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Carbon emissions make Earth greener but are also drying it out

The carbon dioxide we've been pumping into the atmosphere is fertilising plants and making them grow faster – but now those plants are sucking our streams dry.

Australia is already a parched country and will only become drier as the planet warms and rainfall decreases.

But now it turns out that Australia has lost about a quarter of its streamflow over the past 30 years as plants given an extra boost by our carbon emissions grow faster and use more water.

Global greening is happening for a number of reasons. Most obviously, plants are able to grow in places that were previously too cold, for example, in the Arctic, which is warming faster than anywhere else. But in other parts of the world, extra CO_2 is fertilising plants, making them grow faster, especially in dry regions.

How that extra growth would affect water uptake has been a matter of debate. That's because the extra CO_2 has two opposing effects, says Anna Ukkola from Macquarie University in Sydney, Australia.

Waxy leaf seal

Plants have a waxy seal over their leaves that stops them from losing too much water to the air. To get access to CO_2 in the air, which they need to photosynthesise, they have to open little pores in that seal. But they also lose water: CO_2 goes in, water out.

Since there is a lot more carbon in the air than there used to be, plants can close their pores partially and still get the same amount of CO_2 while losing less water, says Ukkola.

Early models concluded that streamflow would increase. If plants lose less water, they reasoned, then there will be more in the streams.

But later models disagreed, showing that it depends on exactly how the plants' growth is affected: if they become more leafy, then they will lose more water to the air.

Researchers have tried to sort this out by growing experimental plots. "But in the experiments, the changes in water use is varied – it's all over the shop," says Randal Donohue from the CSIRO in Canberra, Australia.

Boost plant cover

Donohue and colleagues were the first to show in 2013 that increased carbon dioxide levels were boosting plant cover around the world, by examining satellite images and removing the effects of other factors such as changes in rainfall and land use change.

Using similar methodology, Ukkola and colleagues repeated that analysis for Australia, and then compared the carbon-driven greening in 190 river basins with the changes in streamflow over that time.

After allowing for other factors like changes in rainfall, they found that a significant drop in streamflow was associated with the greening of the landscape. In areas that were greening more, streamflow was also diminishing more.

Overall, the CO_2-induced greening was responsible for a streamflow reduction of between 24 and 28 per cent, says Ukkola. "That's quite worrying for areas that are already water scarce around Australia," she says.

"This paper is showing that the [increase in leafiness] is more significant than the efficiency gain," says Andy Pitman from the University of New South Wales in Sydney.

"The plants are growing more and bigger leaves," he says, which evaporate even more water. "Nobody has been able to do that before."

No benefits

The effects weren't seen in the most arid or the wettest parts of the country. Ukkola says that is probably because in the wettest parts, the plants don't benefit from the extra CO_2 since they aren't constrained by how much water they lose through their leaves. And in the driest areas, there are such significant periods of no rain that the CO_2 fertilisation is unlikely to have a noticeable effect.

Ukkola says the results can probably be extrapolated to places with similar climates to Australia like the Mediterranean.

But to extend the conclusions to other places such as the US and other parts of Europe, the study would need to be repeated. That could be tricky, since you need to find river basins where land use hasn't changed significantly – an easier task in the relatively sparsely populated Australia, Ukkola says.

It's unclear what will happen in the future, since plants might get saturated with CO_2 at some point, and stop benefiting from even higher levels, says Ukkola. "But it's worrying that precipitation is projected to decline in Australia anyway," she says.

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