Climate change and the future of Mono Lake

December 13 2013, by The Earth Institute, Columbia University

Runoff from snow and rain in the Sierras feeds Mono Lake. Credit: D. Funkhouser

Guleed Ali pauses to study his notebook, standing on a steep slope covered in gray volcanic ash and desert brush, high above the present-day shore of Mono Lake in eastern California. He looks across the slope to where, a few hundred yards away, a gash of lighter gray sediment cuts across the hill, then disappears. The exposed sediment is history: A record of deposits left by Mono Lake when it stood far higher than today.

Ali picks a spot, hefts his shovel and begins clawing into the slope, raising puffs of dust, searching for a missing page in that sediment history: something higher upslope, evidence of the stream that would have fed the prehistoric lake: a layer of gravel. He finds only sand – perhaps an ancient beach. He moves across the slope, lifts and plunges his shovel back into the soft hillside.

He is digging for dates, looking back tens of thousands of years into the last ice age: When was the lake higher? When did it shrink, and grow again? How does that chronology correspond with the advance and retreat of the massive ice sheets that covered much of North America? And how did the lake's levels respond to changing climate?

Understanding that past will help scientists like Ali, a PhD student at Lamont-Doherty Earth Observatory, project what might happen in the future as the world warms up. This is no esoteric question for Los Angeles, whose nearly 4 million people depend in part on Mono Lake's watershed for drinking water, green lawns, agriculture and industry.

Mono Lake sits above 6,000 feet, just east of the Sierra Nevada Mountains and not far from the eastern edge of Yosemite National Park. It is among the oldest lakes in the United States: at least 760,000 years old, possibly as old as 3 million years. The lake covers about 70 square miles; at its deepest, it sinks 159 feet. Primarily fed by snowmelt and rainwater running off the Sierras, it has no outlet. The streams and springs feeding the lake pump in chlorides, carbonates and sulfates, making Mono Lake more than twice as salty as the ocean and highly alkaline, with a pH of about 10.

Despite that inhospitable chemistry, the lake is a vibrant ecosystem: algae, brine shrimp the size of rice grains, and black carpets of alkali flies provide the base of a food chain that nourishes millions of migrating shorebirds – among them Wilson's Phalaropes, Eared Grebes

and California Gulls.

But Mono Lake is a landscape caught on the edge: Growing Los Angeles, thirsty for more water, began tapping the streams that feed the lake in 1941, using only gravity to send the water through culverts, tunnels and pipes to the Los Angeles Aqueduct, 350 miles south to the city. By 1982, the lake level had dropped 45 feet, halving the lake's volume and doubling its salinity, threatening the wildlife there.

Tall, craggy limestone towers – called "tufa"—that had formed beneath Mono's waters now stood on dry land. Islands where California Gulls had nested turned into peninsulas, and coyotes trotted across to destroy the rookeries. Creeks dried up, and the riparian desert ecosystem "was shattered for decades," said Bartshe Miller, education director for the Mono Lake Committee, which maintains its headquarters, a gift shop and a row of cabins for researchers and interns in Lee Vining, just above the lake's western shore.

The volunteer Mono Lake Committee, the Audubon Society and others sued, citing laws that required that scenic and recreational values had to be balanced with urban areas' needs for water. In 1983, the California Supreme Court agreed, and a plan was undertaken to restore the lake. Los Angeles cut its water take from Mono Lake, and the city's Department of Water and Power undertook a broad conservation program. The amount of water Los Angeles can take now depends on the lake level.

Since the agreement took effect in the mid-1990s, the lake has risen halfway back to its targeted level. But after years of drought, the level dropped a foot and a half over the past two years. If it drops another four feet, Los Angeles would be cut off entirely. Meanwhile, the extended drought in the Southwest has strained more significant water sources for

LA and other cities, such as the Colorado River system.

What will the future hold? Researchers like Ali are trying to find out, by looking deep into the past. The work has been going on for years, involving many researchers from Lamont and elsewhere, including Ali's advisor, Sidney Hemming, her husband Gary Hemming and her former student, Susan Zimmerman. Former Lamont researcher Scott Stine has been digging into Mono Lake's past for more than three decades.

"I can't imagine ever not working out there," Sidney Hemming said, reflecting on the area's rich geological potential. "Every time I go I feel like I've learned so much that it's unlikely I will have ever run out of new things to learn."

Wilson's Phalaropes are among the migrating birds that stop over at Mono Lake to fatten up for their long journey. Credit: D. Funkhouser

The connection to Columbia dates back to the late 19th century, when Israel C. Russell, who studied and taught at the Columbia School of

Mines (forerunner of the Fu Foundation School of Engineering and Applied Science), wrote about his findings at Mono Lake. Russell was a founder of the National Geographic Society and led the society's first scientific field expedition.

Guleed Ali's parents are from Somalia, and both came to the United States to attend college. Ali was born in New Jersey but raised in Saudi Arabia, where his father worked as a chemical engineer for an oil company. He went to high school in Houston and earned his BS in geology from the University of Arizona; he then came to Lamont-Doherty. He has an evident affinity for arid climates.

At Mono Lake, he works mostly alone. He is not a particularly observant Muslim, but, he said, he fasts during

Ramadan for the self-discipline. When I visited in July, he slept outside his cabin in the lakeside town of Lee Vining, in a sleeping bag, dressed in a long blue and white khamis. He rose before dawn to eat a bowl of cauliflower and mushroom soup, and did not eat or drink, even water, during long days in the dry, dusty landscape. He carries a shovel and a backpack with a rock hammer, GPS reader, notebook and plastic bags for samples. Working his way along stream beds or sliding along steep slopes of volcanic ash in his sandals, he will spend hours looking at the landscape, trying to make sense of what he is seeing.

Shadowed terraces mark ancient shorelines of Mono Lake. The broad cut at the center is Mill Creek; the narrower cut to the right is Wilson Creek. Credit: D. Funkhouser

With no natural outlet, Mono Lake is especially sensitive to changes in precipitation and evaporation. By looking at layers of sediments in deeply cut stream beds, Ali is trying to produce a chronology of events going back thousands of years, to the time when ice sheets and glaciers were at their maximum extent across North America. To the lake's north, east and south lie a series of volcanic hills; 19 different layers of ash from past eruptions – as recently as several hundred years ago—bookmark the sediment, providing datable layers that, coupled with the silts and gravels buried there, can provide a timeline of past lake levels. Gravel can indicate a stream bed; sand, a beach or river delta; fine silt, deeper water.

Ali has found another good source of datable materials: mineral deposits

from algae that once lived on now-exposed tufa that originally formed below the water's surface. With help in the laboratory from former Lamont student Xianfeng Wang (now at the Earth Observatory of Singapore), Ali is trying to get a century- or even decadal-scale resolution of past lake levels.

Such a precise record of past climate, Hemming said, could help piece together the history of North American climate, and help modelers better predict what would happen in the future as the climate changes. That could play an important role in water use planning for the entire Southwest.

More information: For a closer look at scientific research about Mono Lake, visit the Mono Lake Committee's research clearing house website: www.monobasinresearch.org/research/

The blog post has originally appeared at www.ldeo.columbia.edu/news-eve … and-future-mono-lake

Provided by The Earth Institute, Columbia University