Tahoe analysis adds 'when' and 'how much' to climate-change forecasts

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UC Davis scientists today issued the most detailed forecast to date of likely climate-change effects at Lake Tahoe, complete with estimates of when those effects might be seen and how big they might be.

Their findings suggest that even under the most optimistic projections:

• The average snowpack in the Tahoe Basin will decline by 40 to 60 percent by the year 2100;
• Floods will increase in the middle of the century;
• Prolonged droughts will become more common at the end of the century; and
• A new threat to the lake's unique ecology, one that will come from the very bottom of the lake, will become important by the second half of the century.

The report was written for the U.S. Forest Service's Pacific Southwest Research Station. Its lead authors are Robert Coats, a UC Davis researcher and consulting hydrologist, John Reuter, associate director of the UC Davis Tahoe Environmental Research Center, and Geoff Schladow, the center's director.

"Public dollars are funding restoration programs in the Tahoe region, which is a special place for millions of people," said Schladow. "For these programs to succeed, resource managers need to know what to expect in the coming decades.

"Will we have more or less snow, rain and runoff? Will the erosion controls and stormwater basins we are devising now still be useful in 30 or 50 years? What impact might climate change have for Lake Tahoe's water quality and aquatic ecology?" Schladow said.

In recent years, UC Davis researchers have drawn on 100 years of data to describe changes in temperature and precipitation that have already occurred in the Tahoe region.

The new report combines those findings with sophisticated computer models to produce detailed local projections out to the year 2100. The scientists considered two possible future carbon emission scenarios — one "business as usual" — in which population growth and national and international policies affecting global climate change remain unchanged — and the other "optimistic," assuming slower growth and aggressive climate action.

"While there is always some uncertainty when projecting this far into the future, the results appear reasonable," said Reuter. "They provide environmental managers and scientists with our first detailed glimpse of the potential impact of climate change on precipitation, runoff, water quality, and plant and animal resources in Lake Tahoe."

This glimpse gives scientists and resource managers a better chance of taking strategic steps to minimize coming impacts of climate change.

Those potential impacts include:

Precipitation: No strong increase in the amount of annual precipitation was predicted. However, the Tahoe Basin will see a continuing shift from snowfall to rain, as well as earlier snowmelt and runoff. Based on the modeling scenarios, by the end of the century, precipitation in some years could be all rain and no snow. The peak snowmelt in the Upper

Truckee River will occur four to six weeks earlier by the end of the century.

Water flow and quality: Floods will be larger and more frequent in the middle of the century. Peak water flows in the Upper Truckee River, the largest river flowing into Lake Tahoe, will more than double, with the future “100-year flood” resembling today’s “1,000-year flood.” Such high streamflows will threaten regional infrastructure (such as roads and bridges), the authors said.

In the case of water quality, the model simulations showed that, even though more stormwater runoff is forecast, today's best management practices will be able to accommodate the bulk of the increase. The simulations showed that predicted growth in runoff will cause only a 10-percent decline in the performance of urban stormwater control devices configured to current requirements.

Droughts: Droughts will be more severe, especially toward the end of the century and on the east side of the basin.

Truckee River water supply: Toward the end of the century, there are likely to be longer periods when the lake falls below its natural rim and water stops flowing into the Truckee River. (In the last 110 years, the lake has fallen beneath its natural rim on only 20 occasions, and only for a few months or years at a time.) Under the “business as usual” scenario, these periods could be as long as 10 to 20 years. This would eliminate a large part of the downstream water supply for Reno, Pyramid Lake and agriculture. Under the "optimistic" scenario, these periods would last several years at a time and occur more frequently than in the past.

Lake turnover (vertical mixing): The new analysis confirms the researchers' 2008 warning that climate change is likely to greatly alter water circulation in Lake Tahoe. By the second half of the 21st century,

there are likely to be decades-long periods when the lake stops mixing to the bottom. (Historically, this complete mixing or turnover has occurred once every four years, on average.)

Turnover carries oxygen from the surface to the bottom of the lake. Without oxygen, a large part of the lake will be inhospitable to trout and other game fish.

Lake clarity may be impacted as well. Prolonged absence of mixing could start a physical-chemical process resulting in the release of large amounts of phosphorus from the lake's bottom sediments. If this phosphorus reaches the surface, it will feed algae. Algae are one factor contributing to reduced water clarity. In addition, when algae sink to the bottom and decompose, oxygen is taken from the deep water, thus creating a downward spiral in water quality and clarity.

The authors conclude that public programs at Lake Tahoe to restore lake water quality (such as the Environmental Improvement Program and best management practices) are needed more than ever.

“The Total Maximum Daily Load (TMDL) program, which prioritizes fine-particle removal to improve clarity, may be the most important local action to be taken to help mitigate against climate change,” said Schladow. “Phosphorus, the limiting nutrient at Lake Tahoe, will be reduced in direct proportion to the removal of fine particles, and this will help reduce the oxygen demand of the lake and increase its resilience to change.”

There is little time to waste, said Robert Coats. "Lake Tahoe is very close to at least two tipping points. First, a decrease in deep mixing could trigger abrupt changes in water quality and clarity. Second, our modeling results show that a decades-long shut-off of lake outflow by the end of the century is likely, cutting off a large part of the water supply for Reno

and other downstream users.

"When we add the expected terrestrial impacts of increased drought — especially tree deaths and wildfire — it is clear that by 2100, the Tahoe Basin will be different from the one we know today," Coats concluded.

The new report has value to water resource managers beyond the Tahoe Basin, since many other lakes and reservoirs are likely to be affected by climate change. "Our team came away convinced of the value of early collaboration between the science community and regional resource managers," Reuter said.

More information: Read the full report

Provided by UC Davis

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