



ENHANCING NDCs: OPPORTUNITIES IN THE FOREST AND LAND-USE SECTOR

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EXECUTIVE SUMMARY

Highlights

- Conservation, restoration, and improved management of forests are cost-effective solutions for large-scale reduction of greenhouse gas (GHG) emissions and removal of carbon from the atmosphere and thus help to hold the global temperature increase to well below 2.0°C or 1.5°C above preindustrial levels.
- In addition to their climate change mitigation potential, forest conservation, restoration, and management also help countries and communities adapt to climate change. For example, forest products provide livelihoods for millions, mangroves protect coastal lands against rising seas and tidal surges, while inland forests moderate temperature fluctuations and stabilize water supply.
- Forest sector solutions for climate also contribute to achieving Sustainable Development Goals (SDGs), such as ending poverty and hunger, ensuring water availability, and reducing disaster risks.
- However, the first Nationally Determined Contributions (NDCs) that countries have communicated to the United Nations Framework Convention on Climate Change (UNFCCC) often do not make full use of the potential of forest solutions or lack the needed specificity, which could result in missing substantial opportunities to reduce GHG emissions in cost-effective ways.

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- Countries are requested to put forward a second round of NDCs by the end of 2020—including new or updated NDC targets—meaning there is a significant but closing window for countries to enhance their NDCs in this round, which can in turn attract investments and support.
- This guide sets out options and ideas, and highlights benefits for countries of including and/or improving the forest sector component in their NDCs, providing key perspectives, opportunities, and informative background materials.

The forest sector can significantly and cost-effectively¹ contribute to holding global warming to well below 2.0°C or 1.5°C above preindustrial levels (Griscom et al. 2017), **a target that the Intergovernmental Panel on Climate Change (IPCC) (2018) deems imperative to avoid further significant social and economic impacts.** In addition to reducing GHG emissions, forest sector solutions (often called “natural climate solutions” or “nature-based

solutions”) deliver a range of adaptation and sustainable development benefits (Table ES-1). However, forest-related climate finance remains minimal despite the forest sector’s mitigation potential (Buchner et al. 2017).

Despite the urgent need to stop deforestation and restore forests, and the numerous global commitments to achieving these goals, deforestation continues at an alarming rate.

The years 2016 and 2017 marked the highest global annual tree cover loss in the past two decades, with nearly 30 million hectares of tree cover loss each year (WRI n.d).

The process of developing new or updated NDCs provides a valuable opportunity for countries to better understand the mitigation potential of their forests and to enhance the forest sector content in their NDCs. Globally, current NDC targets are insufficient to achieve the mitigation necessary to hold global warming to well below 2.0°C, let alone 1.5°C.

Table ES-1 | **Forest Sector Solutions Considered in This Guide**

SOLUTIONS	SHORT DESCRIPTION
Reduced deforestation and degradation	Conservation of forests, including prevention of forest loss and degradation.
Improved forest management	Management interventions that curtail deforestation and/or degradation, reduce the occurrence of fires, or stimulate reforestation and forest restoration. Improved forest management also includes interventions for the purpose of more efficient extraction of forest resources (e.g. timber and fuelwood) with minimal damage to the forest ecosystem.
Reforestation	Conversion of lands from other land uses to forests, where previously there were forests.
Afforestation	Conversion of lands from other land uses to forests, where historically ^a there were no forests.
Agroforestry	Deliberate planting of trees in croplands and silvopastoral systems.
Fire management	Prevention, control, and suppression of wildfires, including prescribed/controlled burning.
Restoration	Practices aimed at regaining the ecological integrity in a deforested or degraded forest landscape.

Notes: Land management solutions for mangroves and peatlands are separated from those for forests in the IPCC report (2019b), but this guide considers forests to include upland forests, peatland forests, and mangroves.

^a At least for 50 years (Hiraishi et al. 2014).

Source: Based on IPCC 2019b (Tables 6.5, 6.6, and 6.8), modified by the authors.

About This Guide

This guide supplements, as a sector module, the overarching guide, *Enhancing NDCs: A Guide to Strengthening National Climate Plans by 2020* (Fransen et al. 2019), and will assist countries in enhancing their NDCs with clearer and more tangible forest sector content. NDC enhancement guide sector modules are also available for power (electricity), transportation, agriculture and food, short-lived climate pollutants, and the ocean.

NDCs and the Forest Sector

Globally, an estimated 23 percent of GHG emissions are derived from the land-use sector, including agriculture (IPCC 2019b). However, in several, often developing, countries, the land-use sector accounts for up to 80 percent of national emissions (WRI n.d.). For these countries the land-use sector is critical in contributing to the goals of the Paris Agreement. Enhancing the forest sector components of NDCs can not only help countries achieve their mitigation and adaptation goals but also raise the profile of the forest sector and attract much-needed investments and support to implement forest sector solutions. The integration process can also create the requisite institutional arrangements within governments as well as partnerships with key external stakeholders to design and implement effective land sector policies.

Forests emerged as a key sector during the first NDC submissions, with over 75 percent of countries including forest sector targets (IUCN and Climate Focus 2018), estimated to represent 25 percent of planned emissions reductions by 2030 (if fully implemented, and including conditional targets) (Grassi et al. 2017). However, forest sector-specific information (particularly quantitative information) is limited in current NDCs, which could result in missed opportunities to enhance understanding toward countries' commitments and efforts, raise the profile of the forest sector, and attract more support. A majority of NDCs do not contain forest sector-specific quantitative targets, and a quarter of NDCs explicitly exclude the forest sector from their mitigation commitment (IUCN and Climate Focus 2018). These numbers indicate that many countries have not yet fully explored the opportunities provided by integrating the forest sector into the NDC development process to facilitate both mitigation and adaptation efforts in the sector.

Six Steps for NDC Enhancement in Forest Sector

Countries can take the following steps to identify opportunities and options in the forest sector for NDC enhancement. Figure ES-1 provides illustrative examples of how each step can be implemented, with the understanding that countries require flexibility and so steps may be skipped, resequenced, or repeated.

- 1. Establish the institutional arrangements and partnerships** needed to integrate forest sector solutions into NDCs. Stakeholders of forest sector solutions will vary depending on a country's governance structure, but a strong stakeholder engagement process can help facilitate successful partnerships.
- 2. Take stock of progress to date**, by assessing the scope of the countries' submitted NDCs, and forest sector actions and policies implemented to date, to determine the current mitigation potential, expressed in GHG emissions reductions, of listed forest sector actions. To update targets, it is important to investigate recent developments and innovations in forest sector technologies and policies that have taken place in the country and elsewhere, as well as to assess factors that facilitate implementation, and challenges and barriers that need to be overcome.
- 3. Review long-term objectives**, including global forest sector GHG emissions reduction pathways that are consistent with the Paris Agreement's temperature goals as well as goals, and targets of other related international processes and national commitments.
- 4. Identify policy measures** that would reduce emissions and/or increase sequestration and that align with national priorities and development goals to move toward the required global ambition to meet Paris Agreement targets. Threats to forests often originate outside the forest sector and, therefore, policy coordination with related sectors is imperative.
- 5. Assess benefits and costs of policy measures.** A comprehensive assessment of the benefits and costs can improve decision-making about which forest sector solutions to include in an NDC and help determine ways these can be financed.
- 6. Determine how specifically to reflect forest sector solutions in NDCs.** The enhancement options can be integrated into NDCs in different ways, including sector-specific GHG emissions reduction

targets, non-GHG quantitative targets, or sector policy measures to achieve the targets. These options are not mutually exclusive, and, in fact, the countries' contributions and efforts may be better demonstrated when GHG emission targets are accompanied by corresponding non-GHG targets and supported by key policy measures to achieve them. Similarly, non-GHG targets and policies can contribute to enhancement of NDCs when assessed in terms of GHG emissions reductions to understand the potential mitigation contribution. Some examples of targets and policy measures are listed below.

GHG targets

- Sector-wide emissions reductions in the forest sector relative to base-year or business-as-usual (BAU) level
- Emissions reductions or carbon removal as a result of particular actions in the sector

Non-GHG targets

- Forest cover as a ratio of the country's total land area
- Area of deforestation in absolute terms or relative to base-year or BAU level
- Total forest area under legal protection
- Total forest area planted or restored by the target year
- Total area of land with secured land tenure for indigenous people or local communities

Policies/measures

- Creating/enforcing regulations limiting forest conversion into commodity croplands or plantations
- Creating policies and programs to expand or secure indigenous land rights
- Introducing improved forest monitoring and law enforcement programs to combat illegal logging and forest clearing
- Developing fiscal or market mechanisms to allocate financial resources to protect/enhance forest ecosystem services
- Researching climate change impacts on forests and forest users

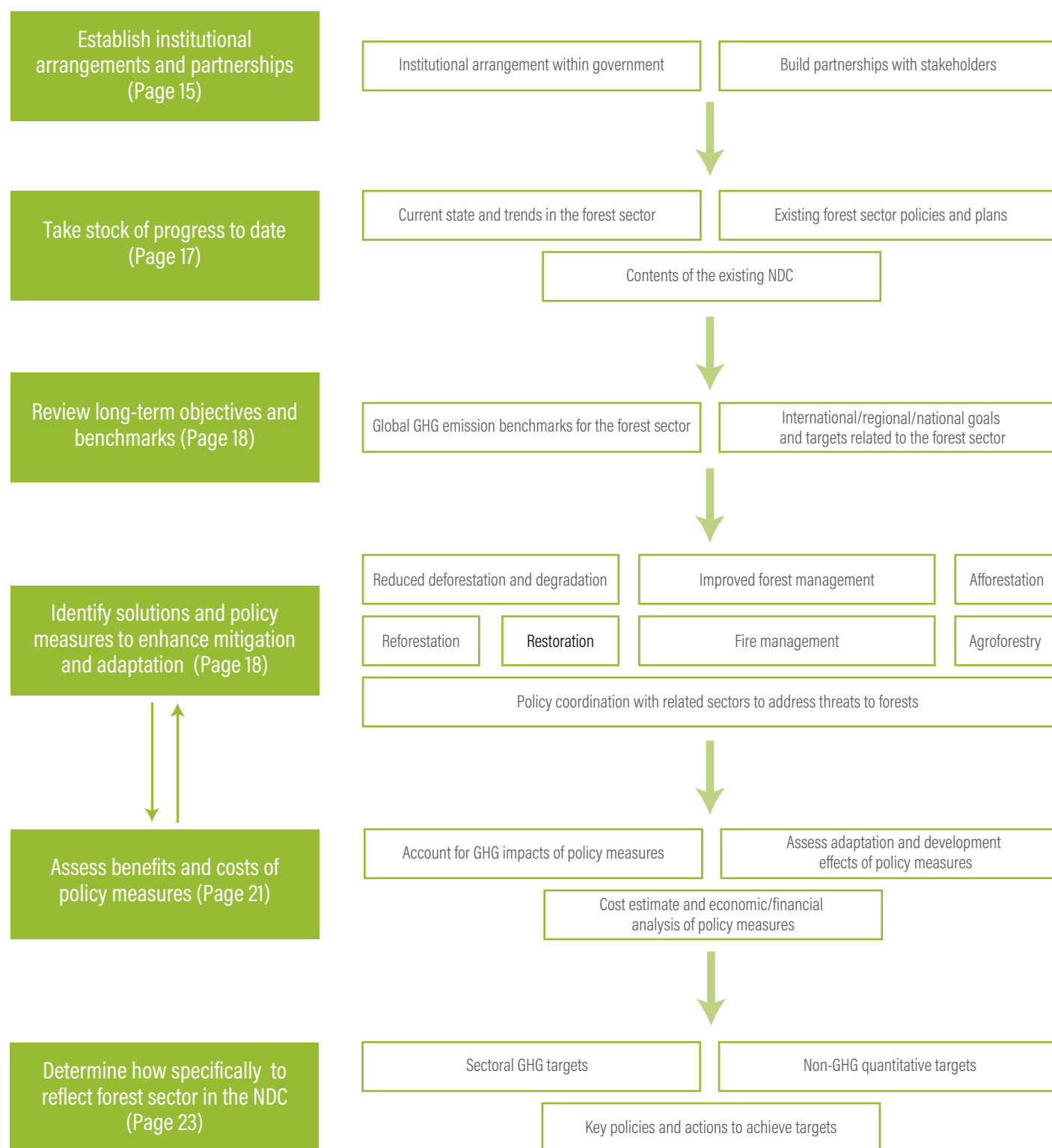
Opportunities for Strengthening Policies and Measures

Taking advantage of technological developments that have occurred in the forest sector, such as increased global monitoring capabilities, can provide countries with high-quality tree cover data, leading to better information on the forests under their jurisdiction. Recent research has also improved our understanding of the different drivers of deforestation and the policies that can be enacted to reverse the trend. For example, establishment of protected areas, law enforcement, and indigenous management have all been shown to slow forest loss (Busch and Ferretti-Gallon 2017).

Aligning finance flows with NDC forest sector goals demonstrates a commitment to creating a regulatory environment that directs public and private sector investments toward forest sector solutions. By making commitments to shift money and attention to the forest sector, countries can demonstrate in their NDCs a readiness to introduce or enhance policies to divert finance flows away from activities driving deforestation and into those promoting conservation and restoration. This shift will require close coordination with multiple government agencies and key external stakeholders to maximize mitigation benefits while balancing land-use trade-offs.

Including or strengthening a commitment to Reducing Emissions from Deforestation and Forest Degradation (REDD+)² in NDCs is one way to effectively communicate domestic efforts toward emissions reductions, signal support needs, and attract additional financial resources. Avoiding deforestation and forest degradation is one of the most cost-efficient means of reducing greenhouse gas emissions and can provide countries with numerous cobenefits such as prevention of flooding, preservation of biodiversity, and conservation of water resources.

Figure ES-1 | Suggested Process of Enhancing the Forest Sector Component of NDCs



Note: Upward arrow indicates that the steps linked with the arrow can be iterative.

Source: Authors.

INTRODUCTION

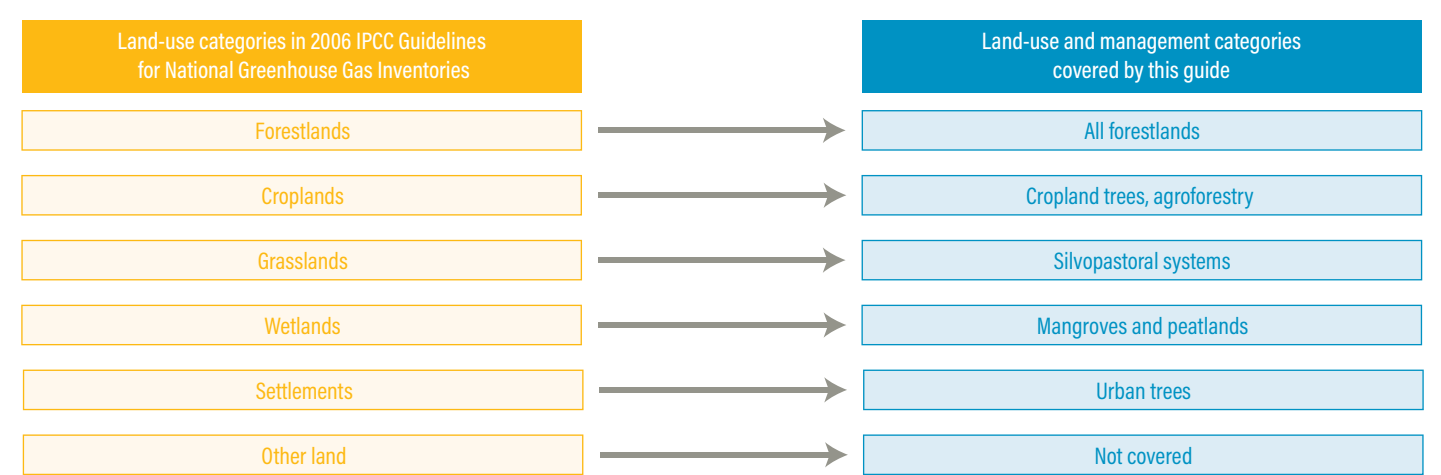
The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2014b) and the IPCC special report on climate change and land (IPCC 2019b) both indicate that net greenhouse gas (GHG) emissions from forest and other land use account for about 11 percent of net global GHG emissions. In addition, the IPCC special report on the impacts of global warming of 1.5°C (IPCC 2018) illustrates that it is imperative for all countries to make every effort to limit global warming to well below 2.0°C or 1.5°C above preindustrial levels to avoid irreversible changes to the environment, such as the loss of valuable ecosystems.

The forest sector has many unique attributes. Forests provide a large, cost-effective mitigation opportunity as the world’s only proven technology for removing and storing carbon at scale. The forest sector is critically important to both climate change mitigation and adaptation. Changes in the sector can not only affect GHG emissions but can also affect the climate across scales through non-greenhouse-gas pathways (Wolosin and Harris 2018). Finally, the forest sector is both vulnerable to climate change impacts and, at the same time, capable of helping countries and communities adapt to climate change.

