Overarching forest goals

Theme 1 Assessment

October 2022

THEME 1

OVERARCHING FOREST GOALS

Theme 1 covers the overarching forest goals of: 1) ending the loss and degradation of natural forests by 2030, and 2) restoring 350 million hectares of degraded landscapes and forestlands by 2030. This report assesses progress toward these targets. The current assessment builds on previous New York Declaration on Forests Goal 1 and Goal 5 progress reports and, provides updates using the latest available data.

The Forest Declaration Assessment (formerly the New York Declaration on Forests (NYDF) Progress Assessment) is an independent, civil society-led initiative to assess progress toward the global goals of halting deforestation and restoring 350 million hectares of degraded land by 2030 as set out in international declarations such as the New York Declaration on Forests (2014) and the Glasgow Leaders' Declaration on Forests and Land Use (2021). Globally, terrestrial and coastal ecosystems including savannas, grasslands, scrublands, and wetlands are all under threat of conversion and degradation. Countering this threat for all ecosystems is essential to meeting global climate and biodiversity goals. This annual assessment of global progress for 2022, however, focuses specifically on forest ecosystems. It is published as a set of four reports covering different themes: Overarching forest goals, Sustainable production and development, Finance for forests, and Forest governance.

Global conservation goals include limiting global temperature rise to 1.5°C, as articulated in the Paris Agreement, and reducing the loss of biodiversity per the Convention on Biological Diversity's Aichi targets. Achieving these results will require a drastic reduction in the conversion and degradation of all natural ecosystems and a commensurate increase in restoration and reforestation activities, which must be pursued through equitable and inclusive measures. This assessment focuses on forests as a prominent subset of these ecosystems. Nothing less than a radical transformation of development pathways, finance flows, and governance effectiveness and enforcement will be required to shift the world's forest trajectory to attain the 2030 goals. The 2022 Forest Declaration Assessment evaluates recent progress toward the 2030 goals and answers the question: ***"Are we on track?"***

Key Messages

Forests are fundamental to regulating and stabilizing the global climate. Meeting the Paris Agreement's ambition of limiting global warming to no more than 1.5°C will require global greenhouse gas (GHG) emissions to reach net-zero by the second half of this century. Eliminating deforestation by 2030 is a major milestone towards achieving the 2050 net zero target. Deforestation and degradation account for 10–12 percent of global GHG emissions. Halting deforestation and forest degradation as soon as possible, and no later than 2030, will substantially reduce the release of terrestrial GHG emissions to the atmosphere. Restoration of forests and other ecosystems can return significant amounts of carbon to stored biomass and help to realize the collective 2030 targets. Protecting forests also comes with clear benefits for people, biodiversity, and sustainable development.

Only eight years remain to achieve the twin global goals of halting and reversing deforestation and degradation by 2030. Despite encouraging signs, not a single global indicator is yet on track to meet the 2030 goals of stopping forest loss and degradation and restoring 350 million hectares of forest landscape.

To be on track to halt deforestation completely by 2030, a 10 percent annual reduction in forest loss is needed. However, deforestation rates around the world declined only modestly in 2021, with a decrease of 6.3 percent compared to the 2018-20 baseline. In the humid tropics, loss of irreplaceable primary forest decreased by only 3.1 percent. This is far short of the 10 percent annual reduction needed to be on track to halt deforestation completely by 2030. Globally, forests became more degraded in 2021, but at a slower rate than during the 2018-20 baseline period; if continued, this slowdown may put the world on track to meet the 2030 zero degradation target. There is a significant year-to-year fluctuation in both deforestation and degradation metrics, which makes it difficult to detect trends over short periods of time. Future assessments will monitor these processes to confirm the limited progress detected in 2021.

Tropical Asia is the only region currently on track to halt deforestation by 2030. While deforestation rates in Tropical Latin America and Africa decreased in 2021 relative to the 2018 to 2020 baseline, those reductions are still insufficient to meet the 2030 goal. Each year that passes without sufficient progress makes it increasingly difficult to meet global forest protection goals – and increases the annual reductions required in future years.

Notable progress in afforestation and reforestation efforts over the last two decades have resulted in new forest areas the size of Peru, with net gains of forest cover in 36 countries. However, overall losses exceeded gains over the same period, resulting in a net loss of 100 million hectares globally. It should be noted that forest cover gains, through reforestation and afforestation activities, do not compensate for forest losses in terms of carbon storage, biodiversity, or ecosystem services. Therefore, highest priority efforts should be directed towards safeguarding primary forests from losses in the first place.

Introduction

1. Why track overarching forests goals?

Forests are fundamental to regulating and stabilizing the global climate. Meeting the Paris Agreement's ambition of limiting global warming to no more than 1.5°C will require global greenhouse gas (GHG) emissions to reach net-zero by the second half of this century.[1] Eliminating deforestation[a] by 2030 is fundamental to achieving the 2050 net zero target. Deforestation and degradation, account for about 10 -12 percent of global GHG emissions.[2] Despite this, forests are also a significant natural carbon sink, contributing net carbon removals from the atmosphere of up to 7.6 gigatons of carbon dioxide-equivalent ($GtCO_2e$) per year between 2001 and 2020.[3] While forests are still a net carbon sink globally, it is concerning that the difference between carbon removals and emissions from deforestation/degradation is shrinking in some regions, a phenomenon particularly evident in the Amazon.[4]

Halting deforestation and forest degradation as soon as possible – and no later than 2030 – will substantially reduce the release of terrestrial GHG emissions to the atmosphere. Meanwhile, restoration of forests and other ecosystems – through activities like reforestation, assisted natural regeneration, and improved forest management – can return significant amounts of carbon to stored biomass. Primary forest is, however, irreplaceable. No level of reforestation or afforestation can equate lost primary forest; degraded and deforested land can be restored, but the quality of carbon storage, biodiversity, and associated ecosystem services may never fully recover.[5] Together with agriculture and other land use activities, reforestation, assisted natural regeneration, and improved forest management practices could contribute an estimated reduction of 8-14 GtCO2e per year between 2020 and 2050, at a cost of less than USD 100 per ton.[6] Protecting forests also comes with clear benefits for people, biodiversity, and sustainable development.[7]

2. What are the building blocks for progress on 2030 forest goals?

Forest goals enshrined in the New York Declaration on Forests, the Glasgow Leaders' Declaration on Forests and Land Use, the Bonn Challenge, and other pledges recognize that halting deforestation and restoring forests requires a wide array of actors and balancing environmental, social, and economic interests. These goals provide the most concrete statements of global ambition to protect and restore forests and are critical to meeting the aspirations of the Paris Agreement, the Sustainable Development Goals (SDGs), and many other global ambitions.

The accompanying reports from this Assessment—focused on Sustainable production and development (Theme 2); Finance for forests (Theme 3); and Forest governance (Theme 4)—highlight critical actions that a variety of stakeholders must take to meet their forests goals. Governments, companies, and civil society must collaborate to accelerate forest action, supported by transparency and accountability. Governments must carefully consider whether voluntary action is a viable foundation to achieve the 2030 forest goals, and how the role of mandatory action, disclosure, and accountability should be increased. Meanwhile, companies need to urgently increase the scope and stringency of corporate action, whether voluntary or mandated. A

[a] Deforestation refers to a tree cover loss event that is: permanent in nature (e.g., when forest is converted to cropland or cleared for development) or when it occurs within humid tropical primary forest boundaries. See Annex A for a full list of key terms.

variety of private sector actors – companies, financial institutions, and philanthropies – have not yet leveraged their significant power to steer development and commodity production onto a sustainable trajectory in line with forest goals.

Additionally, funding for forests will need to dramatically increase by up to 200 times to meet 2030 goals. Indigenous Peoples (IPs) and local communities (LCs) are the most effective stewards and guardians of their forest territories but receive far less funding than their estimated finance needs for securing tenure rights and preserving forest ecosystems. Financial institutions and companies across sectors must recognize and act on the inherent business risks presented by deforestation and forest degradation and put in place measures and policies to combat this risk. Public sector actors must take concrete and far-reaching steps to implement and expand their finance commitments and align fiscal and financial policies with forest goals. Where private sector actors choose to invest in nature conservation and restoration, they must ensure that they are supporting high-quality and high-integrity interventions in line with the mitigation hierarchy[b] and science-based targets.

3. How does this report assess progress?

This report provides a summary of global progress on halting deforestation and degradation and advancing forest restoration. Tracking progress toward these goals uses indicators of gross deforestation, humid tropical forest loss, emissions from forests, forest landscape integrity, and tree cover gain (Annex B: Methodology). A clearer picture of progress or lack thereof will emerge as more years of data become available because all forest change indicators fluctuate quite strongly from year to year. The forest loss and degradation sections of this assessment largely focus on change in 2021 compared to a baseline period of 2018-20. Although the data shows promising changes in the right direction, the most reliable trends to take note of are those that have been sustained for several years in succession. Thus, these trends will be clarified with subsequent years-worth of data. Additional methodological notes and analysis are available in the Technical Annex.

This report focuses almost exclusively on forests, excluding other ecosystems, as the current mandate of the Forest Declaration Assessment is to track progress toward the 2030 forest goals. This focus reflects both the Forest Declaration Assessment's history as an initiative to track progress on the New York Declaration on Forests as well as the disproportionate attention that forests have received on the international stage compared to other biomes.[8] The focus on forests does not imply that other ecosystems are not also important for meeting climate change and biodiversity goals.

This report does not detail the causes of, nor recommend solutions for, tackling deforestation and forest degradation. These topics are covered in three complementary thematic reports on Sustainable production and development, Finance for forests, and Forest governance. Country-level examples and case studies are included from assessments of progress conducted by the Forest Declaration Assessment team on 13 countries[c] in 2022. Finally, this report focuses primarily on developing countries, due to the impact of tropical forests on climate and biodiversity. The Assessment Partners aim to include the global north more prominently in future years' assessments.

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[b] A decision framework that allows for the systematic consideration of negative forest impacts and mitigation options.
[c] Cambodia, Cameroon, Canada, Colombia, Democratic Republic of the Congo, Dominica, Ecuador, Gabon, Indonesia, Kenya, Liberia, Republic of the Congo, and Vietnam.

Findings

1. What progress has been made?

None of the indicators assessed suggest that the world is yet on track to meet the goals of halting forest loss or degradation or restoring 350 million hectares (Mha) by 2030.[d] Each year that passes without sufficient progress makes it increasingly difficult to meet global forests goals by 2030.

There is no single solution for halting deforestation and forest degradation or accelerating restoration around the world. Yet, coordinating actions across sectors to align policies with forest goals, to direct green finance to forests, and to improve the effectiveness of forest governance can bring private and public sector actors closer to their forest goals and pledges. In this regard, some regions and countries have had more success than others.

