

CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES
and SANDIA NATIONAL LABORATORIES



GLOBAL WATER FUTURES

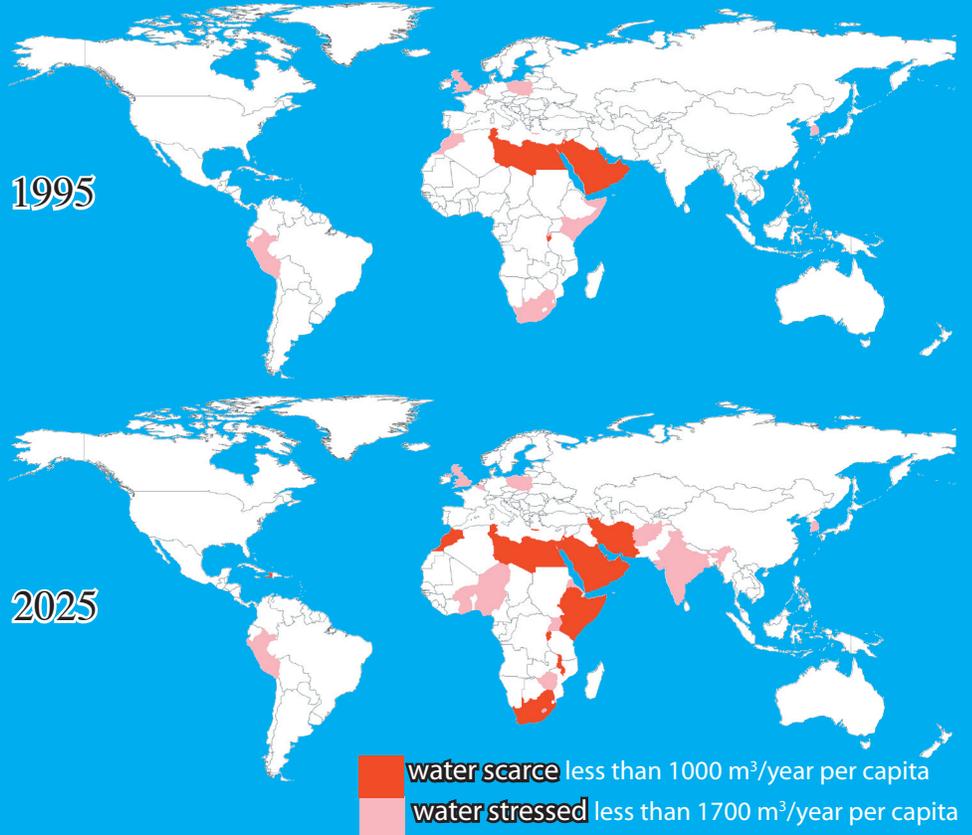
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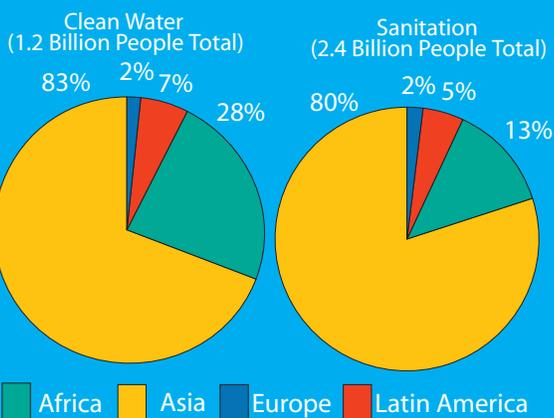
Water Futures at a Glance

We are already using over 50% of the planet's accessible runoff, and yet global withdrawals are projected to increase by 10-20% each decade. Increased demand will limit the water available for both human use and for Earth's environment, with potentially devastating consequences. Already, several of the Earth's major rivers no longer consistently reach the sea and water tables are falling around the world. 1.2 billion people lack access to safe drinking water and 2.4 billion people lack access to basic sanitation facilities, according to the World Health Organization. These numbers are catastrophic in humanitarian and economic terms. 5 million deaths per year are related to lack of sanitation and clean drinking water, accounting for 4 percent of the global disease burden. 135 million people could die of water-related diseases by the year 2020—more than will fall victim to the growing HIV/AIDS pandemic.

