

Hidden water holds the key to a changing desert

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The Tzin Canyon in the central Negev Desert. It looks much the way the ancient Israelites might have seen it, but the desert has changed greatly since then.

Credit: Alan Brown | ISNS

Passover, which celebrates the Israelites' flight from Egypt, ended Tuesday night. Yet after the exodus, they wandered the desert for 40 more years. There, Moses struck a rock with his staff and made water flow.

Thousands of years later, modern Israelites are still trying to coax [water](#) from the harsh Negev Desert.

The Negev burns in the summer and leaves frost on the ground in winter. Last year brought an end to a 15-year drought that killed 70 percent of

the desert's scant perennials.

Yet agriculture thrives here. South of Beer Sheva, the city where Abraham signed a treaty about a well with King Abimelech, green oases of grapes, olives, and pomegranates dot the desert. There are greenhouses and fish farms, made possible by clever engineering and immense reservoirs of water hidden under the desert.

Yet when it comes to development, the Negev is every bit as much a test of faith as it might have appeared to the ancient Israelites.

A Changing Desert

The Negev accounts for 60 percent of Israel's land mass. It begins just north of Beer Sheva, where annual rainfall drops below 10 inches annually. It grows drier moving south. At its southernmost point, the port city of Eliat receives less than an inch of water annually.

Although its landscape appears timeless, the Negev was formed relatively recently, between 5,000 and 18,000 years ago, said Yaron Ziv, a landscape ecologist at Ben-Gurion University of the Negev who studies sand dunes.

"After the last [ice age](#), huge storms carried sand from Africa into the Negev. Lots of plants and animals came with the sand," Ziv said. These species, native to Africa, adapted to Israel's climate and evolved. Many of their descendants are unique to Israel.

The desert changed again more recently. Although the Negev and Egypt's Sinai Peninsula form a single desert, satellite photographs show a tan Sinai of sand dunes and a green spackled Negev.

The difference involves the desert's nomadic herders, the Bedouin.

Starting in the 1950's, Israel restricted their grazing rights. Without their animals crossing the sand, a crust of fungus, moss, lichen, and cyanobacteria formed over the dunes, locking them in place.

The Bedouin continued to roam the Sinai. They eventually over-grazed the land made fragile by 15 years of drought, contributing to the loss of productive land, or desertification.

Yet neither Sinai nor Negev resembles the desert Moses might have seen. In a healthy sand dune system, small tunnels are everywhere along the slopes. Nine different species of gerbil live there, each adapted to a particular aspect of the dune environment.

Atop the healthy dunes, there are only shifting sands and an occasional shrub. Many species of sand beetle live on the top of the dune, none on the slope.

"This is a three-dimensional environment," Ziv explained. The bottom is packed earth, the slope semi-stabilized sand, and the top blowing sand. Three feet under the harsh and arid surface, it is a more comfortable 73 F with 100 percent humidity.

Once, all the western Negev's dunes looked like this. Nomadic herds and wild [animals](#) -- gazelles, wild asses, and giant wild cattle called aurochs -- broke the crust as they grazed, creating a more dynamic and diverse environment.

Ziv hopes to recreate those conditions. His team is looking at how ATVs and army exercises might work the dunes to break up the crust.



A leaf juts out from a vine in late March at Nahal Boker Vineyards. Nearly 2,000 years ago, ancient peoples harvest water to produce wine. Today, farmers tap underground desert aquifers to drip irrigate vines adapted to grow in salty water. Credit: Alan Brown | ISNS

"Ziv's work deals with something we have to deal with in arid countries," said G. Allen Rasmussen, dean of Texas A&M University-Kingsville's College of Agriculture. Rasmussen is a board member of the International Arid Lands Consortium, which promotes cooperative desert research between six U.S. universities and research organizations in Israel, Jordan, and Egypt. The non-profit recently funded some of Ziv's research.

"He's asking fundamental questions about sand dunes, like how old are they, what stabilizes them, and what causes them to become unstable," Rasmussen said. "Those clues can help us deal with re-vegetation of sand dunes to reestablish the environment."

Hidden Resources

Sophisticated water management made such large populations possible. Throughout the Negev, there are many examples of modern water technology, including large greenhouses filled with tomatoes and peppers. They take advantage of abundant land, bright sun, and -- surprisingly -- water.

Hundreds of feet under the desert lay vast aquifers. The water is brackish, though far less salty than seawater. It is not renewable. Like seams of coal, once extracted, it is gone forever. There may be enough to last 100- 200 years.

Israel, which recycles 70 percent of spent municipal water (mostly for agriculture), goes to heroic lengths to use resources sparingly.

Watering is done by drip irrigation, which slowly releases water to plant roots. Not surprisingly, modern drip irrigation began in the Negev in 1965.

There are about 15 fish farms in the Negev. They use hot water to heat greenhouses during chilly desert nights. Spent water irrigates date palms and alfalfa, as well as greenhouse plants. The fish farm at Kibbutz Mashabbe Sade, 20 miles south of Beer Sheva, grows 15,000 sea bass at a time. The water runs through long ponds, where it entrains nitrogen waste from the fish, and then waters acres of olive and jojoba plants. The wastes fertilize the plants.

Most of the Negev's fish, fruits, and vegetables were developed to thrive in brackish water, but it costs money to pump water, irrigate plants and build greenhouses. Negev farmers' competitors are closer to distant markets and receive water free from rain.

One way to compete is by timing harvests, said Uri Hochberg, a graduate student who studies grape physiology at Ben-Gurion University. The

Negev's peppers and tomatoes ripen between growing seasons, when competing crops are not available.

"For two weeks each year, our greenhouses supply most of Europe's peppers and tomatoes," Hochberg said. That earns growers premium prices. They receive six times more for February grapes than those that mature in the fall.

Improving quality also makes crops more competitive. Ben-Gurion plant scientist Aaron Fait hopes to do that by reintroducing wild traits to tomatoes. These include better taste, but also resistance to drought and brackish water. He wants [plants](#) whose seeds all sprout at the same time, so farmers can water their tomatoes more efficiently.

His colleague, Naftali Lazarovitch, is bioengineering pomegranates with more antioxidants.

At Nahal Boker Vineyards, one of the Negev's smallest wineries, Moshe Zohar has grafted many popular varieties onto the root systems of salt-resistant vines. He waters using drip irrigation.

Barkan, one of the nation's largest winemakers, grows cabernet, merlot, pinot noire, and chardonnay further south. Daniel Rogov, a top Israeli wine critic, believes Negev has quality wines and they are improving every year.

Strikingly, it is the desert weather that helps produce outstanding wines. In their last weeks, grapes need warm days, chilly nights, and dry weather to reach full potential.

In fact, nearly 2,000 years ago -- more than 1,000 years after the Israelites moved onto their land of milk and honey -- desert dwellers produced excellent wines.

They were the Nabateans, the famed spice traders of Petra. Their wine was so well-regarded that they shipped it in uniquely shaped clay jugs so buyers would know it on sight. On the hills surrounding their walled towns, they built stone terraces that channeled the scarce rainwater into dry ravines.

Those ancient terraces are visible from Zohar's farm.

Today, Israelis want to farm the Negev on a far vaster scale. Their water management technologies are certainly sophisticated. But perhaps there is something to learn by studying sand dunes and the people who lived here thousands of years ago.

"We always talk about sustainability and carrying capacity," Rasmussen said. "Maybe we don't understand what our carrying capacity is. What would our true capability be if we managed the desert in a different way?"

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