Despite global calls to reduce deforestation and numerous initiatives (e.g., Bonn Challenge, AFR100, Initiative 20x20) that seek to restore millions of hectares of deforested and degraded land, tree cover loss continues. In the 2015 Global Forest Resources Assessment (FAO 2016a), the United Nations Food and Agriculture Organization (FAO) reported a net loss of 129 million hectares (ha) of forest between 1990 and 2015, an area about the size of South Africa. While the rate of annual net forest loss has slowed, the world still lost about 3.3 million ha of forest each year between 2010 and 2015 (FAO 2016a).

There is a significant disparity in forest loss rates among climatic regions, types of forests, and drivers of deforestation. Since 2014, when Global Forest Watch (WRI n.d.) began analyzing tree cover data, tropical tree cover loss has been increasing. The years 2016 and 2017 witnessed the highest and second-highest rates of tropical tree cover loss, respectively.³ In addition to the alarming shrinkage of tropical forests, newly available data on the loss of primary rain forests has highlighted not only the importance of these forests, but also how many we have already lost. Finally, new research about drivers of deforestation allows us to better understand what is causing tree cover loss in different regions of the world, whether it is livestock farming in the Amazon,

Figure 1 | Land-Use and Management Categories Covered by This Guide



Source: Based on IPCC (2006, 2013), modified by the authors.

shifting agriculture in Africa, or wildfires in northern boreal forests (Curtis et al. 2018; Seymour and Harris 2019). Commodity-driven deforestation is particularly troublesome because it usually results in permanent loss of tree cover.

Forest sector solutions such as conservation, restoration, and improved management of forests, agricultural lands/grasslands, and wetlands hold enormous potential and can cost-effectively deliver up to 37 percent of near-term GHG emission mitigation needed by 2030 to keep temperature increases below 2°C. Although forest sector solutions are critical to achieving the global mitigation target, they have garnered remarkably little investment—less than 3 percent of national and international public climate mitigation finance (Buchner et al. 2017). The large potential for mitigation alone makes a strong case for integrating forest sector solutions into NDCs. But the additional contributions that the forest sector provides for social development, adaptation, and ecosystem services, make it a pivotal strategy for national governments.

Figure 1 shows the scope of this guide in terms of coverage of land-use and management categories in comparison with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

About NDC Enhancement

The term *NDC enhancement* captures the idea of NDC progression inherent in the Paris Agreement, starting with the invitation for countries to communicate new or updated NDCs in 2020 (Fransen et al. 2017). Broadly speaking, NDC enhancement addresses multiple dimensions: mitigation (mitigation enhancements can increase ambition and/or facilitate enhanced implementation), adaptation, and communication—taking into account that the objectives and requirements under the Paris Agreement vary across these components (See Figure 2). Ideally, the NDC enhancement process will bring NDCs more closely into alignment with the goals of the Paris Agreement, maximize the benefits of the NDCs for development and resilience, incorporate relevant opportunities to strengthen implementation, and improve transparency.

On mitigation, countries can identify opportunities to strengthen the ambition of their NDCs, given the very large emissions gap between the current global emissions trajectory and the pathway consistent with achieving the Paris Agreement’s goals. Strengthened

Box 1 | Terms Related to NDC Enhancement

New or Updated NDC: From the COP decision adopted together with the Paris Agreement (1/CP.21), these terms refer to the request in the COP decision to Parties concerning NDCs in 2020. A new NDC is one subsequent to the initial NDC, when a Party’s initial NDC contains a time frame up to 2025. An updated NDC is one communicated by a Party whose initial NDC contains a time frame up to 2030.

Enhanced NDC: In this guidance, a new or updated NDC that improves upon the initial NDC with respect to mitigation (ambition and/or implementation), adaptation, and/or communication.

NDC with enhanced mitigation ambition: In this guidance, this refers to an NDC that, if fully implemented, would result in lower cumulative emissions than the fully implemented existing NDC. It is important to note that a new, updated, or enhanced NDC may not necessarily lead to enhanced mitigation ambition. The baseline for determining this is the complete set of mitigation target(s) and/or action(s) articulated in the original NDC. In determining the effect on mitigation ambition, it is important to consider the cumulative impact of all changes to the NDC, including the extent to which they overlap with each other, as well as the targets, policies, and measures in the existing NDC.*

Notes: *Determining whether a new option will enhance a Party’s level of ambition can be technically complex. Consider, for example, an NDC that contains both a GHG intensity target and a renewable energy target. Say the GHG intensity target is close to current projections of GHG intensity, but the renewable energy target vastly exceeds current projections of renewable energy capacity. In this case, the renewable energy target is the key driver of ambition, and raising it will likely enhance overall ambition. Conversely, if the GHG intensity target is more aggressive and the renewable energy target less aggressive relative to current projections, raising the renewable energy target may not raise the overall level of ambition. The “GHG Protocol: Mitigation Goal Standard” (WRI 2014a) and “GHG Protocol: Policy and Action Standard” (WRI 2014b) provide guidance on GHG accounting that can inform analysis of ambition.

Source: Fransen et al. 2019.

mitigation ambition is defined as an enhanced NDC—including its complete set of mitigation targets and actions, and assuming full implementation—resulting in lower cumulative emissions than the existing NDC. To determine the effect of NDC enhancement on mitigation ambition, the cumulative impact of all changes to the NDC, including the overlap in the effect of such changes with one another, must be considered (Box 1; Fransen et al. 2017). Aside from their effects on ambition,

enhancements related to mitigation can also facilitate stronger implementation, if countries commit to specific policies and measures in support of existing targets, including those related to financial flows, coordinated implementation, and greater integration with development.

On adaptation, countries can consider options for enhancing various elements, taking into consideration their objectives of including adaptation in their NDC as well as the relationship between their NDC and their adaptation communication, building on other processes, such as the National Adaptation Plans (NAPs).

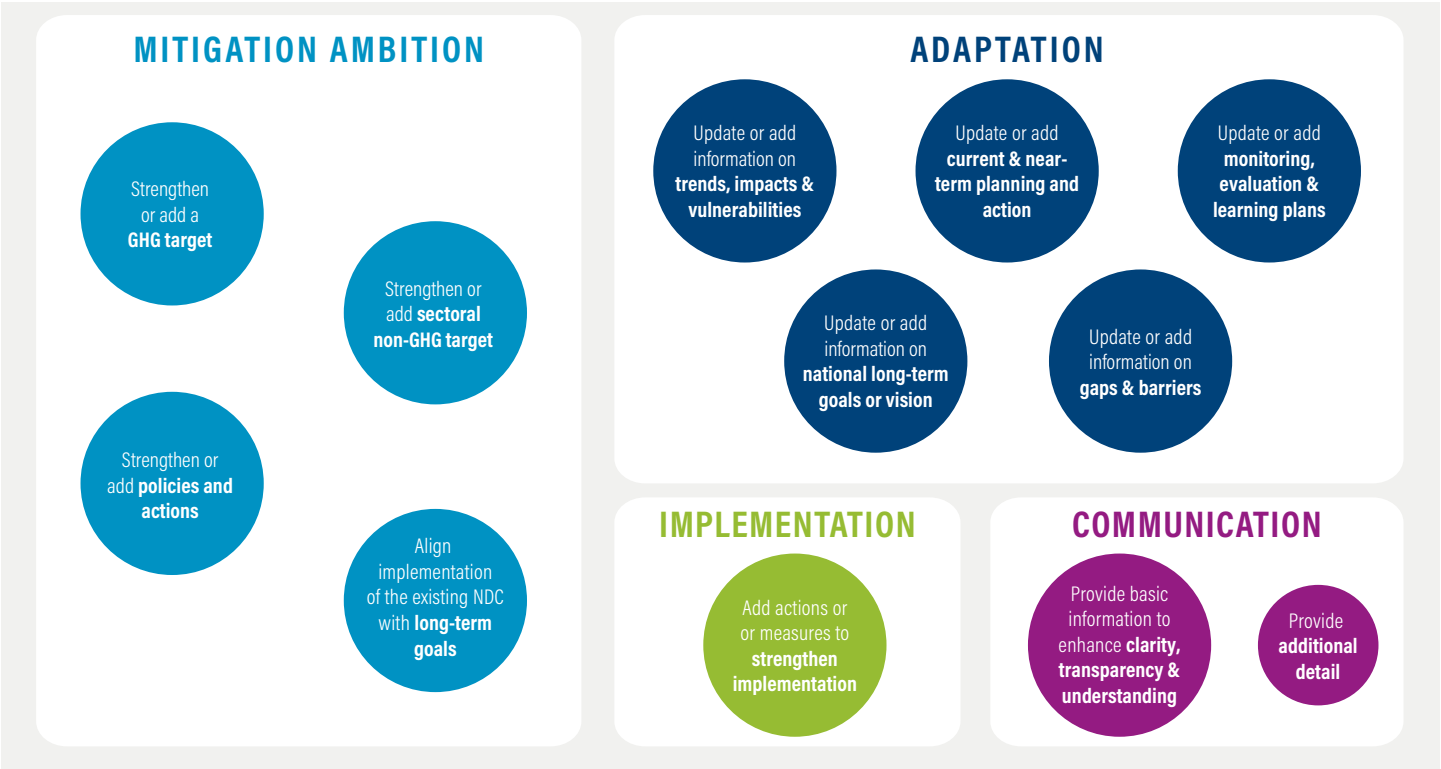
Finally, enhanced communication is essential “to build mutual trust and confidence and to promote effective implementation” (UNFCCC 2015). In enhancing their NDCs, countries can address the elements of clarity, transparency, and understanding (CTU) adopted at the Conference of the Parties (COP) 24 in Katowice, Poland (UNFCCC 2018).

These elements of NDC enhancement are neither mutually exclusive nor interchangeable. It may be appropriate for a country to enhance its NDC across more than one of these dimensions.

About This Guide

This forest sector guide is one module in a broader series of guidance documents on NDC enhancement, developed by the World Resources Institute (WRI) and the United Nations Development Programme (UNDP) (Figure 3). The series includes a general (not sector-specific) guide, *Enhancing NDCs: A Guide to Strengthening National Climate Plans by 2020* (Fransen et al. 2019), as well as additional guidance on sectors and themes, including power, transportation, agriculture and food, forests, the ocean, and short-lived climate pollutants. We recommend that countries consult the comprehensive NDC enhancement guidance as well as other sectoral and thematic modules relevant to their national context.

Figure 2 | Types of NDC Enhancement

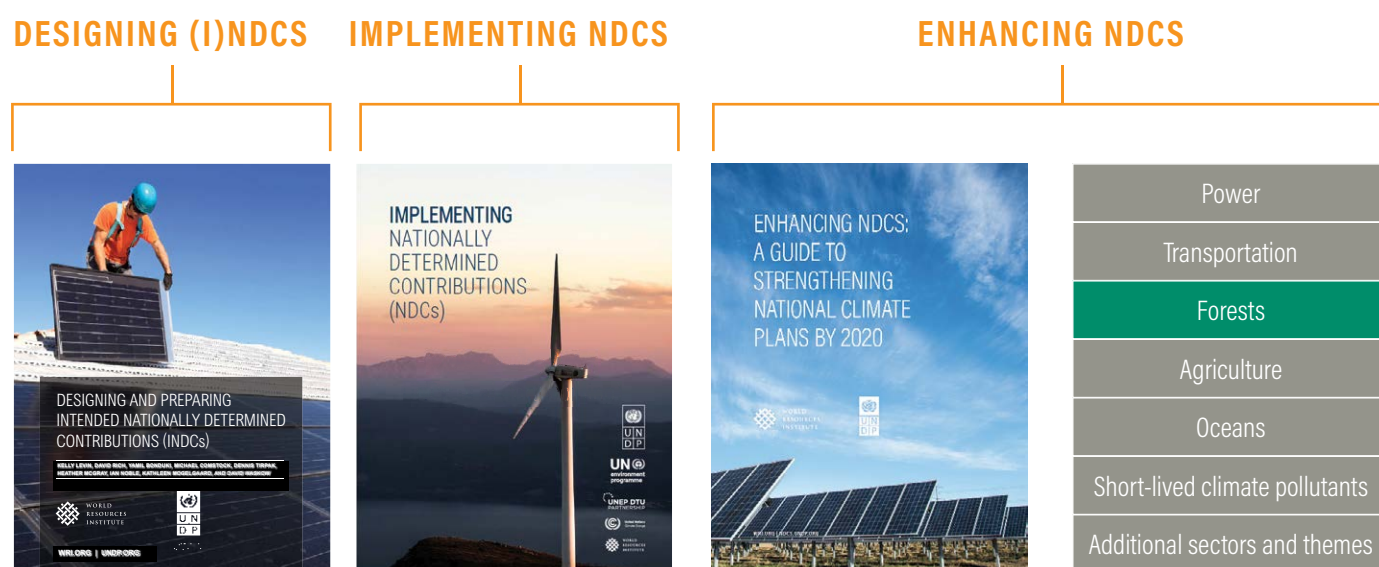


Source: Fransen et al. 2017

The general guide (Fransen et al. 2019) illustrates the process of NDC enhancement (Figure 4). In this forest sector guide, however, all the elements of the enhancement process in Figure 4 are compressed into the steps for designing an enhanced mitigation component of an NDC.

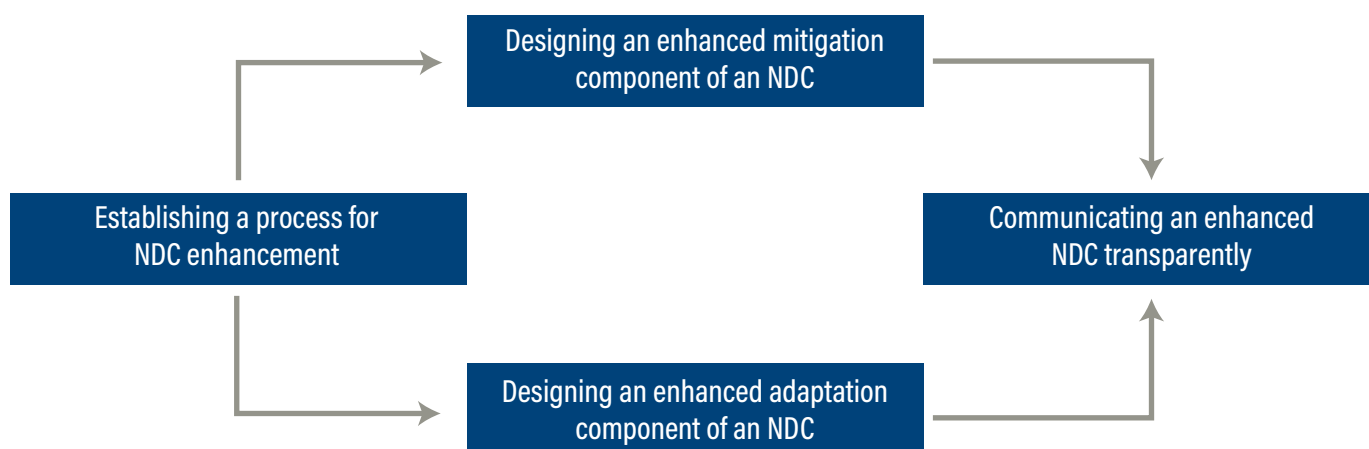
Figure 5 illustrates the resulting step-by-step process countries can follow to enhance the forest sector component of their NDCs. More information related to the elements in Figure 5 can be found in the subsequent sections of this guide.

