

Goal 1 Assessment

Technical Annex to the Five-Year Assessment Report
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Goal 1

At least halve the rate of loss of natural forests globally by 2020 and strive to end natural forest loss by 2030.

Key messages

- In 2018, tropical tree cover loss and associated carbon emissions decreased for the second year in a row after the record highs observed in 2016. In Indonesia, primary forest loss dropped to its lowest rate since 2003, continuing a decline that started in 2017.
- Despite this recent progress, we are still not on track to meet Goal 1's target of halving natural forest loss globally by 2020. Instead, the average annual global gross tree cover loss has been higher in the years following the adoption of the New York Declaration on Forests (NYDF) (2014-2018), increasing by 43 percent or 7.8 million hectares per year (Mha/yr) compared to a 2001-13 baseline. In humid tropical primary forests, detection of annual tree cover loss has been 44 percent higher per year in the years following the NYDF (1.3 Mha/yr greater) compared to a 2002-13 baseline.
- We are also not on track to achieve targeted reductions of carbon dioxide emissions from tropical tree cover loss. Average annual emissions since the signing of the NYDF are 57 percent higher than before the NYDF was signed, increasing from 3.0 to 4.7 gigatons of CO₂ per year.

Overview of goal and indicators

The New York Declaration on Forests' (NYDF) overarching goal, Goal 1, aims to halve natural forest loss by 2020 and halt it by 2030. By specifying "natural forests," Goal 1 excludes monoculture tree plantations or other non-natural forest systems. However, Goal 1 is less clear on what is meant by "loss," i.e. whether the aim is to reduce and then end gross or net loss of natural forests:

- Ending *gross* natural forest loss would mean that, from year to year, there would be no measurable clearing of natural forest area.
- Ending *net* natural forest loss would mean that any measurable area of natural forest clearing would be offset by an equal or greater area of measurable natural forest regeneration/reforestation over the same time period.

In addition to human-induced deforestation from conversion of forest land to another land use such as cropland or pasture, forest loss can arise from natural disturbances such as drought. The effects of such drivers may occur over longer periods of time and may interact with human-induced drivers in a negative feedback loop, further accelerating deforestation and/or preventing natural regeneration.

Therefore, “loss” of forest cover may occur immediately upon conversion to a new land use, or more gradually through the process of forest degradation (**Box 1**).

Box 1. Forest degradation

Forest degradation is the loss of canopy cover that is insufficient to be classified as deforestation (e.g. selective logging), and results in losses of biodiversity and other ecosystem services as well as significant greenhouse gas emissions.¹ Annual emissions from tropical forest degradation have recently been estimated to account for approximately a quarter of forest-related emissions (2.1 Gt CO₂e/yr).² Across Africa, Latin America, and Asia they contribute 70, 81, and 46 percent of all carbon losses, respectively.³ Degradation can take place gradually over years, at finer scales, and through the chance of recovery, biomass gains can partially or wholly offset biomass losses.⁴ Studies of deforestation rarely include land degradation and most studies on degradation focus on regional scales.

Table 1. Criteria and indicators to track Goal 1

| Criterion | Indicator |
|--|---|
| 1. Rate of forest loss | 1.1 Global annual gross tree cover loss (ha) 1.2 Global annual net natural forest/tree cover change (ha) 1.3 Annual tropical primary tree cover loss (ha) |
| 2. Carbon dioxide emissions from forest loss | 2.1 Annual gross carbon dioxide emissions (Mt CO ₂) from tropical forests |

In previous assessments, we assessed progress towards Goal 1 by using two sub-indicators (1.1 and 1.2) based on two available global forest area monitoring data sets. We used global data from Hansen et al. (2013, updated through the year 2018 on Global Forest Watch (GFW))⁵ to track gross tree cover loss (Indicator 1.1) and data from the Food and Agriculture Organization (FAO) of the United Nations’ Global Forest Resources Assessment⁶ to track net forest loss (Indicator 1.2). Key differences between these two sources of global data are outlined in the [2015 NYDF Progress Assessment](#).

This year, based on newly available data, we added a third sub-indicator (Indicator 1.3) to track gross loss of humid tropical primary tree cover. In early 2019, the University of Maryland created a map of the extent of humid tropical primary forest in 2002 using Landsat imagery and remote sensing algorithms to identify low albedo and high texture primary forest canopy structures (**see Box 2** for definitions).⁷ Using primary forest extent to filter global tree cover loss allows targeted monitoring of the forests that are most important for carbon storage and biodiversity, services that cannot be regained easily or quickly through forest restoration. For example, it can take decades to hundreds of years for an area of regenerated or restored forest to accumulate the amount of carbon previously stored in humid tropical primary forest. Because primary forests cannot be restored within the NYDF’s timeframe, net loss of primary forests is the same as gross loss of primary forests.

In addition to developing indicators that track forest loss, since 2016 we have included a second indicator for Goal 1 to track carbon emissions from tropical tree cover loss (Indicator 2.1). Reducing emissions from deforestation is essential to meeting the <2°C degree warming goal of the Paris Agreement on climate change.⁸ Because more carbon-dense forests are concentrated in a smaller subset of tropical countries, halving carbon emissions from deforestation may be achieved by forest protection across a more concentrated set of geographies. As in previous assessments, Indicator 2.1 was created by multiplying the estimated gross tree cover loss in an area by an estimate of the aboveground

carbon content of that area using a map of pre-disturbance biomass (year 2000) produced at 30-meter resolution by the Woods Hole Research Center (available on GFW⁹). This year, we disaggregate emissions into those occurring within versus outside tropical primary forests using data from Indicator 1.3. **Box 2** summarizes the most relevant concepts and definitions for this Goal assessment.