Some countries have implemented comprehensive forest policies, consider forests in their development and economic policies, and tackle poverty reduction and forest protection in tandem (e.g., through payment for ecosystem services or REDD+ programs). In other jurisdictions, private and public sector actors effectively collaborate to address deforestation. On the other hand, many countries still lack sufficient resources and institutional capacities for effective forest governance. More green finance is needed to unlock the full potential of forest protection interventions such as REDD+.

Country case studies throughout this brief provide a closer look at success factors for achieving forest goals in specific country contexts. Further details are covered in the other three thematic reports on Sustainable production and development; Finance for forests; and Forest governance.

1.1 Halting deforestation

The global community has rallied around the goal of "halting deforestation" by 2030. No perfect measure of deforestation exists, so this assessment uses a set of proxies. The first indicator estimates the share of global tree cover loss[9,e] that is likely to have been permanently converted to a new land use, based on the driver of loss.[10] The second estimates the loss of mature, natural humid tropical primary forests.[11] The third estimates the emissions from these forest disturbances, given forests' significant contribution to meeting the Paris Agreement goals.

"Halting" deforestation is defined here as reaching zero gross deforestation[f] by 2030, defined as no permanent land use change from forests to non-forests, and no additional clearing of primary forests, irrespective of any gains in area due to reforestation elsewhere. Assuming a straightforward linear pathway to 2030, reaching the 2030 target will require a 10 percent reduction in the deforestation rate each year from 2021 through 2030, compared to a baseline of the average deforestation rate from 2018-2020. Below, the 2021 deforestation rate is assessed against the 2018-2020 baseline to determine if the world is on track to meet the 2030 goals.

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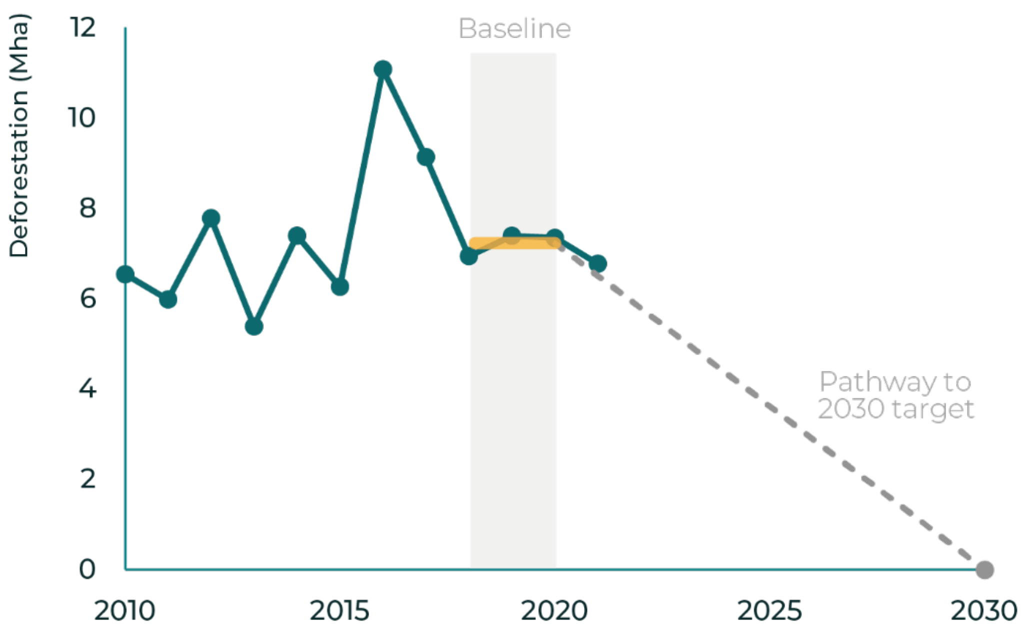
[d] Forest restoration refers to a suite of interventions aimed at halting and reversing deforestation and forest degradation. Forest protection includes reducing deforestation and forest degradation, restoring degraded forestlands, and sustainable management of production forests, with involvement of governments, the private sector, IPs and LCs, and other actors. See Annex A for full list of key terms.

[e] Tree cover loss refers to a loss event that may or not be permanent. Non-permanent tree cover loss routinely occurs in the context of logging, fire, or swidden agriculture. Tree cover loss data is often analyzed as a first step to measure deforestation. See Annex A for a full list of key terms.

[f] The Glasgow Leaders' Declaration on Forests and Land Use does not specify whether it aims to reach *gross* or *net* zero deforestation by 2030. The 2021-2030 benchmark presented here uses the "gross zero" interpretation. Indicators tracking a less ambitious "net zero" pathway will be developed in future assessments as data becomes available, e.g., by using the gross forest loss and gain of the upcoming 2025 FAO Forest Resource Assessment. See Annex A for a full list of key terms.

Global gross deforestation amounted to 6.8 Mha (ha) in 2021 – an area that is comparable in size to the Republic of Ireland – with 3.9 $GtCO_2e$ of associated GHG emissions.[g] Despite the alarming scale of loss, the slightly reduced pace of deforestation represents an improvement in relation to the 2018-2020 baseline. Still, this improvement is insufficient for meeting the 2030 targets. The 2021 deforestation rate experienced a modest reduction of 6.3 percent compared to the 2018-2020 baseline, which is far short of the yearly 10 percent reduction required to achieve zero deforestation by 2030. Each year that reductions fall short of the annual target, the total reductions required in future years to meet the 2030 target increase (**Figure 1**).

Figure 1. Global deforestation rate over the 2010-2021 period, in million hectares, and the pathway to reach the 2030 global gross zero deforestation target



Source: Figure based on original analysis for this report using data from Hansen et al. 2013. Only tree cover loss that is deemed permanent (Curtis et al., 2018) or that occurs within humid tropical primary forests is considered here.
Note: The dashed line indicates that a reduction rate in deforestation of 10 percent per year, as compared to the 2018-2020 baseline, is necessary to reach the 2030 zero gross deforestation target. The reduction in deforestation rate of 6.3% that occurred in 2021 falls far short of the target. The data before and after 2015 are not directly comparable, as the methodology to detect the tree cover loss has been improved and may result in higher estimates of loss for recent years compared to earlier years, although this does not affect the assessment of progress since 2020.[12]

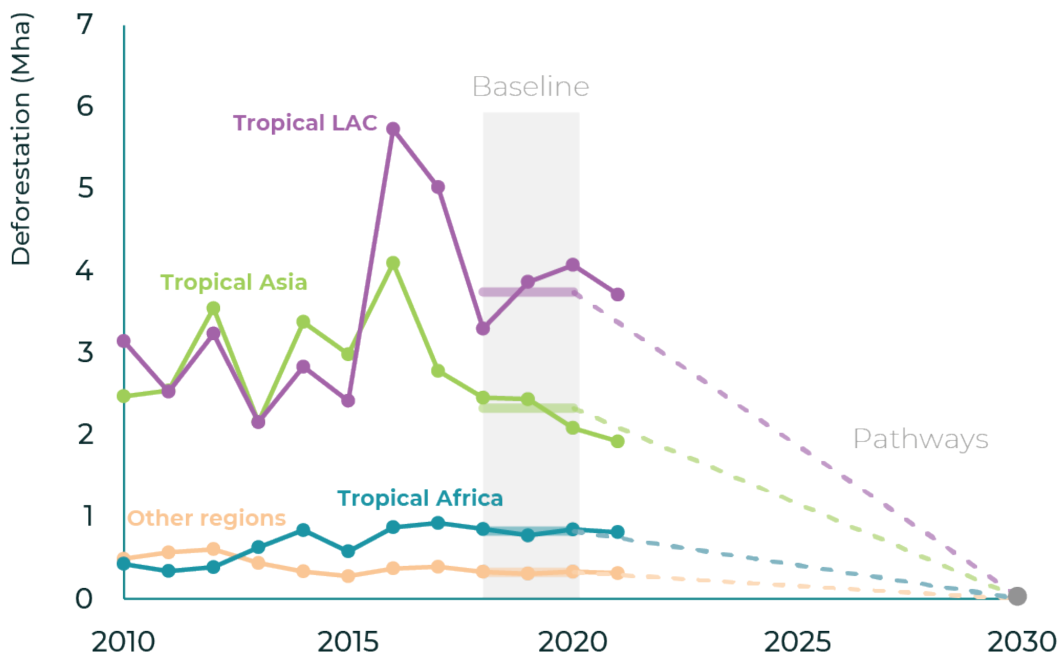
ASSESSING REGIONAL DIFFERENCES

The vast majority (96%) of global deforestation takes place in tropical regions and, therefore, the vast majority (98%) of the decrease in deforestation will also need to come from those regions (**Figure 2**).

Tropical Asia experienced a decrease in forest loss from the baseline and is the only region currently on track to halt deforestation by 2030. Tropical Latin America and Africa also saw a decrease relative to the baseline but are not yet aligned with the 2030 goal. Both regions will need to redouble their efforts in 2022 and beyond to align with the 2030 zero deforestation pathway and Tropical Asia will need to sustain the progress it has recently made.

[g] If deforestation were a country, it would globally rank third in GHG emissions after China and the US.

