Newly identified 'landfalling droughts' originate over ocean

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Landfalling droughts, which form over the ocean and then migrate onto land, can cause larger, drier conditions than droughts that occur solely over the land. Credit: Josh Aarons/Unsplash

Meteorologists track hurricanes over the oceans, forecasting where and

when landfall might occur so residents can prepare for disaster before it strikes. What if they could do the same thing for droughts?

Stanford scientists have now shown that may be possible in some instances—the researchers have identified a new kind of "landfalling drought" that can potentially be predicted before it impacts people and ecosystems on land. They found that these droughts, which form over the ocean and then migrate landward, can cause larger and drier conditions than droughts that occur solely over the land. Of all the droughts affecting land areas worldwide from 1981 to 2018, roughly one in six were landfalling droughts, according to the study published Sept. 21 in *Water Resources Research.*

"We normally don't think about droughts over the ocean—it may even sound counterintuitive. But just as over land, there can be times where large regions in the ocean experience less rainfall than normal," said lead author Julio Herrera-Estrada, a research collaborator with Water in the West who conducted research for the study while he was a postdoctoral researcher at Stanford's School of Earth, Energy & Environmental Sciences (Stanford Earth). "Finding that some droughts start offshore will hopefully motivate conversations about the benefits of monitoring and forecasting droughts beyond the continents."

Droughts can harm or destroy crops, as well as impact water supplies, electricity generation, trade and ecosystem health. Historically, droughts have displaced millions of people and cost billions of dollars. Yet the climate processes that lead to drought are not fully understood, making accurate predictions difficult.

In order to pinpoint the large-scale landfalling droughts that originated over the ocean, the researchers used an object tracking algorithm to identify and follow clusters of moisture deficits all over the world, going back decades in time. They found that the landfalling droughts grew

about three times as fast as land-only droughts, and usually took several months to reach a continent.

"Not all of the droughts that cause damage to humans and ecosystems are going to be these landfalling droughts," said study senior author and climate scientist Noah Diffenbaugh, the Kara J. Foundation Professor at Stanford Earth. "But there is something about the droughts that start over the ocean that makes them more likely to turn into large, intense events."

The researchers analyzed the physical processes of landfalling droughts in western North America, where a high frequency of them occur. They found that droughts that make landfall in the region have been associated with certain atmospheric pressure patterns that reduce moisture, similar to the "Ridiculously Resilient Ridge" pattern that was one of the primary causes of the 2012-2017 California Drought.

The authors state that further analyses may reveal similar or new explanations for the landfalling droughts that they identified in other areas of the world, including Chile, Argentina, New Zealand and Eastern Australia.

"Our paper shows that landfalling droughts are a global phenomenon that affects every continent," Herrera-Estrada said. "There will definitely be a need for other studies to focus more on the physical processes relevant for each individual region."

Because of the large humanitarian and economic impacts of severe droughts, the potential for forecasting landfalling droughts may warrant further investigation, according to the researchers.

"This is an important finding because these landfalling droughts are statistically likely to be larger and more severe relative to non-landfalling droughts," said Diffenbaugh, who is also the Kimmelman Family Senior

Fellow at the Stanford Woods Institute for the Environment. "Because they usually take a number of months to migrate onto land, there is a potential that tracking moisture deficits over the ocean could provide advance warning to help protect against at least some of the most severe droughts."

More information: Julio E. Herrera-Estrada et al, Landfalling Droughts: Global Tracking of Moisture Deficits From the Oceans Onto Land, *Water Resources Research* (2020). DOI: 10.1029/2019WR026877

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