Carbon accounting must include city greenery, researchers say

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The CO2 fluctuations driven by LA's greenery is about one third the level created by the burning of fossil fuels, new research says. Credit: University of Arizona

The Los Angeles basin is often thought of as a dry, smoggy, overdeveloped landscape. But a new study published in *Proceedings of the National Academy of Sciences* shows that the manicured lawns,

emerald golf courses and trees of America's second-largest city have a surprisingly large influence on the city's carbon dioxide emissions. The carbon dioxide fluctuations driven by L.A.'s greenery are about one-third the level created by the burning of fossil fuels.

Scientists, including the University of Arizona's Riley Duren, collected and analyzed 500 air samples from four sites around the basin in 2015 for the presence of a radioactive carbon atom known as carbon-14. Carbon-14 is found in living organisms, including vegetation. By contrast, fossil fuels, which are millions of years old, are totally depleted of carbon-14.

Megacities like Los Angeles contribute significantly to national and global carbon dioxide emissions and are an increasingly important priority for mitigation efforts, the research team said. The green spaces in megacities provide many benefits, including improving air quality, capturing runoff, moderating temperatures and offering outdoor recreation. So, the ability to distinguish fossil fuel pollution from naturally occurring carbon dioxide will be important for designing and evaluating urban pollution control strategies.

Lead study author John Miller, a carbon cycle scientist with the National Oceanic and Atmospheric Administration's Global Monitoring Laboratory, said that when researchers disentangled the carbon dioxide generated by burning fossil fuels from the naturally occurring carbon dioxide, they found that L.A.'s vegetated landscape contributed substantially to the levels of carbon dioxide around the city.

"This is arguably the most significant finding to date from the project: That policy makers interested in reducing the carbon footprints of cities need to pay attention to CO_2 emissions and removals from urban green spaces, not just fossil fuel emissions," said study co-author Duren, a research scientist with UArizona Research, Innovation and Impact who

began the research while at NASA's Jet Propulsion Laboratory. "We were surprised to see the magnitude of the urban biosphere source and sink in a heavily urbanized landscape like L.A.. Basically, lawns and parks and irrigation matter."

"LA is a very dry place," Miller said. "You think of L.A., you think of freeways and sprawl. The natural environment outside the city is not naturally lush. In addition, 2015 was a big drought year, so it was all the more surprising that so much of the CO_2 in our measurements came from living plants."

The timing of the increased carbon dioxide emissions from the growth of plants was another surprise. In a normal Mediterranean climate, winter rains are followed by a seasonal dry season. Plants respond by drawing in carbon dioxide in early spring when rain is available and emitting it in late summer and fall as they go dormant during the dry season.

"LA has a Mediterranean climate, but we saw CO_2 levels drawn down in the middle of summer in response to the watering of lawns, golf courses, trees—even though 2015 was a drought year with water restrictions," Miller said. "Irrigation was compensating for the lack of rain and keeping the urban ecosystem active."

The seasonal fluctuation in ecosystem carbon dioxide amounted to one-third of the carbon dioxide level resulting from combustion of fossil fuels.

Duren said that the study is part of a broader multi-agency program called the Megacities Carbon Project to support science-based decision making locally and to develop actionable carbon measurement methods that can be extended to cities globally.

"It also helps lay the foundation for using carbon-14 measurements as a reference point to improve and correct other tracers of fossil fuel CO_2 emissions," Duren said.

The team is working with colleagues from other pilot projects around the world with a goal of ultimately establishing a sustained global carbon monitoring system for cities.

The carbon-14 approach—which Miller and Scott Lehman, a scientist at University of Colorado, Boulder, have been developing since 2003—allows them to separately track carbon dioxide from ecosystems and from fossil fuel use. A recent study applied the method at a national scale, and in this study, it was used to better understand the different sources contributing to the overall urban carbon emissions.

The takeaway, Miller and Lehman said, is that understanding the urban carbon footprint—how much carbon is produced in a city—is a lot more complicated than simply estimating fossil fuel emissions. There is a need to more accurately measure and track fossil fuel carbon dioxide emissions, as well as the impact of urban greening campaigns to develop and evaluate emissions mitigation strategies.

"If you are the mayor of a major city and you're interested in your city's total carbon balance, you should be interested in how active your biosphere is as well," Miller said. "You can't just look at CO_2 concentrations alone. You can imagine that if the biospheric signal is as large as it is for a dry city like L.A., in wetter places, like Mumbai and São Paulo, ecosystem-produced CO_2 could be an even larger part of the carbon budget."

More information: John B. Miller et al. Large and seasonally varying biospheric CO2 fluxes in the Los Angeles megacity revealed by atmospheric radiocarbon, *Proceedings of the National Academy of*

Sciences (2020). DOI: 10.1073/pnas.2005253117