Improved AI process could better predict water supplies

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Mt. Eyak SNOTEL site, above the coastal town of Cordova, Alaska. Snow depth is about 10.5 feet, 45% density. Taken April 2012. Credit: Daniel Fisher of the USDA Natural Resources Conservation Service.

A new computer model uses a better artificial intelligence process to measure snow and water availability more accurately across vast distances in the West, information that could someday be used to better predict water availability for farmers and others.

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in the *Proceedings of the AAAI Conference on Artificial Intelligence*, the interdisciplinary group of Washington State University researchers predict water availability from areas in the West where snow amounts aren't being physically measured.

Comparing their results to measurements from more than 300 snow measuring stations in the Western U.S., they showed that their

model outperformed other models that use the AI process known as machine learning.

Previous models focused on time-related measures, taking data at different time points from only a few locations. The improved model uses both time and space into account, resulting in more accurate predictions.

The information is critically important for water planners throughout the West because "every drop of water" is appropriated for irrigation, hydropower, drinking water, and environmental needs, said Krishu Thapa, a Washington State University computer science graduate student who led the study.

Water management agencies throughout the West every spring make decisions on how to use water based on how much snow is in the mountains.

"This is a problem that's deeply related to our own way of life continuing in this region in the Western U.S.," said co-author Kirti Rajagopalan, professor in WSU's Department of Biological Systems Engineering.

"Snow is definitely key in an area where more than half of the streamflow comes from snow melt. Understanding the dynamics of how that's formed and how that changes, and how it varies spatially is really important for all decisions."

There are 822 snow measurement stations throughout the Western U.S. that provide daily information on the potential water availability at each site, a measurement called the snow-water equivalent (SWE). The stations also provide information on snow depth, temperature, precipitation and relative humidity.

However, the stations are sparsely distributed with approximately one every 1,500 square miles. Even a short distance away from a station, the SWE can change dramatically depending on factors like the area's topography.

"Decision makers look at a few stations that are nearby and make a decision based on that, but how the snow melts and how the different topography or the other features are playing a role in between, that's not accounted for, and that can lead to over predicting or under predicting water supplies," said co-author Bhupinderjeet Singh, a WSU graduate student in biological systems engineering.

"Using these machine learning models, we are trying to predict it in a better way."

The researchers developed a modeling framework for SWE prediction and adapted it to capture information in space and time, aiming to predict the daily SWE for any location, whether or not there is a station there. Earlier machine learning models could only focus on the one temporal variable, taking data for one location for multiple days and using that data, making predictions for the other days.

"Using our new technique, we're using both and spatial and temporal models to make decisions, and we are using the additional information to make the actual prediction for the SWE value," said Thapa.

"With our work, we're trying to transform that physically sparse network of stations to dense points from which we can predict the value of SWE from those points that don't have any stations."

While this work won't be used for directly informing decisions yet, it is a step in helping with future forecasting and improving the inputs for models for predicting stream flows, said Rajagopalan. The researchers will be working to extend the model to make it spatially complete and eventually make it into a real-world forecasting model.

More information: Krishu K Thapa et al, Attention-Based Models for Snow-Water Equivalent Prediction, *Proceedings of the AAAI Conference on Artificial Intelligence* (2024). DOI: 10.1609/aaai.v38i21.30337

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