UC SANTA BARBARA

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Predicting seasonal changes in river networks

Scientists generally classify streams in one of two groups. Perennial streams flow year-round, while others dry out seasonally or between storms. But these seasonal waterways don't turn on all at once. Their length and configuration is dynamic, and depends on how much water is in the landscape. One UC Santa Barbara scientist is working to move beyond this binary.

A team led by UCSB research associate Jeff Prancevic has provided the first ever predictions for the dynamic flooding and emptying of stream networks. The study, published in Science, uses stream data and topographic measurements to model seasonal dynamics of river systems.

"We wanted to look at differences in how stream networks grow and shrink in different settings, and also to understand if it was climate or topography that was driving those differences in behavior," said Prancevic, who is affiliated with UCSB's Earth Research Institute.

In a 2019 study, he and his colleagues were able to use topographic measurements to understand how water moves through a landscape. By combining this insight with stream gauge data, they found they could predict the expansion and contraction of stream networks. The team analyzed topography across the United States and combined that with streamflow data from almost 15,000 stream gauges.

Prancevic and his coauthors found big differences in the predicted variability of stream networks, with mountain stream networks being more stable and lowland networks more variable, on average. Within this broad range of stream network behavior is the surprising finding that most stream networks are dominated by non-perennial channels. “If you look at the median stream network, 80% of its length is non-perennial, meaning that it flows at least a few days of the year and is dry at least a few days of the year,” he said.

“I think it makes sense to most people that stream networks grow when it rains and the landscape gets wetter,” he added, “but it might be hard to understand why topography matters.” A steep valley, for example, will funnel water into a narrow path, making streamflow relatively stable. Even when it rains, a stream is unlikely to lengthen up the steep headwalls of the valley. Meanwhile, that flow is less constrained in a flat landscape, so the network can expand and contract across the terrain.

The results will help scientists predict how often streams contain running water, as well as the extent of the network that is flowing. Those predictions can be used to better estimate the release of carbon from streams and model the sensitivity of riverine habitat to climatic changes.

Prancevic plans to further investigate what makes topography so influential on the behavior of stream networks. He also wants to evaluate trends in stream length over the past century, as well as how a changing climate might affect where and when we find flowing water.

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