Box 2. Definitions

Afforestation: the process of establishing new forests in naturally non-forest ecosystems such as natural grasslands, or areas that have not been forested for at least 50 years.¹⁰

Deforestation: the conversion of forest to other land use or the permanent reduction of the tree canopy cover below a defined minimum canopy cover threshold.¹¹

Forest: though definitions vary by government, organization, and intended use, generally an area of land of minimum 0.5 hectares with a tree cover density of 10-30 percent, where trees have potential to reach a minimum height of 2-5 meters at maturity in place.¹²

Forest degradation: the reduction of a forest's capacity to provide the full suite of forest ecosystem services, such as biodiversity, carbon, or hydrological services.¹³

Forest landscape restoration (FLR): the long-term process of regaining ecological functionality and enhancing human well-being across forests and related ecosystems that have lost their structure, function, biodiversity or have otherwise been damaged or degraded.¹⁴

Gross forest loss: the magnitude of annual change, counting all tree cover or forest area cleared or reduced below a defined tree cover density threshold, over a defined period of time, without regard to any regeneration or reforestation of natural forest.¹⁵

Natural forest: both primary and secondary forests that are naturally regenerated with primarily native species.¹⁶

Net forest loss: the change in forest area from one reporting period to another, calculated by subtracting the area of regenerated or reforested area from the area of gross forest loss over the period.¹⁷

Primary forest: natural, mature forests that have not been cleared and regrown in recent history (i.e. the past 30-50 years).¹⁸ Consisting of native species, these forests are largely free from industrial-scale land uses and infrastructure, and ecological processes have not been significantly disturbed.¹⁹

Reforestation: the human-driven establishment of a forest on a land area that had been previously deforested.²⁰

Secondary forest: forests that have regenerated largely through natural processes after significant removal or disturbance of original forest vegetation (primary forest) by human or natural causes.²¹

Tree cover: all vegetation five meters or taller with a default canopy density threshold of 25 percent.²² Tree cover indicates the biophysical presence of trees but may not meet many definitions of "forest."

Tree cover gain: the increase in vegetation five meters or taller in an area which previously had no tree cover or tree cover below a defined density threshold; may include natural forest growth or tree plantation establishment.²³

Tree cover loss: the removal or mortality of trees within a defined area; loss may be permanent or temporary.²⁴

Findings

Criterion 1: Rate of forest loss

Indicator 1.1: Global annual gross tree cover loss

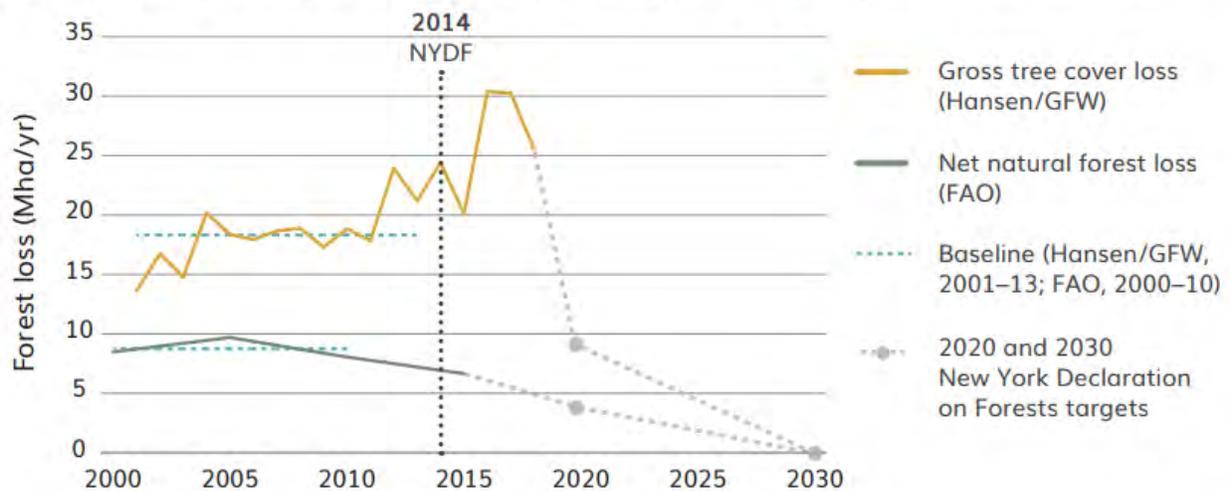
Gross tree cover loss since NYDF was signed continues to be high, but declined in 2018

Tree cover loss continued at high levels in 2018. Although there was notably less gross loss in 2018 compared to 2016 and 2017 – indicating movement in the right direction – the average annual tree cover loss between 2014 and 2018 was still well above the historical baseline. Since the signing of the

NYDF in 2014, global average annual gross tree cover loss during 2014-18 was 43 percent higher than during the baseline period of 2001-13, increasing from an average of 18.3 million hectares per year to 26.1 million hectares per year^a, or roughly the size of the United Kingdom (**Figure 1**).

Tropical forests are at the forefront of recent global deforestation, accounting for between 91 percent and 94 percent of the global total between 2001 and 2015.²⁵ Increases in tree cover loss are concentrated in tropical Africa (146 percent higher annual average loss in 2014-18 than in 2001-13, or an average increase of 2.6 Mha/yr), with lower increases in tropical Latin America and the Caribbean (+31 percent, 1.3 Mha/yr increase) and tropical Asia (+59 percent, 1.4 Mha/yr increase) (**Figure 2**). The annual loss post-NYDF in tropical Africa is now greater than the annual loss in tropical Asia.