Figure 3 | Overview of NDC-Related Guidance by UNDP and WRI



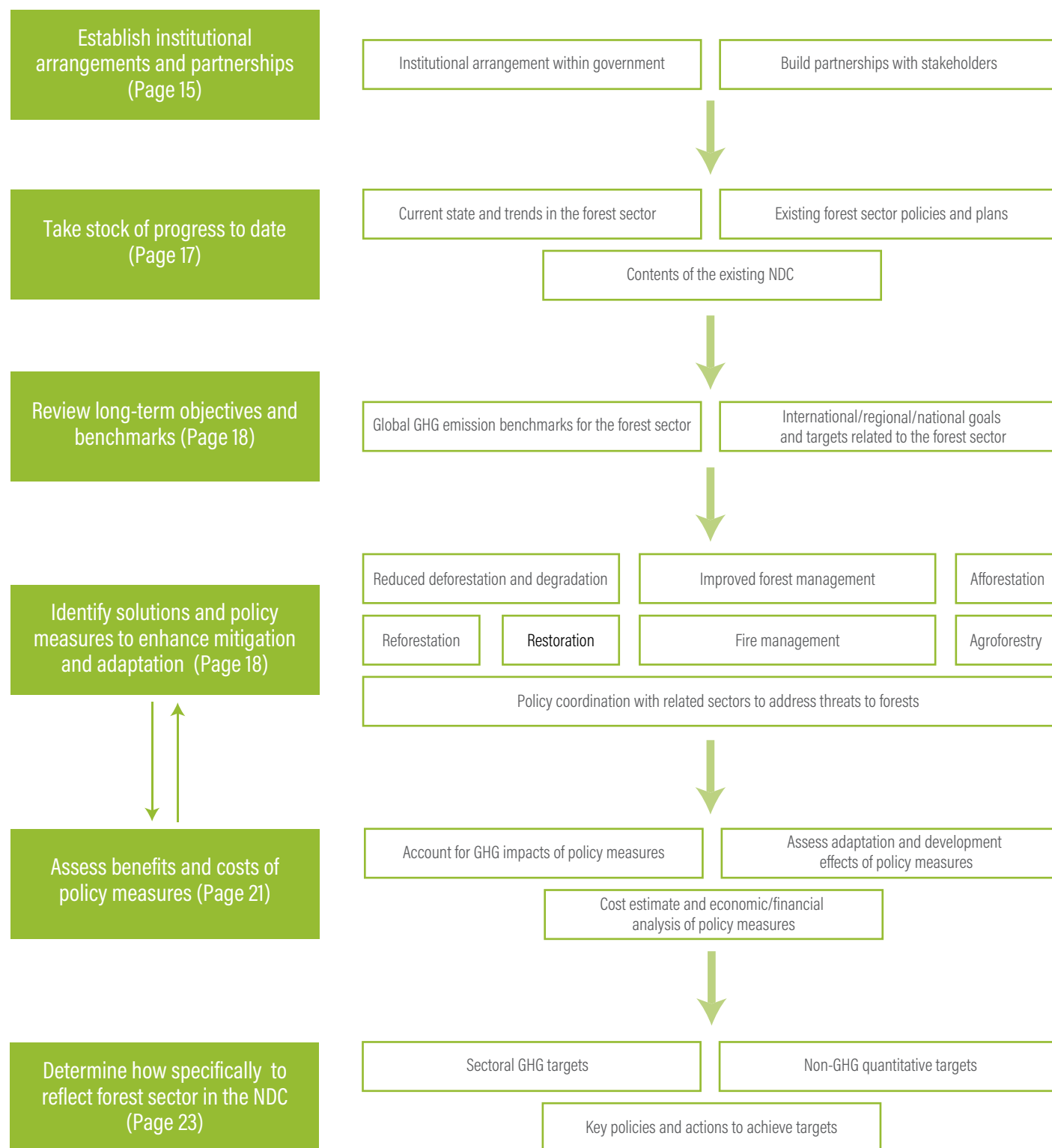
Source: Fransen et al. 2019

Figure 4 | Elements of the Nationally Determined Contribution Enhancement Process



Source: Fransen et al. 2019

Figure 5 | Suggested Process of Enhancing the Forest Sector Component of NDCs



Note: Upward arrow indicates that the steps linked with the arrow can be iterative.

Source: Authors.

CLIMATE CHANGE, DEVELOPMENT, AND FORESTS

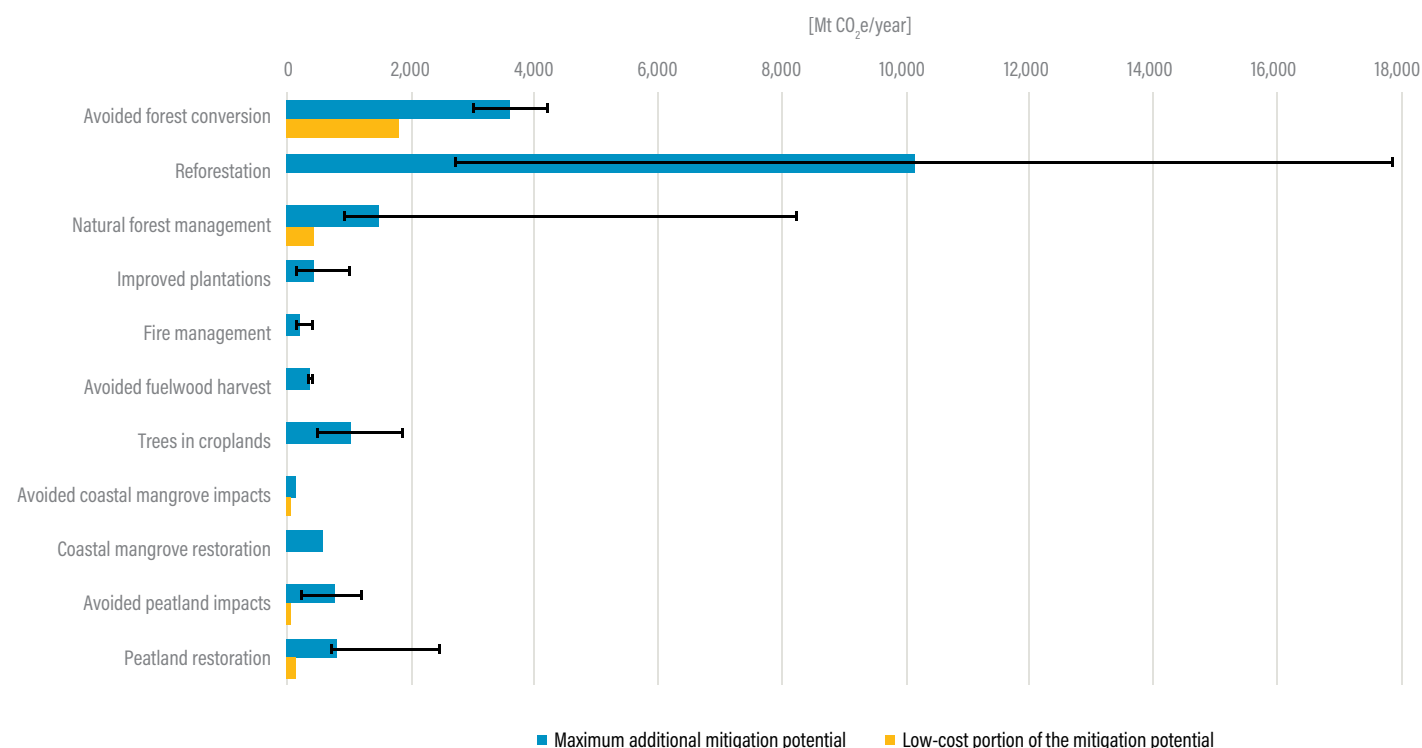
Mitigation Potential

The IPCC special report on climate change and land (IPCC 2019b) indicates that forest-related solutions have significant mitigation potential. Globally, activities such as improved forest management, reduced deforestation and degradation, reforestation and forest restoration, and afforestation can remove up to 26.9 gigatonnes of carbon dioxide equivalent (Gt CO₂e) per year, more than twice China's annual GHG emissions. There is a large active sink of around 11 Gt CO₂e per year into terrestrial ecosystems, especially undegraded forests (Le Quéré et al. 2018), but the carbon sink potential of undegraded forests

is often not accounted for in the context of anthropogenic GHG emissions accounting. NDCs can play an important role in both increasing forest carbon stocks through implementing forest solutions and by ensuring existing sinks are not lost through damage to those ecosystems.

A study by Griscom et al. (2017) provided a more granular view of the mitigation potential of forest-related solutions. It estimated that conserving and restoring natural lands have a global net emissions reduction potential of up to 23.8 Gt CO₂e per year compared to the business-as-usual case (for reference the global emission for all sectors in 2017 was 53.5 Gt CO₂e [UNEP 2018]). Of this, forest-related solutions account for 19.6 Gt CO₂e per year, with the remaining reductions arising from other agriculture and grassland activities. Figure 6 shows the breakdown of mitigation potential of forest-related solutions.

Figure 6 | **Global Mitigation Potential of Forest-Related Mitigation Solutions in 2030**



Notes: Mitigation potential is estimated assuming no current croplands are being converted to forests, but allowing current grazelands to be reforested, considering the potential of future dietary change and a reduction in meat consumption. Range bars indicate the range with 95% confidence intervals. Range bars are not available for avoided coastal mangrove impacts or for coastal mangrove restoration, nor for all low-cost portion data.

^a "Low-cost" is defined as a marginal mitigation cost of up to \$10 per metric ton of carbon dioxide equivalent (tCO₂e).

Source: Data drawn from Griscom et al. (2017), Supporting Information Appendix.

Reforestation, avoided forest conversion to other land use, and improved natural forest management have the largest mitigation potential globally within forest sector solutions. Figure 6 also shows that conservation of forests offers significant low-cost mitigation opportunities.

In assessing a country's mitigation potential in the forest sector, it is important to consider all types of forests, including mangroves and peatland forests, because their mitigation potential is substantial. Mangroves and peatland forests store two to three times more carbon per unit area than boreal, temperate, and tropical upland forests due to extensive carbon storage in subsurface soils as well as in surface vegetation (Donato et al. 2011). Because most of the carbon stored by these forests is below ground, it takes longer for peatlands and mangroves to recover, once degraded, relative to terrestrial forests, making it even more urgent that they are protected (Marín-Spiotta and Ostertag 2016).

For gauging the country-level mitigation potential of the forest sector, the Griscom et al. (2017) study provides useful estimates of mitigation potential per hectare of forest-related solutions by country in its Supporting Information Appendix.⁴

Adaptation and Sustainable Development Benefits

The benefits of forests extend beyond climate change mitigation to climate change adaptation and sustainable development. Countries are encouraged to assess the cobenefits forests provide, and to incorporate them into their enhanced NDCs.

As impacts from climate change increasingly threaten communities across the world, forests can provide significant adaptation benefits. Forests retain and regulate water, which will become more crucial as rainfall becomes more unpredictable (Lawrence and Vandecar 2015). Wetlands soak up potentially deadly floods and support availability of water supplies to farmers during droughts, while mangroves quell storm surges, protecting coastal communities (Global Commission on Adaptation 2019). In urban areas, forests moderate local air temperature fluctuations and soften the impact of heat waves (Salmond et al. 2016). These forest solutions can often be cheaper than traditional infrastructure. For example, restoring mangrove forests that offer protections from rising seas—

while also storing carbon and improving water quality and local fisheries—is two to five times cheaper than building engineered structures (Mitsch et al. 2015).

Forests also provide a range of ecosystem services that are closely related to the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development (Baumgartner 2019; Seymour and Busch 2017) (Figure 7). For example, forests contribute to ending poverty (SDG1) by providing direct income for rural households (e.g., firewood, nontimber products, timber, fruits, and medicine). In fact, poor households often depend on income from forest resources, accounting for more than 20 percent of rural household income in tropical regions (Angelsen et al. 2014). Forests also contribute to ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture (SDG2). They provide food (e.g., fruits, plants, fungi, and bush meat) and protect food production systems from climate anomalies such as droughts and floods (Oliveira et al. 2013). Forests help ensure water availability (SDG6) by capturing rainfall and stabilizing water supplies for drinking and irrigation. For further mapping of linkages between forests and SDGs, see Baumgartner (2019) and Seymour and Busch (2017).

As illustrated so far, forests can simultaneously bestow benefits for climate mitigation, adaptation, and sustainable development. It is essential that countries include the adaptation and developmental cobenefits forests provide when comparing mitigation options across sectors. Nevertheless, there are cases where certain actions entail a trade-off by favoring some ecosystem services at the expense of others (Box 2). As countries update their NDCs, the distribution of costs and benefits among different sectors, populations, and time frames needs to be carefully analyzed.

FOREST SECTOR SOLUTIONS IN NDCS

Rationale for integrating forest sector solutions into NDCs

To hold the global temperature increase to well below 2.0°C or 1.5°C, countries need to raise the mitigation ambition of their NDCs (UNEP 2018), and integrating and strengthening forest sector solutions in NDCs provides an effective means to do so.

Enhancing the forest sector component in NDCs also provides an opportunity to raise the profile of, facilitate understanding toward, and attract support for forest sector solutions. Because the NDC is a high-profile document that can reach broad international and domestic audiences, integrating well-crafted strategies and targets in the forest sector could attract the attention of a broad range of stakeholders and enhance much needed political, social, and financial support for forest sector solutions.

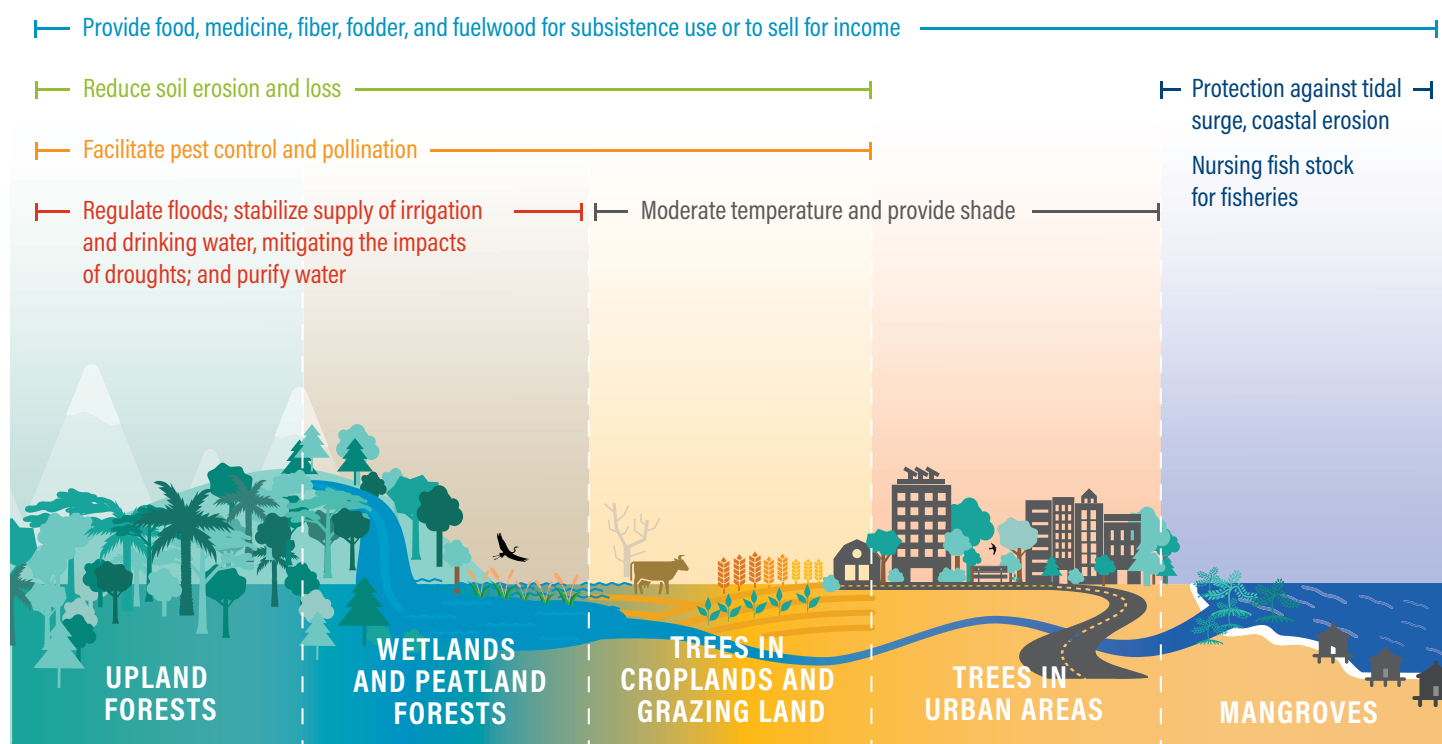
Additionally, the process of developing and implementing forest sector solutions could generate more data and knowledge, building the foundation to improve future planning and actions in the sector. It could also trigger trade-off analyses and debates over cross-sectoral policy issues related to commodity agriculture, biofuels, social development and equity in rural populations,

and indigenous people's rights. The analysis, debate, and subsequent policy planning could enhance policy coherence across related sectors, strengthen interagency coordination, and build stakeholder partnerships.

Coverage in current NDCs

The International Union for Conservation of Nature (IUCN) and Climate Focus (2018) reviewed 165 NDCs and found that 137 NDCs (83 percent) refer to the importance of the forest sector, and 127 (77 percent) include some form of forest-related qualitative or quantitative target. The UNFCCC report on the effect of Intended Nationally Determined Contributions (INDCs) (UNFCCC 2016) estimated the aggregated land use, land-use change, and forestry (LULUCF) sector emissions and removals reflected in the INDCs would

Figure 7 | **Adaptation and Development Benefits of Forest Ecosystems**



Note: The adaptation and development benefits above are neither comprehensive nor universally applicable to every location.

Source: WRI.

The production of biofuels can have cobenefits as well as adverse side effects, and pose serious risks for land degradation, food insecurity, GHG emissions, and other environmental and sustainable development goals. Additionally, the impacts of biofuels are context-specific and highly dependent on the scale of deployment, the type of biofuel feedstock (palm oil, soy, etc.), the initial carbon stock of the land, and the climatic region (IPCC 2019b).

