California is once again being deluged by atmospheric rivers. What are they, and will climate change make them worse?

March 20 2023, by Cynthia McCormick Hibbert

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California is once again being deluged by atmospheric rivers that have unleashed major flooding across the state, with river number 12 scheduled to dump more precipitation the week of March 19.

Experts from Northeastern explained in a story that originally ran in January what causes these flowing streams of vapor that causing the record rains and deadly floods that have put millions of people under an evacuation order.

They talked with Northeastern Global News about the science behind the weather events—and whether climate change and global warming will increase the intensity of rainfall associated with these rivers in the sky.

Atmospheric rivers are responsible for ferrying fresh water from the warm tropics eastward to the Western United States, where the associated vapors condense into rain and sometimes snow.

The 'Pineapple Express'

"There are these ribbons of very moisture laden air that extend out of the tropics," says Samuel Munoz, assistant professor of marine and environmental science at Northeastern's Marine Science Center and Coastal Sustainability Institute.

"When they collide with a coast, that's the dominant mechanism by which California and much of the Western U.S. and Pacific Northwest in Canada get rain," he says.

Because the atmospheric rivers originate in Pacific tropic areas such as Hawaii, meteorologists dub them "the Pineapple Express," says Lindsay Lawrence, a Northeastern Ph.D. student who has bachelor's and master's degrees in meteorology.

"Generally speaking, atmospheric rivers are most extreme during winter months, December, January and February," Lawrence says.

Even in a normal season, atmospheric rivers can wreak havoc.

Capable of being 300 miles wide and thousands of miles long, the moisture-laden streams can carry many times the volume of water of the Mississippi River, says Auroop Ganguly, director of the Sustainability & Data Sciences Laboratory at Northeastern.

"When these massive waterfronts—the largest transporters of freshwater on the planet Earth—hit land, they usually result in massive rain and snow events leading often to devastating floods."

Not all atmospheric river events are catastrophic, but events such as the Pineapple Express have the ability to dump an immense amount of rain and snow in a short amount of time, according to the National Oceanic and Atmospheric Administration.

"We've had six storms in the last two weeks. This is the kind of weather you would get in a year and we compressed it just into two weeks," California Lt. Gov. Eleni Kounalakis said Wednesday, according to CNN, which reported that four more atmospheric rivers are supposed to hit the state in the next week or so.

The new events are on top of the five that have already occurred and been associated with the deaths of 19 people, including a 5-year-old boy swept away in flood waters.

"They have come one after another," Munoz says. "That's causing really huge amounts of water to be delivered all at once."

The impact of climate change

Atmospheric rivers may deliver even more rain in the future, scientists say.

"Ongoing research suggests that they may get more intense in climate

change," Ganguly says.

As the atmosphere warms, it holds more moisture, Munoz says. As with hurricanes, some research associates the increased moisture to heavier rainfalls.

Other scientists are looking into whether climate change is associated with changes in where atmospheric rivers make landfall, possibly moving southward, Munoz says.

Atmospheric rivers have cold fronts and warm fronts located off a low pressure center, Lawrence says.

As the rivers stream westward, the cold front tries to catch up to the warm front, forming a narrow band of water vapor, she says.

If the location of the low pressure shifts, the entire system will move around, Lawrence says. "To know where they are going to move is unfortunately hard to say right now."

Munoz says it appears that catastrophic atmospheric river events occur every 100 to 200 years, with the phenomenon contributing to the Great Flood of 1862. The flood is believed to have killed 4,000 people in California according to U.S. Today and other sources.

Wildfires and drought are making floods worse

The current flooding in California is being aggravated by historic wildfires and drought that are tied to climate change themselves.

"When you burn a forest, the burning of organic compounds produces compounds that are hydrophobic, that repel water," in the form of ash, Munoz says.

When rain falls on the ash it is less likely to seep into the soil and recharge into groundwater and more likely to run off toward streams and rivers and lakes, he says.

The runoff contributes to flooding, Munoz says.

Drought also poses a flooding risk because the soil can get so dry it loses its ability to absorb water, sort of like a too-dry sponge, he says.

"When they're super dry, their ability to take up moisture is reduced."

Planning for the future

"California is sort of this world of extremes," Munoz says.

"They do have prolonged periods of drought, and that's getting more severe. But they also have this history of really severe atmospheric river events that cause flooding. It's possible that in the future these kinds of events will become more severe."

With access to water being such an issue in California, Munoz says he believes officials need to find ways to capture and store water during deluges as part of planning for the future.

Right now, state and local California officials are concerned about saving lives and the infrastructure.

But after the storms are over, Munoz says officials will face important and continuing questions about water supply.

"Are there ways we can store some of this water that right now there's an abundance of but will very quickly flow back out to sea?" he asked. "Is there some way to capture that?"

Provided by Northeastern University