Figure 2. Global deforestation rate by region over the 2010-2021 period, in million hectares, and the pathway to reach the 2030 gross zero target from the 2018-2020 baseline



Source: Figure based on original analysis for this report using data from Hansen et al. 2013. Only tree cover loss that is deemed permanent (Curtis et al., 2018) or that occurs within humid tropical primary forests is considered here.
Note: The data referring to other regions are used here for reference, to highlight that the bulk of deforestation takes place in only two global regions. The data before and after 2015 are not directly comparable, as the methodology to detect the tree cover loss has been improved and may result in higher estimates of loss for recent years compared to earlier years, although this does not affect the assessment of progress since 2020.[13]

CASE STUDY

GHANA AND CÔTE D'IVOIRE

While Ghana and Côte d'Ivoire have lost significant forest cover in the past, in 2021, deforestation decreased in those countries by 13 percent and 47 percent, respectively, compared to 2018-2020. This recent success puts them on track with the 2030 pathway. Since 2017, the governments of Ghana and Côte d'Ivoire have worked with 35 companies, which together account for 85 percent of the world's cocoa trade, to improve the sustainability of resource use in forest landscapes and address the underlying drivers of deforestation such as poverty. The public-private Cocoa and Forests Initiative (CFI), under which this collaborative has taken place, has worked to improve stakeholder collaboration, policies, finance for restoration, and to strengthen governance structures. Under the CFI umbrella, companies are working to improve the transparency of their supply chains and smallholders are adopting sustainable agriculture practices such as agroforestry, while increasing productivity. While it is difficult to identify any single drivers of reduced deforestation, public-private partnerships like CFI present a compelling example for other regions on how collaboration between stakeholders can be built. Going forward, additional action is necessary to address poverty among smallholders and to disincentivize agricultural expansion into forests as a strategy to increase income.[14]

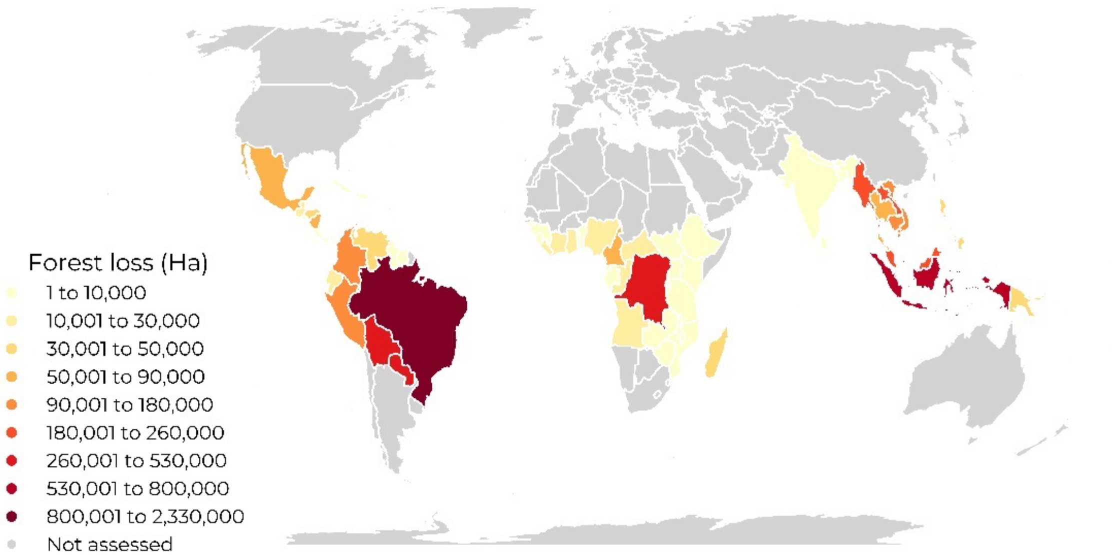
Of the 10 countries with the highest total deforestation, half saw a reduction of deforestation rates in 2021 compared to the 2018-2020 baseline. However, globally, the deforestation indicator is not on track. A key reason for this is that four out of the five top countries with largest absolute deforestation increased their deforestation rates in 2021 – namely Brazil, Bolivia, Democratic Republic of the Congo (DRC), and Paraguay (**Figure 3**).

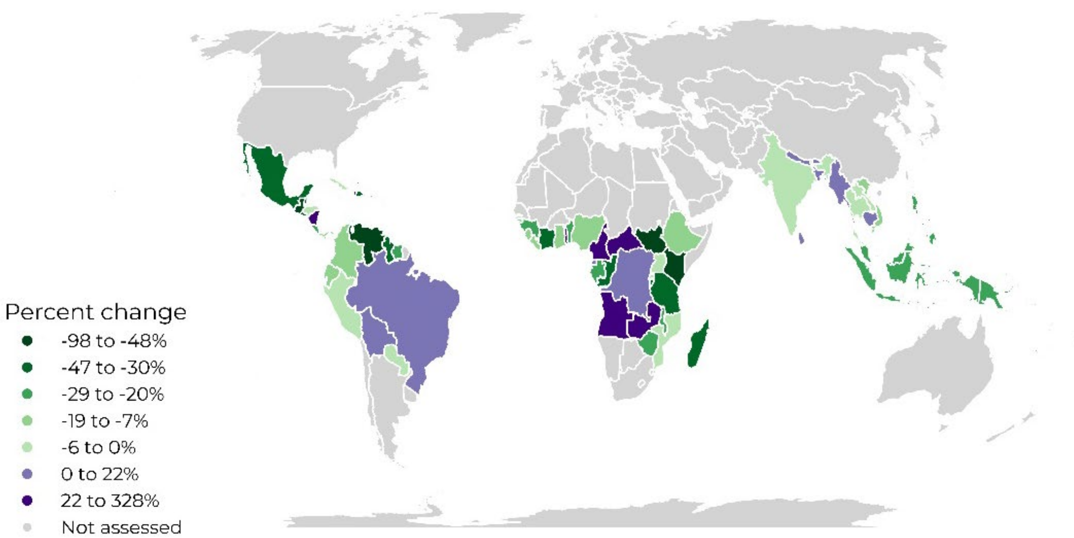
Brazil remains the largest contributor to deforestation globally. Despite Brazil's outsized influence and increasing deforestation trend, tropical Latin America overall has experienced net 0.033 Mha decrease in deforestation in 2021 compared to the 2018-2020 baseline. This decrease in deforestation can mainly be attributed to Mexico, Venezuela, Colombia, Guatemala, and Peru, all of which combined resulted in a joint decrease in deforestation of 0.140 Mha. This decrease was larger than the combined increases experienced in other countries, namely Brazil and Bolivia, where the deforestation trends are diverging from the 2030 target. In practice, increasing deforestation rates in major forest countries will make it very difficult to achieve the 2030 goal globally, regardless of other countries actions (country data available in **Annex B**).

In Tropical Asia, the countries with the largest absolute increase in deforestation are Cambodia and Myanmar. In sharp contrast, Indonesia, the largest deforester in Asia, experienced a sizeable reduction in deforestation in 2021 in relation to the baseline. Similarly, Malaysia, another country with substantial forest cover, experienced a relative reduction.

The DRC and Cameroon are the largest contributors to deforestation in tropical Africa. While the DRC's deforestation rate increased minimally in 2021, its absolute 2021 deforestation accounts for over 60 percent of Tropical Africa's total deforestation. Cameroon experienced a 20 percent increase in its deforestation rate in 2021 relative to the 2018-2020 baseline.

Figure 3. Country-level deforestation (in hectares) in 2021 (Top figure) and percent change in deforestation compared to the 2018-2020 baseline scenario (Bottom figure).



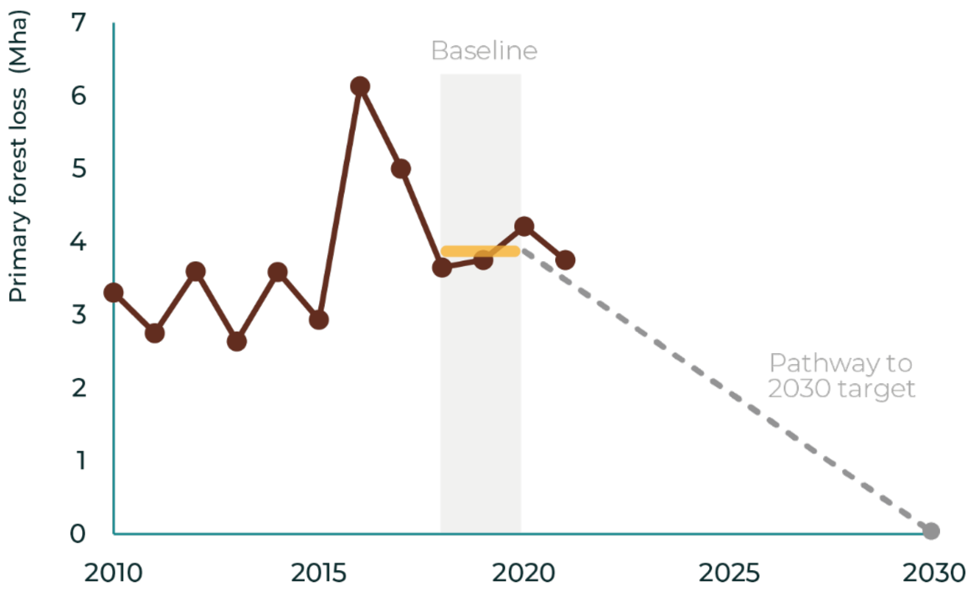


Source: Figure based on original analysis for this report using data from Hansen et al. 2013. Only tree cover loss that is deemed permanent (Curtis et al., 2018) or that occurs within humid tropical primary forests is considered here.
Note: Relative change in deforestation facilitates the comparison of deforestation across countries..

1.2 Humid tropical primary forest loss

Tropical and subtropical forests hold about a third of irrecoverable carbon and biodiversity, experience the majority of deforestation globally, and can take decades or centuries to recover from loss.[15] As no quantification of global primary forest loss is available, this indicator is based on humid tropical primary forest only. In 2021, 3.7 Mha of humid tropical primary forest were cleared, with 2.5 GtCO2e of associated GHG emissions. This represents a 3.1 percent decrease in deforestation in 2021 compared to the 2018-2020 baseline. While this does indicate improvement, the decline of deforestation within humid tropical forests is slower than the decline in global deforestation (6.3%) – and both are well below the 10 percent annual reduction needed to meet 2030 goals **(Figure 4**).

Figure 4. Global tropical humid primary forest loss over the 2010-2021 period, in million hectares, and the pathway to reach the 2030 gross zero target from the 2018-2020 baseline

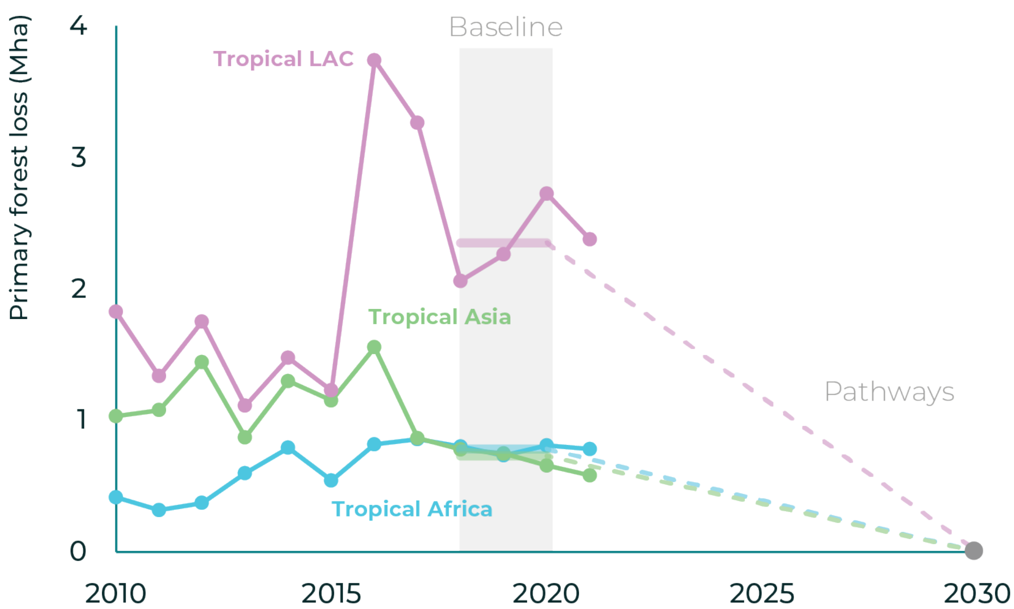


Source: Figure based on original analysis for this report using data from Hansen et al. 2013. Only tree cover loss occurring within primary forest boundaries is considered (Turubanova et al., 2018).
Note: The dashed line indicates that a reduction rate in deforestation of 10 percent per year, as compared to the 2018-2020 baseline, is necessary to reach the 2030 zero gross deforestation target. The data before and after 2015 are not directly comparable, as the methodology to detect the tree cover loss has been improved and may result in higher estimates of loss for recent years compared to earlier years, although this does not affect the assessment of progress since 2020.[16]

Tropical Asia experienced a 20 percent reduction in 2021 against the baseline – the only region that experienced a reduction in humid tropical forest loss. Tropical Asian countries have now experienced five consecutive years of decreasing primary forest loss and the region is on track to reach the 2030 target. This progress should be celebrated and used as an example for other regions. In contrast, yearly loss in Tropical Africa has remained constant and has increased by 1.2 percent in Tropical Latin America (**Figure 5**).

