A megafire induced over a century's worth of erosion near Utah Lake—but there's more to the story, say scientists

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A BYU student takes a water sample from a river in Spanish Fork Canyon. Credit: BYU Photo

As Hurricane Rosa hurtled toward Baja California in October 2018, two BYU students spotted a valuable research opportunity.

Utah County, still smoldering from the devastating Pole Creek megafire that same year, was forecast to receive days of heavy rain in the wake of the hurricane's landfall. For months, Trevor Crandall and Erin Jones had been collecting water samples in Utah Lake's tributaries to understand how land use and wildfires affect stream and lake health. Now, they had a rare chance to observe how back-to-back extreme events influenced water quality and quantity.

"Erin and Trevor called our team of undergraduates together for a kind of 'midnight meeting,'" BYU plant and wildlife sciences professor Ben Abbott recalled. "They knew this would be their only shot to measure the interaction between extreme rain and a fresh megafire."

"In a couple of hours, we got all the instruments ready to go out and deploy," Jones said. "That evening we finished installing our last sampler just as the first drops began to fall on the burn scar. The data we collected overnight was unlike any other I've ever sampled before. I've never seen so much sediment in my entire life—the streams were like chocolate milk."

After a month of urgently sampling 10 locations scattered across three river networks after the rainfall, the group was surprised to see how dramatically the wildfire and the rain had re-sculpted Utah Lake's ecosystem.

For one, in burned watersheds where the wildfire had consumed stabilizing vegetation and leaf litter, the rain had caused massive erosion. There was a 2,000-fold increase in sediment flux compared to unburned areas, creating a plume of ash and soil moving into Utah Lake that was visible from space. "That means that just this one storm moved as much

sediment as the river would typically move in 100 to 200 years," Abbott said.

The team also measured a 6,000-fold increase in particulate carbon and nitrogen washed from the burn scars.

In combination, those changes may spell trouble for the people and organisms who rely on Utah Lake's aquatic ecosystem. Excess nutrients such as nitrogen and phosphorus can cause harmful algal blooms in downstream waterbodies, a condition scientists call "eutrophication" that currently affects about two-thirds of the earth's waterbodies, including Utah Lake.

"This is a global crisis that is off most people's radar, but if you ask sustainability experts, they rank eutrophication right up there with climate change and loss of biodiversity," Abbott said. There are also immediate impacts on society from the erosion. "Sediment from these large fires can clog the canals and reservoirs we use for agricultural water, and the carbon and nutrients can affect drinking water for years or decades, which is costly to treat," Abbott explained.

These consequences to the ecosystem are "alarming," the scientists said, especially because annual wildfire extent in the western U.S. has doubled since the 1980s. "If fires happen in a natural way, then it's not a big issue," said Sam St. Clair, a BYU professor of plant and wildlife sciences. "But when we have suppressed fires and experience more drought and rising temperatures, we build up bigger fuel loads, and then we get these catastrophic fires that make the soil more prone to bigger erosion events."

To help prevent megafires that occur when too much forest fuel accumulates, "the average citizen needs to become better informed about the importance of prescribed fires," St. Clair added, noting that well-

meaning leaders have often insisted on putting these fires out because of public fears.

Stark as these findings were, the study's biggest surprise was that the fire and rain didn't turn out to be the biggest source of change to the aquatic ecosystem. While most studies of this kind compare burned and unburned areas in only "pristine" regions untouched by humans, the BYU group also took samples from areas heavily influenced by urban and agricultural development. Doing so allowed them to compare the relative impact of the two disturbances of the fire and human activity.

"We were genuinely shocked that direct human influences had a larger impact on nutrient status and water chemistry than the wildfire," Abbott said. "As big as the wildfire effects were, you could barely see the difference between a burned and unburned watershed when you compared it to a human-influenced watershed because all the urban and agricultural sites were sky-high in nutrients."

That's because just about everything we do—driving a car, flushing the toilet, fertilizing the lawn —adds carbon, nitrogen, phosphorus and other nutrients to the environment. Those pollutants have to go somewhere and often end up in the groundwater and rivers, such as those that feed Utah Lake.

"When a massive wildfire comes through, everybody can say, "Wow, look at this fire that burned 100,000 acres." Yet, we don't think about the effluent coming out of our wastewater treatment plants every day that has completely altered everything inside Utah Lake. There are things we can do right now to change what we are doing to our ecosystem," said Crandall.

Those suggested changes include improving treatment of wastewater to remove nutrients and being strategic about land use and development as

the population grows. "If we protect our green spaces and vulnerable environmental areas, our population can grow in Utah County while maintaining basically the current footprint we have now," Abbott said. "That's going to be better for society and for the organisms we share the earth with."

The study was recently published in the journal *PLOS ONE* in a special issue on freshwater ecosystems.

More information: Trevor Crandall et al, Megafire affects stream sediment flux and dissolved organic matter reactivity, but land use dominates nutrient dynamics in semiarid watersheds, *PLOS ONE* (2021). DOI: 10.1371/journal.pone.0257733

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