Tree falls during dry season in São Paulo City are due to poor management, study suggests

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Stormy weather was the main cause during the rainy season. Credit: Priscilla Cerqueira

Trees fall every day in São Paulo, Brazil, the largest and most populous city in Latin America, but most tree falls occur in the rainy season owing mainly to the effects of temperature, strong winds and heavy rain. When

trees fall in the dry season, the main direct cause is not weather but a lack of management and adequate conditions for the survival of street vegetation.

These are the key findings of a study published by a group of Brazilian researchers in the journal *Trees—Structure and Function* as part of its "Urban Trees" collection.

The scientists analyzed daily tree fall data and identified some 7,000 occurrences in three years. São Paulo lost 1% of its street trees in the period, for an average of 6.2 falls per day. The worst day was December 29, 2014, when 337 tree falls were reported in 24 hours. Ibirapuera Park, the city's largest green area, had to be closed because of the number of trees blown down in the storm.

Trees are considered crucial to maintaining or improving environmental quality in cities. They play an important role in carbon storage and uptake, helping mitigate the adverse effects of global warming and pollution. They also help reduce flooding by increasing the more permeable soil area and reducing the speed and volume of stormwater runoff by intercepting part of the rain.

"Out of São Paulo's 652,000 street trees, 7,034 fell in the period 2013-16. Our analysis showed that tree fall is driven by precipitation, wind gust and temperature during the wet season. While temperature directly influences tree fall, both precipitation and wind gust may have lagged effects, leading to tree fall some days after the weather event. However, such associations with climate were not observed during the dry season, although trees fell on two-thirds of the days in the season, confirming problems due to poor stewardship and conditions," the article can be summarized as concluding.

The data used in the study came from the City of São Paulo's Center for

Emergency Management. The exact location of each tree fall was not available. The researchers focused on correlations between daily weather and tree falls, estimating immediate effects and the impact of rain and wind a few days after a storm.

"When rainfall is heavy, trees retain much more water and their weight increases. In addition, large amounts of water in the ground reduce soil-root friction, making a fall more likely. If the soil is waterlogged, however, the increase in soil weight offsets the loss of friction, and the tree may not fall during heavy rain. As the soil dries out, its weight decreases without any increase in friction, and it may fall," Giuliano Locosselli, a researcher at IB-USP's Department of Botany and first author of the article, told Agência FAPESP.

The co-authors included Marcos Silveira Buckeridge, a professor at the University of São Paulo's Institute of Biosciences (IB-USP), and Priscilla Cerqueira, an agricultural engineer and head of the Urban Tree Division of the City of São Paulo's Department of the Environment.

According to Locosselli, the results show that the effects of climate are concentrated in the rainy season. "Trees fall apparently without climate-related causes during the dry season, evidencing lack of care and structural problems that have been occurring for some time," he said.

For example, trees are pruned incorrectly, weakening their structure or balance, sidewalks strangle their roots or hinder their development, and there is often insufficient room for them to grow.

"Poorly managed trees are likely to fall even without apparent climate-related causes. Senescent vegetation can fall owing to impairment of photosynthesis, root support, growth and resistance to pathogens, which take advantage of the urban climate to reproduce and develop. It's not unusual to find trees in poor conditions that can fall for no apparent

reason," Locosselli said.

For Cerqueira, evidencing the lagging effects of rain and wind as causes of tree falls is one of the most significant aspects of the study. "Front-line municipal workers see what's happening day to day, and know tree falls are reported all year long, but we used the dry season as a baseline," she said. "The lagging effects of weather are important. Now we need to think about the action that should be taken immediately after stormy rain and wind to minimize the risk of tree falls, and to be ready to act if they happen."

The researchers did not analyze the direct impact of age or pollution on tree health, but Locosselli said the fact that a large number of São Paulo's trees were planted in the 1950s and 1960s contributes to their vulnerability and likelihood of falling.

With regard to air pollution, an article published in 2019 and co-authored by Locosselli showed that atmospheric pollutants stunt the growth of tipuana trees (Tipuana tipu), which are among the most common tree species in the city, and impair the ecosystem services they provide (more at: agencia.fapesp.br/30552).

Suggestions

Among the actions required to protect street trees in São Paulo, according to the study, are management and planning that takes into account species biology, resilience to extreme weather, and the characteristics of the local infrastructure.

The authors also recommend the implementation of tree monitoring programs using tree health indicators, and educational campaigns to win public support for science-based government decisions.

The City of São Paulo is legally responsible for managing street trees (Municipal Law 10,365/87). This includes planting, protecting tree health, pruning, and replacing trees when necessary. The actual work is outsourced to contractors. The electric power utility is allowed to trim tree crowns to make way for overhead power cables.

According to Cerqueira, a 20-year Municipal Urban Tree Plan was implemented in September 2020, aiming at planning and management to enhance resilience of the city to climate change, provision of shade and esthetic benefits, and "satisfaction of the public".

"Several aspects of tree management and planting highlighted in the study match the problems diagnosed by the Municipal Plan, which details programs and actions to address each problem," she said.

The Plan is due for a review in 2025. For this first five-year period it sets priorities such as producing a fall risk analysis protocol and an emergency management project that includes an audit of the agreements signed with contractors and the utility in an effort to reduce the amount of pruning and damage to trees.

"The general public is more aware of the importance of trees. Popular participation has increased. When a tree falls, especially after a storm, we get many more calls. We plan to improve the technical material addressed to the public," Cerqueira said.

With more than 12 million inhabitants, São Paulo has an area of 1,521 square kilometers and a subtropical climate. Roughly 75% of its streets have trees of various native species, including some from the Atlantic Rainforest, as well as exotic species, but most are in more central districts of the city. Planting more trees in outlying neighborhoods is one of the aims of the Municipal Plan.

Next steps

Locosselli said he has embarked on a new study with Cerqueira and other colleagues, analyzing georeferenced data available since 2012 for 30,000 trees in the city. "We're looking at where trees are located to understand how tree falls are influenced by the surroundings and the environment. The study encompasses 19 variables, such as pollution, sidewalk width and slope, climate, and building height. We should be finished well before the end of the year," he explained.

More information: Giuliano Maselli Locosselli et al, Climate drivers of tree fall on the streets of São Paulo, Brazil, *Trees* (2021). DOI: 10.1007/s00468-021-02145-4

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