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Increasing precipitation extremes driving tree growth reductions across Southwest

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Credit: Wikipedia.

As the Earth's temperature warms, its hydrological cycle kicks into overdrive—wet years get wetter, and dry years get drier. According to a new University of Arizona-led study, these increased rainfall extremes could have dire consequences for the semi-arid forests of the western U.S.

"In many parts of the United States, tree growth responds more strongly and consistently to dry years than it does to wet years, so increases in growth during wet years does not completely offset reductions in growth during drought," said Matt Dannenberg, lead author of the study published today in the journal *Science Advances*.

"Because of this, increases in rainfall extremes can lead to long-term declines in tree growth, even with no change in average precipitation. This is particularly true for forests of the Southwest," said Dannenberg, who completed the study as a post-doctoral researcher in the University of Arizona College of Agriculture and Life Sciences and is now an assistant professor in the Department of Geographical and Sustainability Sciences at the University of Iowa.

To better understand how forests may respond to changes in rainfall extremes, the authors analyzed long-term tree-ring records for more than 1,300 sites across the United States. Tree rings document yearly tree growth in response to seasonal climate changes for the full life span of the tree, providing a window into tree growth hundreds of years into the past.

"Tree-ring records are one of our most important data sources for understanding past climate and for placing recent climate change into a long-term context," said co-author Erika Wise, associate professor in the Department of Geography at the University of North Carolina at Chapel Hill. "By looking at how tree growth responded to climate in the past, we were able to investigate how changing precipitation extremes are likely to affect our forests."

The authors used tree-ring data to identify species vulnerable to degradation, or potentially even large-scale mortality, if rainfall extremes continue to increase.

While there was variability across tree species throughout the U.S., the authors were surprised to find most of the major tree species of the U.S. Southwest—a region where precipitation extremes are changing most rapidly—showed clear evidence of strong negative growth responses to precipitation extremes.

"The Southwest's iconic ponderosa pine, Douglas-fir, and piñon pine were particularly affected, as were the bur oak in the upper Midwest, each seeing significantly reduced growth during dry years that wasn't balanced by the growth spurred by wetter years," Dannenberg said.

Global climate models show precipitation variability will likely continue to increase in the 21st century, especially across dry forests of the western U.S. Thus, the critical question remains, what can be done to prepare for, or even prevent, the detrimental impacts of these changes?

While recent research on the need for large-scale reforestation efforts to combat climate change has received traction in the popular media, the authors stress that equal efforts must also be made to better understand and manage existing forests to prevent the degradation of their ability to store carbon.

"We hope our study motivates additional research efforts across dryland ecosystems of the Southwest," said William Smith, senior author on the study and an assistant professor at the University of Arizona School of Natural Resources and the Environment.

"Key Southwest tree species may be at risk as precipitation extremes intensify. The loss of these important species could have profound negative consequences for society, including large reductions in regional ecosystem carbon storage," Smith added. "If we want to avoid these emerging negative effects of climate change, there is an urgent need for more research that can help inform adaptive land management strategies."

More information: "Reduced tree growth in the semiarid United States due to asymmetric responses to intensifying precipitation extremes"*Science Advances* (2019). advances.sciencemag.org/content/5/10/eaaw0667

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