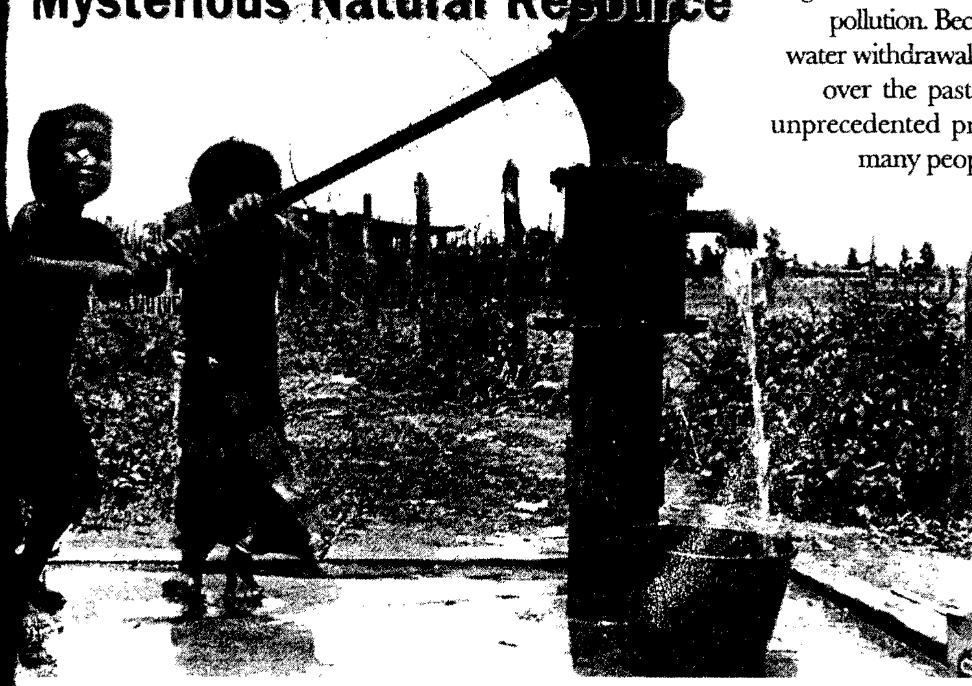
Tapping Technology...

... And Harnessing this 'Rather Mysterious Natural Resource'



UN Photo 133614/Carl Purcell

By David Seckler
Director-General of the International Water Management Institute, Sri Lanka

A study by the International Water Management Institute indicates that by the year 2025 about one third of the population of developing countries–some 1.3 billion people–will live in areas of chronic water scarcity. This means that even if they fully develop their water resources, they will not have enough water to maintain even the 1990 per capita levels of use for agricultural, domestic, industrial and environmental purposes. In most cases, 1990 levels of per capita water use are already too low for adequate health, environmental quality and economic development. Many of the countries in this category will have to withdraw water from agriculture and rely on food imports to meet their needs. Some of them can afford this, many cannot. An additional 500 million people, mainly in sub-Saharan Africa, will experience acute water scarcity. They potentially have sufficient water resources to meet reasonable standards of per capita use, but the costs of actually developing this much water are likely to be prohibitive. Of course, as in all cases of extreme scarcity, poor people will suffer the most.

With this outlook, the task of conserving water through better technology, demand management and by other means becomes especially important. Since agriculture consumes over 80 per cent of all the developed water supplies of the world, people are naturally interested in conserving water in this sector. Most of the world's irrigation is by traditional gravity irrigation systems that have an average application efficiency (henceforth, unless otherwise noted, simply "efficiency") of only 45 per cent. In contrast, sprinkler, level basin and surge systems have efficiencies of around 70 per cent, and drip systems can attain efficiencies of 90 per cent. Much the same is true in the other sectors.

Low-flow toilets and showers are twice as efficient as conventional devices. The industrial sector has already made great advances in increasing efficiency, mainly to control water pollution. Because of technological and other changes, total water withdrawals in the United States has actually decreased over the past decade, while the economy has enjoyed unprecedented prosperity. These considerations have led many people to believe that with appropriate policies, such as pricing water at full marginal cost, sufficient water can be conserved and saved to meet most if not all future needs. But water is a rather mysterious natural resource where not all is as it might appear to be.

This fact may be illustrated by briefly comparing conservation in water with conservation in the energy sector. When an energy device such as an engine or a boiler is inefficient, all of the wasted energy is truly lost to the system in the form of waste heat to the atmosphere. Indeed, one of the principle ways of increasing energy efficiency is by capturing this waste heat and using it to produce more energy, as in co-generation plants, or other useful applications such as heating buildings. These "combined cycle" systems effectively recycle the energy in the form of heat that would otherwise be lost to the system. They do not change the efficiency of the parts of the system, the engine or boiler, so much as they change the system efficiency of all the parts together.

