Date Entered:___/___/___ Reference No.: 461

Water Project Data Entry Form
Bibliography
(type or print clearly)

AUHTORIZATIONS: (2 or 3 initials, be consistent)

Read by: _____ Approved by: KY Entered by: SMA

INFORMATION PERTAINING TO: (check those applicable)

Hydrological Models:___ (Natural:___) Political Models:___

BIBLIOGRAPHIC INFORMATION:
(Names -- LAST, FIRST M. Dates -- MM/DD/YY)

Author(s): Ben Shaul, D'vora

Editor(s): _____

Article or Chapter Title: Rainmaker

Journal or Book Title: Jerusalem Post Weekly

Vol/No: _____ (8 spaces) Page No(s): 17 (12 spaces)

Publisher: —

Date of Publication: Mar 6-12, 1983 (12 spaces) Language Code: E

Place of Publication: —

CLASSIFICATION:

Type Code(s): 380, 750, 660, 180, ___, ___, ___, ___, ___, ___, ___, ___

Basin Code(s): JQ, @, JD, ___, ___, ___ Country Codes: IS, SY, JO, ___, ___

Keyword(s): cloud seeding, technology

Features (Circle applic.): map diagram statistics photos bibliography

Source Type (Circle one): primary secondary

Notes: Interview with A. Gagin, evaluation

LOCATION:
Copy at MERI (Y/N)? ✓ If not, where _____
(organization/contact; library/call nc

461

1983

Rainmaker

The Post's D'VORA BEN SHAUL meets Avraham Gagin, the man responsible for Israel's international success in inducing precipitation.

THE DROUGHT-RIDDEN southwestern U.S. of my childhood was the happy hunting ground of the Rainmakers. In their brightly-painted wagons, filled with bits and pieces of impressive-looking laboratory equipment and an ample supply of phosphorescent rockets to provide astounding fireworks displays, these men (and occasionally women) roamed the arid states. They promised the drought-stricken farmers in Texas, Kansas and Oklahoma that they could bring rain to their parched fields... for a price.

The Rainmakers were cunning enough to operate only when there were clouds in the sky. If, after their incantations and applications, there was rain, the farmer felt himself amply rewarded. If there was only a little rain, he was told that without the Rainmaker, even that bit would not have fallen. In the many cases when there was no rain at all, the Rainmaker would promise a special, renewed effort the next day — without charge. He usually decamped that night, taking the money he had collected with him.

Jews, on the other hand, have always prayed for rain when their parched fields cried out for moisture, for, after all, that was one of the basic promises of the Almighty: "I will send you the rains in their seasons..."

And the first *Rishon Lezion* — Sephardi chief rabbi — the late Rabbi Avraham Gagin of Jerusalem, certainly knew all the traditional prayers for rain.

One wonders just what the first *Rishon Lezion* would think about his grandson and namesake, Prof. Avraham Gagin of the Hebrew University's Department of Meteorology. For Gagin is today not only Israel's number one rainmaker, but also the man responsible for the fact that this country is considered the most successful in the world in increasing its annual level of precipitation.

Together with Yehuda Neumann and Reuven Gavriel, who is now at the University of Rochester in the U.S., Gagin has succeeded in producing an annual rainfall increase of approximately 15 per cent over target areas. This figure, carefully checked by meteorologists and statisticians around the world, has been maintained since 1961.

Why has Israel succeeded when so many other countries, some with vastly greater budgetary resources, have failed?

Gagin says that it's a matter of knowing just which clouds to seed. "We don't make rain," he says, "we simply encourage the rain-producing cloud to let down more precipitation than it ordinarily would have."

Gagin explains that when a person looks at the sky and sees dark clouds, he knows that there will probably be rain; when the clouds are white, he knows there won't. "But of course," he remarks, "all clouds are white; it's a matter of density. When the clouds are thin, then the sun shines through them and they look white. When they are dense, they appear dark, a silhouette against the lighted sky."