Cameroon, Bolivia, Lao Peoples' Democratic Republic (Lao PDR), Cambodia, Brazil, and, DRC all experienced increases in the rate of primary forest loss in 2021, with the four first showing over double-digit increases (see Annex F for full dataset). Only four countries reduced their rate of humid primary forest loss in 2021: Malaysia (-36%), Indonesia (-35%), Colombia (-16%), and Peru (-6%).

Figure 5. Tropical humid primary forest loss by region over the 2010-2021 period, in million hectares, and the pathway to reach the 2030 gross zero target from the 2018-2020 baseline



Source: Figure based on original analysis for this report using data from Hansen et al. 2013. Only tree cover loss occurring within primary forest boundaries is considered (Turubanova et al., 2018).
Note: The dashed line indicates the reduction rate, as compared to the 2018-2020 baseline, that is necessary for each tropical forest region to reach the 2030 zero gross deforestation target. The data before and after 2015 are not directly comparable, as the methodology to detect the tree cover loss has been improved and may result in higher estimates of loss for recent years compared to earlier years, although this does not affect the assessment of progress since 2020.[17]

CASE STUDY

INDONESIA

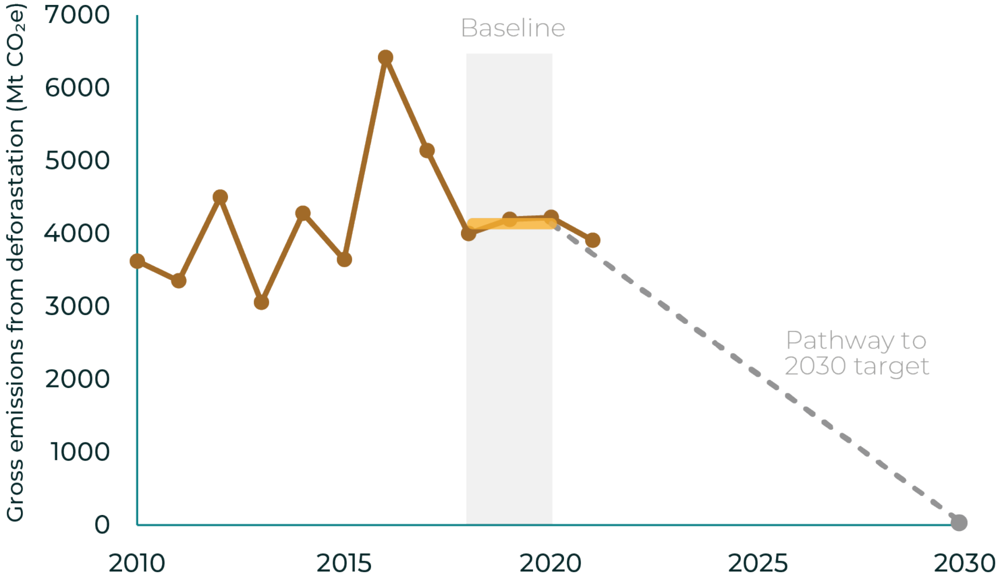
Indonesia is currently on track to meet its 2030 deforestation goal: The rate of primary forest loss has declined over the past five years and was 25 percent lower in 2021 than in 2020.[18] Action by both corporations and the government to address deforestation from palm oil production has been key to achieving this progress. In 2018, the Roundtable on Sustainable Palm Oil tightened its sustainability certification requirements to prohibit deforestation and peatland clearing. Also in 2018, the government imposed a moratorium on new oil palm plantations and enhanced law enforcement. By 2020, more than 80 percent of palm oil refiners had adopted No Deforestation, No Peat and No Exploitation commitments. As a result, deforestation linked to palm oil in 2020 reached its lowest rate in 20 years – and is continuing to fall during a period of expansion of palm oil production.[19] Indonesia has also included targets for peatland restoration in its NDC and requires companies to report on restoration of peat ecosystems in their concession areas.[20]

However, the palm oil moratorium expired in 2021, and there is now a risk that plantation expansion and deforestation will increase in response to palm oil prices, which have rising since 2020.[21] Another concern is recent changes to the forest legal framework that would undermine forest protection and previous achievements if implemented (see Theme 4 report on Forest governance for more).

1.3 Greenhouse gas emissions from forest loss

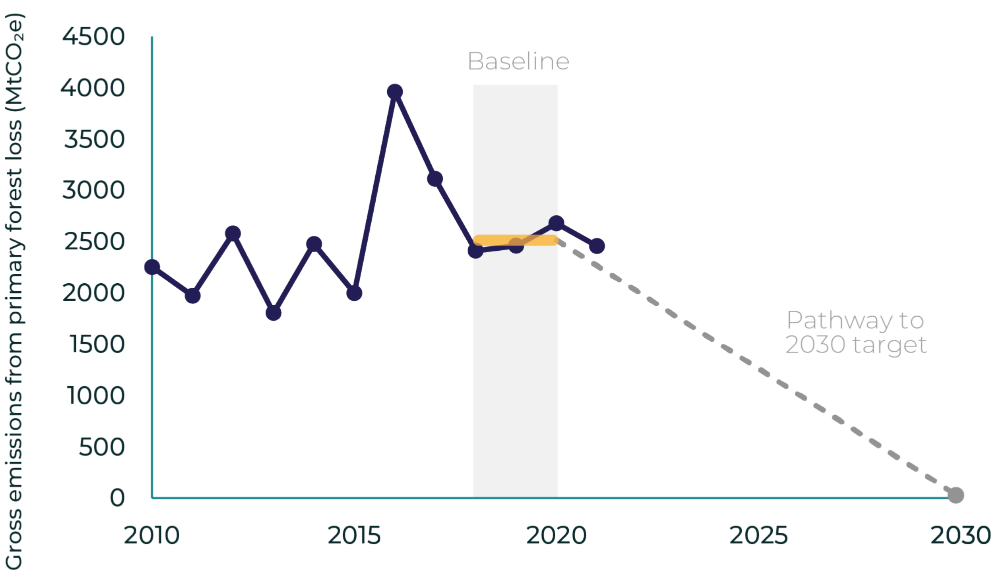
Global average baseline gross emissions from deforestation were 4.1 $GtCO_2e$ per year in 2018-20. Emissions in 2021 decreased by 5.5 percent from this baseline, with a total of 3.9 $GtCO_2e$ emissions from deforestation in 2021 (**Figure 6**). This decrease is not on track with the 10 percent, or 0.39 $GtCO_2e$/year, decrease required to reach the 2030 target.

Figure 6. Global gross emissions from deforestation over the 2010-2021 period, in megatons CO_2-equivalent, and the pathway to reach the 2030 gross zero target from the 2018-2020 baseline



Source: Figure based on original analysis for this report using data from Harris et al., 2021, Hansen et al. 2013, and Curtis et al. 2018, updated through 2021.
Note: The dashed line indicates that a reduction rate in emissions from deforestation of 10 percent per year, as compared to the 2018-2020 baseline, is necessary to reach the 2030 zero emissions from deforestation target. The data before and after 2015 are not directly comparable, as the methodology to detect the tree cover loss has been improved and may result in higher estimates of loss for recent years compared to earlier years, although this does not affect the assessment of progress since 2020.[22]

Figure 7. Global gross GHG emissions from humid tropical primary forest loss over the 2010-2021 period, in megatons CO_2-equivalent, and the pathway to reach the 2030 gross zero target from the 2018-2020 baseline



Source: Figure based on original analysis for this report using data from Harris et al., 2021, Hansen et al. 2013, and Turubanova et al., 2018, updated through 2021.
Note: The dashed line indicates that a reduction rate in emissions from deforestation of 10 percent per year, as compared to the 2018-2020 baseline, is necessary for tropical forest regions globally to reach the 2030 zero emissions from deforestation target. The data before and after 2015 are not directly comparable, as the methodology to detect the tree cover loss has been improved and may result in higher estimates of loss for recent years compared to earlier years, although this does not affect the assessment of progress since 2020.[23]

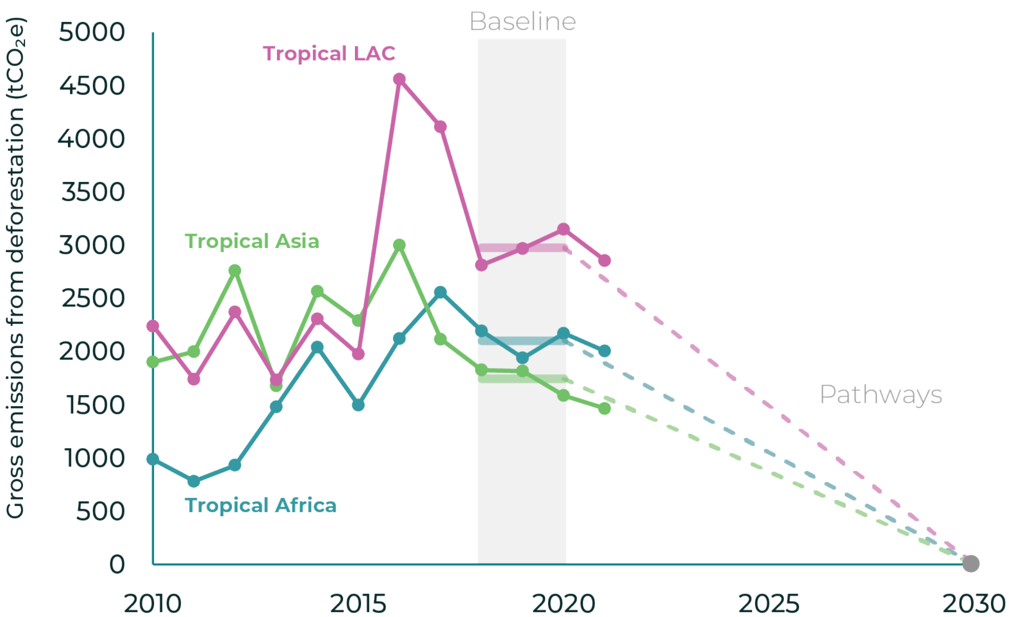
The average 2018-20 global baseline emissions from humid tropical primary forest loss were 2.5 $GtCO_2e$ per year. With 2.46 $GtCO_2e$ emitted due to humid primary forest loss in 2021, emissions have decreased by 2.4 percent compared to the baseline (**Figure 7**).