In an inefficient water system, however, the water that is not utilized in one particular use is not necessarily lost to the system as a whole, that is, the river basin. Instead, the outflow of water from one use is likely to become the inflow of water to another use. In irrigation, for example, it is rightly said that one farmer's drainage is another farmer's water supply. In other words, water resource systems tend to be naturally recycling systems. Because of this, high-system efficiency is frequently attained although all the parts of the system are inefficient.

Egypt provides some interesting examples of the difference between application and system efficiency in water resources. Studies have demonstrated that the average application efficiency of irrigation water applied to farms in Egypt is only 45 per cent. But much of the outflow of water from these farms re-enters the system and is recycled by downstream farmers or by other users. Thus, the system efficiency of the irrigation sector as a whole is around 80 per cent, and that of the entire system, including all the sectors and beneficial discharge to the Mediterranean, is over 90 per cent. In this situation, investing heavily in high-efficiency irrigation technology would make hardly any difference at all to Egypt's water supply and utilization in most cases. Much the same is true of the domestic and industrial sectors in Egypt. Most of the outflows from these sectors return to the Nile system where it is recycled.

In upstream areas like Cairo, low-flow showers and toilets would not result in real water savings. But in areas like Alexandria, next to the Mediterranean sea, the outflows are truly lost to the sea, and high-efficiency technologies in all the sectors would result in real water savings.

Thus, in water there is an important difference between real and only apparent or paper water savings. The difference depends on what happens to the outflow from an application. If it is beneficially recycled, then increasing efficiency is likely to produce only paper water savings. If, however, the outflow is truly lost to the system through non-beneficial evaporation or flows to sinks, such as internal or external seas and saline aquifers, then high-efficiency systems can result in real water savings.

There are other advantages of high-efficiency systems. They can reduce water pollution, whether of salt, fertilizer and pesticide residues in irrigation, or domestic and industrial waste in those sectors. They reduce the amount of water that must be diverted from a source to serve applications and thus leave more water in lakes, reservoirs, rivers, etc., for environmental and other uses. High-efficiency irrigation systems provide greater control of plant-soil-water relationships, frequently resulting in increased crop yields of 20 to 50 per cent. All of these effects support the use of high-efficiency systems, quite apart from their direct contribution to water conservation.

However, in one important area, these high-efficiency systems could produce highly counter-productive effects: groundwater supplies. In India, for example, over one half of the total irrigated area is in pump irrigation, and nearly all of the drinking water for the rural population is from groundwater. In many areas of India, groundwater tables are falling by one meter or more per year. This threatens the only supply of reasonably sanitary drinking water in rural areas and the single greatest source of food production in the country. Nor is the groundwater depletion problem confined to India; it is rapidly becoming a universal problem in the arid and semi-arid regions of developing countries.

The solution to this problem does not lie in restricting withdrawals of groundwater; this merely reduces the supply of the most valuable water to needy people. Rather, groundwater supplies must be recharged through surface water that would otherwise be wasted. But this is not an easy task. Surface water must either be treated to potable quality before pumping it into aquifers to avoid pollution of the aquifers, or allowed to slowly percolate through soils to be naturally purified. However, treatment is prohibitively expensive, and natural percolation and purification require vast areas of land recharge facilities.

Irrigated areas have historically filled this role through deep percolation flows of irrigation water from surface areas to the aquifers. But, by definition, these deep percolation flows only occur in inefficient irrigation systems. It is no accident that many of the areas with the highest rates of depletion are areas with high-irrigation efficiency. Here is a clear case where high-application efficiency leads to low-system efficiency.

Another, and perhaps the most important, way to achieve water conservation in agriculture through technology is indirectly by increasing crop yield per drop of water consumed. The Green Revolution increased average yields per unit of land by about two and one half times, and decreased the length of the growing season. Together, these effects amount to a 330 per cent increase in the agricultural productivity of water. Or to put it the other way around, more than three times as much real water would be required to achieve today's food production had the Green Revolution not occurred.

In sum, there is great potential for achieving water conservation through technology and other means. In some cases, as in the Green Revolution, water conservation may arise by unintended and even unexpected means. In other cases, where outflows are beneficially recycled, measures that appear to conserve water may result only in paper water savings at substantial cost. And, if one is not careful, one can create counter-productive, even catastrophic, effects in this field, as in the case of groundwater depletion. Water conservation is a tricky business, but it is one of the most important and interesting things we can do. ❑

Point of Fact: **The environment's impact on health is a high World Health Organization priority, particularly in the development of community water supply and sanitation facilities within the Africa 2000 initiative, which establishes partnerships between national governments, external support agencies, NGOs and the private sector. Nearly 400 million people on the continent do not have access to safe water and nearly 3 million die each year from water and sanitation-related diseases. Already, 38 countries have designated focal points for the initiative and 34 of them have begun implementation of projects within its framework ... notable progress given that the first Africa 2000 regional consultation was convened less than three years ago.**