Increasing the use of biofuels may seem advantageous for policymakers in the energy or transport sector, striving to reduce sector emissions from burning fossil fuels, but emissions reductions in one sector can result in increased emissions in another. An expansion of feedstock production for biofuels, particularly "first generation" biofuels that are produced from biomass with alternative use for food, may drive deforestation either directly or indirectly, by displacing existing cropland, which leads to forest clearing elsewhere to create new cropland (Morris et al. 2018). Therefore, any reduced emissions from the expansion of biofuel production must be compared to the carbon impacts of any associated deforestation. In addition to their carbon impacts, biofuels may raise food prices due to reductions in cropland and may lead to the loss of valuable ecosystem services due to deforestation. Similar trade-offs exist for using biomass for electricity and heat generation; therefore, policy planning requires careful and transparent assessment of potential unintended consequences.

lead to approximately 1.0 Gt CO₂e reduction in 2030, relative to 2005 level, which is significantly smaller than the up to 19.6 Gt CO₂e per year emissions reduction potential explained in the "Mitigation Potential" section above. Among the 127 NDCs with forest-related targets, 63 include both mitigation and adaptation targets, 54 include mitigation only, and 10 NDCs include adaptation only. Grassi et al. (2017) estimated, using information in NDCs and other supplementary sources, that if the NDCs, including conditional targets, are fully implemented, LULUCF sector GHG mitigation could represent about 25 percent of emissions reductions planned by the NDCs. The following summary draws on the analysis by Kroeger et al. (2018) and IUCN and Climate Focus (2018). All percentages below are based on the 165 NDCs reviewed.

GHG targets:

While 93 NDCs (56 percent) indicate that the forest sector is included in GHG accounting for their economy-wide mitigation commitment, fewer than 10 percent include quantitative GHG or CO₂ emissions reduction or removal information specific to the agriculture or the forest sector as a part of their economy-wide target or as separate sector-specific targets (IUCN and Climate Focus 2018). Additionally, about 64 percent of the GHG targets are conditional on international support (Kroeger et al. 2018).

Non-GHG quantitative targets:

Only 20 percent of NDCs include non-GHG quantitative targets related to forest landscape restoration, with about 72 percent of the non-GHG targets conditional on international support (Kroeger et al. 2018). Examples of non-GHG quantitative targets include the following:

- Increase in area or percentage of forest cover
- Increase in area of afforestation, reforestation, or forest restoration/enhancement
- Increase in area under forest protection, sustainable management, agroforestry, or arboriculture
- Increase in forest stock volume
- Reduction in deforestation rate

Actions/policies/measures:

Instead of communicating quantitative targets, some countries aim for improved forest sector outcomes by detailing specific actions, policies, and measures to be implemented:

- Enhance forest information and monitoring
- Enhance monitoring and enforcement of forest management regulations, such as illegal logging prohibition and application of reduced impact logging
- Increase management of forest fires and pests
- Include an environmental service payment program
- Create a forest certification program
- Introduce improved technologies for afforestation, reforestation, and sustainable forest management, including agroforestry
- Replace invasive species with native species with higher carbon stock

- Increase research, introduction, and promotion of tree species and varieties more resistant to expected climate impacts (e.g., droughts)
- Provide alternative energy options for fuelwood
- Enhance efficiency in fuelwood utilization

However, it is not clear how these policies, measures, and actions are selected by countries, and they are rarely woven into a unified strategy to achieve NDC targets.

Gaps in current NDCs

Although over 80 percent of NDCs highlight the importance of forests in achieving climate goals, there is an overall lack of specificity and clarity in forest sector contents, particularly quantitative targets and coherent strategies for achieving them, which makes it difficult to assess how successfully the forest sector is represented in the NDCs.

Of the 165 NDCs reviewed, 40 do not account for forest sector GHG emissions in their mitigation contributions: they do not include the forest sector in their economy-wide GHG target, or they have neither an economy-wide target nor a forest sector-specific GHG target (IUCN and Climate Focus 2018). Only about 10 percent of NDCs include quantitative forest sector GHG emission or removal information (IUCN and Climate Focus 2018), indicating that a vast majority of NDCs lack clarity on the role of the forest sector in the national mitigation strategy. Even in the case of NDCs that do include forest sector GHG emission or removal information, some of them account only for emissions reductions or removals of specific activities or components of the sector rather than for sector-wide emissions.

Some countries may have separate supporting or technical documents supplementary to NDCs, and detailed information on the forest sector, including sectoral targets, may be included in such documents. However, those documents have a very limited audience. Including concise but key information on the forest sector in NDCs could facilitate understanding toward the countries' efforts and contributions, raise the profile of the forest sector, and attract financial and political support.

Figures 8 (A) and 8 (B) show the number of NDCs that include forest and land-use sector targets and the policy measures based on the data collected using the NDC contents search tool of Climate Watch (Climate Watch NDC Content 2018). The figures indicate that forest-related solutions with large GHG emissions reduction or

removal potentials (Figure 6), such as forest conservation, reforestation, and sustainable forest management are commonly represented in NDCs.

However, regarding the scope of forest types covered, carbon-rich forests such as mangroves and peatland forests are not well represented. Among 118 countries that have mangrove forests in their territory, only 28 countries referred to mitigation measures related to coastal wetlands in their NDCs (Wetlands International n.d.), and only three countries referred to commitments related to peatland protection or restoration (Climate Watch NDC Content 2018). This is a significant coverage gap that needs to be addressed.

STEPS FOR NDC ENHANCEMENT IN THE FOREST SECTOR

1) Establish institutional arrangements and partnerships

Key Points

- Internal and external stakeholders vary depending on the country's governance structure and on the forest sector solutions to be integrated into the NDC.
- Technical teams play a key role in providing data, analyses, and advice for designing forest sector solutions as well as facilitating informed discussions in the stakeholder engagement process.

Establishing a sound process to develop new or updated NDCs is an important first step. Fransen et al. (2019) provide generic guidance for that task, but this section provides sector-specific supplementary information focusing on institutional arrangements within the government and partnerships with external stakeholders.

NDCs are to be developed and communicated by each government that is a party to the Paris Agreement. The government department tasked with developing the forest sector component of the NDC may vary among countries. But regardless of the department in charge, the task should not be restricted to a small circle of government officials. By involving key stakeholders, forest sector goals will have a better chance of being known, owned, implemented, and supported. It is important to note that the involvement of stakeholders partly depends on the

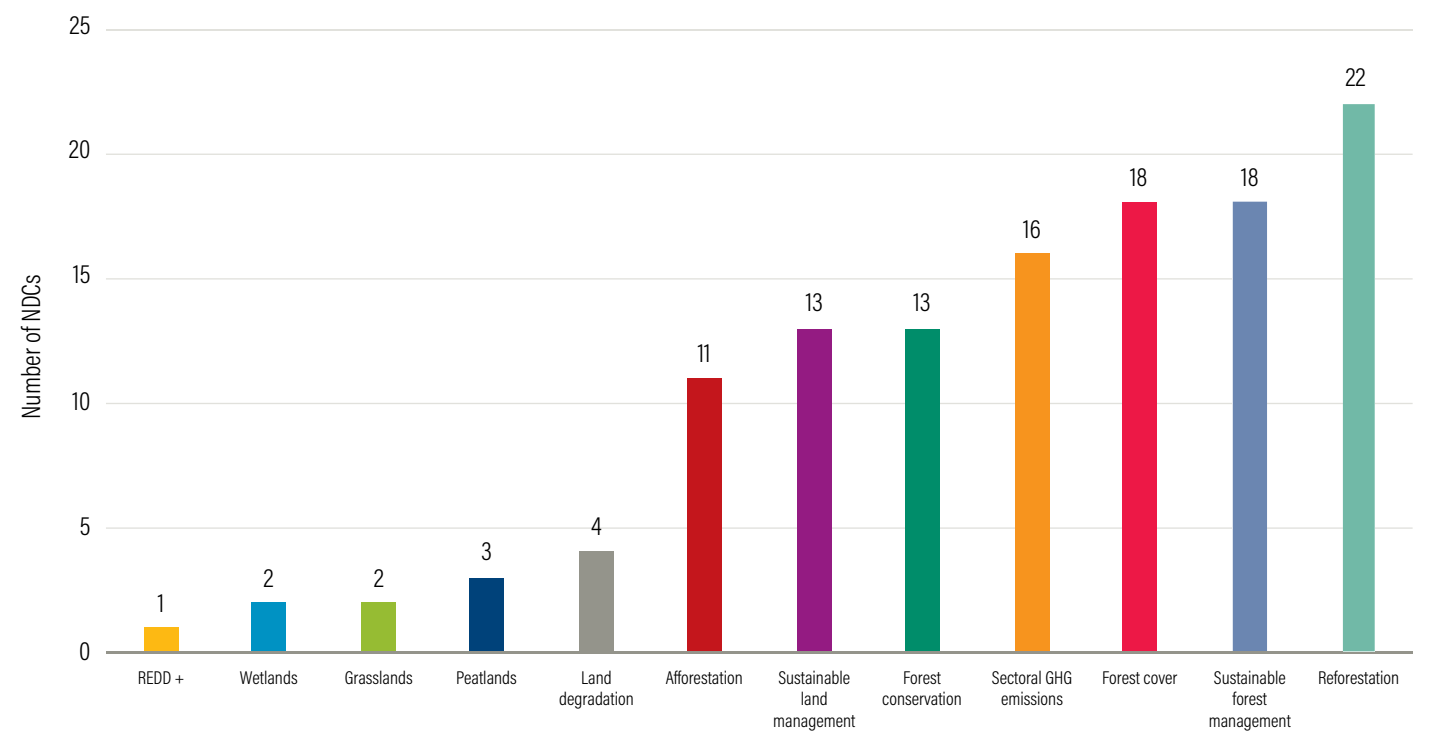
type of forest sector solutions envisaged. For example, to address deforestation, relevant stakeholders need to be identified in consideration of the main drivers of deforestation in the country (e.g., commodity agriculture, mining, etc.) and land ownership (e.g., private land or public land) and so on. It may therefore be necessary to involve additional stakeholders during the NDC designing process when new solutions are incorporated, or new understanding is gained.

In many cases, government departments in charge of forestry and the natural environment lead the development of the forest sector component. In addition to lead departments, forest sector solutions need to be coordinated with other government departments in charge of related sectors and issues, such as agriculture, rural development, indigenous peoples’ affairs, energy,

and transportation, as well as government departments in charge of finance and development planning. Finally, if commercial activities, such as commodity production, are driving forces of forest loss in the country, industry and businesses also need to be involved to better understand their role in the forest sector and to increase the chances of their buy-in and cooperation.

Many forest sector policies and actions are implemented locally and must consider local benefits and impacts. Subnational governments whose jurisdiction covers the lands where actions need to be taken should be represented in the development process. Likewise, representatives of local communities and indigenous peoples in the area need to be consulted as they may have customary land rights and extensive knowledge of the land and can contribute their expertise to forest

Figure 8A | Types of Targets Related to Forest and Land-Use in NDCs



Note: Some NDCs include more than one target or policy measure. Targets include qualitative targets.

Source: Based on data from Climate Watch NDC Content (2018), modified by the authors.

sector actions. Finally, forest sector policies must incorporate gender-responsive analyses to understand how the implementation of policies is likely to influence the distribution of benefits and burdens (Larson et al. 2014).

Although not unique to the forest sector, building a capable technical team and ensuring access to the best-available science and data are particularly important during the establishment of institutional arrangements and partnerships. The technical team may consist of government specialists and experts from academia and research institutions. In addition to their valuable contributions to data collection, analyses, and deliberations for designing the forest sector solutions of NDCs, the technical team can provide scientific information and knowledge in the stakeholder engagement process to facilitate informed discussions.

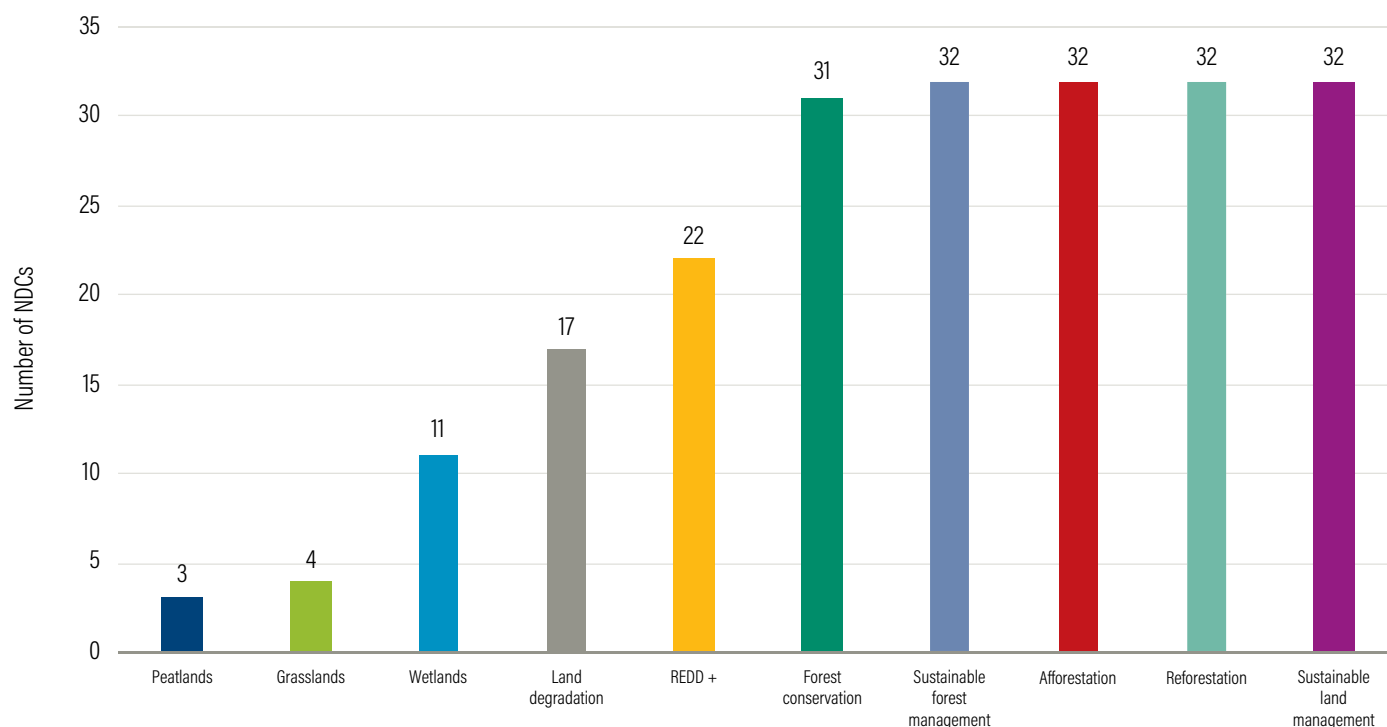
2) Take stock of progress to date

Key Points

- Assessing the contents of the previous NDC can help identify opportunities for enhancement.
- Reviewing technical and policy developments within the country and elsewhere can also inform the next steps toward raising ambition.

A key initial step is to collect the latest data and information on the current state and trends in the forest sector in the country (e.g., tree cover, tree cover loss/gain, map of forest types, etc.) as well as existing forest sector commitments, policies, and plans. It is also useful to review the progress of implementation of the sector policies and plans, factors that facilitate the implementation, and challenges and barriers that need to be overcome.

Figure 8B | Types of Policy Measures Related to the Forest and Land-Use Sector in NDCs



Note: Some NDCs include more than one target or policy measure. Targets include qualitative targets.

Source: Based on data from Climate Watch NDC Content (2018), modified by the authors.

Because most countries have already submitted their first NDCs, the process will naturally start from reviewing and analyzing their existing NDCs. In the context of enhancing forest sector contents, it is useful to assess the scope of the NDC in terms of objectives (i.e., mitigation, adaptation, and sustainable development), targets, implementation strategy, types of interventions, policy measures, geographical regions, GHGs covered (e.g., CO₂, methane), and type of forests (e.g., upland forests, mangroves, peatland forests, and cropland trees).

Taking stock of recent developments and innovations in forest sector technologies and policies in the country and elsewhere is also useful. New technologies and policy instruments may pave the way for forest sector solutions in new geographical areas, or in terms of social and economic issues, which were previously considered too difficult to address. For example, there are cases where the advancement of satellite earth observation technologies has made it possible to monitor vast and inaccessible forests, helping to identify illegal forest destruction, and a collaborative policy scheme between timber-producing and -consuming countries has gained stricter control over illegal timber markets (e.g., Forest Law Enforcement, Governance and Trade [FLEGT] initiative) (European Forest Institute n.d.).

3) Review long-term objectives and benchmarks

Key Points

- Global benchmarks for the forest sector inform the level of ambition required to stay on track to achieve the Paris mitigation goal, providing guidance for countries to enhance forest sector NDC targets based on the unique situation of each country.
- Related national and international processes and national commitments may also provide benchmarks for the forest sector component of NDCs.

Benchmarks are needed to check alignment of a country’s national forest climate strategy with the temperature goals of the Paris Agreement. The IPCC special report on the impacts of global warming of 1.5°C (IPCC 2018) made clear that any chance of achieving the 1.5°C goal requires the forest sector to play a major part by transforming into

a net carbon sink rather than a source of emissions by mid-century. To achieve this emissions target, Kuramochi et al. (2018) reviewed existing literature on GHG emission scenarios and mitigation potential. They proposed 10 key benchmarks that must be met between 2020 and 2025 to stay on track for limiting global warming to 1.5°C. One benchmark highlights the forest and land-use sector and states that it will be necessary to reduce net emissions from forestry and other land use by 95 percent below 2010 levels by 2030, and stop net deforestation by 2025. These are global benchmarks and, therefore, not automatically applicable to every country, but they may be considered in setting targets in the NDCs.

