CO2 sensor network shows effects of metro growth (Update)

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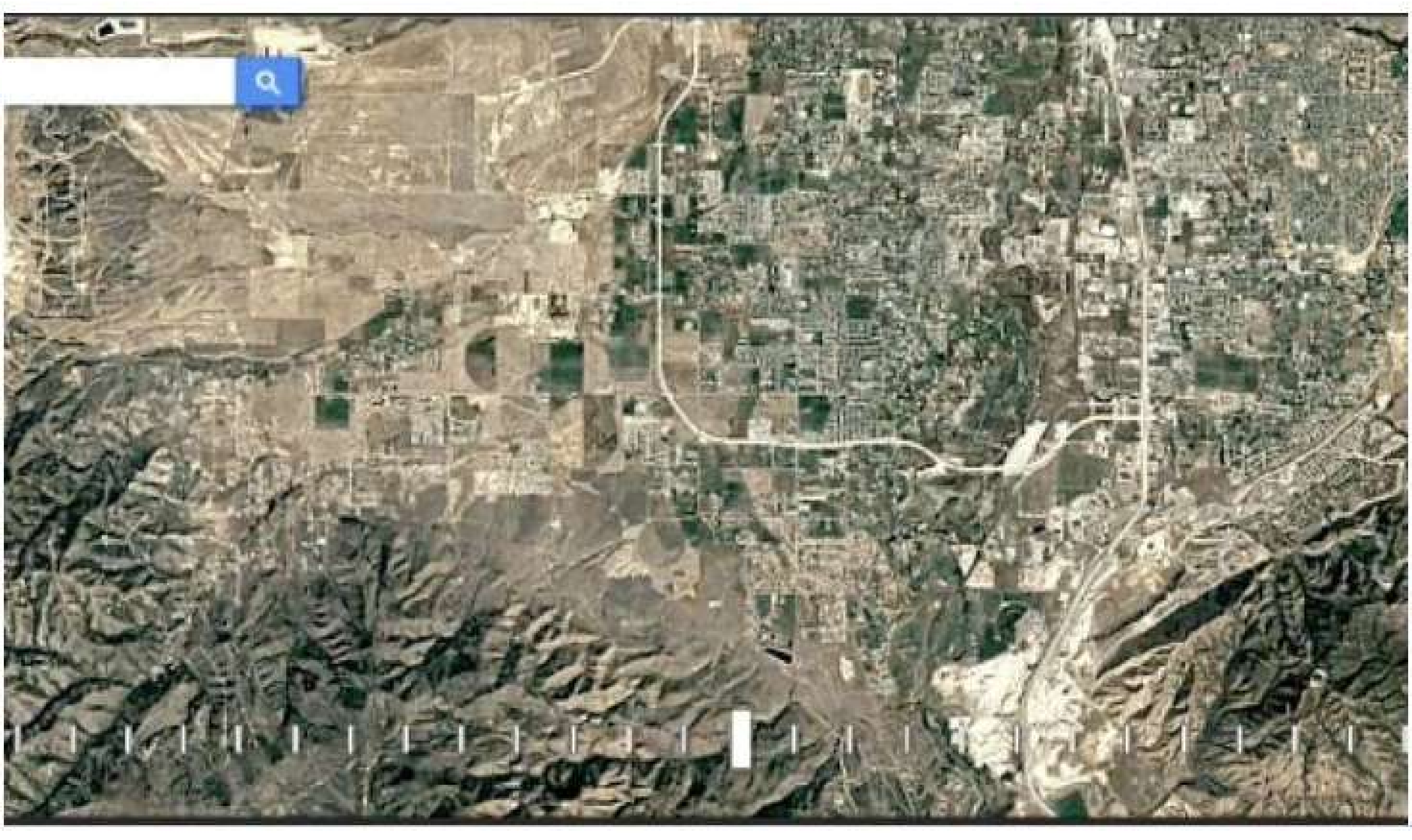


In February 2001, before the Olympic cauldron in Salt Lake City roared to life and focused the world's spotlight on Utah, scientists at the University of Utah placed the first of several carbon dioxide (CO_2) sensors atop a building on campus.

