Can a seasonal drought forecast be wrong and still worth using for making water leasing decisions?

Yes! Even when forecasts are wrong as much as one-third of the time, in the long run, irrigators with junior water rights are better off using a seasonal drought forecast to make water leasing decisions as compared to not using it. The estimated value of the forecast information for a junior irrigator is up to $174/acre.

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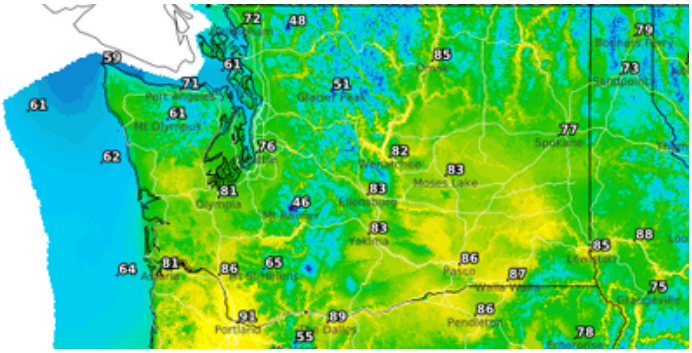
This research highlight is based on work in progress.

It should come as no surprise that weather forecasts are more likely to be wrong the further into the future they are looking. Most people are comfortable inviting friends over for an outdoor barbecue on a Saturday if the forecast the day before calls for warm and dry temperatures. However, the forecast for the following weekend is much less certain. We should have even less confidence in forecasts for 2, 3, or 4 months ahead — referred to as seasonal forecasts — which may lead one to conclude that they aren't worth considering at all. However, a forecast can provide value even if there is a good chance it is wrong.



Why is that? The value of a forecast depends on a range of factors in addition to its accuracy, including: the ability of taking an action that mitigates adverse weather, the cost of that action, the frequency of adverse weather occurrence, and what kind and how often the forecast makes errors. In the long run, if using the forecast allows one to take actions that cost less than taking no action, the forecast will be valuable, despite not being perfectly accurate.

Our research applied methods for quantifying the economic value of seasonal drought forecasts when used to make water leasing decisions in the Pacific Northwest (PNW).

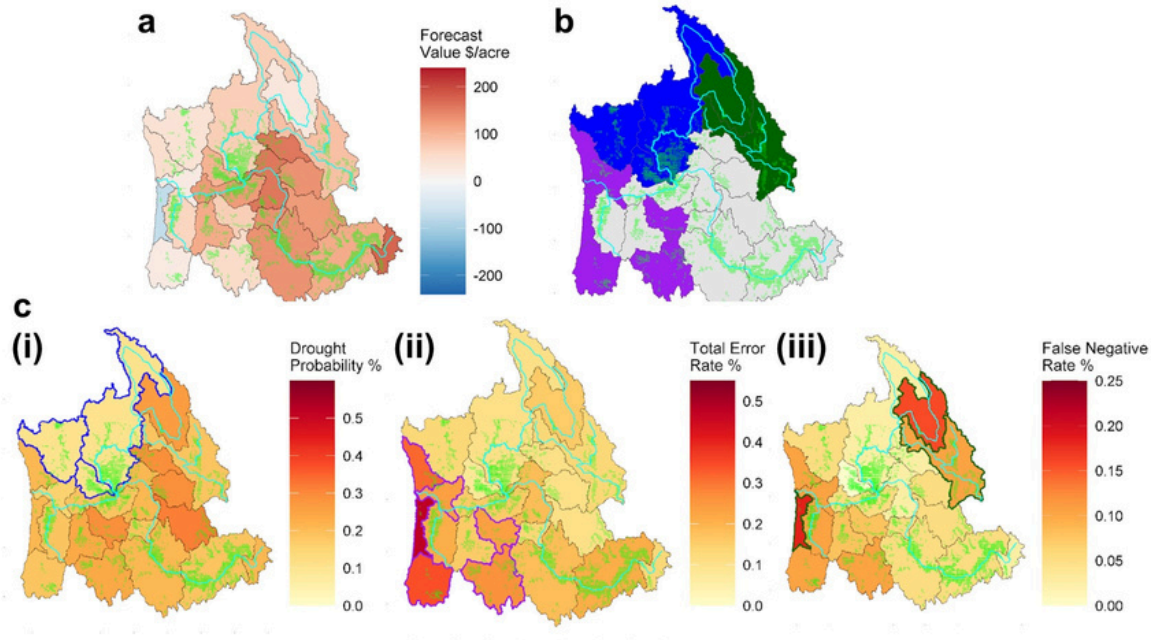
In the western U.S., rights to water for irrigating crops are based on a seniority system where some receive less water during a drought but others do not. A farmer whose water allocation is reduced during a drought could lease water from another farmer with a more senior water right to avoid this outcome. This may make financial sense for both farmers if the drought affected farmer is growing a more valuable crop. The challenge for the less senior (i.e. junior) farmer is that lease decisions have to be made in the early spring before it is clear how much water they will be allocated.