Consistent with their deforestation trends, Indonesia and Malaysia saw the largest reductions in emissions from deforestation in relative terms in 2021 – reducing deforestation by 28 percent (450 $MtCO_2e$) and 26 percent (121 $MtCO_2e$), respectively. Meanwhile, Bolivia and Brazil presented the largest relative increases in emissions in 2021 by 12 percent (240 $MtCO_2e$) and 5.6 percent (1400 $MtCO_2e$), respectively (see **Annex F** for dataset).

The countries with the greatest relative increases in GHG emissions from humid primary forests were Bolivia (23% increase in relation to the baseline), Cameroon (23%), Lao PDR (16%), Cambodia (12%), and Brazil (9%). Lao PDR has experienced an overall decrease in deforestation but has disproportionately increased its rate of loss in high-ecological value forests (see Annex F).

Tropical Asian countries overall saw a reduction in emissions from deforestation in 2021. As with deforestation, tropical Asia was the only region that saw a reduction in emissions from humid tropical forest loss. Asian countries have now experienced five consecutive years of decreasing emissions from primary forest loss and the region is on track to reach the 2030 target. Annual emissions from deforestation decreased slightly in tropical Africa and tropical Latin America in 2021. However, emissions from deforestation have generally been increasing in those regions since 2010, and both regions will need significant reductions to align with the 2030 zero emissions from deforestation target (**Figure 8**).

Figure 8. Regional gross GHG emissions from deforestation by region over the 2010-2021 period, in tons CO_2-equivalent, and the pathway to reach the 2030 gross zero target from the 2018-2020 baseline



Source: Figure based on original analysis for this report using data from Harris et al., 2021, Hansen et al. 2013, and Turubanova et al., 2018, updated through 2021.
Note: The dashed lines indicate the reduction rate in emissions from deforestation, as compared to the 2018-2020 baseline, necessary for each tropical forest region to reach the 2030 zero emissions from deforestation target. The data before and after 2015 are not directly comparable, as the methodology to detect the tree cover loss has been improved and may result in higher estimates of loss for recent years compared to earlier years, although this does not affect the assessment of progress since 2020.[24]

CASE STUDY

GABON

Gabon, which has over 90% of its total area covered by forests,[25] has been able to reduce its already low rate of deforestation by 28% between 2018-2020 and 2021. In 2021, Gabon was the first country to receive payments from the Central African Forest Initiative for reducing carbon emissions from deforestation. Gabon was awarded USD 17 million for forest protection measures such as creating 13 new national parks and implementing a project to combat illegal logging.[26] These measures have also contributed to decreased tree cover loss from shifting agriculture and artisanal small-scale mining. To address the growing risk to forests from commercial agriculture, the government of Gabon in 2019 adopted the Roundtable on Sustainable Palm Oil Principles and Criteria as national standards for palm oil production[27] and mandated in 2018 that all forest concessions should be certified under Forest Stewardship Council standards by 2022.[28] Further, Gabon has created AGEOS, an agency specialized in forest mapping using tele-detection methods to monitor the forest cover in real-time.

Additionally, Gabon developed an Emerging Gabon Strategic Plan (PSGE)[29], which outlines actions to ensure sustainable resource management while also reducing poverty and accelerating economic growth. Gabon has not yet implemented a Strategic Planning and Land Use Program (PNAT). But with the help of the Central African Forest Initiative (CAFI), the country is currently developing one for an improved spatial planning system to determine which areas should be developed for agriculture, mining, infrastructure development, and conservation.

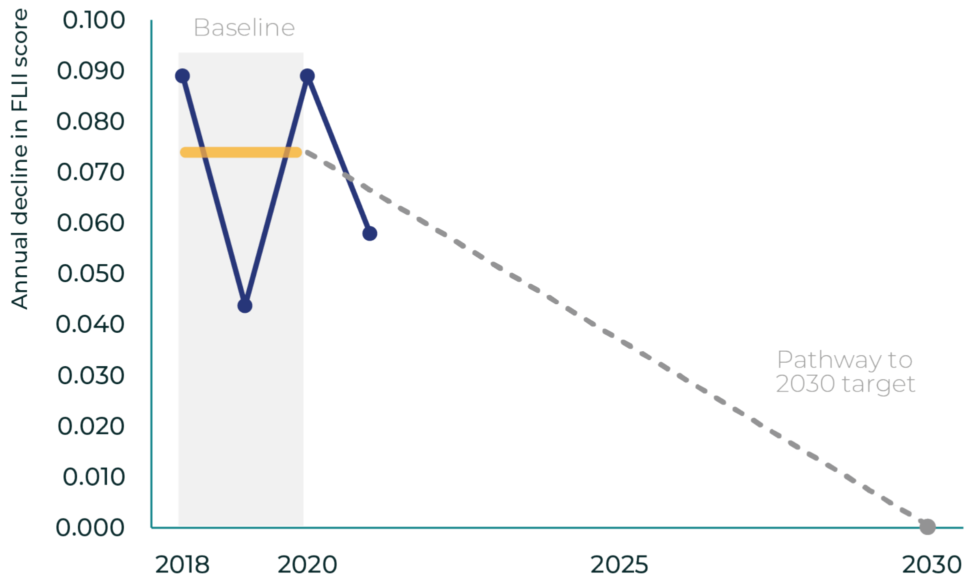
1.4 Degradation

While deforestation is the process of clearing forests permanently, forest degradation leads to a forest that still exists but is diminished in qualities such as carbon storage, biodiversity, and other ecosystem services. Degradation can often be a precursor to deforestation. Forest degradation can be measured in many ways. The Forest Landscape Integrity Index (FLII)[30] indicator tracks the ecological integrity of forests using data on the intensity and distribution of human pressures known to cause degradation, combined with observed losses in forest connectivity. Because the Glasgow Leaders' Declaration called for a halt (even a reversal) in land degradation by 2030, the FLII benchmark is equivalent to a 10 percent reduction in new degradation each year compared to the 2018-2020 baseline, reaching zero new degradation by 2030.

According to the FLII indicator, degradation of forests is ongoing both globally, with an average loss of 0.074 FLII points per year, and in all individual regions. Yet, the global rate of degradation appears to have slowed down in 2020-21, with a loss of 0.058 FLII points, thus roughly aligning itself with the annual degradation rate target (**Figure 9**). However, annual losses show substantial year-to-year fluctuations, demanding further years of data before a clear trend can emerge.[h] Moreover, since observed rates increased in four out of eight global regions, it cannot yet be concluded that the world is on track for this target.

[h] Note: The analysis of the FLII presented here quantifies the relative change in integrity, but not changes in the area of forest with differing degrees of degradation. In future years, the Assessment Partners aim to include this additional information, as well as associated emissions impact.

Figure 9. Annual change in global forest degradation as measured by the change in Forest Landscape Integrity Index (FLII)



Source: Figure based on original analysis for this report using data from Grantham et al., 2020.
Note: This figure shows the global annual change in forest degradation as quantified by the Forest Landscape Integrity Index (FLII) score. The solid line shows the annual change in FLII compared to the previous year. Positive values indicate a FLII decline, and therefore an increase in degradation, over the 2018-2021 period. The dashed line represents the pathway to reach the 2030 zero annual degradation target from the 2018-2020 baseline. Degradation in 2021 decreased in relation to the baseline. In contrast to other indicators, data on the FLII index is only available from 2017.

1.5 Restoration

The agreed global goal on restoration is to restore 350 Mha of lost and degraded forest landscapes by 2030. Global data on forest cover and tree cover gain using remote sensing technology is not yet available. However, in late 2021, the University of Maryland and World Resources Institute produced new prototype data on forest cover gain for the period 2000 to 2020, is used in this analysis as a proxy for forest restoration.

In addition, this Assessment analyzes how much forest land can be realistically restored between 2020 and 2050, measuring the potential to shift from a non-forest cover to a forest cover state through afforestation and reforestation activities, as well as natural forest regrowth. These indicators should be interpreted as a proxy for forest restoration opportunity potential.

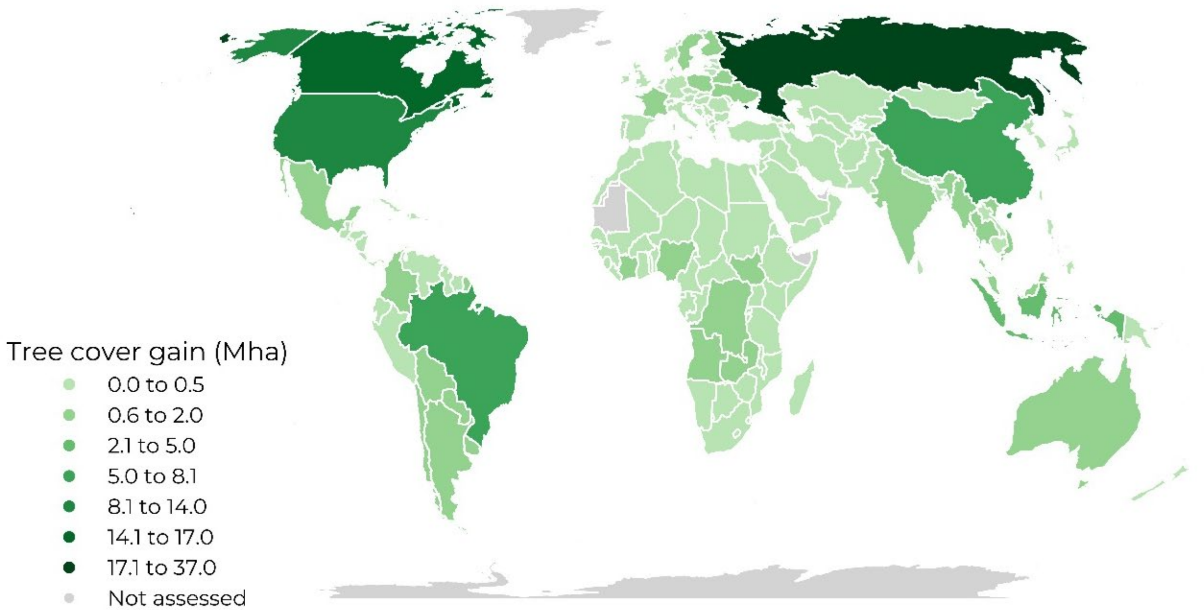
TREE COVER GAIN, 2000-2020

Over the previous two decades (2000-2020), global tree cover[i] increased by roughly 130.9 Mha – an area slightly larger than Peru. Three quarters of the global gain was concentrated in 13 countries; the largest gains were observed in Russia (28.4% of the total), Canada (13.0%), the United States (10.7%), Brazil (6.2%), and China (5%) (**Figure 10**). China saw the largest net tree cover gains (2.1 Mha).[31]

[i] The data on tree cover gain is the best-available proxy for forest gain. Tree cover gain includes gain from natural regrowth and restoration interventions, as well as gain from industrial tree plantations and agricultural tree crops, which are not typically considered forests.