Apart from the UNFCCC process, there are other international processes related to the forest sector (Table 1), such as the Bonn Challenge (Bonn Challenge n.d.), AFR100, Initiative 20x20, and Land Degradation Neutrality (LDN) targets. These international processes set collective goals and targets, and some participating countries make national commitments to contribute to achieving them. In addition to commitments made under international processes, countries may have set forest-related targets in their national development or sectoral plans, or their climate mitigation or adaptation plans. It is useful for countries to take stock of such international goals and targets, as well as their own national targets and commitments as benchmarks for NDC target setting.

4) Identify solutions and policy measures to enhance mitigation and adaptation

Key Points

- Threats to forests often originate outside the forest sector, therefore policy coordination with the related sectors is imperative.
- Conservation of primary forests has immense value in terms of GHG mitigation, climate adaptation, and development.
- Agroforestry and silvopastoral systems provide an alternative approach to increasing the forest carbon stock without converting croplands or grazing lands into forests.

To achieve desired climate mitigation and adaptation outcomes, there are several major solutions in the forest sector that countries can pursue. Additionally, there

are diverse policy measures countries can deploy to implement these solutions. Identifying a suitable set of solutions and corresponding policy measures is the most challenging step in enhancing an NDC.

Forest Sector Solutions for Climate Mitigation and Adaptation

Most forest sector solutions can be classified into one of several types. This section explains forest sector solutions based on the typology in the recent IPCC report on climate change and land. Table 2 lists the “integrated response options based on land management in forests” included in the IPCC special report on climate change and land (IPCC 2019b). (Agriculture-based solutions, such as climate-smart agriculture, are covered by a separate sector module of this guidance series and, therefore, are not included here.)

It is important to note that threats to forests often come from the activities of other sectors, such as the agriculture, transportation, energy, and industry sectors. For example, deforestation cannot be addressed without engaging in

collaborative policymaking with other sectors because deforestation often occurs when forests are converted to a new land use that is then claimed by another sector. Therefore, policies of those sectors that affect forests negatively or positively need to be assessed and made coherent with forest sector policies.

Among the options listed in Table 2, **reduced deforestation and degradation**, particularly conserving intact primary forests, is the highest priority because loss of such forests is essentially irreversible in the relevant time frame. This solution also offers a large low-cost mitigation potential illustrated in the “Mitigation Potential” section above. Primary forests, especially primary tropical rain forests, store more carbon than other types of upland forests and are essential to preserving tropical biodiversity (Gibson et al. 2011). Primary forests are also able to better cope with short-term climatic shocks, making them more resilient to droughts and wildfires than degraded forests (Watson et al. 2018). Finally, species-rich primary forests provide significant sustainable development benefits through diverse ecosystem services (Box 3).

Table 1 | **International and Regional Processes Related to the Forest Sector**

TITLE	DESCRIPTION	NATIONAL COMMITMENT
Bonn Challenge	A “global effort to bring 150 million hectares (ha) of the world’s deforested and degraded land into restoration by 2020, and 350 million hectares by 2030” (Bonn Challenge n.d.).	49 countries have made commitments under this process.
African Forest Landscape Restoration Initiative (AFR100)	An African regional “country-led effort to bring 100 million hectares of land in Africa into restoration by 2030” (AFR100 n.d.).	27 countries have made commitments.
Initiative 20x20	A “country-led effort seeking to change the dynamics of land degradation in Latin America and the Caribbean by bringing 20 million hectares of land into restoration by 2020” (Initiative 20x20 n.d.).	15 countries have made commitments. ^b
Land Degradation Neutrality (LDN) Target-Setting Programme	A program under the United Nations Convention to Combat Desertification for countries to set targets toward Land Degradation Neutrality (LDN). ^a	122 countries have made commitments.

Notes: ^a Land Degradation Neutrality (LDN) is defined by the Parties to the Convention to Combat Desertification as a “state whereby the amount and quality of land resources, necessary to support ecosystem functions and services and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems” (UNCCD n.d.).

^b Some countries’ commitments have a time horizon beyond 2020.

Source: Compiled by the authors based on the information provided on the websites of those initiatives.

Table 2 | **Forest Sector Solutions Considered in This Guide**

SOLUTIONS	SHORT DESCRIPTION
Reduced deforestation and degradation	Conservation of forests, including prevention of forest loss and degradation.
Improved forest management	Management interventions that curtail deforestation and/or degradation, reduce the occurrence of fires, or stimulate reforestation and forest restoration. Improved forest management also includes interventions for the purpose of more efficient extraction of forest resources (e.g., timber and fuelwood) with minimal damage to the forest ecosystem.
Reforestation	Conversion of lands from other land uses to forests, where previously there were forests.
Afforestation	Conversion of lands from other land uses to forests, where historically ^a there were no forests.
Agroforestry	Deliberate planting of trees in croplands and silvopastoral systems.
Fire management	Prevention, control, and suppression of wildfires, including prescribed/controlled burning.
Restoration	Practices aimed at regaining the ecological integrity in a deforested or degraded forest landscape.

Notes: Land management solutions for mangroves and peatlands are separated from those for forests in the IPCC report (2019b), but this guide considers forests to include upland forests, peatland forests, and mangroves.

^a At least for 50 years (Hiraishi et al. 2014).

Source: Based on IPCC 2019b (Tables 6.5, 6.6, and 6.8), modified by the authors

Improved forest management entails sustainable management and use of forest resources. It can facilitate climate mitigation through lowering the carbon impact of management activities (e.g., logging) and leave a higher carbon stock and carbon sequestration capacity in the standing forest, as well as foster various ecosystem services. However, such effects depend on the management strategies that are applied. For example, if forests are allowed to grow with little disturbance via conditions that are close to primary forests, they can store more carbon and provide diverse ecosystem services. Conversely, if the emphasis is on high timber production, the forest carbon stock and other benefits may be smaller (IPCC 2019b). There could also be an integrated strategy across different solutions where high timber productivity is pursued in production forests, thereby reducing timber demand pressure on primary forests.

Restoration, including all activities that increase tree cover, such as reforestation, afforestation,⁵ agroforestry, silvopastoral forestry, and increased tree cover in rural landscape, has significant climate mitigation potential (as is indicated in the “Mitigation Potential” section above), while simultaneously delivering socioeconomic and ecosystem benefits. The integration of trees in the agricultural rural landscape enables climate

mitigation, adaptation, and sustainable development benefits and can improve agricultural production and enhance resilience to changing climate by moderating temperature and/or providing shade (more information can be found in the agricultural sector module of this guidance series [Ross et al. 2019]). However, the IPCC special report on climate change and land (IPCC 2019b) flags that climate benefits of restoration depend on site-specific contexts and approaches taken, and could potentially take up land for competing use such as food production.

In 2015, wildfire was responsible for 4.2 million hectares of global tree cover loss, which accounted for over 20 percent of total global tree cover loss (WRI n.d.). While a majority of the tree cover loss was determined to be temporary (Curtis et al. 2018), natural fires in boreal systems still degrade regional carbon stocks. The risk of wildfire is projected to increase in some regions as fire seasons become longer and forests become drier due to climate change (IPCC 2014a). **Fire management** includes prescribed burning to reduce the risk of larger, uncontrollable wildfire (IPCC 2019b) and prevention of drainage and disturbance of peatlands that become prone to burning when they are dry, resulting in massive carbon emissions (Turetsky et al. 2015).

Box 3 | Investing in Near-Term Actions for Long-Term Benefits

Forests take a long time to grow; therefore, forest sector planning requires long-term perspectives. Stable forests that are composed of multiple species provide the greatest climate change mitigation, adaptation, and sustainable development benefits (Aerts and Honnay 2011). What is important is not just the diversity of tree species, but the diversity of entire biota in the forest (Perring et al. 2015). Single-species, fast-growing plantations will not be able to provide the same vital ecosystem services that forests with rich biodiversity do. Additionally, such species-rich forests, if destroyed, take decades and even centuries to grow and reach their full potential of ecosystem functions.

Existing natural and intact forests provide exceptional value for countries relative to degraded forests. These include carbon sequestration and storage, water provision, indigenous culture, and maintenance of human health and biodiversity (Watson et al. 2018; Funk et al. 2019). Investing in the protection of intact forests is particularly relevant for many “high forest, low deforestation” countries where historical emissions are low. Some carbon benefits of conserving intact forests may be difficult to formally recognize in NDCs, given current accounting rules (e.g., their sink values, the resilience of their stocks, and their security against longer-term human threats), but it is still worth highlighting them.

Countries also need to start investing in forest restoration now for long-term mitigation, adaptation, and sustainable development benefits that will grow increasingly necessary, even essential, as the climate changes. Therefore, countries may consider including a plan for such investments with long-term benefits, even though, considering the lead time required for its implementation and initial slow uptake of sequestration, they may not significantly contribute to achieving goals and targets in this round of NDCs.

Another important consideration when enhancing NDCs is the need to avoid long-term “lock-in” to deforestation pathways. Lock-in is a phenomenon of path-dependency where decisions and events at one point in time self-reinforce over time, perpetuating particular ways of doing things and making it difficult to shift to alternative pathways (Erickson et al. 2015). Drivers of lock-in often come from outside the forest sector, such as agriculture, mining, and transportation. Therefore, cross-sectoral policy coordination is indispensable to addressing drivers of deforestation.

One of the common lock-in drivers for deforestation are commodity production and consumption systems. There are global supply chains of forest-threatening commodities, such as palm oil, soy beans, timber, and beef, which have already locked tropical forests in many countries into deforestation pathways for decades. It is important to proactively prevent lock-in with any new commodity practices that may put forests at risk. For example, investment in excessive industrial processing capacity for timber, pulp, or wood pellets inevitably drives overexploitation of forest resources to keep the mills running. Similarly, policies that create subsidies or mandates for “first generation” biofuels can lead to environmentally perverse outcomes (Seymour 2018). Where forests are already locked into commodity-driven deforestation pathways, it will be necessary to develop policies and practices that limit expansion and mitigate further destruction. There are examples of such efforts; for instance, the state of Sabah, Malaysia, has established an initiative that aims for all palm oil produced in the state to be certified sustainable by 2025 (Bahar 2018). (See website, “The State of Jurisdictional Sustainability” [Earth Innovation Institute n.d.] for more examples of similar approaches.)

Exploring the possibility of strengthening each solution described above could help countries identify opportunities to enhance the forest sector component of their NDCs.

Policy Measures to Implement Forest Sector Solutions

There are diverse options among policy measures to implement forest sector solutions. Table 3 shows a handful of examples.

For more detailed information on the above solutions, there are a number of existing guides on designing policy measures. For example, Angelsen et al. (2009) provide useful guidance on policy planning, particularly for reducing deforestation. IUCN and WRI (2014) provide

detailed guidance centered on restoration activities. Brack and Bailey (2013) describe policy measures for forest-products-consuming countries to reduce deforestation in producing countries. Some key policy measures are further discussed in the next chapter.

5) Assess costs and benefits of policy measures

Key Points

- It is important to assess costs and benefits of envisaged forest sector policies as comprehensively as possible.

- It may be difficult to estimate monetary values of some costs and benefits or even measure them, but informed decisions will be facilitated by analyzing all costs and benefits (both measurable and unmeasurable) and making potential trade-offs and cost-benefit distributions among stakeholders explicit.

In this step, the GHG emission mitigation effects of the identified policy measures are accounted for, and their adaptation and sustainable development benefits are assessed. In addition, costs of implementing those policy measures are estimated and analyzed in comparison with their climate mitigation, adaptation, and sustainable development benefits. If those policy measures are found to be feasible and beneficial overall, strategies to finance those measures should be explored. These are important but challenging tasks, and countries may choose to implement these tasks after their new or updated NDCs are communicated. It is beyond the scope of this guide to describe these tasks in detail; instead, some useful existing guides are introduced here.

Decisions adopted at COP 24 (UNFCCC 2019) provide guidance on mitigation elements to be included in NDCs, and countries are encouraged to include information on how GHG accounting approaches, methodologies, and assumptions are used in their NDCs (Fransen et al. 2019, 57–63). It is encouraging that some countries included forest-related information in the context of adaptation in their first NDCs, but even if targets or policies are described in the context of adaptation, it is important to account for their GHG emission impacts and integrate them into the countries' overall mitigation commitments (Fransen et al. 2019). GIZ (2018) and Greenhouse Gas Management Institute and Verra (2018) provide very useful guidance on GHG accounting for the forest sector.

When GHG mitigation effects of policies are accounted for and aggregated to the sector-wide GHG emissions (or removal) estimates, the possibility of leakage needs to be assessed and addressed. Emission leakages occur when emission mitigation policies in one area lead to emission increases in other areas. For example, if the conversion of forests to croplands is restricted in one area but leads to an increase in other areas, the effect of the policy cannot be assessed only by projecting the emissions in the area where the policy is applied.

Table 3 | **Examples of Policy Measures**

SOLUTIONS	EXAMPLES OF POLICY MEASURES FOR GOVERNMENTS
Reduced deforestation and degradation	<ul style="list-style-type: none"> ▪ Designation of protected areas ▪ Regulations on conversion of forests to other land uses, including strengthening law enforcement ▪ Regulations on production and marketing of timber and other forest products ▪ Land tenure establishment for indigenous people or local communities ▪ Jurisdictional sustainability certification of commodities ▪ Ecosystem service payment
Improved forest management	<ul style="list-style-type: none"> ▪ Jurisdictional sustainability certification of commodities ▪ Regulations on private forest management ▪ Introduction of sustainable management practices in national forests ▪ Dissemination of sustainable management practices for subnational/private forests
Reforestation, afforestation, and restoration	<ul style="list-style-type: none"> ▪ Public finance investment ▪ Tax incentives
Agroforestry	<ul style="list-style-type: none"> ▪ Tax incentives ▪ Dissemination of agroforestry practices
Fire management	<ul style="list-style-type: none"> ▪ Regulations on use of fire ▪ Dissemination of prescribed use of fire

Source: Based on IPCC (2019b) and Niel et al. (2019), modified by the authors.

Cost and benefit assessment for forest sector policies is fraught with difficulties. Costs of forest sector policies consist of direct costs to implement the policies and the opportunity costs of forgoing alternative use of the lands (e.g., cropping, ranching, and mineral exploitation) (Seymour and Busch 2016). Estimating opportunity costs is particularly challenging because it is necessary to develop counterfactual alternative land-use scenarios, which bear various uncertainties. On the benefits side, many ecosystem services provided by forests are difficult to monetize due to the lack of markets for these services (e.g., moderation of temperature fluctuation and flood control), leading to high levels of uncertainty. Therefore, conventional cost-benefit analysis may not be useful in such cases where cost and/or benefit estimations are highly unreliable. Despite the difficulties, it is important to use the best information available to conduct the cost and benefit assessment, including distributional inequality of costs and benefits among different stakeholders.

IUCN and WRI (2014) provide some concise and useful guidance on cost and benefit estimation and analysis of forest sector policy measures. Verdone (2015) gives a more detailed introduction to cost-benefit analysis in forest sector policies (see Appendix A for links to these materials). Chazdon and Guariguata (2018) introduce a range of decision support tools, not limited to cost-benefit analysis, for forest landscape restoration.

6) Determine how specifically to reflect forest sector solutions in NDCs

Key Points

- Deploying the various forest sector options in combination and in a coherent manner could effectively demonstrate a country's contributions and efforts toward enhancing its NDC.
- Forest sector targets and policies included in NDCs need to be coherent with those of other related sectors (e.g., agriculture, energy, and transportation).

There are various options countries can consider for including forest sector components in their NDCs. This chapter provides nonexhaustive and non-mutually exclusive examples of the types of contributions countries may communicate in their NDCs. In fact, countries' contributions and efforts can be better demonstrated

when GHG emission targets are accompanied by corresponding non-GHG targets, and supported by key policy measures to achieve them. While GHG emission targets are key to achieving the mitigation goal of the Paris Agreement, it is also important to understand how the forest sector contributes to adaptation and sustainable development targets. Non-GHG targets and supporting policies can provide additional clarity when countries are communicating their NDCs. In their first NDC submissions, countries included diverse types of information (Table 4), such as targets, plans, policies, and actions. In laying out such information, countries can effectively communicate their NDCs and increase understanding by making them transparent and verifiable with regard to causal linkages between targets, policies, and measures.

It is also important to make sure forest sector targets and policies are coherent with other sector (climate or development) targets and policies (and vice versa), and to make any potential trade-offs across sectors explicit. For example, forest conservation policies may be in conflict with energy policies (e.g., biofuel production, oil and gas extraction), agricultural policies (e.g., food security, commodity production), or transportation policies (e.g., blending mandate of biofuels, road network expansion). Therefore, countries need to take an integrated approach to developing NDCs, holistically considering targets and policies of multiple sectors, as well as mitigation, adaptation, and sustainable development objectives.

For more information on elements to be included in NDCs, Fransen et al. (2019) provide introductions to the related guidance adopted at COP 24.

