

Research identifies climate-change refugia in dry-forest region

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The study was conducted in a Brazilian national park and was based on analysis of tree rings in the species *Amburana cearensis*, as well as satellite images (Dolina dos Macacos, a sinkhole in Parque Nacional Cavernas do Peruaçu).
Credit: Luciano Fioroto

Several indicators point to the adverse impacts of climate change on the planet's vegetation, but a little-known positive fact is the existence of climate-change refugia in which trees are far less affected by the gradual rise in temperatures and changing rainfall regimes. Climate-change refugia are areas that are relatively buffered from climate change, such

as wetlands, land bordering water courses, rocky outcrops, and valleys with cold-air pools or inversions, for example.

A study conducted in Peruaçu Caves National Park in the state of Minas Gerais, Brazil, with FAPESP's support, confirmed and quantified this type of occurrence. "These refugia are excellent candidates for land management initiatives, offering a high probability of success and lower expenditure in [conservation areas](#)," said Milena Godoy-Veiga, a Ph.D. candidate at the University of São Paulo's Institute of Biosciences (IB-USP) and lead author of the article on the study published in *Forest Ecology and Management*.

The other authors include Godoy-Veiga's thesis advisers, Gregório Ceccantini and Giuliano Locosselli.

According to Godoy-Veiga, climate-change refugia are frequently located in karstic regions. Karst is a topography formed over time from chemical dissolution of soluble rocks such as limestone, dolomite, etc., and characterized by underground drainage systems with subterranean rivers, sinkholes, and caves, as well as dramatic above-ground features such as steep cliffs and dry gullies. "This is the landscape in Peruaçu Caves National Park, where there are ground height differences of as much as 200 meters, with the high parts projecting shadows over the low parts, and the environment comprising all the other features mentioned," she said.

The researchers reached the conclusion that climate-change refugia are to be found in a large proportion of the park by analyzing [growth rings](#) in samples of the tree species *Amburana cearensis* (vernacular names *amburana-de-cheiro* and *cerejeira*). "We counted over 4,500 growth rings in samples from 39 trees," Godoy-Veiga said. "Chronological analysis is usually done with a mean value for all trees, but we were able to analyze each tree individually thanks to a partnership with two

researchers at Israel's Weizmann Institute of Science, who are also co-authors of the article: Elisabetta Boaretto, who heads a laboratory, and Lior Regev, the scientist responsible for the particle accelerator in which radiocarbon dating is done."

They were able to date the tree rings precisely using the "bomb peak" curve, which is applicable to modern samples owing to the sharp rise in carbon-14 levels in the atmosphere and all living beings following the nuclear tests conducted during the Cold War. The levels peaked in the mid-1960s and then fell again with the signing of various international treaties banning nuclear weapons tests.

"Our analysis shows that 22 out of 39 trees were sensitive to temperature and the amount of summer rain. Six were sensitive only to rainfall, and 11 were apparently not affected by the region's weather. Based on these results, we defined areas of the park that can be considered climate-change refugia, and confirmed this using [satellite images](#) taken during the dry and rainy seasons," Godoy-Veiga said.

"We compared the images to construct a vegetation index, which clearly showed that the presumed climate-change refugia were the least seasonal areas of the park, where most of the trees don't lose their leaves. These areas are associated with lower terrain and deeper soil, or are near rocky outcrops and the Peruaçu River."

Located in Brazil's central region in a transition zone between two important biomes, Cerrado (savanna) and Caatinga (semi-arid shrubland and thorn forest), Peruaçu Caves National Park is a monumental karst landscape with huge caves and speleothems (stalactites, stalagmites and other mineral formations) created over thousands of years by rainwater and the Peruaçu, a tributary of the São Francisco.

Besides caves, the park has almost 600 square kilometers of dry forest,

where the study was conducted. "Analyzing only the park's non-degraded portions, which correspond to about 80% of the total area, we concluded that almost a quarter, or more than 100 square kilometers, could be held to contain climate-change refugia," Godoy-Veiga said.

The various factors mentioned have created a microenvironment that is sheltered from the region's prevailing climate, providing more favorable conditions for land management and increasing the likelihood of its success.

However, this horizon should be considered soberly without exaggerated expectations as it is already clear that extreme weather such as the phenomena caused by El Niño in 1997 has adverse effects on tree growth even in refugia. "The study is a major advance in the identification of [climate-change](#) refugia even in dry forest areas such as those located in northern Minas Gerais, but despite protection from rising temperatures and changes in rainfall patterns in these refugia, the trees there are vulnerable to extreme weather," Locosselli said.

Ceccantini agreed. "Large numbers of trees have died in recent years and are still standing in the park. The study helps us understand why and how we need to react in order to conserve this natural heritage," he said.

"Understanding how climate affects trees on a microscale helps design strategies to take better care of trees, not just in conservation units such as national and state parks, but also in urban areas, where [trees](#) play a very important role in enhancing the quality of life for the inhabitants."

More information: Milena Godoy-Veiga et al, The value of climate responses of individual trees to detect areas of climate-change refugia, a tree-ring study in the Brazilian seasonally dry tropical forests, *Forest Ecology and Management* (2021). [DOI: 10.1016/j.foreco.2021.118971](https://doi.org/10.1016/j.foreco.2021.118971)

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