Appropriate technology

Solar desalination for irrigation

Only some 10% of the world's land resources are used to cultivate crops. One of the reasons for this is that nearly a third of the land surface is desert; and yet abandoned towns, dried-up wells and historical accounts testify that large parts of the deserts were once fertile and populous. They need not be lost forever. There are nutritious soils in the seemingly dead sand dunes. What must be done is to get the water cycle working again, to re-establish the water supply.

New techniques in water engineering are available and Swedish solar energy researchers are showing that the costs need not be unreasonable. Aapo Sääsk, an economic scientist, and Orvar Elmqvist, a research engineer, are working on a water desalinator using solar energy, an "LTE system"(1), designed on completely new principles. An experimental model at the Royal Institute of Technology in Stockholm has demonstrated that desalinated water can be obtained at not more than a third of the normal present-day cost. Prototype development is now being financed by the Swedish Board for Technological Development.

Their basic formula is as follows: **sea + sun + desert = water + trees + crops.**

The world supply of water

It is expected that water consumption throughout the world will total 6 000 km³ or approx. 23% of the existing fresh-water resources before the year 2000. However, the accessible water resources are very unevenly distributed over the earth, with regions of more or less pronounced shortage and excess.

Unfortunatly, the greatest excess of water occurs in arctic or sub-arctic regions where temperatures render conditions unsuitable for sizeable concentrations of people, whilst the shortages are more common in the very regions where suitable temperatures prevail.

As population is sure to increase for a time in the hottest regions, where fresh water is already being heavily exploited or in short supply, the exploitation of resources will be appreciably above the average total consumption of 23%.

Irrigation based on either nuclear power or solar energy seems to be the only economically sound alternative. The latter seems particularly attractive, as countries with heavy demands for irrigation also experience the most intensive solar radiation.

A number of new techniques have recently been developed for this purpose, designated by the generic term WHD (waste heat desalination). The LTE system is one such technique. LTE—low-temperature evaporation—is suitable both for very large-scale production of fresh water and for small plants for villages. The basic principle is to make use of solar energy for increasing water temperature. The water is then made to evaporate and condensed by natural cooling, effected either by deep-sea water or by low night temperatures.

The LTE system uses cheap materials for very large vertical evaporating surfaces, in a compact design which can operate in relatively low temperature differentials—down to approx. 15 °C. Production is directly proportional to the consumption of solar energy and is thus higher during hot dry seasons, when water requirements are greatest. There is no surplus capacity.

A prototype to be tested in 1980 is now in preparation. Mr Elmqvist hopes that the first plant will be ready in 1982.

Afforestation and climate

In the heyday of the Roman Empire, the deserts of North Africa were its granaries. Drilling for sub-soil water can help reclaim the desert, but in the long term a natural water cycle must be re-established. And that means planting trees. Drilling for water in the subsoil yields only short-term benefits which often lead to the region drying even further. There are deterrent examples of this from the USA, whilst there is evidence (from Italy, for instance) that selective re-afforestation produces undreamt improvements in climate. Dry springs forgotten for centuries flow

FAO — A. Defever

The labour of drawing water from the desert

Can solar power do it instead?

(1) LTE: Low temperature evaporation.

again when the water cycle has started to work normally, assisted by the trees.

Excavating canals from rivers, constructing dams in mountains and storing rainwater have enabled the People's Republic of China to reclaim almost a million hectares of desert and plant crops.

What should those countries do which consist mostly of desert or semi-desert, and lack China's huge population? It could be said that they need not cultivate more than the population require, but that would be to deny them the asset which the potential area of cultivation represents. In the long run, the only natural water reserves which can be considered for supplying shortages are the world's seas, which for human purposes are inexhaustible. And remarkably enough, a third of the littoral is adjacent to areas of pronounced water shortage.

