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Climate Change

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Options for Conserving Stable Forests

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Acronyms

AGB	Aboveground Biomass
ART	Architecture for REDD+ Transactions
BGB	Belowground Biomass
BIP	Biodiversity Indicators Partnership
CBD	Convention on Biological Diversity
CO_2	Carbon Dioxide
EFT	Ecological Fiscal Transfer
FAO	Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility
FRA	Forest Resources Assessment
FREL	Forest Reference Emission Level
GHG	Greenhouse Gas
GLOBIO	Global biodiversity model for policy support
HDI	Human Development Index
HFLD	High Forest Low Deforestation
IFL	Intact Forest Landscape
IMAGE	Integrated Model to Assess the Global Environment
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
ISFL	Initiative for Sustainable Forest Landscapes
ITMO	Internationally Transferred Mitigation Outcomes
LAC	Latin America and the Caribbean
LULUCF	Land Use, Land Use Change, and Forestry
METT	Management Effectiveness Tracking Tool
MSA	Mean Species Abundance
NBSAP	National Biodiversity Strategy and Action Plan
NDC	Nationally Determined Contribution
NTFP	Non-Timber Forest Product
NTFU	Non-Timber Forest Use
PES	Payment for Ecosystem Services
RAPPAM	Rapid Assessment and Prioritization of Protected Area Management
REDD+	REDD+ covers five activities: (i) Reducing emissions from deforestation; (ii) reducing emissions from forest degradation; (iii) conservation of forest carbon stocks; (iv) sustainable management of forests; and (v) enhancement of forest carbon stocks. Activities (i) and (ii) are part of REDD and (iii) – (v) fall under the "+."
RSA	Relative Species Abundance
SOC	Soil Organic Carbon
SMF	Sustainable Management of Forests
TREES	The REDD+ Environmental Excellence Standard
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change

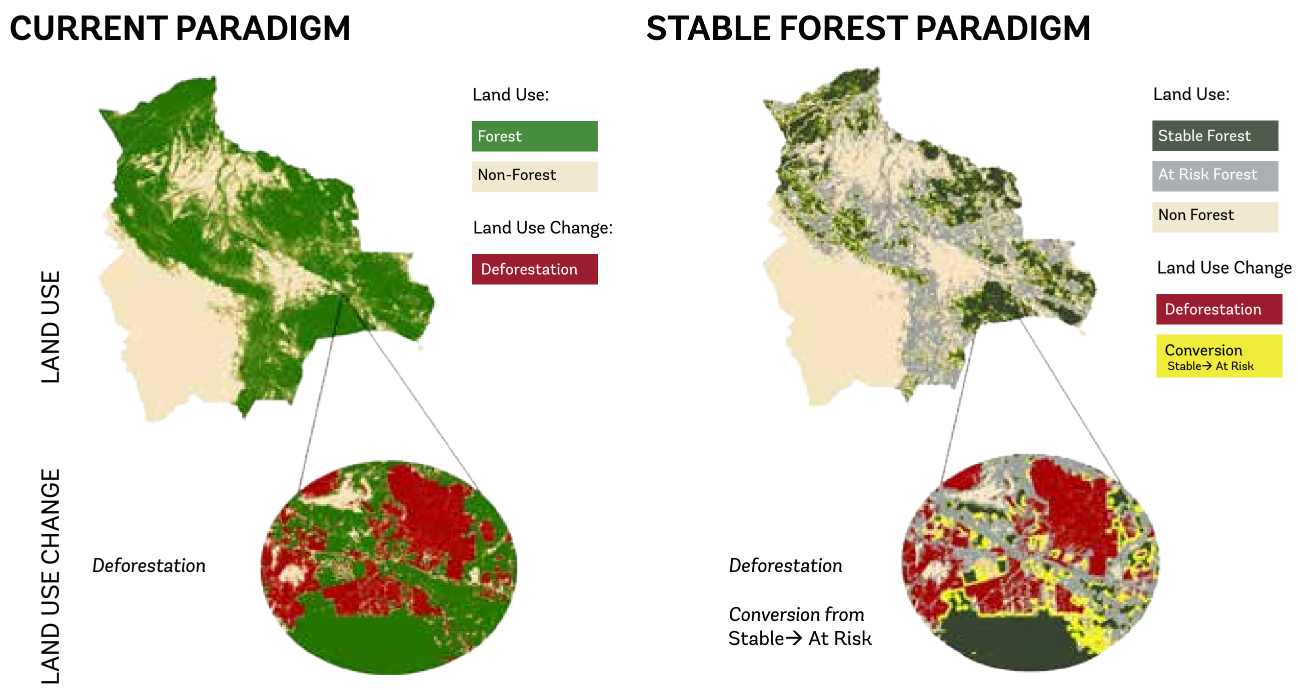
Executive Summary

1.Importance of stable forests

Stable forests are defined as forests "not already significantly disturbed nor facing predictable near future risks of anthropogenic disturbance" (Funk et al., 2019). Forests not classified as "stable" are referred to here as at-risk forests, as they are under greater threat of deforestation and forest degradation.

The belief that stable forests need to be conserved reflects their extensive contributions to carbon sequestration, hydrology, biodiversity, climate, culture, and society. Stable forests are mostly excluded from policy and financial valuations that could incentivize maintenance and ongoing protection, such as REDD+.[1] Stable forests lack the historical emissions that could provide the kind of reference against which protection and results-based payments are currently estimated. As a result, large areas of stable forest that hold vast carbon stocks are not valued or protected. Over time, they risk becoming fragmented, degraded, converted to at-risk forest, and ultimately deforested. Meanwhile, efforts to conserve global forests tend to focus exclusively on areas under imminent threat of deforestation. This approach is akin to spending money only on firefighters while ignoring more cost-effective methods to reduce fire risks. The failure to assign value to stable forests is a classic example of the free rider problem,[2] whereby free goods or services are overexploited and fail over time.

The stable forest paradigm introduced here highlights the transition (or conversion) from stable forest to forest at risk of degradation—as a prelude to the final phase—deforestation. Conventional approaches to the evaluation of forest cover typically overlook that transition (see figure below). Because at-risk forests are more likely to be deforested, this novel paradigm promotes preventative action to conserve all forests by halting this initial conversion, thereby maintaining forests in a healthy, threat-free condition for the long term. This shift in focus offers a new and significant strategy to limit overall global deforestation and degradation while preserving the full suite of ecosystem services stable forests provide. Protecting stable forests needs to be implemented as part of a global unified forest conservation strategy. It should not—and logically cannot—divert funding away from other more vulnerable high-value forests. On the contrary, the successful protection of stable forests demands the protection of all at-risk forest areas in the vicinity.



1 REDD+ covers five activities: (i) reducing emissions from deforestation; (ii) reducing emissions from forest degradation; (iii) conservation of forest carbon stocks; (iv) sustainable management of forests; and (v) enhancement of forest carbon stocks."

2 The free rider problem is a type of market failure that occurs when the beneficiaries of goods or services do not pay for the production of those goods or services, resulting in overuse and overexploitation.

2. Report overview

Through six chapters and three accompanying Annexes, this report examines the following questions:

1. What is the global extent of stable forests?

This report quantifies the extent of stable forests globally. The analysis delineates stable forests as areas with tree canopy cover greater than 25%, at a distance of at least 1 km from the forest edge, and a low-to-moderate human footprint index (less than 3).

2. What is the value of the benefits that stable forests provide?

The report values four major ecosystem services provided by stable forests in the tropics: carbon storage, biodiversity, non-timber forest uses (NTFUs), and hydrological services. This is based on existing studies that have valued these services and provided estimates of value per hectare.

3. What options do we have to effectively protect stable forests?

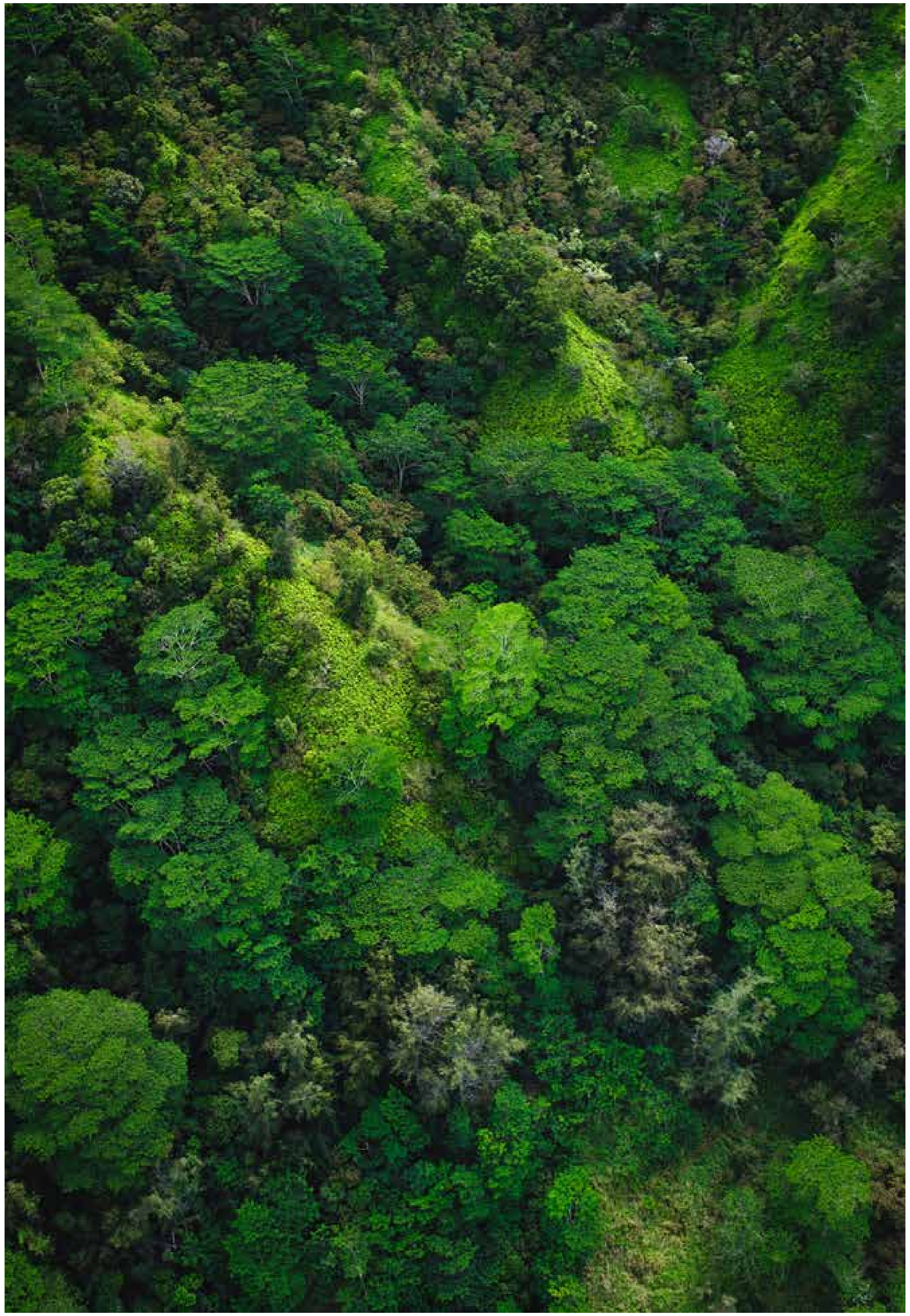
The report assesses existing policy approaches of greatest relevance to the conservation of stable forests and provides policy recommendations accordingly.

Conclusions are additionally supported by an analysis of the extent of, value of, and policy options for stable forests in five systematically selected case study countries: Georgia, Guyana, Indonesia, Liberia, and Republic of Congo.

Key stable forest facts

Area	Carbon	Value
2019 area: 625 million hectares (ha) (16.6 % of all forest area), with 88% in the tropics. **Stable forest losses (2010–2019):** 20.6%, through conversion to at-risk status. Losses varied in case studies from 4.9% (Georgia) to 51.7% (Liberia). **Deforestation:** Four times greater in at-risk forests than stable forests globally, but eight times greater in the tropics; ranging from 3.4 to 34.7 times greater in case study countries.	**Storage:** 140.9 Gt C (516.6 Gt CO_2e). **Sequestration:** 416 Mt C per year (yr^{-1}) (1,527 Mt CO_2e), which equates to almost as much as annual emissions from the entire global waste sector, all of Brazil's emissions, or double Canada's emissions (or Germany's) in 2018.	**Asset value[3]:** USD $4,910 billion ($8,960 ha^{-1}). **Value lost[4]:** $5.7 billion yr^{-1}, representing a small fraction of the total asset value of stable forests (just 0.12% in the tropics overall, 0.4% in Indonesia, and as low as 0.002% in Georgia). **Maintenance value[5]:** $177 billion yr^{-1}.

3 Present value of the ecosystem service flows that would be lost from the stable forest area if it were deforested, based on total stacked value of four ecosystem services evaluated in stable forests. The values of different ecosystem services are assumed to be additive, although in reality this may not be the case. The carbon fraction of this value is based on a conservative value of $14 per t CO_2e.
4 Benefits the country could be paid through traditional programs to reduce deforestation, associated with areas under imminent threat of deforestation, based on the average value lost from 2010–2019 due to deforestation of stable forests.
5 The annual resources that would be needed to ensure the asset value does not decline—these could be associated with maintaining stable forest areas such that they are not converted to "at-risk" forests under threat of deforestation.



3. Key recommendations

Although stable forests cannot by definition experience immediate deforestation, they are under significant threat of fragmentation and edge encroachment, which will result in conversion to at-risk forest and subsequent degradation and deforestation. Market forces or the private sector will not spontaneously correct underlying policy, governance, and market failures. Effective policy is needed that operates across government, the private sector, civil society, and indigenous groups. This policy needs to either create revenue tied to maintaining stable forest by recognizing the high value of carbon and other ecosystem services in stable forests, or impose a social or economic cost on actions that reduce stable forests. This report does not claim that stable forest is more important than other vulnerable high-value forests, or that it is in more urgent need of protection. Instead, it identifies the need for a new paradigm that recognizes the tremendous value of stable forests and highlights options to maintain them now, rather than focusing on them only when they are being lost. The policy solutions proposed below are intended to complement and reinforce efforts to protect at-risk forest, not to replace those efforts. The aim is to halt the progressive slide from stable forest to at-risk forest to non-forest. How a country meets these objectives will vary depending on national circumstances and relevant drivers of stable forest loss.

1. Focus on domestic policy reform and governance

Stable forest maintenance and protection requires effective domestic policy that recognizes stable forest value. Domestic policy should aim to engage domestic funding—both public and private—tailored to national circumstances. Domestic funding can be engaged by either increasing the costs of damaging stable forest (such as subsidy reform: to remove harmful subsidies), or creating revenue linked to its protection (such as ecological fiscal transfers—EFTs—or payment for environmental services—PES). For example, Guyana could create a PES scheme to support stable forests linked to its new-found oil wealth. In Republic of Congo, on the other hand, EFTs that connect internal government transfers of oil revenue to maintenance of stable forests may be more appropriate. Similarly, subsidy reform will be different in each country, but can be budget neutral if harmful subsidies are redirected to support stable forest and change investment flows. Countries with weak governance could focus on improved forest governance to control illegal activities along with fiscal reform over other policy options, such as market mechanisms or attracting green finance.

2. Develop a conservation credit for stable forests to support Paris Agreement, Convention on Biological Diversity, and domestic policy

A conservation credit is a common accounting unit that allows monitoring, valuation, and comparisons over time and between stable forests. The units can be created as no-regrets nonmarket accounting units that could support a range of nonmarket and market policies that require monitoring and/or valuation of stable forests. The idea does not require creating a new market, though this is an option. For example, conservation credits could be used to value EFT payments, with monitoring, reporting and valuation consolidated into a single unit that can be used to prioritize EFTs and compare results between forests. The concept could also be used to help value protected areas, debt-for-nature swaps, or forest planning, and could be used as a tradable unit in a PES scheme. Only a new PES scheme relies on creating a new market mechanism and identifying new buyers for a conservation credit—other examples simply use the concept to compare and value forests linked to other policy options.

Conservation credits can be valued using the annual maintenance cost approach as a starting point. Using the annual maintenance cost moves beyond valuing forests on the basis of their imminent loss or their potential to offset emissions. This approach should help to value stable forests and reduce their transition to at-risk forests, which are more costly to protect per hectare. It recognizes the key role that stable forests must play to achieve the Paris Agreement targets and the CBD's Post-2020 Global Biodiversity Framework and 2050 vision, whereby biodiversity is valued, conserved, restored and wisely used, most of the existing intact and wilderness areas are retained, and key ecosystem services are maintained.

Conservation credits can stack payments for ecosystem services (carbon, biodiversity, hydrological services, and non-timber forest uses). These can be further tailored to national circumstances and priorities. As stable forest areas are maintained, decrease, or increase, payments could be adjusted accordingly. This can include pre-agreed spatially explicit valuation to incentivize high valuation of and payments for high-priority stable forests. Although the annual maintenance value is a small fraction of the asset value, it should still generate substantial value in heavily forested countries. This could be paired with existing REDD+ policy and results-based finance that focuses on protecting at-risk forests. The approach would fit within existing decisions and articles under the Paris Agreement and CBD.

In line with Paris Agreement and CBD funding aims, sources of funding for conservation credits should include a combination of donor funding and domestic government funding. Credits can also be linked to domestic resources directly or indirectly. For example, restructuring or redirecting existing subsidies could generate new revenue to fund conservation credits, and the private sector can be engaged through PES. As noted above, credits can also be linked to EFTs. However, conservation credits will not operate in isolation from domestic policy reform. Alongside other work to improve forest governance, the conservation credit concept could be supported via a new "Stable Forest Fund" created under the mandate of the Parties to the UNFCCC and CBD, which could be managed by the Global Environment Facility or a multilateral development bank such as the World Bank. The fund should focus on complementing and adding to existing efforts to protect forests, rather than duplication (further research would be required to establish such a fund).

3. Conduct additional research

Our understanding of stable forests and the benefits they provide will improve if several key data gaps are addressed. These gaps should be prioritized in future research to generate further data on how stable forests are valued, how policies are developed, and how stable forests could be used as a broader indicator of drivers of deforestation. Important areas for future research include:

Drivers of stable forest loss, including within protected areas, to better inform and target policies to reduce this loss.

Link between degradation and conversion to at-risk forest, including a disaggregated spatial analysis to make it possible to value carbon lost after conversion to at-risk forest.

Difference between deforestation in stable and at-risk forest, including country-level analysis to fine-tune the analysis of deforestation rates in stable forests.

Valuation differences between stable and at-risk forest, including country-specific studies to better value ecosystem services—particularly non-timber forest products—investigating how these may change when a section of stable forest becomes at-risk forest.

Valuation basis for maintenance payments, including the development of a theoretical and empirical framework to estimate maintenance value by stable forest ecosystem and country.

Analysis of conservation credits and Stable Forest Fund, including how these could be operationalized and connected to domestic policy.

Typology analysis, including of country characteristics (such as significant mining or commodity-driven deforestation) and correlation with stable forest losses to identify high-priority countries.

Infectious disease transmission, including how pathogen transfer to humans increases when forests are fragmented (Faust et al., 2018) particularly stable forests, and how this could be factored into reducing stable forest loss and thus the risk of future pandemics.

Chapter 1:

Introduction

1.1. Background

Approximately one-third of remaining global forest area is considered undisturbed primary forest[6] (FAO, 2020c). The terms "wilderness" or "primary" forests are often used interchangeably with virgin, native, pristine, untouched, old-growth, mature, intact, undisturbed, or hinterland forests, which refer to forests which in recent history have been left largely or completely undisturbed by human activity. It is estimated that in the tropics alone these forests are responsible for approximately half the terrestrial carbon sequestration occurring globally (Hubau et al., 2020) and 40% of global aboveground forest carbon storage (Maxwell et al., 2019). In addition, undisturbed forests regulate water more efficiently than degraded or planted forests (Alvarez-Garreton et al., 2019; Locatelli & Vignola, 2009; Watson et al., 2018), act as critical regulators of temperature and rainfall (Ellison et al., 2017; Watson et al., 2018), and provide cultural and touristic value, although there is wide heterogeneity across forests worldwide.

Terms such as undisturbed or structurally intact forests use the absence of historical disturbance to assess forests at a given moment in time. In this report, the term stable forest is used, defined by Funk et al. (2019) as forests "not already significantly disturbed nor facing predictable near-future risks of anthropogenic disturbance.

Global climate change mitigation efforts have focused on changes in emissions, notably decreasing emissions or increasing sequestration.[7] Stable forests do not readily fit within greenhouse gas (GHG) emission reduction reporting, as these forests have neither historical emissions nor the potential to increase sequestration relative to a reference level of natural sequestration. The focus on emissions or sequestration relative to a historical or projected reference level neither recognizes the services that stable forests provide to the planet nor offers any incentive to governments, civil society, or the private sector to protect and maintain stable forests. This underlines the need for a new paradigm that focuses not just on the loss of forest to non-forest land uses but also on the loss of stable forests to a non-stable or "at-risk" classification.

1.2. Importance of stable forests

The conventional approach to the study of forest change—the current paradigm—considers forests, non-forest area, and deforestation (Figure 1). This approach is incomplete, because it only focuses on the end point of an extended transition that occurs from untouched stable forest through increasing stages of risk due to human accessibility (with or without accompanying forest degradation) before reaching th end point of deforestation. The new paradigm introduces two new forest classes (stable and at-risk forest) and a new classification of change (conversion to at-risk forest from stable forest).

What is the global extent of stable forests?

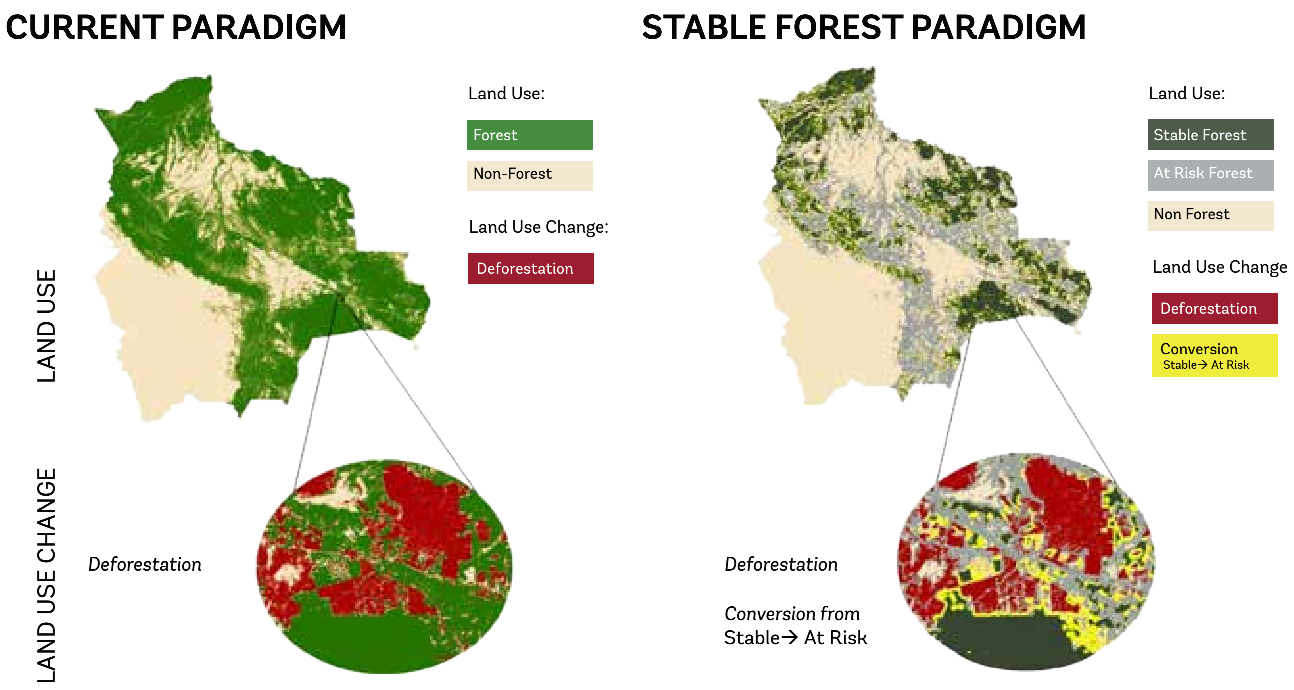
What is the value of the benefits that stable forests provide?

What options do we have to effectively protect stable forests?

6 The Food and Agriculture Organization (FAO) defines primary forest as naturally regenerated forest of native tree species, where there are no clearly visible indications of human activities, and the ecological processes are not significantly disturbed (FAO, 2020).

7 As exemplified by REDD+ under the UNFCCC.

Figure 1. Stable forest paradigm



There have been various approaches to evaluate forests that could be considered stable or free of human disturbance. The stable forest paradigm builds upon the most common of these, as explained in Table 1, which expands on the overview summarized visually above in Figure 1. These approaches involve spatial analyses and political approaches (discussed in section 1.1 of Annex A) that contrast with frameworks such as traditional REDD+ accounting, which instead focuses on forests at risk of deforestation and degradation. In short, the stable forest paradigm aims to address gaps in the conventional approaches. For additional detail on how the spatial definition of stable forest builds on other approaches, see section 2.1.1.

