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MEDITERRANEAN DEAD SEA PROJECT

"Each country must strive to build up its own scientific and technical potential, that is, the sum of the national skills and resources which it must have at its disposal for defining and solving all the problems that it must face in the sphere of science and its practical application."

"UNESCO's Application of Science to Development"

from The Activities of UNESCO in Science and Technology, p. 12.

ENERGY, ECOLOGY AND ECONOMICS

In the Great Jordan Rift Valley, between the Mountains of Moab to the east and the Judean Desert to the west, lies one of nature's marvels — the Dead Sea. Its strange salt formations affords more than mere objects of curiosity. The sea yields an infinitely rich source of minerals for both Israel and the Kingdom of Jordan. For the past three decades, scientists have been concerned about the future of this natural phenomenon. The surface of this inland lake has been rapidly dropping in level and shrinking in size — deteriorating into ecologically unacceptable mud flats (Fig. 1).

The Negev region of Israel, sharing part of the shores of the Dead Sea, is barren and sparsely populated, potentially productive, but lacking fresh water and energy resources. Although Israel has made impressive technological progress in the development of efficient irrigation systems, limited sources of water severely restrict agricultural and industrial growth in the Negev. Energy has been an even more elusive problem because Israel has virtually no energy-producing raw materials within its borders. Almost all its energy requirements must be satisfied by importation of foreign oil and coal. It seemed obvious for some time that extraordinary but realistic measures were required to resolve these interrelated problems of energy, ecology and economics as they apply to underdeveloped regions of the country.

The Mediterranean-Dead Sea Project (MDP) is an imaginative response to these problems designed to:

— create additional sources of energy;
— restore the Dead Sea to its natural historic shape and level;
— develop opportunities for further agricultural and industrial development in desert regions.

This ambitious project is not really new. Linking the Mediterranean with the Dead Sea has actually been in conceptual development by numerous planners and visionaries since the turn of the century. In 1899, Max Bourcart, a Swiss engineer, outlined the advantages of building a canal from the Mediterranean to the Beit She'an Valley and on to the Dead Sea. Bourcart further proposed the establishment of three hydro-electric power stations on the canal. Formal study and design of this scheme was initiated by the government of Israel in 1974. Many qualified scientists, engineers, environmental specialists and economists have participated in the eight year long examination of this project. The findings of these intensive studies were further

reviewed by independent, internationally acclaimed scientists and engineers. The results of these efforts were crystalized in a scheme to construct a Mediterranean - Dead Sea water conduit of a total length of about 110 km, consisting of pressure pipes, canals, an 80 km tunnel, a pumping station and a hydro-electric power plant. (Fig. 3). This scheme is now being finally and meticulously examined as to the soundness of its engineering and environmental facets as well as its financial and economic merits. When these studies are completed, and if the results meet with the approval of the Government of Israel — only then will detailed design and actual construction be undertaken.

Between 8 and 10 years will be required to complete this complex project.

RESTORATION OF THE DEAD SEA

Located at the lowest point of the earth's land surface, the Dead Sea has a higher salinity and density than any other body of water in the world.

With no outlet, the Dead Sea is a totally closed lake. Evaporation, the only outlet for water from the Dead Sea, takes place at an extraordinary rate of some 1.6 meters a year. Since the recording of water levels at the beginning of this century until the early 1930s, the Dead Sea maintained an average level of about 390 meters below sea level, as a natural result of the hydrological balance between evaporation and incoming rivers and flood water.

However, the large scale water diversion projects such as Israel's National Water Carrier and the East Ghor Canal in the Kingdom of Jordan, have caused a seventy five percent reduction in the flow into the Dead Sea, resulting in the fall of the surface level by some 10 meters since the 1960 s.Further diminution is expected when the Kingdom of Jordan's Maqarein High Dam on the upper Yarmouk River is completed. It is anticipated that the Dead Sea will decline to a new low of 406 meters below sea level by 1990, representing a total drop of 15 to 16 meters in less than 30 years.

