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As climate warms, plants may demand more water, cutting supplies for people

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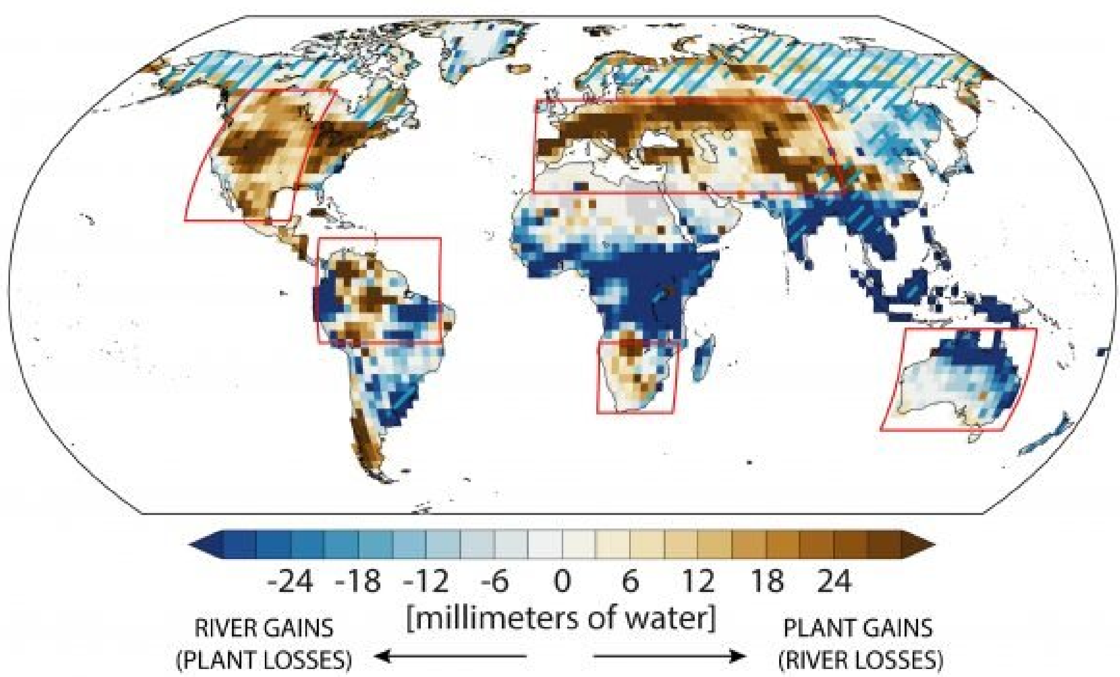

Projected future changes in water availability. Blue colors indicate more runoff from precipitation, which may increase supplies for humans. Brown colors indicate that more water will be retained by plants, reducing supplies. Credit: Justin Mankin

As climate changes, plants in North America, much of Eurasia, and parts of central and South America will consume more water than they do now, leading to less water for people, according to a new study in the journal *Nature Geoscience*. The research suggests a drier future despite anticipated increases in precipitation in populous parts of the United States and Europe that already face water stresses.

The study challenges many climate scientists' expectations that plants will make much of the world wetter in the future. Scientists have long postulated that as carbon dioxide concentrations increase in the atmosphere, plants will reduce their water consumption, leaving more freshwater available in soils and streams. This is because as more carbon dioxide accumulates in the air, plants can perform the same amount of photosynthesis while partly closing the pores (stomata) on their leaves. Because plants give off moisture through their stomata, this would reduce their water loss to the atmosphere, keeping more water on land in the form of soil moisture, streams and water bodies.

But the new findings suggest that this story is limited to the tropics and the extremely high latitudes, where freshwater availability is already high, and competing demands on it are low. For much of the mid-latitudes, the study finds, projected plant responses to climate change will actually dry out the land.

About 60 percent of the global water flux from the land to the atmosphere goes through plants. "Plants are like the atmosphere's straw," said lead author Justin Mankin, an assistant professor of geography at Dartmouth College and adjunct research scientist at Columbia University's Lamont-Doherty Earth Observatory. "The question we're asking here is, how do the combined effects of carbon dioxide and warming change the size of that straw?"

Using climate models, the study examines how freshwater availability may be affected by projected changes in the way precipitation is divided among plants, rivers and soils. For the study, the research team used a novel accounting of this partitioning, developed earlier by Mankin and colleagues at Lamont-Doherty to calculate the future effects of a warmer, carbon dioxide-enriched climate.

The new study suggests how the interaction of three key impacts of climate change on plants will reduce regional freshwater availability. First, as carbon dioxide increases in the atmosphere, plants require less water to photosynthesize; this increases moisture on land. Yet, as the planet warms, growing seasons will become longer and warmer; plants thus will have more time to grow and consume water, drying the land. Finally, as atmospheric carbon dioxide increases, plants are likely to grow more, because photosynthesis will become more efficient. For some regions, the latter two impacts—extended growing seasons and amplified photosynthesis —will outpace the closing of stomata. This means that more vegetation will consume more water for a longer amount of time, with the net result of drier land.

As a result, for much of the mid-latitudes, plants will leave less water in soils and streams, even if there is additional rainfall, and vegetation is more efficient with its water usage. The result underscores the importance of improving how climate models represent specific ecosystems and their response to climate change, said Mankin.

The world relies on freshwater for human consumption, agriculture, hydropower and industry. Yet, for many places, there is a fundamental disconnect between when precipitation falls and when people need water. This is the case with California, which gets more than half of its precipitation in the winter, but where demand peaks in the summer. "Throughout the world, we engineer solutions to move water from point A to point B to overcome this disconnect," said Mankin. "Allocating water is politically contentious, capital-intensive and requires really long-term planning, all of which affects some of the most vulnerable populations. Our research shows that we can't expect plants to be a panacea for future water availability."

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