SALINE WATER UTILITY

FOR

PLANT GROWTH

BY
Emnetu Tesfay

A REPORT PREPARED FOR THE AGRICULTURAL DEPARTMENT OF EPLF IN 1985

17/9/1984

Dr. Tom Wilkie
Features Editor
New Scientist
Commonwealth House
1-19 New Oxford Street
London WCIA ING

Dear Dr. Wilkie

I have recently been made aware of a successful experiment where various types of crops and vegetables were planted by using sea water. Although I am a regular reader of " New Scientist " I have not come across a coverage of this scientific breakthrough. I may as well have skipped it. I therefore decided to request the assistance of your office to provide me references of personalities and institutions involved in the experiment including any material (reports, studies - or articles) you may have on the subject.

I look forward for an early response. Thank you in advance.

Best regards,

Emnetu Tesfay E. Tesfay

Digranesv. 15
4000 Stavanger
Norway

15/9/1984

Editor
Science in the News
Voice of America
Washington D.C.
U.S.A.

Dear Sir:

I write this letter hoping that your office will provide me information concerning a scientific report which was recently aired by VOA in its " Science in the News " program. The subject is the result of a successful experiment in the U.S. where various crops and vegetables were grown by using sea water. The VOA program mentioned a certain scientific journal and personalities that are involved in the experiment. I would therefore like to request the assistance of your office to send me:

a) The name of the journal that covered the report and the issue number or date.

b) Name and addresses of the scientists or institutions involved in the experiment.

c) Any material your office may have on the subject. Reports, studies or articles.

I look forward for an early response. Thank you in advance.

Best regards,

Emnetu Tesfay E. Tesfay

Digranesv. 15
4000 Stavanger
Norway

17/9/1984

Director
Science Reference Library
25 Southampton Buildings
London WC 2 A I AY
U.K.

Dear Sir:

I am able to write this letter of inquiry after coming across the address of your institution in the pages of the magazine " New Scientist." The subject of my inquiry is the reported successful experiment of planting various types of crops and vegetables by using sea water. I was recently made aware of such experiment although I do not have any references. I therefore decided to request the assistance of your office to provide me names and addresses of personalities and institutions involved in the experiment including any material (reports, studies, articles) you may have on the subject.

I look forward for an early response. Thank you in advance.

Best regards,

Emnetu Tesfay E. Tesfay

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4000 Stavanger
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Emnetu Tesfay . Esq
Digranesu 15
4000 Stavanger
Norway

our ref: ENQ NO 84158/PW/WA

your ref:

date: 22 October 1984

Dear Mr Tesfay

Your enquiry of 17 September was passed to me for reply. Searching through our collections I found a few items related to the subject of saline conditions and crops which I quote below. Where possible, I have included the address of the authors or editors.

Yours sincerely

P Ward

Mrs P Ward
Reader Services

÷NLH Maliwal, G.L.
Salt tolerance of crops and plant metabolism in saline substrate: an annotated bibliography 1940-1980.
Dehradun, International Book Distributors, 1982. 197p.

Gujarat Agricultural University,
Dantiwada Campus
Sardarkrishinagar 385506
Dist. Banaskantha
Gujarat
India

÷NLH Gupta, I.C. and Pahwa, K.N.
International research on saline irrigation waters: an annotated bibliography. 1950-1980
New Delhi: Agricola Publishing Academy, 1981. 394p.

Central Soil Salinity Research Institute
Karnal 132001
Haryana
India

— ÷NLH

Gupta, I.C.
A century of soil salinity research in India: an annotated bibliography, 1863-1976
New Delhi: Oxford & IBH Publishing, c1978. 400p.

— GV

Hollaender, A. Editor
The biosaline concept: an approach to the utilisation of unexploited resources.
N.Y., London: Plenum, c1979. 391p.
(Environmental Science Research Series, Vol.14. Based on the International Workshop on Biosaline Research, Kiawah, S.C., 1978)

Associated Universities Inc.
Washington DC.
USA

— ÷NLH

Kislali, A.S. technical editor
Plant production under saline conditions. Cento symposium on plant production under saline conditions, May 11-13, 1976 at Cukurova University.
(Ankara), CENTO, (1976.
CENTO Scientific Programme Report No.21

— ÷NLH

Hanks, R.J. and Hill, R.W.
Modelling crop responses to irrigation: in relation to soils, climate and salinity.
Bet Dagan, Israel and Ottawa, 1980. 66p.