However, these gains were offset by 231.4 Mha of tree cover loss in the same countries during that period. In total, although there was a global net loss of 100.5 Mha of tree cover,[j] thirty-six countries gained more tree cover than they lost (**Figure 11**),[32] which demonstrates potential for scaling up restoration and reversing forest loss globally. After China, India (0.87 Mha), Uruguay (0.54 Mha), Belarus (0.52 Mha), and Ukraine (0.43 Mha) presented the largest net gains. Globally, 118.6 Mha (approximately 90 percent) of the total tree cover gain – likely due to natural regeneration and assisted natural regeneration – occurred outside known plantations.[33]

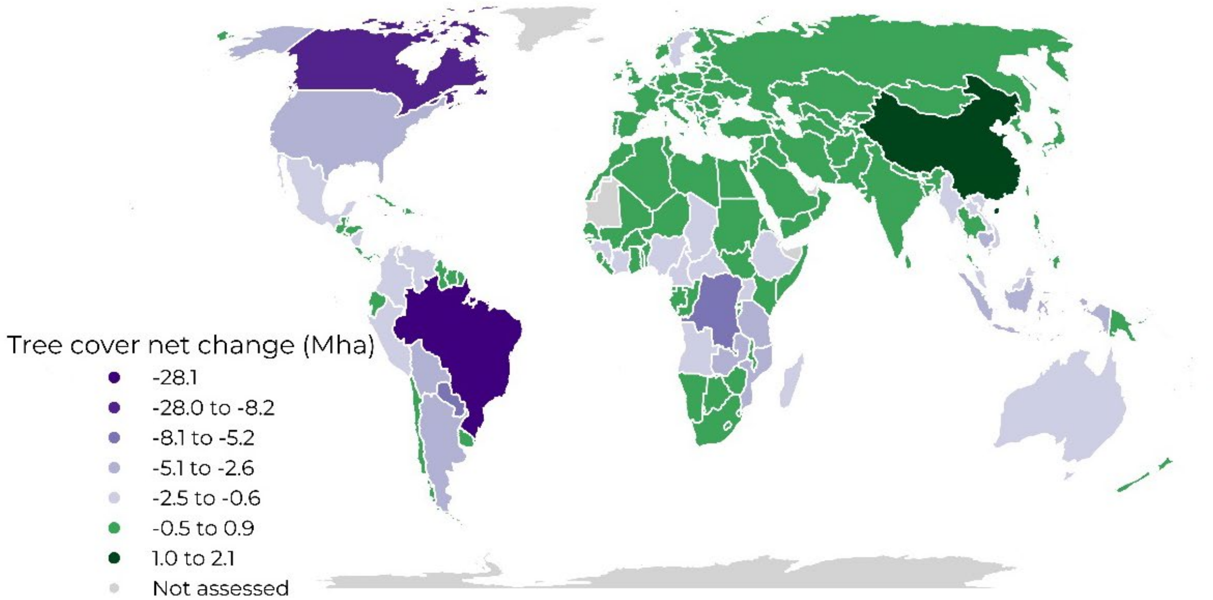
Figure 10. Tree cover gain between 2000 and 2020, in million hectares



Source: Data extracted from Potapov et al. (2022)[34]

[j] It is important to highlight that tree cover gain does not cancel out tree loss. Although forest cover gain is occurring in many places, it doesn't negate the impacts of loss – especially of primary forests.

Figure 11. Tree cover net change over the 2000-2020 period, in million hectares



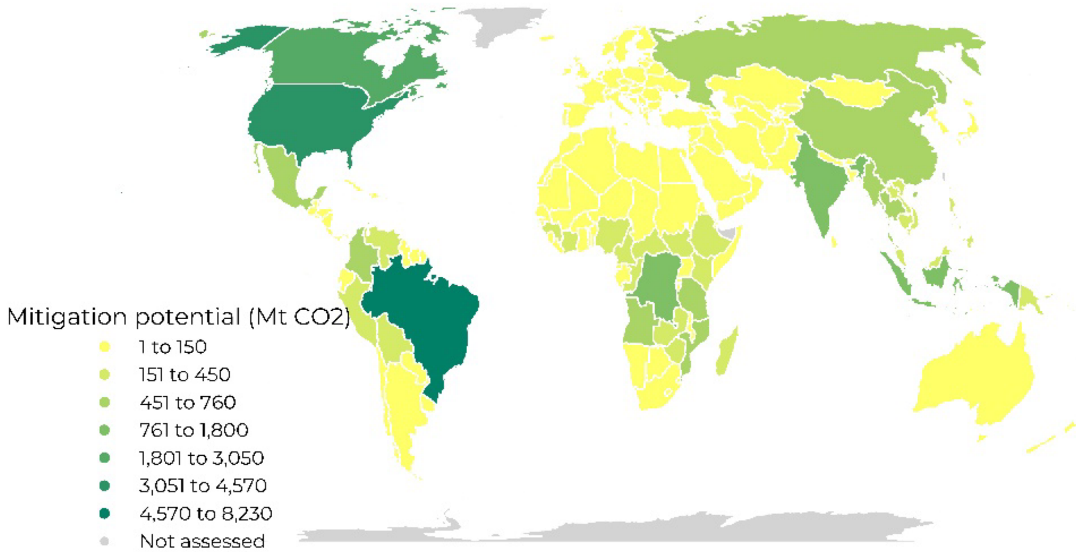
Source: Data extracted from Potapov et al. (2022)[35]

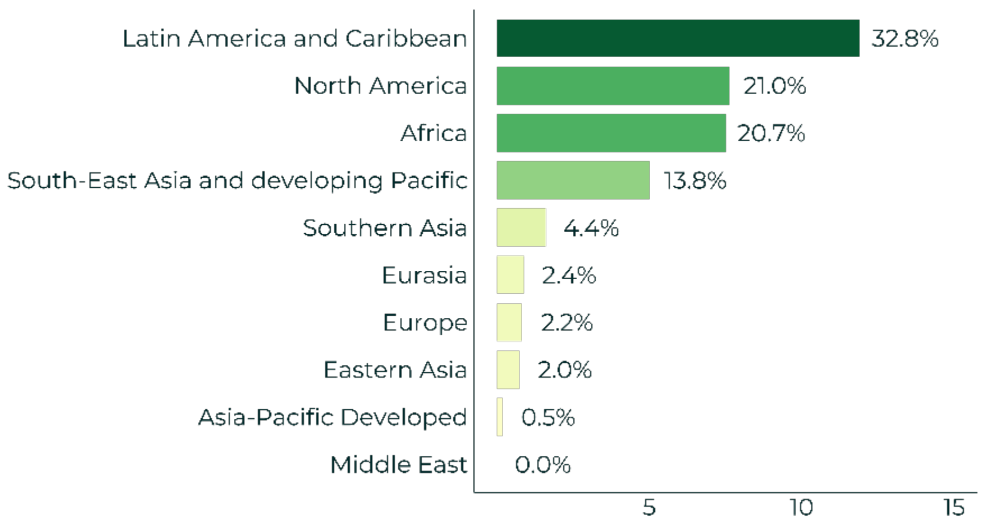
COST-EFFECTIVE MITIGATION POTENTIAL FROM RESTORATION

The cost-effective mitigation potential[k] identifies the pathway to the 2030 global restoration goal and assesses over the coming decade whether the world is on track. The global cost-effective mitigation potential of restoration over the 2020-2050 period amounts to 36.252 billion tCO_2e (**Figure 12**, top). At a regional level, Latin America and the Caribbean have the largest cost-effective mitigation potential (32.8% of the global potential, equivalent to 11,898 $MtCO_2$ or 396.6 $MtCO_2$ per year), followed by North America (21.0%), and Africa (20.7%) (**Figure 12,** bottom).

[k] In simple terms, cost-effective potential can be understood as the amount of mitigation that can be reasonably expected to be unlocked given economic constraints. Following the cost-effective definition outlined by Roe et al. (2021), the threshold of USD 100/tCO_2eq was set by using "the middle of the range for carbon prices in 2030 for a 1.5°C pathway, and at the low end of the range in 2050."