Source: Gardner-Outlaw and Engelman (1997)



Percentage of People Without Access To...



The world's population is projected to rise from 6.4 billion people today to between 7.3 to 8.4 billion people by 2025. This population growth will be concentrated in many water-stressed regions, such as the Middle East and the African continent. Between 2015 and 2020, the number of people living in urban centers will surpass the number living in rural areas for the first time in history. According to UN projections, by 2030, the urban population will comprise 60% of the total global population. The many mega-cities of the world, those with populations over 10 million, will face severe water shortages and sanitation crises. They will also be located mainly along coastlines, making them vulnerable to natural disasters, such as typhoons, tsunamis and hurricanes.

Current aid levels are insufficient to meet the many challenges of providing adequate water supply and access to the world's people. Despite the strategic importance of water issues to the United States and its allies, current coordinated efforts have not been fully implemented or have been underfunded. According to the United Nations, meeting Millennium Challenge goals to reduce by half the proportion of people without access to safe drinking water will require between \$15 and \$30 billion on top of the \$30 billion already invested annually. Development and stability in the many affected regions necessitates that water issues be dealt with immediately. It is a race against increasing scarcity.

Solutions For the Future

Reduce Supply-Demand Pressure

The implementation of new and existing technologies is necessary to reduce the intense pressure on water in terms of both supply and demand. On the supply side, both high-tech and low-tech solutions will be necessary to widen access to safe drinking water in the near term and to ensure long-term availability of this precious resource. Improving agricultural efficiency in the developed and developing worlds will be critical, as agriculture accounts for 70 percent of global water usage.



Support Infrastructure Development



According to the World Bank and International Monetary Fund, reducing by half the number of people without access to sanitation by 2015 will require providing an additional 1.5 billion people with access to safe water and 2 billion with basic sanitation. Some 125 million people each year, or more than 340,000 every day, will need to be connected to infrastructure. The developed world must make better use of and continue to develop new technologies to aid with the management of water resources in the short and long terms.

Expand Financial Resources

Developing infrastructure means expanding financial resources. Developed countries should build on the commitments made by the G-8 members at the Evian Summit in 2002, as well as the 2002 World Summit on Sustainable Development in Johannesburg. Redoubling efforts to foster public-private partnerships will be essential to meeting these commitments.



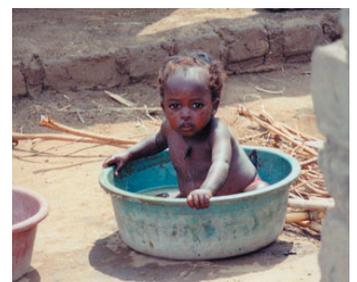
Enable Market-Based Pricing



Setting the price of water to reflect the costs associated with producing and consuming water will aid in the expansion and improvement of infrastructure. Moreover, undistorted pricing will rationalize water consumption. Such cost-recovery methods require strong governance and integrated management structures.