Table 1. Conventional forest paradigms and how they are sharpened by stable forest analysis (the new paradigm)

Framework	Aim	Gaps addressed by the stable forest paradigm
Current REDD+ results-based payments	Evaluate forest area that has been deforested and degraded and provide funding to prevent future losses or incentivize enhancements.	- Stable forest paradigm focuses on areas that could become future hotspots for deforestation and degradation rather than those currently at-risk - Stable forests are excluded from traditional REDD+ GHG driven results-based payments
High-Forest Low-Deforestation	Characterize countries that have high forest area and low deforestation rates and provide options for these countries to attract international finance.	- Stable forests may be in much higher concentrations in HFLD countries but are found worldwide, and HFLD countries have both stable forests and at-risk forests. The mechanisms to support HFLD countries are based on a REDD+ approach which would exclude stable forests
Intact Forest Landscapes	Generate spatial boundaries of large undeveloped forest areas to be used as a baseline for forest degradation monitoring to help implement policies on landscape alteration (Potapov et al., 2008). The definition requires a minimum patch size of 50,000 ha and minimum width of 10 km (and 2 km at corridors).	- Highly valuable, smaller patches of forest are included in stable forests - Stable forests include areas that could be restored as stable after previously having been excluded - Stable forests focus less on degradation and more on risk
Primary Forests	Widely used to represent forest areas with low human impact and native tree species, although definition varies.	- Stable forests have a clear defined spatial delineation that includes a distance-from-edge requirement - Stable forest focuses on risk level of anthropogenic influence
Hinterland Forests	Complement the IFL approach by incorporating a disturbance interval, which allows secondary forests with recovered ecosystem function to be considered (Tyukavina et al., 2016a).	- Stable forests include both tropical and temperate forests, smaller patches of forests, and forests that have recovered from historical disturbance

The stable forest paradigm provides a longer-term view of forest protection and promotes preventative action to conserve forests. Although stable forests rarely face immediate threats, policy and financial incentives that promote long-term protection should be set now. This will ensure that stable forests are maintained in a healthy, threat-free condition that continues to generate ecosystem services and will not begin the slide through conversion to at-risk forest, forest degradation, and deforestation. By contrast, and by definition, at-risk forests are likely to be deforested. This entails facing greater opportunity costs of alternative (and potentially more profitable) land uses, and inevitably paves the way to heavier and more urgent funding to prevent overt deforestation. If value is provided to stable forests now, we can conserve overall forest area and the full suite of ecosystem services that forests provide.

This report does not claim that stable forests are more important or more urgent to protect than other vulnerable high-value forests. Instead, it identifies the need for a new paradigm that recognizes the colossal value of stable forests and highlights options to maintain them now rather than focusing on them only when they are being lost. Protecting stable forest against being converted to at-risk forests is a strategy to reduce long-term deforestation of all forest area and maintain ecosystem services. The solutions proposed throughout this report should be implemented alongside those to protect at-risk forest, and indeed would require protection of at-risk forests as part of a stable forest strategy.

1.3. Report scope and objectives

1.3.1. Research question

This report aims to answer the following research questions:

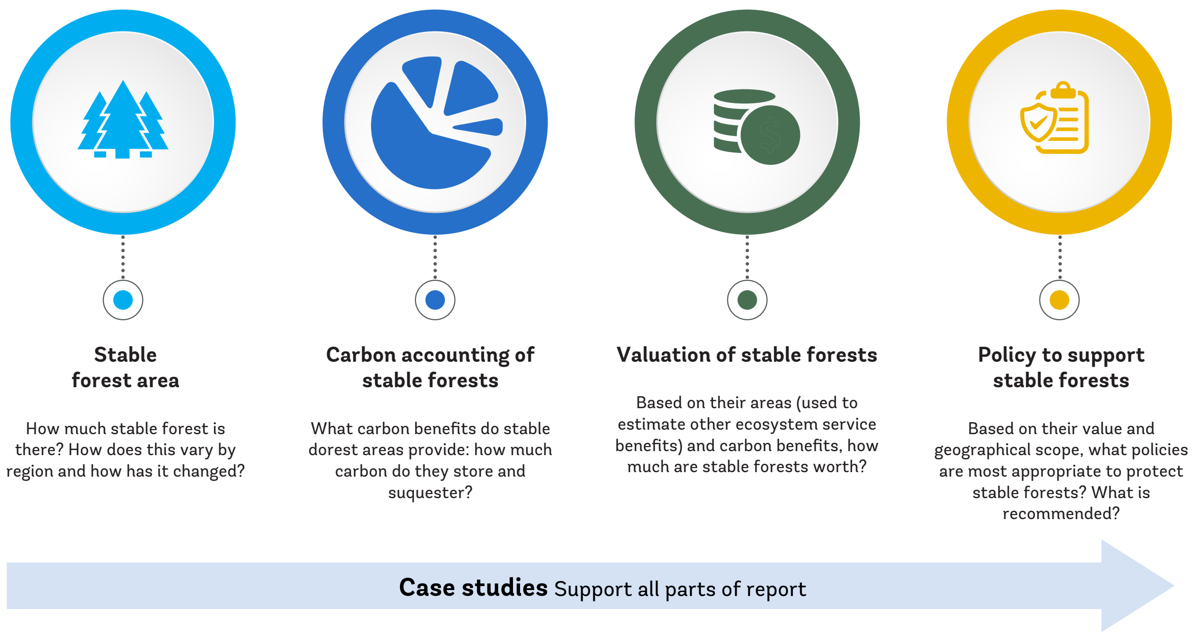
What is the global extent of stable forests?
What is the value of the benefits that stable forests provide?
What options do we have to effectively protect stable forests

1.3.2. Outline

The report is divided into 6 main chapters:

- **Chapter 1:** introduces the importance of stable forests and sets out the scope and objectives of the report.
- **Chapter 2:** addresses the mitigation potential of global stable forests, considering their area and distribution at a 100 m resolution.
- **Chapter 3:** considers carbon stocks in stable forests and their sequestration potential.
- **Chapter 4:** discusses the economic value of stable forests, using the data presented in the first two chapters.
- **Chapter 5:** presents policy options and recommendations for stable forests, building on information in Chapters 2–4 (Figure 2).
- **Chapter 6: applies the spatial, economic, and policy analysis to five case study countries. All other chapters** draw upon the information and key takeaways gleaned from the case studies presented in Chapter 6 (Figure 2).

Figure 2. Stable forest report outline



The report is accompanied by a Glossary defining key terms and three Annexes with additional supporting literature review research, data, and methodologies:

- **Annex A:** presents a literature review of the definition and scope of stable forests and economic and policy approaches to conserve them.
- **Annex B:** provides additional data and methodology to accompany Chapters 2 and 3.
- **Annex C:** accompanies the case studies with additional data, literature review, and methodology.

1.3.3. Target audience

The report has been developed for policy makers (and civil society adjacent to policy making) both in countries with significant areas of stable forests and in countries with a potential interest in providing finance and financial systems to protect and maintain stable forests.

1.3.4.Scope

Forest area

Stable forest

To analyze stable forests, a specific spatial scope was adopted to represent areas "not already significantly disturbed nor facing predictable near-future risks of anthropogenic disturbance" (Funk et al. 2019).

Global stable forest criteria: areas with tree height greater than 5 m, tree canopy cover on more than 25% of the area, greater than 1 km from the forest edge, and with low-to-moderate human pressure determined using the Human Footprint layer.

These criteria are explained in more detail in Chapter 2 and are more specific in the case studies in Chapter 6, where the distance from forest edge is based on analysis of where most deforestation across all forests occurred over the past two decades within each country. Analysis of stable forest area is performed at a 100 m resolution and is sensitive to any changes in resolution.

At-risk forest

Forest area which is not defined as stable is referred to as "at-risk forest" as it is under greater threat of deforestation or degradation than stable forests. In this report, the term at-risk does not necessarily suggest that these forests are unsustainably managed, are not valuable, or that all share an identical risk of deforestation or degradation. At-risk forests are merely closer to anthropogenic influences and therefore could be at a greater risk of disturbance. At-risk forests would include areas of sustainably managed forest harvested for timber, or small areas of forest that although not at great risk of deforestation are nevertheless near human settlements. In theory, both those types could be maintained in perpetuity as forests, but such areas that are under active human management are beyond the scope of this report.

Stable forest loss

In this report, "stable forest loss" includes any loss of stable forest area due to *conversion to at-risk forest.* Conversion to at-risk forest occurs due to a change in distance from forest edge; this proximity to forest edge exposes the forests to human influence and the risk of forest degradation and/or deforestation. By definition, direct deforestation of stable forests cannot occur, because the access factors needed to allow deforestation would immediately class the forest as "at-risk." Where deforestation of stable forests is recorded, this represents an area that transitioned from stable forest through the at-risk category to deforestation. The "deforestation of stable forest" referred to in this report therefore highlights areas that were converted to at-risk forest and later deforested, rather than direct deforestation of stable forests.

Non-carbon benefits

The non-carbon benefits included in this report (Chapter 4 and Chapter 6) are: biodiversity, non-timber forest uses (including non-timber forest products—NTFPs—as well as ecotourism and recreation), and hydrological services. Although stable forests provide many other ecosystem services, these additional services are not included in the analyses presented here.

Geographic scope

The spatial scope of the report changes by section reflecting the balance between the complexity of analysis and the significance of stable forests by geography:

- **Chapter 2**: **Mitigation potential**: This is a *global* analysis. The analysis also considers stable forests broken down by: continent, protected areas, the top 10 countries by stable forest area, different ecological zones, and high-forest low-deforestation (HFLD) countries.
- **Chapter 3: Carbon stocks:** This is a *global* analysis.
- **Chapter 4: Valuation of stable forests:** The economic valuation focuses on stable forests in *tropical ecological zones.*
- **Chapter 5: Policy to support stable forests:** The policy analysis is *global*, presenting international and domestic level options to conserve stable forests.
- **Chapter 6: Stable forests in case study countries:** This analysis focuses on *Georgia, Guyana, Indonesia, Liberia,* and the *Republic of Congo*.

The tropics hold 87.7% of stable forests and account for 78.8% of all global stable forest losses from 2010 to 2019 (Table 2). As such, they are a higher priority for policy options to protect stable forests and therefore were selected for the valuation analysis. To reflect this, four of the five case study countries are in the tropics.

Table 2. Stable forest area and losses in the tropics

Region	Stable forest area 2019 (ha)	Stable forest area lost (2010–2019) (ha)
Tropical	548,108,357	128,213,028
Non-Tropical	76,830,027	34,399,728

Temporal scope

The analyses in Chapters 2–4 consider stable forests in 2010 and 2019. At the case study level in Chapter 6, the analysis includes stable forests in 2000, 2010, and 2019.

1.4 Key international policy framework

Forest conservation is an important part of the international climate regime, including the United Nations Framework Convention on Climate Change (UNFCCC) and its Paris Agreement and the Convention on Biological Diversity (CBD). A "conservation credit" could be developed within these frameworks. These are introduced below to provide context and are discussed in more detail in Chapter 5.

1.4.1 Existing International Agreements

UNFCCC, the Paris Agreement, and REDD+

The UNFCCC recognized the importance of conserving and enhancing forests in 1992 (Article 4.1(d)). Within the UNFCCC, stable forests could be considered in countries' Nationally Determined Contributions (NDCs) under the Paris Agreement, an international treaty adopted in December 2015. Articles 5, 6.2, 6.8 and 9.1 of the Paris Agreement allow the most flexibility for Parties to define the terms and conditions of their cooperation and are the most likely options to support stable forests.

The Paris Agreement includes REDD+ under Article 5, which includes the conservation of forest carbon stocks and sustainable management of forests within the five REDD+ activities. However, even though stable forests continue to naturally sequester carbon and serve as an important sink that must be protected to mitigate climate change, results-based finance for REDD+ focuses on reducing historical anthropogenic emissions from deforestation and forest degradation or increases in carbon sequestration above a reference level. Most areas of stable forests do not have a history of deforestation and are not under imminent threat. Therefore, they are unlikely to be valued or benefit from (or even be considered for) results-based efforts focused on reducing anthropogenic GHGs or increasing removals.

Article 6 of the Paris Agreement contains three mechanisms for Parties to collaborate to implement their NDCs. Article 6.2 focuses on cooperation between Parties on mitigation and adaptation, Article 6.4 is seen as a new emissions trading mechanism for offsets, and Article 6.8 focuses on nonmarket approaches to promote mitigation and adaptation ambition amongst other goals. Article 6 does not mention specific sectors and there are different opinions on whether forests and REDD+ are included under key clauses. Negotiations on further guidance for these articles are ongoing, but stable forests' ecosystem services fall within the "non-carbon benefits" and resilience aspects of articles 5 and 6. Article 9.1 is a catch-all obligation on developed countries to provide financial resources to assist developing countries' obligations regarding mitigation and adaptation under the UNFCCC.

CBD

The CBD is a multilateral treaty signed in 1992 that aims to a) conserve biological diversity, b) promote sustainable use of the components of biodiversity, and c) allow for fair and equitable sharing of benefits arising from the utilization of genetic resources. Key commitments relevant to stable forests include ones to: increase the amount of effectively managed protected areas, reduce harmful subsidies, value and protect ecosystems and the services they provide, and mobilize financial resources to achieve these goals. Each of these commitments contained indicators under the Aichi Targets, which were created in 2010 as part of the CBD's Strategic Plan for Biodiversity 2011–2020. The Aichi Targets were intended to create an overarching framework on biodiversity not only for the CBD and its protocols, but for the entire United Nations system, including treaties addressing climate change. New Goals, Milestones, Targets and Indicators are being developed for the Post-2020 Global Biodiversity Framework that will affect protected areas and any forests they contain. This new framework is still being finalized, but the most recent draft has targets to expand conservation areas to 30 percent of the earth's surface by 2030 and to ensure 50 percent of land areas globally are under spatial planning to address land use change and retain most of the existing intact and wilderness areas (Convention on Biological Diversity, 2020).

1.4.2 Conservation credits

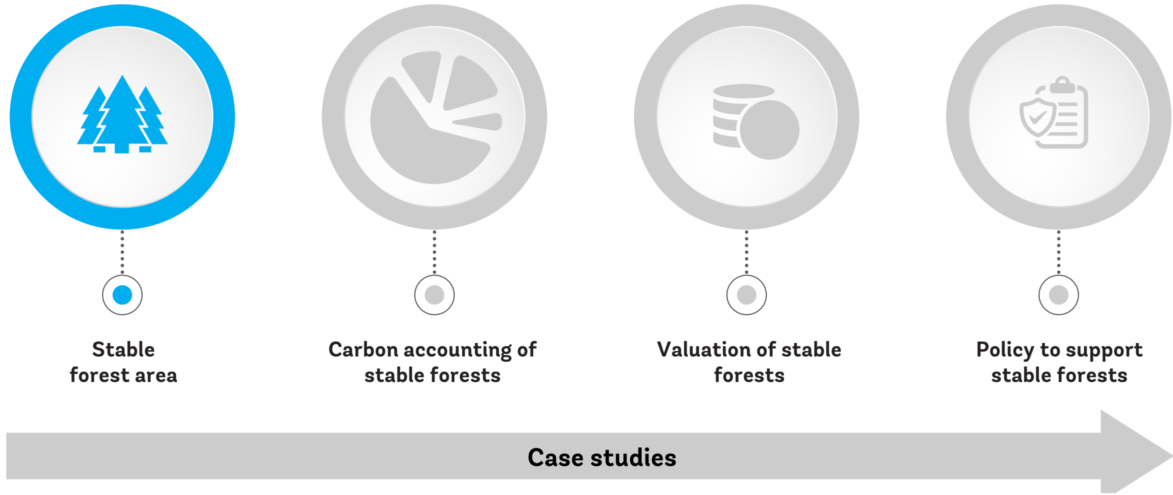
This report introduces the concept of a "*conservation credit*" in Chapter 5 as a common international accounting unit to stack ecosystem services associated with stable forests. This can start with the ecosystem services included in this report (carbon storage and sequestration, hydrological services, NTFPs, and biodiversity) and extend to others as needed. Stacking ecosystem services into a single credit combines objectives of different conventions into a comparable unit and would allow for monitoring, valuation, and comparisons over time and between stable forests. This type of credit could initially be described as a no-regrets strategy that uses a nonmarket mechanism to support a range of nonmarket policies that require monitoring and valuation of stable forests and will evolve to include market policies over time. The annual maintenance cost approach (a small portion of the total value of stable forest, described in Chapter 4) could be used as a starting point to value conservation credits, with the bundle of services and their valuation further tailored to countries' national circumstances and priorities. As stable forest areas are maintained, decrease, or increase, payments could be adjusted accordingly. The proposed credits are not offsets and recognize the key role stable forests must play in the global effort to achieve the Paris Agreement targets and the Convention on Biological Diversity's Post-2020 Global Biodiversity Framework.

Conservation credits could be paired with existing REDD+ policy and results-based financing, which would include protection of forests outside of stable forest areas. Within stable forests, REDD+ financing currently applies to only small areas of forest, and so REDD+ would not provide significant funding to generate conservation credits in stable forests. However, programs that limit further erosion of stable forest areas would be encouraged by the establishment of a separate "Stable Forest Fund" that provides maintenance funding for high value ecosystem services in stable forest areas that are not under immediate threat, as well as the generation of conservation credits.

When combined, the entire forest estate of at-risk and stable forest should be valued using these complementary approaches. In line with Paris Agreement and CBD funding aims, sources of funding for conservation credits would include a combination of donor funding and domestic government funding. Domestic resources may come from restructuring or redirecting existing subsidies and revenue, along with the private sector that can be incentivized through domestic policy and corporate social responsibility commitments. However, conservation credits are not a panacea. To be effective, conservation credits will need to attract domestic finance and be accompanied by domestic policy reform and improved forest governance, discussed in Chapter 5.

Chapter 2:

Stable forest area



SUMMARY

Overview

This chapter: a) provides a summary of the methodology used to assess global stable forests, b) estimates stable forest area globally and in key regions (including different biomes, HFLD countries, and protected areas), and c) estimates stable forest losses from 2010 to 2019. Stable forest area and loss rates are essential to identify areas of importance for policy focus and protection efforts.

Key findings

Stable forest area: There are 625 million ha of stable forests, of which more than half are in Latin America and the Caribbean (369 million ha).

Stable forest losses: Globally, 20.6% of stable forests were lost from 2010 to 2019. This loss represented a conversion to at-risk forests, some of which was later deforested.

At-risk forests from 2010 to 2019 were subject to deforestation at a rate four times faster than that recorded in the area that had been stable forest in 2010. Deforestation rates in tropical at-risk forests are eight times higher than in tropical stable forests and range from 3.4 to 34.7 times higher in case study countries.

Protection of stable forest areas: 43.2% of stable forests fall within protected areas. There is no correlation between stable forest area and the proportion of forest area registered as protected. 13.8% of stable forests were lost from protected areas from 2010 to 2019.

Stable forests within different biomes: Tropical forests account for approximately 50% of the world's forests but 87.7% of stable forests. Stable forests are underrepresented in temperate and boreal zones due to high fragmentation.

Stable forests in HFLD countries: In 2019, 13 HFLD countries held 15.8% of the world's stable forests. These countries have 2.7 times more stable forests as a percentage of forest area than the global average.

2.1. Mapping global stable forest area

2.1.1. Definition

Components

Building on the qualitative definition of stable forests from Funk et al. (2019), there are three main criteria that spatially define stable forests for the quantitative analysis in this study:

Canopy cover threshold: A 25% canopy threshold is used (as in the hinterland forest dataset; Tyukavina et al., 2016b). This threshold captures both deciduous and coniferous stands in tropical and temperate zones.

Distance from forest edge: Multiple studies have found that most degradation occurs within 1 km of the forest edge, including higher tree mortality driven by anthropogenic and natural causes (Ibisch et al., 2016; Tyukavina et al., 2016).

Human footprint: Measurement of human disturbance as an indicator of forest stability was identified as an important factor in our literature review (see Annex A), leading to the inclusion of the human footprint layer produced by Venter et al. (2016). This layer incorporates the built environment, trends in land cover change, and population density, to provide a standard global anthropogenic pressure index. A low-to-moderate human pressure threshold is used in this analysis (defined here as a human footprint index less than 3 on a 1–10 scale, with 10 being the greatest human pressure); this aligns with existing mapping efforts, including the "Last of the Wild" areas (Allen et al., 2017).[8]

Alignment with other forest delineations

The original intention of the study was to use an existing spatial delineation from the literature. However, the purposes of these definitions vary, such that none proved entirely suitable. Instead, the definition proposed adopts existing definitions as a foundation, subject to changes as detailed here. Stable forests were compared to three popular spatial definitions analyzing forests with low human impact: Intact Forest Landscapes (IFL) (Potapov et al., 2008), primary tropical forest area (Turubanova et al., 2018), and hinterland forests (Tyukavina et al., 2016b) (Table 3). A detailed analysis of other literature studying forests that could be considered stable is presented in Annex A.1. The stable forest definition presented here builds on these three and other forest delineations in the following ways:

Time relevance: It uses forest loss data up to 2019, making it more up to date than existing delineations.

Biomes: Stable forest area is evaluated in both temperate and tropical regions, unlike many other studies (see Annex A.1).

Patch size: This analysis does not incorporate a patch size constraint, unlike the widely regarded IFL dataset, (minimum area of 50,000 ha) or hinterland forest delineation (minimum area of 10,000 ha). These sizes are informed by the areas required to sustain viable populations of large mammals. Because the objective of this analysis was not focused on biodiversity but rather on risk of anthropogenic influence, patch size was excluded from the definition of stable forests. Therefore, the delineation of stable forests includes smaller patches that may be excluded from the IFL or hinterland definitions but have a low risk of deforestation.

Forested areas: The definition focuses solely on forest areas, unlike IFL which includes some non-forest landscapes (predominantly in Northern temperate areas, visible in Figure 3).

Specificity: Stable forest analysis is more specific than only evaluating primary forests because although many stable forests are considered primary forest, not all primary forests are stable as they may be susceptible to high rates of deforestation.

Flexibility: This methodology can be flexible over different landscapes by using local historical deforestation of all forests to inform the distance criteria to stable forests (used for case studies in Chapter 6).

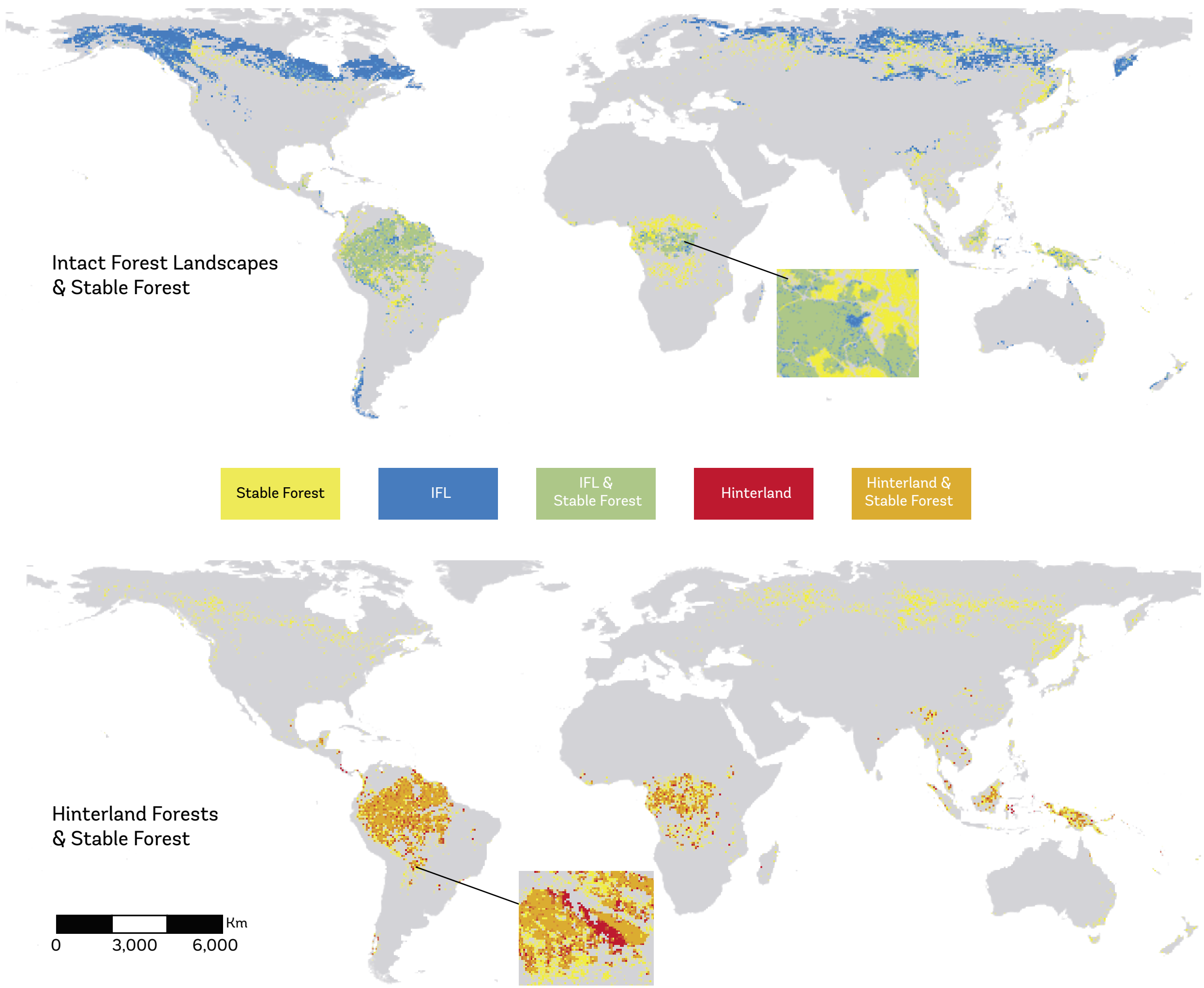
7 Forest Structural Condition Index (SCI) and the Forest Structural Integrity Index (FSII) from the Hansen et al. (2019) dataset were not included as components in the definition of stable forest for this analysis as these spatial layers do not have global coverage (see Annex A, Figure A.3).

Table 3. Comparison of stable forest spatial definition to other key forest definitions from Potapov et al. (2008), Turubanova et al. (2018) and Tyukavina et al. (2016). For additional comparison of forest definitions, see Annex A.