Given the smaller inflow and the extremely high rate of evaporation of the Dead Sea, its level will continue to drop unless water is brought in from outside its natural catchment basin. According to most recent scientific calculations, if some means are not

implemented to increase the amount of water flowing into the Dead Sea, by the middle of the next century the Dead Sea will be reduced to a large salt-filled ditch, 450 meters below sea level. flat. The continued fall in level of this wondrous body of water is recognized today as an ecological hazard that may lead to irreversible damage and economic losses. (Fig. 2)

SATELLITE VIEWS OF THE DEAD SEA

1972 *1981*

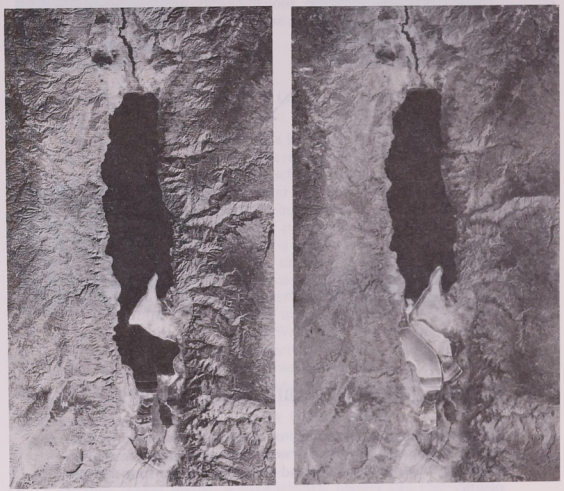

Fig. 1

The regression of the Dead Sea has already reduced its area from 1000 to 800 square kilometers.

PROJECTED DEAD SEA LEVELS 1930-2035

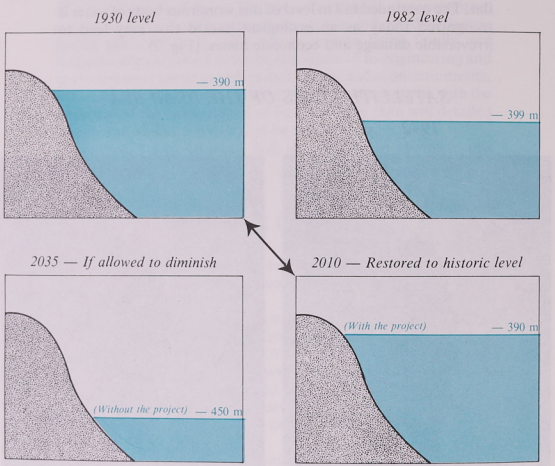

Fig. 2

TAPPING THE RENEWABLE ENERGY SUPPLIES

Though situated in the midst of one of the world's oil-rich territories, Israel has virtually no indigenous energy resources available to support the life and economy of over four million people.

Under the interim and final peace agreements with Egypt, Israel returned all the oil fields it had developed along the southwestern shores of the Sinai peninsula which had been supplying 25% of

Israel's total oil needs. In 1979 Israel spent only $700 million on overseas oil purchases. In 1980, one year after turning over the Sinai oil fields, Israel's oil bill had soared to $2.2 billion — an amount equal to the value of the country's entire industrial output!

Now, Israel has again become totally dependent on imported oil. In 1980 crude oil importation reached 31.3% of the country's total imports. No country in the West has reached such a level of dependence.

For this and other reasons, the unique opportunities offered by the Mediterranean-Dead Sea Project for developing clean alternative sources of indigenous energy at acceptable costs gained both public and governmental interest and support.

PRINCIPAL ELEMENTS OF THE PLAN

The Mediterranean — Dead Sea Project is designed to produce electricity by exploiting the difference in levels between the two seas. The starting point of the scheme will be an intake facility drawing Mediterranean sea water through a buried conduit into a nearby pumping station. Flowing eastward, pumped water will travel through an underground pipeline to a 22 kilometer long canal 100 meters above sea level crossing the northern Negev. Entering an 80 kilometer long tunnel, the sea water will flow south of Beersheva and will cross the Zohar Hills in the Arad region directly to a plateau overlooking the Dead Sea. At the end of the tunnel the sea water will be stored in two regulating reservoirs of different heights. Water will flow from these reservoirs through a high pressure penstock, from a height of more than 400 meters to an underground power station built into the mountain near the Dead Sea. The power station of 800 megawatt capacity is planned to function only during peak electrical load periods on the average of about 8 hours a day.

