

Study uses social media and machine learning to show environmental injustices in Philadelphia's urban parks

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Matthew Walter, a doctoral student in UD's Department of Geography and Spatial Sciences, was the lead author on a recently published study that looked at parks in the City of Philadelphia. The study shows that a majority of the parks that are considered to be of high quality are located in areas that tend to have more affluent, white and college educated residents. The parks that scored the lowest tend to be in areas where the residents are historically marginalized: mostly low-income, Black and Hispanic, with lower educational attainment. Credit: Kathy F. Atkinson/University of Delaware

In urban areas throughout the United States, it is imperative for all communities to have equal access to high quality parks. These parks can have many benefits for the physical and mental well-being of the residents who live in close proximity to the urban green spaces. For instance, they are a place to socialize and exercise outdoors while also providing vegetation nearby, which can help reduce urban heat.

Yet, in the City of Philadelphia, not all parks are created equal, according to a new study from the University of Delaware.

Using a machine learning algorithm to analyze 285 parks from more than 100,000 park reviews gathered from Google Maps, the study shows that a majority of the parks that are considered to be of high quality are located in areas that tend to have more affluent, white and college educated residents. The parks that scored the lowest tend to be in areas where the residents are historically marginalized: mostly [low-income](#), Black and Hispanic, with a lower educational attainment.

The researchers corroborated the reviews with the physical characteristics of those parks using satellite and aerial imagery, as well as data from police reports and the Philadelphia Parks and Recreation Department.

The [study](#) was published in *Scientific Reports* and was led by Matthew Walter, a doctoral student in the Department of Geography and Spatial Sciences, which is part of the College of Earth, Ocean and Environment. This paper is the first part of Walter's dissertation, in which he will continue to look at green spaces outside of parks in [urban areas](#).

The co-authors include UD's Pinki Mondal and Benjamin Bagozzi. Mondal is an assistant professor in the Department of Geography and Spatial Sciences who also holds a joint appointment with the Department of Plant and Soil Sciences and is a resident faculty member at the UD

Data Science Institute. Bagozzi is an associate professor in the Department of Political Science and International Relations and assistant director of the Master of Science in Data Science program. Idowu Ajibade, associate professor in the Department of Environmental Sciences at Emory University, was also a co-author on the paper.

Social media shows social injustice

Walter said that by looking at social media reviews of parks from 2011 to 2022, and by looking at a large amount of reviews spread across a wide range of parks, the researchers were able to see how a large population of the City of Philadelphia was feeling about its urban parks.

Because people can put whatever they want into the reviews, which also come with a one-to-five-star rating system, the data they collected is known as unstructured data.

"In order to see what people were saying about these parks and to see why people are giving it higher scores or lower scores, we used a technique called Natural Language Processing, which is using machine learning to extract information out of a large set of information," Walter said. "That's how we condensed the text-based part of the review into a few different categories or topics. We could see which keywords are most likely to be mentioned and we did that by using anchor words where you can steer the model towards different groupings using those anchor words."

The researchers used eight different topics, and for each one they used 10 different anchor words to set the topic up. For example, if they wanted to look at a park's safety, they could put in different words related to safety and it would find similar words and then flag the reviews that had a high probability of mentioning safety.

Other topics included things like aesthetics and natural amenities.

The research found that neighborhoods that had residents over the age of 65, with higher median incomes, a college degree and predominantly white populations, tended to live in areas with higher park scores, indicating that these groups have a disproportionate access to higher quality parks.

These areas were found to be located in Northwest and Central Philadelphia, home to several highly visited and highly rated parks, including Wissahickon Valley Park, Love Park, Rittenhouse Square, Logan Square, Washington Square and Franklin Square.

Census tracts that had parks with lower scores tended to show neighborhoods where the residents were predominantly Black or Hispanic, living below the poverty level, had [young children](#) and were without high school or college degrees.

"We saw a pretty strong correlation between most of the historically disadvantaged groups and the park score," Walter said. "Based on what other studies have found and the historical data, this is kind of what you would expect. Unfortunately, we found that to be the case."

Mondal said that the study verified that all areas of Philadelphia are not created equal when it comes to access to high-quality parks.

"We all know that location matters," Mondal said. "We experience that in our day-to-day lives, and it's humbling to see that coming clearly through this empirical, data-oriented study."

Verifying perceptions

To verify the perceptions that were put into the Google Map reviews, the

researchers followed up with verification from satellite and aerial imagery, as well as the data collected from the Philadelphia Police Department and the Philadelphia Parks and Recreation Department.

"Sometimes, when you work on perception-based studies, people can say, 'Well, it's just perception. It's how people feel.' And so what we were able to achieve is that we used all these different sources of evidence and found that it actually supported these perceptions," Mondal said. "We found that for the most part, all of these perceptions, all of this [social-media](#) data was very accurately captured by this evidence."

Of particular concern to the researchers was that one key demographic group that didn't have access to highly rated parks were the ones who need it the most: young children.

In the areas where the census data showed more young children, the park reviews were more likely to mention condition and safety when compared to other topics. This lower perceived park quality for young children raises a concern for childhood health and development.

Walter said that a lot of what he saw in the reviews mentioned people not feeling safe because of drug-use within the park or drug paraphernalia, such as needles, being left in the park.

"Those reviews had people saying they don't feel safe bringing their children to this park because of drug-use or whatever reason they feel unsafe," Walter said. "Communities might only have one or two parks to bring their children to and, basically, they can't because of something that makes them feel unsafe. It's definitely something that should be addressed if you want to reduce this inequality."

Mondal said they also found concerns with the safety of the park equipment in those areas with young children.

"Children need playgrounds. They need to play. And some of the conditions of the park equipment was not good," Mondal said. "So when people say safety, it's not always crime reporting. It's also safety of the equipment that the kids need to use. The conditions and the [safety issues](#)—that came up very strongly in these parks that have lower scores."

Both Mondal and Walter said they hope this study can help policymakers re-evaluate how money is being spent to improve the parks in Philadelphia. Instead of allocating more resources to parks that already receive an abundant amount of funding, for example, city planners and park managers could look at allocating more money to smaller parks in areas of the city that don't have any other park options nearby.

"I'm hoping this study could be used as additional justification to improve those parks and put more money and resources into them," Walter said. "Our research showed what problems people were having with the parks, and I think that's something that could be addressed by [park](#) planners. They could see why people are having these issues leading to negative experiences and use that as a way to improve parks, specifically, to address the concerns of those people that are using the parks."

More information: Matthew Walter et al, Social media analysis reveals environmental injustices in Philadelphia urban parks, *Scientific Reports* (2023). [DOI: 10.1038/s41598-023-39579-4](https://doi.org/10.1038/s41598-023-39579-4)

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