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CALIFORNIA'S CHANGING CLIMATE

WATER AT RISK AS STATE WARMS

By Mike Taugher
MediaNews

Without water and the ability to move it efficiently over hundreds of miles -- to cities, suburbs, farms and factories -- California would be unrecognizable as the fertile, vibrant state it is today.

Already, scientists say, there are clear signs that global warming will put that vital flow in jeopardy.

The Sierra Nevada snowpack, a natural reservoir that stores 40 percent of the state's water supply in the winter and gradually releases it in the spring and summer, is shrinking. The mountains are getting more rain and less snow, and the snowpack is melting at least a week earlier than it did before World War II.

Sea level has risen half a foot at the Golden Gate. It is expected to rise more, threatening the purity of water and the integrity of levees in the Sacramento-San Joaquin River Delta, the fragile heart of California's water system.

As these trends accelerate, they could unhinge the state's finely tuned system for capturing and distributing water, leading to more winter flooding and summer drought. The changes will be difficult to manage, and there are wide differences of opinion on how and whether that can be done.

Some scientists predict that in the coming decade, fresh water -- the subject of fierce and perpetual battles among farmers, cities and environmentalists -- will become even more scarce.

Gradual attrition

"It happens slowly," said Steve Hall, executive director of the Association of California Water Agencies. "You might not notice it until there are some real consequences."

Statewide, the loss could amount to 3 million to 4 million acre-feet a year within 50 years. That is more water than is delivered each year by the California Aqueduct, the 444-mile canal that supplies Southern California with water from the delta.

The shift also could cause more flooding. For a hint of what that might look like, recall May 2005. An unusually warm spring storm moved into higher elevations around Yosemite National Park. Where clouds would normally drop snow, it rained.

The rain quickly washed into streams, which filled and broke through riverbanks in low-lying areas, causing widespread flooding in Yosemite Valley. Campgrounds drowned, water pooled on roads and officials closed the valley for a day.

For a relatively small storm, it caused a lot of havoc.

"This is an analogue of what might happen," said Daniel Cayan, a researcher at the Scripps Institution of Oceanography in La Jolla. "As time goes on, we're expecting those warmer storms to be more frequent."

Climate models predict that California's average temperature will increase 3.6 to 10.8 degrees Fahrenheit in the next century. For every 1.8 degrees of added warmth, snow level in the Sierra is expected to move 500 feet higher.

Even at the low end of that range, snow level would rise about 1,000 feet, cutting the state's snowpack in half, according to one simulation by climate scientists. In the worst case, the Sierra snowpack could shrink by as much as 90 percent.

The northern Sierra, California's most important snow country, is at a lower elevation than the southern portion of the range and is especially sensitive to warming temperatures.

"That rain/snow line is going to rise to the summit" in much of the northern Sierra, said Jeff Mount, director of the Center for Watershed Sciences at the University of California-Davis. "That changes everything."

More than 150 scientific papers have been published on climate change and California's water. They contain an increasingly clear message that global warming is here, said Peter Gleick, president of the Oakland-based Pacific Institute. A scientist and environmental advocate, he published the first detailed study of how climate change could affect the state's water supply 27 years ago.

"I can't tell you if it's 80-20, 70-30, 60-40 or 50-50," Gleick said. "But we can't explain the changes that we're seeing without invoking human influences. They cannot be just the results of natural variability."

Six years ago, scientists using data on Sierra snowmelt and the first spring blooms of lilacs and honeysuckles concluded that spring has been arriving earlier in the West since the 1970s.

At first, the researchers could not rule out the possibility that the shift was caused by the warm phase of a natural climate cycle. But later studies mostly rejected natural causes as an explanation.

A 2005 paper in the *Journal of Climate* confirmed the early blooming trend. It added that Western mountain streams continued to swell with melted snow one to four weeks earlier in the spring, even after the climate cycle shifted back to its cooler phase.

"These trends are large throughout the western United States but largest in the Pacific Northwest and the Sierra Nevada," the paper reported.

It suggested that natural weather cycles were not enough to explain these trends. Human activity must be a factor.

In September, some of the same scientists published a report in the *Journal of Climate* that said warmer winters and early springs also were causing more precipitation to fall as rain instead of snow. Again, the trend was strongest in the Sierra Nevada and the Pacific Northwest.

"I think we would be foolish to dismiss this as an early symptom of global warming," said Cayan, who is a co-author of both papers.

Controversy over reservoirs

Water officials and Gov. Arnold Schwarzenegger say a warming climate is a good reason to build more reservoirs; by capturing more rain and early snowmelt, they would help make up for losses in other parts of the system.

However, building those storage facilities is politically controversial, expensive and environmentally damaging. Some, including Gleick, say conservation, efficiency and underground water storage are better options.

"I would argue that we don't know if we can manage the system for the changes that are coming, but it's possible," Gleick said.

"We want the reservoirs to be as empty as possible in the winter for flood control, and yet as full as possible at the beginning of summer for the dry season. We make a decision on every reservoir when to stop letting water go and start filling it up, and we base that decision on our historical experience of storms when they come, and our measurements of how much water is in the mountain as snow.

"If we just change the operating rules for these reservoirs, we might be able to manage climate change," Gleick said, adding that it will take a lot more study to determine whether that is possible.

Compared with other western states, California stores more of its water as snowpack, rather than in reservoirs. Dams on the Colorado River upstream of California, for example, can store several years' worth of runoff, while Northern California reservoirs hold about one year's worth, water officials said.

Balancing act

For dam operators, the balancing act they perform will become more difficult.

If they overestimate the threat of winter flooding and draw down reservoirs too far, they are more likely to end up with water shortages in the summer.

If they fill reservoirs too early in the rainy season, they risk flooding downstream communities, such as Sacramento, when later storms hit.

Mount, of UC-Davis, said the interests of cities and farms will be in direct conflict, and it will be impossible for water managers to satisfy both.

``You've got a world-class hog wrastle right there," he said.

The environment will have a new claim on water, too.

If mountains drain earlier in the year, less cold water will be available in rivers for salmon and other fish. Policy-makers could see building more reservoirs as a solution.

``I see a giant tug of war," Mount said.

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