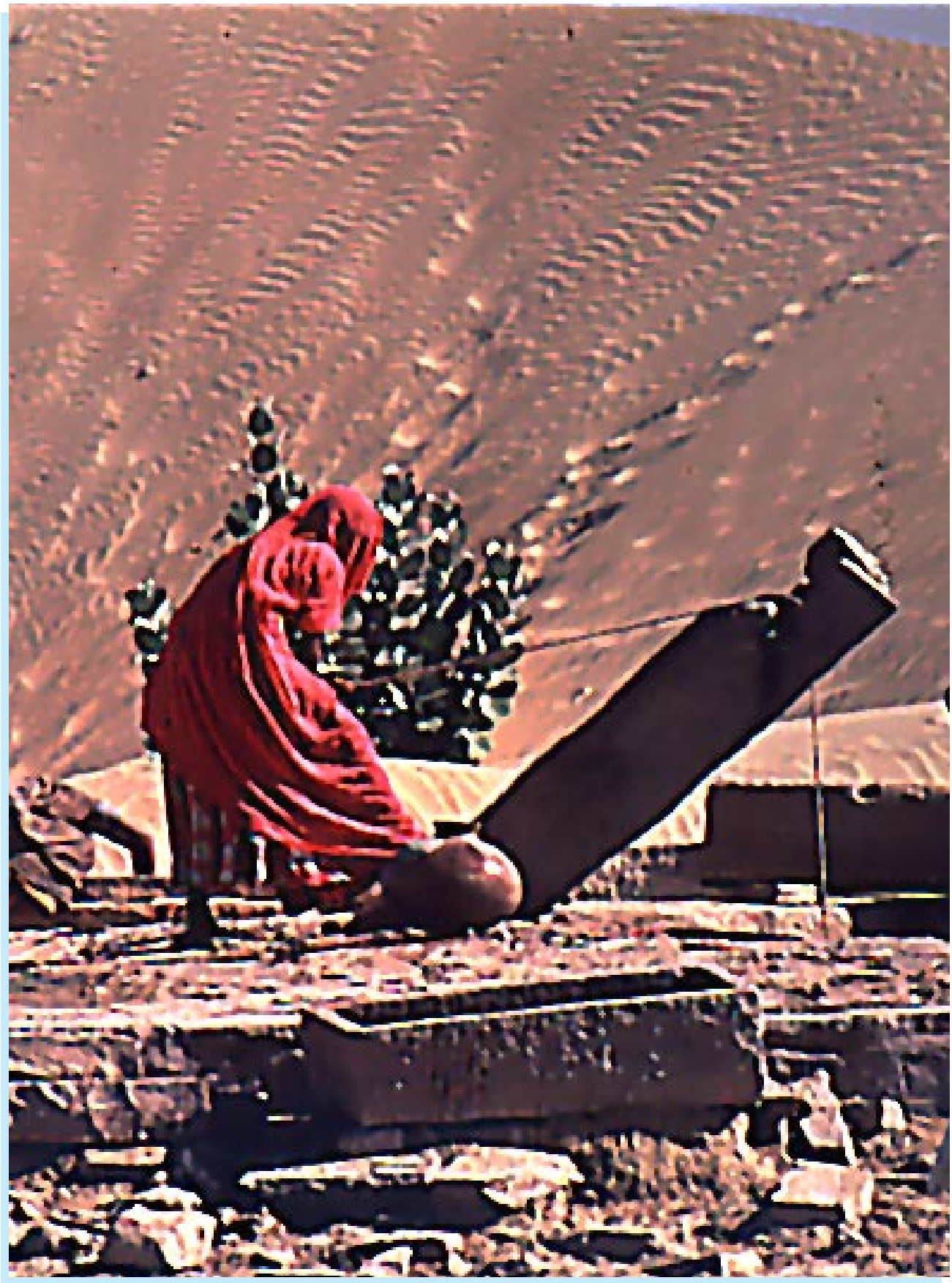

Better management of the world's fragile water resources and reducing pollution of water supplies are priorities for a sustainable future.

ESTs for water conservation 10

Serious problems of water availability and quality pose a threat to future development in some areas of the world, as well as threatening continued economic growth in the industrialized countries. It is necessary to reduce pollution of existing supplies and to cut back on water usage. Environmentally sound technologies can play an important role in achieving both objectives, including in the key area of agriculture, and industry is under pressure to give priority to these issues.