GHG emissions reduction targets

Forest sector GHG emissions reduction (or removal) targets are strongly linked to which type of activities are implemented in what type of forest or on what type of land. GHG reduction targets for the forest sector as a whole do not give much information on potential and possible activities. Therefore, it is useful for countries to set both targets on land areas (gross increase and decrease as well as net change) and GHG emissions reduction targets. Forest sector GHG mitigation information can be integrated into economy-wide targets or presented as separate sector targets. If the forest sector is not covered in the economy-wide target, or the country chooses not to present an economy-wide target, countries can set

forest sector GHG mitigation targets to make use of the mitigation potential of the sector to raise mitigation ambition. On the other hand, if forest sector emissions are included in the economy-wide target, countries can still consider setting forest sector-specific targets to bolster action and drive abatement in the sector, or presenting an indicative forest sectoral breakdown of the economy-wide target to enhance clarity and specificity of the NDC. As is the case for all sectors, countries can strengthen clarity and specificity of their NDCs by indicating the scope of GHG covered (e.g., will it include only CO₂ or also other GHGs such as methane), baseline (e.g., relative to a base-year level or BAU level), and target years with or without milestones. If the target is relative to a business-as-usual emission level, it will be clearer when it is accompanied by descriptions of how it is calculated or by citations of references.

Emissions reduction targets can take different forms. Here are some examples:

- Sector-wide emissions (i.e., the total emissions from the forest sector) reductions relative to base-year or BAU level
- Emissions reductions or carbon removal as a result of a particular type of action (which can be combined with non-GHG quantitative targets)

Sectoral non-GHG quantitative targets

Non-GHG quantitative targets can be presented in the context of both climate change mitigation and/or adaptation with/without linkages to sustainable development objectives. Here are some examples:

- Forest cover as a ratio of the country's total land area
- Area of deforestation/forest degradation in absolute terms or relative to base-year or BAU level
- Total forest area under legal protection (e.g., protected area), kept at high levels of ecological integrity, under sustainable management, or under forest certification in absolute terms or relative to base-year/BAU level
- Total forest area planted or restored by the target year
- Total area of land with secured land tenure for indigenous people or local communities in absolute terms or relative to base-year/BAU level

Policies and measures

The guidance on elements to be included in NDCs was decided at COP 24, and it implies policies and measures can be included in NDCs in the context of both mitigation and adaptation. Countries can demonstrate commitments to introduce or enhance policies and measures in the forest sector as a means to achieve forest sector goals and targets. It is also possible to include policies and measures that aim for long-term goals but do not directly contribute to the near-term targets of the current NDC. Examples of policies and measures that can be included in NDCs include the following:

- Formulation and implementation of regulations limiting forest conversion into commodity croplands or plantations
- Creation of policies and programs for expanding or securing indigenous land rights
- Jurisdictional certification (the application of predetermined criteria for certification,—e.g., Roundtable on Sustainable Palm Oil— at the level of the jurisdiction) of forest products and sustainable commodities
- Introduction of improved forest monitoring and law enforcement programs to combat illegal logging and forest clearing
- Research on the monetary and nonmonetary values of forests' ecosystem services, and development of fiscal or market mechanisms to allocate financial resources to protect/enhance them, reflecting their value
- Research on climate change impacts on forests and forest users, and development/update of a national adaptation strategy as a part of the country's National Adaptation Plan (NAP) process or as an independent process

The table below provides country examples of forest sector contents in the existing NDCs. The list is not comprehensive. It should be noted that these examples are illustrative and do not necessarily represent the level of ambitions required to align with the pathway consistent with the well-below 2°C or 1.5°C goal.

Table 4 | Country Examples of Forest Sector Contents in Existing Nationally Determined Contributions

GHG EMISSIONS REDUCTION TARGETS (OR NONCOMMITTAL INDICATIVE INFORMATION)	
Sector-wide emissions reductions relative to base-year or BAU level	<p>Japan: Target removals of approximately 37.0 megatonnes (Mt) CO₂ (corresponding to 2.6% reduction of economy-wide total emissions in fiscal year [FY] 2013) in land use, land-use change, and forestry (LULUCF) sector, including 27.8 Mt CO₂ by forest carbon sinks (corresponding to 2% of total emissions in FY2013).</p> <p>Madagascar: Increase carbon absorption in LULUCF sector by 61 Mt CO₂ in 2030 relative to BAU.</p>
Emissions reductions as a result of particular type of action	<p>Belize: Reduce GHG emissions through reserves and sustainable forest management with cumulative reduction of up to 2.5 Mt CO₂ over the period from 2020 to 2030, depending on the level of financial support. Likewise, reduction in fuelwood consumption and restoration of mangroves are expected to reduce up to 0.1 Mt CO₂ during the same period.</p>
NON-GHG QUANTITATIVE TARGETS (OR NONCOMMITTAL INDICATIVE INFORMATION)	
Forest cover as a ratio of the country's total land area	<p>Costa Rica: Expand forest coverage to 60% (compared to 54.4% in 2013).</p> <p>Kenya: Achieve tree cover of at least 10% of total land area.</p>
Area of deforestation/forest degradation in absolute terms or relative to base-year or BAU level	<p>Brazil: Zero illegal deforestation by 2030 in Brazilian Amazonia.</p> <p>Mexico: 0% deforestation by 2030.</p> <p>Namibia: Reduce deforestation rate by 75% relative to BAU scenario in 2030.</p>
Total forest area under legal protection (e.g., protected area), sustainable management, or forest certification in absolute terms or relative to base-year/BAU level	<p>Bolivia: Increase forest area with integrated and sustainable community management approaches to 16.9 million hectares (ha) in 2030, compared with 3.1 million ha in 2010.</p> <p>Myanmar: Reserved Forest and Protected Public Forest = 30% of national land area; Protected Area Systems = 10% of national land area.</p>
Total forest area planted or restored by the target year	<p>Honduras: Afforestation/reforestation of 1 million ha of forest before 2030.</p> <p>Vietnam: Plant 20,000 to 50,000 ha of additional mangroves.</p>
POLICIES AND MEASURES	
Certification of forest products and sustainable commodities	<p>Costa Rica: Explore synergies between adaptation practices and the reduction of emissions by avoided deforestation, including through the forest certification program.</p>
Introduction of improved forest monitoring and law enforcement program to combat illegal logging and forest conversion	<p>Guinea Bissau: Reduce illegal and indiscriminate felling of trees by 2030.</p> <p>Suriname: Enhance forest monitoring to address illegal logging.</p>
Research on value of forests' ecosystem services, and development of fiscal or market mechanisms to allocate financial resources to protect/enhance them, reflecting their values	<p>Costa Rica: Explore synergies between adaptation practices and cutting emissions by avoided deforestation, including through the Environmental Services Payments program.</p> <p>Ivory Coast: Establish a payment incentive scheme for environmental services to encourage village reforestation and conservation of natural forests in rural areas and support small producers to adopt sustainable production practices.</p> <p>Suriname: Explore options for the payment of climate services that forests provide.</p> <p>Vietnam: Establish policy of paying for forest environmental services.</p>

Source: Compiled by the authors, based on information provided in NDCs.

OPPORTUNITIES TO STRENGTHEN POLICIES AND MEASURES

Take advantage of technological development and policy evolution

One of the major barriers to conserving and managing forests in the past has been the difficulty of monitoring vast, remote, and inaccessible areas. This challenge has made it hard to detect threats and emerging trends—such as forest fires, pest outbreaks, illegal logging, and forest clearing—at their early stages and to immediately respond with the necessary actions. Fortunately, technological advancements and increasingly dense networks of land observation satellites, combined with more sophisticated data analysis and user interface software, have dramatically improved this situation. Global Forest Watch (GFW) (WRI n.d.) is an example of a newly available tool that embodies those technological developments.

Thanks to these technological developments, countries now have access to an increasing volume and quality of data and information on the state of forests in their jurisdiction. These changes may create opportunities for them to upgrade the level of forest management by including measurable targets; broadening the scope of policies and actions; and extending them to new regions, forest types, or forest carbon pools, which were not covered by previous NDCs. Likewise, more timely information now available from new technologies may help countries strengthen their control over illegal logging, conversion of forests, and the timber trade. Therefore, countries may wish to review those technological developments and consider how they can use them to improve their NDCs' forest sector component (Box 4).

In terms of policy innovations, recent research has also improved our understanding of the different drivers of deforestation and the types of policies that can be enacted to reverse the trend. Establishment of protected areas, law enforcement, and indigenous management have all been shown to slow forest loss (Busch and Ferretti-Gallon 2017). Policies customized to specific jurisdictions are needed to effectively address deforestation drivers (Seymour and Harris 2019), further highlighting the importance of including country-specific policy measures in NDCs.

Align finance flows with NDC's forest sector goals

Land-use decisions are key to implementing forest sector policies, but political economy factors and power imbalances can stymie efforts to control land use. The fact that tropical deforestation in Southeast Asia and Latin America is driven mostly by commodity production (Curtis et al. 2018) implies that food and forest business interests typically wield more influence than many forest-dependent, smallholder agriculturalists and indigenous people in those regions who are the most vulnerable to climate change.

Current private and public financial flows are strongly aligned with prioritization of short-term economic gains and gross domestic product (GDP) growth, and consequentially deforestation. Although comprehensive data on private finance are limited, a survey by Hamrick (2016) found that for 2015, private organizations (92 organizations mainly in North America, Europe, and Latin America) committed slightly less than US\$1 billion to sustainable forestry and timber production. In comparison, four major commodities (palm oil, soy, beef, and wood products) alone attract \$100 billion of capital and trade financing each year (Haupt et al. 2018). Public sector finance paints a similar picture. Governments in high-deforestation countries provide subsidies for the production of key agricultural products that drive deforestation (Haupt et al. 2018). McFarland et al. (2015) estimated that soybean and beef production in Brazil, and palm oil and timber production in Indonesia, are provided various forms of subsidies (e.g., concessional loans, interest rate subsidies, production input subsidies, tax benefits, and compensation of lost income for producers or processors, and public investments in supply chain infrastructure) equivalent to at least \$47 billion per year.

While financing directed at climate change has grown, the financial flows targeted at forest sector solutions have remained insufficient. An estimated \$70 to \$160 billion per year is required globally for sustainable forest management, and \$20 to \$40 billion per year is needed to halve deforestation by 2020 (Tuukka et al. 2014). However, the agriculture, forestry, land use, and natural resource sectors combined received only a small fraction of national and international public climate (mitigation and adaptation) finance, averaging \$7 billion a year in 2015 and 2016, which is only about 5 percent of the tracked global total public climate finance for all sectors (Buchner et al. 2017).

To shift money and attention to the forest sector, countries can demonstrate, in their NDCs, a readiness to introduce or enhance enabling policies to divert finance flows away from activities driving deforestation and into those promoting forest conservation and restoration (Box 5).

Implement REDD+

Financing climate solutions and policies is a major challenge, particularly in developing countries, which explains why some countries put forward goals and targets contingent on international support in their first NDCs. However, finance is even more challenging in the forest sector because the full benefits of forests are rarely assessed and taken into account in policy planning; thus, forest sector policies often receive less attention and resources than they require.

In recognition of these challenges, various international financial support programs are now available for developing countries. One example is the increasing availability of REDD+ finance, but to be eligible, countries must first undertake a series of actions. They must develop a national strategy or action plan, a forest reference emissions level, a national forest monitoring system, and a safeguards information system, all of which could be highlighted in an enhanced NDC as activities to facilitate implementation of the NDC. REDD+ is not just about accessing available sources of finance, the process of implementing REDD+ can strengthen countries' capacity to implement forest sector policies. Thus, including a commitment to implementation of REDD+ in an NDC is one way to increase clarity and effectively communicate domestic efforts toward emissions reductions, signal support needs, and attract additional financial support. Only 22 countries referred to policy measures related to REDD+ (Figure 8) in their first NDC submission.

The framework, rules, and procedures for REDD+ have been developed through UNFCCC negotiations, and its framework was adopted as the "Warsaw Framework for REDD+" at COP 19 in 2013. REDD+ was integrated into the Paris Agreement, and a number of support initiatives (Table 5) have been put in place to make it fully operational. However, rules and procedures under the Paris Agreement around international transfers of mitigation outcomes from all sectors, including those resulting from REDD+, are still being negotiated. REDD+ can also be implemented outside the UNFCCC, under

Box 4 | Technological Advancements in Forest Policies

Countries such as Brazil, Colombia, Peru, and Uganda have been using satellite monitoring early warning systems for illegal logging and forest clearance (Petersen et al. 2018). Sweden combines satellite image data and machine learning and operates an early warning system for forest fires (KTH Royal Institute of Technology n.d.). Satellite-based transnational monitoring systems are also developed and made available to the public, and countries can use them to enhance the monitoring and management of forests (Petersen et al. 2018). Apart from early warning, remote sensing with light detection and ranging (LiDAR) borne by satellites, aircrafts, and drones has made more accurate forest biomass estimation possible, which is expected to be used for forest carbon accounting for Reducing Emissions from Deforestation and Forest Degradation (REDD+) in the future.

Stopping illegal logging and regulating the timber trade are vital to preserving endangered forests. Newly available technologies can help governments of timber-producing and -consuming countries to monitor supply chains and crack down on illegal activities. These systems and technologies include geo-referenced harvesting inventories using the global positioning system (GPS), tagging timber with barcodes and radio frequency identification (RFID) chips, and identifying the geographical origin of wood using DNA markers or isotopes (FAO 2016b).

bilateral agreements (e.g., the one between Norway and Indonesia) or voluntary international programs (e.g., Verified Carbon Standard).

REDD+ is implemented through three phases: readiness, implementation, and results-based finance. A range of support programs and funding are made available by multilateral funds and development banks, bilateral donors, private companies, and foundations, as illustrated in Table 5 (Lujan and Silva-Chávez 2018). Several countries, including Brazil, Colombia, the Democratic Republic of Congo, Ecuador, Ghana, Indonesia, Mozambique, and Peru, have made agreements with funders (either developed country governments or international financial institutions like the Green Climate Fund and the World Bank) for results-based payments upon verification of emissions reduction outcomes. Most recently, the Architecture for REDD+ Transactions (ART) was launched to help unlock finance for forest countries by providing a credible voluntary standard and a rigorous process to verify emissions reductions

Box 5 | Country Examples of Enabling Policies for Forest Conservation

India reformed its fiscal policy, in 2015, of allocation of tax revenue to state governments, using forest cover as one of the weighting parameters to calculate the amount transferred to states, thus incentivizing state governments to conserve forests (Busch 2015).

Indonesia introduced the forest moratorium policy in 2011 that banned clearing primary forests and peatlands, which was extended three times and made permanent in August 2019 (Reuters 2019). The policy is considered “the single policy with the largest mitigation potential” (Wijaya et al. 2017). Indonesia also introduced an oil palm moratorium policy, which suspends issuing a license to new oil palm plantations for three years from 2018 (*Jakarta Post* 2018).

Bolivia, Brazil, and Colombia have put regulations in place to secure land tenure of indigenous communities in designated areas, although these regulations can be vulnerable to changes in administration and to policy shifts. Research by Ding et al. (2016) found that the deforestation in forestlands with indigenous land tenure was significantly lower than in other areas.

(ART n.d.). Simultaneously, Emergent, a REDD+ transaction platform, was launched to facilitate the purchase of jurisdictional REDD+ credits at a large scale, providing forest-rich countries with another avenue to access finance. Emergent and other transaction platforms are a key to avoiding “double counting” of REDD+ credits. The Paris Agreement states that emissions reductions can only be counted toward one country’s NDC, meaning the transfer of mitigation outcomes between countries must result in an appropriate corresponding adjustment to the mitigation accounting of both countries to ensure the emissions reduction is not double-counted.

Some of those REDD+ results-based payment agreements are made at subnational jurisdictions, as in the case of the states of Acre and Mato Grosso in Brazil. Although REDD+ ultimately aims for implementation at the national level, subnational jurisdictional REDD+ programs have emerged as important stepping stones as REDD+ has moved away from individual projects and adopted a jurisdictional approach. The jurisdictional approach addresses forest and land-use governance holistically within one or more territories or jurisdictions

Table 5 | Examples of Support Programs and Funding Sources for REDD+

SUPPORT TYPE	READINESS	IMPLEMENTATION	RESULTS-BASED PAYMENT
Multilateral	Green Climate Fund (GCF) ^a		
	FCPF Readiness Fund ^b		FCPF Carbon Fund ^b
	UN-REDD Program		
		BioCarbon Fund Initiative for Sustainable Forest Landscapes ^c	
		Forest Investment Program ^d	
		Global Environment Facility ^e	
Bilateral	NICFI ^f		
			REDD Early Movers (REM) Programme
	Various other programs by European Union, Germany, Japan, Norway, the United Kingdom, and the United States		
Private sector			Emergent
Foundation	Climate & Land Use Alliance		

Notes: ^a GCF allocated \$500 million for a pilot program of results-based payment. GCF also finances activities in readiness and implementation phases (the maximum amount is not set).

^b Forest Carbon Partnership Facility (FCPF) Readiness Fund and Carbon Fund have current funding of \$400 million and \$900 million, respectively (FCPF n.d.).

^c BioCarbon Fund Initiative for Sustainable Forest Landscapes has the funding capital of \$134 million for upfront finance (BioCFPlus) and \$226 million for results-based finance (ISFL n.d.).

^d Forest Investment Program has the funding capital of \$775 million (Climate Investment Funds n.d.).

