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Lessons from Brazil's São Paulo droughts (commentary)

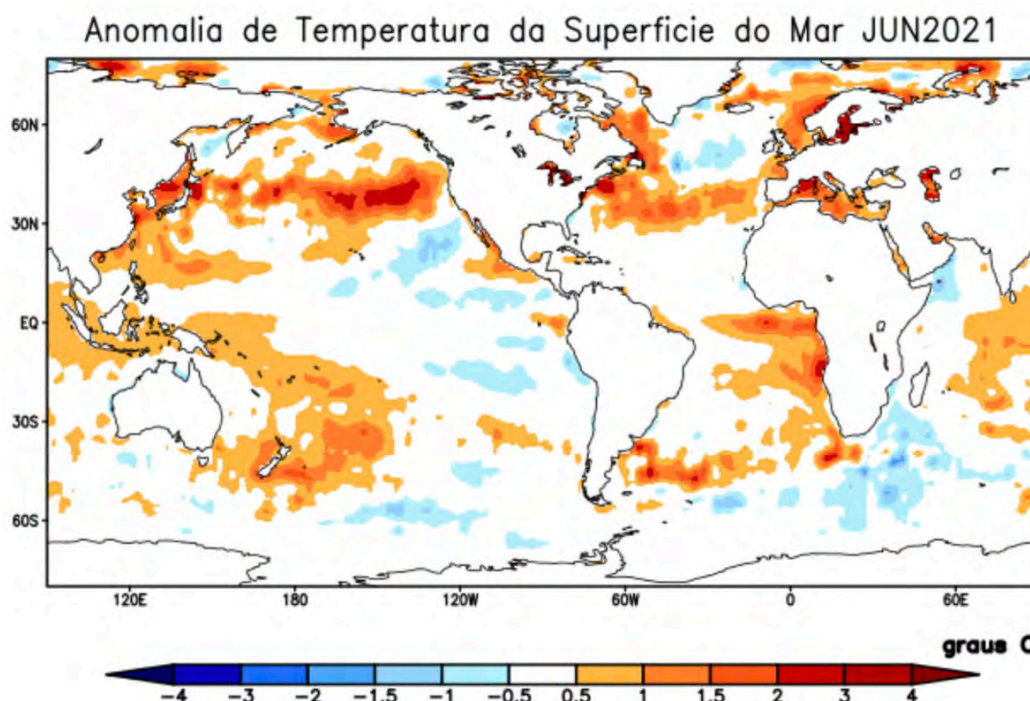
by **Philip M. Fearnside** on 30 July 2021



- *São Paulo is increasingly facing severe droughts, as is the case in 2021. In 2014 the city came close to having its reservoirs run dry. Brazil's agriculture and hydropower also depend on reliable rains.*
- *Anthropogenic climate change is increasing the fluctuations in ocean surface water temperatures, and the frequency is increasing of the combination of warm water in the Atlantic and cold water in the Pacific off the coasts of South America, a combination that leads to droughts in São Paulo.*
- *The trends in ocean temperatures are expected to worsen these droughts, but what could make them truly catastrophic is the prospect of this variation being combined with the impact of deforestation depriving São Paulo of the water that is recycled by the Amazon forest and transported to southeastern Brazil by the "flying rivers." The lessons are clear: control global warming and stop deforestation.*
- *This post is a commentary. The views expressed are those of the author, not necessarily Mongabay.*

The year 2021 is a La Niña year, and [La Niña](#) events typically [lead to droughts](#) in southeastern Brazil where São Paulo, the world's [fourth largest city](#), is located. La Niña events result from a cooling of surface water in the eastern part of the Pacific Ocean (Figure 1). On a decadal scale, the [driest decades in this region](#) correspond to those with a combination of cold water

in the Pacific, indicated by negative values of the Pacific Oscillation Index (POI), and warmer water in the South Atlantic, indicated by positive values of the Atlantic Multidecadal Oscillation (AMO) index. This is the case in 2021, and in April the POI dropped dramatically to even more negative values.



