

## About

This data set includes tree cover extent, primary forest extent, aboveground live woody biomass (AGB) stocks and densities, annual tree cover loss, annual tree cover loss by dominant driver, annual primary forest loss, annual forest greenhouse gas (GHG) emissions, average annual forest CO<sub>2</sub> removals (sequestration), and average annual net GHG flux at the country and first (state, province) sub-national levels.

- Tree cover loss, tree cover loss by driver, and emissions are available as annual data for 2001-2024.
- Primary forest loss is available as annual data for 2002-2024.
- Emissions, removals and net flux are available as annual averages for 2001-2024.
- Tree cover is available for 2000 and 2010.
- Aboveground biomass stocks and densities are available for 2000.

The tree cover data was produced by the University of Maryland's GLAD laboratory in partnership with Google (Hansen et al. 2013). Tree cover loss is defined as "stand replacement disturbance" which is considered to be clearing of at least half of tree cover within a 30-meter pixel. Primary forest is defined by Turubanova et al. 2018. Tree cover loss by dominant driver are from Sims et al. 2025. Carbon densities, emissions, removals, and net flux (megagrams CO<sub>2</sub>e/yr) are from Harris et al. 2021. The emissions data quantifies the amount of carbon dioxide emissions to the atmosphere where forest disturbances have occurred, and includes CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O and multiple carbon pools. Removals includes the average annual carbon captured by aboveground and belowground woody biomass in forests. Net flux is the difference between average annual emissions and average annual removals; negative values are net sinks and positive values are net sources.

Tree cover loss, tree cover extent, and AGB stock and density are presented for percent canopy cover levels  $\geq 10\%$ , 15%, 20%, 25%, 30%, 50% and 75% in 2000. Emissions, removals, and net flux are presented only for percent canopy cover levels  $\geq 30\%$ , 50%, and 75% in 2000, plus areas with tree cover gain between 2000 and 2020 (Potapov et al. 2022) regardless of percent canopy cover. We recommend that you select your desired percent canopy cover level before your analysis and use it consistently throughout analyses. The Global Forest Watch website uses a  $\geq 30\%$  canopy cover threshold as a default for all statistics.

## Tabs

**Country tree cover loss:** Hectares of tree cover loss at a national level, between 2001-2024, categorized by percent canopy cover in 2000.

**Country primary loss:** Hectares of primary forest loss at a national level, between 2002-2024, at 30% tree canopy density only.

**Country carbon data:** Aboveground woody biomass stocks and densities in 2000 (Mg AGB and Mg AGB/ha, respectively); average annual GHG emissions, removals (sequestration), and net flux between 2001 and 2024 (Mg CO<sub>2</sub>e/yr); annual GHG emissions (Mg CO<sub>2</sub>e). Provided by percent canopy cover in 2000 ( $\geq 30\%$ , 50%, and 75% only).

**Country drivers:** Hectares of tree cover loss at a national level, between 2001-2024, at 30% tree canopy density and categorized by dominant driver.

**Subnational 1 tree cover loss:** Hectares of tree cover loss at the first sub-national level, between 2001-2024, categorized by percent canopy cover in 2000.

**Subnational 1 primary loss:** Hectares of primary forest loss at a sub-national level, between 2002-2024, at 30% tree canopy density only.

**Subnational 1 carbon data:** Aboveground woody biomass stocks and densities in 2000 (Mg AGB and Mg AGB/ha, respectively); average annual GHG emissions, removals (sequestration), and net flux between 2001 and 2024 (Mg CO<sub>2</sub>e/yr); annual GHG emissions (Mg CO<sub>2</sub>e). Provided by percent canopy cover in 2000 ( $> 30\%$ , 50%, and 75% only).

**Subnational 1 drivers:** Hectares of tree cover loss at the first sub-national level, between 2001-2024, at 30% tree canopy density and categorized by dominant driver.

## Citations

Hansen, M.C., P.V. Potapov, R. Moore, et al. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." *Science* 342: 850–53. Data available on-line from: <https://glad.earthengine.app/view/global-forest-change>.

Turubanova, S., Potapov, P.V., Tyukavina, A. and Hansen, M.C., 2018. Ongoing primary forest loss in Brazil, Democratic Republic of the Congo, and Indonesia. *Environmental Research Letters*, 13(7), p.074028.

Harris, N.L., D.A. Gibbs, A. Baccini, et al. 2021. "Global maps of twenty-first century forest carbon fluxes." *Nature Climate Change* 11: 234-240. <https://doi.org/10.1038/s41558-020-00976-6>. Data available on-line from: <https://data.globalforestwatch.org/datasets/gfw::forest-greenhouse-gas-net-flux>

Gibbs, D.A., M. Rose, et al. 2025. "Revised and updated geospatial monitoring of 21st century forest carbon fluxes." *ESSD* 17(3): 1217-1243.

<https://essd.copernicus.org/articles/17/1217/2025/>

Gibbs, D.A., N. Harris. 2024. <https://www.globalforestwatch.org/blog/data/whats-new-carbon-flux-monitoring/>

Sims, M., R. Stanimirova, A. Raichuk, M. Neumann et al. 2025. "Global Drivers of Forest Loss at 1 km Resolution." *Environmental Research Letters*. doi: 10.1088/1748-9326/add606.

Global Administrative Areas Database, version 4.1. Available at <http://gadm.org/>

## Cautions

In this data set, "tree cover" is defined as all vegetation greater than 5 meters in height, and may take the form of natural forests or plantations across a range of canopy densities. "Loss" indicates the removal or mortality of tree cover and can be due to a variety of factors, including mechanical harvesting, fire, disease, or storm damage. As such, "loss" does not equate to deforestation. Improvements in the detection of tree cover loss due to the incorporation of new satellite data and methodology changes between 2011 and 2015 may result in higher estimates of loss in recent years compared to earlier years. See <https://www.globalforestwatch.org/blog/data-and-research/tree-cover-loss-satellite-data-trend-analysis/> for more information.

The emissions, removals, and net flux data are the products of modeling and thus have an inherent degree of error and uncertainty. Users are strongly encouraged to read and fully comprehend the metadata and other available documentation prior to data use. Gross removals and net flux reflect the annual averages over the model period of 2001-2024, not annual time series from which a trend can be derived. Emissions are from stand-replacing disturbances and do not include emissions from forest degradation. Emissions and removals reflect gross estimates, e.g., carbon emissions from any disturbance that occurs without accounting for regrowth. Thus, emissions and removals data must be used with particular caution and in conjunction with each other.

Several inputs and constants for emissions, removals, and net flux have been changed since the initial publication of the model. More information on these updates can be found at <https://www.globalforestwatch.org/blog/data/whats-new-carbon-flux-monitoring/>.

The data on the drivers of tree cover loss classifies the dominant driver at 1-km resolution over the full 2001-2024 time period. Caution should be used when interpreting drivers for individual years, as the driver of small-scale loss events when multiple drivers are present in each 1-km cell may not always be captured. As a result, driver proportion for individual years may be over- or under-estimated. See the publication for more information about the data: <https://doi.org/10.1088/1748-9326/add606>.

## Contact

For further questions regarding this data set, please contact Liz Goldman at the World Resources Institute ([elizabeth.goldman@wri.org](mailto:elizabeth.goldman@wri.org)).

## Version change log

v20250521 Dataset covering 2001-2024