^e GEF-6 (2014–2018) allocated over \$700 million for forests, including \$70 million targeted at forest landscape management and restoration.

^f Norway’s International Climate and Forest Initiative has disbursed over \$1.5 billion to REDD+

Source: Based on the mapping by Lujan and Silva-Chávez (2018).

of governments (particularly subnational governments) and provides valuable insights into the main drivers and agents of deforestation in the region (Duchelle et al. 2018). Government actors lead the process, engaging a broad range of stakeholders and land users in the jurisdiction, including commodity supply chain companies, farmers, and local (including indigenous) communities to create a REDD+ program with adequate carbon accounting, safeguard measures, and incentive mechanisms (Boyd et al. 2018).

One often forgotten aspect of REDD+ is the “conservation of existing carbon stocks” part of the “+,” which implicitly refers to forests not at immediate risk from deforestation and degradation, known as high forest, low deforestation (HFLD) regions. It has so far proved difficult to account for the carbon benefits of this activity (Lee et al. 2018), but it remains an important part of any strategy to minimize emissions from and maximize removals by the forest sector (Funk et al. 2019). Progress in accounting issues is likely to be driven partly by countries, signaling a strong desire to include these activities in their NDCs.

CONCLUSIONS

Forest sector solutions—especially avoided deforestation, forest restoration, and improved land management—are an indispensable and cost-effective way to reduce GHG emissions and help hold the temperature increase to well below 2.0°C or 1.5°C above preindustrial levels. Simultaneously, forest sector solutions deliver climate change adaptation and sustainable development benefits and provide a wide range of ecosystem services. However, countries’ intentions to tap into the great potential of the forest sector were not fully demonstrated in the first round of NDCs.

Developing and updating NDCs offers a chance to revisit and renew the assessment of the potential benefits; establish clear and ambitious targets and underpinning implementation strategies, interventions, and policies; build a coalition within the government and with external stakeholders; raise the profile of the forest sector; and attract investments and support.

This guide proposes steps and provides perspectives, options, and other key information to guide countries through the process of enhancing the forest sector component of their NDCs. Seizing this opportunity can help protect people and ecosystems threatened by climate change and yield a multiplicity of other benefits for generations to come.

APPENDIX A

Useful Resources

This guide outlines overall steps and key issues in developing or enhancing the forest sector contents of an NDC. There are a range of guidance materials related to various aspects of NDC enhancement that countries may find useful. Below is a nonexhaustive list of reference materials.

1) Overall process guide on NDC enhancement

Enhancing NDCs: A Guide to Strengthening National Climate Plans by 2020 (Fransen et al. 2019). This is a generic non-sector-specific guidance on enhancing NDCs. <https://www.wri.org/publication/enhancing-ndcs>.

“Guide to Including Nature in Nationally Determined Contributions: A Checklist of Information and Accounting Approaches for Natural Climate Solutions” (Beasley et al. 2019). https://www.nature.org/content/dam/tnc/nature/en/documents/Guide_to_Including_Nature_in_NDCs.pdf.

“Pathway for Increasing Nature-Based Solutions in NDCs: A Seven-Step Approach for Enhancing Nationally Determined Contributions through Nature-Based Solutions” (UNDP 2019). <https://www.ndcs.undp.org/content/ndc-support-programme/en/home/impact-and-learning/library/nature-based-solutions-for-ndcs-pathway-framework.html>.

2) Data and tools

“FAOSTAT” (FAO n.d.). <http://www.fao.org/faostat/en/#data>.

“Global Forest Watch (GFW)” (WRI n.d.) GFW provides global and country-specific maps and data on various indicators, such as (current and historical) forest cover, forest type, land use, and forest carbon stock and emissions. <https://www.globalforestwatch.org/>.

“Accelerating Climate Ambition and Impact: Toolkit for Mainstreaming Nature-Based Solutions into Nationally Determined Contributions” (Paniagua et al. 2019). https://www.ndcs.undp.org/content/dam/LECB/docs/pubs-tools-facts/Toolkit_for_Mainstreaming_Nature-based_Solutions_into_Nationally_Determined_Contributions.pdf.

3) Identifying solutions and policy measures to enhance mitigation and adaptation

“Realising REDD+: National Strategy and Policy Options” (Angelsen et al. 2009). https://www.cifor.org/publications/pdf_files/Books/BAngelsen0902.pdf.

“Why Forests? Why Now? The Science, Economics and Politics of Tropical Forests and Climate Change” (Seymour and Busch 2016). <https://www.cgdev.org/sites/default/files/Seymour-Busch-why-forests-why-now-full-book.PDF>.

“REDD Programme Collaborative Online Workspace” (UN-REDD n.d.). This website provides a portal to a wealth of materials related to REDD+. <https://www.unredd.net/>.

“A Guide to the Restoration Opportunities Assessment Methodology (ROAM)” (IUCN and WRI 2014). https://www.iucn.org/downloads/roam_handbook_lowres_web.pdf.

“The State of Jurisdictional Sustainability” (Earth Innovation Institute n.d.). This website provides a wealth of information related to a jurisdictional approach, including country examples. <https://earthinnovation.org/state-of-jurisdictional-sustainability/>.

“Ending Global Deforestation: Policy Options for Consumer Countries” (Brack and Bailey 2013). This publication proposes various policy options for forest products-consuming countries to help reduce deforestation in other countries. <https://www.chathamhouse.org/publications/papers/view/194247>.

4) GHG accounting of the forest sector

“2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 4, Agriculture, Forestry and Other Land Use” (IPCC 2006). <https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html>.

“2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands” (IPCC 2013). This is supplementary to the 2006 IPCC Guidelines and provides additional guidance on GHG accounting for wetlands, including mangroves. <https://www.ipcc-nggip.iges.or.jp/public/wetlands/>.

“2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 4, Agriculture, Forestry and Other Land Use” (IPCC 2019a). This refinement updates (but does not replace or revise) the 2006 guidelines based on the up-to-date science. <https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html>.

“Accounting of the Land-Use Sector in Nationally Determined Contributions (NDCs) under the Paris Agreement” (GIZ 2018). https://www.transparency-partnership.net/system/files/document/Guide%20Accounting%20of%20land-use%20sector%20in%20NDCs%28vf%29_20181010.pdf.

“Forest Guidance: Guidance for Assessing the Greenhouse Gas Impacts of Forest Policies” (Greenhouse Gas Management Institute and Verra 2018). <https://climateactiontransparency.org/icat-guidance/forest-sector/>.

5) Assessing costs and benefits of policy measures, and identifying finance options

“A Cost-Benefit Framework for Analyzing Forest Landscape Restoration Decisions” (Verdone 2015). <https://portals.iucn.org/library/sites/library/files/documents/2015-018.pdf>.

“A Guide to the Restoration Opportunities Assessment Methodology (ROAM)” (IUCN and WRI 2014). https://www.iucn.org/downloads/roam_handbook_lowres_web.pdf.

“Decision Support Tools for Forest Landscape Restoration: Current Status and Future Outlook” (Chazdon and Guariguata 2018).

This publication introduces decision support tools that are useful in analyzing costs and benefits of forest landscape restoration options. <https://www.cifor.org/library/6792/>.

“Mapping Forest Finance: A Landscape of Available Sources of Finance for REDD+ and Climate Action in Forests” (Lujan and Silva-Chávez 2018). <https://www.edf.org/sites/default/files/documents/EDF101-REDD%2BFinance.pdf>.

ABBREVIATIONS

BAU	business as usual
COP	Conference of the Parties (to United Nations Framework Convention on Climate Change)
CO ₂ e	carbon dioxide equivalent
FAO	Food and Agriculture Organization of the United Nations
FCPF	Forest Carbon Partnership Facility
GHG	greenhouse gas
GPS	global positioning system
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
LULUCF	land use, land-use change, and forestry
NCS	natural climate solutions
NDC	Nationally Determined Contribution
REDD+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries
RFID	radio frequency identification
SDGs	Sustainable Development Goals of the 2030 Agenda for Sustainable Development
UNFCCC	United Nations Framework Convention on Climate Change

ENDNOTES

1. In this guide, the term “cost-effective” is based on the definition by Griscom et al. (2017) and refers to a condition that the marginal abatement cost of carbon does not exceed US\$100 per metric ton CO₂. US\$100 is used as a benchmark that corresponds to the estimated social cost of carbon by 2030. The marginal abatement costs of carbon for forest sector solutions do not generally take into account opportunity cost of mineral exploitation in forestlands, policy administration costs for governments, and a range of nonmarket ecosystem service benefits. Therefore, it should be noted that the statement of cost-effectiveness about forest sector solutions in this guide is based on rough estimates.
2. “Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries (REDD+)” is a framework under the UNFCCC to provide developing countries with support and incentives for reducing emissions from forests.
3. The tree cover loss is the total loss without taking tree cover gain into account, and, unlike deforestation, it does not necessarily mean permanent loss of forest.
4. In referencing the country-level mitigation potential estimates by Griscom et al. (2017), readers are encouraged to bear in mind the following caveats offered in the web-based tool using the same data (Nature4Climate n.d.):
 - The aim of the Carbon Mapper is to serve as an initial engagement tool to make countries aware of NCS potential in their countries; to serve as a starting point for deeper dives to more accurately assess their real NCS mitigation for inclusion in future revisions of their NDCs.
 - The country-level pathway estimates presented in the Carbon Mapper are approximations based on global datasets and do not use official national datasets and/or baseline setting procedures. These pathway estimates also do not use national definitions of a carbon accounting pool; therefore, the NCS estimates presented in the Carbon Mapper cannot be directly compared with NDCs or with results available from national carbon accounting systems.
 - We fully recognize the gaps in in-depth country-level pathway analysis and therefore encourage regional/national assessments of NCS potential to improve estimates for individual countries.
5. The difference between reforestation and afforestation is that the former establishes forests on lands that were previously forests, whereas the latter does so on lands that have not been forests for at least 50 years (Hiraishi et al. 2014).

REFERENCES

- Aerts, R., and O. Honnay. 2011. "Forest Restoration, Biodiversity and Ecosystem Functioning." *BMC Ecology* 11 (1): 29. doi:10.1186/1472-6785-11-29.
- AFR100. n.d. African Forest Landscape Restoration Initiative. <http://afr100.org/>. Accessed November 20, 2019.
- Angelsen, A., M. Brockhaus, M. Kanninen, E. Sills, W.D. Sunderlin, and S. Wertz-Kanounnikof, eds. 2009. *Realising REDD+: National Strategy and Policy Options*. Bogor, Indonesia: Center for International Forestry Research.
- Angelsen, A., P. Jagger, R. Babigumira, B. Belcher, N.J. Hogarth, S. Bauch, J. Börner, C. Smith-Hall, and S. Wunder. 2014. "Environmental Income and Rural Livelihoods: A Global-Comparative Analysis." *World Development, Forests, Livelihoods, and Conservation* 64 (December): S12–28. doi:10.1016/j.worlddev.2014.03.006.
- ART. n.d. "Attracting New Investment to Protect and Restore Forests." Architecture for REDD+ Transactions. <https://www.artredd.org/>. Accessed July 24, 2019.
- Bahar, N.H.A. 2018. "Sabah, Malaysia." In *The State of Jurisdictional Sustainability*, edited by C. Stickler, A. Duchelle, J.P. Ardila, D. Nepstad, O. David, C. Chan, J. Rojas, et al. San Francisco; Bogor, Indonesia; and Boulder, CO: Earth Innovation Institute (EII), the Center for International Forestry Research (CIFOR), and the Governors' Climate and Forests Task Force (GCF-TF). https://earthinnovation.org/wp-content/uploads/2018/09/profiles_led/SJS_Profiles_ENG/Malaysia/Profile_SABAH_Bahar_2018_ENG.pdf.
- Baumgartner, R.J. 2019. "Sustainable Development Goals and the Forest Sector—a Complex Relationship." *Forests* 10 (2): 152. doi:10.3390/f10020152.
- Beasley, E., L.S. Murray, J. Funk, B. Lujan, K. Kasprzyk, and D. Burns. 2019. "Guide to Including Nature in Nationally Determined Contributions: A Checklist of Information and Accounting Approaches for Natural Climate Solutions." Nature4Climate, Conservation International, The Nature Conservancy, Environmental Defense Fund, National Wildlife Federation, Land Use & Climate Knowledge Initiative, Climate Advisers, and Wildlife Conservation Society. https://www.nature.org/content/dam/tnc/nature/en/documents/Guide_to_Including_Nature_in_NDCs.pdf.
- Bonn Challenge. n.d. "Bonn Challenge." <http://www.bonnchallenge.org/>. Accessed June 24, 2019.
- Boyd, W., C. Stickler, A.E. Duchelle, F. Seymour, D. Nepstad, N.H.A. Bahar, and D. Rodriguez-Ward. 2018. "Jurisdictional Approaches to REDD+ and Low Emissions Development: Progress and Prospects." Working Paper. Washington, DC: World Resources Institute.
- Brack, D., and R. Bailey. 2013. "Ending Global Deforestation: Policy Options for Consumer Countries." London: Chatham House (The Royal Institute of International Affairs). <https://www.chathamhouse.org/publications/papers/view/194247>.
- Buchner, B., P. Oliver, X. Wang, C. Carswell, C. Meattle, and F. Mazza. 2017. "Global Landscape of Climate Finance 2017." Climate Policy Initiative. <https://climatepolicyinitiative.org/wp-content/uploads/2017/10/2017-Global-Landscape-of-Climate-Finance.pdf>.
- Busch, J. 2015. "India's Big Climate Move." Washington, DC: Center for Global Development. <https://www.cgdev.org/blog/indias-big-climate-move>.
- Busch, J., and K. Ferretti-Gallon. 2017. "What Drives Deforestation and What Stops It? A Meta-analysis." *Review of Environmental Economics and Policy* 11 (1): 3–23. doi:10.1093/reep/rew013.
- Chazdon, R.L., and M.R. Guariguata. 2018. *Decision Support Tools for Forest Landscape Restoration: Current Status and Future Outlook*. Bogor, Indonesia: Center for International Forestry Research (CIFOR).
- Climate Investment Funds. n.d. "Forest Investment Program." <https://www.climateinvestmentfunds.org/node/2>. Accessed September 16, 2019.
- Climate Watch NDC Content. 2018. Washington, DC: World Resources Institute. <https://www.climatewatchdata.org>.
- Curtis, P.G., C.M. Slay, N.L. Harris, A. Tyukavina, and M.C. Hansen. 2018. "Classifying Drivers of Global Forest Loss." *Science* 361 (6407): 1108–11. doi:10.1126/science.aau3445.
- Ding, H., P.G. Veit, A. Blackman, E. Gray, K. Reyter, J.C. Altamirano, and B. Hodgdon. 2016. "Climate Benefits, Tenure Costs: The Economic Case for Securing Indigenous Land Rights in the Amazon." Washington, DC: WRI.
- Donato, D.C., J.B. Kauffman, D. Murdiyarso, S. Kurnianto, M. Stidham, and M. Kanninen. 2011. "Mangroves among the Most Carbon-Rich Forests in the Tropics." *Nature Geoscience* 4 (5): 293–97. doi:10.1038/ngeo1123.
- Duchelle, A.E., F. Seymour, M. Brockhaus, A. Angelsen, A.M. Larson, M. Moeliono, G.Y. Wong, T.T. Pham, and C. Martius. 2018. "REDD+: Lessons from National and Subnational Implementation." Working Paper. Washington, DC: WRI. https://wriorg.s3.amazonaws.com/s3fs-public/ending-tropical-deforestation-redd-lessons-implementation.pdf?_ga=2.140641201.2061382388.1559573753-2040269075.1523901373.
- Earth Innovation Institute. n.d. "The State of Jurisdictional Sustainability." <https://earthinnovation.org/state-of-jurisdictional-sustainability/>. Accessed September 15, 2019.
- Erickson, P., S. Kartha, M. Lazarus, and K. Tempest. 2015. "Assessing Carbon Lock-In." *Environmental Research Letters* 10 (8): 084023. doi:10.1088/1748-9326/10/8/084023.
- European Forest Institute. n.d. "What Is the EU FLEGT Action Plan?" <http://www.euflegt.efi.int/flegt-action-plan>. Accessed July 21, 2019.
- FAO (Food and Agriculture Organization of the United Nations). 2016a. "Global Forest Resources Assessment 2015: How Are the World's Forests Changing?" Rome: FAO. <http://www.fao.org/3/a-i4793e.pdf>.

FAO. 2016b. "Traceability: A Management Tool for Enterprises and Governments." Technical Paper No. 1, FAO FLEGT Programme. Rome: FAO. <http://www.fao.org/3/a-i6134e.pdf>.

FAO. n.d. "FAOSTAT." <http://www.fao.org/faostat/en/#home>. Accessed October 28, 2019.

FCPF (Forest Carbon Partnership Facility). n.d. <https://www.forestcarbonpartnership.org/about>. Accessed September 16, 2019.

Fransen, T., E. Northrop, K. Mogelgaard, and K. Levin. 2017. "Enhancing NDCs by 2020: Achieving the Goals of the Paris Agreement." Working Paper. Washington, DC: WRI. doi:10.1163/9789004322714_cclc_2017-0020-024.

