from a lack of water. But this approach, too, may have serious economic and political constraints.

Rather than seeking new distant sources of water, smart planners are beginning to explore using alternative kinds of water to meet certain needs. Why should communities raise all water to drinkable standards and then use that expensive resource for flushing toilets or watering lawns? Most water ends up flowing down the drain after a single use, and developed countries spend billions of dollars to collect and treat this wastewater before dumping it into a river or the ocean. Meanwhile, in poorer countries, this water is often simply returned untreated to a river or lake where it may pose a threat to human health or the environment. Recently attention has begun to focus on reclaiming and reusing this water.

Wastewater can be treated to different levels suitable for use in a variety of applications, such as recharging groundwater aquifers, supplying industrial processes, irrigating certain crops or even augmenting potable supplies. In Windhoek, Namibia, for instance, residents 'have used treated wastewater since 1968 to supplement the city's potable water supply; in drought years, such water has constituted up to 30 percent of Windhoek's drinking water supply. Seventy percent of Israeli municipal wastewater is treated and reused, mainly for agricultural irrigation of nonfood crops. Efforts to capture, treat and reuse more wastewater are also under way in neighboring Jordan. By the mid-1990s residents of California relied on more than 160 billion gallons of reclaimed water annually for irrigating landscapes, golf courses and crops, recharging groundwater aquifers, supplying industrial processes and even flushing toilets.

New approaches to meeting water needs will not be easy to implement: economic and institutional structures still encourage the wasting of water and the destruction of ecosystems. Among the barriers to better water planning and use are inappropriately low water prices, inadequate information on new efficiency technologies, inequitable water allocations, and government subsidies for growing water-intensive crops in arid regions or building dams.

Part of the difficulty, however, also lies in the prevalence of old ideas among water planners. Addressing the world's basic water problems requires fundamental changes in how we think about water, and such changes are coming about slowly. Rather than trying endlessly to find enough water to meet hazy projections of future desires, it is time to find a way to meet our present and future needs with the water that is already available, while preserving the ecological cycles that are so integral to human well-being.