Figure 12. Cost-effective mitigation potential over the 2020-2050 period, in $MtCO_2e$ by hectare (top figure), and in $GtCO_2e$ by region (bottom figure)



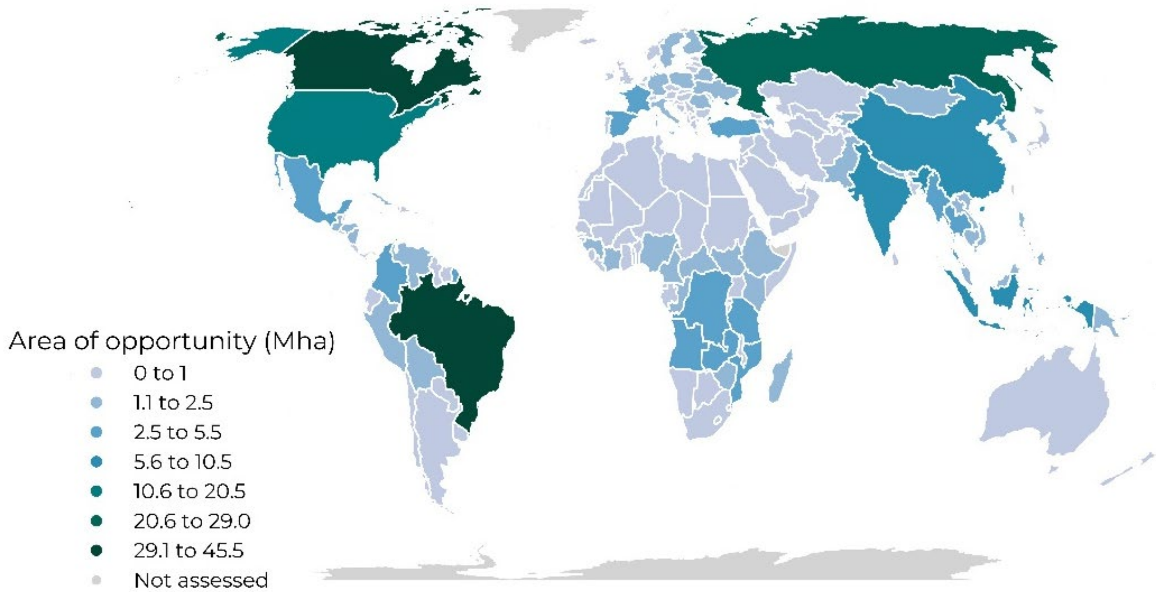


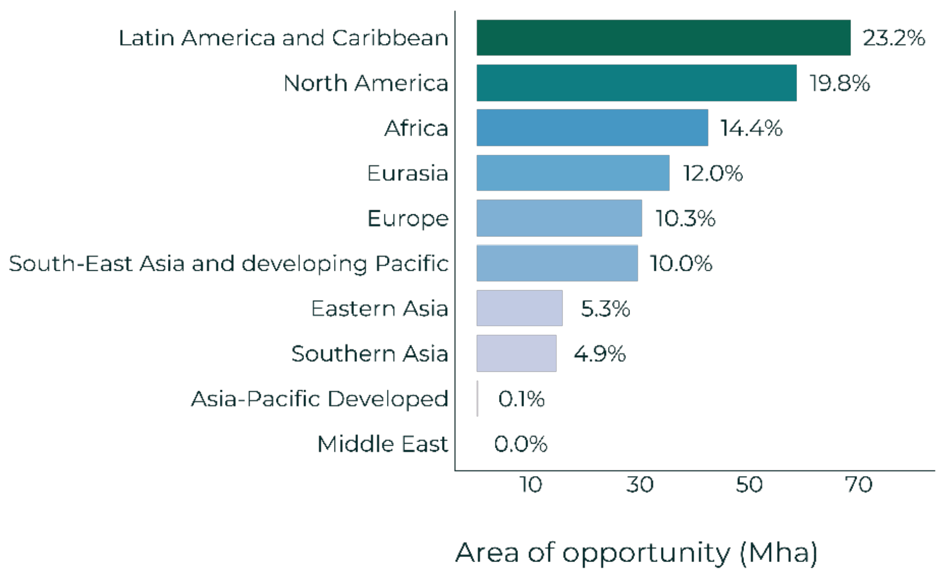
Source: Data extracted from Roe et al. (2021)

The global cost-effective area of opportunity for 2020-2050 is 295.1 Mha (**Figure 13**, top), which is approximately equivalent to the area of India. The majority (80%) of the mitigation potential is concentrated in only twenty-four countries. Brazil stands out, accounting for 22.7 percent of the global mitigation potential (8.232 billion tCO_2 over the thirty-year period, or 274 million tCO_2 per year; 45.5 Mha of restoration area of opportunity) and together with the United States, which represents 12.6 percent (4.572 billion tCO_2 or 152 million tCO_2 per year; 20.4 Mha), adds up to 35 per cent of the global figure. Other key countries are Canada (8.4% of the global total), Indonesia (5.0%), India (3.2%), and DRC (2.9%).

Differences across and within regions are substantial. In alignment with mitigation opportunity, Latin America and the Caribbean have the largest area of opportunity (**Figure 13**, top), accounting for 23.2 percent of the global area with potential for afforestation, reforestation, and natural forest regrowth (equivalent to 68.5 Mha). North America (19.8% or 58.6 Mha) and Africa (14.4% or 42.4 Mha) follow. Eurasia and Europe account for 22.2 percent of the area of opportunity, but host only 4.6 percent of the mitigation potential.

Figure 13. Cost-effective area of opportunity (2020-2050), in million hectares





Source: Data extracted from Roe et al. (2021)

When accounting for both area of opportunity and mitigation opportunity, the best opportunities overall lie in the United States of America (233.8 tCO_2 per ha), Brazil (181.0 tCO_2 per ha), Indonesia (171.0 tCO_2 per ha), DRC (215.3 tCO_2 per ha), Angola (208.8 tCO_2 per ha), or Tanzania (214.7 tCO_2 per ha).

A full list of countries with their mitigation potential, area of opportunity, and mitigation density can be found in Annex F.

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Annex A. Key terms

COST-EFFECTIVE RESTORATION

Interventions are considered cost-effective if the cost of mitigating one tonne of CO_2 equivalent is up to USD 100. The threshold of USD 100/tCO_2eq was set by using "the middle of the range for carbon prices in 2030 for a 1.5°C pathway, and at the low end of the range in 2050" (Roe et al., 2021, p. 6027).

DEFORESTATION

A tree cover loss event that is: permanent in nature, e.g., when forest is converted to cropland or cleared for development; or when it occurs within humid tropical primary forest boundaries.

FOREST LANDSCAPE INTEGRITY INDEX

The Forest Landscape Integrity Index (FLII) tracks the ecological integrity of forests using data on the intensity and distribution of human pressures known to cause degradation, combined with observed losses in forest connectivity.

FOREST LANDSCAPE RESTORATION (FLR)

The long-term process of regaining ecological functionality and enhancing human well-being across deforested or degraded forest landscape.

FOREST PROTECTION

A suite of interventions aimed at halting and reversing deforestation by 2030, in line with the Paris Agreement and Glasgow Leaders' Declaration. Forest protection includes reducing deforestation and forest degradation, restoring degraded forestlands, and sustainable management of production forests, with involvement of governments, the private sector, IPs and LCs, and other actors.

FOREST RESTORATION AREA

Area shifting from a non-forest cover state to a forest cover one through afforestation and reforestation activities. The restoration area in this report, therefore, does not include the restoration of degraded forests or interventions in other ecosystems.

GROSS ZERO DEFORESTATION

The Glasgow Leaders' Declaration on Forests and Land Use calls to "… halt and reverse forest loss and land degradation by 2030" but does not specify whether the goal should be to reach gross or net zero by the end of the decade. The 2021-2030 benchmark presented in this year's report for the different indicators uses the "gross zero" interpretation. Indicators tracking a less ambitious "net zero" pathway will be developed in future assessments as data becomes available (e.g., by using the gross forest loss and gain of the upcoming 2025 FAO Forest Resource Assessment).

TREE COVER LOSS

A loss event that may or not be permanent. Non-permanent tree cover loss routinely occurs in the context of logging, fire, or swidden agriculture. Tree cover loss data is often analyzed as a first step to measure deforestation.

Annex B. Methodology

1. Forest loss Indicators

The new FDA's reporting framework (Annex D) analyses forest loss and degradation indicators in two different ways. First, the 2021 data are compared to a 2018-2020 baseline, in order to assess whether there has been a short-term improvement or worsening of any given indicator. The baseline of 2018-20 was chosen to smooth out any single-year anomalies. Second, the 2021 data is benchmarked against a future pathway that delivers the 2030 objectives (e.g., reaching zero deforestation by 2030).

While multiple reduction pathways are in principle possible, for all deforestation, tropical primary forest loss, and forest degradation indicators, a straightforward and transparent linear reduction pathway is established. Each year of the decade (including 2021) requires a 10 percent reduction in loss relative to the baseline to reach zero gross loss by 2030. This is consistent with previous NYDF progress assessments, which also tracked progress against a linear reduction pathway.

The tree cover loss underlying deforestation and tropical primary forest loss was calculated using a >30 percent tree cover density threshold. 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 (Weisse and Potapov 2021) but does not affect the comparison of 2021 data to the 2018-2020 baseline.

Deforestation

Deforestation (ha/yr) is estimated as the part of global tree cover loss (Hansen et al. 2013) that leads to a permanent conversion of forest to a new land use according to a map of the drivers of tree cover loss (Curtis et al., 2018). This includes all tree cover losses that are likely attributed to the production of agricultural commodities and urbanization (Curtis et al., 2018) as well as tree cover loss due to shifting agriculture in humid tropical primary forests (primary forests as mapped by Turubanova et al. 2018). **Table 1** outlines the 30 countries with the highest deforestation in 2021.

Humid tropical primary forest loss

Humid tropical primary forest loss (ha/yr) measures the tree cover loss occurring as of 2001 within humid tropical primary forests, which are defined as mature natural humid tropical forest cover that has not been completely cleared and regrown in recent history (Turubanova et al., 2018). No corresponding map of primary forest is available globally; hence, this indicator is limited to the humid tropics.

Gross GHG emissions from forests

GHG emissions from global deforestation (measured in megatons of carbon dioxide equivalent per year, or $MtCO_2e$/yr) are estimated by combining data on carbon stocks and tree cover loss (Harris et al., 2021, updated with tree cover loss through 2021). Our estimates of gross GHG emissions include aboveground carbon, belowground carbon, deadwood and litter carbon, as well as soil organic carbon. CO_2, CH_4, and N_2O emissions from peat drainage and forest fires are also included. Emissions are attributed to deforestation using Curtis et al. (2018) (updated through 2021) following the same categories used for the global deforestation indicator.

Gross GHG emissions from humid tropical primary forest loss (tCO2e/yr) are estimated by overlaying gross emissions from Harris et al. 2021 with humid tropical primary forest extent in 2001 (Turubanova et al., 2018).

Table 1. Countries with the highest absolute levels of deforestation (in million hectares, Mha) and the relative and absolute change from 2018-2020 baseline to 2021 level

		DEFORESTATION			
		2018-2020 baseline (Mha)	2021 (Mha)	Absolute change from baseline (Mha)	Relative change from baseline
1	Brazil	2.25	2.33	0.076	3%
2	Indonesia	1.04	0.78	-0.260	-25%
3	Bolivia	0.50	0.53	0.030	6%
4	Democratic Republic of the Congo	0.48	0.50	0.016	3%
5	Paraguay	0.26	0.26	0.003	1%
6	Malaysia	0.34	0.26	-0.080	-24%
7	Lao PDR	0.24	0.23	-0.015	-6%
8	Myanmar	0.18	0.18	0.003	2%
9	Peru	0.18	0.17	-0.012	-7%
10	Colombia	0.19	0.16	-0.031	-17%
11	Argentina	0.13	0.16	0.022	17%
12	Vietnam	0.17	0.14	-0.026	-15%
13	Cambodia	0.13	0.14	0.009	7%
14	United States	0.12	0.10	-0.020	-16%
15	Cameroon	0.07	0.089	0.018	25%
16	Thailand	0.09	0.087	-0.002	-2%
17	Mexico	0.11	0.068	-0.038	-36%
18	Nicaragua	0.05	0.064	0.017	37%

		DEFORESTATION			
19	**Madagascar**	0.08	0.049	-0.027	-35%
20	**Philippines**	0.06	0.045	-0.015	-25%
21	**Papua New Guinea**	0.06	0.043	-0.015	-26%
22	**Honduras**	0.04	0.042	0.000	-1%
23	**Venezuela**	0.07	0.031	-0.036	-54%
24	**Liberia**	0.03	0.025	-0.003	-12%
25	**Angola**	0.01	0.024	0.014	131%
26	**Nigeria**	0.03	0.022	-0.003	-10%
27	**Guatemala**	0.04	0.020	-0.019	-48%
28	**Republic of the Congo**	0.03	0.019	-0.008	-30%
29	**Central African Republic**	0.01	0.019	0.008	71%
30	**Canada**	0.01	0.016	0.005	51%

Source: Based on original analysis for this report using data from Hansen et al. 2013, Curtis et al. 2018, and Turubanova et al. 2018.