CO_2 is a key greenhouse gas leading to anthropogenic climate change, with cities around the world as major emitters of CO_2. Now five CO_2 sensors monitor the air at sites on the Salt Lake Valley floor. It's the only multisite urban CO_2 network in the world with more than a decade of continuous measurements– and it's showing how urban and suburban growth impacts a metro area's CO_2 emissions.

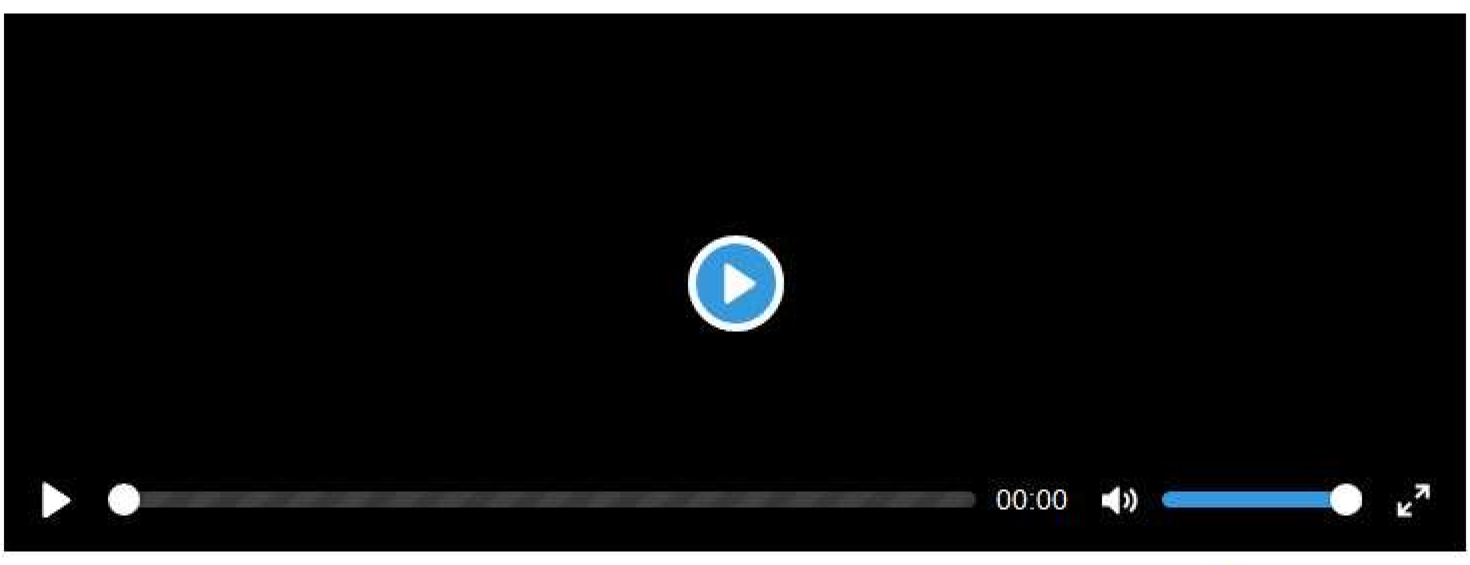
In a study published today in *Proceedings of the National Academy of Sciences*, a team led by atmospheric scientists Logan Mitchell and John Lin report that suburban sprawl increases CO_2 emissions more than similar population growth in a developed urban core.

"The general thought is that more compact cities on a per capita basis emits less carbon," Lin says. "Some of these cities also have these expanding fringes. These places are less 'green', so to speak. That expanding frontier is moving."

Building the network

From the first sensor, placed atop the eight-story William Browning Building on the U campus, the network has expanded to include sensors in the Sugarhouse (placed in 2005), Murray (2005) and Rose Park (2009) areas, all well-established urban and suburban neighborhoods in the northern Salt Lake Valley. A sensor placed on Hidden Peak, at the top of the Snowbird ski resort in the Wasatch Mountains, measures background CO_2 levels.

Mountains, measures background CO_2 levels.



