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Hotter than your average spa: Rising temps in Amazon lakes sound alarm over climate change

The drought in the central Amazon was already showing signs of unusual severity in early September 2023, but the situation turned catastrophic by the end of the month, when the carcasses of two species of endangered river dolphins began to line the shores of Lake Tefé, a large floodplain lake.

Why the dolphins were turning up dead was initially unclear, but researchers soon identified a likely suspect: heatstroke, an event never before recorded in freshwater environments. The event was especially alarming because the endangered species is a top predator, and their demise threatens the broader ecosystem.

While the world focused on record-breaking temperatures in the air and oceans, the climate was heating Amazon's freshwater lakes. A team of researchers, including faculty from UC Santa Barbara, documented the phenomenon and recorded unprecedented water temperatures, raising concerns over the impacts of extreme climate events on Amazon ecosystems and human populations.

The international team, led by researchers from the Mamirauá Institute in Amazonas, Brazil, presented their main findings in the journal Science. The study uncovers the causes and consequences of heat waves in Amazonian lakes, along with the alarmingly widespread warming these environments have experienced in

recent decades due to climate change.

“We were surprised that such exceptionally high water temperatures could occur simply as a result of sunny skies and low wind speeds,” explained co-authors John Melack and Sally MacIntyre, limnology professors at UCSB. “And we are concerned that these conditions are becoming more common.”

Lake Tefé: A sentinel of climate change

Lake Tefé — a large floodplain lake in Amazonas, Brazil — has become the epicenter of the Amazonian climate crisis. During the 2023 drought, its surface area was reduced by about 75%, shrinking from 379 km² to just 95 km². Most of the remaining area became shallow water less than half a meter deep.

The lake baked in the hot equatorial sun. Between September and October, afternoon temperatures in the lake’s water column reached over 40° Celsius (104º Fahrenheit). For comparison, the average surface water temperature in similar tropical lakes is about 29-30°C (84-86º F).

“Under normal conditions, the deeper water is usually colder, serving as a refuge for animals to escape very high temperatures. However, in the extreme drought of 2023, this refuge simply did not exist,” said lead author Ayan Fleischmann, a senior researcher at the Mamirauá Institute.

The scope and causes of the crisis

The scientists found that the heatwave in Lake Tefé was part of a larger trend. High water temperatures occurred throughout the central Amazon that year, with temperatures above 37° C (98.6º F) recorded in other floodplain lakes.

Researchers at UCSB took insights gained from many years studying the Amazon’s floodplain lakes and combined them with hydrodynamic model simulations to identify four main factors behind the superheating of Amazonian lakes. Several factors combined to raise water temperatures. Intense solar radiation — aggravated by low cloud cover — warmed the water like a heating lamp each day. And since the

water was more turbid than normal, it absorbed more heat than usual. The reduced water volume also favored heating.

However, the results imply that the low water levels and increased air temperature were less decisive factors than the lack of wind. Wind can cool bodies of water like a child blowing on a bowl of soup. But this period saw low wind speeds. “This highlights the complexity of the Amazon aquatic system and how the combination of specific factors can lead to extreme situations,” Melack said.

The 2023 drought was exceptional, yet it reflects a larger change underway: The region's waters are warming. According to satellite measurements of 24 Amazonian lakes between 1990 and 2023, temperatures have increased by 0.6° C (1.1º F) per decade, on average. Some lakes have warmed by up to 0.8° C (1.4º F). Freshwater heat waves have become more frequent over the past decade, signaling a worrying trend. In 2024, the Amazon suffered another extreme drought that raised lake temperatures to alarming levels.

Socio-environmental impacts of the extreme drought

Extreme droughts represent an enormous challenge for the region’s human population as well. These conditions deplete natural resources, like fisheries, and isolate riverine communities by restricting movement along the rivers that function as the Amazon’s main routes for transport. This endangers these populations by making access to food, drinking water and medicine difficult.

The study sends a clear message: climate change is directly impacting the aquatic ecosystems of the Amazon. The superheating of the lakes in 2023 (and later again in 2024) was not an isolated case, but rather an exceptional extreme event within a long-term trend likely driven by global climate change.

Amazonian lakes can serve as sentinels of the global climate crisis, but understanding their warnings requires more information. Long-term monitoring programs of Amazonian aquatic ecosystems are scarce but, the researchers said, are precisely what’s needed to promote science-based climate and disaster policies.

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Climate Change

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