International Irrigation Information Center: Publication No.6
PO Box 49
Bet Dagan
Israel

— ÷NLH

San Pietro, A
Biosaline research. A look to the future.
New York, Plenum Press, 1982. 578p.

finnes NTH

Indiana University
Bloomington
Indiana
USA

— Ag317.45/4 (1981)

Holmes, J.W. and Talsma, T.
Land and stream salinity seminar. Murdoch University 12-13 November, 1950.
(Organised by the Government of Western Australia)
Amsterdam etc, Elsevier, 1981. 392p.

Flinders University of South Australia
Adelaide
South Australia

— "WATER DESALINATION IN DEVELOPING COUNTRIES"
A UNITED NATIONS PUBLICATION

Voice of America
Washington, D.C. 20547

VOA
USIA

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We are enclosing a copy of our booklet, Words and Their Stories.

Sincerely,

Frank C. Beardsley
Chief
Special English
Voice of America

newscientist
Commonwealth House, 1-19 New Oxford Street, London WC1 1NG
Telex: 9157 48 MAGDIV G
Switchboard: 01-404 0700

26 September 1984

Emnetu Tesfay
Digranesv. 15
4000 Stavanger
Norway

Dear Mr Tesfaye

Thank you for your letter of 17 September. The only article that vaguely resembles what you wish to know is in the enclosed magazine entitled "The seagrass lady" on page 51/52.

Hope this helps.

Yours sincerely

Karen Iddon

Karen Iddon
Secretary to R. Fifield

Registered Office: IPC Magazines Ltd., King's Reach Tower, Stamford Street, London SE1 9LS Registered Number: 53626 England.

Taking the Salt Out of Sea Water

In an attempt to help water-poor areas of the world, scientists are constantly looking for new ways to turn sea water into fresh water. In principle, water desalination is simple, but it has proven to be difficult to do cheaply and efficiently. The latest desalination efforts, however, indicate that the problem is not insoluble.

At the end of this month, researchers at the Ichigasaki labs of Japan's Water Re-Use Promotion Center will complete a five-year experiment using liquefied natural gas (LNG) to remove salt from sea water. The process relies on a simple physical principle: when salt water freezes, the salt separates out. The problem in applying the principle is that it requires large amounts of energy to freeze the water. The center's system overcomes this obstacle by using supercold LNG (minus 161 degrees Celsius) to freeze the sea water.

In the center's experimental desalination plant southwest of Tokyo, LNG is injected directly into a tank of sea water. The relatively warm water converts the LNG into a gas; in turn, the LNG freezes the water. The ice crystals are pumped into a washing tower, where screens filter out some of the brine and jets of fresh water strip off the rest. The frozen fresh water is shunted into a melting tank where it is mixed with fresh water. And the LNG, now gasified, can be sold or burned for power to run the process. The test plant is capable of producing 2,400 gallons of fresh water per day.

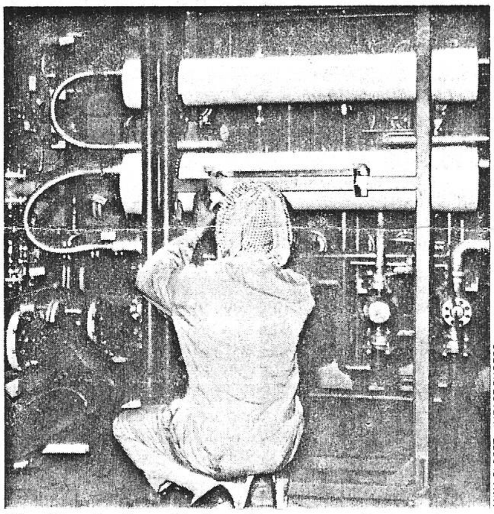
The Japanese system is one of the most efficient desalination processes yet devised. But the system's efficiency depends upon a constant supply of LNG. This requirement has created a paradox. Most countries that produce LNG—such as Saudi Arabia—have so much excess energy that they can use simpler, if less efficient, desalination systems. And energy-poor countries that need the Japanese system generally cannot afford to buy it. The Japanese are nonetheless turning the technology over to the private sector in hope that some well-funded company will be able to market it properly.