Google Earth Engine data shows development and growth in the southwest Salt Lake Valley. Farmlands in 1984 become fully developed subdivisions by 2017. Credit: Google Earth Engine

CO_2 sensors require resource-intensive maintenance and calibration, factors that may explain why few other cities have multisite networks. Lin says the primary driving force in creating the network, however, was a forward-thinking vision among U researchers led originally by Jim Ehleringer, Diane Pataki and Dave Bowling in the biology department. Because of that vision, Lin says, "We know more about CO_2 in the Salt Lake Valley than any other urban area. We are one of the leading urban CO_2 networks, and the U is at the center of that."

See the locations of sensors used in this study **here**.

Suburban Growth

An additional sensor was placed in the southwest corner of the valley, intended to represent rural areas. But that sensor, located just west of South Jordan, has yielded some of the most interesting results. Although the area consisted of open fields when the sensor was first placed in 2004, it is now a bustling, developed area. The sensor picks up emissions from a wide swath of the region, as far east as Draper and as far south as Lehi.

"That part of the valley is a really important part of the story," Lin says.

"You're going from a land surface type where there's no people around and you have suburban expansion into this undeveloped land," Mitchell adds. "It's changing the CO_2 emission framework quite a bit."

The sensor in the southwestern corner of Salt Lake Valley provided an opportunity to directly compare the effect of population growth on emissions in different land-use areas. Over the same time that population in the southern part of the Salt Lake Valley and neighboring Utah Valley exploded, Salt Lake City grew by around 10,000 people. But the growth in CO_2 emissions wasn't comparable with the growth associated with suburban expansion in the southern end of Salt Lake Valley.

The research team concluded that growth in CO_2 emissions around the valley was more influenced by the type of neighborhood than by the total number of people moving into that neighborhood.

"In the more urban area, there's population growth there, but it's in the mature part of the city, not associated with growth in CO_2," Mitchell says. "If you add more people into downtown Salt Lake City, they're going into an existing place. But it's this population growth in rural areas that is seeing an increase in CO_2 emissions."

Comparing to global data

The team compared their results to four inventories of global carbon emissions to see if the same trend held. Just as with the U data, the inventories showed that population growth was not directly correlated to emissions growth. But the inventories showed a constant rate of emissions over the Salt Lake Valley, failing to capture the high CO_2 growth rate in suburban areas.

Global inventories are getting better and more refined, Mitchell says. "This is the bleeding edge of inventory construction—starting to look at spatial structures in cities in these inventories. Because no other city has a long-term record, no one's been able to look at the evolution over time across a city."

Lin and Mitchell are now leading a project called CO_2-USA (CO_2-Urban Synthesis &Analysis network) to link CO_2 monitoring networks in urban areas across the country. "Some might have three to five years of data," Lin says. "We're hoping to join forces and to compare and contrast cities."

Locally, the team's next focus is on looking at the relationships between air quality and CO_2 measured at their tower sites (now numbering 12 and situated in surrounding basins) as well as incorporating the air quality data collected since 2014 on mobile sensors that ride along with light rail TRAX trains. The trains, operated by the Utah Transit Authority, crisscross the valley, and the data they collect fill in the gaps between long-term stationary CO_2 monitoring sites.

Lin also plans to use their data to make projections about Salt Lake's emissions future, including the city's goal to reduce CO_2 emissions by 80 percent by the year 2040. "The hope is that we or others who use these tools can help inform where the most bang for their buck is or whether 80 percent is even realistic given the projected population growth."

"Salt Lake City is one entity in the valley, but it's not the only one," Mitchell says. "If you reduce emissions by 80 percent and everyone moves out further from work and commutes in, it's not actually solving the problem."

This research was supported by the National Science Foundation, the National Oceanic and Atmospheric Administration and the U.S. Department of Energy.

The CO_2 data are publicly accessible. Archived and real-time measurements can be found at **air.utah.edu/** .

Explore further: **Nursery stock, homeowner preferences drive tree diversity in Salt Lake Valley**

More information: Long-term urban carbon dioxide observations reveal spatial and temporal dynamics related to urban characteristics and growth, *Proceedings of the National Academy of Sciences* (2018). **www.pnas.org/cgi/doi/10.1073/pnas.1702393115**

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