Warm water in the Atlantic and cold water in the Pacific off South America in April 2021. Source: [CPTEC/INPE](#)

This year southeastern Brazil has been hit with a [major drought](#) affecting hydropower generation, agriculture and urban water supplies. The primary factor is a large variation in rainfall linked to global climate change, with the effect of the gradual increase in Amazonian deforestation being a smaller effect added onto this variation. However, over time, the advance of deforestation will indeed lead to more drought in southeastern Brazil, especially if the “[Trans-Purus](#)” region in the western part of the Brazilian Amazon between the Purus River and the border with Peru is deforested. It is possible that deforestation in the Amazon is already having some effect on the average rainfall in southeastern Brazil, as climate models comparing the Brazilian Amazon with the original vegetation versus the vegetation that was present in 2007 indicated that in rainfall in the southern part of the Amazon region was already being impacted. The fact that the southern portion of the Amazon region is located in the path of the South American low-level jet ([SALLJ](#)) winds, known as the “flying rivers,” implies that Brazil’s Southeast Region, which is further along the path of these winds, would also be affected. However, this refers to average rainfall rather than the variation that dominates in explaining the current drought.

In addition to the reduction in water-vapor inputs to the “flying rivers,” the winds themselves are changing. Over the last three decades there has been an [intensification](#) of the northern Andes branch of the SALLJ, which carries

water vapor to Bolivia, Paraguay and northwestern Argentina, while the central Andes branch [has weakened](#), reducing flow to southeastern Brazil.

Read related: [Amazon and Cerrado deforestation, warming spark record drought in urban Brazil](#)

The frequency of [major droughts](#) in southeastern Brazil is [increasing significantly](#). The [2014 drought](#) in this region was remarkable, and the “water crisis” that year resulted from a combination of causes. There had been below-normal rain since the previous year, the temperature was unusually high, and a high pressure system parked over the São Paulo area for 51 days, [creating a barrier](#) in the lower atmosphere, blocking the entry of moisture from the Atlantic and inhibiting rain. At the same time, a [displacement](#) of the South Atlantic convergence zone ([SACZ](#)) prevented the arrival of water vapor from the Amazon via the “flying rivers,” this displacement being the same one that contributed to the Madeira River’s record flood that year. The wind system that diverted the “flying rivers” was linked to a [teleconnection](#) (a causal link at a distance) with the [Walker circulation](#) cell in the Pacific, which, in turn, was altered by an abnormal heat source near Australia. The surface water of the Atlantic near the coast of southeastern Brazil was warm, and this condition is [associated with droughts](#) in the region. The trend towards warmer water in this portion of the South Atlantic is in part due to the [Agulhas leakage](#), which is [linked to global warming](#). The [Agulhas current](#) in the Indian Ocean carries warm-water down the coast of Africa from Mozambique to the Cape of Good Hope, where it turns sharply to the east under the influence of the westerly winds and the Antarctic circumpolar current (the “[ACC](#),” also known as the “west-wind drift”) (Figure 2). However, with global warming the westerly winds that drive the ACC are displaced to the south, leaving room for “leakage” from the Agulhas current into the South Atlantic. Major leakages are occurring with greater frequency, and the warm water can spread in different directions, including to the coast off São Paulo.