World demand for fresh water, by industry, farming and households, is growing faster than the supply available. While there are about 1,400 million cubic kilometres of water on Earth, only 2.5 per cent is fresh water, and only about 0.5 per cent is readily available for human consumption from lakes, reservoirs, rivers and surface ground-water. In its *Global Environment Outlook 1997* (GEO-1) report, UNEP warned that water resource issues will be the major impediment to further development in several regions, and noted the likely future problems from competing demands. The World Business Council for Sustainable Development (WBCSD) has voiced concern that industry could suffer water use restrictions because governments will give priority to other needs. It is expected that within the next few decades major international problems will be sparked by the sharing of fresh water resources.

Water has become a critical issue on the global sustainable development agenda. The focus is on managing resources more efficiently by improving the quality of water supplies and easing the pressure of demand, particularly by industry and agriculture, the two heaviest users. These objectives are linked: if there is less pollution and contamination of supplies, there will be more cleaner water available, especially for domestic consumption. Similarly, if industry can re-use more of the water it currently uses, it will need to consume less overall.

Environmentally sound technologies (ESTs) can play a key role in meeting both objectives. In fact, companies are paying increasing attention to water pollution issues. They are taking advantage of the wide variety of technologies available to improve water quality by controlling industrial waste discharges, as well as to treat wastewater so that in many cases it can be re-used safely (see Chapter 6). Membrane-based treatment technologies have emerged in response to the demands for more pretreatment and production of clean water. They work by separating contaminants on the basis of their molecular weight and size: for example, ultrafilters reject oily substances over a range of concentrations, and reverse osmosis (well established in desalination projects for a number of years) rejects ionic impurities. Moreover, as industries move progressively towards adopting cleaner production and eco-efficient techniques and technologies, much of the current pollution will be prevented at source. However, using high-tech solutions can, in some situations, create problems. For instance, water purification by reverse osmosis is very costly and requires a large amount of energy. So, there are disadvantages as well as advantages to using technologies that appear to be environmentally sound.

BOX 10.1

Water conservation in China

China ranks sixth in the world in the total amount of its water resources, but only 88th in terms of fresh water per capita. Currently, demand is outstripping supply. Industrial waste is one major reason for water shortages in many areas: the rate of water re-use by industry generally is less than 30 per cent.

A series of water conservation measures in recent years have increased the rate of industrial water re-use greatly. For example, cities like Datong, Zibo and Baotou have water re-use rates of 92.8 per cent, 91.7 per cent and 88.1 per cent respectively, while average annual water consumption by industry in Beijing was reduced by over 6 per cent between 1978 and 1984. How was this reduction achieved?

Cooling water represents 70 per cent of total industrial water use. The introduction of closed cooling water systems means that industries can re-use much more water, while reducing effluent discharges. Various industries have also adopted non- and low-waste processes, and multi-purpose closed recycling systems. In the electro-plating industry, for instance, 99 per cent of washing water is recovered by using countercurrent washing evaporation and recovery-ion exchange. Wastewater from oil extraction can be recharged underground after treatment and closed recycling processes in coal washeries have dramatically reduced the amount of discharged wastewater.

In industry in the developed countries, there is a trend towards improved water use. French industry, for instance, reduced its demands for water by 12 per cent between 1984 and 1990, and globally, industries like oil, and pulp and paper, have reduced their discharges by nearly 70 per cent. In addition, industry groups like the WBCSD accept that industry must contribute to developing new water management policies and initiatives, many of them involving environmentally sound technologies. One particular problem to be tackled is the use of water in megacities, which swallow enormous amounts of water. The amount that is wasted is huge, primarily due to the lack of basic household ESTs for water conservation. Small-scale technologies, including those for lavatory cisterns and showers, can have an important impact.

Agriculture

Worldwide, agriculture is the major user of water, accounting for 70 per cent of global water use (up to 80 per cent in some individual countries), which is primarily for irrigation. Irrigation has been a cornerstone of global food production, allowing huge areas of the Earth's sunniest, warmest and most fertile lands to become important crop-producing regions. However, there has been a heavy price to pay in water usage and water wastage, as the efficiency of irrigation systems averages less than 40 per cent. In many large surface-water systems, less than half the water diverted from reservoirs actually benefits crops. Much seeps through unlined canals, while an additional amount runs off the land or percolates unused through the soil because farmers apply water unevenly, excessively, or at the wrong times. Waterlogging and salinization are also serious problems in China, India, Russia and the United States.