Promote Multilateral Cooperation

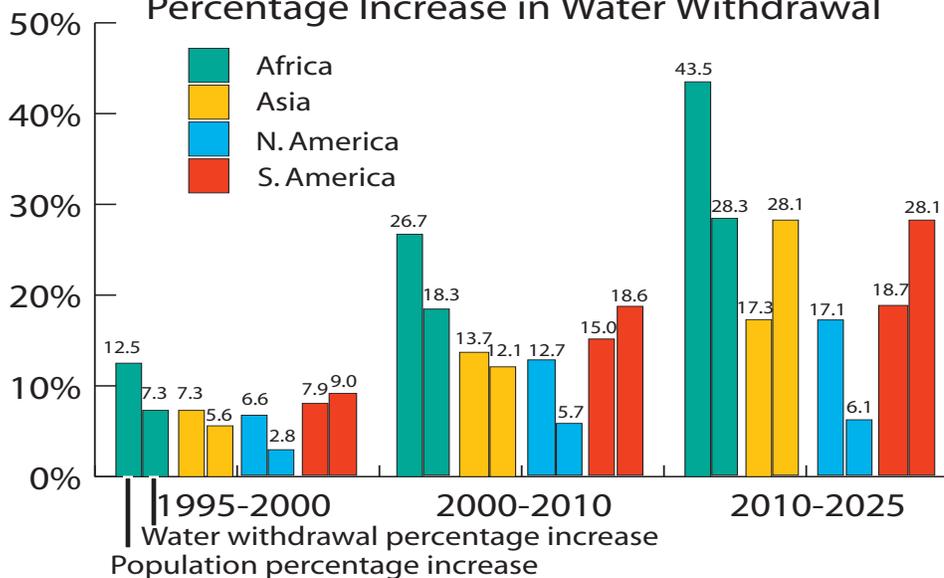
There are over 260 river basins across the world shared by two or more countries and thirteen basins flowing through five or more countries. 40 percent of the world's population lives near these shared river basins. Despite continued warnings that water scarcity may lead to armed conflict in the future, evidence suggests that water could provide greater opportunity for cooperation. In order to avoid conflict, however, cooperative approaches must be holistic. In close consultation, nations and communities alike will have to work toward an inclusive, long-term vision of sustainable water usage.



Photos: Water For People (2004)

Reduce Supply-Demand Pressure

Percentage Growth in Population Vs. Percentage Increase in Water Withdrawal



Sources:
Population Statistics: UN Population Division (2002) - Medium Estimates
Water Withdrawal Statistics Source: Shiklomanov (1999)

Pollution and the Environment

Around the world, the quality of water is under assault by human waste, industrial wastes, heavy metals, and agricultural pesticides and fertilizers. Water contamination by human waste is the cause of 6,000 deaths each day, most of which are children under the age of five. The health risk is especially acute in rural areas. China and India are among the most polluted countries in the world, plagued with toxic rivers. Water contamination is not, however, confined to the developing world. In the United States, for instance, tens of thousands of synthetic chemicals that are released into the environment every year are not even monitored. As a result, the long-term trends for most contaminants, and their resulting effect on human health and ecosystems, are unknown.



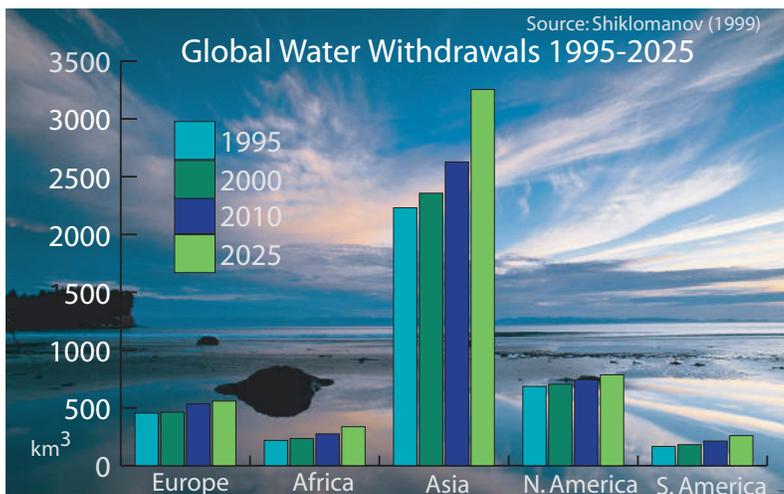
An extremely small percentage of the world's water is readily usable fresh water. Of the approximately 1.4 billion km³ of water on Earth, most is saline, frozen as ice, or locked underground, leaving only about 0.3 percent of the global water total as fresh water available for human use. Of that small percentage, over one-half is already being used by humans, leaving little available for ecosystems or for future human exploitation. A large proportion of the world's fresh water is located either in remote or sparsely populated regions. For instance, the Amazon River Basin contains about 15 percent of the Earth's freshwater runoff but supplies water to less than 1 percent of