Forest Delineation	Definition	Parameters	Strengths	Gaps
Intact Forest Landscapes	Forest and non-forest areas in an unbroken expanse of natural ecosystems within current forest extent, showing no signs of significant human activity, and large enough that all native biodiversity, including viable populations of wide-ranging species, could be maintained (Potapov et al., 2008).	**Layer year(s)**: 2000, 2013, 2016 **Extent**: Global **Minimum patch size**: 50,000 ha **Minimum width**: 10 km (2 km at corridors)	- Provides multiple time points, allowing for change analysis - Method has been applied to national scale monitoring	- Focuses on biodiversity overlooks highly valuable, smaller patches of stable forests - Once forest is excluded as an IFL, it cannot be restored - Includes non-forest area
Primary Humid Tropical Forest	Mature natural humid tropical forest cover that has not been completely cleared and regrown in recent history (Turubanova et al., 2018).	**Layer year(s)**: 2001 **Extent**: Tropical **Minimum patch size**: none **Minimum width**: none	- Medium (30 m) resolution - Includes forest area excluded from IFL	- Excludes non-tropical primary forest - Only available at one time period
Hinterland Forests	Structurally intact forest, less likely to be affected by degradation dynamics (Tyukavina et al., 2016).	**Layer year(s)**: 2007, 2012 **Extent**: Tropical **Minimum patch size**: 10,000 ha **Minimum width**: 2 km at corridors	- Provides multiple time points, allowing for change analysis - Includes 12-year interval of extant forest with no disturbance - Flexible criteria depending on the planned application	- Excludes non-tropical forest - Low resolution (90 m)
Stable Forests	Forests not already significantly disturbed nor facing predictable near-future risks of anthropogenic disturbance (Funk et al., 2019).	**Layer year(s)**: 2010, 2019 **Extent**: Global **Minimum patch size**: none **Minimum width**: none	- Flexible over different landscapes by using historical deforestation of all forests to inform the distance criteria - Forest loss data up to 2019 (more up to date)	- Global data presented has a low spatial resolution (100 m)

Stable forests, as defined by the global criteria, overlap well with existing datasets. Over 90% of stable forest areas overlap with one or more of the three datasets analyzed above. This high level of agreement can be attributed to the fact that while each delineation measures slightly different characteristics, all focus on forests predominantly exempt from human impact. This definition also adds relevant areas that may not be included in the above datasets. When compared with the IFL layer, 31.1% of areas defined as stable forests fall outside of IFL areas, highlighting that this analysis captures forest area that has been previously unaccounted for but that still has minimal human disturbance and a low risk of deforestation and degradation (Figure 3).

Figure 3. Stable forest compared with hinterland forests (bottom) and intact forest landscapes (IFL) (top)

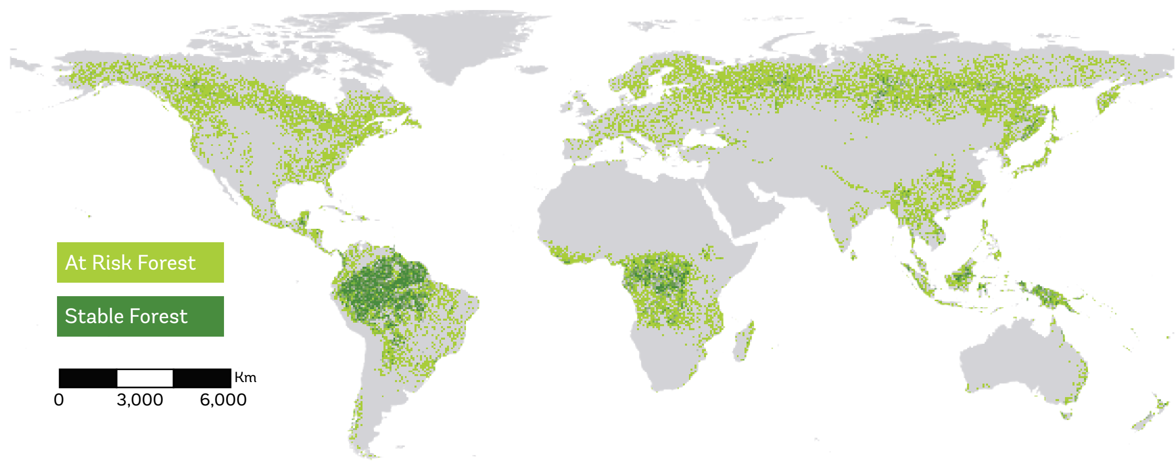


Ideal stable forest definition

An ideal stable forest definition would be readily applicable globally at a high resolution (for example, at least a 30 m resolution, which would refine estimates of stable forest area) through all ecological zones and would be flexible to include many points in time and thereby allow detailed comparison. A reliable forest cover layer is integral to a stable forest definition. The definition should include variables that capture forest degradation. The definition should not include a patch size constraint, in order to capture smaller forest areas that could be important for biodiversity and other ecosystem services. The type of edge to patches would be important: for example, the mere existence of a road—if distant from human populations—is not necessarily an overt risk to forest stability. Furthermore, forest areas under long-term sustainable forest management could be very stable. A deforestation edge should be the greater focus, as such an edge gives access to illegal entry, to escaped fires and stray livestock, as well as to drought conditions and wind damage. A variable to account for anthropogenic pressures over time—including continual road creation, expanding land use conversion, and growing population—would also be an important component of an ideal definition.

An ideal definition of stable forests could also rely on an analysis of all past deforestation and degradation in an area, current land use, population, and other socioeconomic factors to generate a model of both current and likely future risk of deforestation and degradation. Results of this model could then be used to define areas that are at low risk of deforestation and degradation, not only based on forest characteristics but also more detailed anthropogenic factors. However, there are time and resource constraints to such a detailed measurement.

Figure 4. Global stable forests in 2019



2.1.2. Mapping approach

The Global Forest Change dataset (Hansen et al., 2013) is used to determine the forest layer, the annual loss of forests, and distance to the forest edge. The forest mask and distance metric were combined with the Human Footprint dataset and other boundaries such as administrative regions, protected areas, and global ecological zones. The resulting dataset is pixel-specific and allows the user to identify forest areas at the appropriate distance to the edge and under the desired human pressure threshold. The final dataset may underestimate stable forests in temperate zones due to the use of the Hansen et al. (2013) dataset, which has been found to underrepresent forest change within temperate forests. Furthermore, the Hansen et al. (2013) global forest change product does not capture forests that are below five meters tall, and thus excludes important boreal forest systems (Seidl et al. 2020). There are a range of factors contributing to uncertainty in these estimates, discussed in Annex B.1. This analysis of stable forests is at a 100 m resolution and therefore stable forest area, losses, carbon stocks, and removals presented below are sensitive to any changes in resolution. Detailed methodology can also be found in Annex B.1.

2.2. Global stable forests

2.2.1. Stable forest area

Latin America and the Caribbean hold the greatest area of stable forests (369 million ha), accounting for 38.4% of LAC's total forest area (Figure 5) and 59% of the world's stable forests. More than half (52%) of stable forests are in just three countries (Brazil, Russia, and the Democratic Republic of the Congo) (see Annex B.2.1 for more details and areas). Brazil alone holds over 208 million ha of stable forests. The importance of stable forests also depends on the percentage of forested area considered stable. There are four countries in which stable forests cover over half of the total forest area, including recognized high forest low deforestation (HFLD) countries (da Fonseca et al., 2007) such as French Guiana, Suriname, and Guyana. Annex B.2 breaks down stable forest areas by various criteria, including biomes, and lists the "top 10" countries, first in terms of total stable forest area, then in terms of proportion of forest that is stable. Seven of the top 10 countries by percentage stable forest, and five of the top 10 countries by total stable forest area, are in South America, highlighting the continent's importance in the conservation of stable forests.

Area of stable forests:
625 million ha

% of forest area:
16.6%

2.2.2. Stable forest loss

Although stable forests are broadly characterized by a lack of human impact, rapid deforestation in at-risk areas undermines their inherent stability. Loss of stable forest is an outcome of extending forest edges due to deforestation in at-risk forests, resulting in a conversion of stable to at-risk forest. In the tropics, 19.0% of stable forest area was lost from 2010 to 2019. Deforestation of area that was stable forest in 2010 was 0.18% yr^{-1} from 2010 to 2019, compared to 0.71% in at-risk forests (four times greater). In the tropics, this trend is more pronounced: at-risk forests undergo eight times greater deforestation than stable forests. These patterns highlight the importance of addressing degradation and deforestation, particularly at forest edges, to protect stable forests. The difference between deforestation rates in at-risk relative to stable forests is greater at the case study level (Figure 6). This underlines the importance of analyzing stable forests at a national rather than global level, as the definition of stable forests will be more specific to country deforestation conditions. The distance-to-edge criterion changes in response to the proportion of area lost in each 500 m distance band from the forest edge. Notably, all stable forest deforestation from 2010 to 2019 occurs in areas that were first converted to at-risk forest at some point in the 2010 to 2019 period before being deforested.

Stable forest conversion to at-risk forest in case study countries

In the five case study countries analyzed in Chapter 6, stable forest loss rates varied greatly by country; it was by far highest in Liberia, which has witnessed rapid declines in stable and at-risk forest cover.

INDCs of top 10 countries

Forest protection and reforestation are a major part of the commitments the countries with the top 10 greatest stable forest areas have made in their Intended Nationally Determined Contributions (INDCs). These commitments may have significant impacts on stable forest area in the future. While countries such as Bolivia and Venezuela have set specific forest area targets, others, including Canada and Indonesia, have pledged to protect all existing forests. Indonesia has also committed to including community-based forest management as a tool to reduce pressure on valuable primary forest.

Figure 5. Percentage of forest area comprised of stable forest area and at-risk forest area in 2019

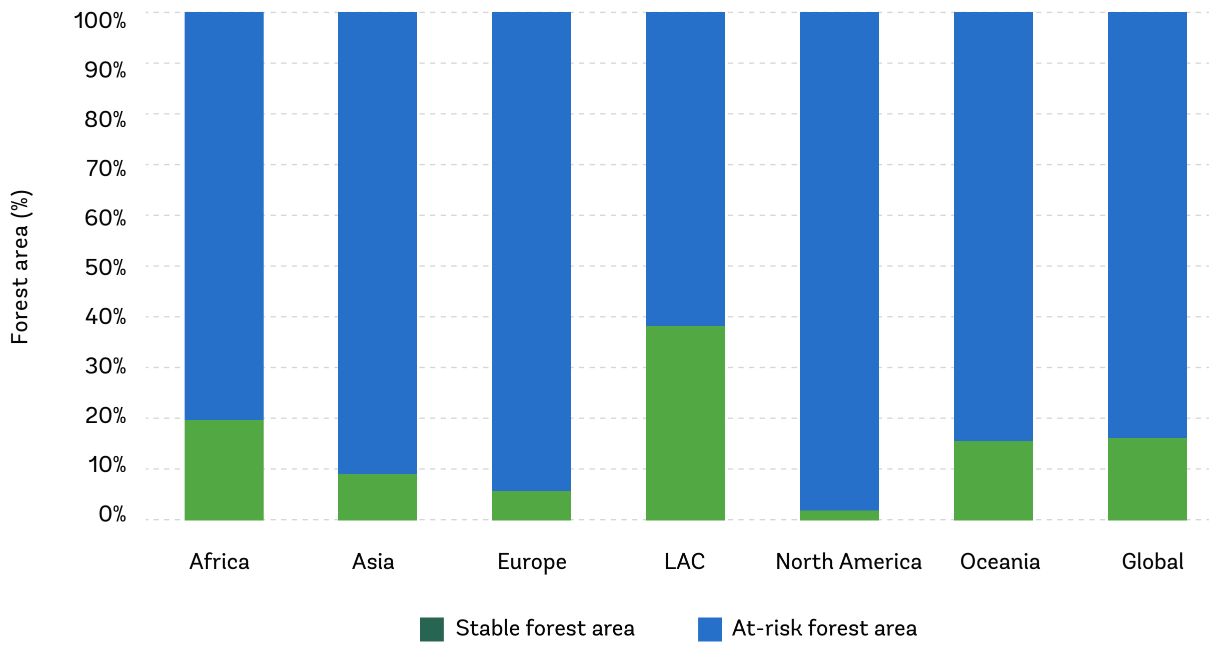
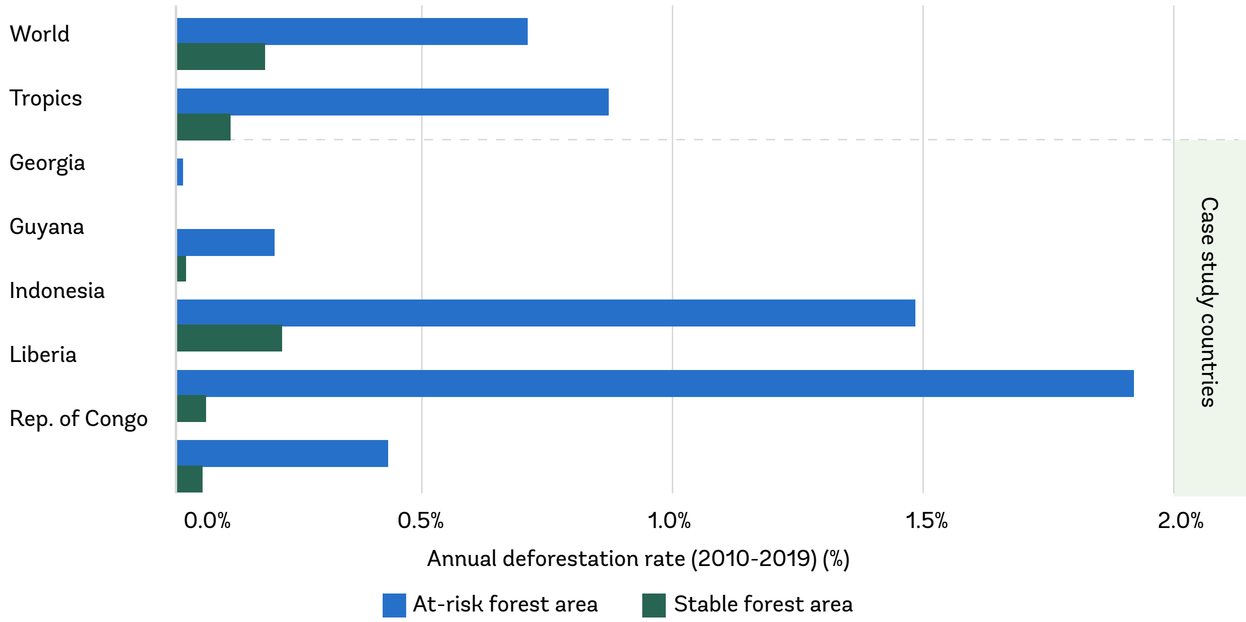


Figure 6. Comparison of average annual deforestation rates (2010–2019) in stable and at-risk forests



Stable forest losses (due to a conversion to at-risk forest) are not correlated to country income level: loss rates in high-income (29.7%) and upper-middle-income countries (18.1%) are similar to lower-middle- income (30.6%) and low-income (21.9%) countries. They also have no correlation with Human Development Index (HDI) ranking (see Annex B.2 for all loss rates by income and HDI ranking). Stable forest loss is therefore not only an issue in lower income or less developed countries, but rather a global phenomenon we must address.

Stable forest conversion to at-risk forest in case study countries

In the five case study countries analyzed in Chapter 6, stable forest loss rates varied greatly by country; it was by far highest in Liberia, which has witnessed rapid declines in stable and at-risk forest cover.

Country	Stable forest loss (2000-2019)	Stable forest loss (2010–2019)
Georgia	18.2%	4.9%
Guyana	25.8%	15.2%
Indonesia	49.0%	27.4%
Liberia	84.6%	51.7%
Republic of Congo	38.4%	22.8%

2.2.3. Alignment with biomes

Area of stable forests: 625
% stable forests in tropics:
87.7% (vs. 50.2% of all forests)

Tropical forests hold 87.7% of stable forests, dominated by tropical rainforest and tropical moist forest (see Annex B.2.3 for a breakdown by ecological zone).[9] Forests in temperate zones are more fragmented than dense tropical forests, resulting in a relatively low area of stable forests. Given the high proportion of stable forests in the tropics, it is crucial that policies target issues relevant to tropical countries. This need is reflected in case study selection in Chapter 6, which is predominantly focused on countries in the tropics. Stable forests may be underrepresented in non-tropical areas due to the extent of the Hansen dataset used in this analysis, discussed above.

2.2.4. Alignment with protected areas

Stable forests protected: 43.2%
% All forests protected: 20.1%

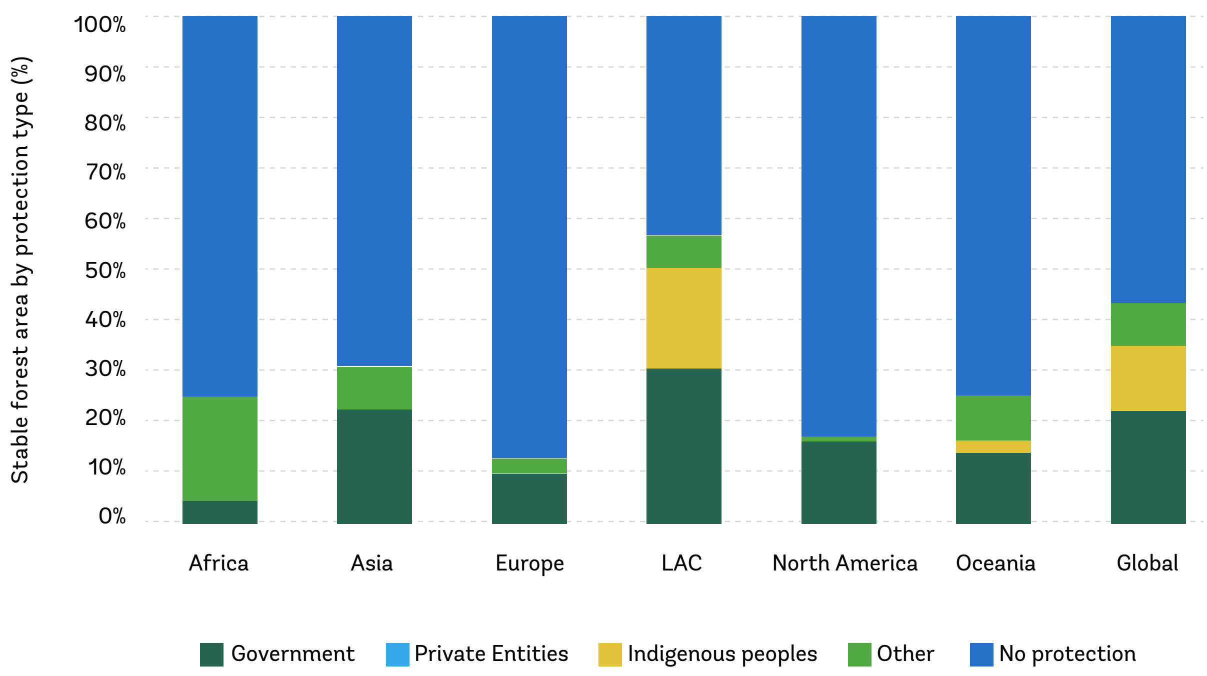
Latin America and the Caribbean have the greatest protection rates of stable forests at 57%.[10] The percentage of stable forests under some form of protection varies widely at the national level (see Annex C.2 for protection rates in top 10 countries by stable forest area). The most common form of protected stable forest area is government protection, which covers 23% of stable forests globally and comprises more than half (52%) of stable forests within protected areas (Figure 7).

Case study countries: high stable forest losses even within protected areas

In Liberia, protected areas witnessed lower loss rates in stable forests from 2000 to 2019 (66.04%) than non-protected stable forest (88.80%, see Annex C.6). However, these rates remain extremely high even within protected areas. The same applies in Indonesia, where stable forest net loss was 34.93% in protected areas and 52.41% in non-protected areas. In the Republic of Congo, a large majority of stable forests lie within designated protected areas (69.9%). Although net stable forest loss from 2010 to 2019 is less in protected areas overall (19.89%) compared to non-protected stable forests (50.84%), protected areas that are reported as government-managed appear to have higher rates of stable forest loss (51.8%) than areas not under any protection (19.34%—see Annex C.7). From the case study analysis, it is clear that governance plays a significant role in how effective protected areas are in preventing deforestation and stable forest losses (see Chapter 5). For example, Liberia has very low governance indicators for key areas such as government effectiveness, regulatory quality, rule of law, and control of corruption: this reduces the scope for domestic policy options to be effective. This is supported by the literature; global analysis across 71 countries found protected areas were more effective in countries with higher levels of control of corruption, protection of property rights, and democracy, but did not find a correlation between political stability and deforestation (Abman, 2018).

9 Stable forest area within ecological regions evaluated using the Food and Agriculture Organization (FAO) Global Ecological Zones spatial layer (FAO, 2013).
10 Stable forest area within area under protection is evaluated according to the IUCN World Database of Protected Areas (IUCN & UNEP-WCMC, 2014). Based on IUCN categories, four sub-categories of protected area under different governance structures were generated for the purposes of this analysis: Government, Private entities, Indigenous peoples, and Other (details of each category are in Annex B.1).

Figure 7. Proportion of stable forest area by protection type and continent



2.2.5. Alignment with HFLD nations

HFLD analysis

Countries with HFLD status could particularly stand to benefit from highlighting the value of stable forests, alongside other work to preserve forest at greater risk of deforestation and degradation. A list of HFLD countries in 2019 is presented in Table 4, developed using data from the Food and Agriculture Organization's (FAO) statistical database (FAOSTAT) updated with the latest 2020 Forest Resources Assessment (FRA). The methodology requires countries to have a minimum of 50% forest cover and a rate of change in forest area less than the global average based on FAOSTAT data over a 10-year period, based on the approach of da Fonseca et al. (2007).[11] Countries with an HDI over 0.8 in 2019 (considered very high human development) (UNDP, 2020) are excluded to focus the analysis on high-priority countries: less developed countries have a greater risk of deforestation (Jha & Bawa, 2006). This resembles the exclusive focus by da Fonseca et al. (2007) on "developing" countries. A list of HFLD countries in 2010 was also generated using the same approach to serve as a basis for comparing changes in HFLD status over time. This is because FAOSTAT data is subject to retroactive updates and although closely aligned, this approach may have differed slightly to that of da Fonseca et al. (2007) and therefore a direct comparison may be subject to misinterpretation.

Stable forests in HFLD nations

In 13 HFLD countries or territories[12] (Table 4), the percentage of forests that are stable is 2.7 times greater than the global average: stable forests comprise 45.5% of HFLD forests compared to 16.6% globally. This highlights the immense importance of stable forests in HFLD countries. There have, however, been relatively high rates of stable forest conversion to at-risk forest in some HFLD countries from 2010 to 2019, exceeding the global loss average in seven countries.

% all stable forests in HFLD countries: 15.8%

11 The rate of net conversion of global forest area was 0.263% from 2009 to 2019 and 0.296% from 2000 to 2010 using FAOSTAT data. This value does not consider afforestation and reforestation, but instead only net area converted from forest land to other land uses over the previous decade. These values were used in place of the 0.22% deforestation rate used by da Fonseca et al.

12 Note that the islands of American Samoa, Cook Islands, Dominica, Grenada, Guam, Marshall Islands, Niue, Pitcairn, Saint Vincent and the Grenadines, Seychelles, and the United States Virgin Islands are also considered to be HFLD according to the above criteria but are excluded from this list as they all have less than 50,000 ha of forest in 2019 according to FAOSTAT and therefore their contribution to forest and stable forest area is minimal. The Federated States of Micronesia has 64,000 ha of forest area but is beyond the borders of the global spatial analysis and therefore is also excluded.

Table 4. Stable forest area in HFLD countries and territories (using updated da Fonseca et al. approach) with HDI < 0.8, 2019

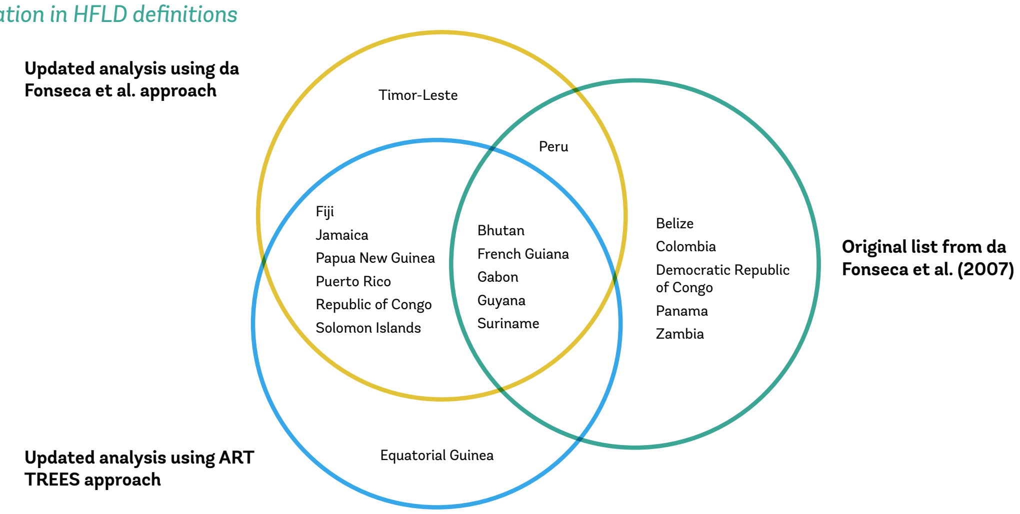
Country*	Stable forest area, 2019 (ha)	Total forest area, 2019 (ha)	% of forest area that is stable forest	% Loss of stable forests, 2010–2019
Bhutan	54,975	2,596,708	2.1%	6.5%
Fiji	142,286	1,317,887	10.8%	33.0%
French Guiana	5,359,939	8,092,332	66.2%	16.2%
Gabon	9,584,397	24,498,170	39.1%	28.0%
Guyana	11,433,798	18,807,525	60.8%	15.3%
Jamaica	28,328	730,439	3.9%	26.1%
Papua New Guinea	10,455,454	41,320,034	25.3%	29.2%
Peru	40,924,843	75,166,270	54.4%	15.8%
Puerto Rico	786	457,835	0.2%	65.9%
Republic of Congo	11,627,998	27,768,879	41.9%	24.2%
Solomon Islands	148,507	2,371,789	6.3%	70.8%
Suriname	9,268,728	13,773,244	67.3%	14.6%
Timor-Leste	1,330	731,444	0.2%	19.0%
Total	99,031,369	217,632,556	45.5%	19.9%

HFLD definition variations

This analysis also compiles a list of HFLD countries based on the REDD+ Environmental Excellence Standard (TREES) version 2.0 approach developed by the Architecture for REDD+ Transactions (ART) (ART Secretariat, 2021). The ART TREES HFLD approach allows participants with an HFLD score greater than 0.5 to qualify for the TREES HFLD label. The HFLD score is calculated for participants with forest cover greater than 50% and annual deforestation rate less than 0.5% during the historical reference period, and is derived from a "forest cover score" and "deforestation score" (described in more detail in TREES v2.0). This analysis uses a historical reference period of 10 years. In comparison with the methodology presented above and using the same FAOSTAT data, one additional country would be included as HFLD (Equatorial Guinea) and two would be excluded (Peru and Timor-Leste) (Figure 8).