A 10 per cent improvement in irrigation efficiency would release a substantial volume of water for other uses, and substituting marginal for high-quality water would produce similar benefits. The technologies exist to achieve these gains but, as the Food and Agricultural Organization of the United Nations (FAO) reports, while "many of the technical solutions have been produced and implemented in the developed countries, adoption has been slow in most developing countries, mainly because of their cost and complexity".

Technologies and systems

Adopting modern technologies and better management practices, including using simple low-tech systems, is the answer. A few of these technologies and systems are discussed below.

- Low-energy precision application systems which deliver water closer to the ground and in large droplets, cutting evaporation, can be 90 per cent more efficient than surface irrigation. Large sprinklers can be made

more efficient by attaching vertical drop tubes to the sprinkler arm.

- Surge flow irrigation, the intermittent application of water to furrows or borders, creating a series of on and off periods of constant or variable time spans, has a reported efficiency of 70 per cent or more. Its use has grown rapidly in the United States, although it still needs to be adapted to farming conditions in developing countries.
- In many developing countries, the critical need is to improve the performance of canal systems. Studies in the Philippines have shown that when farmers actively participate in the planning and management of projects, canals and other infrastructure work better, more land gets irrigated and rice yields are higher.
- Yields can also be improved by simple techniques to increase soil moisture in the root zones of crops. For example, farmers can build check dams of earth and stone to capture runoff from hillsides, and then channel this water to their fields. These simple practices work. In India, a watershed management effort involving about 600,000 hectares, nearly a third of the cultivated area, was based on low-cost techniques used by farmers to increase soil moisture in their fields, and cropping intensity was reported to have doubled.
- The Environmental Defense Fund in the United States says that a variety of proven small-scale techniques collectively offer a viable, environmentally sound alternative to large irrigation projects. It calculates that even the most expensive small-scale methods, including small reservoirs to store rainfall, percolation tanks to replenish groundwater, and check dams to increase rainwater productivity, cost less than half as much per hectare as irrigation from a huge dam would cost.
- Another need is to make increasing use of treated urban wastewater for irrigation, returning valuable nutrients to the land and helping to keep troublesome pollutants out of rivers and streams. Israel is re-using 35 per cent of its municipal wastewater, mostly for irrigation. Already more than 15,000 hectares

BOX 10.2

Permaculture in Australia

The Environmental Technology Centre at Murdoch University, Perth, Western Australia, practises permaculture (sustainable agriculture) in an attempt to grow an integrated food forest in seemingly unfavourable conditions.

The coastal plain of Perth is a series of alluvial sand dunes, which means the 'soil' is deep infertile sand with minimal water holding capacity, and while rainfall is a moderate 800 millimetres a year, most of it falls in the three months of winter, leaving the summers long, hot and dry. Good quality groundwater is available at modest depth.

Permaculture entails reducing the current reliance on annual grasses and replacing them with perennial trees and shrubs which provide both food and soil building material. The over-clearing of native trees for wheat production in Western Australia has caused soil salinity and poor, easily eroded soil structure, forcing farmers to rely almost entirely on superphosphate fertilizer for plant nutrients.

The 2-hectare project also grows plants for windbreaks, mulch, nitrogen fixation, timber production, for attracting birds and insects, and for micro-climate control. These various elements are zoned, so that those requiring the most attention are located close to the office, while those needing less attention, such as the mixed orchards, nut trees, timber trees and mulch producers, are placed increasingly further away.

To improve the soil structure and water holding capacity, waste organic material from various sources was brought in initially and spread on the soil. Brewery waste, for instance, was used extensively, while the local municipality supplies mulched tree prunings from local parks and gardens. Mulch, now grown on site, is critical to retaining water in the dry summer and, when combined with 'dripper' irrigation, produces a healthy soil and minimal water losses through evaporation.

Natural granite and dolomite rock dust and 'green manure' are used instead of artificial fertilizers. Leguminous species are interplanted throughout to fix nitrogen in the soil and to provide mulch. Once established, the gardens are self-fertilizing and pesticides are not used. Apart from rainfall, all water on site is supplied from pumped groundwater: some of it is used to irrigate the growing areas. The dripper irrigation pipes allow watering in windy conditions, or during the heat of the summer days.

