Study shows how El Niño and La Niña climate swings threaten mangroves worldwide

May 23, 2025 5:00 AM Stacey Plaisance
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New international research from Tulane University is the first to demonstrate global-scale patterns in how El Niño-Southern Oscillation (ENSO) influences mangrove growth and degradation. (Photo by Daniel Friess)

A new international study led by researchers at Tulane University shows that the El Niño and La Niña climate patterns affect nearly half of the world's mangrove forests, underscoring the vulnerability of these vital coastal ecosystems to climatic shifts. Mangroves are shrubs or trees that grow in dense thickets

mainly in coastal saline or brackish water.

The research, published in *Nature Geoscience*, is based on nearly two decades of satellite data from 2001 to 2020 and is the first study to demonstrate global-scale patterns in how El Niño-Southern Oscillation (ENSO) influences mangrove growth and degradation.

Previously, impacts had only been documented at individual sites, such as a dramatic die-off in northern Australia in 2015 when more than 40 million mangrove trees perished along a 1,200-mile stretch of coastline.

“We wanted to know whether these events were isolated or part of a broader pattern,” said lead author Zhen Zhang, a postdoctoral scholar at Tulane School of Science and Engineering. “Our findings confirm that ENSO has large-scale, recurring effects on mangrove ecosystems around the world.”

El Niño is a climate pattern of Pacific Ocean temperature and wind shifts that affect global weather. El Niño brings warm waters to the eastern Pacific; La Niña brings cool waters there. These changes disrupt rainfall, storms and temperatures worldwide—causing floods, droughts and shifts in hurricane activity.

El Niño is known for triggering coral bleaching, droughts, wildfires, and now, researchers have confirmed it also plays a major role in mangrove health.

The study identified a striking “seesaw” effect: During El Niño events, mangroves in the Western Pacific experience widespread degradation, while those in the Eastern Pacific see increased growth. The opposite occurs during La Niña events, with growth in the west and decline in the east.

Researchers pinpointed sea level changes as the key driver behind these patterns. For example, El Niño often causes sea levels to drop temporarily in the Western Pacific, increasing soil salinity and leading to mangrove dieback.

The research team, including collaborators from Xiamen University and the National University of Singapore, used satellite-derived Leaf Area Index data, which measures plant productivity based on leaf density, alongside oceanic and climate datasets to assess mangrove health over time.

Tulane Earth and Environmental Sciences professor Daniel Friess, a co-author of the study, said mangrove forests provide essential services to hundreds of millions of people worldwide, including storm protection, carbon storage and fisheries support. But their existence depends on a narrow set of environmental conditions, making them particularly sensitive to climate variations like El Niño.

“Mangroves are one of the most valuable ecosystems on the planet, yet they exist in a delicate balance with their environment,” Friess said. “A better understanding of how this unique habitat is influenced by changing environmental conditions will help us conserve and restore them, while supporting the coastal communities that rely on them.”

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Study shows the "seesaw" effect of El Niño and La Niña causes floods, droughts and shifts in hurricane activity, stressing mangrove forests worldwide. (Photo by Daniel Friess)