What it takes to recover from drought

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Trees killed by drought in the American Southwest during the 2000s. Credit: William Anderegg.

Drought-stricken areas anxiously await the arrival of rain. Full recovery of the ecosystem, however, can extend long past the first rain drops on

thirsty ground.

According to a study published August 10 in *Nature*, the length of drought recovery depends on several factors, including the region of the world and the post-drought weather conditions. The authors, including William Anderegg of the University of Utah, warn that more frequent droughts in the future may not allow time for ecosystems to fully recover before the next drought hits.

When things dry up

Droughts can be defined in several ways. The first is meteorological, defined as a period of less than average precipitation. The second is agricultural, in which the lack of rainfall impairs the productivity of plants. The third is hydrological, when water sources such as lakes, reservoirs, and aquifers begin to dry up to below-average conditions.

Anderegg and colleagues' new study asks the question: What does recovery from all three of these types of drought look like in different parts of the world? "There was a broad presumption that ecosystems and plants recovered almost immediately when the weather got wetter," Anderegg says. "We didn't know what the patterns were globally, including which plants seemed to recover faster or slower and which variables influenced that recovery time."

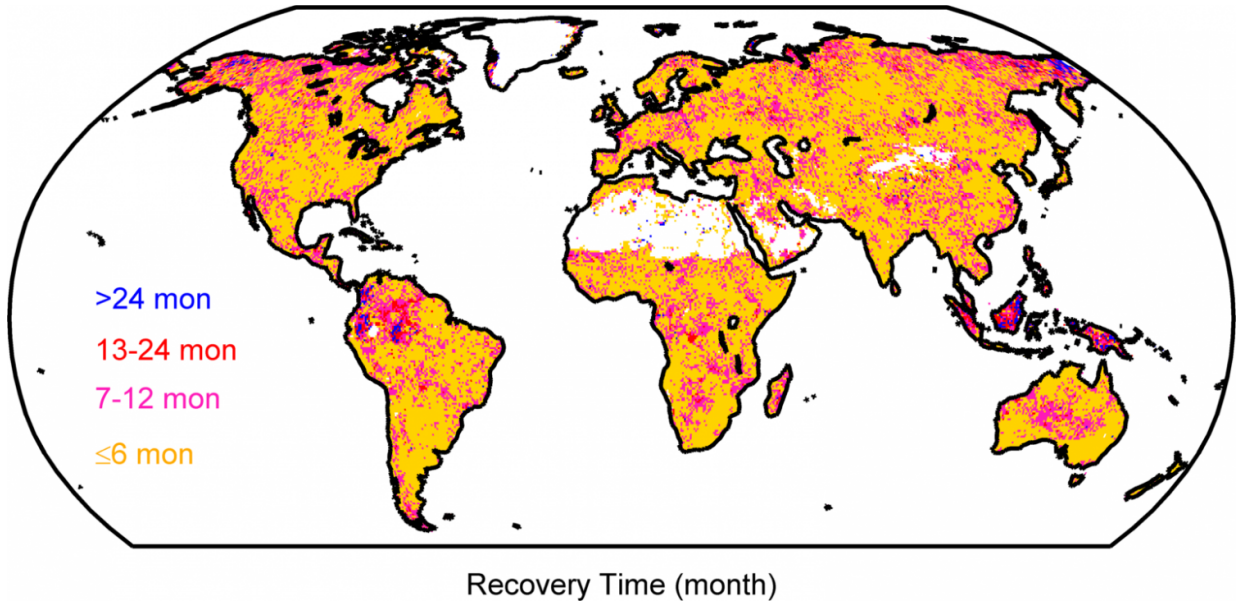
The measure they used to evaluate drought conditions is called the Standardized Precipitation-Evaporation Index. It's an approximation that takes into account temperature, soil moisture, recent rainfall and plants' demand for water. To assess drought recovery times, the team evaluated global satellite data to measure gross primary productivity, a measure of the rates at which plants convert sunlight into biomass. Drought recovery, they said, means an ecosystem fully recovers to its pre-drought productivity.

Plants can suffer long-term, even permanent damage from droughts. "Plants can be irreversibly damaged during drought stress," Anderegg says. "They can lose part of their water transport systems, and that damage can take years to recover." Droughts can also bring on more severe vegetation impacts like disease and fire. "That's an amplifier that can last past the drought."

How ecosystems recover

They found that the post-drought climate conditions were the most influential factors in drought recovery time. Wet conditions, such as those that slammed California after its long drought, hastened recovery. Dry conditions and temperature extremes, lengthened recovery. However, Anderegg says, "there are likely to be places in California where the drought was so severe that the ecosystem will not recover to the previous level because so much of the vegetation has died."

Location mattered as well. In general, most areas of the world are able to recover from a drought in less than six months. Some areas need up to a year. But the high-latitude Arctic regions and the tropics of South America and Southeast Asia need more time - up to two years. "That's worrisome because those regions store the largest chunks of carbon in ecosystems across the globe," Anderegg says.



Spatial pattern of drought recovery time. White areas are water, barren, or did not experience any relevant drought events. Credit: Christopher Schwalm

The double whammy

With climate models forecasting that the extent and severity of drought is likely to increase, also increasing the likelihood that ecosystems may be hit with new droughts before they have recovered from the previous one. "That could have a double whammy effect," Anderegg says. "A second drought could be harder on an ecosystem and have the potential to push it off a cliff." Ecosystem collapse in the face of perpetual drought could change verdant forests into grass and shrubs.

Such a double whammy hit the Amazon rainforest in 2005 and 2010, when back-to-back droughts, each with a once-in-a-century severity, hit the region. "Satellites showed that forests hadn't recovered from the 2005 drought by the time the 2010 drought struck," Anderegg says.

The study underscores the importance of drought recovery time in assessing drought impacts on ecosystems. Rain brings relief, but doesn't solve drought-related problems immediately, Anderegg says. "Often recovery is longer than the drought itself."

More information: Christopher R. Schwalm et al, Global patterns of drought recovery, *Nature* (2017). DOI: 10.1038/nature23021

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