Figure 1. Gross and net forest loss relative to 2020 and 2030 targets, in million hectares



Note: For the Hansen/Global Forest Watch (GFW) estimates, tree cover loss was calculated using a >25 percent tree cover density threshold. Improvements to the methodology for detecting tree cover loss starting in 2011 may result in higher estimates of loss in 2011-18 compared to 2001-10. For the Food and Agriculture Organization (FAO), the line represents a crown cover threshold of 10 percent. Hansen/GFW data is reported every year, while FAO data is reported every five years.

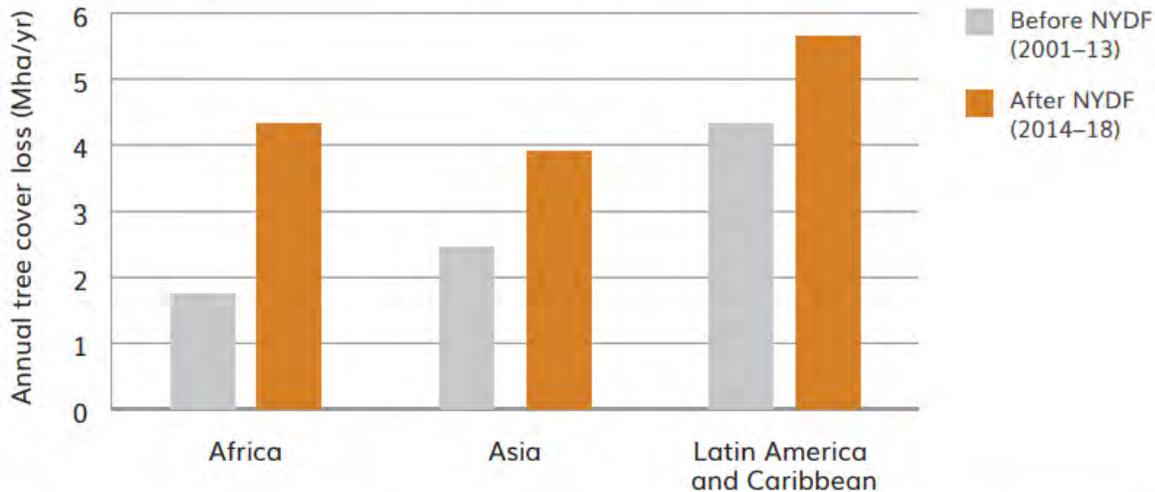
Source: Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A. et al. (2013). Tree Cover Loss (Hansen/UMD/Google/USGS/NASA). Global Forest Watch database. <http://data.globalforestwatch.org/datasets/>; Food and Agriculture Organization of the United Nations. (2016). Global forest resources assessment 2015. Rome: FAO. <http://www.fao.org/forest-resources-assessment/past-assessments/fra-2015/en/>

Between 2014 and 2018, three countries in the Congo Basin (Democratic Republic of the Congo (DRC), Republic of Congo and Cameroon) lost 7.6 million hectares of tree cover, an area bigger than Panama. Most loss in Africa's Congo Basin is driven by subsistence and small-scale commercial farmers clearing forests manually to feed themselves and those in nearby towns and cities; industrial-scale clearing represents just one percent of all forest loss.²⁶ However, since 2007, industrial-scale agriculture and selective logging have increased steadily, particularly in Cameroon and DRC; these activities are likely to expand along with continued encroachment of subsistence agriculture into previously intact forest areas

^a All statistics are for forests with tree cover density >25%. The Hansen et al. (2013) dataset uses satellite imagery at a 30-meter pixel resolution and measures areas with tree cover as a proxy for forest area, defined as all vegetation 5 meters or taller with a default canopy cover threshold of 25 percent. Global Forest Watch illustrates the Hansen et al. 2013 dataset, with updated data through 2018. A change in the methodology and the inclusion of new satellite data in 2011 and 2013, respectively, may result in higher estimates for tree cover loss in 2011-18 compared to 2001-10. This may impact the magnitude of detected increase in tree cover loss. For more about the methodology change see Potapov et al., 2015 at <https://blog.globalforestwatch.org/data-and-research/a-freshlook-at-forests-2011-2013>.

as the region’s population continues to expand (see [case study on Congo Basin](#)). In West Africa, Ghana and Côte d’Ivoire together have lost an average of 0.44 million hectares per year of tree cover since 2014. This is 181 percent higher than average annual loss during the 2001-13 baseline period. In these countries, land use change for commercial agriculture, particularly cocoa, in combination with mining (legal and/or illegal), have been the main drivers of deforestation.²⁷

Figure 2. Average annual tropical tree cover loss by region, in million hectares



Note: Comparison of tropical tree cover loss by region before (2001–13) and after (2014–18) the signing of the New York Declaration on Forests (NYDF). Tree cover loss calculated using a >25 percent tree cover density threshold. Improvements to the methodology for detecting tree cover loss starting in 2011 may result in higher estimates of loss in 2011–18 compared to 2001–10.

Source: World Resources Institute analysis based on 2018 data from Global Forest Watch.

In Latin America, Brazil remains the deforestation hotspot. Since 2014, Brazil has lost a total of 18 million hectares of tree cover loss, about the size of Cambodia. In Brazil, commercial agriculture like cattle and soy are the largest cause of deforestation (see case study). Despite a sharp decline in deforestation in the legal Amazon in the past 10 years, loss continues at high rates.²⁸ Other Latin American countries with large areas of loss include Argentina, Bolivia, Paraguay, Colombia, and Mexico. Except for Argentina and Paraguay, all of these countries have seen increased annual tree cover loss since the NYDF was signed in 2014. In Argentina, forest loss declined between 2014 and 2018, with loss in 2018 the lowest since 2002. In a 2017 study²⁹, the declining deforestation trend was attributed to the law enforcement at the subnational level in Argentina, but this attribution has been challenged.^{30,31}

Indicator 1.2: Annual net forest change

Gross tree cover loss and net natural forest change begin to converge when considering land cover change drivers

When net natural forest regrowth is counted as offsetting natural forest clearing, net annual natural forest loss is decreasing after peaking at 9.7 million hectares in 2005.³² Compared to a 2000-10 baseline period, the average rate of net natural forest loss in 2010-15 declined by 23 percent (see **Figure 1**). On their surface, Indicators 1.1 and 1.2 appear to have contradictory trends: increasing gross tree cover loss

and decreasing net natural forest loss, respectively. However, the two indicators start to converge once information about drivers of land cover change are used to approximate land use (**Box 3**).

