Earth saw record-high greening in 2020: What's at the root?

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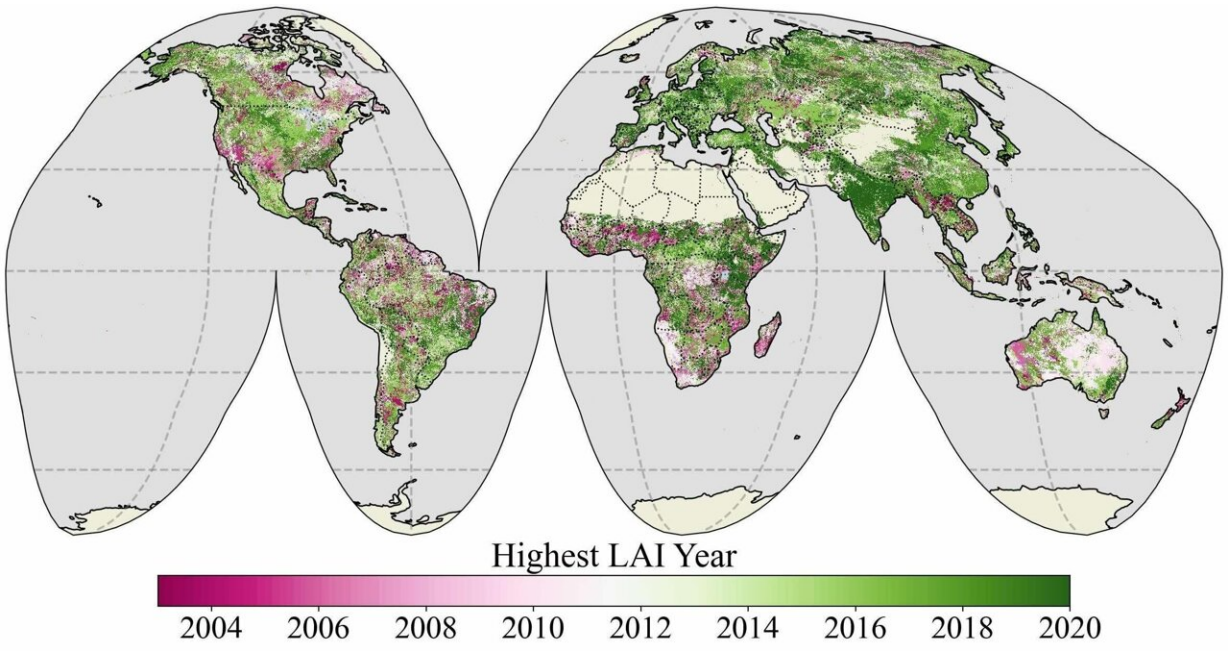

Satellite-based leaf area index (LAI), a measure of leaf abundance at the surface, illustrates changes in vegetation greenness from 2003 to 2020. Credit: *Remote Sensing of Environment* (2024). DOI: 10.1016/j.rse.2024.114494

As pandemic lockdowns forced humans into isolation, Earth's vegetation was thriving. The year 2020 was the greenest in modern satellite records from 2001 to 2020, according to a recent study published in *Remote Sensing of Environment*. Consistent growth in northern and temperate regions, combined with a brief period of tropical growth, primarily led

to this remarkably verdant period.

Terrestrial (land-based) vegetation is vital to life on Earth as we know it. Plants regulate carbon and water cycles, feed organisms and help offset fossil fuel emissions, among many other benefits. Monitoring greening trends and variability can inform ecosystem management practices and strategies for addressing climate warming.

"Terrestrial vegetation, like trees and shrubs, takes up carbon dioxide through photosynthesis, so they can offer a natural climate-warming solution," said Yulong Zhang, a research scientist in the Division of Earth and Climate Science within the Duke University Nicholas School of the Environment, who led the multi-institutional study.

The researchers analyzed satellite data collected from 2001 to 2020 for signs of greening based on several measures, such as vegetation structure, density and plant health. An overall trend toward more abundant vegetation emerged, with considerable variability from year to year. However, 2020 stood out as markedly greener than the others.

The team wondered: Was the pandemic responsible for the leafy bonanza? For example, lockdowns and travel restrictions temporarily reduced daily activity and air pollution, which could have enabled plants to flourish in brighter sunlight in the absence of human disturbance, the authors suggested.

To tease out the drivers of Earth's green-up, they used machine learning and ecological simulations to explore how different environmental and human factors might have affected vegetation growth. Contrary to expectations, pandemic-related lockdowns had a limited effect on global greening.

"Although short-term air quality improvements and reduced disturbances

slightly boosted greenness in lockdown regions, these effects faded quickly and were further counteracted by natural climate variability as the year progressed," Zhang said.

The team found that 2020's record-high greening was instead primarily associated with temperate and colder regions, fueled by rising CO_2 levels, climate warming and reforestation efforts. The effects of climate warming were most prominent in cooler areas, such as boreal forests, where rising temperatures extended growing seasons.

Additionally, "China and India were massive green hotspots, thanks to tree planting, land restoration and agricultural management efforts," noted co-author Tong Qiu of the Nicholas School. "High rainfall in 2019-2020 also boosted vegetation growth in the tropics, likely linked with climate oscillations, or patterns, such as La Niña and the Indian Ocean Dipole."

The study highlights Earth's remarkable ability to adapt to environmental changes, the authors concluded. However, they issued a note of caution.

"Climate extremes, water scarcity, wildfire risk and increased human pressures could potentially slow down or even reverse these gains under a warming climate," said co-author Wenhong Li, also of the Nicholas School. "If that happens, we may see an acceleration of ongoing climate warming."

To that end, the team is calling for expanded monitoring and the development of advanced models to predict vegetation trends and variability as climate change accelerates.

More information: Yulong Zhang et al, Earth's record-high greenness and its attributions in 2020, *Remote Sensing of Environment* (2024). DOI: 10.1016/j.rse.2024.114494

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