A New Application of an Old Theory

Kuwait, which is totally dependent upon desalination for its fresh-water supply, has taken a different approach. The government is experimenting with a new application of an older scientific concept known as "reverse osmosis." Put simply, the process purifies sea water by passing it through specially designed membranes that trap salt. The Kuwait Institute for Scientific Research and the government's Water Resources Development Center, along with a West German concern, have built a $20 million reverse-osmosis plant 10 miles northeast of the capital, Kuwait.

At the plant, sea water is pumped through relatively crude filters that remove silt and other large particles. The water flows into storage tanks and then, under high pressure, through membranes made of Aramid, a family of very resilient polymers, or cellulose acetate. The membranes can trap enough salt in one pass to make the water drinkable. The plant should be able to produce more than 260 million gallons of drinking water every year.

Reverse osmosis requires very little energy. The most expensive components of the Kuwait plant are the membranes themselves, which can represent as much as one-third of the total cost of the system. Researchers are experimenting with three different types of filters to see if they can bring costs down. They expect to complete their evaluation tests within two years.


ANNA CLOPET—IMPACT PHOTOS

Checking the Kuwaiti plant: Reverse osmosis at work

Power From Waves

An oceanographic engineer at the University of Delaware in Newark has designed a small and inexpensive desalination system that also uses a form of reverse osmosis. C. Michael Pleass's device, named the Delbuoy, relies on the natural and constant action of waves for its power.

The Delbuoy system consists of a buoy seven feet in diameter tethered to a 10-foot-long, high-pressure pump. The pump is anchored in up to 60 feet of water. A pipe running from the pump is inserted about 20 feet into the sandy sea bottom. The bobbing motion of the buoy operates the pump, which draws sea water into the pipe. At this point, most particles have already been filtered out of the sea water by the sand of the sea floor. The high-pressure output water travels through a three-foot-long module containing filtering membranes similar to those used by the Kuwaiti plant. The resulting fresh water runs through a second tube into onshore storage tanks.

The Delbuoy system trades off energy efficiency—since the energy is free—for longevity and ease of maintenance. In case of a major storm the Delbuoy has been fitted with a sacrificial link that will drop the expensive components to the safety of the seafloor. Divers can install a Delbuoy system for a total cost of approximately $2,500 for a 250-gallon-a-day unit. A prototype installed at a University of Puerto Rico site survived a recent hurricane. The system still needs long-term trials, however. Pleass is seeking partners to help finance the necessary testing.

ROGER SCHULMAN with CYNTHIA CATTERSON, DAVID LEWIS and ELIZABETH COLTON

For company addresses, write **Newsweek** New Products Dept., 444 Madison Avenue, New York, New York 10022.

A saline solution to Israel's drought

Israel is now facing a water shortage. Instead of piping water from the wet north to the southern desert, some scientists say that a giant store of salty water trapped below the desert should be piped north

Helen Gavaghan, Beersheba

IF WE do not conquer the desert, the desert will conquer us—so thought David Ben-Gurion, Israel's first prime minister. Ben-Gurion's government set about conquering the desert by piping water from the wet north to the desert in the south of Israel. Now the north is in trouble. One of its fresh water sources is contaminated with sea water, another source is sinking to dangerously low levels. During the past few years, far less rain has fallen on the north than usual, and meteorologists anticipate that next year will be the same. "Israel is in a state of emergency," says Jacob Bear, professor of hydraulic engineering at the Israeli Institute of Technology.