A seasonal forecast could help them make this leasing decision. They do not want to be stuck without water, but they also do not want to pay for an expensive water lease if drought conditions dissipate thanks to a wet and cool late spring and summer. The forecast's value therefore depends on how often it is correct, but also on whether it over- or under-predicts droughts when it is wrong. It also depends on the leasing cost versus losses that occur from not having water. For example, if leasing water is extremely expensive compared to losses from not having enough water, then forecasting a drought that does not occur is very damaging to a forecast's value. This example also demonstrates that a forecast will have more value if droughts happen more often. It is difficult for a forecast to have value if adverse weather rarely occurs.

We applied this economic framework for valuing forecasts to the case of seasonal drought forecasts for the Columbia River Basin (CRB). Irrigation is critical to agricultural production in much of the CRB, and water is primarily from surface water sources that are heavily dependent on snowpack accumulated during the winter. Our approach was to focus the model on a range of different cases related to key forecast values including drought frequency, lease cost, and drought losses. Forecast accuracy, or skill, was based on actual seasonal forecasts.

We found that this kind of seasonal forecast is valuable in most of the PNW, with exceptions in localized places, such as the northern part of the Oregon coast (Figure 1a). When used for making water leasing decisions, our results estimate the value of

Figure 1. (a) Forecast value based on assumptions on water leasing price of $300/acre and agricultural profit of $1500/acre, and (b) locations of low forecast value with color corresponding to (c) factors contributing to low forecast value: 1. low drought probability (see i), 2. high error (see ii), and 3. medium/high drought probability, but high missed droughts (see i and iii).



using a seasonal drought forecast for a junior irrigator at an average of $87/acre across the study area, with the highest value in the Snake Headwater region at $174/acre. We also explored why areas had lower or higher forecast values. Low forecast values were driven by three main elements (Figure 1b): 1) drought probability is low (northwest of the CRB); 2) forecast error is high (coastal PNW); 3) forecast error is more in the form of missed droughts than false alarms (northeast of the CRB). Locations with high forecast value have the opposite of these elements: 1) drought probability is close to the ratio of water leasing price over agricultural profit; 2) forecast error is low; 3) low missed droughts. As an example, the Snake Headwater region had the highest forecast value of $174/acre due to a drought probability that is close to 0.2 (1 out of 5 years), low error, and low missed droughts.

The results of our work can help farmers know if it makes sense to use seasonal forecasts to support decision making, and where we expect more value when farmers follow seasonal forecasts. It can also provide guidance for agencies, like the National Weather Service, on how the seasonal drought forecast could be improved to better support farmer decision-making.

Chen “Jacky” Xu, Ph.D., is a researcher and data scientist in climate (water), agriculture, and economics at Washington State University. Dr. Xu is interested in applying a broad range of hydrological, geospatial, and statistical tools that empower data-driven decision-making, and bridging the gap between climate data engineers and decision-makers to address the challenges posed by climate change on the human-environment nexus. This work is part of Dr. Xu’s Ph.D. dissertation (2024).

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Full paper:
Xu, C., Brady, M., Rajagopalan, K., Kondal, A., Adam, J. (2024) Assessing the economic value of seasonal forecast information for water leasing decisions. Water Resources Research, In Progress.

This work was supported by the USDA National Institute of Food and Agriculture, project #1016467.