

ENVIRONMENT

Bringing an Iranian oasis back from the dead

Water crisis and rising air pollution are stoking regional tensions

By Richard Stone, in Zabol, Iran

Sun-bleached skiffs lie in a jumble along the barren southern shore of Hamoun-e Puzak, a former lake. In the afternoon heat, Fata Morgana cliffs shimmer on the horizon. The boats aren't much use these days. Hamoun-e Puzak and two sister lakes are now seas of sand, and the marshes they supported have withered away.

"People would fish here. Children would swim here. No more," says Nayyereh Pourmollae, who heads the environment department of Sistan and Baluchestan province in southeastern Iran. The Hamoun wetlands, which once encompassed as much as 5800 square kilometers along Iran's border with Afghanistan and supported settlements stretching back 5 millennia, "are an ecological catastrophe," she says. On the Iranian side, villages are emptying. Winds in what has become a dust bowl ravage crops and sweep up pesticide residues and other pollutants. And a haven for migratory birds and other wildlife is vanishing.

But now, after years of bickering about which country is to blame, Iran and Afghanistan are discussing solutions.

Since 2014, the United Nations Development Programme (UNDP) has been crafting a restoration plan that would require Afghanistan to help restore the flow of the Helmand, the main river feeding the former wetlands, and Iran to overhaul its water management. And last month, experts from the two nations met in Paris for a workshop on transboundary water issues. The bilateral efforts hearten water researchers. As dire as the situation has become, "The Hamouns can be saved," says Farhad Yazdandoost, an expert on water resources management at Khajeh Nasir Toosi University of Technology in Tehran.

Water woes plague Iran. Precipitation is sparse in most areas and unreliable, but some of the worst scourges are self-inflicted. Hundreds of thousands of illegal

wells nationwide are depleting aquifers, for example, and scores of major dams are diverting water for irrigation. In one high-stakes initiative, the government is trying to save Lake Urmia, which covered about 5200 square kilometers at its peak but has largely evaporated (*Science*, 4 September 2015, p. 1044). The decline of the Hamouns, which lie in a poor border region beset by drug smugglers, has occurred out of the spotlight. Yet it threatens people and ecosystems on both sides of the border, making it "one of the biggest human security challenges we face in south or west Asia," says Ahmad Abrishamchi, a water expert at Sharif University of Technology in Tehran.

The vulnerable hydrology of the Hamoun oasis was its undoing. Snowmelt in the Hindu Kush mountains of Afghanistan feeds the Helmand, which flows into Hamoun-e Puzak. From there, water would spill into the other two lakes (see map, right). The result was an expansive way station for flamingos and other migratory birds and a home for otters, deer, and leopards. The delta would expand and contract seasonally; in springtime, water would circulate back into Afghanistan.

But that was decades ago. In the early 1950s, Afghanistan built Kajaki Dam on the Helmand, upstream of Kandahar. The Helmand's flow tapered, but the Hamoun oasis held on until Afghanistan dug irrigation canals in the 1990s, Iranian officials say. "Virtually everything depends on what happens upstream in Afghanistan," Yazdandoost says.

"I don't buy that," says Sher Jan Ahmadzai, a water expert and director of the Center for Afghanistan Studies at the University of Nebraska in Omaha. He says there has been virtually no development on the Afghan side of the border in the past 40 years. Ahmadzai and Afghan officials place the blame squarely on Iran's own water management, including diversions from the Helmand to supply four

reservoirs—the Chah-nimeh—filled in the 1990s and 2000s to store freshwater for the provincial capital, Zahedan, and other towns.

Either way, these days the Helmand in Iran is dry, apart from water pulses that arrive between February and April, says Reza Mirshekar, an ecologist with the province's environment department. Last October, when *Science* visited Jarike Dam, where the Helmand crosses into Iran, not a drop of water was present in a riverbed choked with

A sea of sand

The three Hamoun lakes dried up more than a decade ago, taking an entire wetland ecosystem with them.



yellow sand and fringed with scraggly tamarisk. Jarike was built in the 1960s to control springtime flooding, Mirshekar says. Now, the rusting structure is an anachronism. "The last flood was 30 years ago," he says.

Dwindling water resources have left the area on the knife-edge of sustainability. Clusters of blue-and-white-checked water towers, replenished primarily by water from other regions, stand guard over many villages in Iran's Sistan region. Cities such as Zahedan and Zabol rely on the Chah-nimeh. "If these

dry up, everyone here will have to migrate," Pourmollae says. The situation is even more dire on the Afghan side of the border, where most people now rely on water trucked over from Iran, Ahmadzai says.

The retreat of the Hamoun lakes and wetlands—a process that accelerated in the late 1990s until the surface water largely vanished in 2004—has compounded the crisis. Fierce winds blow from May to September, sweeping up toxic dust. In 2016, Zabol had the highest levels of fine particulates of any city anywhere, according to the World Health Organization—an annual mean of 217 micrograms per cubic meter of the smallest particles, called PM2.5. That surpasses notoriously polluted cities such as Beijing and New Delhi.

The restoration plan UNDP is developing with input from Iran and Afghanistan would ensure that less water is diverted from the Helmand for agriculture; channel some water from the Chah-nimeh reservoirs to the Hamouns during the dry months; and, in both countries, encourage a switch to less thirsty crops and widely implement drip irrigation. Afghanistan's government is ready to work with Iran on a solution, Ahmadzai says.

Negotiating the details and funding will take years, Ahmadzai predicts. Yet Soroosh Sorooshian, a water expert at the University of California, Irvine, is convinced that the Hamouns are not a lost cause. "Experience has shown that water bodies that have dwindled to nothing can bounce back," he says. "It might take decades, but there is still hope."

In an abandoned village west of Zabol, near a former lake shore, single-story domed houses of beige brick are half buried in sand. Outside the home of one of the last remaining families, a young girl corrals a little lamb almost as big as she is and cradles it like a baby. Her family is hopeful despite the devastation, Mirshekar says. "They are waiting for the water to come back." ■



On a desiccated Hamoun lakebed, grazing destroys fragile groundcover and can worsen dust storms.

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