

Designing cities to combat climate change

May 24 2016, by Brian Wallheimer



The downtown Dallas, Texas (USA) skyline from a levee along the Trinity River. Facing southeast. Credit: drumguy8800/Wikipedia

Urban planners can take steps to reduce the heat cities may experience from climate change, but there would be other consequences and tradeoffs to consider, according to a study at Purdue University.

Dev Niyogi, a Purdue University professor of agronomy and earth, atmospheric and planetary science and Indiana's state climatologist, wanted to know what effect, if any, urban planning could have on mitigating rising temperatures associated with [urban heating](#) and [climate change](#). The amount of concrete and lack of vegetation in many large cities could make those places "heat islands," where temperatures rise

higher than in the suburbs or rural areas.

"Are there ways the two synergize and make the combination of climate change and urbanization worse?" Niyogi said. "Or are there ways that we can utilize urban form and function in a way that can help us mitigate what is happening with climate change?"

Niyogi and colleague Long Yang, a postdoctoral research associate at Princeton University who had been a visiting scholar at Purdue, looked to Beijing, China, as a model. The two collaborated with researchers from Tsinghua University, IBM and the National Center for Atmospheric Research. The city is developing in different ways, with some concentration in the city as well as areas where satellites cities are branching out.

"It is sort of emblematic of the rapid urbanization taking place," Niyogi said.

Yang said most studies look at thermal loading as cities develop, but little is known about how the design of a city can affect its heat. In this scenario, they considered population doubling and either being in a compact, central city, or spread among a central city and several satellite cities.

Based on complex urban climate models, Niyogi, Yang and their collaborators found that creating polycentric cities - those with a center and suburban satellites - could reduce future temperatures in cities that are developed in a more compact way over time.

"The thermal comfort over the old downtown area increased in the polycentric city compared to the compact city scenario," Yang said.

But that comes with tradeoffs.

All that heat and pollution doesn't just go away, Niyogi said. Those in satellite cities would have to travel longer distances as destinations are spread out, and that means more miles driven by vehicles and other forms of transportation. And while the thermal load would decrease in the [central city](#), Niyogi and Yang found that the thermal load for the region increases to compensate.

In other words, the heat may simply spread around, and pollution is likely to increase.

Niyogi says that while there are no simple solutions, the decisions that go into urban planning will affect cities and their surrounding areas in some way as temperatures rise.

"This will require an intimate interaction between the urban planning community and the urban climate community," Niyogi said. "While people have been looking at it in a theoretical perspective, we take a real scenario, a real case, a real plan and show that it matters. How you design the city is going to matter in terms of the tradeoffs that we'll want to achieve for future climate and the impacts on the population."

Daniel Aliaga, associate professor of computer science at Purdue, employed inverse modeling tools to understand how changes in Beijing's urban planning would affect temperatures and pollution. He can predict how changes in [urban planning](#) policy will affect the [city](#) in decades to come, as well as determining the types of changes that would be necessary to reach a desired outcome in the future. The hope is to develop easy-to-use tools for planning committees as they determine policies that will affect urban heating in their cities.

"You could say, 'In 20 years, I want a particular case, so what should be the building setbacks and building heights, and what materials should I use to get there,'" Aliaga said. "That's a useful thing, to enable these

visual and quick-responding tools for the concerned citizen,"

Niyogi and Yang will continue to monitor Beijing and other urban areas, using wider spans of time to improve model projections.

More information: Long Yang et al. Contrasting impacts of urban forms on the future thermal environment: example of Beijing metropolitan area, *Environmental Research Letters* (2016). [DOI: 10.1088/1748-9326/11/3/034018](https://doi.org/10.1088/1748-9326/11/3/034018)

Provided by Purdue University

Citation: Designing cities to combat climate change (2016, May 24) retrieved 19 April 2024 from <https://phys.org/news/2016-05-cities-combat-climate.html>

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