Electricity consumption is not uniform; usage tends to be concentrated during certain hours. For this reason generating plants must be capable of meeting peak demand. More so than thermal power plants, a hydroelectric facility can respond to such requirements with relative ease. It is easily set in operation and does not require lengthy stoppages for maintenance. Storage of sea water from the Mediterranean in regulating reservoirs

GENERAL LAYOUT OF THE MEDITERRANEAN-DEAD SEA PROJECT INCLUDING FUTURE DEVELOPMENT POSSIBILITIES

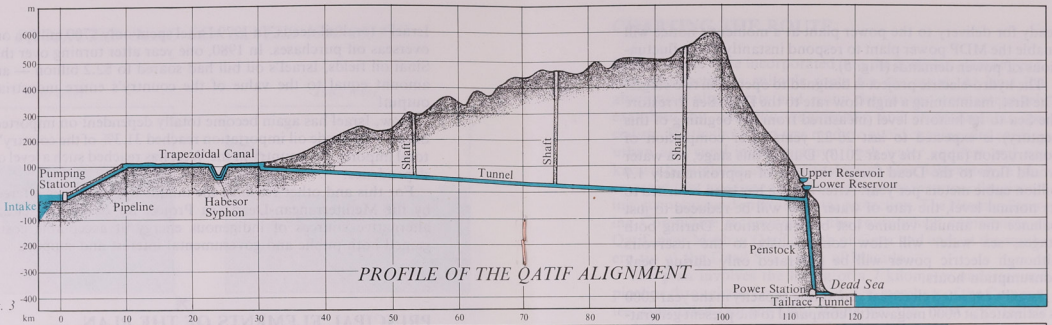

Fig. 3

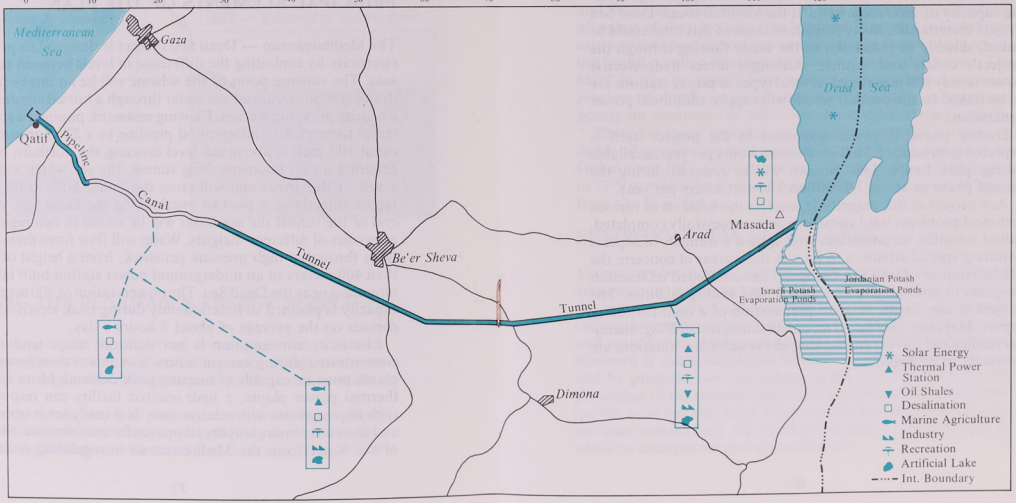

Fig. 4

ready for delivery to the power plant at a moment's notice will enable the MDP power plant to respond instantly to the fluctuations of power demands (Fig. 5).

The hydro-electric project is designed to operate in two stages. The first, maintaining a high flow rate to the Dead Sea to restore the Sea to its historic level (measured from the begining of this century) is expected to last 20-22 years after completion of construction (appx. the year 2010). During this stage, sea water would flow to the Dead Sea at the rate of approximately 1.7 billion cubic meters per year. After the sea has been returned to its normal level, the rate of water flow will be reduced to just balance the annual volume lost by evaporation. During both stages, sea water will flow continuously to the reservoirs although electric power will be generated only during peak consumption hours.

Israel's expected electrical generating capacity in the year 2000 is estimated at 6000 megawatts, compared to the present generating capacity of 2600 megawatts. If the Mediterranean-Dead Sea Project materializes, thirty percent or more of this total could be linked, directly or indirectly, to the water flowing through the project's canals and tunnels. Although direct hydroelectric power is only 800 megawatts, several types of power stations are to be linked to the conduit which will supply additional power generation.

During phase 1, power generated in the project itself is expected to produce 1.7 billion kilowatt hours per year, available during peak hours. This amount will be reduced during the second phase to about 1.1. billion kilowatt hours per year.

