California looks at new way to manage water

By Lenny Bernstein, Washington Post

Like a pitcher taking the mound on opening day, Frank Gehrke gets the spotlight in California every early April. That's when the otherwise obscure state water official trudges into the Sierra Nevada mountains, media in tow, and plunges aluminum tubes into the snow.

With those snow samples — and historical data and mathematical formulas — Gehrke and his colleagues can tell anxious farmers and hydroelectric power generators how much water they can expect for the coming summer.

Even with about 150 people taking samples across the state and the help of satellites and sensors buried in the ground, it's a highly uncertain way to gauge much of the water supply for a thirsty state, where every drop is precious and expensive to move. According to one study, the predictions are off by 18 percent at least half the time.

Manually checking the water content of the snowpack is a winter ritual in the Sierra. Photo/LTN file

That could change dramatically if an experiment in snowpack measurement under way this month proves promising. For the past few weeks, researchers from NASA and the California Institute of Technology's Jet Propulsion Laboratory have been flying over the Tuolumne River Valley, which runs through Yosemite National Park, with sophisticated instruments that measure the snow's depth and area, as well as the amount of energy it absorbs from the sun.

That will allow them to more precisely predict the volume of water that will come from the Sierra snowpack for 2.6 million people in the San Francisco area, how fast it will melt, where it will flow and how soon, the researchers say.

And they can deliver that information within 24 hours — a potential godsend to the people who control the hundreds of reservoirs strung the length of the state. When water managers guess wrong about the supply headed from the mountains, the valuable liquid can spill over dams or run dangerously short. Those can be expensive mistakes for consumers, farmers and electric utilities.

"What [the new method] gives me that we have never had is an actual estimate of what the total volume of water is in the mountains," said Bruce McGurk, a consultant to the Airborne Snow Observatory (ASO) project and former manager of the Hetch Hetchy reservoir, which serves the San Francisco area. "All we've ever had is the statistical relationship between snow measurement at a bunch of points" and the water flow, he said.

Gehrke's calculations show that the state will deliver only 35 percent of its normal water supply to agencies across California, which must figure out how to make up some of the difference. Farmers already are preparing to see their allocations cut and consumers are being urged to conserve. Knowing more about when the water will come down from the mountains would help.

“The idea that you can determine the total snow water equivalent in the basin is the icing on the cake of snow science,” Gehrke said.

At 20,000 feet, a DeHavilland Twin Otter aircraft jammed with equipment can cover the entire Tuolumne River basin in about six hours, according to Thomas Painter, the lead scientist on the ASO project, which has been aloft weekly since the beginning of April. Light-detection and ranging lasers, more commonly known as lidar, measure the depth of the snow, while a spectrometer maps the area it covers.

Also critical is the snow’s “albedo,” or reflective quality, which dictates how much sunlight it absorbs and helps determine how quickly it will turn to water. Albedo varies considerably; freshly fallen snow reflects 90 percent of the sunlight that hits it, while older snow, which forms larger crystals, reflects only 60 percent. Dust and black carbon carried to the snowpack by winds also can change the percentage. The spectrometer measures that as well.

The information is fed into powerful computers and combined with historical measures and models of snow density, Painter said. The end product, the scientists hope, will be the best estimate of water volume and flow ever developed, a truly new generation of snow science and snowpack measurement.

Satellites can map the snow’s area, but they provide huge snapshots, compared with the aerial surveys, which can show a patch of snow a yard or two square, and a patch of bare ground next to it, Painter said. And the satellite images can take weeks to arrive.

A sparse network of underground sensors, known as “snow pillows,” provides some idea every few hours of the snow’s depth, but they weigh everything that lands on them, including tree branches and the occasional bear, Painter said. They are small and there are far too few of them, none in the higher elevations of a mountain range that reaches more than 13,000 feet. There is no method to calculate snow albedo.

“We are massively undersampling the snowpack,” Painter said.

Climate change has begun to make the historic data that snow scientists use less reliable, McGurk said. “Our predictive tools get noisy,” he said. “What that means is you have to hedge more.”

Attempts at aerial snow measurement have been made for the past five or 10 years, said Ethan Gutmann, associate scientist at the National Center for Atmospheric Research, who has mounted a single, fixed laser in the Rocky Mountains near Boulder, Colo., to measure the snowpack there.

The aerial survey can cover a huge area once a week, while Gutmann’s laser provides continuous, precise information but for a much smaller swath. It is much less expensive than the $1 million aerial project and not subject to days when planes can’t fly, he said.

But the ASO, he said, is “the future of snow science and resource management for mountainous areas” and probably beyond.

Hetch Hetchy is a small reservoir by California standards; it holds just 360,000 acre-feet of water. (An acre-foot is the volume of water that would cover an acre at a depth of one foot, or about 326,000 gallons.). When water is plentiful, the challenge is to channel it to hydroelectric generators without allowing it to collect too quickly in the reservoir and spill over the dam.

The water needed to generate electricity at the Kirkwood Powerhouse 11 miles away is worth $66,000 per day, McGurk said. Any mistake that results in the use of gas or coal to generate power is therefore quite expensive and releases greenhouse gases into the atmosphere. Heavy spills also can affect downstream ecosystems, he said.

In times of scarcity, like the approaching summer, the trick is to keep the reservoirs as full as possible, while supplying consumers and farmers with the water they need. Moving water is an extremely expensive proposition in California. About 15 percent of the power used in the state goes to pumping water through its vast network of reservoirs and pipelines, McGurk said.

“There are very large dollar figures attached to this water and knowing how much is there and when it’s going to come out,” Gutmann said.

In droughts, water managers may have to shortchange power generators to ensure that reservoirs are full when the snowmelt stops flowing in the spring. “There is a great penalty, both political and personal,” for missing that goal, McGurk said.

“We’ve had reasonably good tools, and we were doing OK,” he said. “And what we’re trying to do is get to the next level.”