In response to the crisis, the government last month imposed limits on the amount of water available to the country, and decided to apply its rules about water consumption stringently. No longer will consumers whose meters show they have exceeded their allotted ration be fined. Instead, they will be cut off. Agriculture bears the brunt of the cuts, but industry and towns are also affected.

The government's action followed recommendations from a committee of scientists that advises on long-term planning. All but one of the committee believed that the government had to cut water supplies now. Arie Issar, head of the desert hydrology unit at the Ben-Gurion University of the Negev, disagreed with his colleagues. Issar believes that the country's problems today stem from mistakes made in the past by planners, and he sees no reason why consumers, in particular farmers, should suffer. In Israel, says Issar, farmers have used water responsibly and efficiently.

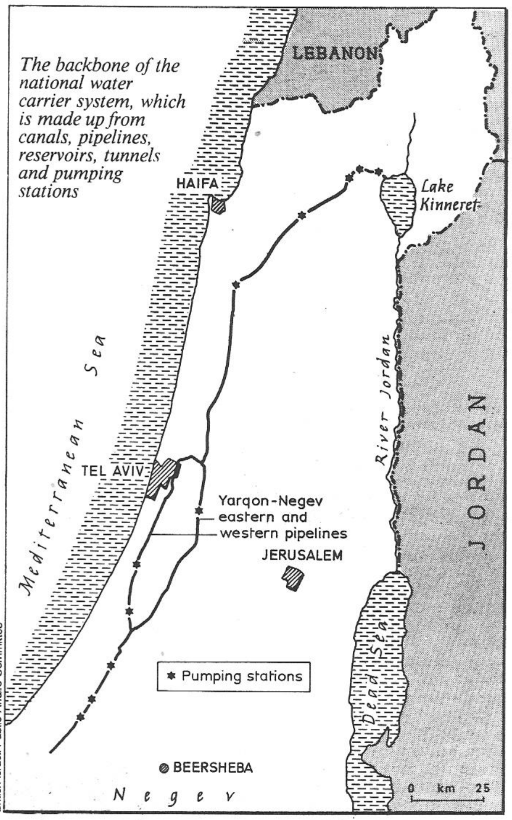
Issar believes that the planners were wrong not to prepare to exploit a giant source of salty water that scientists first discovered below the Negev in 1967. If plans had been made, or were made now, to tap this water source, Issar believes the country could continue to draw on its fresh water sources at the same rate as now. He argues that the fresh water would be replenished as soon as the salty water below the Negev met the needs of some consumers, such as farmers and some industry.

Bear agrees that the aquifer below the Negev should be exploited, but says that water rationing is also necessary. "We cannot go on using water at the rate we are in the hope that the supply under the Negev will buy us enough time to replenish our fresh water resources in the north."

Israel's difficulties stem from rapid agricultural and industrial development, coupled with rising living standards. For example, by the end of the 1970s, there were 400 000 acres of irrigated farmland compared with 75 000 in 1948, when Israel came into being. The result of increasing demands for water is that there is a fine balance between what goes into the country's replenishable water stores and what comes out. The few years of poor rainfall recently have tipped the scales, and now Israel draws more out of its stores each year than it puts in.

These stores are Lake Kinneret (the Sea of Galilee) and two large sub-surface zones containing fresh water—the aquifers. One aquifer stretches under the coastal plain alongside the Mediterranean. The other extends from south of Jerusalem up to Lake Kinneret.

The water in Lake Kinneret is replenished by rain falling on Mount Hermon in the Lebanese mountains, which flows down the River Jordan, and by rain on the mountains surrounding the lake. The recent years of low rainfall and the lake's falling level were demonstrated dramatically in February. Members of a kibbutz by the side of the lake discovered a fishing boat that sank 2000 years ago which had lain undisturbed on the lake bed.