Fransen, T., I. Sato, K. Levin, D. Waskow, D. Rich, S. Ndoko, and J. Teng. 2019. *Enhancing NDCs: A Guide to Strengthening National Climate Plans by 2020*. Washington, DC, and New York: World Resources Institute (WRI) and United Nations Development Programme (UNDP).

Funk, J.M., N. Aguilar-Amuchastegui, W. Baldwin-Cantello, J. Busch, E. Chuvasov, T. Evans, B. Griffin, et al. 2019. "Securing the Climate Benefits of Stable Forests." *Climate Policy* 19 (7): 845–60. doi:10.1080/14693062.2019.1598838.

Gibson, L., T.M. Lee, L.P. Koh, B.W. Brook, T.A. Gardner, J. Barlow, C.A. Peres, et al. 2011. "Primary Forests Are Irreplaceable for Sustaining Tropical Biodiversity." *Nature* 478 (7369): 378–81. doi:10.1038/nature10425.

GLZ (Deutsche Gesellschaft für Internationale Zusammenarbeit). 2018. "Accounting of the Land-Use Sector in Nationally Determined Contributions (NDCs) under the Paris Agreement." Bonn, Germany: GLZ, GmbH. https://www.transparency-partnership.net/system/files/document/Guide%20Accounting%20of%20land-use%20sector%20in%20NDCs%28vf%29_20181010.pdf.

Global Commission on Adaptation. 2019. *Adapt Now: A Global Call for Leadership on Climate Resilience*. Rotterdam, the Netherlands, and Washington, DC: Global Center on Adaptation and World Resources Institute.

Global Environment Facility. 2016. "Forests." <https://www.thegef.org/topics/forests>.

Grassi, G., J. House, F. Dentener, S. Federici, M. den Elzen, and J. Penman. 2017. "The Key Role of Forests in Meeting Climate Targets Requires Science for Credible Mitigation." *Nature Climate Change* 7 (3): 220–26. doi:10.1038/nclimate3227.

Greenhouse Gas Management Institute and Verra. 2018. "Forest Guidance: Guidance for Assessing the Greenhouse Gas Impacts of Forest Policies." Initiative for Climate Action Transparency (ICAT). Washington, DC: Greenhouse Gas Management Institute and Verra. <https://climateactiontransparency.org/icat-guidance/forest-sector/>.

Griscom, B.W., J. Adams, P.W. Ellis, R.A. Houghton, G. Lomax, D.A. Miteva, W.H. Schlesinger, et al. 2017. "Natural Climate Solutions." *Proceedings of the National Academy of Sciences* 114 (44): 11645–50. doi:10.1073/pnas.1710465114.

Hamrick, K. 2016. "State of Private Investment in Conservation 2016: A Landscape Assessment of an Emerging Market." Washington, DC: Ecosystem Marketplace. <https://www.forest-trends.org/publications/state-of-private-investment-in-conservation-2016/>.

Haupt, F., C. Streck, C. Watson, I. Schulte, and K. Behm. 2018. "Goal 8: Provide Support for the Development and Implementation of Strategies to Reduce Forest Emissions." New York Declaration on Forests: Progress Assessment. Forest Declaration. http://forestdeclaration.org/wp-content/uploads/2018/08/goal_8-finance_for_forest_action%E2%80%9393forest_declaration.pdf.

Hiraishi, T., T. Krug, K. Tanabe, N. Srivastava, B. Jamsranjav, M. Fukuda, and T. Troxler, eds. 2014. *2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol*. Geneva: Intergovernmental Panel on Climate Change (IPCC). http://www.ipcc-nggip.iges.or.jp/public/kpsg/pdf/KP_Supplement_Entire_Report.pdf.

Initiative 20x20. n.d. <http://initiative20x20.org/>. Accessed September 14, 2019.

IPCC (Intergovernmental Panel on Climate Change). 2006. "2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 4, Agriculture, Forestry and Other Land Use," edited by S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe. Hayama, Kanagawa, Japan: National Greenhouse Gas Inventories Programme. <https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html>.

IPCC. 2013. "2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands." IPCC. https://www.ipcc-nggip.iges.or.jp/home/docs/wetlands/Wetlands_Supplement_precopyedit.pdf.

IPCC. 2014a. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. New York: Cambridge University Press. <https://www.ipcc.ch/report/ar5/wg2/>.

IPCC. 2014b. *Climate Change 2014: Mitigation of Climate Change*. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, edited by O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, et al. New York: Cambridge University Press.

IPCC. 2018. "Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty," edited by V. Masson-Delmotte, P. Zhai, H.O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, et al. Geneva: World Meteorological Organization.

- IPCC. 2019a. "2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories." IPCC. <https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/>.
- IPCC. 2019b. "Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems." IPCC. <https://www.ipcc.ch/report/srccl/>.
- ISFL (Initiative for Sustainable Forest). n.d. "BioCarbon Fund Initiative for Sustainable Forest Landscapes." <https://www.biocarbonfund-isfl.org/funding>. Accessed September 16, 2019.
- IUCN and WRI (International Union for Conservation of Nature and World Resources Institute). 2014. "A Guide to the Restoration Opportunities Assessment Methodology (ROAM): Assessing Forest Landscape Restoration Opportunities at the National or Sub-national Level." Working Paper (Road-test edition). Gland, Switzerland: IUCN. <https://portals.iucn.org/library/sites/library/files/documents/2014-030.pdf>.
- IUCN and Climate Focus. 2018. "Increasing Ambition & Action on NDCs through FLR." InfoFLR. July. <https://infoflr.org/what-flr/increasing-ambition-and-action-ndcs-through-flr>.
- Jakarta Post*. 2018. "Oil Palm Moratorium: The Future Offered." <https://www.thejakartapost.com/academia/2018/12/15/oil-palm-moratorium-the-future-offered.html>.
- Kroeger, A., M.G. Espinosa, and P. Premachandra. 2018. "New York Declaration on Forests: Progress Assessment on Goal 5." Forest Declaration. https://forestdeclaration.org/wp-content/uploads/2018/08/goal_5-restore_forests%E2%80%9393forest_declaration.pdf.
- KTH Royal Institute of Technology. n.d. "Satellite Data and AI Help Fight Sweden's Forest Fires." <https://phys.org/news/2019-04-satellite-ai-sweden-forest.html>. Accessed June 5, 2019.
- Kuramochi, T., N. Höhne, M. Schaeffer, J. Cantzler, B. Hare, Y. Deng, S. Sterl, et al. 2018. "Ten Key Short-Term Sectoral Benchmarks to Limit Warming to 1.5°C." *Climate Policy* 18 (3): 287–305. doi:10.1080/14693062.2017.1397495.
- Larson, A.M., T. Dokken, and A.E. Duchelle. 2014. "Can Safeguards Guarantee Gender Equity? Lessons from Research on Women in Early REDD+ Implementation." Center for International Forestry Research (CIFOR) REDD+ Safeguards Brief 4. Bogor, Indonesia: CIFOR. <https://www.cifor.org/library/5191/>.
- Lawrence, D., and K. Vandecar. 2015. "Effects of Tropical Deforestation on Climate and Agriculture." *Nature Climate Change* 5 (1): 27–36. doi:10.1038/nclimate2430.
- Le Quéré, C., R.M. Andrew, P. Friedlingstein, S. Sitch, J. Hauck, J. Pongratz, P.A. Pickers, et al. 2018. "Global Carbon Budget 2018." *Earth System Science Data* 10 (4): 2141–94. doi:10.5194/essd-10-2141-2018.
- Lee, D., M. Skutsch, and M. Sandker. 2018. "Challenges with Measurement and Accounting of the Plus in REDD+." San Francisco: Climate and Land Use Alliance. <http://www.climateandlandusealliance.org/reports/plus-in-redd/>.
- Lujan, B., and G. Silva-Chávez. 2018. "Mapping Forest Finance: A Landscape of Available Sources of Finance for REDD+ and Climate Action in Forests." New York and Washington, DC: Environmental Defense Fund and Forest Trends. <https://www.edf.org/sites/default/files/documents/EDF101-REDD%2BFinance.pdf>.
- Marín-Spiotta, E., and R. Ostertag. 2016. "Recovery of Ecosystem Processes: Carbon and Energy Flows in Restored Wetlands, Grasslands, and Forests." In *Foundations of Restoration Ecology*, edited by M.A. Palmer, J.B. Zedler, and D.A. Falk, 365–94. Washington, DC: Island Press. https://link.springer.com/chapter/10.5822/978-1-61091-698-1_13.
- McFarland, W., S. Whitley, and G. Kissinger. 2015. "Subsidies to Key Commodities Driving Forest Loss: Implications for Private Climate Finance." Working Paper. London: Overseas Development Institute.
- Mitsch, W.J., B. Bernal, and M.E. Hernandez. 2015. "Ecosystem Services of Wetlands." *International Journal of Biodiversity Science, Ecosystem Services & Management* 11 (1): 1–4. doi:10.1080/21513732.2015.1006250.
- Morris, B., A. Dickie, and F. Seymour. 2018. "The Global Debate about Biofuels and Land-use Change." Working Paper. Washington, DC: World Resources Institute.
- Nature4Climate. n.d. "NCS World Atlas FAQ." <https://nature4climate.org/ncs-world-atlas-faq/>. Accessed September 17, 2019.
- Niel, B., Y. Laurens, R. Lapeyre, P.C. Motel, and J.-L. Combes. 2019. "Forest Spirits. What We Know—and Don't Know—about the Effectiveness of Policies against Deforestation." Working Paper n° 13. Clermont Ferrand, France: CERDI (Centre d'études et de recherches sur le développement international).
- Oliveira, L.J.C., M.H. Costa, B.S. Soares-Filho, and M.T. Coe. 2013. "Large-Scale Expansion of Agriculture in Amazonia May Be a No-Win Scenario." *Environmental Research Letters* 8 (2): 024021. doi:10.1088/1748-9326/8/2/024021.
- Paniagua, E., E. Mammadyarov, J. Ervin, and N. DeSantis. 2019. "Accelerating Climate Ambition and Impact: Toolkit for Mainstreaming Nature-based Solutions into Nationally Determined Contributions." Washington, DC, and New York: Nature4Climate, NDC Partnership, New York Declaration on Forests Global Platform, and UNDP.
- Perring, M.P., R.J. Standish, J.N. Price, M.D. Craig, T.E. Erickson, K.X. Ruthrof, A.S. Whiteley, L.E. Valentine, and R.J. Hobbs. 2015. "Advances in Restoration Ecology: Rising to the Challenges of the Coming Decades." *Ecosphere* 6 (8): art131. doi:10.1890/ES15-00121.1. http://d2ouvy59p0dg6k.cloudfront.net/downloads/r2_wwf_indc_brief.pdf.
- Petersen, R., K. Renschler, and M. Weisse. 2018. "Early Warning Systems for Deforestation: An Explainer." *Global Forest Watch Blog*. July 7. <https://blog.globalforestwatch.org/data-and-research/early-warning-systems-for-deforestation-an-explainer>.

- Reuters. 2019. "Indonesia President Makes Moratorium on Forest Clearance Permanent." August 8. <https://www.reuters.com/article/us-indonesia-environment-forest-idUSKCN1UY14P>.
- Ross, K., R. Carter, T. Damassa, R. Waite, K. Hite, R. Gasper, and L. Pegorsch. 2019. *Enhancing NDCs: Opportunities in Agriculture*. Washington, DC, New York and Nairobi: WRI, UNDP, and Oxfam.
- Salmond, J.A., M. Tadaki, S. Vardoulakis, K. Arbutnott, A. Coutts, M. Demuzere, K.N. Dirks, et al. 2016. "Health and Climate Related Ecosystem Services Provided by Street Trees in the Urban Environment." *Environmental Health* 15 (S1). doi:10.1186/s12940-016-0103-6.
- Seymour, F. 2018. "Integrating the Land Sector into Long-Term Strategies, with Special Attention to Forests." Expert Perspectives, Long-Term Climate Strategies, World Resources Institute, October 25. <https://www.wri.org/climate/expert-perspective/integrating-land-sector-long-term-strategies-special-attention-forests>.
- Seymour, F., and J. Busch. 2016. *Why Forests? Why Now? The Science, Economics and Politics of Tropical Forests and Climate Change*. Washington, DC: Center for Global Development. <https://www.cgdev.org/publication/why-forests-why-now-science-economics-and-politics-tropical-forests-and-climate-change>.
- Seymour, F., and J. Busch. 2017. "Forests and SDGs: Taking a Second Look." Washington, DC: World Resources Institute. <https://www.wri.org/blog/2017/09/forests-and-sdgs-taking-second-look>.
- Seymour, F., and N.L. Harris. 2019. "Reducing Tropical Deforestation." *Science* 365 (6455): 756–57. doi:10.1126/science.aax8546.
- Turetsky, M.R., B. Benscoter, S. Page, G. Rein, G.R. van der Werf, and A. Watts. 2015. "Global Vulnerability of Peatlands to Fire and Carbon Loss." *Nature Geoscience* 8 (1): 11–14. doi:10.1038/ngeo2325.
- Tuukka, C., M. Katila, K. Lindroos, and J. Salmi. 2014. "Private Financing for Sustainable Forest Management and Forest Products in Developing Countries—Trends and Drivers." Washington, DC: Program on Forests (PROFOR).
- UNCCD (United Nations Convention to Combat Desertification). n.d. "Achieving Land Degradation Neutrality." <https://www.unccd.int/actions/achieving-land-degradation-neutrality>. Accessed November 20, 2019.
- UNDP (United Nations Development Programme). 2019. "Pathway for Increasing Nature-Based Solutions in NDCs: A Seven-Step Approach for Enhancing Nationally Determined Contributions through Nature-Based Solutions." New York: UNDP. <https://www.ndcs.undp.org/content/ndc-support-programme/en/home/impact-and-learning/library/nature-based-solutions-for-ndcs-pathway-framework.html>.
- UNEP (United Nations Environment Programme). 2018. "The Emissions Gap Report 2018." Nairobi: UNEP.
- UNFCCC (United Nations Framework Convention on Climate Change). 2015. "Paris Agreement." https://unfccc.int/sites/default/files/english_paris_agreement.pdf.
- UNFCCC. 2016. "Synthesis Report on the Aggregate Effect of INDCs." Bonn, Germany: UNFCCC. <https://unfccc.int/process/the-paris-agreement/nationally-determined-contributions/synthesis-report-on-the-aggregate-effect-of-intended-nationally-determined-contributions>.
- UNFCCC. 2018. "COP Decision 1/CP.24." <https://unfccc.int/event/cop-24>.
- UNFCCC. 2019. "Decision 4/CMA.1, FCCC/PA/CMA/2018/3/Add.1 Further Guidance in Relation to the Mitigation Section of Decision 1/CP.21." <https://unfccc.int/decisions?f%5B0%5D=body%3A4099&search2=&page=1>.
- UN-REDD (United Nations-Reducing Emissions from Deforestation and Forest Degradation). n.d. "UN-REDD Programme Collaborative Online Workspace." <https://www.unredd.net/>. Accessed July 22, 2019.
- Verdone, M. 2015. "A Cost-Benefit Framework for Analyzing Forest Landscape Restoration Decisions." Gland, Switzerland: International Union for Conservation of Nature. <https://portals.iucn.org/library/sites/library/files/documents/2015-018.pdf>.
- Watson, J.E.M., T. Evans, O. Venter, B. Williams, A. Tulloch, C. Stewart, I. Thompson, et al. 2018. "The Exceptional Value of Intact Forest Ecosystems." *Nature Ecology & Evolution* 2 (4): 599. doi:10.1038/s41559-018-0490-x.
- Wetlands International. n.d. "Countries Can Strengthen Climate Plans in 2020 with Peatland and Mangrove Targets." *Wetlands International* (blog). <https://www.wetlands.org/news/countries-can-strengthen-climate-plans-2020-peatland-mangrove-targets/>. Accessed September 13, 2019.
- Wijaya, A., H. Chrysolite, M. Ge, C. Wibowo, A. Pradana, U. Utami, and K. Austin. 2017. "How Can Indonesia Achieve Its Climate Change Mitigation Goal? An Analysis of Potential Emissions Reductions from Energy and Land-Use Policies." Working Paper. Jakarta, Indonesia: World Resources Institute. doi:10.1163/9789004322714_cclc_2017-0020-001.
- Wolosin, M., and N. Harris. 2018. "Ending Tropical Deforestation: Tropical Forests and Climate Change: The Latest Science." Working Paper. Washington, DC: World Resources Institute. <https://www.wri.org/publication/ending-tropical-deforestation-tropical-forests-and-climate-change-latest-science>.
- WRI (World Resources Institute). 2014a. "Greenhouse Gas Protocol: Mitigation Goal Standard." Washington, DC: WRI. https://ghgprotocol.org/sites/default/files/standards/Mitigation_Goal_Standard.pdf.
- WRI. 2014b. "Greenhouse Gas Protocol: Policy and Action Standard." <https://ghgprotocol.org/policy-and-action-standard>.
- WRI. n.d. "Global Forest Watch." <https://www.globalforestwatch.org/dashboards/global>. Accessed June 3, 2019.

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