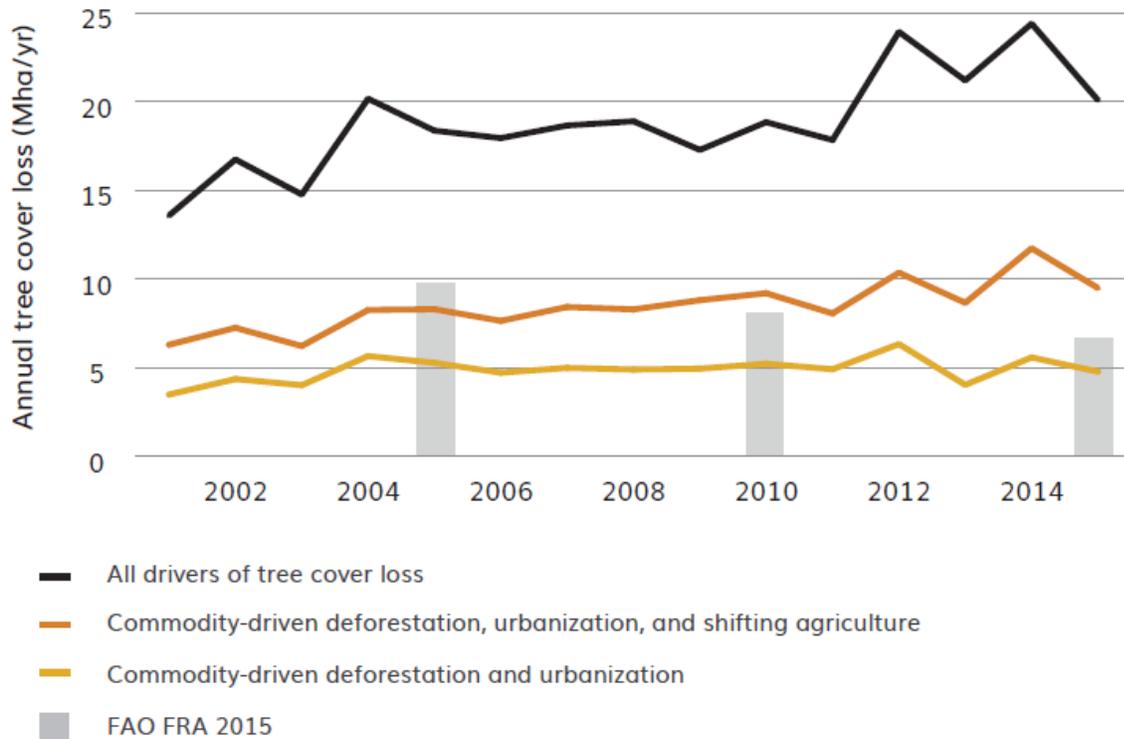
Box 3. Convergence of forest loss indicators

Gross tree cover loss updated annually on GFW (Hansen et al. 2013) and used for Indicator 1.1 does not distinguish permanent forest conversion associated with a change in land use (i.e., deforestation) from other forms of forest disturbance that may be associated with subsequent forest regeneration. This creates confusion when global tree cover change statistics derived from satellite imagery (Indicator 1.1) are compared directly against global land use change statistics reported by governments to the FAO (Indicator 1.2).

To better translate Hansen et al.'s data for global tree cover change into a form more comparable to the FAO's land use change data, Curtis et al. (2018) sought to determine the fate of disturbed forest land. This involved, first, identifying whether forest clearing was temporary (i.e. whether forests regenerated within the observation period) or permanent (i.e. the land use changed, or trees did not regrow during the observation period). Second, Curtis et al. trained a model to spatially attribute global tree cover loss to one of five dominant drivers of land cover and land use change: commodity production, urbanization, shifting agriculture, forestry, and wildfires. Although urbanization and commodity expansion are generally accepted as direct drivers of deforestation, the extent to which shifting agriculture represents land use change has not achieved consensus in the international community. Thus, shifting agriculture may or may not be considered a driver of deforestation, and it is useful to compare the FRA to global tree cover loss with and without shifting agriculture included as deforestation. For the period 2010-15, permanent global tree cover loss attributed to commodity-driven deforestation and urbanization (5.2 Mha/yr) was more aligned with FAO's global estimate of net annual natural forest change (net loss of 6.5 Mha/yr). If Curtis et al.'s 5.0 million hectares per year of tree cover loss attributed to shifting agriculture was also added to the deforestation figure, then the estimate would increase to 10.2 million hectares per year. This range, from 5.2 to 10.2 million hectares per year, contains the FAO's net annual natural forest change estimate of 6.5 million hectares per year from 2010-15 (**Figure 3**). This suggests that commodity-driven deforestation, urbanization, and shifting agriculture combined approximate the FAO's net annual natural forest change.

Figure 3.