the world's population. Because water resources are so unevenly distributed across the Earth, the average water availability for people from different global regions vary widely. Per capita water availability ranges from 180,000 m³/year in Canada, Alaska, and parts of Oceania to as little as 200-300 m³/year in North Africa and the Arabian Peninsula. These figures are especially striking when one considers that per-capita water availability below 1700 m³/year per capita is considered "water stressed" and under 1000 m³/year per capita is considered "water scarce," a threshold below which serious social, public health and economic problems arise.

According to the UN Task Force on Water and Sanitation (2003), close to half of all people in the developing world are suffering from one or more diseases directly associated with inadequate access to water and sanitation. These diseases include diarrhea (the leading killer of children), ascariasis, guinea worm, hookworm, schistosomiasis and trachoma. In 2001, it was estimated that trachoma accounted for 3.95 million years of blindness. By some estimates, 80% of all illnesses in developing countries are water-related.

HIV/AIDS has rightly been elevated as a global issue of strategic concern in the past five years. But many of the same areas of the world suffering from HIV/AIDS also lack clean drinking water. This causes severe complications. HIV/AIDS patients taking anti-retroviral drugs experience dehydration and need clean drinking water. Moreover, the immune systems of those suffering from HIV/AIDS are especially vulnerable to the many water-related diseases.

Reduce Supply-Demand Pressure



One-third of all people, spanning more than forty countries, live under water-stressed conditions. Looking forward, the bottom line is more people, less water. By the middle of this century, the number of people chronically short of water could skyrocket to 4 billion.

World population is expected to increase from the current 6.4 billion to between 7.3 to 8.4 billion people by 2025. That growth is expected to outpace expansion of available freshwater, leading to a per-capita decrease in resource availability. At the same time, the rate of global water withdrawal is rising rapidly. Withdrawal has risen almost seven times over the past century, from 579 km³ in 1900 to 3,973 km³ in 2000. Demand is expected to grow even

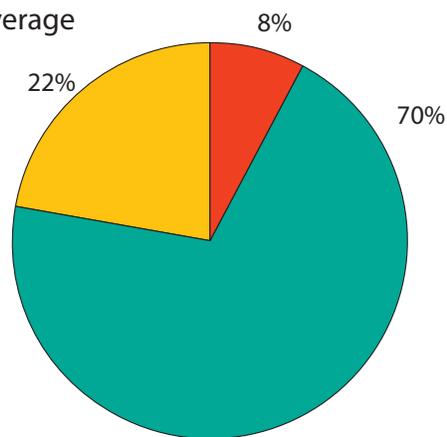
faster—to a projected 5,235 km³—by the year 2025. The Middle East, North Africa and sub-Saharan Africa are zones of extraordinary water stress, and are also undergoing dramatic demographic changes. They are home to some of the fastest growing, most rapidly-urbanizing populations in the world. The total global urban population without improved waterservices—including even a basic latrine—is currently 173 million but may grow by as many as 972 million over the coming decade.

70% of global water withdrawal goes to agriculture—the most inefficient sector. The UN claims that in the developing world, only 38 percent of water withdrawn for irrigation actually reaches the plants in the fields. Today, a mere 7 percent of the world's cropland is irrigated, producing more than one-third of the world's food. The UN Food and Agriculture Organization estimates that irrigated land will have to increase in area by 20-30 percent over the next twenty-five years in order to meet growing food demand. This represents a 14 percent increase in water withdrawals for the developing world. With competition over water rising between agricultural, industrial and municipal users, current farming practices are unsustainable. Future increases in food production must be achieved without drastic rises in water withdrawal. Improving water efficiency of agriculture and maximizing food output while minimizing water inputs will require better use of technology and management practices. One such technology is drip irrigation, a process in which water is fed through hoses or pipes under pressure and then dripped through holes or nozzles at the base of the crop. Water loss due to evaporation decreases to 5 percent.