In contrast to the list of HFLD countries and territories proposed by da Fonseca et al., the updated list does not include Panama, Colombia, the Democratic Republic of Congo, and Belize. Even though all these countries have over 50% forest cover, their rates of change in forest area exceed the global average over the past 10 years.

Figure 8. Variation in HFLD definitions



HFLD status: past changes and future threats

Some countries lose HFLD status due to increased deforestation or a drop in forest cover below 50%. Using FAOSTAT data and the da Fonseca approach to calculate HFLD countries in 2010, five countries lost HFLD status from 2010 to 2019: Cambodia, Laos, Samoa, São Tomé and Príncipe, and Zambia.

Forests in HFLD countries may be threatened by changing populations. Rapid population growth could exacerbate pressure on natural resources. The median annual population growth in HFLD countries and territories (for which data is available) is 0.98%, less than the global average of 1.08%. However, certain HFLD countries such as the Republic of Congo, Solomon Islands, Gabon, and Papua New Guinea have much higher growth rates (2.6%, 2.6%, 2.5%, and 2.0%, respectively; World Bank, 2020c) and therefore could be susceptible to greater deforestation and forest degradation, threatening their HFLD status. For example, Zambia, which lost HFLD status, has a very high population growth rate of 2.9%, ranking in the top 20 globally.

HFLD Case study country: Republic of Congo

Two of the five case studies considered in Chapter 6 are HFLD: Guyana and the Republic of Congo (RoC). Guyana and RoC have high proportions of stable forest area (60.7% and 57.2% respectively in the case study analyses). RoC could be more at risk than Guyana of losing HFLD status. While 2.8% of all forests were lost from 2000 to 2019, 38.4% of stable forests were lost, indicating there is significant human presence in forests despite low overall deforestation. RoC currently ranks in the bottom 10th percentile on key governance indicators of government effectiveness, regulatory quality, and control of corruption. It has consistently received low rankings on these indicators from 2000 to 2019, with a notable and steady decline in control of corruption between 2005 and 2019 (see Annex C.7). It has conditionally committed to reducing deforestation by 20% by 2035, but like many other countries has highlighted the need for support from international finance mechanisms to meet its international commitments. Its commitments create clear opportunities to collaborate with other countries to protect stable forests under Articles 5, 6.2, 6.8 and 9.1 of the Paris Agreement. This could include collaboration on a "conservation credit" approach that allowed consistent monitoring and valuation of stable forests, which could be connected to domestic policy and would include stable forests not considered under the REDD+ framework that RoC already engages in.

The likelihood of HFLD countries losing their HFLD status will depend on national policies, including their INDC or NDC forest-related commitments. Some countries, such as Bhutan, Papua New Guinea, Jamaica, and Suriname, aim to maintain all their current forests, which would guarantee future HFLD status. Papua New Guinea aims to achieve a 25% reduction in both the area undergoing deforestation and degradation compared to 2015 levels, as well as increase tree planting. Other countries, such as the Solomon Islands, Fiji, and Micronesia, do not account for the forestry sector in their INDCs, although some acknowledge the importance of forests or existing efforts within the country to protect forests, such as Gabon. Developing an explicit forest-related goal in the INDCs of HFLD countries could be an important step in preserving stable forests and maintaining HFLD status. Any goals to protect stable forests should be combined with efforts to reduce deforestation and degradation in all forests and should not be implemented separately. Stable forests are inherently linked to the conservation of at-risk forests and therefore require an integrated strategy.

2.3. Gaps and recommendations for future research

This global analysis has highlighted technical gaps which hinder our understanding of stable forests and the benefits that they provide. These gaps should be prioritized in future research. Addressing these could improve how stable forests are valued and how policies are developed.

2.3.1 Drivers of stable forest losses

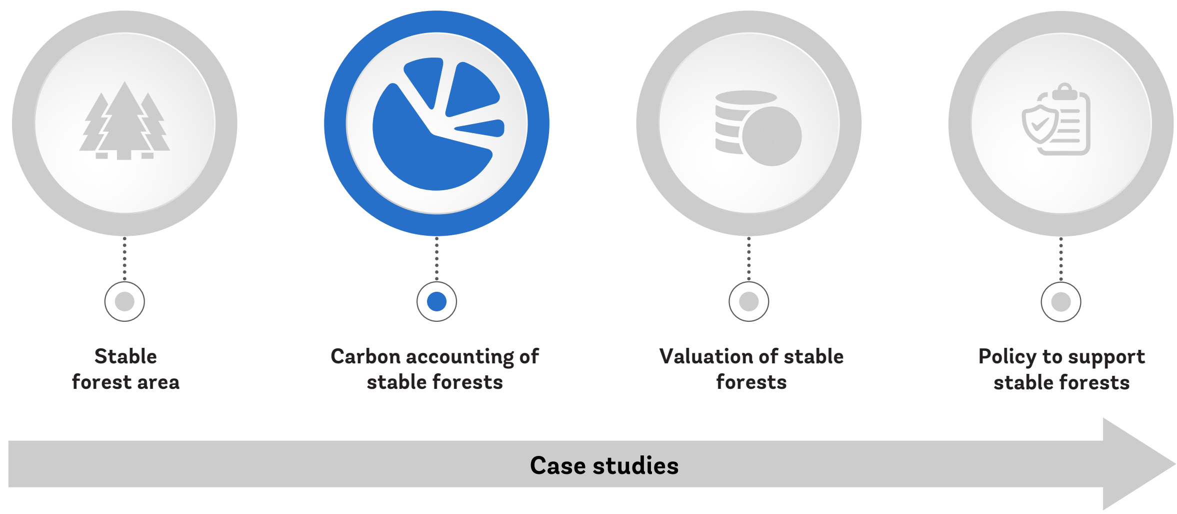
Gap identified from this analysis
Stable forest loss is significantly driven by fragmentation, given the importance of changing forest edges impacting stable forest area. There is a gap in our understanding of the drivers of fragmentation, which may differ slightly from the drivers of overall forest loss and must be understood, the better to prevent the conversion of stable to at-risk forest. This would form a specific new study area – drivers of loss of stable forests.

Recommended next step
A more detailed spatial analysis of the drivers of this fragmentation is recommended. This additional analysis should determine the relative contribution of different drivers, such as road building or clearing for agriculture, and should be linked to the analysis of drivers within REDD+. This research could also focus on where this fragmentation is happening, such as whether rapidly developing lower-middle income countries experience greater fragmentation rates.

Outcome
More targeted policies could then be developed to address these drivers and encourage sustainable management of forests. Policies should target both stable forest and at-risk forest through a combined strategy.

Chapter 3:

Carbon accounting of stable forests



SUMMARY

Overview

Estimating the carbon stored in and sequestered by stable forests is an important prerequisite of any engagement in current international financing schemes to protect forests, as discussed in Chapter 5. This chapter estimates the carbon stocks in stable forests and how much carbon stable forests remove from the atmosphere each year.

Key findings

Carbon stocks: Stable forests store approximately 140.9 billion tonnes of carbon. SOC accounts for 27.6% of total carbon stored in stable forests worldwide.

Carbon removals: Stable forests sequestered roughly 416 million tonnes of carbon (1,527 million tonnes of carbon dioxide equivalent) in 2019. Tropical stable forests accounted for 81% of these removals, especially tropical rainforests, which accounted for 73% of global stable forest removals.

3.1 Estimating mitigation potential

3.1.1 Carbon stocks

The analysis includes stable forest carbon stocks in aboveground biomass (AGB), belowground biomass (BGB) and soil organic carbon (SOC), building on previous literature that has predominantly focused on AGB (see Annex A.3). To calculate carbon stocks within stable and at-risk forest areas, the stable and at-risk forest delineations were overlaid with aboveground and SOC carbon layers from the GEOCARBON dataset (Avitabile et al., 2014, 2016; Santoro et al., 2015) and the Global Soil Organic Carbon Map from FAO (2019), respectively. The resulting dataset is spatially explicit. Santoro et al. (2015), whose data are used for the temperate biomass estimates in the GEOCARBON dataset, acknowledge that they underestimate biomass in forest areas with high growing stock volumes and therefore likely underestimate stable forest AGB. BGB was estimated based on AGB using lookup factors from the Intergovernmental Panel on Climate Change (IPCC) 2006 and 2019 Guidelines, with lookup factors averaged across continents (IPCC, 2006, 2019a). See Annex B.2 for further details and a discussion of related uncertainty. Total carbon stocks in stable forests could be also underestimated in temperate areas given the discussion in section 1.1.2 of temperate areas in the Hansen et al. (2013) dataset.

3.1.2 Sequestration

Estimates for annual carbon sequestered from living biomass in stable forests (excluding SOC and woody debris) were calculated using methods outlined in Chapter 2 and Chapter 4 of Volume 4 of the IPCC 2006 Guidelines (IPCC, 2006) and updated removal factors from the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2019a). Annex B.2 explains the methodology and sources of uncertainty in more detail. Total sequestration in stable forests could be underestimated in temperate areas given the discussion in section 1.1.2 of temperate areas in the Hansen et al. (2013) dataset. Sequestration rates are not estimated for at-risk forests, being beyond the scope of this report.

3.2 Stable forest reference level

3.2.1 Carbon stocks

Carbon stocks in stable forests are 10.6 times greater than annual global carbon emissions (*Climate Watch*, 2020). Average carbon stocks within stable and at-risk forests vary globally. On average, at-risk forests store 50.3% less carbon on a per unit area basis than stable forests. The proportion varies by continent and is greatest in Africa (Figure 9). The literature review in Annex A.3 compares carbon stocks in forests that may be considered stable to those in more at-risk forests, and demonstrates that similar differences in carbon stocks have been found in previous literature. Although higher rates of carbon in AGB are associated with stable forests, SOC, which accounts for 27.6% of carbon stored in stable forests, is not as clearly linked (Figure 9).

Carbon in stable forests: 140.9 billion t C
Storage by continent:
LAC: 55.8%
Africa: 20.4%
Europe: 5.1%
Asia: 12.6%
Oceania: 4.0%
North America: 2.1%

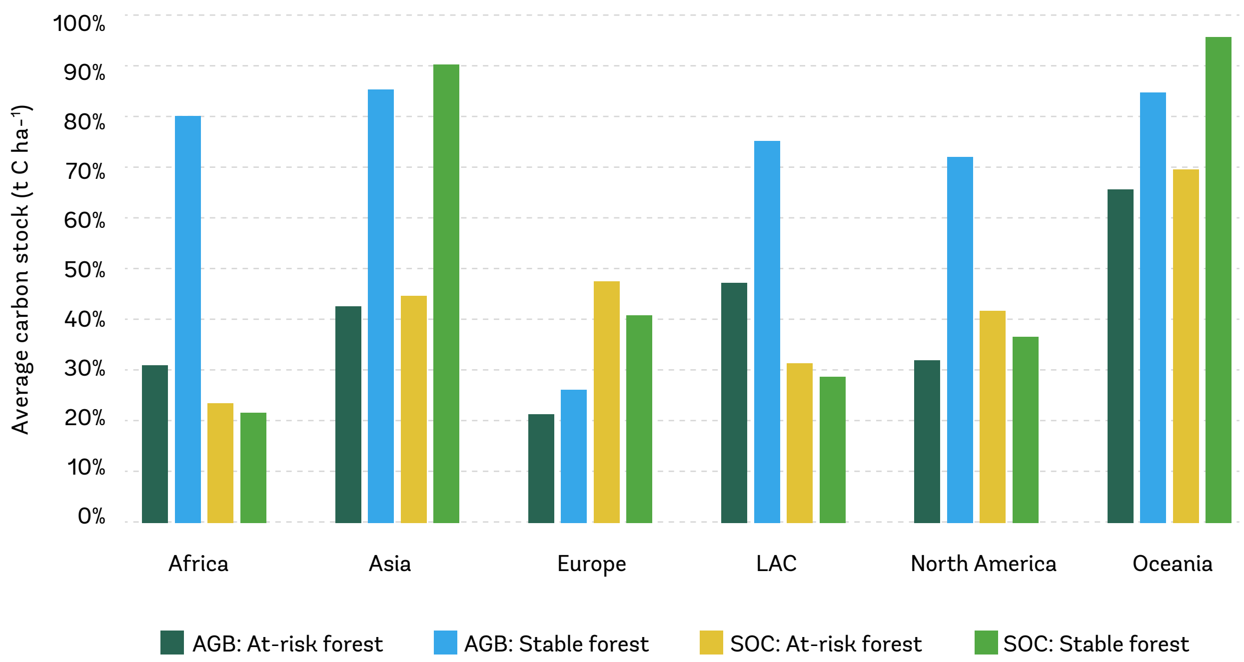
The difference in carbon stocks between stable and at-risk forests is likely driven by the fact that carbon stocks are significantly lower near forest edges, where there is more at-risk forest. This is in line with other studies, especially in the tropics, where biomass 500 m or closer to the forest edge has approximately 25% less biomass (Chaplin-Kramer et al., 2015). Differences in biome or forest type may also drive the higher carbon stock observed in stable forest. For example, most stable forests in Africa are made up of dense tropical moist broadleaf forests. Meanwhile, most African at-risk forests are made up of drier, naturally more sparse forests, which therefore store less carbon. However, the differences in carbon between stable and at-risk forest does not necessarily mean there is immediate degradation when a forest is converted from stable forest to at-risk. Instead, it highlights that on average, at-risk forests have witnessed greater degradation and are therefore likely to have lower carbon stocks.

Even if stable forests are not currently susceptible to emissions from deforestation or degradation (as per their definition), increasing frequency of fires, insect outbreaks, and natural disasters due to climate change may change the carbon stocks in stable forests in the future, as may encroaching forest edges.

Soil carbon stocks in stable forests in Indonesia: case study country

The carbon stored in Indonesia's stable forests is influenced by large areas of carbon-rich peat forests that overlap with stable forest area. Stable forests in Indonesia store a high proportion of carbon in soil (45.8%) compared to the global average and other case study countries. Stable forests in the province with the most peatland forests, Riau, store 317 t C ha^{-1} in SOC, far exceeding the national stable forest average of 194 t C ha^{-1}. Carbon stocks in SOC in stable forests store on average 43.6% more carbon than at-risk forests per hectare. The case of Indonesia underlines that it is essential to conserve carbon-rich forest areas, which often overlap with dense stable forests and can be part of a multi-pronged strategy to protect valuable at-risk and stable forests.

Figure 9. Comparison of aboveground biomass and soil organic carbon between stable and at-risk forests in each continent



3.2.2 Sequestration

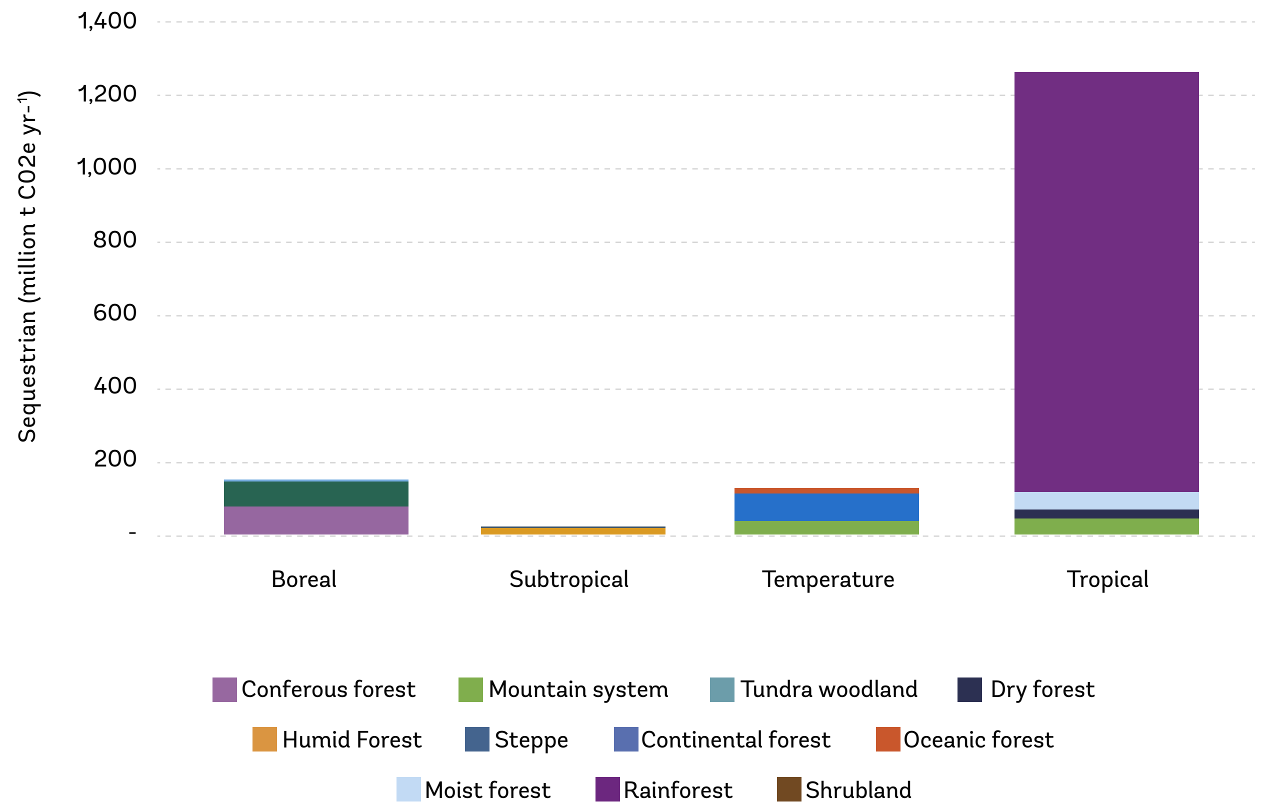
The annual carbon sequestration by AGB and BGB in stable forests (1.5 Gt CO_2e yr^{-1}) is approximately equivalent to annual emissions from more than 332 million passenger vehicles (EPA, 2018), or roughly 3.12% of annual global GHG emissions[13] (based on global emissions of 48,940 Mt CO_2e in 2018) (*Climate Watch*, 2020). In 2018, this was almost as much as annual emissions from the entire waste sector (1,607 Mt CO_2e), was more than all of Brazil's emissions (1,421 Mt CO_2e) or Japan's (1,155 Mt CO_2e), and double all emissions from Germany (777 Mt CO_2e) or Canada (763 Mt CO_2e) (*Climate Watch*, 2020). Rainforests alone (Figure 10) comprise 73% of global stable forest sequestration. Although significant, stable forest removals are likely not eligible under crediting frameworks due to their non-anthropogenic nature and additionality challenges, explained in Chapter 5.

Stable forest removals in 2019: 416 Mt C yr^{-1}
Removals by continent:
LAC: 48.7%
Africa: 22.8%
Asia: 6.3%
Europe: 12.3%
North America: 3.1%
Oceania: 6.8%

Even though stable forests are likely old-growth, unmanaged forests, they still act as an important carbon sink. Luyssaert et al. (2008) demonstrated that contrary to conventional belief, old-growth forests are not carbon neutral and continue to sequester carbon as trees grow. They estimated that old-growth forests remove 2.4 ± 0.8 t C ha^{-1} yr^{-1} on average (which also includes sequestration by SOC and woody debris) up to an upper limit already reached by some forests in the Pacific Northwest USA. Although Gundersen et al. (2021) have criticized this rate as too high, they still conclude that on average, old-growth forests sequester 1.6 ± 0.6 Mg C ha^{-1} yr^{-1}. The carbon dioxide fertilization effect could further increase carbon sequestration in both stable and at-risk forests: increasing CO_2 concentrations stimulate plant growth (Ueyama et al., 2020; Gedalof & Berg, 2010; Alexandrov & Oikawa, 2002), although this CO_2 fertilization effect is limited by nitrogen availability (Terrer et al., 2016) and has been disputed more broadly (Beedlow et al, 2004).

13 Sequestration estimates exclude those from very small areas of stable forests which may have been detected in temperate and subtropical deserts as well as in temperate steppes, for which there were no available relevant defaults provided by the IPCC.

Figure 10. Removals by stable forests in different ecological zones in 2019



3.3 Gaps and recommendations for future research

There was one key gap identified relevant to the carbon accounting of stable forests.

3.3.1 Link between degradation and conversion to at-risk forest

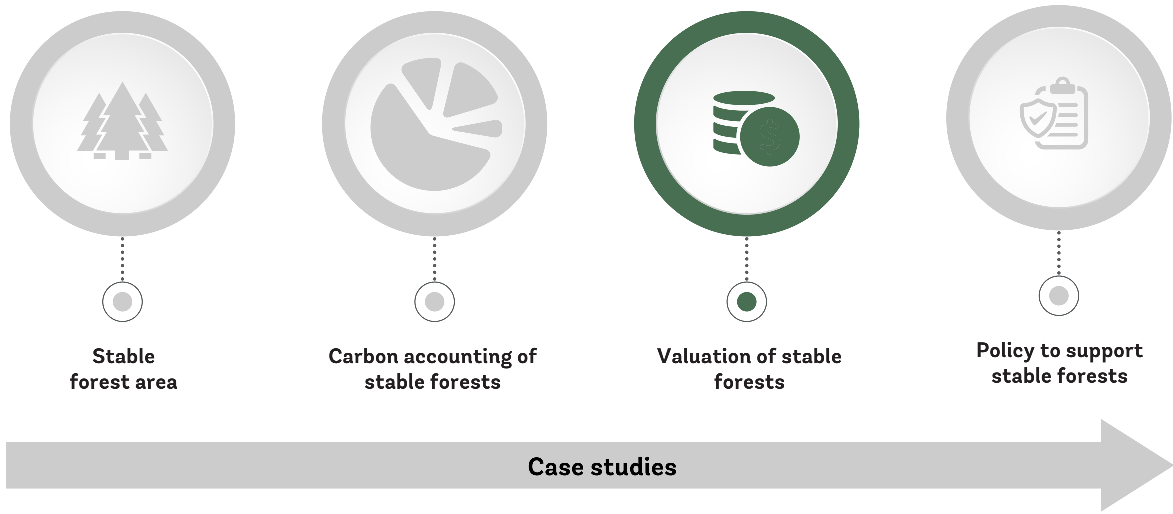
Gap identified from this analysis
Initial results comparing the Avitabile et al. (2019) carbon map to stable forest area suggest that stable forests hold more carbon per hectare than at-risk forests. However, there is a lack of understanding of how carbon stocks would directly change upon the conversion of stable to at-risk forests, that is, whether these forests inherently witness more degradation of carbon stocks. It is possible that the carbon maps, which themselves are largely modeled, are just assuming lower carbon stocks closer to forest edges and therefore are artificially producing this result.

Recommended next step
This analysis would require the assembly of a detailed picture of how carbon stocks have changed over time in specified forest areas to be able to compare changes in stable forest area to changes in carbon. As this is challenging to do on a global level, it could be more appropriate to evaluate this initially on a case study level.

Outcome
This would make it possible to value the carbon loss in the conversion from stable to at-risk forest, further highlighting the higher value in stable forest relative to at-risk forest. If stable forests do lose carbon when converted to at-risk forest, this could usher in different financing opportunities under REDD+.

Chapter 4:

Valuation of stable forests



SUMMARY

Overview

This chapter values four ecosystem services provided by stable forests in tropical ecological zones: carbon storage, biodiversity, non-timber forest uses, and hydrological services, based on the estimates of stable forest area and carbon stocks presented in Chapters 2 and 3. These services are assumed to be additive, although they may not be in reality. The valuation of forests can provide insights into potential protection mechanisms (such as whether REDD+ is financially viable or whether alternative approaches are needed) and can open policy doors for needed financial flows.

Key findings

Example of valuation of stable forests: The total stacked value of the four ecosystem services in tropical countries is estimated to be $4,910 billion in 2019, with an average loss of $5.7 billion yr^{-1} from 2010–2019 based on the deforestation of areas that were stable forest in 2010.

Valuing carbon: The per hectare value of carbon is derived using a conservative cost of carbon ($14 per ton of CO2e basis) based on current global markets. A rental approach could also be used, valuing stable forests for a fixed time limit.

Valuing biodiversity: Two approaches have been explored, the species area relationship described in MacArthur & Wilson (2001) and the Mean Species Abundance (MSA) indicator used by FAO (2020).

Valuing non-timber forest uses (NTFUs): There are no models of NTFUs that can be implemented globally to predict values associated with stable forests, although their value may be large.

Valuing hydrological services: These can be valued based on averages of other services including water purification, water regulation, flood prevention, erosion control, hydroelectricity, and microclimate regulation. These values are highly dependent on individual watersheds.

4.1 Overview

The value of stable forests is derived by valuing four ecosystem services provided by those forests: carbon storage, biodiversity, non-timber forest uses (NTFUs), and hydrological services. This approach is presented here as applied to stable forests in **tropical** zones. The relevant calculation uses the per hectare values of these services given by various previous studies. These are applied proportionately, by area, to the areas of tropical stable forest (as defined in Chapter 2 above). First, the asset value of ecosystem services provided by current stable forests is estimated. Then, any deforestation of area that was stable forest in 2010 is considered, and the loss of forest area is valued. There are important challenges associated with conducting this aggregate analysis of nonmarket values, and these are discussed below.