Comparison of forest loss indicators conveying net forest loss, gross tree cover loss, and tree cover loss by specific drivers



Note: The Food and Agriculture Organization of the United Nations (FAO)'s Forest Resources Assessment (FRA) reports net forest loss and was last published in 2015. Gross tree cover loss from all drivers from Global Forest Watch/Hansen et al. 2013 data. Gross tree cover loss from commodity-driven deforestation, urbanization, and shifting agriculture from Curtis et al. 2018. Mha/yr = million hectares per year.

Source: Food and Agriculture Organization of the United Nations. (2015). Global forest resources assessment 2015. Rome: FAO. <http://www.fao.org/forest-resources-assessment/past-assessments/fra-2015/en/>; Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A. et al. (2013). Tree Cover Loss (Hansen/UMD/-Google/USGS/NASA). Global Forest Watch database. <http://data.globalforestwatch.org/datasets/>; Curtis, P. G., Slay, C. M., Harris, N. L., Tyukavina, A., & Hansen, M. C. (2018). Classifying drivers of global forest loss. Science, 361(6407), 1108–1111.

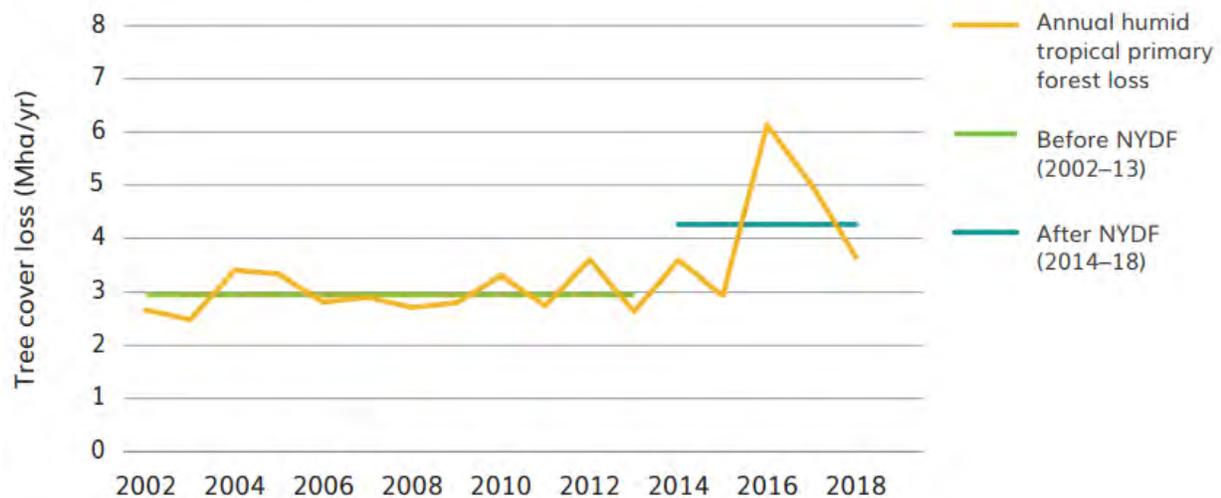
Indicator 1.3 Tropical primary forest loss

Tropical primary forest loss is still well above baseline, but declined for the second year in a row

Primary forests, by definition, are undisturbed and therefore have had time to accumulate large amounts of carbon and provide complete ecosystem services. They will not regenerate within timeframes relevant to NYDF. Filtering tree cover loss by primary forests provides a minimum estimate for how much irreplaceable forest is lost each year and in what regions. Since the signing of the NYDF in 2014, the average annual rate of tropical humid primary forest loss has increased by 44 percent relative

to the baseline period of 2002-13, from 3.0 to 4.3 million hectares per year (**Figure 4**).^b The greatest percent increase was in Africa (+146 percent, 0.45 Mha/yr increase) compared to Latin America (+35 percent, 0.61 Mha/yr increase) and Asia (+30 percent, 0.26 Mha/yr increase). Six of the ten tropical countries with the highest percent increase in primary forest loss over the baseline period were in West Africa, highlighting the mounting pressures on primary and natural West African forests^c. Conversely, primary forest loss in Indonesia in 2018 dropped to its lowest rate since 2003, continuing a decline that started in 2017.

Figure 4. Average annual loss in humid tropical primary forests, in million hectares



Note: Comparison of tree cover loss in humid tropical primary forests before (2002-13) and after (2014-18) the endorsement of the New York Declaration on Forests (NYDF). Tree cover loss calculated using a >25% tree cover density threshold. Improvements to the methodology for detecting tree cover loss starting in 2011 may result in higher estimates of loss in 2011-18 compared to 2001-10.

Source: For tree cover loss, Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A. et al. (2013). Tree Cover Loss (Hansen/UMD/Google/USGS/NASA). Global Forest Watch database. <http://data.globalforestwatch.org/datasets/>; For primary forest loss, Turubanova, S., Potapov, P. V., Tyukavina, A., & Hansen, M. C. (2018). Ongoing primary forest loss in Brazil, Democratic Republic of the Congo, and Indonesia. *Environmental Research Letters*, 13(7), 074028.