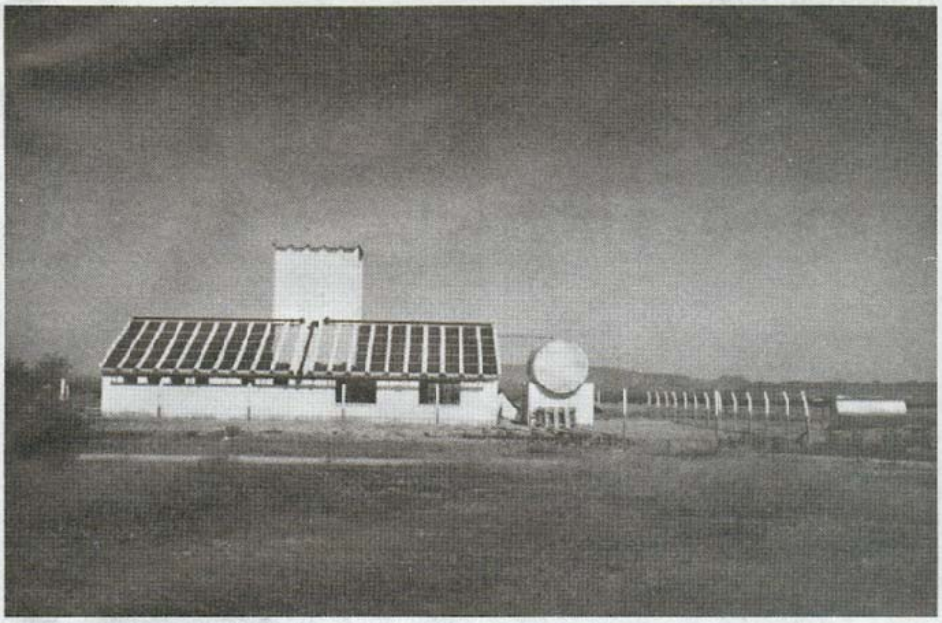
Even in the Sahara, where the central inland regions are some 2 000 km from the coast, desalinated sea-water could be piped in. The first step is to reclaim the coastal strips, then to work inland making water transport a part of local infrastructures on the way.

All known ways of purifying sea water are relatively energy-expensive. The quantities of water required to bring the barren regions gradually back to life are so huge that the conventional sources of energy now in use are insufficient. Existing desalination undertakings are therefore limited to small units meeting local urban needs and are of no world-wide significance.

Calculations show, however, that the costs of exploiting the huge reserves of natural water with new energy techniques on a large scale need not be unreasonable.

Experience shows that after reclamation has reached a certain minimum level, the water cycle gradually begins to work again. Thus the need for supplied water gradually falls, and the surplus can be used to push reclamation further inland. By direct action on the soil and with the equally effective assistance of natural factors, we can "indirectly" achieve a control of the water cycle in the long term which is impossible by direct action.

There are many other methods of supplying water to areas of shortage. Russia is considering the diversion of the great Siberian rivers to the south. The USA and Saudi Arabia have even examined the idea of making large nuclear-powered units tow ice in plastic bags from the Arctic. But already minor advances which have been made by damming rivers or diverting their waters, tapping surface or underground lakes, etc. have had very unwelcome environmental consequences.



Solar-powered pump in Mexico

The sun can not only draw the water but purify it as well

The desalination of sea-water using solar energy has no such environmental disadvantages. It is just one way of imitating nature.

A closer look at costs

Desalinated salt water from existing plants costs around US \$ 1 per m³. More recent low-temperature plant, which has not as yet been fully tested, operates at approx. 60 cents per m³. Now that development is under way, it is likely that the costs may be reduced further to perhaps 20 cents per m³.

Up to now desalination plants have produced water primarily for domestic consumption, where its relatively high production cost has not been a critical factor so much as the cost of distribution. For vegetables, desalinated water is cheap enough already. Water could cost up to US \$7 before the intensive production of vegetables for export to industrialized countries becomes unprofitable. However, water for the home market in the countries concerned must cost considerably less.

Any reclamation of desert regions must start with afforestation, however, and even if reclamation need not always be profitable in the short term it must be accepted that it cannot generally start until it is fully clear at what water cost afforestation really becomes profitable.

In an extreme desert region, the rainfall is only 0-100 mm per annum (compared with up to 700 mm in large parts of Sweden, for instance) and the evaporation is high, very often over 2 000 mm per annum. It is therefore necessary, especially at the outset, to irrigate the roots of each newly-planted tree. Such techniques are well-known today and were so in more primitive forms for thousands of years.

For maximum growth, the tree must have around 40 m³ water per m³ of pulp produced.

At around \$ 12 per m³, international pulp prices are very low at present, and the present cost of water per tree with the WHD technique is altogether too high (around \$ 30 per m³ of pulp produced). Even at lower water cost the price of pulp production becomes so high that the only option is to sell on the local market.

However, the calculation for food-producing trees is better. In desert climates, the best food-producing trees yield 25-50 tons of fruit per hectare per annum with normal care. Even at a water cost of 60 cents per m³ for a harvest of 40 tons, the cost of water is only 5-10 cents per kilo of fruit.

And the best prospects of all are for a combination of food-producing trees and other crops, for instance vegetables. As already pointed out, the present high cost of water at \$ 1 per m³ is no barrier to profitability.

So the irrigation of deserts is now a question not of profitability but of obtaining finance; and that, unfortunately, is subject to the economic decision-makers' common fear of entering new fields and exploiting new technology. □

Mr Aapo Sääsk, who kindly provided this information, can be reached at:
AB Scarab Development
Hovslagargatan 5
S-III 48 STOCKHOLM
Sweden