British Israeli Public Affairs Committee

In 1949, David Ben-Gurion's government in Israel laid the foundations of a plan to pipe water from the north down to the desert in the south. Now the Israeli government is considering a new network that could take salty water from the desert to farms in the north

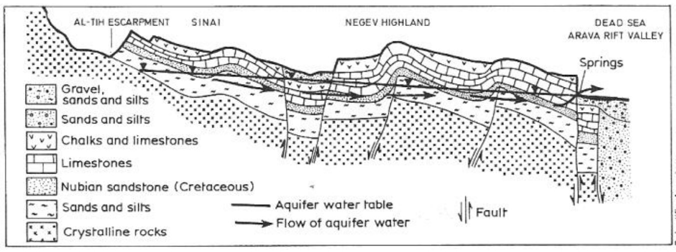
More seriously, indicators show that the water in the aquifers is being replenished too slowly. The fresh water in the coastal aquifer should be above sea level, because fresh water floats on saltwater. As the aquifer level decreases, sea water flows into and contaminates the fresh water. According to Bear, the coastal aquifer is already polluted, despite a computer-controlled system that monitors the aquifer and sea level. The computer switches on machinery that is supposed to maintain the respective levels of the two by pumping reclaimed sewage into the land at the sea's edge. The second aquifer is also in trouble. Bear says that in some places, the top of the aquifer is below the pumps that propel water up to the national water-distribution system.

In recent years, rain has replenished these sources at a rate of about 1·7 billion cubic metres per year. The water is pumped from the aquifers and Lake Kinneret into the national system that runs from north to south. Along the way, industry, agriculture and domestic users now draw roughly 2·1 billion cubic metres per year giving an annual deficit of 400 million cubic metres. Reclaimed sewage fills about half of this deficit; the other half is met by over-pumping the two great fresh water aquifers.

The shortfall creates an immediate problem, but also threatens future agricultural and industrial development. Besides rationing water, the government needs to find additional sources.

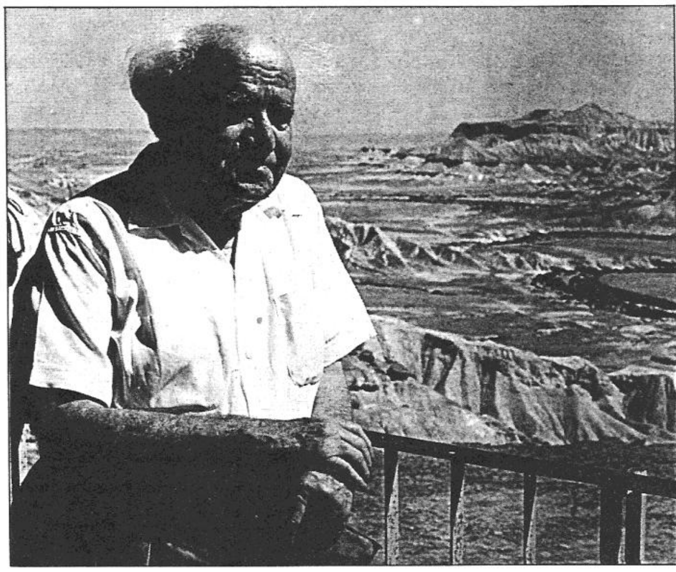
The options are to reclaim sewage, to capture all marginal sources of water, cloud seeding, desalination and to exploit the water below the Negev.

Desalination was the favoured solution of the 1970s. Now engineers and politicians accept that it is too expensive. To desalinate water requires a lot of energy, and Israel has very few sources of fossil fuel.



Scientific American

The geology of the aquifer below the Negev. In 1981, the Israeli government carried out a feasibility study to see whether this water could be tapped



British Israeli Public Affairs Committee

David Ben-Gurion, Israel's first prime minister

Even with the current low price of oil, desalinated water costs about \$1·2 per cubic metre. The aim, says Issar, is to provide water at no more than \$0·2 per cubic metre.

Cloud seeding, another exotic option, also has disadvantages. The idea is to send up a plane loaded with, say, silver iodide, when rain seems likely. Releasing the silver iodide into cloud increases the number of nuclei of condensation, giving more chance of rain. Earlier this year, the Israeli Water Resources Commission began a research programme to look at cloud seeding. The main practical point to establish is the relationship between increasing rainfall and how much water finds its way into the aquifers and Lake Kinneret.