Though West African countries have had large increases in the rate of primary forest loss compared to other countries, the absolute loss of area of primary forest remains much higher in large forest countries like Brazil and Indonesia (**Figure 5**). Annual primary forest loss in tropical Africa was still much smaller than in other tropical regions between 2014 and 2018 (0.76 Mha/yr in Africa, 1.13 Mha/yr in Asia, and 2.35 Mha/yr in Latin America). Of the ten countries with the highest amounts of tropical primary forest loss on average between 2014 and 2018, four are in Latin America (Brazil, Bolivia, Colombia, Peru), three are in Africa (DRC, Cameroon, Madagascar), two are in Asia (Indonesia, Malaysia), and one is in Oceania (Papua New Guinea). Despite significant investments into REDD+ readiness, average loss of primary forest in the Democratic Republic of the Congo more than doubled in the last five years (+158 percent).^d

^b A change in the methodology and the inclusion of new satellite data in 2011 and 2013, respectively, may result in higher estimates for tree cover loss in 2011-18 compared to 2001-10. This may impact the magnitude of detected increase in tree cover loss. For more about the methodology change see Potapov et al., 2015 at <https://blog.globalforestwatch.org/data-and-research/a-fresh-look-at-forests-2011-2013>

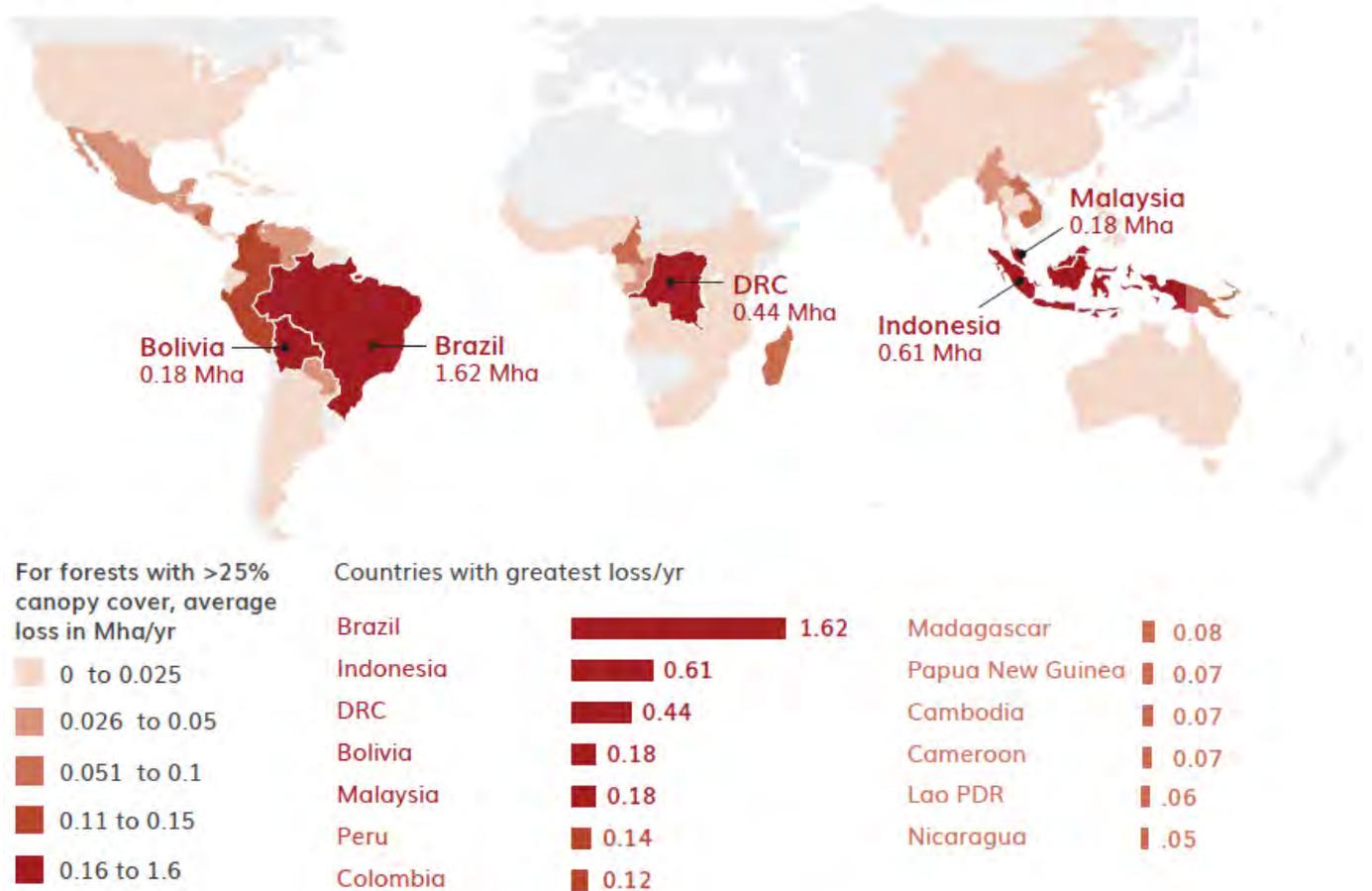
^c Among countries with an average of more than 1000 ha/yr forest lost between 2001 and 2013.

^d Much of the increase in tree cover loss detected in Central Africa, specifically, may be linked to the improvement of the tree cover loss methodology to include Landsat 8, which is better at detecting small-scale tree cover loss dynamics like those prevalent in Central Africa.

There were also substantial increases in Madagascar (+171 percent), Papua New Guinea (+184 percent), Colombia (+81 percent), and Peru (+61 percent).

Figure 5.

Average annual humid tropical primary forest loss between 2014 and 2018, in million hectares



Source: World Resources Institute analysis of 2018 data from Global Forest Watch

In Southeast Asia since 2002, Indonesia has lost 9.2 million hectares of humid primary forests – an area the size of Portugal – to palm oil plantations, forest fires, small-scale agriculture, timber plantations, infrastructure, and mining. Palm oil plantations have caused the largest portion of forest loss during this period, driving 23 percent of deforestation. The second largest driver of forest loss was the conversion of forests to grass/shrubland driven by fires, responsible for 20 percent of deforestation.³³ Timber plantations and smallholder agriculture were also significant drivers, each accounting for almost 15 percent of forest loss in the years 2001-16.³⁴ However, the rate of forest loss went down significantly in 2017 and 2018, by more than 30 percent compared to the average annual loss rate over the reference period of 2001-16.³⁵ A combination of several factors including actions taken by government, the private sector and civil society organizations on different fronts and different levels, as well as wetter weather conditions can explain this sharp reduction in forest loss in Indonesia (see [case study on Indonesia](#)).