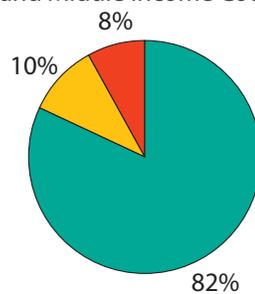
Water Use by Sector

Source: World Bank World Development Indicators 2001

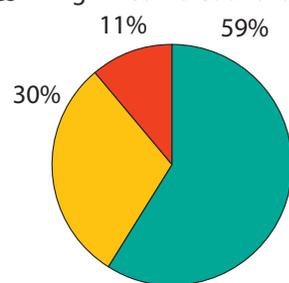
World Average



Low and Middle Income Countries



High Income Countries



Domestic Agricultural Industrial



U.S. Department of Agriculture

Support Infrastructure Development

According to a World Bank and IMF 2004 monitoring report, in order to meet the Millennium Development Goals, an additional 1.5 billion people will need to be served with clean water and 2 billion will need to be served with adequate sanitation services. Infrastructure spending – both

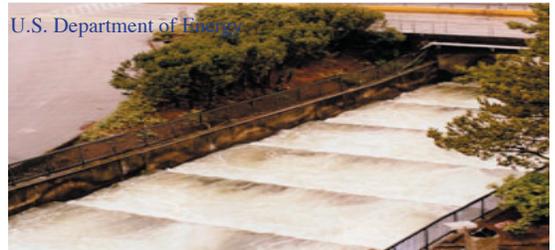
investment and maintenance – will need to increase by 3.5 to 5 percent of GDP in low-income countries and 2.5 to 4 percent of GDP in lower-middle-income countries. Expanding infrastructure and raising investment effectively will require integrated approaches that include governments, the private sector, and local communities. Water resource monitoring technologies that allow governments to take stock of natural water flows, usage, and pollution will aid in this process. Sandia National Laboratories is working



on the development of micro-chemical and nano-electrode real-time sensors aimed at monitoring pollutants in drinking and industrial process water distribution systems. Such systems, however, require well-trained professionals and expensive technologies to maintain. Partnerships involving capacity building and technological development between the developed and developing world will facilitate the expansion of these systems.

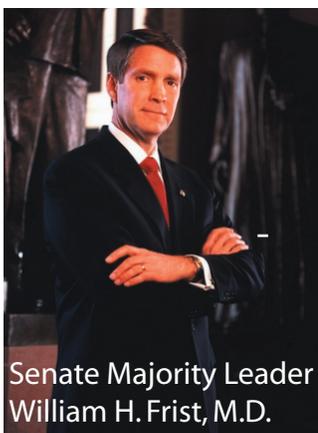
Water and energy are inextricably linked. The kinetic power of water is harnessed to produce electricity through hydropower facilities. Water is used as a coolant in both fossil fuel thermoelectric power generation and nuclear generation. Increased demand for energy equates to increased demand for water. Additionally, water technologies such as water desalination are highly energy-intensive, and are currently limited in their utility to areas where energy is cheap.

U.S. Department of Energy



Expand Financial Resources

At the 2003 G-8 Summit in Evian France, member states issued a statement that began with the declaration, "As water is essential to life, lack of water can undermine human security." The G-8 pledged to address global water challenges by taking these actions: (1) promote of good governance; (2) fully utilize all financial resources; (3) develop infrastructure by empowering local communities and leaders; (4) strengthen monitoring, research and assessment; and (5) reinforce the engagement of international organizations. Since the Evian Summit, however, no discernible progress has been made on this initiative. Without the help of these powerful, industrial nations, it is unlikely that improvements in the world's water situation will occur.



Senate Majority Leader
William H. Frist, M.D.