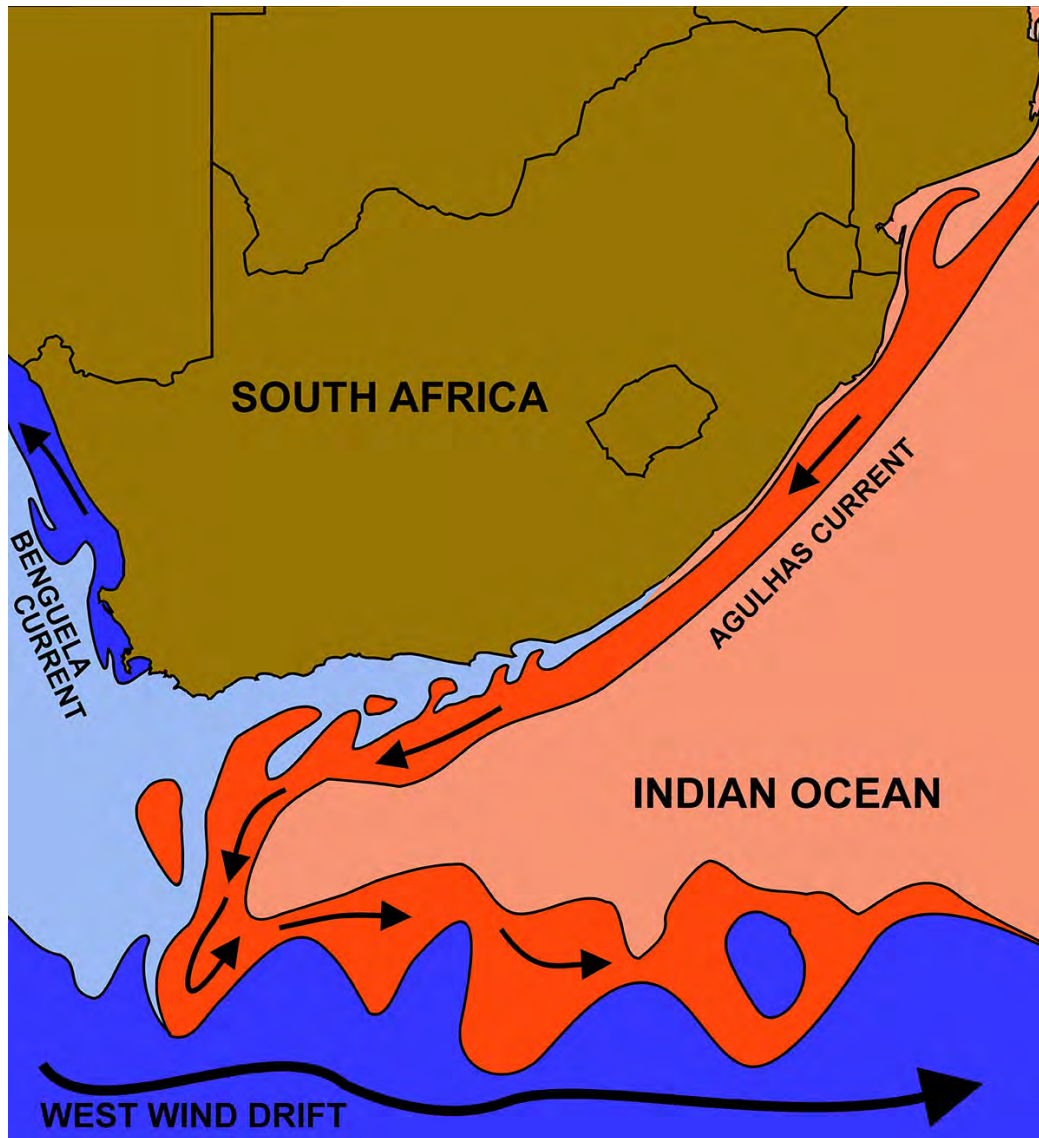


Figure 2. The Agulhas current. Source: [Wikipedia](#)