Criterion 2: Rate of carbon dioxide emissions from tree cover loss

Indicator 2.1: Annual gross carbon dioxide emissions from tropical tree cover loss

Greenhouse gas emissions from tropical primary forest loss continues to be above baseline

Reducing deforestation is a crucial part of achieving global climate change mitigation commitments. In 2018, gross emissions from tropical tree cover loss (4.2 gigatons CO₂ (Gt CO₂)) were significantly lower than the peak observed in 2016 (6.1 Gt CO₂). This is about the same amount of CO₂ as Europe emits every year. However, average emissions since the signing of the NYDF are still 57 percent higher, increasing from 3.0 to 4.7 gigatons CO₂ per year.

This year, using primary forest extent from Indicator 1.3, it is possible to report on the extent of emissions from the loss of humid tropical primary forests. Annual emissions resulting from the loss of humid tropical primary forests were 48 percent higher since the NYDF was signed than before, increasing from an average of 1.4 to 2.1 gigatons CO₂ per year. Moreover, in 2018, almost half (44 percent, or 1.8 Gt CO₂) of emissions from tropical forests occurred from loss of primary forests. Emissions increased more than loss area (48 percent increase vs. 44 percent) between 2001-13 vs. 2014-18, reflecting the relatively higher climate impacts of losing tropical primary forest areas. As with forest loss, countries with large percent increases in emissions were concentrated in Africa, with smaller percent increases in Latin America and Asia (**Figure 6**). However, the 10 countries with the largest absolute increases in primary forest loss were also the countries with the largest absolute increases in emissions (in ascending order: Bolivia, Madagascar, Cameroon, Colombia, Peru, Papua New Guinea, Malaysia, Brazil, Indonesia, DRC).

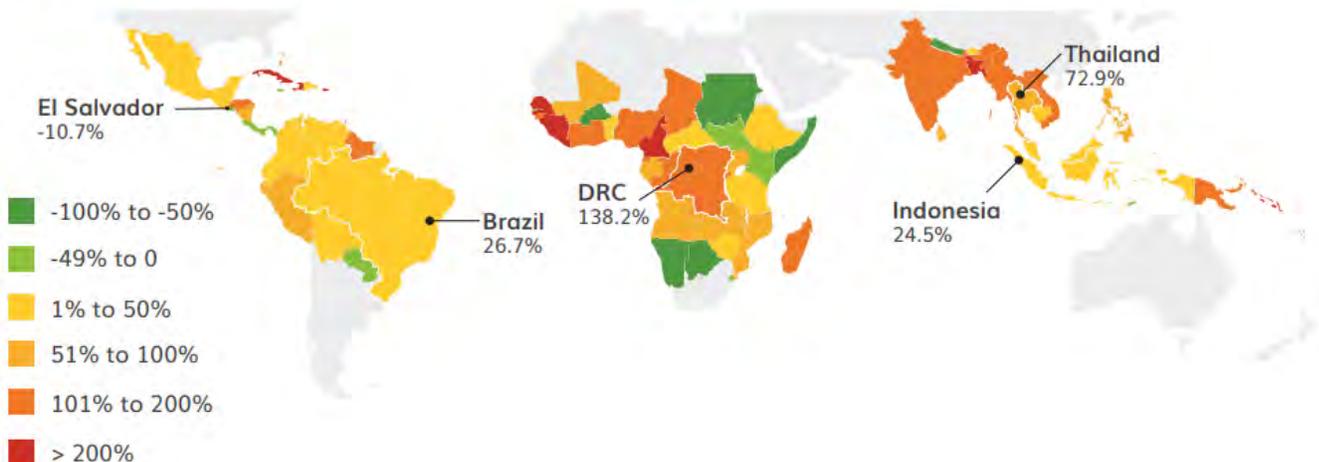
Data developments

Several new data developments are underway that will enable continued refinement of Goal 1 indicators in future updates:

