Small Deforestation Clearings Drive Massive Carbon Losses in Tropical Forests, New Study Shows

Study led with major contributions from the Laboratoire des Sciences du Climat et de l'Environnement (LSCE) published in Nature ***

Tropical forests hold nearly **half of Earth's above-ground forest carbon**, yet they are increasingly threatened by human-driven disturbances and climate-intensified fires and storms. A new study published today in *Nature* provides the most spatially detailed picture to date of how tropical forest carbon has changed over the past 30 years — and reveals that **the smallest deforestation clearings, often less than two hectares, are responsible for more than half of total carbon losses**.

Using a high-resolution bookkeeping approach that integrates **sub-hectare Earth observation data** with innovative, spatially explicit biomass recovery curves, the research team mapped carbon losses and recovery trajectories across all tropical forests from 1990 to 2020. The work was co-led by scientists at the **Laboratoire des Sciences du Climat et de l'Environnement (LSCE)** in France supported by CEA, CNRS and UVSQ.

Key Findings

- **Tropical humid forests lost 15.6 ± 3.7 Pg[1] of carbon** over the past three decades, while tropical dry forests remained roughly carbon-neutral.
- **Small clearings (<2 ha)** represent only 5% of disturbed forest area but account for **56% of net carbon losses**, primarily due to persistent land-use conversion to croplands, pastures, roads, or settlements.
- Fire-driven carbon losses in many dry tropical forest regions are partly balanced by long-term post-fire recovery, unlike the persistent impacts of small-scale deforestation and non-fire degradation.
- Disturbances have progressively shifted into **denser, more carbon-rich humid forests**, amplifying the climate impact of each hectare lost.
- By contrast, repeated fires in dry forests have gradually reduced per-event losses due to declining fuel loads.
- Undisturbed tropical forests remain a **net carbon sink**, partially compensating for losses in disturbed areas — but the overall tropical AGC balance from 1990–2020 is close to neutral.

[1] 1 Pg C = 1 billion ton of carbon

A New Window on Tropical Forest Carbon

The study represents the first spatially explicit 30-meter resolution reconstruction of carbon losses and gains across all tropical forests. Unlike previous global models that rely on simplified assumptions or continental averages, this new approach captures how disturbance type, size, and local climate conditions shape forest recovery, thanks to new high resolution biomass maps from the European Space Agency.

“This work revealed that small-scale human activities — not just large clear-cutting or wildfire — are quietly driving the majority of tropical carbon losses,” said Yidi Xu, a postdoctoral researcher at the LSCE research team who is the first author of the study.

“Protecting young and recovering forests is just as essential as preventing new deforestation.” explained Philippe Ciais at LSCE, who co-led the study.

Implications for Climate Policy

The findings highlight urgent priorities for climate mitigation:

- Reducing **small-scale agricultural expansion and degradation**, especially across Africa, where such disturbances account for **over 97% of net carbon losses**.
- Protecting **young, recovering forests**, whose carbon sequestration potential is sharply reduced by repeated disturbances.
- Strengthening monitoring of forest edges and encroachment fronts where carbon-dense forests are increasingly exposed.

The team emphasizes that the method can support **national carbon inventories**, REDD+ implementation, and targeted conservation planning. By revealing where carbon losses occur—and where forests are successfully regrowing—the study provides a powerful tool for safeguarding one of Earth’s most important climate buffers.

For more information or press inquiries, please contact LSCE’s communications office.

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Small clearing in tropical forest