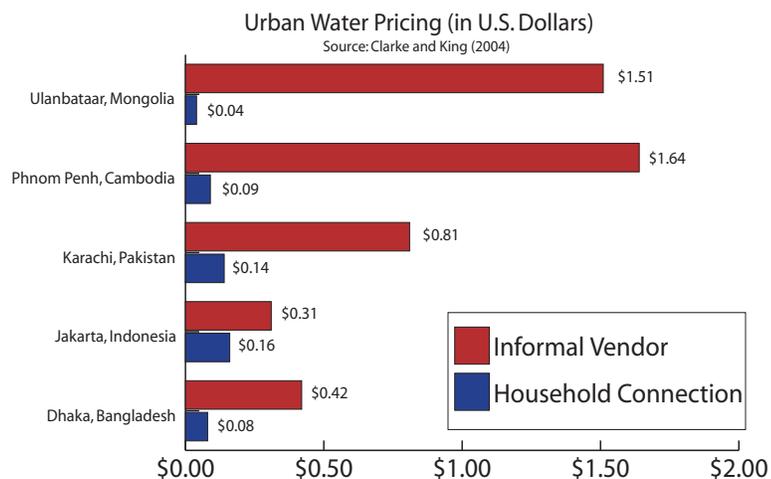
"The statistics are staggering ... [and] should alarm any person of conscience."

Senator William H. Frist, M.D. in a November 20, 2004 speech on water issues on the Senate Floor.

The private sector has a major role to play in both the management of water resources and development of new technologies. ITT Industries, for example has reduced maintenance and operating costs on its pumps by 30-50 percent, allowing more widespread application in the developing world. Procter & Gamble (P&G) has developed a product called PUR, a small packet of chemicals that can purify ten gallons of some of the filthiest water on Earth in about twenty minutes. The product retails for about ten cents a packet and P&G has provided it at cost around the world for disaster areas and humanitarian crises. Most recently, 15 million sachets were shipped to tsunami-affected areas.

Enable Market-Based Pricing

Rationalized global use of water is not possible when prices are subsidized and seriously distorted. Global water expert Sandra Postel estimates that the world's farmers seldom pay more than 20 percent of the real cost for water transported to their fields through government-run irrigation projects, which are often highly inefficient. Opponents warn that "real" pricing will result in water utilities ignoring the needs of poor communities or disproportionately increasing the burden on low-income families; but such strategies could actually improve and expand access. Already, the poor often pay the highest price for water in developing countries. Unregulated vendors sell water by the container at a significant markup to families not connected to distribution infrastructure.



Promote Multilateral Cooperation



Water sources are frequently transnational, and therefore seem a likely trigger for conflict. In addition to the many trans-border aquifers, there are over 260 river basins shared by two or more countries, and thirteen basins shared by five or more countries. Historic data suggests, however, that shared water resources have resulted in many instances of cooperation but few overt conflicts. Water negotiations and management solutions can and have been a route of interstate diplomacy for solving, not creating resource conflicts. But such a hopeful scenario may fade as water scarcity around the world worsens. Future cooperative efforts over water are dependent upon a major push to address water issues in the present.

Countdown to improve water conditions ...

- 5 Define and mobilize the organizational structures and procedures necessary to move the ball forward.
- 4 Mobilize technologies both existing and on-the-horizon; alleviate relentless demand pressures.
- 3 Rationalize the use of water according to market-based, supply-demand driven criteria.
- 2 Reduce the high human costs associated with lack of sanitation.
- 1 Improve conditions in water-stressed regions around the world.



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Through science and technology, people, infrastructure, and partnerships, Sandia's mission is to meet national needs in five key areas:

- *Nuclear Weapons* – ensuring the stockpile is safe, secure, reliable, and can support the United States' deterrence policy
- *Nonproliferation and Assessments* – reducing the proliferation of weapons of mass destruction, the threat of nuclear accidents, and the potential for damage to the environment
- *Military Technologies and Applications* – addressing new threats to national security
- *Energy and Infrastructure Assurance* – enhancing the surety of energy and other critical infrastructures
- *Homeland Security* – helping to protect our nation against terrorism

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