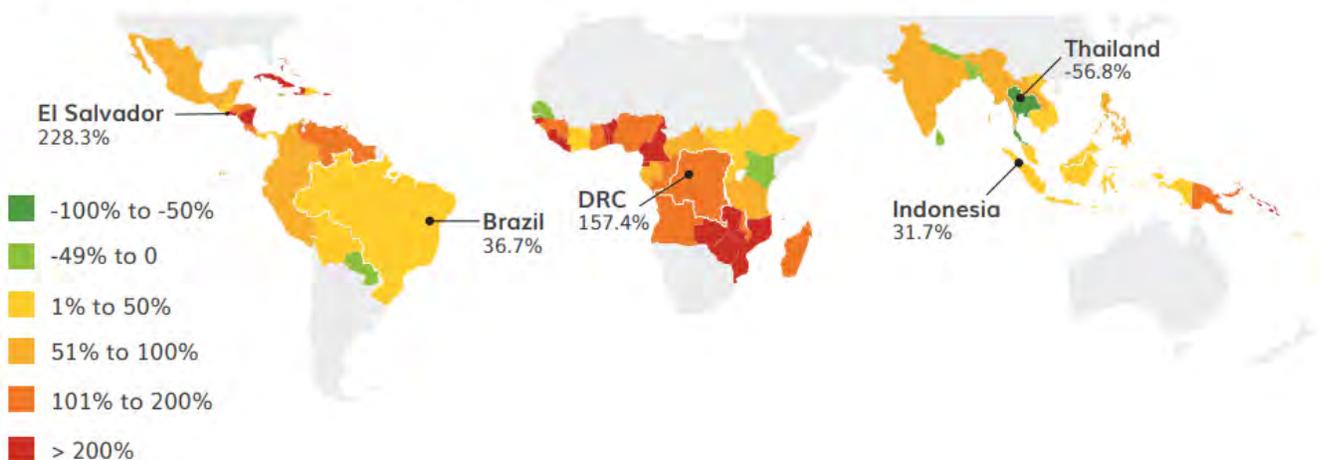
- **Drivers of tree cover loss.** The global map of drivers of tree cover loss (Curtis et al. 2018³⁶) is currently being updated through 2018. More detailed regional analyses of forest loss drivers were also recently published for the Brazilian Legal Amazon³⁷, Congo Basin³⁸, and Indonesia³⁹.
- **Mapping global plantations.** GFW compiled and synthesized the best available spatial information on the extent and geographic location of the world's planted forests and agricultural tree crops into a global Spatial Database of Planted Trees (SDPT)⁴⁰. This mapping effort allows GFW to report more confidently on areas of tree cover change in natural forests *after 2015* by excluding areas of global tree cover loss that occurred within SDPT boundaries; these changes in tree cover can be considered as loss associated with plantation or agricultural activity and not as the loss of natural forest. However, the temporal inconsistency of the data for different countries means that it is not appropriate for inferring dynamics of conversion between natural forests and tree plantations prior to the year 2015. Thus, we did not incorporate this information into the Goal 1 update. The SDPT will continually evolve and improve as new data are produced by governments and independent researchers. [Version 1.0 of the database](#) was released in March 2019.
- **Tracking net forest area change.** While the GFW platform currently reports only gross tree cover loss on an annual basis, upcoming data on global gross tree cover gain will allow for the annual monitoring of regrowth and re-establishment of the tree canopy, and for an annual estimate of net forest area change. Annual tree cover loss and gain for the lower Mekong Delta are in development by the University of Maryland and will be available on GFW in early 2020, and scaled globally thereafter. See the [Goal 5 update](#) for an initial analysis of the Mekong Delta.

Figure 6. Change in average annual CO₂ emissions from gross tree cover loss in tropical countries between 2002–13 and 2014–18, in percent

(a) In all forested area



(b) In humid tropical primary forest only



Note: Comparison of average annual gross CO₂ emissions from aboveground biomass loss by country before (2002–13) and after (2014–18) the signing of the New York Declaration on Forests (NYDF). Forest is defined as areas with >25 percent tree cover density in 2000. Negative values represent decreases in emissions.

Source: World Resources Institute analysis based on 2018 data from Global Forest Watch.

- **Tracking gross and net forest-related GHG fluxes.** Indicator 2.1 does not take into account carbon removals by forests from forest growth or expansion, which could be useful for tracking Goal 5 restoration targets. Various monitoring approaches are under development to estimate annual gross and net carbon dioxide fluxes from forests. These estimates will provide a more comprehensive picture of the role forests play in the global carbon cycle and the extent to which progress is being made in reducing emissions and increasing removals from forests.
- **Country submissions of Forest Reference Emission Levels.** Significant progress in tropical forest area change monitoring has also been made across many developing countries, driven largely by

increased donor support in the REDD+ context.⁴¹ This is reflected by the increasing number of countries developing and/or submitting their Forest Reference Emission Levels (FRELs) for review to the United Nations Framework Convention on Climate Change (UNFCCC), which includes estimates of historical deforestation and emissions from deforestation. By June 2019, reference levels had been submitted from 28 countries, including four submissions since the last NYDF update (Argentina, Bangladesh, Guinea-Bissau, Solomon Islands).⁴² In 2018, Harris et al.⁴³ published an in-house comparison of deforestation estimates reported in national and subnational FREL submissions against Hansen et al.'s Global Forest Change (GFC) data. After aligning geographic boundaries, time periods, and tree canopy density thresholds to ensure valid comparisons, they found that the sum of nationally-determined average deforestation rates across 33 REDD+ countries was 7.9 million hectares per year compared to an annual average rate of gross tree cover loss of 6.9 million hectares per year (a difference of approximately 1 Mha/yr). Despite differences in estimates at the country level – likely due primarily to differing national definitions of forests, the alignment of GFC tree cover loss, and nationally-reported deforestation estimates – Harris et al. concluded that the GFC data represent in aggregate, a reasonably accurate, unbiased, and consistent way to monitor tropical deforestation rates.

Endnotes

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- ² Pearson, T. R., Brown, S., Murray, L., & Sidman, G. (2017). Greenhouse gas emissions from tropical forest degradation: an underestimated source. *Carbon Balance and Management*, 12(1), 3.
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- ⁴ Goetz, S. J., Hansen, M. C., Houghton, R. A., Walker, W., 68 Laporte, N., & Busch, J. (2015). Measurement and monitoring needs, capabilities and potential for addressing reduced emissions from deforestation and forest degradation under REDD+. *Environmental Research Letters*, 10(12), 123001
- ⁵ Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A. et al. (2013). Tree cover loss (Hansen/UMD/Google/USGS/NASA). Global Forest Watch database.
- ⁶ Food and Agriculture Organization of the United Nations. (2015). *Global forest resources assessment 2015*. Rome: FAO.
- ⁷ 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.
- ⁸ Zarin et al. 2016
- ⁹ Global Forest Watch. 2019. [Aboveground live woody biomass density \[dataset\]](#).
- ¹⁰ UNFCCC. (2002); FAO. (2016a).
- ¹¹ FAO. (2016a); Curtis, P. G. et al. (2018).
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