Aguas Argentinas

Improving quality of life with new solutions

At a time when water is one of the most urgent sustainable development challenges, Aguas Argentinas is carrying through one of South America's most important urban management projects ensuring that over the next 30 years, ten million people receive clean drinking water.

The company is part of a consortium of seven national and international partners, led by Suez-Lyonnaise des Eaux, which four years ago was awarded a concession to upgrade, renovate and expand existing infrastructure of water and sewage systems. Aguas Argentinas is the franchise holder for Buenos Aires and its suburbs, reaching a population of ten million.

Since 1993, US$1.02 billion has been invested and rapid progress made on renovating, redeveloping and extending the water and sewage network. The results to date:

- a new water treatment system handling 300,000 m^3 a day has achieved a 37 percent increase in drinking water production capacity;
- an extra 1.6 million people are receiving safe drinking water, bringing the total served to 7.6 million;
- 800,000 more people have been linked to the sewage system, bringing the total to 5.8 million.

The largest infrastructure projects currently under way include:

- A Drinking Water Transportation Tunnel to supply West Buenos Aires with a capacity of 36,000 m^3/h, a length of 15.3 kilometres and a diameter of 3.5 metres, being constructed 30 metres underground.
- Construction of a new North Wastewater Treatment Plant. First module will be operational during 1998 to cover the needs of 270,000 people. The complete project will meet the needs of 1,100,000 people.
- Enlargement of Southwest Wastewater Treatment Plant. The first stage will increase capacity by 40 percent to meet the needs of 500,000 people. The final project will serve 2,000,000 people.
- Aguas Argentinas has developed a new remote-controlled cleaning system to clear the waste that has built up in the main sewage collectors of Buenos Aires. The first five kilometre section was cleaned during 1996. This new technology allows the cleaning operations to be performed without creating odour or noise, dramatically improving the performance of the wastewater systems.

In four years, Aguas Argentinas has rapidly improved water quality to meet stringent international standards, achieved consistency in production levels, installed procedures to track service quality and developed a massive training effort for employees to focus on customer satisfaction.

In addition to completing the development of infrastructure to serve ten million people, Aguas Argentinas is also working to induce essential cultural changes in the population – such as increasing responsibility for the environment and a prudent use of natural resources. It is presently developing a major educational programme for elementary schools within the Concession area. The programme aims at making the children aware of the importance of water as a vital resource. It offers a basic idea of water waste and environmental sanitation. By the end of 1997, the programme had reached approximately 300,000 children.

Aerial view of General San Martín water treatment plant (*left*)

Aerial view of General Manuel Belgrano water treatment plant (*right*)

Reconquista 823 (1003) Buenos Aires, Argentina. Tel: (54-1) 319-0800/0999

are irrigated with the reclaimed water, and the authorities plan to re-use 80 per cent of the country's total wastewater by 2000.

Chemical pollution

Modern agriculture affects water quality through the runoff of fertilizers, pesticides and soils into surface waters, and the leaching of fertilizers and pesticides into groundwater. In order to protect the quality of both surface water and groundwater it is necessary to reduce the amounts of chemicals being used. Two promising approaches have been developed and are briefly discussed below.

- Integrated pest management (IPM) employs a wide range of pest-control methods including growing pest-resistant varieties of crops (for instance, a variety of maize has been bred that confers resistance to seven major diseases); introducing populations of natural enemies; using pest diseases and insect hormones; practising crop rotation; and using various tillage techniques. A carefully timed and judicious application of conventional pesticides reduces chemical use, which in turn decreases polluted runoff and leaching, so improving water quality. For example, FAO's rice IPM programme has reached about 600,000 farmers in Asia, cutting pesticide usage by up to two-thirds, increasing yields, and reducing water and land pollution.
- Integrated plant nutrition systems (IPNS) aim to improve the efficiency of plant nutrient supply to crops through using on- and off-farm sources of nutrients more effectively. IPNS also helps to improve the productive capacity of the soil through sustainable agricultural production. According to FAO, IPNS may "significantly" reduce the need for mineral fertilizers by providing "timely and sufficient" supplies of plant nutrients and reducing plant nutrient losses on cropping systems. One benefit is the reduction in fertilizer runoff, thereby minimizing the pollution of surrounding water resources.