For the valuation of case study countries in Chapter 6, an additional literature search was conducted to look for any location-specific studies with estimates of the value of the ecosystem services in our selected case study countries (see Chapter 6 and Annex C). Relatively few were found; we therefore used the spatially explicit benefit transfer developed in Siikamaki et al. (2021) to generate values for hydrological services and NTFUs specific to each country.

Valuing stable forests is a crucial step in making a range of financial and policy mechanisms available to better protect stable forests. The carbon stocks discussed in Chapter 3 are only one of the many ecosystem services provided by stable forests that can be valued.

4.1.1 Key assumptions and exclusions

Although timber values are of undeniable importance to many landscapes, they have not been included in this study. First, it is difficult to assign timber production to a specific place (though emerging data on the location of plantations and timber concessions will help with this in the long run). Second, stable forests are by definition located far from forest disturbance, and therefore far from areas where harvests are likely to occur. As stable forests transition to at-risk forests, timber harvesting and attendant degradation probably occurs. Currently, it is not possible with existing data sources to evaluate degradation and timber harvests in at-risk forests globally, or even within the case study countries.

A related market mechanism that we have not considered in this study is sustainable management of forests (SMF). Although it encompasses an increasing number of forested hectares globally, SMF probably does not overlay stable forests because of the physical separation of stable forests (by definition) from edges and the consequent low likelihood of harvest.

This valuation also does not consider the costs of protecting stable forests and therefore does not attempt to make a full assessment of the costs and benefits of conserving stable forests. However, the benefit estimates here do give an indication of the value of the resources at stake. Therefore if protection measures were to cost less (on a per hectare basis) they would clearly pass any cost–benefit test.

This analysis assumes that the four ecosystem services we consider are additive, which allows us to add (or "stack") the individual estimates of the values for these ecosystem services to determine total ecosystem service value. In reality, these ecosystem services are not likely to be purely additive, in that as the area of remaining stable forests declines over time, the production of services may change as a function of other services rather than in direct proportion to forest area. However, given the paucity of research into the interaction of ecosystem services as forest area changes, for the purpose of this study they are assumed to be additive (as discussed in more detail below).

In calculating the value lost each year from stable forests, this analysis only considers the stable forest area that from 2010 to 2019 underwent the entire transition from stable forest to at-risk forest to no forest, rather than the potential value lost solely from the first phase of that transition (conversion of stable to at-risk forest). Although there could be significant losses in value associated with that conversion, they have not thus far been evaluated on a global scale and are therefore excluded here.

4.1.2 Challenges

There are numerous challenges and barriers associated with valuing stable forests, including:

1. **The global estimate of the value of stable forests in these four ecosystem services is based on average $\$ ha^{-1}$** (USD per hectare) **values for the world, but forests are highly heterogenous owing to factors such as forest structure, location, and climate.** With the exception of carbon, studies of the value of biodiversity, NTFUs, and hydrological services have not been conducted in all ecosystems, but for this analysis, values from existing studies have been transferred to all ecosystems. As a global externality, a carbon price can be applied equally everywhere (although different countries may impose policies that cause local prices to differ). Biodiversity is somewhat similar, in that the $\$ ha^{-1}$ value for biodiversity is dependent in part on losses in biodiversity being a global externality. Although there is undoubtedly a global externality associated with changes in the water cycle, the studies used to estimate hydrological value focus on flood protection, water supply, and other values that are driven primarily by local population and other local factors. Further, given the complex nature of interactions between forest cover and water flows, the marginal effect of changes in forest cover may vary nonlinearly by location of forest loss and by the overall quantity of forest loss. These factors would need to be captured with much more detailed local hydrological modeling than we are able to conduct here. The benefits of NTFUs are mostly gained by the local population. Although a growing number of them have international ties through supply chains, the value within a given landscape is expected to vary depending largely on local supply and demand characteristics. To some extent, these limitations are addressed in Chapter 6, which uses the values for individual countries for NTFUs and hydrological services from Siikamaki et al. (2021).

2. **Policy analysis will require some assessment of future changes in stable forests**. In principle, the costs of preserving stable forests should be compared to the benefits associated with future potential losses. Thus, one needs to develop a reasonable reference level assessment of the land-use changes that the stable forests in any region may undergo. This reference level is critical for the valuation of each of the ecosystem services considered. Unfortunately, different countries, or even regions within countries, may have access to and choose to adopt a variety of methods to develop a reference level.

4.2 Approach to valuing stable forests

4.2.1 Stacking services

This section outlines an approach to value and stack four ecosystem services in stable forests:

1. Carbon
2 .Biodiversity
3. Non-Timber Forest Uses (NTFUs)
4. Hydrological services

Chapter 3 estimated carbon stocks and sequestration associated with stable forests. However, these are not the only ecosystem services stable forests provide. Stable forests provide many other benefits that can be classified using the Millennium Ecosystem Assessment framework (2003) into the following services:

- **Provisioning** services, which are the tangible products humans receive from forests, such as wood, water, and food.
- **Regulating** services, which are derived from the regulation of ecosystem processes, such as climate, hydrology, and certain diseases.
- **Cultural** services, which are the nonmaterial benefits people obtain, including recreation, aesthetic experience, spiritual enrichment, and so forth.
- **Supporting** services, which are the underpinning services that enable other services to function, such as biodiversity, soil formation, and primary production.

These services are discussed in detail in Annex A.1.5. The general approach to valuing ecosystem services of interest focuses on: i) linking a \$ ha^{-1} value to a given area of stable forest to determine asset value; and ii) analyzing any change in area to determine the benefits of slowing losses of stable forests. Estimates of the \$ ha^{-1} value from a number of studies were examined (such as de Groot et al., 2012), however, we used estimates from Siikamaki et al. (2021) for all but carbon in this analysis. Siikamaki et al. (2021) conduct a meta-analysis of existing nonmarket valuation studies for ecosystem services and conduct a benefit transfer to provide country-level estimates of values. The work updates an earlier study by the same authors (Siikamaki et al., 2015), includes a number of recent studies on ecosystem service values, and is used in the World Bank publication, "Changing Wealth of Nations" (Lange et al., 2018) and its subsequent updates. The resulting values, used in this study for tropical stable forests, are as follows:

- **Carbon:** depends not only on estimates of stable forest area but also the carbon density of stable forests. Stiglitz & Stern (2017) argue that the social cost of carbon (per hectare value of carbon) is \$40 per t CO_2e and that it is rising at 2.5% yr^{-1}. However, market values for carbon at present are closer to \$14 per t CO_2e, which is the value adopted in this study.
- **Biodiversity:** linked to changes in stable forest area and species abundance. This value is derived from Siikamaki et al. (2021) and varies by region for the tropical analysis and by country for the case studies. The resulting average value for tropical stable forests determined in this study was \$453 ha^{-1}.
- **NTFUs:** This value is the same for all hectares in a given region. NTFUs are interpreted broadly, including outputs from non-timber forest products (NTFPs) such as food and fuelwood, along with uses such as recreation and tourism. This value is derived from Siikamaki et al. (2021) and varies by region for the tropical analysis and by country for the case studies. The resulting average value for tropical stable forests determined in this study was \$1,236 ha^{-1}.
- **Hydrological services:** This value is derived from Siikamaki et al. (2021) and varies by region for the tropical analysis and by country for the case studies. The resulting average value for tropical stable forests determined in this study was \$193 ha^{-1}.

Although only these four services are evaluated here, other ecosystem services are also important—both commercial (such as timber) and nonmarket types. For example, maintaining forest area can reduce infectious disease risk by limiting human exposure to pathogens from other animals (Faust et al., 2018); this could be crucial in preventing public health emergencies such as the COVID-19 pandemic.

For the purposes of this study, we assume that the four services above are additive, or that they can be stacked. In the ecosystem services literature this approach is generally called "stacking", although stacking often refers to adding together payments for various services when one is designing a program to preserve a given forest or ecosystem, not estimating their underlying economic value (see Annex A.6 for further discussion of economic approaches adopted in the literature). Payments and corresponding economic values will in most cases diverge sharply because most ecosystem services are public goods, thus realized demand will fall well below the true benefits the services provided to society. For instance, while the social cost of carbon has been widely measured by economists, carbon remains an externality, with only limited property rights and duties associated with atmospheric emissions established by some governments around the world. Thus, the demand for carbon sequestration services provided by stable forests will be substantially lower than the value of the carbon storage services provided when using the social cost of carbon. The 'public good' nature of carbon illustrates why payments in voluntary markets for carbon hover around \$2–\$10 per t CO_2e, payments for offsets in regulatory markets are closer to \$14–\$20 per t CO_2e, and the social cost of carbon is \$40 per t CO_2e.

Based on the assumption of additivity, payments for stacked services could be consolidated into a "conservation credit" that bundles or aggregates the services into a single accounting and payment unit, discussed in Chapter 5.1.3. This assumption likely abstracts from reality, given that certain ecosystem services may be bundled and difficult to differentiate. For instance, many NTFPs are derived from species that may be lost from a stable forest area if biodiversity declines. Thus, changes in the per hectare value of NTFPs may be linked to changes in biodiversity, however, this analysis cannot account for those links.

4.2.2 Valuing services

Three approaches to valuing the ecosystem services are presented as follows (see box).

Box: Valuation concepts

Asset Value
Asset value is the present value of the future stream of the stacked ecosystem service flows that would be obtained from the stable forest area in 2019. It is an estimate of the value that would be lost if the stable forest area in 2019 vanished today. The ecosystem services are valued using estimates found to be appropriate for each case study country or region.

Annual Maintenance Value
One way to think about maintaining stable forests is with the concept of the annual amount of resources that would be needed to ensure that the asset value does not decline, which is defined here as the annual maintenance value. For economic assets, this is often the depreciation that occurs as an asset is used. Businesses that seek to maintain the productivity of their capital over time must invest at least as much as the annual depreciation to maintain physical, human-built assets such as houses, factories, and other infrastructure. Typical maintenance expenditures in the construction and housing sectors are 2–5% of the replacement of the asset value. For this analysis, a fixed percentage (3.6%) of the total current asset value of ecosystem services is used to determine the annual expenditure that would be necessary to maintain the asset.
In the case of a stable forest that remains intact and does not face natural losses or degradation, the asset grows in value as carbon accumulates. However, these forests are nonetheless susceptible to natural risks (such as senescence, fire, windthrow, insects, invasive species) and potentially anthropogenic risks (such as logging, mining, land conversion, animal poaching, fragmentation). As with physical assets, natural assets also require periodic or annual investments in maintenance and upkeep to ensure that they maintain high levels of ecosystem services. Natural assets that are valued in private markets, such as high-value forest plantations, receive such investments regularly in the form of competition suppression, thinning, tree removal, fire suppression, fertilizer applications, protection from unplanned anthropogenic disturbance, and other maintenance.

Annual Equivalent RED Benefit
The annual equivalent RED benefit refers to the value of avoided future deforestation in current stable forest areas; this would correspond to the benefits the country could be paid through traditional programs to reduce emissions from deforestation (and therefore reduce deforestation). To calculate this value, this analysis first determines the present value of ecosystem services conserved by avoiding the reference level deforestation otherwise predicted to occur in the 2019 stable forest area from 2020 to 2030. Then, the annual equivalent value of this benefit over a 10-year period is calculated. As mentioned in Chapter 1, this is not direct deforestation, as all stable forest will convert to at-risk forest for at least a short period of time before the forest area that was previously stable is deforested.

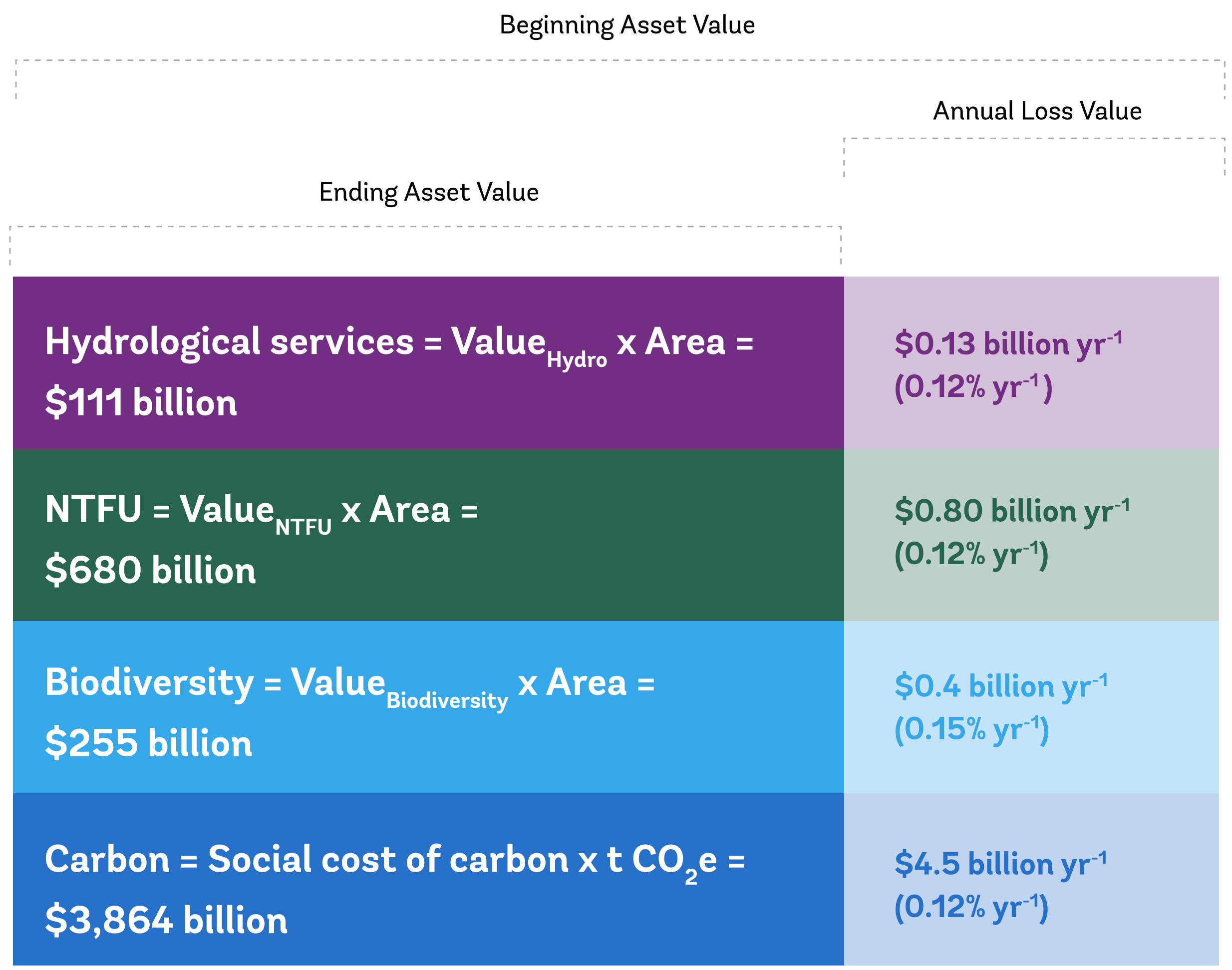
One problem with using asset value for policy is that as forests transition from stable to at-risk, they are no longer stable, but the value of the ecosystem services in the forest remains the same. The relevant forest area is merely at greater risk of future loss. The familiar issues of additionality, permanence and leakage are also important to consider when valuing carbon and other ecosystem services in projects that reduce losses from stable forests. These three issues are discussed in more detail in Section 1.3.2 of Annex B.

For the purposes of this study, valuation assumes fully stocked stable forests; however, it is important to acknowledge that degradation of carbon stocks could occur. In particular, degradation of carbon stocks may occur when forests move from stable to at-risk. However, we are unable to measure the extent of this type of degradation, and thus cannot value it. Although the analysis above demonstrates that at-risk forests on average have lower carbon stocks than stable forests, we cannot assume for specific forest hectares when this carbon might be lost following conversion, or if it would be lost at all. If metrics and criteria to quantify the extent of forest degradation were standardized and adopted, degradation could valued using analogous techniques to those outlined above.

4.3 Example valuation of stable forests in tropical countries

This section illustrates the calculation of asset value of stable forests in tropical countries, the change in value on an annual basis since 2010 (Figure 11), and the annual maintenance value. The methods used to calculate these values are summarized in Annex B.3 and discussed below.

Figure 11. Stacked value of stable forests in tropical countries. Total asset value is a function of the stock carbon and area of stable forest in tropical countries in 2019. The annual loss value (or the annual equivalent RED benefit) is a function of a reference scenario change in stable forest area and is based on an estimate of change from 2010 to 2019.



4.3.1 Valuing carbon

The economic value of the exchange of carbon between the atmosphere and forests is the marginal damage due to climate change (Sohngen & Mendelsohn, 2003), or the social cost of carbon (Nordhaus, 2017). The value of a ton of carbon in forests is thus defined by the economic impact that one ton would have if it were released into the atmosphere. Although the social cost of carbon is nearly \$40 t CO_2e at present (Nordhaus, 2017; Stiglitz & Stern, 2017), this analysis uses \$14 t CO_2e as the value for carbon, given that this estimate is closer to current prices in global markets that trade forest carbon offsets (such as in California or New Zealand).

The analysis above estimates an area of 625 million ha of stable forests globally. Roughly 88% of the stable forest area, 548 million ha, exists within countries that could be considered tropical. These forests contain 276 billion t CO_2e in aboveground stocks, or 504 t CO_2e ha^{-1}, based on the analysis in Chapter 3. With a current estimate of the social cost of carbon of \$14 t CO_2e, the value of this carbon asset in tropical countries is \$3,864 billion, or \$7,050 ha^{-1}. Note that this estimate considers only the aboveground component of carbon stocks, unlike Chapter 3, which also considers belowground and soil carbon stocks. In the case studies in Chapter 6, we conduct a more thorough analysis including belowground and SOC stocks.

Carbon asset value, 2019: \$3,864 billion
Carbon annual equivalent RED benefit, 2010-2019: \$4.5 billion yr^{-1}

Over the past 10 years, deforestation of areas that were stable forest in 2010 and were at some point during this period converted to at-risk forest in tropical countries has been approximately 628,546 ha yr^{-1}, amounting to losses of 319 million t CO_2e yr^{-1} in aboveground carbon. At \$14 t CO_2e, the value of this loss (the annual equivalent RED benefit) is \$4.6 billion yr^{-1}. These losses do not include degradation that may have occurred in forests that transitioned from stable to at-risk. Because these carbon losses relate to deforestation, we assume that the entire aboveground stock is lost at the time of clearing, which is consistent with conversion of the land to roads, agriculture, or mining. To the extent that some of the losses relate to timber harvesting and wood products, these results overestimate losses. However, we also have not included the BGB and SOC components in these estimates, so we likely underestimate losses.

Note that these estimates of the value of carbon lost from 2010 to 2019 are estimates of carbon lost due to deforestation of areas that were stable forest in 2010 and at some point over this period were converted to at-risk forest and then deforested. However, many patches of stable forests have also been reclassified as at-risk forests over this period, which could have two effects on carbon value. First, stocks that are more at-risk may require more effort to protect. In the context of these valuation concepts, increasing risk suggests that one would need greater maintenance payments to ensure that stocks remain in place. Second, aside from deforestation, degradation could reduce carbon stocks. Degradation is exceptionally hard to measure, however, and analysis of such carbon stock changes would require a global spatial model and analysis of any change in carbon after transition to at-risk forest. This study will thus focus on deforestation risks.

Note on the valuation of carbon in peatlands

Peatlands remain a critical issue in the protection of stable forests. Peatlands are estimated to contain over 2200 Gt CO_2e globally (Dargie et al., 2019; Harenda et al., 2018; Yu et al., 2010). Harenda et al. (2018) suggest peatlands sequester 0.4 Gt CO_2e yr^{-1}, implying that the main concern for peatlands is their potential loss due to fire, deforestation, or conversion to another land use. Tropical peatlands may store 3000–5000 t CO_2e ha^{-1}, although they sequester carbon relatively slowly at 0.5 t CO_2e ha^{1} yr^{-1} (Yu et al., 2010).

In principle, the value of belowground carbon is the same as that of aboveground carbon, but in practice there are crucial distinctions. Although aboveground carbon tends to be more susceptible to losses from natural and anthropogenic forces, these can be reversed relatively quickly, unlike any loss of carbon from peat stocks. In other words, if anthropogenic fires lead to large-scale emissions, and the land is subsequently used for grazing or palm plantations for several years before reverting back to forests, aboveground stocks can be restored relatively quickly: meanwhile, belowground stocks may take many years to reaccumulate.

Annual carbon losses from peat forests have not generally been quantified. While there are estimates of losses due to forest fires in Indonesia and elsewhere (Harenda et al., 2018), annual deforestation of forests above peatlands may or may not cause large-scale annual emissions from peatland soils. It is important to gain a better understanding of this relationship to value potential losses. The large potential pool of carbon stored in tropical peatlands, along with the limited reversibility of carbon losses from peatlands, suggest special efforts should be undertaken to preserve carbon in those forests. These large potential losses, however, do not suggest peat forests should be valued any differently, given that carbon emitted from peatlands has no different impact on the atmosphere than carbon emitted from other sources.

Options for future projections

The annual equivalent RED benefit requires making a projection of future deforestation and forest accumulation in a project area. Projection methods are best applied to countries or subregions within countries. A projection depends on assumed or modeled future trends in deforestation rates, which in turn depend on markets and locally important trends in population, income, and infrastructure (notably roads). Future potential emissions also depend on ecosystem factors, such as biome, soil type, climate, and even potential future climate change. Policies, such as the extent of REDD+ policy in a country, would also affect deforestation rates. Potential approaches to make a future projection of deforestation in areas that are currently stable forest include:

- Use a five- or 10- year historical analysis of deforestation in areas that were stable five or 10 years ago to determine the historical rate of forest loss. Such an analysis should be conducted spatially and should start with the stable forest boundary five or 10 years before the projection period begins. An average annual change in forest area can be calculated based on the initial stable forest boundary.
- Use a more detailed analysis to analyze trends in stable forests in different areas of a country separately. The more detailed analysis would be useful for larger countries that have different economic and land-use drivers or trends in different regions with stable forests.
- Use a more complex analysis that relies on economic drivers combined with detailed spatial projection approaches, based on economic modeling.

In this report, a 10-year projection to value future losses is used, based on a five-year historical record. Lost carbon is valued as the present value of the emission that would occur in the reference scenario without a policy that eliminates stable forest losses. For the analysis of tropical countries in this study, we have used regional (Latin America, Africa, and Asia) estimates of historical forest loss as the reference level for future losses, rather than country-specific estimates.

4.3.2 Valuing biodiversity

This study focuses on valuing the change in biodiversity that may arise as the forest edge changes in response to deforestation and stable forests transition to a less stable state. For more background on the valuation concepts and ideas discussed in this section, we encourage readers to consult the recent review by Dasgupta (2021). Two approaches were explored to value biodiversity. Both rely on first determining a per hectare value for biodiversity and then multiplying that value by the area remaining in stable forests:

Theory of island biogeography: This approach can be applied at multiple scales and can be used to calculate the aggregate value of biodiversity in stable forests in tropical countries. It uses the species-area relationship described in MacArthur & Wilson (2001) and Annex B.3, whereby the number of species in a forested ecosystem is proportional to the area of the ecosystem remaining.

Mean Species Abundance (MSA): This approach uses methods described in FAO (2020a); it values changes in biodiversity associated with changes in stable forest area and patch size in stable forests. This approach is only used in case study countries in Chapter 6.

After analyzing literature available in the database compiled by de Groot et al. (2012) database, particularly studies in genetic resources and gene pool ecosystem services, (explained further in Annex B.3) and Siikamaki et al. (2021), the biodiversity values per hectare used in this study were estimated to be \$524 ha^{-1} for tropical forests in Latin America, \$277 ha^{-1} in Africa, and 485 ha^{-1} in Asia. These estimates are derived from the country values from Siikamaki et al. (2021) weighted by the forest area in each country with tropical forests within the respective continent. Note that this likely undervalues biodiversity because biodiversity is essential to many other ecosystem services, such as non-timber forest products or ecotourism, and this value does not include the value of those services.

Biodiversity asset value, 2019: \$255 billion
Biodiversity annual equivalent RED benefit, 2010-2019: \$0.4 billion yr^{-1}

The asset value of biodiversity in 2019 is estimated to be \$255 billion. The annual equivalent RED benefit of biodiversity lost in stable forests is estimated to be \$0.4 billion yr^{-1}. This small value results from the relatively small forest area deforested over the 2010–2019 period from areas that were stable forests in 2010. This value is a function of two changes: a change in forest area and a reduction in the per hectare value of biodiversity. The value per hectare declines because each hectare remaining is slightly less rich in species abundance according to the Theory of Island Biogeography, which is the approach used to estimate the change in value. There are, however, uncertainties regarding the rate at which the per hectare value changes with a reduction of area, but even under an alternative assumption that there is substantially more value lost with each hectare of deforestation, the value of biodiversity lost still remains relatively modest, at around \$0.3 billion yr^{-1}.

Biodiversity in case study countries

For case studies in Chapter 6, biodiversity values are estimated using both the island biogeography and mean species abundance (MSA) approaches. The MSA approach in FAO (2020) uses information on patch size in addition to the change in total area of stable forests (in hectares) to determine how a change in stable forest area influences biodiversity value. The biodiversity approach used in case study countries is useful as it captures more of the nuances associated with forest patch size and fragmentation, both of which are key to the stable forest paradigm. This approach could be adopted in other countries or regions on a smaller scale for a more accurate understanding of how stable forest losses affect biodiversity.

