Enhanced levels of carbon dioxide are likely cause of global dryland greening, study says

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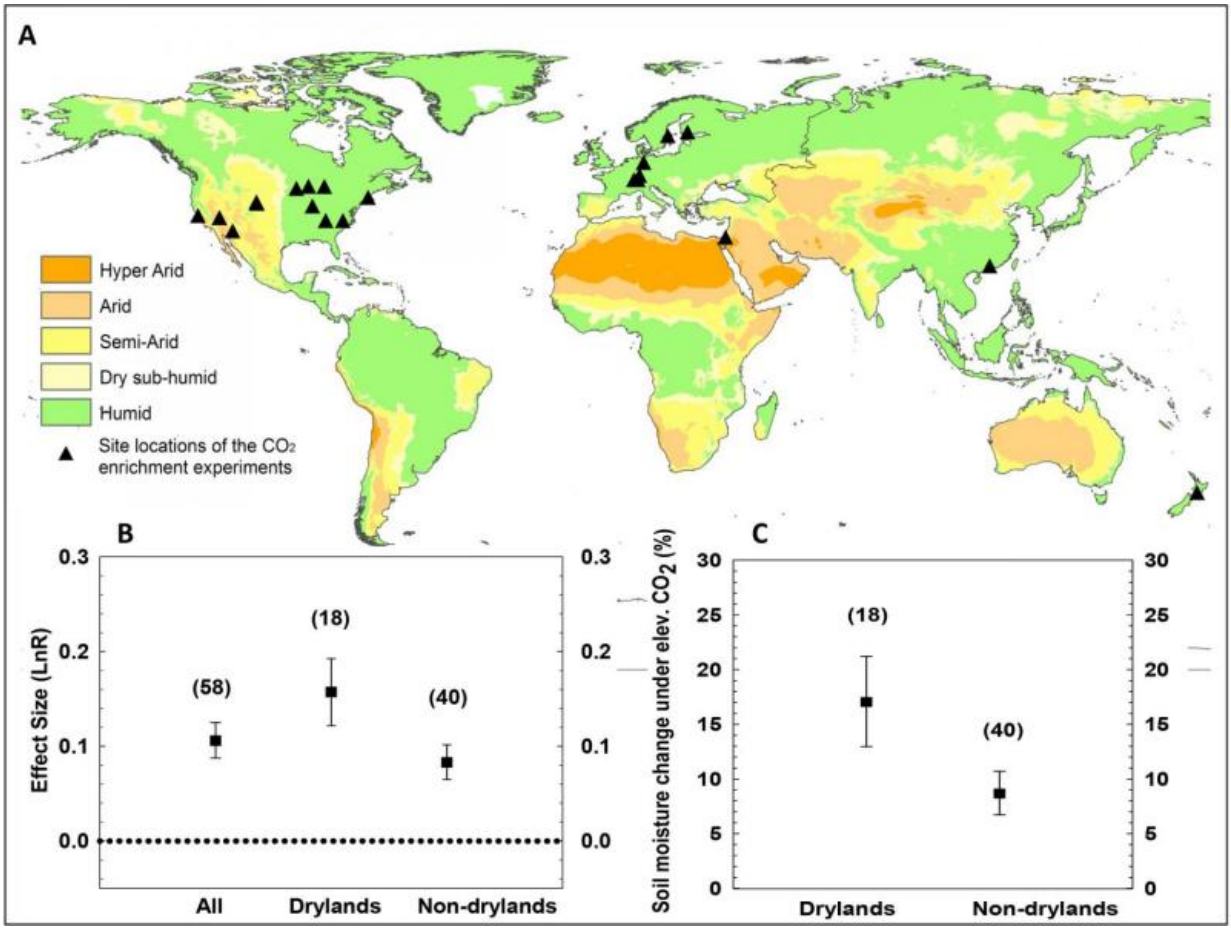

Global distributions of carbon dioide enrichment experiments

Enhanced levels of atmospheric carbon dioxide are a likely key driver of

global dryland greening, according to a paper published today in the journal *Scientific Reports*.

The positive trend in vegetation greenness has been observed through satellite images, but the reasons for it had been unclear.

After analyzing 45 studies from eight countries, Lixin Wang, assistant professor of earth sciences in the School of Science at Indiana University-Purdue University Indianapolis, and a Ph.D. student in Wang's group, Xuefei Lu, concluded the greening likely stems from the impact of rising levels of atmospheric carbon dioxide on plant water savings and consequent increases in available soil water.

"We know from satellite observations that vegetation is greener than it was in the past," Wang said. "We now understand why that's occurring, but we don't necessarily know if that's a good thing or not."

In some regions, greening could be caused by species change, with greener invasive plants replacing indigenous ones or bushes encroaching on grasslands that are used to graze cattle, Wang said.

Defined broadly as zones where mean annual precipitation is less than two-thirds of potential evaporation, drylands are the largest terrestrial biome on the planet, home to more than 2 billion people.

Recent regional scale analyses using satellite-based vegetation indices such as the Normalized Difference Vegetation Index have found extensive areas of dryland greening in areas of the Mediterranean, the Sahel, the Middle East and northern China, as well as greening trends in Mongolia and South America, according to the paper.

Lu and Wang considered other potential drivers that could have caused the greening, including increased rainfall and changes in land-

management practices. But only carbon dioxide provided a global explanation for changes to dryland vegetation.

To date, the global average concentration of carbon dioxide in the atmosphere has increased by nearly 27 percent between 1960 and 2015, with the expectation of a continued rise in years to come, according to the researchers.

The researchers believe the greening is a response to higher atmospheric carbon dioxide inducing decreases in plant stomatal conductance—the measure of the rate of passage of carbon dioxide entering, or water vapor exiting, through the stomata of a leaf—and increases in soil water, thus enhancing vegetation growth.

The researchers examined the sensitivity of soil water change to varying levels of carbon dioxide, finding a significant positive change in soil water along the carbon dioxide enrichment gradient.

"The stability of the rate of change justifies using higher carbon dioxide enrichment levels to interpret soil water responses to currently observed carbon dioxide enrichment," Wang said.

The analysis also showed that elevated carbon dioxide significantly enhanced soil water levels in drylands more so than it did in non-drylands, with soil water content increasing by 9 percent in non-drylands compared to 17 percent in drylands, Wang said. Determining the mechanisms of stronger soil water responses in drylands will require further investigation.

Studies including Wang's earlier work in Africa have shown that even small changes in soil moisture in drylands could be significant enough to cause large changes in vegetation productivity.

"Importantly, the observed response lends weight to the hypothesis that any additional soil water in the root zone is then available to facilitate vegetation growth and greening under enhanced carbon dioxide," Wang said. "Future studies using global-scale process-based models to quantitatively assess the carbon dioxide impact on soil moisture is needed to further validate the hypothesis."

Going forward, Wang said, the positive effect of carbon dioxide-induced water savings may eventually be offset by the negative effect of carbon dioxide-induced temperature increases when the temperature increase crosses a certain threshold.

Another author of the paper is Matthew McCabe, an associate professor from King Abdullah University of Science and Technology in Saudi Arabia.

More information: Xuefei Lu et al. Elevated CO2 as a driver of global dryland greening, *Scientific Reports* (2016). DOI: 10.1038/srep20716

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