There is, however, another difficulty. What will the neighbours think? Louis Berkofsky, director of the Jacob Blaustein Institute for Desert Research at the Ben-Gurion University of the Negev, says: "Clouds seeded here would pass into Jordan."

Of the other three options, only plans to tap the water under the Negev are still uncertain. Sewage-reclamation is already well advanced, though behind schedule, and the government is considering ideas for exploiting marginal sources, such as the saline springs that run into Lake Kinneret. Currently, these are diverted to the Jordan and flow down to the Dead Sea.

Besides exploiting these sources, says Issar, the country should be able to store the excess water which accumulates when rainfall is above average. "We do not have enough storage space. In good years flood gates are opened and the water flows down to the Dead Sea."

Sewage reclamation, storage and the marginal water sources are not enough, however, to meet growing industrial and agricultural development and to allow the fresh water aquifers to recover. Issar insists that the government should be setting up pilot plants now to explore the problems of recovering the water from below the Negev. "The aim should be to prove the idea and have blueprints by the year 2000."

The aquifer beneath the Negev stretches under the Sinai. Scientists estimate that it contains 70 billion cubic metres below the Negev alone. At greater depth, there is another giant aquifer, though this is saltier than the one Issar wishes to exploit now.

The saltiness of the aquifer is one of the problems facing anyone wishing to see it developed. It contains about 600 parts per million of salts compared with the 240 parts per million in the water of Lake Kinneret.

The idea for exploiting this water is to mix it with reclaimed sewage, either centrally or where it is used. One possibility which the government is considering is to build a second national network of pipes to carry the saline water. Even if the water under the Negev is never developed, the pipes could carry reclaimed sewage and water from saline springs. Such salty or brackish water is useless for drinking, but would be good for irrigation.

A second major problem with the Negev aquifer is that it cannot be replenished. Issar estimates that the 70 billion cubic metres would last for 200 years. Once all the water was mined, the resource would be gone for good, but Isaar points out that the situation is no different to mining coal, and that the water is needed now.

To collect the water, engineers would need to sink deep shafts and dig long tunnels or galleries. Water from the rocks would then seep into the tunnels, flow to the bottom of the shafts and be pumped up to ground level. The idea of tunnels collecting and/or storing water is not new. The Iranians, for example, developed a similar idea 2000 years ago. The idea has not yet been tried, says Isaar, with modern technology.

One of the unknowns about the scheme is how long the tunnels would need to be. The water-bearing rock below the Negev is not very porous, and there might need to be long tunnels to collect enough water. The longer the tunnel, the more money would ne needed for the project, and money is one of the things the Israeli government does not have a great supply of. Although the nature of the rocks could turn the plan into an expensive exercise if long tunnels were needed, the solid nature would avoid problems of subsidence, says Bear.

Whatever the problems, Issar is convinced that planners and financiers must start considering this water resource now. He says that there are similar aquifers under the Sahara and Saudi Arabia. A pilot project in Israel could serve as a model to develop these resources. And because the plan is essentially resource development, Issar believes that the financially hard-pressed Israeli government could get loans from international agencies. "But," says Issar, "it will take time to overcome the conventionalism of the water commission and the ministry of agriculture. It took me 10 years in the first place to convince people that there is an aquifer." □

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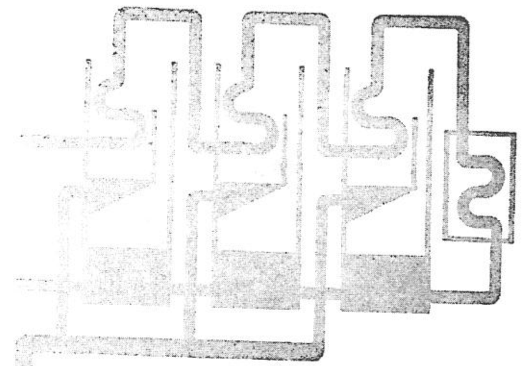

WATER DESALINATION IN DEVELOPING COUNTRIES

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