4.3.3 Valuing non-timber forest uses

Unlike biodiversity and carbon, there are no global, or even local, models to predict NTFU outputs associated with stable forest areas or stocking. Several studies, however, estimate the value of NTFPs in forested ecosystems. These studies suggest the value of NTFPs may be fairly large; de Groot et al. (2012) found the annual value of food provisioning services in forests to be around \$200 ha^{-1} yr^{-1} in tropical forests and \$299 ha^{-1} yr^{-1} in temperate forests. One problematic aspect of using estimates such as these is whether the estimates apply to specific forested areas or whether they apply more broadly. Many studies of NTFPs focus on estimating value in locations where NTFPs are harvested, but not in locations where they are not. However, not all forests are harvested equally intensively, either because they do not contain the requisite species or because they are distant from populations that value the resources. Siikamaki et al. (2021) attempt to circumvent this problem by developing a meta-analysis of valuation studies, which allows them to predict value in different forests depending on distance, income, and other factors.

NTFUs asset value, 2019: \$680 billion
NTFUs annual equivalent RED benefit, 2010-2019: \$0.8 billion yr^{-1}

Non-timber forest products NTFPs range from site specific products that are demanded only by local populations, to internationally traded goods, such as rubber, xate (palm leaves) or certain berries and nuts. NTFPs are important components of NTFUs, as defined above, which also include recreation and tourism.

Based on the de Groot et al. (2012) database and the results of Siikamaki et al. (2021), the values of NTFUs across different forests are as follows: Tropical Americas = \$1,335 ha^{-1}; Tropical Asia = \$1,893 ha^{-1}; and Tropical Africa = \$1,410 ha^{-1}. Unlike the estimates for biodiversity, the per hectare value of NTFUs is not adjusted to take account of the reduction in stable forest area from 2010–2019.

Non-timber forest uses in case study countries: Liberia and Georgia

NTFUs play a crucial role in many cultures and the asset value of stable forests should reflect this. The value of NTFUs in Georgia is estimated from Siikamaki et al (2021) to be \$2,420 ha^{-1} in Georgia and \$2,203 ha^{-1} in Liberia, both of which are high. NTFUs thus comprise a greater proportion of the total stable forest asset value in Liberia (14%) and Georgia (19%) than other countries (Chapter 6). The NTFU value includes both recreational uses and collection of non-wood forest products. For Georgia, the greatest value lies in recreational uses, which is driven by the level of income enjoyed there. In Liberia, there is a high value for both recreational uses and non-wood forest product extraction. More than one-third of the population lives in forested areas and most Liberians rely on products provided by forests. Woodfuel from charcoal serves as the main cooking fuel for 98% of the population; forests also act as key sacred sites in Liberian communities. The spatial analysis of relative NTFP importance in Liberia by Neugarten et al. (2020) relies on the assumptions that: a) all natural habitats are equally valuable (due to limited available date); and b) NTFP importance is greatest near areas of high human accessibility—inherently less likely to be stable forests. Therefore, most stable forest areas do not appear to correlate with areas of high NTFP importance even though they may have extremely high potential to be of high value for NTFPs. Case study analysis highlights that more data is needed to accurately value the diverse and complex NTFUs that stable forests could offer.

4.3.4 Valuing hydrological services

There are numerous ways to assess the physical elements of water flows. However, it is exceedingly complicated to assess how changes in the area of stable forests in a given location, or globally, may affect downstream flows (such as potential flood damage or hydroelectricity), local climate regulation (such as weather for crop or NTFP production), erosion (export of soil or carbon), reservoir recharge (irrigation), among other services. Determining a functional relationship between forest area and headwaters or important river courses, likely requires site-specific hydrological modeling with spatially detailed land use maps, soil maps, and weather information, in addition to the ability to update weather predictions as local land uses change.

Hydrological services asset value, 2019:
$111 billion

Hydrological services annual equivalent RED benefit, 2010–2019:
$0.13 billion yr^{-1}

Despite this limitation, many studies have shown that forests play an important role in moderating and modulating hydrological flows. For this assessment we use estimates from de Groot et al. (2012) and Siikamaki et al. (2021) to derive an estimate of the value of hydrological services (described in more detail in Annex B.3). The values are: Tropical Americas = \$245 ha^{-1}; Tropical Asia = \$85 ha^{-1}; and Tropical Africa = \$128 ha^{-1}. Unlike the estimates for biodiversity, the per hectare value of water regulation is not adjusted to accommodate the reduction in stable forest area from 2000–2019.

4.3.5 Stacking services: further economic aspects

Carbon: When approaching various ecosystem service values, carbon is the most straightforward to quantify in physical terms and in value. Carbon also carries the greatest weight because the value of carbon used in this analysis, \$14 t CO_2e, suggests that the standing value of tropical forest carbon is large, given the large stocks. Importantly, the value used for carbon is only roughly 35% of current estimates of the social cost of carbon, implying that from a societal perspective, developing methods to preserve stable forests is a substantially more valuable undertaking than the estimates in this report might suggest. Similarly, we have assumed that the value of carbon remains constant over time, which significantly undervalues current carbon storage in stable forests, given that the concentration of carbon in the atmosphere is continuing to rise.

Biodiversity: Biodiversity value is not assumed to change over time, although in reality it should (as should hydrological services and NTFUs). Biodiversity value would likely be increasing in any location if the overall area of forests is declining and the stock of biodiversity globally is declining. This increase in biodiversity value (the value per hectare) would result from increasing scarcity of biodiversity, as well as increasing global population and income (where higher income raises the willingness to pay for biodiversity).

The value assigned to biodiversity likely significantly undervalues the benefits provided by biodiversity. First, although there are now a number of studies on biodiversity values, the amount of data on the economic value of biodiversity is still relatively limited compared to estimates of value for traditional marketed products. Second, we have assumed that the value of biodiversity on a per hectare basis is relatively constant across the forest losses observed in stable forests. However, the value of biodiversity is more appropriately measured as function of the losses of all forests. Since deforestation risk is much greater in at-risk forests, the value of preserving biodiversity may be increasing. Finally, there may be nonlinearities in the valuation of biodiversity, such that if and when stable forest areas reach a critical lower bound, the value of remaining biodiversity will likely rise sharply.

Hydrological services: The value of hydrological services included in this study focuses largely on the watershed related benefits of stable forest protection. The value of these services also likely increases as stable forests become scarcer. The tools required to conduct analyses in each watershed to determine the increase in value currently do not exist, but over time, as watershed tools become better at assessing how upstream forest areas connect to downstream flood risk, estimates of a change in value should improve. Links between forests and global hydrological cycles are not included in this analysis, but it is possible as data improves that this connection could be made more apparent.

NTFUs: NTFUs are the most locally specific aspect of this analysis. Changes in stable forest area will alter the supply of NTFUs locally, and hence alter the per hectare value. Many NTFUs have substitutes available in markets (such as non-forest recreation, or fruits and nuts grown in plantations rather than harvested from natural sources in stable forests). Thus, forest losses will certainly lower the net value of NTFUs locally, but the value per hectare may not change substantively.

While valuing and stacking these services is imperfect, as noted at the start of this section the prices paid for ecosystem services can differ substantially from the value assigned to them. Payments for the bundle of services via a "conservation credit" would reflect the willingness to pay for the aggregate bundle of services. The next chapter examines the policy landscape in terms of support for the valuation of ecosystem services provided by stable forests—and payment for them accordingly.

4.4 Gaps and recommendations for future research

Several gaps were identified in the valuation analysis. They should be prioritized in future research to produce more accurate valuation estimates for stable forests.

4.4.1 Valuation differences between stable and at-risk forest

Gap identified from this analysis

Stable forests clearly provide significant ecosystem services in the form of carbon storage, biodiversity, hydrological services, and potential for non-timber forest uses. These services have been shown to have a high asset value, although this may be an underestimate because not all services are valued in this analysis. We have also likely undervalued future losses of stable forests because we have applied the values for stable forests to at-risk forests, which may have degraded ecosystems services. There is a need for analysis, at a case study and global level, which would allow for a detailed comparison of the value of stable forests relative to at-risk forests.

Recommended next step

Beginning at a case study level, the differences in value between stable forest and at-risk forests could be evaluated for select ecosystem services.

Outcome

Stable forests should be assigned a higher asset value than at-risk forests, leading to greater maintenance payments associated with the area of stable forests, providing incentives for countries to design policies to protect them. Incentives should link to those already existing for other forests.

4.4.2 Maintenance value

Gap identified from this analysis

The maintenance value provides a conceptual framework from which to value efforts to protect stable forests, but additional work is required to develop a theoretical and empirical approach to estimate maintenance value for different ecosystems.

Recommended next step

Develop a theoretical and empirical framework to estimate maintenance value by stable forest ecosystem and country.

Outcome

Maintenance values would be more representative of what would be needed to protect stable forests and would provide a financial incentive to conserve stable forests.

4.4.3 Biodiversity analysis with MSA approach

Gap identified from this analysis

We were unable to measure the value of biodiversity losses globally using the MSA approach, which accounts for changes in patch size and would require more detailed spatial analysis of changes in fragmentation over time.

Recommended next step

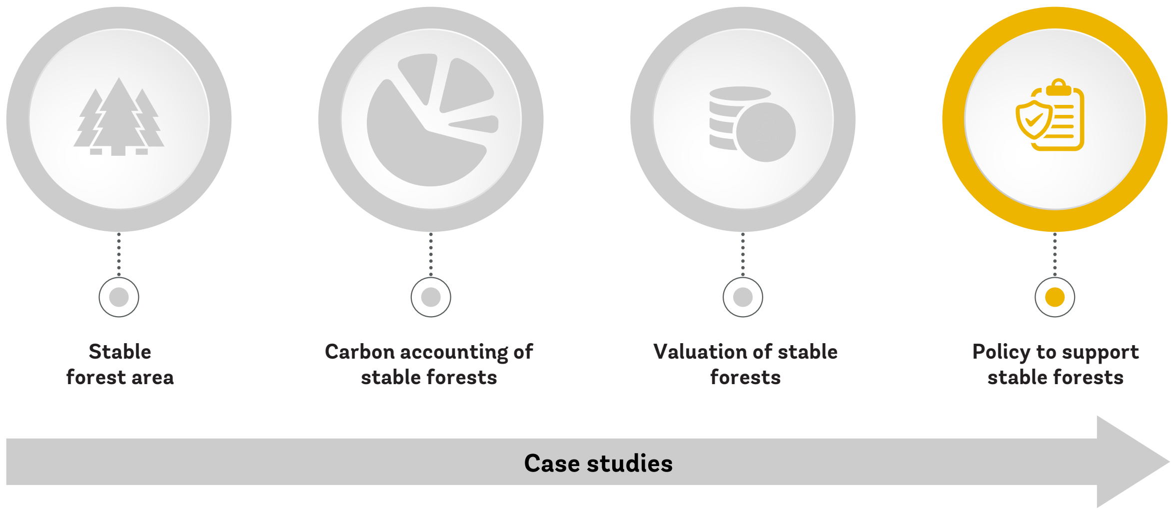
Global analysis of forest losses in stable forests should include assessment of patch size and estimates of MSA changes and valuation of those changes due to deforestation.

Outcome

The value of biodiversity lost due to stable forest deforestation would be more accurate as it would account for the dynamic influence of patch size on biodiversity.

Chapter 5:

Policy to support stable forests



SUMMARY

Overview

Chapter 5 outlines international and domestic policy options that are relevant to stable forests. Based on the characteristics of stable forests presented in Chapters 2–4 and lessons from case studies in Chapter 6, it proposes potential policy solutions to limit stable forest losses. These policy recommendations could serve as a basis for future action that would complement existing initiatives to protect at-risk forests.

Key findings

International policy framework: The Paris Agreement and Convention on Biological Diversity (CBD) already support stable forests: stopping the transition from stable to at-risk forest will help achieve the objectives of both conventions.

- **Paris Agreement:** Stable forests falls under REDD+ (Article 5) and Article 6.2 and Article 6.8 can also support stable forests. The task becomes simpler if it focuses on the non-carbon benefits and adaptation aspects of maintaining stable forests. Stable forests can also be supported under Article 9.1. Stable forests that are not under threat of deforestation may not be a credible source of offsets due to limited scope to reduce deforestation or increase sequestration above baseline removals.
- **CBD:** Protected areas are a cornerstone of the CBD and encompass stable forests in many countries. Maintaining intact wilderness areas and increasing resource mobilization commitments are expected to be integral parts of the post-2020 global biodiversity framework. Biodiversity monitoring and reporting under the CBD can also be used to estimate non-carbon benefits under the Paris Agreement.

Domestic policy is needed to protect stable forests: Effective domestic policy that operates across government, private sector, civil society, and indigenous groups is needed. This policy can be connected to the Paris Agreement and CBD. Domestic policy that can be tailored to national circumstances to protect stable forests includes:

- **Fiscal policy:** Adjusting domestic budgets, taxes, and subsidies.
- **Direct regulation:** Protected areas and other forms of controlling forest clearing.
- **Market mechanisms:** Payment for ecosystem services (PES).
- **Green finance:** Debt-for-nature swaps, green bonds, sustainability-linked loans, and environmental impact bonds.

A **"conservation credit"** that brings together different ecosystem services could be used to connect international and domestic policy. This could be supported by a Stable Forest Fund if needed.

5.1 Overview

Prior sections quantified the area and value of ecosystem services provided by stable forests, but what does this mean for policy makers? Why should policy makers act to value stable forests, and how is the value captured and reflected in government policy and the economy?

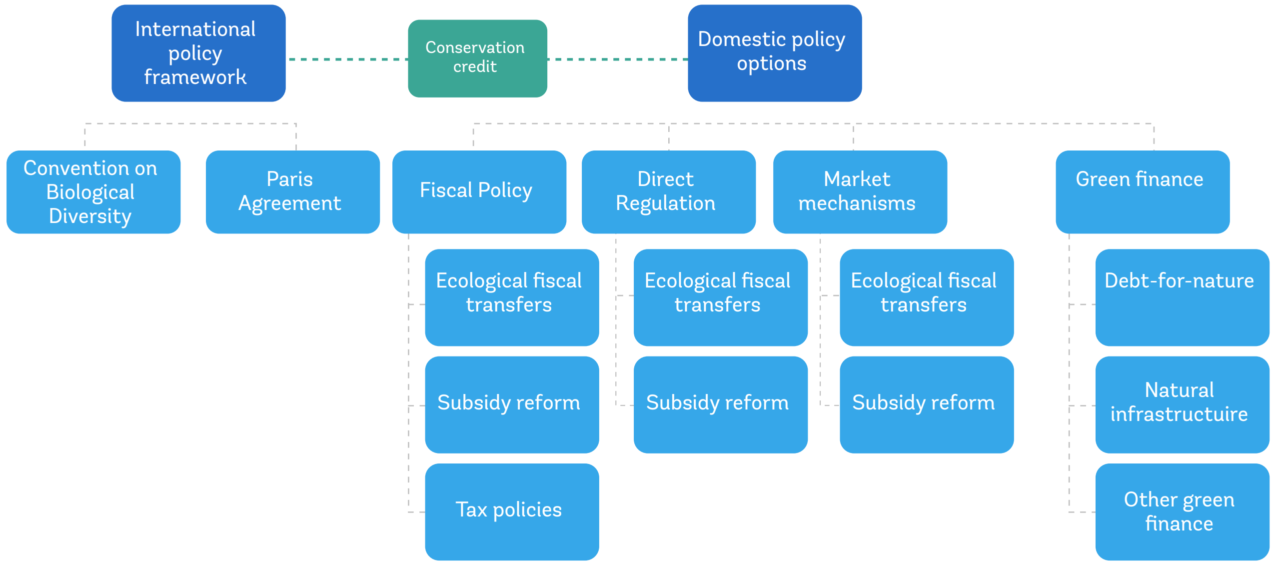
Climate change, biodiversity loss, and other environmental concerns dominated the top long-term global risks identified by the World Economic Forum in 2019 (World Economic Forum, 2019). Forest fragmentation that increases the human–forest interface increases the risk of zoonotic pathogen transfer (Faust et al., 2018) and the risk of pandemics such as COVID-19. Agriculture and forestry are key components of climate mitigation scenarios (IPCC, 2018, 2019b) and must be part of the global effort to mitigate and adapt to climate change. The sector could deliver 6.56 billion t CO_2e yr^{-1} across 79 tropical countries and territories between 2030 and 2050 at a cost of less than US$100 per t CO_2e, with approximately 53% of this mitigation potential associated with the protection of forests, peat, and mangroves (Griscom et al., 2020).

Despite this, financial markets and economic models fail to value biodiversity and forests correctly, and the business case for conservation is often difficult to unravel (Deutz et al., 2020; McKinsey & Company, 2020; Waldron et al., 2020). Forests—and stable forests in particular—are a classic example of the free rider problem, where free goods or services are undervalued, overexploited, and fail over time. Forest policy that focuses on valuing and protecting forests at imminent risk of deforestation is akin to only funding care in hospitals, while ignoring preventive health care in the community. The economic analysis in Chapter 4 highlights the significant difference between the underlying asset value of stable forests and the much smaller carbon market value associated with stopping deforestation through the annual RED equivalent benefit. As a result, stable forests are not properly valued or adequately protected.

Private finance will have an important role to play in forest protection and management (World Bank, 2020a), but market forces or the private sector will not spontaneously correct underlying market failures. Similarly, a compensation mechanism to maintain forests will not on its own be effective. Effective policy that operates across government, private sector, civil society, and indigenous groups is needed to re-align incentives, help realize the value of stable forests and provide long-term protection. This policy should aim to slow and halt the conversion of stable forest to at-risk forest and reduce deforestation and forest degradation of all forest. This will help control deforestation pressures shifting from at-risk to stable forests if at-risk areas are protected. Forest governance and institutional capacity also need to be improved in many countries, as weak governance and low capacity will undermine any policy.

A policy framework to support stable forests already exists under the Paris Agreement on climate change and the Convention on Biological Diversity (CBD). The current decisions have enough flexibility to include the concept of a conservation credit and can be linked to and support domestic policy or local efforts that protect stable forests. The policy solutions put forward below (and summarized in Figure 12) are not intended to replace efforts to protect at-risk forest under threat today, but rather add to these to protect all forests and block the transition pathway from stable forest to at-risk forest to no-forest. The policy analysis moves beyond the notion that there is a fixed conservation budget for forests that needs to be allocated between different forests. The proposed policy reforms will support all forests and do not necessarily require shifting funding from one forest objective to another. How a country meets these objectives will differ based on national circumstances, the drivers of deforestation generally, and the reasons for stable forest loss.

Figure 12. Policy framework to support stable forests



5.2 International policy framework: Climate and biodiversity

5.2.1 Climate change and forests

Forest conservation is an important part of the international climate regime. The basic structure of the UNFCCC and Paris Agreement were summarized in Chapter 1. This section focuses on relevant articles of the Paris Agreement and related aspects of GHG accounting, with additional discussion in Annex A.7.

REDD+ Forest Reference Emission Levels and Stable Forests

Article 5 of the Paris Agreement incorporates all the prior UNFCCC decisions on REDD+ into the Paris Agreement. This includes the Warsaw Framework and agreements covering Forest Reference Emission Levels (FRELs) and results-based payments. The Warsaw Framework and other UNFCCC REDD+ decisions create a framework for results-based finance, but to date do not include all the requirements to generate REDD+ offsets under the Paris Agreement (O'Sullivan, 2020). How these existing decisions apply to stable forests needs to be considered.

Anthropogenic emissions and the managed land proxy

UNFCCC and IPCC GHG reporting and accounting focuses on anthropogenic emissions and removals. However, it is challenging to determine anthropogenic emissions for forests and land use. In 2003 the IPCC reported that "the scientific community cannot currently provide a practicable methodology that would factor out direct human-induced effects from indirect human-induced and natural effects for any broad range of land use, land use change, and forestry (LULUCF) activities and circumstances" (Schimel & Manning, 2003). To address this challenge the IPCC adopted the "managed land proxy" to estimate GHG emissions and removals as a proxy for anthropogenic emissions and removals (Iversen et al., 2014)land use change and forestry (LULUCF. Under this approach, countries designate areas of land as "managed" or "unmanaged" and all emissions (or removals) that occur on land designated as "managed" are included in the reporting under the UNFCCC and counted as anthropogenic irrespective of the cause (Schimel & Manning, 2003). The IPCC revisited this approach in 2009, and although it noted valid concerns it reaffirmed its use as a globally-applicable, assessed, and approved method to separate anthropogenic emissions and removals (IPCC, 2010).

The UNFCCC and Paris Agreement focus on anthropogenic emissions and removals. However, it is very hard to differentiate anthropogenic emissions or removals from other causes in forests. To include stable forests in a FREL, stable forests need to be treated as "managed lands" (see text box). If a country applies the managed land proxy to stable forests, it could include emission reductions or removals from stable forests in its FREL irrespective of whether these were anthropogenic or not. This can create complexities and challenges as a country must report on and be liable for all emissions and removals, irrespective of the source. Using the managed land proxy in this way is acceptable within a country's GHG inventory and NDC and allows stable forests to be considered under the full spectrum of REDD+ activities that account for GHG reductions and enhancements of carbon stocks.

If a country chooses to include stable forests in its FREL or national reporting, there are three ways that this could generate revenue for a country that is tied to stable forests.

1. GHG reductions or enhancements against a historical FREL

If a country develops a FREL based on historic emissions and accounts for stable forests using the managed land proxy, then all REDD+[14] activities that account for GHG reductions or enhancements can be considered.

REDD+ financing that focuses on reduced deforestation and forest degradation will not be applicable to most stable forests, given minimal historic deforestation and minimal imminent deforestation risk. These activities could also in theory be applied to the stable forest areas most likely to be converted into at-risk forests (on the basis of trends over the past 20 years), although additional analysis would be needed to demonstrate the reference case and any emission reductions associated with conversion to at-risk forests.

Any reclassification of stable forest area to at-risk forest puts the forest at a greater risk of deforestation or degradation, which could result in emissions and forgone sequestration, although this may not occur immediately upon conversion to at-risk forest. First, an analysis of historical and current at-risk forests could determine the proportions of these forests that are likely to be deforested or degraded and their associated emissions and forgone sequestration. Emission factors could be developed for the conversion of stable forest to at-risk forest as recommended in section 3.1.1. However, this needs to account for the loss of carbon stocks from at-risk forest and lost sequestration over time, as the change in category alone does not guarantee an immediate change in stocks. Emission factors for at-risk forest that account for loss of carbon and lost sequestration over time could then be paired with the area of stable forest converted to at-risk forest. This type of approach would provide an estimate of emissions and forgone sequestration through the conversion to at-risk forest.

Stable forests could potentially be considered as land under SMF or conservation under the "plus" side of REDD+. Although this may provide a pathway for some stable forests to be eligible for REDD+ finance linked to emission reductions or carbon stock enhancements, this is inherently problematic. While stable forests may continue to sequester carbon, this natural sequestration should already be captured in the reference level. It is therefore unlikely that this would lead to results-based payments linked to stable forests not under threat or not being actively managed to increase carbon stocks. The reference level and lack of additionality will also make it challenging (if not impossible) to credibly issue internationally traded offsets for naturally occurring reductions or removals from stable forests.

Seven countries include SMF, conservation, or both activities in their FRELs, which are compared in the table in Annex B.2.4. Of the five countries that define conservation activities in their FRELs, four only include conservation areas as those designated as protected in some way, which would cover the 37% of stable forests under protection according to this analysis. Honduras, meanwhile, defines conservation areas as those which have remained forests over the reference period and have maintained their carbon stocks, but excludes these carbon stocks from their FREL. This area could have significantly more overlap with this report's definition of stable forests. As other countries develop updated FRELs with more REDD+ activities included, a broader definition of conservation may encompass more stable forests.

14 REDD+ covers five activities: (i) Reducing emissions from deforestation; (ii) Reducing emissions from forest degradation; (iii) Conservation of forest carbon stocks; (iv) Sustainable management of forests; and (v) Enhancement of forest carbon stocks. Activities (i) and (ii) are part of REDD and (iii) – (v) fall under the "+".

ART TREES and HFLD crediting

The new ART TREES approach creates the potential for HFLD countries to statistically model deforestation in an upward (linear) trend. This increases the opportunity for HFLD countries to issue credits even when they have historically low deforestation rates. The ART TREES approach calculates emissions from deforestation over a maximum of the past 15 years to determine whether there is an upward trend. The projected trend over the next five years provides the basis for calculation of emission reductions.

The approach is likely to be limited, as HFLD countries typically do not have aggressively rising deforestation rates and a linear trend over five years can only rise by a relatively small amount. Seven countries that qualify as HFLD under the ART TREES criteria in Chapter 2 (Equatorial Guinea, Gabon, Guyana, Papua New Guinea, Republic of Congo, Solomon Islands, and Suriname) have increased net forest emissions when comparing those from 2005–2010 to 2015–2020 using FAOSTAT data. Although this is not a detailed analysis of annual emission levels over the past 15 years, it indicates which countries would be most likely to benefit from ART TREES HFLD crediting as these countries have experienced upward trends in deforestation emissions. Some HFLD countries have experienced significant deforestation emissions increases over this time period, such as Papua New Guinea (240.5%) or Suriname (170%), while others have experienced far less (Republic of Congo – 15%, Equatorial Guinea – 0.04%). Further analyses at the country level would be required to determine appropriate ART TREES HFLD crediting levels in these countries.

Six countries define SMF, and their definitions vary broadly. Three countries require forest to be under a certain management plan to classify as an SMF activity. Although these areas may have low rates of net deforestation or degradation, they could exclude stable forests as they may only be plantations (as in Kenya) or be near roads or settlements used to harvest timber or other products. Meanwhile, India classifies all its forests as sustainably managed, thus more disaggregation is required to target stable forests. Panama specifies forests under SMF must not be deforested nor degraded and must have less volume extracted than can naturally regenerate. In Bhutan, SMF includes all forest remaining forest outside protected areas (thus also stable forests outside protected areas). Bhutan's and Panama's definitions may have the greatest overlap with stable forest area. Nevertheless, it seems that conservation activities may be more applicable to stable forests, given the unlikelihood of all stable forests falling under the appropriate management regime required to be designated "sustainably managed."