Any project of this magnitude requires the solution of various technical problems until construction is successfully completed. Initial scientific investigations highlighted a number of aspects requiring special attention. Aware of these areas of concern; the Mediterranean - Dead Sea Company has continued its research program in laboratories and actual field testing facilities. The project is now at the stage of preparation of a final feasibility report. Mapping, geological reconnaissance, test drilling, chemical studies and further engineering and economic evaluations are currently in progress.

CHARTING THE ROUTE

Many factors were incorporated into the complex planning process of selecting a suitable route for the canal. At least five alternative alignments and many derivatives were intensively examined by scientific, engineering and environmental specialists. Particular effort was made to avoid or safeguard existing urban and rural infrastructures, fresh water aquifers and any known holy places and archaeological sites. Ultimately, a plan emerged that was found most advantageous in terms of engineering, economic and environmental protection. The Neeman Steering Committee recommended the route which commences at Qatif, near Moshav Qatif, south of Gaza and ends at the southern tip of the Dead Sea, south of Masada.

The plan involves the laying of a 7 kilometer underground pipeline through the Gaza District. The members of the Committee, concluded that the Qatif Route was the most appropriate and desirable. They were satisfied that it was appropriate from all points of view, including the legal one. It seemed reasonable to assume that some type of agreement could be formulated providing for all possible legal eventualities for the Gaza District. The MDP facility designed for the segment of the route which spans a portion of the Gaza jurisdiction will be totally underground posing no hindrance or difficulties for normal surface activity.

There are many precendents for operations of this nature. A Saudi oil pipeline has been passing through Israeli villages in the Golan since 1967 without incident. The peace treaty with Egypt in 1979 provides for purchase and continuous oil supply to Israel from the Sinai fields.

ENVIRONMENTAL SAFEGUARDS

Technology is a human instrument for human needs. It exists to assist man in relating to nature, but it cannot be allowed to upset the balance of nature. A thorough study has been undertaken of the environmental impact of the project — both the long term as well as those which may occur during the period of construction. Research is continuing in the laboratory, by theoretical models and by practical research testing in the field. Concern for the protection of the environment was a decisive factor in determining the most suitable route for the canal. Environmental priorities also substantially increased construction cost estimates in order to incorporate protective devices.

The project is designed and constructed so that:

— Between the Mediterranean coast and the Dead Sea most of the facilities will be underground. Visible structures will be only those which must be located at the surface;
— Intake systems, canals, tunnels and shafts will disrupt surface infrastructures and planned rural development as little as possible;
— The pumping station located within the Qatif sand dunes will be buried thirty meters below the surface.
— The open 22 kilometer canal and 80 kilometer-long tunnel will be protectively lined in the best and most proven engineering methods to avoid leakage of sea water;
— Reservoirs will be built on impermeable rock and will also have an impermeable bottom of asphalt-concrete;
— Embankments will be able to withstand possible seismic shock;
— In light of the long time span (30 years) planned for restoring the level of the Dead Sea, and the need (independent of the MDP) for both the Israeli and Jordanian potash works to periodically raise their dikes, both activities will automatically coordinate so as to prevent dislocation to either potash works.

Exhaustive testing indicates that physio-chemical and biological effects of Mediterranean sea water introduced into the Dead Sea will neither adversely affect the environment nor the long term economic potential of the Israeli and Jordanian potash industries (Fig. 6). Investigation now taking place suggests that the addition of the sea water will actually increase the life span of potash production for both countries.

Along with the numerous benefits to be derived from the project, we recognize that some minor dislocations could occur to a few Jordanian roads and small areas of cultivation after an extended period. We can only hope that, on these subjects, early negotiations can take place between Israel and the Kingdom of Jordan. Israel has expressed its willingness to seek understanding and reach reasonable agreement with Jordan about these issues.

The Mediterranean-Dead Sea Project is important not only for the hydro-electric power generated, but also for several other related energy producing projects (Fig. 4).

Solar Ponds: Solar energy devices have been in operation in Israel for several years and new techniques are now being developed such as solar ponds which can utilize Mediterranean water.

Mediterranean Sea water, after surging through the hydro-electric power station will be "floated" on top of the heavier and more dense Dead Sea water. The upper layer allows the sun to heat the heavier water beneath and the difference in temperature between the layers can be used for powering turbines to produce electricity. Eventually, this MDP-related project may make possible an installed capacity of 1000-1500 megawatts, which would be linked to the network.

