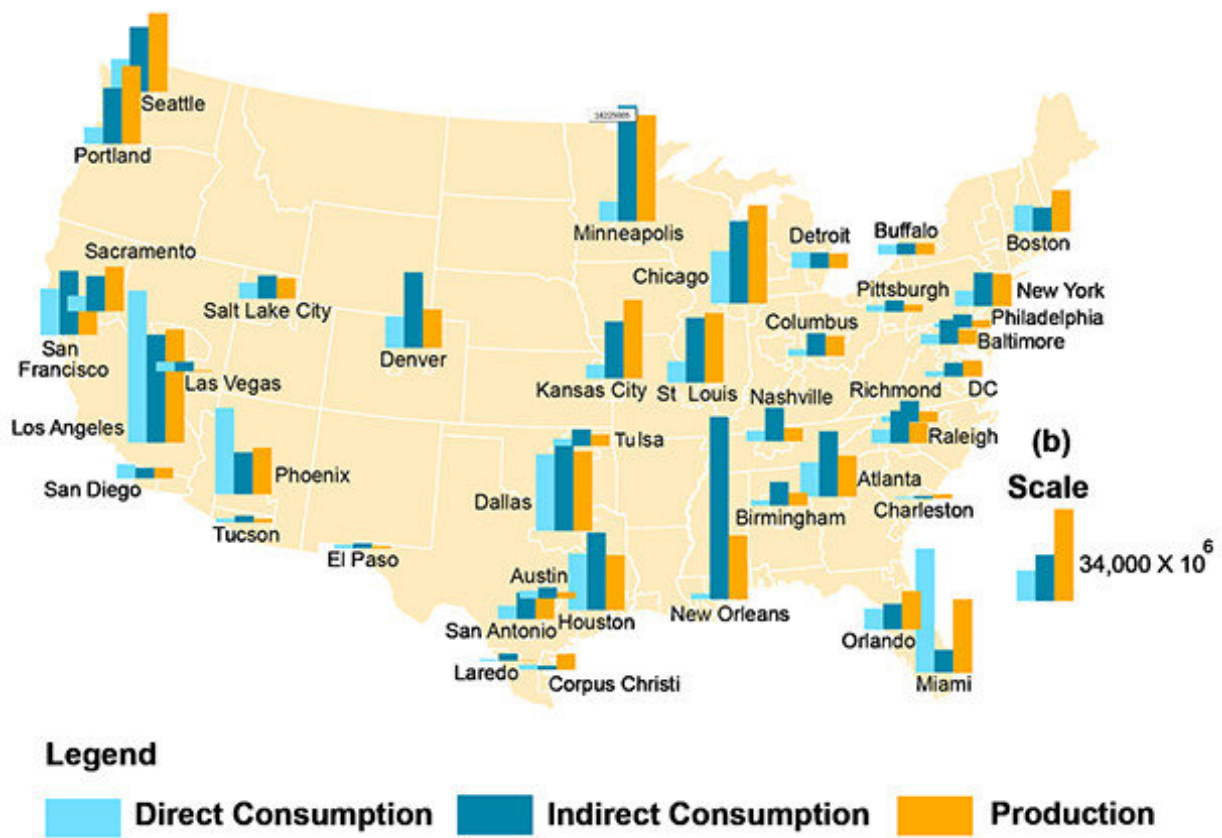


Larger cities have smaller water footprint than less populated counterparts

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Water footprint of consumption and production for the analyzed US cities. The water footprint of consumption is separated into direct and indirect contributions. Credit: Penn State

Global sustainability is important now more than ever due to increasing

urban populations and the resulting stress it can have on natural resources. But increased populations in cities may lead to greater efficiency, as a team of Penn State researchers discovered when they analyzed the water footprint of 65 mid- to large-sized U.S. cities.

"Human life on the planet has never been more complex," said Caitlin Grady, assistant professor of [civil engineering](#). "We're so intertwined with so many aspects of the global trade and global economy. People in rural areas are still buying food like bananas from across the world and because of this we need more complex and rigorous tools to analyze how to manage our limited resources."

In order to develop these tools, researchers first need to better understand the urban [water](#) footprint. Grady and her colleagues set out to do just that.

"We looked at the overall picture of water consumption," Grady said. "Not just the water that comes out of your tap but also the water that goes into the food that each [city](#) produces and consumes, so it's both the direct water use and indirect water use, which we call your water footprint."

They analyzed agricultural, livestock and industrial commodity flows, and the corresponding virtual water contents using data from the U.S. Department of Agriculture, the U.S. Geological Survey and the U.S. Department of Transportation. The team then used these values to calculate an overall water footprint for each city. Their results were published in August in *PLOS ONE*.

What they found was that on average, larger cities, for their populations, consume less water.

"As the population increases, cities are consuming less per capita of the

water resources, so the larger cities are getting more out of the water that they have based on population," Grady said.

Tasnuva Mahjabin, a doctoral student in civil engineering and contributing researcher on the project, said that multiple factors are likely contributing to these results.

"Water footprint consumption and production are tied to the changing composition of urban economic activities with city size, suggesting that large cities are more service-oriented with less prevalence to secondary sector industries," Mahjabin said. "This allows large cities to have reduced water footprints by shifting water-intensive economic activities to less populated regions."

And although the overall water usage decreased in correlation with a city's size, the researchers noted that not all types of water usage yielded a more efficient footprint.

Water that has been sourced from surface or groundwater resources mainly mirrored water-related weather patterns and showed little correlation with population. However, the amount of water used from precipitation contributed to consumption both positively—by transferring the dependence of food consumption on population into the water footprint—and negatively—by increasing diversity.

Several exceptions did arise. New Orleans, for example, has a much larger water footprint for their size and their [population](#) compared to the trend, whereas Las Vegas falls well below the average for water footprint production. The team is tracking the complexity of these findings in an effort to more accurately dissect the results.

The researchers hope to use their findings to benchmark cities and potentially set realistic targets to support the development of strategies

for reducing the [water footprint](#). This information could also be valuable to policy makers and city planners concerned with designing economic incentives that support water sustainability.

"A city in California may have a very strong campaign to have people take shorter showers and reduce water consumption, but they may also be a huge food producer," said Grady. "That's not necessarily a bad thing, but if you look at these things together you have a more complete picture of how you can manage the limited resources you have, and how you can prioritize the use of those resources."

In the future, the researchers plan to make their analyses more robust by incorporating more locations and including the [water consumption](#) needed to provide electricity to different regions. They would also like to analyze network resilience and network risk. Ultimately, they hope to create a platform where not only the public could investigate linkages but the government, as well.

More information: Tasnuva Mahjabin et al, Large cities get more for less: Water footprint efficiency across the US, *PLOS ONE* (2018). [DOI: 10.1371/journal.pone.0202301](https://doi.org/10.1371/journal.pone.0202301)

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