Israeli meteorologists, financed by Mekorot, the national water authority, have learned that the technique of cloud seeding, the injection of a fine powder of silver iodide into a cloud, works best when the cloud is dense, with a temperature of -5 to -15¾ Centigrade at the top of the cloud. At these temperatures a crystal of ice forms around each particle of silver iodide; and each ice crystal is an embryonic raindrop. At temperatures of 5 to 7¾ Centigrade these drops fall as rain, at colder temperatures, as sleet or snow.

Using this technique they have been able to turn clouds that were potentially low rain producers into high precipitators, and have managed to get rain out of clouds that otherwise would have probably produced nothing at all.

CLOUD SEEDING is carried out by two basic methods in Israel, Gagin explains.

The first is the system of silver iodide generators, located all over Israel. The generators, called *tanourim*, or stoves, look something like a smoke-stack or cannon attached to a large pressure cooker. Filled with silver iodide and acetone, they are ignited internally and throw a mist of silver iodide particles into the sky. Many a radio listener has been mystified to hear a news broadcast end with instructions to "light the stoves... or turn them off."

The second system involves seeding clouds from light aircraft which carry generators under their wings. These planes, Gagin says, fly back and forth along a predetermined line when the cloud formations are auspicious and continuously spray a fine mist of silver iodide particles into the clouds.

According to Gagin, one of the reasons why Israel has succeeded, while the U.S. has not, is that Israel depends on a system of stored water and the irrigation of fields during the dry season. In the U.S., agriculture anticipates year-round rainfall, and consequently attempts to combat drought by seeding summer clouds are singularly unsuccessful. American agriculture is simply not geared to the wide-scale irrigation of fields and crops.

During the first Israeli experiments, from 1961 to 1967, the activities of the rainmakers were a carefully guarded secret. No one knew how the neighbouring Arab states would react to attempts to tamper with the natural course of things. In fact, no one could even say for sure whether more rain in Israel would mean less in Jordan, Syria and Lebanon.

Once the statistics from these Middle Eastern states had been analysed by the University of Colorado, it became clear that seeded clouds which managed to drift across the political boundaries had resulted in an average increase of rainfall of some 20 per cent in regions downwind from Israel's seeding areas. Although it was hardly possible to send a rain cloud labelled "courtesy of the government of Israel," the neighbouring states were not displeased with the results.

Professor Gagin

In 1969, once most of the catchment area of the Kinneret was in Israeli-held territory, the entire operation was moved inland in order to increase rainfall over the catchment area itself. Results were the same as in the first experiment. From 1969 to 1975, precipitation increased 13 per cent over the entire target area and 18 per cent over the catchment area. This confirmed the earlier experiments to the satisfaction of scientists around the world. Every scientific experiment must, in the end, be evaluated by this jury of peers.

BUT IF the rainmakers and the government are pleased with the results, the average citizen, struggling with leaking roofs, cars that won't start, laundry that hasn't dried in a week and all the other inconveniences that accompany prolonged rainfall, is often tempted to wonder if "enough isn't enough."

Perhaps this would be the case were it not for the fact that Israel's water reserves are not only low at the moment, but have reached what could be termed crisis levels.

Israel depends on two sources for t of its water supply: the Kin- t and the underground water that is pumped up from below the surface through artesian wells. Both of these resources are in a state of severe depletion; even after the unusually heavy rains that have fallen this year, the Kinneret is still at its lowest level in 20 years. The underground reserves are not faring any better. In some areas of the Negev and the Arava, acacia trees have died because the water table has fallen to a level where their deep roots no longer can find the necessary moisture.

Nor is it at all certain that this winter's rains, which certainly have not run off into the lake, have managed to fill up the underground reserves. The aquifers, those delicate underground channels and caverns where water accumulates, are not like a kitchen pot that can be emptied and refilled at will. Every emptying of these aquifers causes them to dry out, and as a result their fragile walls can crumble. This, in turn, leads to blockage of the smooth underground flow of water and to limited storage capacity. It can also close certain channels to the entry of fresh water, making the water that does collect there become salty, turning a once productive well into one whose water is unusable.

