Warming climate may spread drying to a third of Earth, says study

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The U.S. corn belt and many other regions around the world may be at greater risk of drought by 2100 as warmer temperatures wring more moisture from the soil. (Cathy Haglund, Flickr)

Increasing heat is expected to extend dry conditions to far more farmland and cities by the end of the century than changes in rainfall alone, says a new study. Much of the concern about future drought under global warming has focused on rainfall projections, but higher evaporation rates may also play an important role as warmer temperatures wring more moisture from the soil, even in some places where rainfall is forecasted to increase, say the researchers.

The study is one of the first to use the latest climate simulations to model the effects of both changing rainfall and evaporation rates on future drought. Published this month in the journal *Climate Dynamics*, the study estimates that 12 percent of land will be subject to drought by 2100 through rainfall changes alone; but the drying will spread to 30 percent of land if higher evaporation rates from the added energy and humidity in the atmosphere is considered. An increase in evaporative drying means that even regions expected to get more rain, including important wheat, corn and rice belts in the western United States and southeastern China, will be at risk of drought. The study excludes Antarctica.

"We know from basic physics that warmer temperatures will help to dry things out," said the study's lead author, Benjamin Cook, a climate scientist with joint appointments at Columbia University's Lamont-Doherty Earth Observatory and the NASA Goddard Institute for Space Studies. "Even if precipitation changes in the future are uncertain, there are good reasons to be concerned about water resources."

In its latest climate report, the Intergovernmental Panel on Climate Change (IPCC) warns that soil moisture is expected to decline globally and that already dry regions will be at greater risk of agricultural drought. The IPCC also predicts a strong chance of soil moisture drying in the Mediterranean, southwestern United States and southern African regions, consistent with the *Climate Dynamics* study.

Using two drought metric formulations, the study authors analyze projections of both rainfall and evaporative demand from the collection of climate model simulations completed for the IPCC's 2013 climate report. Both metrics agree that increased evaporative drying will probably tip marginally wet regions at mid-latitudes like the U.S. Great Plains and a swath of southeastern China into aridity. If precipitation were the only consideration, these great agricultural centers would not be considered at risk of drought. The researchers also say that dry zones in Central America, the Amazon and southern Africa will grow larger. In Europe, the summer aridity of Greece, Turkey, Italy and Spain is expected to extend farther north into continental Europe.

"For agriculture, the moisture balance in the soil is what really matters," said study coauthor Jason

Smerdon, a climate scientist at Lamont-Doherty. "If rain increases slightly but temperatures also increase, drought is a potential consequence."

Today, while bad weather periodically lowers crop yields in some places, other regions are typically able to compensate to avert food shortages. In the warmer weather of the future, however, crops in multiple regions could wither simultaneously, the authors suggest. "Food-price shocks could become far more common," said study coauthor Richard Seager, a climate scientist at Lamont-Doherty. Large cities, especially in arid regions, will need to carefully manage their water supplies, he added.

The study builds on an emerging body of research looking at how evaporative demand influences hydroclimate. "It confirms something we've suspected for a long time," said Toby Ault, a climate scientist at Cornell University, who was not involved in the study. "Temperature alone can make drought more widespread. Studies like this give us a few new powerful tools to plan for and adapt to climate change."

Rainfall changes do not tell the whole story, agrees University of New South Wales researcher Steven Sherwood, in a recent Perspectives piece in the leading journal *Science*. "Many regions will get more rain, but it appears that few will get enough to keep pace with the growing evaporative demand."

The authors have made all their data and calculations public available on a supplementary website.

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