Degradation

The Forest Landscape Integrity Index (FLII) provides an index of the overall level of degradation (i.e., human modification) for all forests across a continuous scale from the lowest (FLII = 0) the highest (FLII = 10) level of integrity (Grantham et al., 2020) annually from 2017. The Glasgow Leaders' Declaration calls for a halt to land degradation (including forest degradation), implicitly by 2030. Therefore, the 2030 target is set at zero further degradation (i.e., no further loss in FLII). Analogous to other indicators, the pathway to reach this 2030 target reflects a 10 percent decline each year from the baseline rate, which is the average annual loss of FLII units across 2018-2020.[a] The FLII uses proxies for degradation, combining observable pressures within pixels (agriculture, forest cover loss and infrastructure), inferred pressures (e.g., edge effects, overharvest), and losses in forest connectivity in the surrounding landscape to give an aggregate score.

[a] Given that many Forest Landscape Restoration pledges exist a less conservative benchmark could be applied (See section Annex C). Future assessments may revise this benchmark upwards as certainty regarding methodological developments allow.

2. Restoration indicators

Rate of forest cover and tree cover gain

Global data on forest cover and tree cover gain using remote sensing technology are still under development. Recent technological advancements in satellite sensors offer new possibilities for measuring tree height, which improve accuracy for estimating tree gain (and loss) globally. For instance, in late 2021, the University of Maryland and the World Resources Institute (WRI) leveraged data provided by the Global Ecosystem Dynamics Investigation Lidar (GEDI) onboard the International Space Station (ISS) to produce new prototype data on forest cover gain for the period 2000-20.[1]

While these methods have improved understanding of the changing dynamics of global forests, the data they generate does not perfectly align with the indicators employed in this Assessment to measure the rate of forest cover and tree cover gain. The dataset reveals areas where tree cover has increased, but it does not indicate if the gain in tree cover resulted from forest restoration or afforestation versus other factors, such as regeneration after natural disturbances or land abandonment. The data set reports the accumulated gain that occurred between 2000 and 2020 as a single time step. Forthcoming data from University of Maryland and WRI, expected by late 2023, will improve upon this first prototype to include a time series of annual estimates, which will enable a more thorough understanding of the temporal dynamics of tree cover gain. Furthermore, the BIOMASS mission from the European Space Agency (ESA) is expected to start delivering high resolution data on above ground biomass in the first quarter of 2023.

Cost-effective potential for restoration

This assessment indicates how much can be realistically restored between 2020 and 2050, measuring the potential to shift from a non-forest cover state to a forest cover state through afforestation and reforestation activities and through natural forest regrowth. The restoration potential data is available in terms of mitigation potential (measured in $MtCO_2$), the mitigation density (Mt CO_2per hectare (ha)),[2] and the area of forest restoration opportunity (measured in ha).[3] These indicators can be interpreted as a proxy for forest restoration opportunity potential, while keeping in mind the challenges in representing the broad scope of restoration or FLR with any single metric.

Available literature provides estimates of restoration potential both in technical and cost-effective terms.[b] The former refers to the mitigation potential achievable with available technologies, regardless of the cost of implementation. The latter considers the implementation of mitigation activities that are feasible under the price threshold of USD 100/$tCO2_e$[c]. As noted by Roe et al. (2021), the technical potential might not be feasible or desirable due to economic, social, political, or environmental constraints and tradeoffs. Hence, cost-effective potential estimates are considered a more realistic and actionable target for policy,[d] and are the focus of the Forest Declaration Assessment's analysis.

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[b] Interventions are considered cost-effective if the cost of mitigating one tCO_2e is at least USD 100. The threshold of USD 100/tCO2eq was set by using 'the middle of the range for carbon prices in 2030 for a 1.5C pathway, and at the low end of the range in 2050' (Roe et al., 2021, p. 6027).

[c] In simple terms, cost-effective potential can be understood as the amount of mitigation that can be reasonably expected to be unlocked given economic constraints. Following the cost-effective definition outlined by Roe et al. (2021), the threshold of \$100/tCO_2eq was set by using 'the middle of the range for carbon prices in 2030 for a 1.5C pathway, and at the low end of the range in 2050'.

[d] Please see <u>Annex E</u> for further information on the methodology and an in-depth explanation of how conservativeness has been additionally enhanced by applying an algorithm that ensures consistency between various pieces of research.

The dataset is based on the cost-effective sectorial estimates from the paper Roe et al. (2021) covering the period 2020 to 2050. Roe et al. (2021) adapted existing mitigation potential estimates from afforestation, reforestation, and natural forest regrowth from two existing papers:

i) Busch et al. (2019):[4]

They "produce spatially disaggregated marginal abatement cost curves for tropical reforestation by simulating the effects of payments for increased CO2 removals on land-cover change in 90 countries" (p. 463). The study defines reforestation as the transition of land from non-forested to forested at 30% tree cover. This definition includes afforestation, although they did not use the term to avoid promoting conversion of native non-forest ecosystems. Busch et al. did not distinguish between anthropogenic versus natural reforestation processes in their data. Other biomes such as deserts and mangroves are excluded from the analysis.

Busch et al. (2019) first model the historical reforestation area (2000 – 2010) as a function of economic and biophysical driver variables. These include agricultural revenues, slope and elevation, distance from the nearest city of more than 750,000 inhabitants, the extent of protected areas, and biome type. Second, they project reforestation area per decade from 2010 to 2050 and convert projections into CO_2 removals in above and below-ground biomass based on the type of biome and whether reforestation is through natural regrowth or forest plantations. Finally, Busch et al. (2019) produce marginal abatement cost curves by applying a per-hectare carbon price effect to the model, which simulates payments for carbon removals.

The analysis accounts for non-linear trends in land-cover change (for instance, the inverted-U-shape relationship between reforestation and deforestation), assumes a 10 percent discount rate and does not include long-lived wood products.

ii) Austin et al. (2020)[5]

They use a Global Timber Model (GTM) to project the mitigation potential of avoided deforestation, forest management activities, increasing harvest rotations, and afforestation/reforestation in response to carbon price signals across 16 regions. Afforestation/reforestation interventions include natural forest regrowth and the establishment of managed timber plantations.

The GTM is a dynamic economic optimization model representing the forestry sector. It determines optimal levels of afforestation/reforestation (together with other interventions) by maximizing net welfare (i.e., producers' and consumer's surplus) and assuming future macroeconomic and environmental conditions.

The model differentiates forest types and associated biomes, accessibility to the area and management intensity. Austin et al. (2020) first establishes a baseline scenario representing the extent of future forest and land management, and associated CO_2 fluxes in above- and below-ground biomass and soil carbon, in the absence of carbon price. Second, they develop scenarios under alternative carbon price scenarios and compared these projections to the baseline scenario to estimate net mitigation potential. The model assumes a 5% discount rate.

Roe et al. (2021) averages the cost-effective mitigation potential (with the threshold set to $100/t$CO_2$e) from both papers, when available, or considers the only available estimate when others are missing. These papers are held in highest regard for the provision of reliable mitigation potential estimates since they include spatial opportunity, costs, and are based on well-grounded econometric analyses. Additionally, by averaging the two most updated estimates, Roe et al. (2021) account for the factors considered in the two separate studies, and it is therefore expected to deliver very robust estimates.

Roe et al. (2021) calculates the cost-effective area of opportunity by measuring the land area associated with a given mitigation potential. Thus, the indicator on mitigation density equals the mitigation potential of each country divided by the respective area of opportunity.

The resulting dataset provides one or more indicators of restoration potential for 224 countries. Furthermore, Roe et al. (2021) provides annual estimates for both mitigation potential and area of opportunity, which are multiplied by 30 years to obtain the overall estimate for the period 2020-50. This adjustment allows for comparability between these indicators and the commitments database (see Annex E).

[1] Potapov, P., Hansen, M. C., Pickens, A., Hernandez-Serna, A., Tyukavina, A., Turubanova, S., et al. (2022). The Global 2000-2020 Land Cover and Land Use Change Dataset Derived From the Landsat Archive: First Results. *Frontiers in Remote Sensing*, *3*, 856903. https://doi.org/10.3389/frsen.2022.856903.

[2] Roe, S., Streck, C., Beach, R., Busch, J., Chapman, M., Daioglou, V., et al. (2021). Land-based measures to mitigate climate change: Potential and feasibility by country. *Global Change Biology*, *27*(23), 6025–6058. https://doi.org/10.1111/gcb.15873.

[3] World Resources Institute. (2014, May 30). Atlas of Forest and Landscape Restoration Opportunities. https://www.wri.org/data/atlas-forest-and-landscape-restoration-opportunities.

[4] Busch, J., Engelmann, J., Cook-Patton, S. C., Griscom, B. W., Kroeger, T., Possingham, H., et al. (2019). Potential for low-cost carbon dioxide removal through tropical reforestation. *Nature Climate Change*, *9*(6), 463–466. https://doi.org/10.1038/s41558-019-0485-x.

[5] Austin, K. G., Baker, J. S., Sohngen, B. L., Wade, C. M., Daigneault, A., Ohrel, S. B., et al. (2020). The economic costs of planting, preserving, and managing the world's forests to mitigate climate change. *Nature Communications*, *11*(1), 5946. https://doi.org/10.1038/s41467-020-19578-z.

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ABOUT

The Forest Declaration Assessment is a continual and collaborative process achieved collectively by civil society organizations and researchers, known as the Forest Declaration Assessment Partners. Previously the NYDF Progress Assessment, the Forest Declaration Assessment has since 2015 published annual updates on progress toward global forest goals. All assessment findings undergo a rigorous peer review process conducted by experts across the globe. To learn more about the Forest Declaration Assessment, please visit www.forestdeclaration.org/about/assessment.

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