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Water, Population & Human Health: Confluence of Trends Threatens World Health

A June 24 Congressional forum co-sponsored by Harvard University Medical School's Center for Health and the Global Environment and the Environmental and Energy Study Institute, identified a number of trends that could converge in the first 25 years of the new century to adversely

affect world health and well being. Among the elements of this convergence are continuing rapid growth in population, especially in urban slums without adequate sanitation; worsening scarcity of fresh water for drinking and irrigation of food crops; and increased incidence

and mobility of waterborne and other infectious diseases. These trends have synergistic effects, which are expected to be worst in water-short developing countries with rapid population growth, but the United States and other developed countries will not be immune.

POPULATION GROWTH, WATER SCARCITY & FOOD

Robert Engelman, Director of the Population and Environment Program of Population Action International, pointed out that for most of human history, water scarcity was a temporary and local problem. But the problem has been broadened dramatically by shifting ratios of human beings to the amounts of fresh water available and need to irrigate crops, cool industrial processes and provide water for drinking, bathing and sanitation. "Where population growth is rapid, water scarce, and institutions weak," Engelman said, "the risks of conflict and disease are especially

acute." This theme was repeated in varying forms by the other speakers.

Beyond 2025, Engelman saw several hopeful signs. He said: "Over the long term there are two critical approaches that offer hope for resolving water scarcity: more careful and efficient use of the resource and an eventual end to population growth. Notable progress is being made in both these areas." There is even a prospect, he said, that at the end of the first century of the new millennium, world population may dip below the current level of 6 billion.

Dr. Sandra Postel, Director of the Global Water Project, Amherst, Mass., noted that water usage has increased six-fold since 1900, and despite new efficiencies in its use, a limit to supply expansion is very near. She said that because it is impossible in most countries to capture more than 30 percent to 50 percent of the annual runoff from rainfall, runoff must be two to three times higher than the amount required to meet irrigation, industrial and household demands. According to Postel, this amounts to an average of 1,700 cubic meters of runoff per person per year to avoid water stress. Water supplies are stressed in more than 40 countries. In India, water from the Ganges River is hardly reaching the sea because of upstream demand. The same conditions prevail for the lower Colorado River, the Tigris-Euphrates and the Nile. Central Africa is "well-watered," she noted, but scarcity conditions prevail in the north, east and south. Some rivers in China are under stress, despite the abundance of water in other regions. Although inadequate runoff can be

BRIEFING PANELISTS

Robert Engelman

Director, Population and Environment Program, Population Action International;

Dr. Sandra Postel

Director, Global Water Policy Project, Amherst, Massachusetts;

Dr. Timothy E. Ford

Associate Professor of Environmental Microbiology, Director, Program in Water and Health; Harvard School of Public Health;

Dr. Mary Wilson

Assistant Professor, Harvard Medical School and Harvard School of Public Health and Chief of Infectious Disease, Mt. Auburn Hospital, Cambridge, MA.

supplemented by groundwater, aquifers in most water-short areas have been “overpumped” to such an extent that their levels have dropped precipitously.

Most of the scarcity, she pointed out, is occurring in areas where population growth is greatest. There are currently 470 million people in Africa, Asia, and the Middle East who are living in water-stressed countries (less than 1,700 cubic meters per person per year) and this figure is expected to rise to more than 3 billion by 2025.

Postel pointed out that worldwide, more than 200 rivers flow through two or more countries, but international law provides only vague guidance on how to share these rivers equitably, and treaties for the sharing of water are virtually nonexistent. In areas of water scarcity this creates what she referred to as “hot spots”. For example, tensions over water persist in all the major river basins of the Middle East as populations grow rapidly.

A major reason for the tension over water scarcity is concern about food security. Lack of adequate water is a crucial barrier to food self-sufficiency

for many countries. Food production, Postel noted, is water-intensive and two-thirds of the water drawn from streams and lakes is for agricultural uses. Of the 34 countries in Africa, Asia and the Middle East with less than 1,700 cubic meters per capita of annual runoff, only South Africa and Syria do not import grain, and 70 percent of these nations import at least 20 percent of their grain. Israel imports 40 percent. Since grain requires approximately 1,000 cubic meters of water for each ton of production, its importation is one way to offset agricultural water scarcity.

Postel used the term “virtual water” to describe this process of substituting grain importation for water, noting that water scarcity could account for one-fourth of the global trade in grain. But she hastened to add that virtual water is not a complete solution to water scarcity due to the limited ability of poor water-stressed nations to pay for imported grain. Consequently, a more equitable distribution of food must be found to meet the nutritional needs of poor water-stressed nations.

Building large dams is not a satisfactory approach either, Postel maintained, because they are a primary

contributor to deterioration of water quality, destruction of fisheries, extinction of species and other damage to the aquatic ecosystems on which human life depends. Less destructive measures to increase water use efficiency on crop lands are essential she said, citing as examples small-scale water harvesting, terracing and other means of channeling and storing rainwater, as well as improving irrigation efficiency. She noted that researchers at the International Irrigation Management Institute in Sri Lanka had found that water use was reduced by 25 percent when rice fields were not flooded prior to planting. Drip irrigation systems which deliver water directly to the roots of crops and low pressure sprinklers also produce substantial water savings, she said. But, unfortunately, such measures have spread slowly because of high initial capital costs, relatively low crop prices and, at least in the U.S., government subsidies that artificially lower irrigation water prices. Postel also expressed concern over the current effort in Congress to repeal provisions in the 1992 Energy Policy Act that mandated more efficient plumbing fixtures, such as low-flow shower heads and toilets.