DAILY ELECTRICITY LOAD CURVE

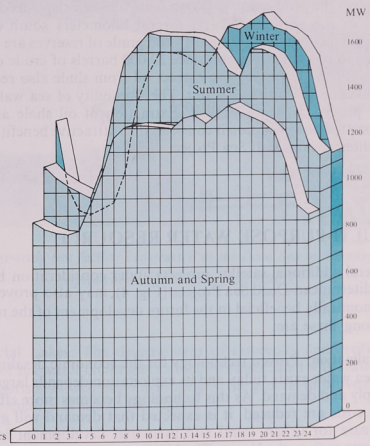

Fig. 5

Inland Thermal Power Stations: At present, power stations in Israel are situated along the Mediterranean coast. However, available land and environmental considerations greatly limit construction of additional power stations of any kind along the coast. Suitable inland sites must now be considered, but these require significant quantities of water for cooling purposes. The proposed conduit is capable of providing this needed water. The most appropriate area, according to preliminary site investigations, is in the western Negev, a treeless region of sand dunes and bare outcrops some 5-30 kilometers from the proposed canal. Power generated by the first inland station is planned to be in the magnitude of 1000 megawatts.

Oil Shale: A third project, still in the experimental stage, involves the production of power from oil shale deposits discovered in the northern Negev, several kilometers south of the proposed conduit. The quantity and grade of reserves are considered to be sufficient to produce 20,000 barrels of crude oil per day, but the technology to extract oil from shale also requires significant quantities of water. The suitability of sea water for this process is being studied. Extraction of oil shale and an associated power station is considered an attractive benefit of the Mediterranean-Dead Sea Project.

MULTI-PURPOSE WATER RESOURCE

Several additional satellite projects under consideration by the Mediterranean-Dead Sea Project (Fig. 4), may also prove to be economically beneficial in the future development of the region. Among these are:

Desalination: Proven technology for the economic desalination of sea water exists today and its exploitation depends largely on supply and demand. As this technology becomes more efficient and costs are reduced, it is expected that demand will greatly increase for urban, rural and industrial development in arid regions such as the Negev. The MDP envisions future desalination plants along the length of the canal, and especially at the Dead Sea valley.

Fig. 6

Large-scale test facility constructed at the Dead Sea to investigate physio-chemical and biological effects.

Artificial Lakes: The development of reservoirs and artificial lakes of sea water could service facilities associated with fisheries and tourism as well as contributing to the general improvement of the quality of life in the region.

IMAGES OF THE FUTURE

Soon, Israel expects the launching of one of the largest development projects it has ever undertaken. Engineers and scientists have now evolved an extensive plan for the revitalization of the deserts of the Negev. The application of technology has been channeled in the most creative way to generate long-term contributions to the economy and welfare of the peoples of this region. The scientific basis and technology of the MDP, is a commitment to the improvement of the environment and a mechanism for fulfilling human needs. No effort was spared in developing features to be built into the project for environmental protection. The initial objectives of developing a system for plentiful and clean energy, as well as ensuring rational use of water resources, have both been fully borne in mind.

The use of scientific knowledge and technology to provide energy and water resources, by its very nature, often transcends national borders.

The people of Israel expect the sharing of the benefits of this project with the Kingdom of Jordan, which has an equal stake in restoring the Dead Sea to its historic configuration as well as the storage and consumption of fresh water for irrigation of the region. The Mediterranean-Dead Sea Project is an opportunity for cooperative arrangements between the peoples who share the waters of the Jordan River.

The MDP can also be viewed as a vast long-term laboratory for research on subjects vital to the proper management of scarce resources in desert regions of the world. New capabilities and understanding derived from the scientific research and technology developed for the MDP may be beneficial to other countries considering similar projects. Scientists in Saudi Arabia, for example, have been developing a plan for hydro-electric power for the Dawhat Salwah Depression near Bahrain drawing water from the Persian Gulf. Egypt is considering developing the Oattara Depression in its Western Desert as an energy production plant with a conduit from the Mediterranean.

In a world of rapidly diminishing natural assets, the Mediterranean-Dead Sea Project deserves to be viewed as an effort to develop and protect the meager natural resources bestowed upon this land, as well as the rejuvenation of a barren territory which had once provided sustenance for mankind. In striving to restore life to this ancient land, the Mediterranean-Dead Sea Project will also serve as a bridge of understanding between Israel and its neighbors.