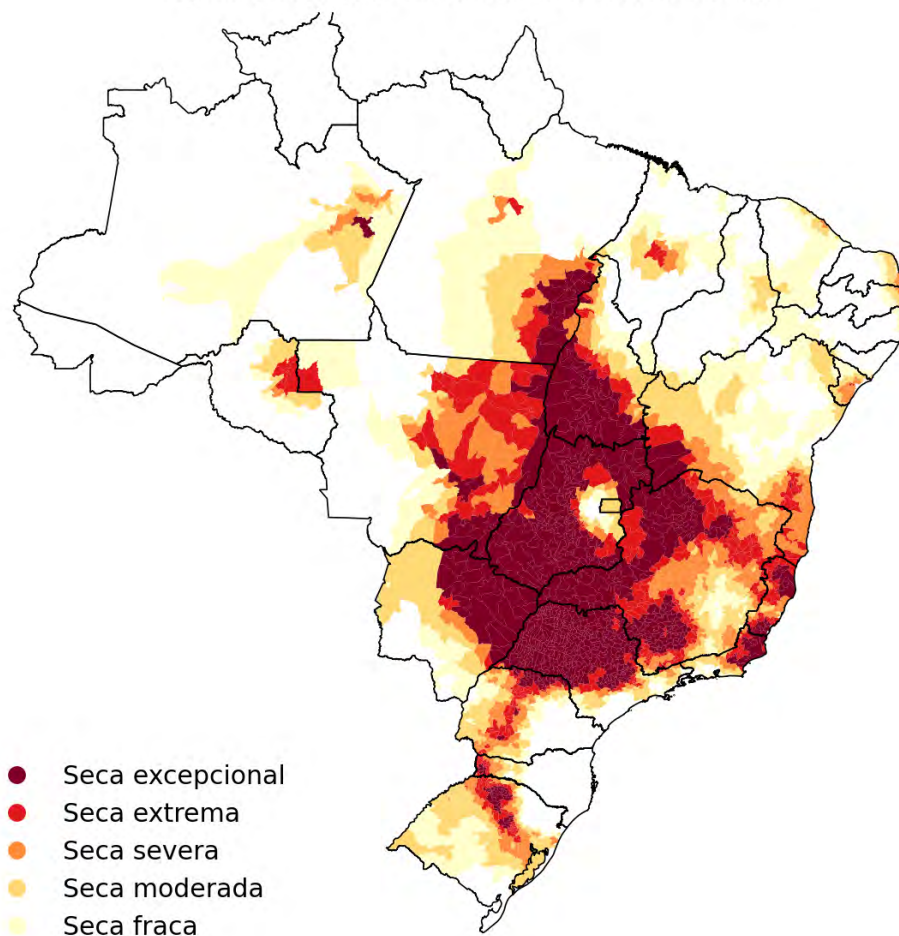
São Paulo's drying reservoirs

The volume of water in the reservoirs supplying greater São Paulo in 2014 [fell to only 5%](#) of their total capacity. With the “dead volume” of the reservoirs being pumped out and almost exhausted, the city of São Paulo came within a few days of running out of water even for drinking. Mitigation measures were implemented in subsequent years, but, even so, experts on São Paulo's water system [warned](#) that “The assumption that water problems will finally be resolved by building more infrastructure may fail due to growing human needs and climate change.”

The 2014 drought likely resulted from [anthropogenic climate change](#), but the drought was not directly linked to deforestation in the Amazon. The 2021 drought (Figure 3) is similarly a variation augmented by climate change. The problem is that if the effect of more deforestation in the Amazon is added to this variation, the sum could be catastrophic not only for the country's large urban centers, but also for agribusiness (see [here](#), [here](#) and [here](#)). The

Paraná/La Plata river basin depends on the Amazon for [70% of its water](#). Deforestation continues gradually, each year increasing a little the loss of the forest's environmental services. The forest recycles an enormous amount of water every year, greater than the flow of the Amazon River, and if the region is turned into cattle pasture this recycling will no longer happen. The water that is now recycled is [transported](#) forward by winds known as "flying rivers," thus providing water vapor to generate rain, including in São Paulo (see [here](#), [here](#), [here](#), [here](#) and [here](#)). If not recycled, water that enters the Amazon after evaporating from the Atlantic Ocean will fall only once as rain and then return to the ocean via the Amazon River.

Água no solo para Abril 2021 (classes de seca)



The 2021 drought: soil water in April. Source: [CEMADEN](#)

The dependence of Brazil's Southeast, South and Center-West Regions on Amazon water alone makes it strongly in the country's national interest to stop all deforestation in the Amazon. It is not enough just to stop "illegal" deforestation, which is the government's [announced objective](#). Stopping deforestation is possible because practically all [deforestation is for pasture and soy](#), the clearing for subsistence crops for the local population being minimal.

This text is updated from a Portuguese-language version published by [Amazônia Real](#).

Header image: Prolonged dry conditions have caused the worst drought in central and southern Brazil in almost a century. The Operational Land Imager (OLI) on NASA's Landsat 8 captured an image of Lago das Brisas on the Paranaíba River on June 17, 2021. Photo credit: NASA