URBAN SLUMS, WATER INFRASTRUCTURE & DISEASE

Dr. Timothy Ford, Associate Professor, Harvard School of Public Health and Director, Program in Water and Health, pointed to the worldwide increase of urban slums as “a potential public health disaster.” Over the next 25 years, some 90 percent of the increase in urbanization is expected to occur in developing nations, where 90 percent of water and sewage is untreated. Where it exists, the infrastructure for urban water and waste water treatment is usually inadequate because it was

designed for much smaller populations. Even in developed nations, such as the U.S., aging systems and the emergence of new microbes threaten the health of millions. According to Ford, proliferation of waterborne disease is an inevitable consequence of inadequate water and sewage treatment.

Much of the delivery system of pipes for both water and sewage in this country is aging. Many systems

contain sections of pipe that are over 100 year old. Cross sections of distribution system pipes show large buildups of slime (Biofilm), which actually protects microorganisms from disinfection. In addition, corrosion due to the age of the systems can lead to breakage that mixes sewage waste with drinking water.

Ford cited statistics from the Centers for Disease Control and Prevention, which counted 405,366 cases of waterborne disease in 1993-

1994. This number included the Cryptosporidiosis outbreak in Milwaukee, which is believed to have infected 403,000 individuals, even though Milwaukee had a high quality treatment system. The 2,366 remaining cases provide a highly skewed view of the incidence of waterborne diseases because of underreporting of problems from E. Coli and viruses, which are seldom reported to authorities. Other disease organisms thought to be greatly underreported include Salmonella, Shigella, Campylobacter and Giardia lamblia. Even relatively well-maintained water delivery systems may provide environments for growth of organisms such as Legionella, the Mycobacteria and other opportunistic pathogens.

Dr. Mary Wilson, Assistant Professor, Harvard Medical School and Harvard School of Public Health and Chief of Infectious Disease, Mt. Auburn Hospital, Cambridge, Mass., crystallized the confluence of five factors relating to population: size, density, location, mobility, and vulnerability. All influence the presence and spread of infectious diseases. She pointed out that the current volume, speed and reach of both travel and commerce is unprecedented in human history and is reshaping the spread of infectious diseases.

Urbanization, and especially growth of periurban slums in tropical and developing countries, crowd people together under deteriorating sanitary conditions and create an environment where infections can rapidly reach large populations. Infectious diseases are the most common cause of death in the world today. Globally, one of every two deaths in children and young adults is caused by just six infections: AIDS, malaria, tuberculosis, measles, diarrheal diseases, and acute respiratory infections. Many important

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diarrheal infections are spread by contaminated water.

She said 65 percent of infectious disease deaths globally are caused by pathogens that are spread from person-to-person; 22 percent are caused by food, water and soil borne infections. Disease vectors thrive in urban slums, she noted, characterizing these areas as "a bug's dream come true." The number of megacities with populations exceeding eight million is expected increase from 20 in 1990 to 33 in the year 2015.

The highest rates of population growth are in the poorest regions, many in tropical or subtropical areas without adequate sanitation and clean water. Urban centers draw workers from rural areas, providing a conduit for the movement of pathogens between urban and rural regions. Cholera is among the infections commonly spread by contaminated food and water. While only 384,000 cases of cholera were reported to authorities in 1995, researchers have estimated that six million occurred. During an outbreak of cholera that began in Peru in 1991 and which continues sporadically in Latin America to this day, an estimated one million cases led to 10,000 deaths through 1994.

Global travel, including migrations due to war, politics and natural disasters, brings new "microbiological baggage" into areas where populations

are vulnerable. Global commerce allows pathogens to hitchhike on airplanes and in the bilges of ships. Cities everywhere are linked by airports to the world at large. About 5,000 airports have scheduled worldwide service. In 1996, 2.5 billion people passed through airports.

The growing population is exposed to an increasingly diverse range of viral strains, Wilson said, adding that large populations provide abundant hosts in which viruses and other microbes can replicate, mutate, recombine and exchange genetic material. As illustrated by the dengue virus, population expansion is linked with increasing viral diversity. Importantly, also, the age structure of the population is shifting toward increasing numbers of vulnerable elderly persons. An expanding number of people have compromised immune status because of HIV, chemotherapy and other medical conditions.

Antibiotics saturate our environment, she said. In the U.S., about 40% of antibiotic use is in animals, including aquafarming. This contributes to the emergence of antibiotic resistant strains of disease-causing organisms, a problem also emphasized by Dr. Ford. Dr. Wilson also noted that many infections are profoundly influenced by temperature, humidity, and climate. Extreme weather events and changes in climate can be expected to affect some infectious diseases.

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