> "It is more urgent than ever to endow the multilateral institutions and mechanisms with the financial means to ensure a transfer of technology and substantial aid to the countries needing it"
>
> His Majesty Hassan II,
> King of Morocco

> "Eco-efficiency, access to clean and environmentally-friendly technology and actions to address unsustainable consumption and production patterns must be adopted as international priorities"
>
> Gert Hanekom, Minister of Environment and Tourism, Namibia

IPM and IPNS are two emerging approaches to sustainable farming that impact directly on water quality. According to FAO, there will be an increasing take-up of new technologies, initially in developed countries, and the result will be "new or better tools for technology development in developing countries, and some of the technologies for developed country markets will be directly usable". The World Resources Institute (WRI) says the way to protect the resource base on which agricultural production depends, including good quality water supplies while increasing agricultural production to feed more people, is through a combination of cutting-edge high technology and the tried-and-true methods of the past.

sabesp

Companhia de Saneamento do Estado de São Paulo

LEADERSHIP IN WATER AND WASTEWATER SOLUTIONS

As the biggest environmental sanitation company in Latin America – and one of the largest in the world – Sabesp is contributing to a better environment within the region. Operating water and waste systems in São Paulo – Brazil's largest and richest state – Sabesp's products and services are bringing the benefits of a cleaner, safer environment to more than 22 million people.

But the company is more than a major source of water for the population. As a leader in the field of water and wastewater treatment, Sabesp has won international recognition, and with its state-of-the-art technology supported by highly-trained, expert engineers and technicians, the company assists other Latin American countries in finding solutions in various key environmental areas.

There has also been a marked turnaround in Sabesp's economic situation. Today, under new administration and thanks to the introduction of a modern dynamic management system based on co-participation, the company has become a benchmark of success and efficiency amongst suppliers of sanitation infrastructure services.

The results speak for themselves. In 1995, Sabesp earned a profit of more than US$26 million and, with the company now open for private investment, Sabesp is seeking to raise more than US$650 million in private-sector financing over the next four years.

The management of Sabesp is committed to environmental leadership. With its plans to invest more than US$3 billion in the short-term and around US$5 billion through to the next millennium, the company will be financing and developing new projects in one of the world's largest water and wastewater markets.

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Sanitation

Poor sanitation, a major cause of the degradation of groundwater and surface water, is an especially acute problem in developing countries, which cannot afford to provide every dwelling with individual piped water and sewerage connections. The focus there has been on developing viable alternatives, including those described below.

- Effluent sewerage is a hybrid between a septic tank and a conventional sewerage system. A tank, located between the house sewer and the street sewer, retains the solid wastes, thereby allowing smaller sewers to be laid at flatter gradients and with fewer manholes. These systems have been widely used in small towns in Australia and the United States, and in India, Latin America and parts of Africa.
- Simplified sewerage was developed in Brazil, where it is routinely used. It allows smaller, shallower, flatter sewers with fewer manholes. It works as well as conventional sewerage, but costs about 30 per cent less.
- The condominial system was developed and applied in northeast Brazil. It comprises shallow, small-diameter backyard sewers, laid at flat gradients, and costs about 70 per cent less than a conventional system.

A key issue

Some of the issues connected with the use of ESTs in other areas also apply, inevitably, to their role in the better management of freshwater resources. For instance, there are economic barriers to technology transfer. The fact that most technologies are owned by private companies makes it more difficult for them to be spread to new users. Training for local authorities and communities is vital, so that they can understand the problem of water conservation and the role of ESTs. Here, technology assessment, including the selection, adoption, application and operation of ESTs, is an important tool for decision makers to find and select the most appropriate technology. Pricing is certainly another key issue: water can no longer be provided as a free commodity. Maintaining water sources and supplies to control the quantity and quality are also essential. For example, in many countries, as much as 60 per cent of the water for distribution is lost through the pipes before it reaches the user.

Water has now emerged as a key issue, in both industrialized and developing countries, because it is a major factor in the process of industrialization. In developing countries, there is severe pressure on available supplies which can have a serious impact on water quality. In countries without guaranteed access to water industrial progress can be slowed, and even stopped. Industry fears that, increasingly, it will have to compete with other users and could take second place to these. That is why the WBCSD has urged that companies give priority to improving water management practices and technology, including setting quantifiable targets for conserving water (involving reduction, re-use and recycling); designing eco-efficient water practices, such as zero emission processes, reducing water usage and improving water quality; and transferring technologies to developing countries.

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