2. Adjustments to FRELs to account for future emission projections

The Warsaw Framework allows adjustments to FRELs based on national circumstances. This can include adjustments to future emission projections due to low rates of historic deforestation, but it can be challenging to quantify increasing rates of future deforestation in a manner that is sufficiently rigorous to issue offsets. An updated version of the ART TREES[15] standard for jurisdictional REDD+ crediting was released for public consultation in February 2021. The updated version includes provisions that allow HFLD countries to project an upward trend in emissions. If this method remains after public comments are addressed, it will make it easier to issue offsets for HFLD countries compared to using the historical average (see text box). Verra—the body that oversees several voluntary accounting standards for REDD+—recently updated its Jurisdictional and Nested REDD+ standard. Although the update does not include rules that would allow upward trends for HFLD countries, Verra is analyzing how to credibly allow jurisdictional FRELS with upward trends that could be applied to HFLD countries or forests. A further update is expected accordingly later in 2021.

15 ART stands for Architecture for REDD+ Transactions, a voluntary initiative that seeks to reward countries for REDD+. ART manages The REDD+ Environmental Excellence Standard (TREES), which specifies requirements for the quantification, monitoring, reporting and verification of Greenhouse Gas (GHG) emission reductions from REDD+ activities at a jurisdictional and national scale. See https://www.artredd.org

3. Non-carbon benefits

If comprehensive GHG accounting across stable forests is too challenging, countries could focus on reporting the non-carbon benefits of stable forests. The REDD+ decisions also recognize that the non-carbon benefits of forests should be incentivized for the long-term sustainability of REDD+ and that non-carbon benefits of forests can contribute to adaptation and can attract finance (Decision 9/CP.19; Decision 18/CP.21). In contrast to GHG accounting, policy approaches may also be based on the valuation of non-carbon ecosystem services that stable forests provide, which could be stacked alongside carbon benefits. This may also warrant including stable forests in FRELs reported to the UNFCCC and could involve a conservation credit approach, discussed below in Chapter 5.2.3.

Articles 6 and 9 of the Paris Agreement

Article 6 of the Paris Agreement contains three mechanisms for Parties to collaborate to implement their NDCs. Article 6.2 focuses on cooperation between Parties on mitigation and adaptation; Article 6.4 is seen as a new emissions trading mechanism for offsets; and Article 6.8 focuses on nonmarket approaches to promote mitigation and adaptation ambition among other goals. Article 6 does not mention specific sectors and there are different opinions on whether forests and REDD+ are included under key clauses. Negotiations on further guidance for these articles are ongoing.

Article 6.2 allows for countries to collaborate on both mitigation and adaptation and includes the use of internationally transferred mitigation outcomes (ITMOs). Most authors argue that forests are already or should be included under Article 6.2 (Graham, 2017; O'Sullivan, 2020; Streck et al., 2017), but some take a narrower view and argue that it has not yet been determined whether or not forests will be included (Michaelowa et al., 2019; Roth et al., 2019). This debate is centered around forests being used within the ambit of an ITMO, which is not yet defined. Given that the ongoing maintenance and enhancement of stored carbon in stable forests is essential to meet the Paris Agreement targets (Dinerstein et al., 2019), an argument can therefore be made that stable forests contribute to overall mitigation outcomes. On this basis, maintaining stable forests could fall within the scope of an ITMO—if a stable forest ITMO is not used as an offset. However, the ongoing debate on how forests might subserve an Article 6.2 ITMO can be sidestepped if attention is focused on the adaptation benefits of maintaining stable forests: also included in Article 6.2. This removes any debate over using stable forests as an ITMO and allows for more general collaboration under Article 6.2 that includes all the non-carbon benefits of stable forests.

Article 6.8 focuses on nonmarket approaches for Parties to collaborate to implement their NDCs. Collaboration under 6.8 aims to promote mitigation and adaptation ambition, enhance public and private sector participation in NDC implementation, and enable cooperation across instruments and institutions.

Article 9.1 is a catch-all obligation on developed countries to provide financial resources to assist developing countries' obligations regarding mitigation and adaptation under the UNFCCC.

Paris Agreement conclusions

Articles 5, 6.2, 6.8 and 9.1 allow the most flexibility for Parties to define the terms and conditions of their cooperation and are the most likely options to support stable forests under the Paris Agreement. So long as the stored carbon in stable forests is not used as an offset, countries should have significant flexibility to define units and other metrics to monitor and assess the outcomes of their collaboration without the need for further decisions under the UNFCCC or Paris Agreement. This includes the flexibility for collaborating parties to define metrics of any compensation modalities for carbon and other ecosystem services or attributes that can be characterized as non-carbon benefits.[16] This can cover all the ecosystem services valued above, which could be aggregated into a "conservation credit" for payment purposes (discussed in section 5.2.3).

16 Decision 18/CP.21 "Methodological issues related to non-carbon benefits resulting from the implementation of the activities referred to in decision 1/CP.16, paragraph 70" recognizes non-carbon benefits are unique to countries' national circumstances and Parties have wide latitude on how they define and report on non-carbon benefits.

5.2.2. Convention on Biological Diversity

Parties to the CBD should "develop national strategies, plans or programmes" for biodiversity conservation, and integrate these strategies into domestic policy (Article 6). The CBD's primary approach to conserve biodiversity is through in-situ conservation (Article 8), and Parties should adopt "economically and socially sound measures that act as incentives for the conservation and sustainable use of components of biological diversity" (Article 11). The CBD also establishes obligations and mechanisms for developed country Parties to provide financial resources to help developing country Parties meet their obligations under the CBD (Article 20, 21).

The Aichi Biodiversity Targets were created in 2010 as part of the CBD's Strategic Plan for Biodiversity 2011–2020. They were intended to create an overarching framework on biodiversity not only for the CBD and its protocols, but for the entire United Nations system, including treaties addressing climate change. Many of the Aichi Targets are relevant for stable forests, and several are included in the table below along with a summary of how parties to the CBD addressed the targets in their national biodiversity strategies and action plans (NBSAPs).

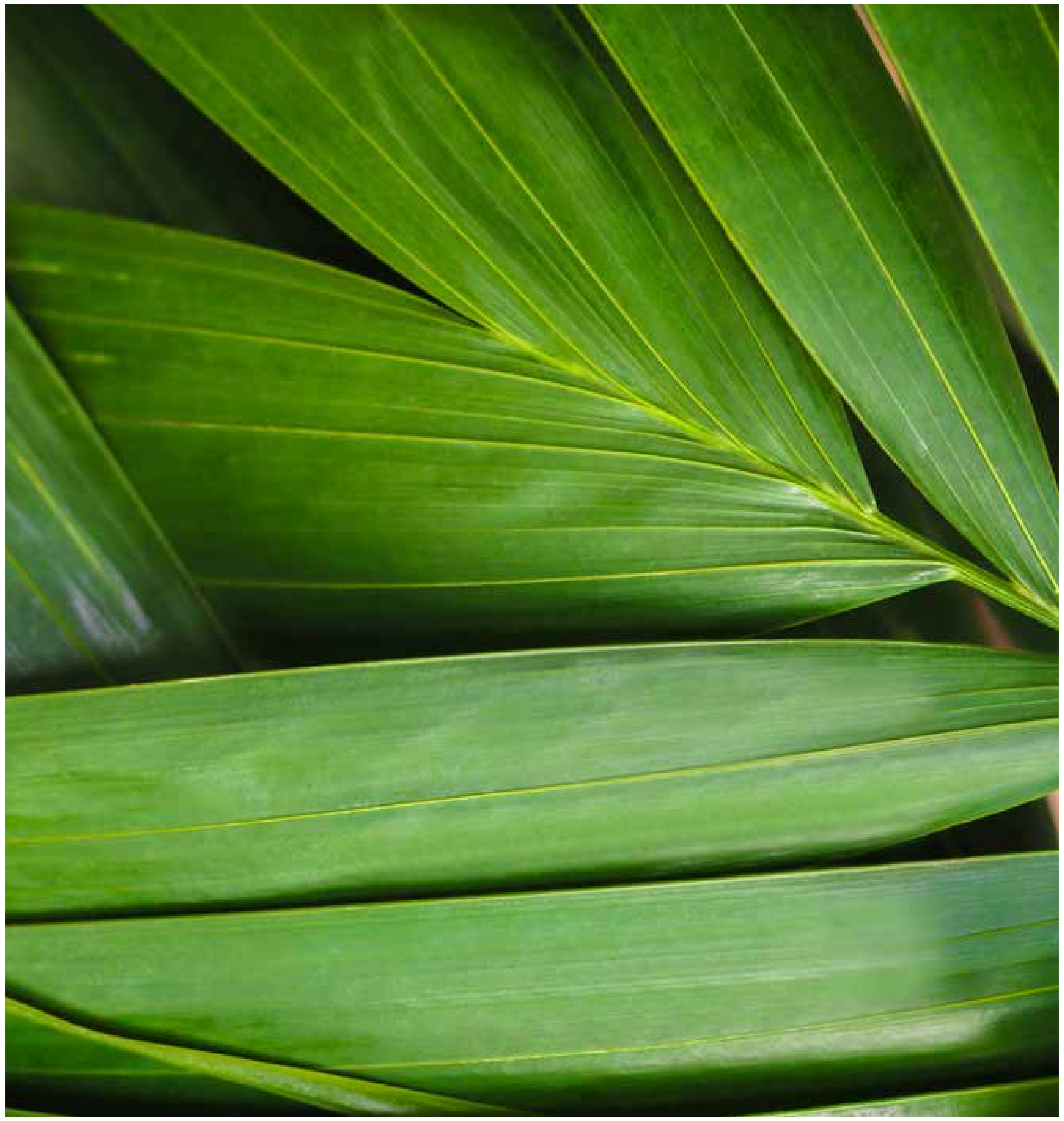


Table 5. Summary of relevant Aichi targets[17]

No.	Aichi Target	Inclusion of Aichi Target in National Biodiversity Strategies and Action Plans (NBSAPs)
2	*Biodiversity values have been integrated into national and local development […] and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.*	84% of NBSAPs address target 2. 7% of those meet or exceed it. 92% fall below the scope and ambition envisaged.
3	*Incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed […] and positive incentives for the conservation and sustainable use of biodiversity are developed and applied […]*	59% of NBSAPs address target 3. 21% of those meet or exceed it. 79% fall below the scope and ambition envisaged.
5	*The rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.*	79% of NBSAPs address target 5. 9% of those meet or exceed it. 91% fall below the scope and ambition envisaged.
7	*Areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.*	81% of NBSAPs address target 7. 13% of those meet or exceed it. 88% fall below the scope and ambition envisaged.
11	*At least 17% of terrestrial and inland water […] especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes […]*	90% of NBSAPs address target 11. 15% of those meet or exceed it. 85% fall below the scope and ambition envisaged.
14	*Ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods, and well-being, are restored and safeguarded […]*	66% of NBSAPs address target 14. 24% of those meet or exceed it. 76% fall below the scope and ambition envisaged.
15	*Ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.*	69% of NBSAPs address target 15. 21% of those meet or exceed it. 78% fall below the scope and ambition envisaged.
20	*The mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels.*	75% of NBSAPs address target 20. 27% of those meet or exceed it. 74% fall below the scope and ambition envisaged.

While many of the Aichi targets were missed, the CBD is currently developing a post-2020 Global Biodiversity Framework that expands on many of the Aichi Targets. The Zero Draft of the Post-2020 Global Biodiversity Framework (Convention on Biological Diversity, 2020) contains several 2050 Goals, 2030 Milestones, 2030 Action Targets, and implementation mechanisms that support stable forests.

The draft 2050 Goals include increasing "the area, connectivity and integrity of natural ecosystems" and ensuring that "nature's contributions to people have been valued, maintained or enhanced through conservation and sustainable use". These long-term goals are carried through the 2030 Milestones and 2030 Action Targets.

17 CBD Subsidiary Body on Implementation. "Analysis of the Contribution of Targets Established by Parties and Progress towards the Aichi Biodiversity Targets." March 16, 2020.

The Milestones include bracketed targets to increase the "area, connectivity and integrity of natural systems", goals to value nature through "green investments, ecosystem service valuation in national accounts, and public and private sector financial disclosures". Several Action Targets are also particularly relevant to stable forests and policy recommendations in this report (**emphasis added**):

> *Target 1. By 2030, **[50%]** of land and sea areas globally are under spatial planning addressing land/sea use change, **retaining most of the existing intact and wilderness areas**, and allow to restore [X%] of degraded freshwater, marine and terrestrial natural ecosystems **and connectivity** among them.*
>
> *Target 2. By 2030, **protect and conserve**, through well connected and effective systems of protected areas and other effective area-based conservation measures, **at least 30 per cent** of the planet with the focus on areas particularly important for biodiversity.*
>
> *Target 7. By 2030, increase contributions to climate change mitigation adaption and disaster risk reduction from **nature-based solutions and ecosystems based approaches**, ensuring resilience and minimizing any negative impacts on biodiversity.*
>
> *Target 13. By 2030, **integrate biodiversity values** into policies, regulations, planning, development processes, poverty reduction strategies and accounts at all levels, ensuring that biodiversity values are mainstreamed across all sectors and integrated into assessments of environmental impacts.*
>
> *Target 17. By 2030, redirect, repurpose, reform or eliminate incentives harmful for biodiversity, including [X] reduction in the most harmful subsidies, ensuring that incentives, including public and private economic and regulatory **incentives, are either positive or neutral for biodiversity**.*
>
> *Target 18. By 2030, **increase by [X%] financial resources from all international and domestic sources**, through new, additional and effective financial resources commensurate with the ambition of the goals and targets of the framework and implement the strategy for capacity-building and technology transfer and scientific cooperation to meet the needs for implementing the post-2020 global biodiversity framework.*
>
> *Target 19: By 2030, ensure that **quality information**, including traditional knowledge, is available to decision makers and public for the effective management of biodiversity through promoting awareness, education and research.*

Mean species abundance (MSA) versus relative species abundance (RSA)

MSA is an indicator of biodiversity intactness, accounting for the abundance of a species under pressure relative to its abundance in pristine or undisturbed ecosystems. It can measure biodiversity trends, serving as a proxy for the CBD indicator on trends in species abundance. MSA compares an average of any changes in population to a 1970 baseline and estimates loss from major human impacts such as land use, climate change, infrastructure, and others (Alkemade et al., 2009). By contrast, RSA is a broader term that denotes how common a species is—relative to others—in an area. It reflects the evenness of the distribution of species in a community. RSA is a vital indicator of overall biodiversity, as a community with a highly uneven distribution is considered less biodiverse. Nevertheless, more complex indicators such as the MSA, Biodiversity Intactness Index, Biodiversity Integrity Index, or Living Planet Index are typically preferred for policymakers over RSA because they tend to offer a more complete picture of the complexities of an ecosystem.

Another key element of the post-2020 framework is resource mobilization. Broader resource mobilization should aim to: i) strengthen engagement of a wide range of financial and private institutions; and ii) mainstream biodiversity into national economic budgets and development plans, including key productive sectors (Convention on Biological Diversity, 2018). The Zero Draft of the Post-2020 Global Biodiversity Framework includes resource mobilization as one of the key "implementation support mechanisms" and includes "an enhanced financial mechanism that delivers resources for developing countries" along with "additional financial and non-financial resources from all sources, including from international and domestic sources and the public and private sectors" as crucial components (Convention on Biological Diversity, 2020).

A new set of targets and indicators is also being considered as part of the post-2020 framework (OECD, 2019b). Unlike GHGs, which can be measured and monitored in a standard unit of t CO_2e, measuring biodiversity is inherently more difficult, and there are challenges to monitoring the Aichi targets consistently and comparably. The Biodiversity Indicators Partnership (BIP) developed guidance on national indicators for use by the CBD to monitor progress towards the Aichi targets (Biodiversity Indicators Partnership, 2011). A different approach for countries is being considered in the Post-2020 Global Biodiversity Framework (OECD, 2019b).

The new approach may use headline indicators that are quantitative, consistent, and comparable. This will increase transparency and measurability between global and national targets. One of the possible headline indicators being considered is MSA (see text box) (Alkemade et al., 2009). This indicator is used in spatially explicit global models such as the Integrated Model to Assess the Global Environment (IMAGE) that is in turn used in the Global biodiversity model for policy support (GLOBIO) (CDC Biodiversity, 2017). MSA is also being considered as an indicator by financial institutions more broadly to assess and disclose the biodiversity impacts of their investments (PBAF Netherlands, 2020).

Conservation credit: an overview

What is it? A common accounting unit consisting of a bundle of ecosystem services or non-carbon benefits that can be combined into a single credit.

How would it operate? It would be consistent with decisions under the Paris Agreement and CBD, and could be integrated within a Stable Forest Fund. It could be used to support results-based financing and other market and nonmarket policies such as EFTs, PES schemes, or direct funding for protected areas.

How would it be valued? The maintenance cost approach in Chapter 4 can be used as a starting point to value conservation credits.

Why a conservation credit? It would allow consistent monitoring, valuation, and comparisons over time and between stable forests to increase potential funding across different environmental conventions.

Who would pay? Funding could be sourced from a combination of donor funding, domestic government funding linked to policy reform, and the private sector. If needed, it could also be funded through a new Stable Forest Fund.

5.2.3 Conservation credits

The valuation of stable forests above demonstrates the value of these forests, yet much of this value cannot be captured under current GHG accounting under the Paris Agreement. The Paris Agreement does, however, recognize the value of non-carbon benefits of stable forests, and resource mobilization is a key element of the Convention on Biological Diversity's post-2020 framework. To bring these pieces together, it is possible to develop a "conservation credit" as a common accounting unit that would be consistent with existing Paris Agreement and CBD decisions and would allow monitoring, valuation, and comparisons over time and between stable forests.

The credit could consist of a bundle of ecosystem services or non-carbon benefits that can be combined into a single credit that allows consistent monitoring, reporting, valuation, and potentially funding across environmental conventions. The approach moves beyond valuing forests based on their potential to offset emissions from other sectors. It recognizes and values stable forest as part of the globe's green infrastructure that delivers multiple climate, biodiversity, and other ecosystem services. This includes the key role stable forests must play in the global effort to achieve the Paris Agreement targets and the Convention on Biological Diversity's Post-2020 Global Biodiversity Framework and 2050 vision, whereby biodiversity is valued, conserved, restored, and wisely used and ecosystem services are maintained. The concept fits within existing decisions under Articles 5, 6.2, 6.8, and 9.1 of the Paris Agreement, particularly when tied to the adaptation benefits and other co-benefits of maintaining stable forests. It is also consistent with Articles 11 (Incentive measures) and 20 (Financial Resources) of the CBD and the Post-2020 Global Biodiversity Framework on resource mobilization.

Conservation credits could use indicators that can be reported under the UNFCCC and CBD. The indicators being developed under the CBD can be reported as a non-carbon benefit associated with REDD+ activities under the Paris Agreement, including conservation of forest carbon stocks. The global MSA indicator can be supported by other area-based and widely recognized biodiversity designations such as Key Biodiversity Area designations for country-specific comparisons and reporting.

Stable Forest Fund

The UNFCCC and CBD have each given rise to multi-donor funds and financial mechanisms to support their objectives. A new "Stable Forest Fund" could be created under the mandate of the Parties to each convention. This could occur jointly or separately under the conventions. Such a fund could be managed by the Global Environment Facility, which is a designated financial mechanism of both conventions. Alternatively, a multilateral development bank such as the World Bank could establish and act as trustee for a new multi-donor trust fund focused on stable forests. This could sit alongside the other climate and forest focused funds already managed by the World Bank. In all cases, the fund should focus on complementing existing efforts to protect forests rather than duplication. The fund could focus financing explicitly on maintaining stable forest areas by preventing their conversion to at-risk forests. This could include supporting improved forest governance or other policy options discussed in section 5.3 below. Conservation credits used by the fund could be derived from estimates of the value of key ecosystem services that are protected, using valuation concepts of the kind proposed in this report.

Conservation credits can be valued using the annual maintenance cost approach as a starting point, with the bundle of services and their valuation further tailored to countries' national circumstances and priorities. As stable forest areas are maintained, decrease, or increase, payments could be adjusted accordingly. This can include pre-agreed spatially explicit valuation to incentivize high valuation and payments for priority stable forests. Although the annual maintenance value is a small fraction of the asset value, it should still generate substantial value in most heavily forested countries when applied across all stable forests. This would help correct the free rider problem and could be paired with existing REDD+ policy and results-based finance that focuses on smaller areas of forest at risk of deforestation or degradation. When combined, the entire forest estate of at-risk and stable forest should be valued.

If conservation credits are used directly to channel funding, in line with Paris Agreement and CBD funding aims, sources of funding should include a combination of donor funding and domestic government funding. Domestic resources may come from restructuring or redirecting existing subsidies and revenue, along with the private sector that can be incentivized through domestic policy and/or corporate social responsibility commitments. The concept could also be applied and tested in a Stable Forest Fund, which could be established within or outside the governance of the UNFCCC or CBD (see text box).

The concept can be applied as a no-regrets accounting unit in nonmarket contexts, and does not require the creation of a new tradable unit. The credit can support a range of market and nonmarket policies that require monitoring and/or valuation of stable forests discussed in Chapter 5.3 below. For example, conservation credits could be used to value EFT payments, with monitoring, reporting and valuation consolidated into a single unit that can be used to prioritize EFTs and compare results between forests within a country. The concept could also be used to help value and direct funding towards protected areas, value debt-for-nature swaps, value forests in planning, or be used as a tradable unit in a PES scheme. Only a new PES scheme relies on creating a new market mechanism and identifying new buyers for a conservation credit—the other examples simply use the concept to compare and value forests linked to other policy options.

5.3 Implementation: A policy menu tailored to national circumstances

5.3.1 Overview

The public international law and policy foundations under the UNFCCC and CBD need to be linked to domestic efforts to maintain stable forests. Monitoring, reporting, and recognizing the value of a basket of ecosystem services—potentially linked via a "conservation credit"—can be connected to a large suite of domestic policy, regulations, and funding options. These are key policy tools to protect and maintain stable forests and achieve key policy objectives, and in most cases can be equally applied to protect at-risk forests and thereby provide comprehensive support to the entire forest estate. However, at-risk and stable forests will not be protected by increased funding alone, and international sources of funding will not be sufficient. A mix of domestic policies and measures is needed to address underlying drivers of stable forest loss, improve governance and institutional capacity, create value in stable forests, and mobilize domestic and international finance. There are many ways to categorize domestic policy options. The breakdown presented below organizes domestic efforts broadly into: i) fiscal policy; ii) direct regulation; iii) market mechanisms; and iv) green finance (Figure 12), although other ways to group these policies are possible. Each of these can be linked to the Paris Agreement and the CBD and is summarized in Table 6, with further analysis below and in Annex A.7.

Fiscal policy refers to how governments allocate their budgets. It is potentially the largest source of funding that can affect forest cover and should be a priority. Ecological Fiscal Transfers (EFTs) involve budget distribution from higher to lower level of government tied to lower-level government achieving environmental targets. Applied to stable forests, EFTs could be linked to the extent of stable forest cover maintained in a state or province. EFTs can involve large amounts of finance, have been found to be an effective incentive to maintain forests, and can be linked to other policy such as direct regulation of forest cover. Subsidies and tax policy are another significant policy instrument, but this can have positive and negative impacts on forests cover. Subsidy and tax reforms can be connected to other policy incentives such as PES, and reform of harmful subsidies is a priority under the CBD.

Direct regulation includes protected areas and other regulations to control forest clearing on private lands or to protect forests or the species they contain. The efficacy of direct regulation is directly tied to governance, and more attention is needed to support forest governance. This includes supporting the rights of Indigenous Peoples and local communities. Establishing effective protected areas is a key objective under the CBD, as is respecting Indigenous Peoples' rights to the benefits of biodiversity.

Market mechanisms cover a range of PES models including regulated and voluntary schemes that can be effective when well designed. The source of funding is the key limitation across schemes, but PES could be combined with other policy options such as fiscal reform or insurance. PES schemes that do not involve offsets will likely be better suited to support stable forests.

Green finance covers a range of other approaches to finance stable forests such as through debt-for-nature swaps, natural infrastructure, and other forms of green finance such as bonds and guarantees. Debt-for-nature swaps have historically been limited but could be considered as part of post-COVID-19 economic relief packages. Other options have limited application in developing countries but may be worth exploring on a case-by-case basis.

Table 6. Summary of policy options to support stable forests

Policy option		Summary	Analysis
Fiscal policy	Ecological fiscal transfers (EFT)	Budget distribution from higher to lower-level of government tied to lower-level government achieving environmental targets. Stable forests and their ecosystem services could be monitored, included in targets, and valued on a comparative basis within a country.	Priority policy option. Found to be effective in several countries, with potential to influence significant amounts of government funding. May be limited where governance is centralized or government funding is limited but can readily be connected to international support and other policy.
	Subsidy & tax reform	Subsidies and tax policies can drive forest loss or, conversely, be designed to support sustainable agriculture and forest conservation. Reform can help minimize the negative impacts and increase the positive impacts of subsidies and tax policies on forests.	Priority policy option. Harmful subsidies dwarf other financial flows that support conservation efforts globally, but reform is inherently political and difficult. Reform could be tied to other positive policy options such PES or green finance.
Direct Regulation	Protected areas	Protected areas are a cornerstone of the CBD, but management and governance challenges have reduced their efficacy in many countries.	Improving forest governance is a cross-cutting priority. Attention should focus on forest governance and protected areas, including by Indigenous Peoples. Support for improved governance can be linked to other options such as EFTs or PES.
	Other forms of direct regulation	Governments can regulate clearing forests not owned by the state or impose moratoriums. This can be challenging given vested interests. Voluntary corporate initiatives are also possible, such as roundtables on sustainable commodity production.	Direct regulation requires effective governance to be successful and can be considered on a case-by-case basis. Voluntary industry efforts can have results, but the voluntary nature can limit the implementation of robust industry-wide changes.
Market Mechanisms	Payments for ecosystem services (PES)	PES systems can be effective if well designed and are flexible enough to cover a range of services provided by forests. Regulated and voluntary options are possible.	Source of funding is a key limitation, but PES can work alongside other policy options such as subsidy reform and green finance. PES can be readily connected to international support.
	Biodiversity offsets and emissions trading	Examples of specific types of PES schemes based on offsetting a particular ecosystem service (biodiversity or GHG).	Limited application. Biodiversity offsets could provide some supplemental funding. Conservation of stable forests may generate few GHG reductions under a historical reference level.
Green finance	Insurance	The impacts of losing forests can be factored into insurance products and premiums.	Limited to countries with sufficiently mature insurance markets.
	Debt-for-nature swaps x	Foreign debt is purchased at a discount, and proceeds used to fund conservation.	Historically limited but could be considered as part of COVID-19 economic relief packages.
	Natural infrastructure & other green finance	Stable forests can be included within planning and finance. Some relevant ideas are beginning to emerge; by contrast, relatively tried and tested modes of green finance (such as bonds) do not always target forest conservation.	Comprehensive planning and finance involving forests and land use should be encouraged. Specific policy actions can be considered suited to specific country contexts.