Given this situation, it is obvious that there can be no such thing as too much rainfall. Even when one considers the costs of flood damage, fewer tourists, disrupted electricity and telephone services and lost work days, the fact remains that all these factors are transient — but water, or the lack of it, is a permanent concern.

Another line of argument is that increased rainfall means tampering with natural forces, and that one should leave nature alone. There is certainly a lot to be said for this point of view, and it would undoubtedly be valid if we did indeed live in a natural environment.

BUT IN ORDER to get back to a situation where everything is the way nature intended it, one would have to go back many thousands of years. There are a large number of man-made factors already at work which ultimately influence the amount of rainfall in a given area.

One of the most important of these, Gagin mentions, is deforestation and devegetation. This phenomenon has been going on almost as long as human civilization, due to overgrazing on the one hand and the deforestation of land, in order to prepare fields for cultivation, on the other.

The meteorologist says that it is not enough to assume that a tropical region exists, with its vast areas of vegetation, just because there's so much rain. As it happens, there's also a lot of rain because of the existing vegetation. The large amounts of carbon dioxide emitted by the vegetation increase the amount of solar rays absorbed and result in the increased ability of water to reach the layers where clouds are formed. Denuded areas have little moisture to offer and not enough carbon dioxide to enhance the process. Satellite photographs show that overgrazed and denuded areas have a totally different reflectivity from areas where even desert foilage abounds.

A second factor is the existence of cities and industrial complexes. Here is the classic example of "both good news and bad news." The good news, says Gagin, is that cities act very much like mountains. They generate heat, the clouds coming over them are lifted and then dropped, and the increased buoyancy results in greater precipitation. This is expressed well in the Laporte anomaly. Laporte, Illinois, near Chicago, has an increased rainfall due to its steel industry.

The bad news is the effect of pollution on rain clouds. Clouds that form over a relatively clean sea, such as those that form in the South Pacific and reach Hawaii, have as few as 50 particles of solid matter per square inch. These particles form nuclei for large raindrops. Since they are few, a great deal of water attaches to each embryonic raindrop.

Clouds that form over land masses where there is a large amount of dust, however, may have as many as 1,000 particles per square inch. This is the case with clouds in the Mediterranean region. These particles are so numerous that the amount of water attaching to them is limited, and they therefore often fail to let down their load — it just isn't heavy enough. Pollution, especially when clouds pass over industrial complexes, adds further quantities of particulate and gaseous matter to the atmosphere, and further increases the number of particles around which water can collect. In this case, many clouds have so many particles that they never get heavy enough to let down precipitation unless they are assisted by the rainmakers.

IT ISN'T ONLY Israel that may benefit from the studies conducted by Gagin, his co-workers, and Mekorot. Recently, a delegation of leading meteorologists and water conservationists from South Africa came to Jerusalem for the express purpose of learning from the experts here.

The South Africans knew exactly why they were here. There's a desert in Africa that is on the march. It is growing eastwards at a rate of some 75 to 100 kilometres a year, and it is getting wider, in some areas, at an annual rate of 50 kilometres or more. This has been happening, without let-up, for some 12 years already, although the factors that triggered it off started as many as 20 years ago.

In addition to this, the rains in the southern part of the African continent have always been cyclic, and drought, real drought, is no stranger to the veld. This fact, as a new and predictable drought period approaches, coupled with the expanding desert to the north of the Republic of South Africa, is ample cause for worry. The experts were here to look for ways of increasing rainfall throughout the area.

Another project which Israel has been asked to aid is the Agridev development area in Peru. Some 60,000 square kilometres of land, at a high altitude, is dependent on water from the Andes mountains for irrigation. The Israeli company, Agridev, which is developing the area, plans to bring some 500 Peruvian settlers there this year. The area is, at the moment, undergoing a severe drought, and Gagin says that Israeli meteorologists have been asked to come at once to see what can be done to increase rainfall.

Basic research done here on clouds in the Mediterranean can also serve as guidelines for all the states in the Mediterranean basin, if they develop the technology to implement the knowledge.

Whether or not one feels good about wet feet and drippy awnings, one thing is sure: in Israel, everyone may still be talking about the weather, but there's also someone who is doing something about it.

A B