5.3.2 Fiscal policy

Adjusting how domestic budgets, taxes, and subsidies are designed can impact forest cover. Domestic budgets and tax policy are estimated to be the largest source of funding for biodiversity globally (57%, or $75 to $78 billion yr^{-1} in 2019). At the same time, agricultural and forestry subsidies that harm biodiversity were estimated to be $451 and $55 billion respectively in 2019, which significantly outweighs the positive spending (Deutz et al., 2020). Similar trends are seen with spending on forest protection, where agricultural subsidies that drive deforestation significantly outweigh efforts to protect forest cover (Deutz et al., 2020; Kissinger, 2015; McFarland et al., 2015). When comparing REDD+ finance to protect forests against agricultural subsidies in Brazil and Indonesia, the average annual domestic agricultural subsidies in Brazil and Indonesia exceeded 2014 levels of REDD+ finance by factors of 70 and 164 times respectively (McFarland et al., 2015). Two key policy options to reform these forces can be considered— EFTs and subsidy reform.

Ecological fiscal transfers

EFTs involve a higher level of government distributing funds to lower levels of government based on ecological indicators such as maintaining forest cover. EFTs have been enacted or proposed in Brazil, China, the EU, France, Germany, India, Indonesia, Poland, and Portugal (Busch et al., 2020; Mecca et al., 2020). They can both compensate state and local governments for forgoing the opportunity to convert forest into other land uses and incentivize governments to increase forest cover or other ecosystem services targeted by the fiscal transfer (Nils Droste et al., 2017). They are therefore a dual-purpose policy that can simultaneously compensate the lost economic benefit from protecting stable forest and incentivize their protection and enhancement.

EFT potential in Guyana and Indonesia

Guyana and Indonesia provide two contrasting examples of EFT applicability. Guyana's forests are centrally managed by the Guyana Forestry Commission. This could make it difficult to tie allocation of government funding to the regions to maintenance of stable forest. However, given the large areas of forest managed as Amerindian land, it could be possible to strengthen local Amerindian governance of forests and connect this to direct transfers from the federal government.

Indonesia is currently considering EFTs, with examples found at the national, provincial, and local government levels. National-level instruments are referred to as 'central-to-local' ecological fiscal transfers, and current reforms being considered include revenue sharing levies from deforestation activities and special allocation funds for forest and mangrove rehabilitation. Some provincial-to-local and regency-to-local EFT schemes have also been adopted. In Indonesia, EFTs are of greatest interest to provinces and regencies (akin to municipalities) with high natural resource stocks, such as Kalimantan and Papua. The Village Development Index is another existing fiscal transfer scheme to provide support from the central government to local governments and communities (Mecca et al., 2020). EFTs are a promising policy option to support stable forest protection in Indonesia as they can directly connect government budgets with protection of stable forests.

Brazil has used EFTs since the 1990s to allocate a portion of federal taxes to states. This now covers 26 states and has resulted in positive impacts on forest conservation (Comini et al., 2019; de Paulo & Sobral Camões, 2019; OECD, 2013; Ring, 2008; Rocha et al., 2020), but high transaction costs may also have dampened the effect in Minas Gerais and across Brazil (de Paulo & Sobral Camões, 2019; Lima de Paulo & Camões, 2019). India established the world's largest EFT system in 2015 (Busch & Mukherjee, 2018). A recent review of the impact of the scheme (Busch et al., 2020) shows mixed results. India's EFTs were approximately $7.4 billion yr^{-1} between 2015–2016 and 2018–2019, which amounts to approximately $185 $ha^{-1} yr^{-1}$. This is a sizable amount of funding that dwarfs REDD+ payments globally. The impact on protecting and restoring forests is less clear, though the authors note that more time may be needed to detect the effects of the EFT. Other research shows potentially positive impacts of EFTs in Portugal (Santos Rui et al., 2012) and Europe (N. Droste et al., 2018).

EFTs should be a priority policy option that countries consider to reduce the conversion of stable to at-risk forest and at-risk forest to no forest. EFTs can use the proposed basket of indicators to target high-priority stable or at-risk forests to compare, conserve, quantify and track the maintenance of forests over time, and trigger domestic transfers. However, EFTs need some degree of decentralized forest governance where payments can be linked to local forest governance. Care should also be taken to ensure local forest protection incentivized by EFTs respects the rights of indigenous peoples and local communities. Impacts may be limited where domestic budget transfers between levels of government are limited, but EFT funding can also be connected to international funding and domestic policy such as direct regulation. This can be simplified if a common set of indicators and monitoring requirements to demonstrate results is used.

Subsidy reform

Subsidy reform is a broad category of fiscal reform that can include removing environmentally-harmful subsidies (such as fuel subsidies) and using the savings for environmental benefits; removing subsidies that threaten forests (such as agricultural subsidies that encourage forest clearing); or creating positive subsidies that encourage forest protection (credit subsidies for forest friendly activities, such as small scale NTFP business or eco-tourism) (Oakes et al., 2012). Government-sponsored Payments for Ecosystem Services discussed below could also be viewed as a type of subsidy. Subsidies are inherently political choices influenced by economic, social, cultural, historical, and geopolitical factors. They can have positive and negative impacts, but once in place reform can be difficult (Deutz et al., 2020; McFarland et al., 2015).

Elimination of harmful subsidies is an ongoing priority under the CBD[18]. Agricultural and forestry subsidies that are most harmful to the environment provide: i) support based on production levels or price; ii) income support; or iii) indirect support. However, subsidies cannot be viewed solely through an environmental lens, and reform needs to consider the impacts on poor and marginalized groups in society that benefit from the status quo. Negative social impacts should be avoided, but harmful subsidies can be replaced with subsidies for environmentally beneficial agricultural or forestry practices that should also have positive social impacts (Deutz et al., 2020). For example, direct payments for production that drive agricultural expansion into forested areas could be replaced with payments to support more sustainable practices for farmers who do not expand their area under cultivation.

Reform of harmful subsidies should be a policy priority across all countries to help slow or halt the conversion of stable forest to at-risk forest, and deforestation or degradation of at-risk forest. This can be difficult, but international funding and technical assistance can help developing countries identify and reform subsidies that drive forest fragmentation and deforestation. Reform could be linked to other policy options to support forests, such as market mechanisms, tax reform, or green finance. A bundle of ecosystem service indicators can be used to assess impacts on forests over time, which could include further results-based payments to governments if reform leads to effective maintenance of stable forests.

Tax policies

There are several options to adjust tax policies to support forest protection. Taxes on activities that drive forest loss can be increased, or tax credits provided to activities that do not. Increased taxes on other environmentally harmful products or forest-dependent sectors can also be earmarked to fund forest protection or conservation directly (Deutz et al., 2020; Hamrick, 2016; McKinsey & Company, 2020). However, any such tax adjustments need to be carefully assessed to ensure that there are causal connections between environmental taxes and environmental quality (Shahzad, 2020). Any tax reform should be given the same considerations as subsidy reform discussed above.

18 Target 17 of the Zero Draft of the Post-2020 Global Biodiversity Framework states: By 2030, redirect, repurpose, reform or eliminate incentives harmful for biodiversity, including [X] reduction in the most harmful subsidies, ensuring that incentives, including public and private economic and regulatory incentives, are either positive or neutral for biodiversity (Convention on Biological Diversity, 2020). The earlier Aichi Target 3 states: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions. See https://www.cbd.int/sp/targets/.

5.3.3 Direct regulation

Direct regulation refers to laws or policies that prevent forest from being cleared. This is often in the form of protected areas but can include other regulations that prevent forest from being cleared on privately held land.

Protected areas

Protected areas are a cornerstone of the CBD and many national strategies to protect forests. However, analysis of the efficacy of protected areas shows mixed results (see Annex A.7), and governance and rule of law is often cited as a key factor determining efficacy of protected areas (Abman, 2018; Geldmann et al., 2020). Most protected areas are managed by governments, with regional variation in how many are managed by indigenous peoples, the private sector, or shared governance (see Figure 7 in Chapter 2.2.4). Establishing formal, government-managed protected areas may lead to increased forest loss if formal protection weakens existing indigenous or local tenure, governance, or sustainable management (Geldmann et al., 2020; Hayes, 2006). Strengthening tenure and management rights of indigenous groups or local communities—even if not linked to formal protection—can help to protect and maintain forests (Amin et al., 2019; Araujo et al., 2009; Duchelle et al., 2014; RAiSG et al., 2017; Robinson et al., 2014; Walker et al., 2020). However, some research has also found that protection by indigenous groups is less effective when undermined by population growth, internal resource use and weak local governance (Vuohelainen et al., 2012). See Annex A.7 for further discussion on protected area governance, rights of Indigenous Peoples, and other biodiversity area designations such as Key Biodiversity Areas and nongovernmental designations such as High Conservation Value areas that can be used to prioritize areas to protect.

More attention must be directed toward improvement of forest governance in countries with stable forests and weak governance. This is particularly important in light of the CDB's draft post-2020 Global Biodiversity Framework target to expand conservation areas to 30 percent of the earth's surface by 2030 and to ensure 50 percent of land areas globally are under spatial planning to address land use change and retain most of the existing intact and wilderness areas (Convention on Biological Diversity, 2020). Additional support should consider all types of governance arrangements and focus on local participation and engagement of existing rights holders and users of forest resources. Funding for improved governance could be linked to other policy options, such as EFTs or market mechanisms.

A bundle of ecosystem service indicators could be used to trigger international payments or technical assistance to support improved forest governance and used to monitor the ongoing protection of stable forests over time. Additional governance surveys or indicators could be added to monitoring and reporting protocols to track and assess governance over time. Candidate tools include the *Rapid Assessment and Prioritization of Protected Area Management* (RAPPAM) Methodology, the *Management Effectiveness Tracking Tool* (METT) and the United Nations Educational, Scientific and Cultural Organization's (UNESCO) *Enhancing our Heritage* (EoH) Toolkit.

Protected Areas in Georgia and Republic of Congo

Georgia has 89 protected areas that cover 9% of its terrestrial lands. Georgia has stronger governance than other case study countries, and saw low rates of stable forest loss in protected areas compared to non-protected areas (15.55% versus 18.59% from 2000 to 2019). Georgia made a conditional commitment under the Paris Agreement to expand protected areas to 20% of terrestrial lands. This would also exceed the CBD's 2020 Aichi Targets and represent an important step towards the CBD's draft post-2020 Global Biodiversity Framework. Georgia's stronger governance makes expansion of protected areas a feasible policy option to protect stable and at-risk forests and should coincide with efforts to improve the efficacy of protected areas by increased governance capacity, improved planning, management, monitoring, and local community engagement (Forest Department, 2014).

Republic of Congo has established 34 protected areas that cover 37% of the terrestrial landscape, but struggles with weak governance. Protected areas experienced lower rates of stable-forest loss than unprotected areas (19.89% versus 50.84% from 2000 to 2019), but protected areas managed by the government appear to have higher rates of stable forest loss (51.8%) than other forms of protected area management (19.39%) and areas not under any form of protection. Protected area efficacy is undermined by governance challenges and maintaining current protected areas is clearly a challenge and any expansion will be difficult. This topic needs further research, but the solution will probably entail a combination of: i) stopping encroachment into protected areas, ii) focusing on encouraging climate-smart and regenerative agriculture with existing migrants inside protected areas, and iii) some encouragement of out-migration from protected areas over time. Any out-migration should be encouraged through policy and economic incentives to "pull" people out of protected areas rather than coercive "push" policies or forced relocation. The principles of free, prior, and informed consent should also be incorporated into any voluntary migration policies. Improving forest and land use governance should therefore be a policy priority to strengthen protected areas. This could include public–private or non-state options, whereby non-state actors provide additional technical assistance and capacity support to address local drivers to protect and maintain protected areas or other sites with stable forest. The analysis of protected areas shows protected areas under "collaborative governance" had the lowest rates of overall forest loss between 2000 and 2019 (0.33%), but still saw losses of stable forest in line with national averages for protected areas.

Other forms of direct regulation

Many other forms of direct regulation can be considered, including regulations that control clearing forest on privately held land or regulation of species found in stable forests by listing them as endangered or protected. Direct regulation of land clearing in Queensland, Australia and Brazil was found to be largely effective (Arima et al., 2014; Nepstad et al., 2014), albeit subject to various limitations and reversals in some cases (Azevedo et al., 2017). These two examples include many parallels—of considerable relevance elsewhere—that challenged the legislation and its success in controlling land clearing: despite improvements in governance, it took decades for land clearing rates to reduce in both examples and powerful economic interests continued damaging practices irrespective of the longer-term consequences. In both cases growing public awareness and concern about forest and biodiversity loss were important to provide a political climate for reform, but both countries have seen political swings and at times reversals in policy and efforts to halt land clearing (Linacre et al., 2015). Similar challenges could be expected to impede direct regulation of private land elsewhere; and effective regulation will require effective governance. This option can be considered on a case-by-case basis depending on national circumstances.

Listing high value plant or animal species as protected is another form of direct regulation that can have domestic and international consequences. If a species is listed as protected this typically triggers additional domestic regulations to safeguard their habitats. It can also be linked to international conventions such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) that may create further protections that benefit forests.

Finally, there are several voluntary industry declarations and efforts to reduce deforestation and protect forests, such as the New York Declaration on Forests, industry roundtables, Tropical Forest Alliance, and the Cocoa and Forest Initiative. However, it remains to be seen how effectively voluntary corporate declarations and initiatives such as these actually drive large-scale reductions in forest loss.

5.3.4 Market mechanisms

A subset of current market mechanisms can be used to protect stable forests. As a general concept PES can be applicable, along with more specific types of PES such as biodiversity offsets. A detailed review of market mechanisms is found in Annex A.7.

Payments for ecosystem services

PES schemes can cover payments for a diverse set of environmental services. A 2018 global analysis identified over 550 active programs that made an estimated US$36–42 billion in payments each year (Salzman et al., 2018). Common examples include payments associated with climate change (such as paying for emission reductions or removals), fresh water (such as watershed protection to increase water quality and/or quantity downstream), marine (such as fisheries and habitat management), and biodiversity (such as habitat protection). The concept can also be extended to payments for social or other objectives (such as resilience) that could be influenced by incentive-based payments.

Evidence on the efficacy of PES schemes is mixed, but well-designed PES schemes can be effective at protecting forests (see Annex A.7). A key limitation of PES is identifying who will pay for the ecosystem services. The largest market for PES is watershed protection followed by forest and land use carbon (World Bank, 2020a) but current offset-based forest carbon PES schemes provide few incentives to protect stable forests. Voluntary PES schemes are often limited by scale, but this can be overcome if underlying market failures that do not value ecosystem services are corrected through regulations that require PES. Regulated schemes can bring larger sources of payments, but they function as a tax so their impact on economies needs analysis. There could be opportunities to consider creating regulated PES in the context of subsidy reform or other tax policy reform discussed under the "fiscal policy" options above. PES schemes could also be linked to green finance and insurance discussed under other mechanisms below.

The scope of ecosystem services covered by a PES is broad and can be tailored to cover key services provided by stable forests. A bundle of ecosystem service indicators, some of which are presented and valued above, could be used by a country to help value a basket of services provide by forests and support monitoring and reporting. This could also be linked to any international support for stable forests that uses the same indicators.

PES in Guyana and Liberia

Guyana supports REDD+ PES and participated in an early REDD+ transaction with Norway. The recent oil discoveries and creation of a Sovereign Wealth Fund could be used to create a domestic PES scheme. To most effectively maintain stable forests, a PES scheme would need to focus on preventing the transition from stable to at-risk forest and be linked to forest management and governance efforts. This could include expansion of Amerindian managed protected areas with payments correlated to the size of stable forest patches to capture the increased biodiversity value of larger patches and to incentivize their protection. International support for Guyana could be directed towards helping establish such a scheme with a focus on ongoing good governance. Liberia has some experience with PES, but faces governance challenges; implementation and efficacy are unclear. Mining companies are required to use biodiversity offsets under the 2014 Mining Act¸ and there have been proposals to develop a national biodiversity offset scheme to help fund protected areas, but it is unclear if this was implemented. Liberia is also participating in national REDD+ initiatives, including the Forest Carbon Partnership Facility, and has a bilateral agreement with Norway for USD$150 million if emissions are reduced, but Liberia has not yet met any reduction targets. Governance challenges make large-scale, policy-driven market mechanisms difficult to implement. More localized approaches may be possible, but will need to contend with broader forest governance challenges that risk overwhelming any localized efforts.

Emissions trading

The World Bank estimated that there were 28 national or subnational emissions trading schemes (ETS) operational in 2019 with further schemes under development (World Bank 2019) and the International Carbon Action Partnership tracked 21 ETS covering 29 jurisdictions with nine more under development (ICAP 2020). There are three ways that forests could be supported via ETS: i) a source of offsets within a domestic or international ETS;[19] ii) stable forests could be treated as a covered sector under an ETS with emission caps; or iii) auction revenues from the sale of emission allowances from an ETS could be used to support stable forests. As discussed in Chapter 2.2 on the international policy framework above, if stable forests are not under threat there is no additionality associated with their protection or natural sequestration, so they are not a good source of offsets. The other options are also difficult to apply to stable forests, making ETS a difficult policy option for many countries to pursue (see Annex A.7).

5.3.5 Green finance and other options

The interest in natural infrastructure, green finance and financial products has been growing, and some emerging—as well as tried and tested—options are considered, though not all are likely to be relevant for stable forests.

19 This includes ITMOs being considered under Article 6.2 of the Paris Agreement and any market mechanism under Article 6.4.

Debt-for-nature swaps

Debt-for-nature swaps were first initiated by the WWF in 1984 to enhance conservation efforts in developing countries. Foreign debt is purchased at a discount, converted to local currency, and the proceeds are used to fund conservation (Resor, 1997). Debt-for-nature swaps do not currently make a significant contribution to global finance for biodiversity conservation (UNDP, 2018). However, there may be increased interest in debt-for-nature swaps as part of broader relief packages as developing countries struggle to come out of the economic impacts of the COVID-19 crisis (McKinsey & Company, 2020; World Bank, 2020a).

Forests as natural infrastructure

The value of natural infrastructure was estimated at \$26.9 billion yr^{-1} in 2019, most of it associated with watershed protection (Deutz et al., 2020). Governments should consider natural infrastructure as part of urban and city planning, which could be funded through budgets or other options above. International support can be provided to help developing countries and cities with this planning.

Other green finance

Many other forms of green finance continue to emerge and grow in importance. Examples include green bonds, sustainability-linked loans, and environmental impact bonds, amongst others. There are also some emerging examples of insurance companies valuing the services of natural assets, though this may be less relevant to protecting stable forest (see Annex A.7). These products continue to grow, with sustainability-linked loans growing 168% in 2019 to \$122 billion, though some such as green bonds do not always target conservation activities. Increased disclosure of the environmental impacts of finance and investment—such as the Task force on Nature-related Financial Disclosures—should help accelerate green finance (World Bank, 2020a).

5.4 Policy conclusions: Bringing the pieces together

The analysis of changes in stable forest area provides new evidence that the world's forests are under pressure from human impact, with high rates of stable forest loss over the past decade. The economic analysis demonstrates that there is substantial asset value in the world's stable forests, which translates into economic losses when this forest is deforested. Economic losses can also be expected when stable forest is converted to at-risk forest, because more forest that had previously been almost inaccessible is now closer to human impacts. However, this analysis is unable to calculate the value of these losses due to a lack of data. These economic losses occur across a wide range of ecosystem services, although this report only values carbon, biodiversity, hydrological services, and NTFUs. The economic analysis also highlights the significant difference between the underlying value of stable forests as an asset and the much smaller annual equivalent RED benefit (the value of stopping deforestation in areas that were stable forests in 2010).

REDD+ already provides policy options to value and reduce deforestation and forest degradation, and for areas of forest under threat of deforestation, the per hectare value of reducing deforestation approaches the asset value. However, the amount of forest to which this applies is limited to areas under imminent threat, and it does not address the free rider problem, adequately value stable forests, or capture the conversion from stable forest to at-risk forest. Taking preventative action to halt this conversion to at-risk forest is a key long-term strategy to protect not just stable forests, but all global forests and the ecosystem services they provide.

A new "Stable Forest Fund" or the concept of a "conservation credit" can be used to direct revenue to support forest protection. The credit could be tied to an area of stable forest and help promote consistent and comparable monitoring, reporting, and valuation of stable forests, and it can support a range of market and nonmarket policies that require monitoring and/or valuation of stable forests. The conservation credit concept does not require the creation of a new market to trade credits, though this is an option. For example, conservation credits could be used to value EFT payments, with monitoring, reporting and valuation consolidated into a single unit that can be used to prioritize EFTs and compare results between forests within a country. The concept could also be used to help value and direct funding towards protected areas, value debt-for-nature swaps, value forests in planning, or be used as a tradable unit in a PES scheme. Only a new PES scheme relies on creating a new market mechanism and identifying new buyers for a conservation credit—the other examples simply use the concept to compare and value forests linked to other policy options. The annual maintenance value could be used to value conservation credits or stable forests. This is a fraction of the asset value but applied over larger areas of eligible forest would generate substantial value in most heavily forested countries. This could be paired with existing policy that focuses on protecting forests at risk of deforestation or degradation and thereby value and incentivize the protection of all remaining forests. Stable forest and at-risk forest strategies should be developed together, as protecting at-risk forests, and particularly the at-risk buffer zones near stable forests, will also have inherent benefits for the preservation of stable forests.

The concept of a conservation credit or maintenance payments for stable forests is consistent with the CBD and Articles 5, 6.2, 6.8, and 9.1 of the Paris Agreement, and many countries have Paris Agreement and CBD commitments to protect forests and/or expand protected areas. The commitments under these conventions need to be brought together through the adaptation benefits, biodiversity benefits, and other co-benefits of maintaining stable forests. However, any international financial mechanisms need to be linked to domestic policy and domestic resource mobilization. Domestic policy will need to be tailored to specific drivers that affect stable forest loss and should also consider the heterogeneity of forests and different ecosystem services and values of different forests. Several domestic policy options can be considered:

Fiscal policy: Fiscal policy is potentially the most powerfully policy tool to support forests and reduce the transition from stable to at-risk to non-forest. Conservation credits or maintenance payments can be integrated directly into EFTs that tie payments to hectares of stable forest. Funding could come from a combination of domestic budgets and international sources. However, for EFTs to work there needs to be some decentralization of forest and land-use governance along with internal fiscal transfers. Where these conditions exist, it could be an appealing option. For example, Indonesia is already working with EFTs, whereas Liberia has a centralized fiscal policy and therefore broader fiscal policy reform may be needed before EFTs could be considered. Guyana, on the other hand, has centralized forest governance but may nonetheless be able to consider EFTs associated with Amerindian governance of forest areas.

Governments and donors can also pursue subsidy and tax reform to stop forest loss and the conversion of stable to at-risk forests. Reforming harmful subsidies could free up government funding that could be directed towards forest protection, and the results of any reform could be monitored and quantified by tracking total hectares of stable forest within a country or target area. Conservation credits or a Stable Forest Fund could also be used to help pay for the results and fund or compensate the new subsidy and tax system.

Direct regulation: Protected areas are the cornerstone of the CBD, but the case studies and literature show their efficacy can be undermined by weak governance. Georgia has the strongest governance of the case study countries and the most effective protected areas. In contrast, Liberia and Republic of Congo have weak governance and very high rates of loss of stable forests in protected areas, with government- managed protected areas in Republic of Congo seeing higher rates of stable forest loss than unprotected areas. Good governance must underpin any work in both existing protected areas and new protected areas, therefore a Stable Forest Fund and/or conservation credits tied to stable forests could help pay for improvements in governance. Payments tied to maintaining stable forests will create further incentives to improve governance of protected areas. Changing other regulations on forest clearing outside protected areas is also highly dependent on good governance but could be incentivized in a similar way as subsidy or tax reform discussed as part of fiscal policy.

Market mechanisms: Large-scale market mechanisms are dependent on good governance to be effective, and project level PES have also had mixed results in some countries. For example, Liberia has been offered REDD+ result-based payments from Norway but has not yet received any payments. Indonesia has a long history of PES projects, but the efficacy of some has been criticized. Indonesia has collaborated with Norway on bilateral

REDD+ transactions, but also objects to some third-party efforts to drive national and subnational REDD+.[20] Nevertheless, there are many ways to structure PES, and PES markets are well suited to accommodate conservation credits and maintenance payments for stable forests which can be funded internationally or domestically. Emerging evidence on the efficacy of PES programs has provided numerous suggestions for fine-tuning PES programs for better success at achieving their objectives. However, a key limitation of PES is identifying ongoing sources of finance. A combination of finance from subsidy reform, direct regulation, and/or fiscal transfers could be considered.

Green finance: There is growing interest in using financial services and products to support conservation. Addressing the free rider problem and valuing stable forests though the above policy options should accelerate green finance innovation. Conservation credits or maintenance payments can be used to value debt-for-nature swaps, and credits or payments could be used in green bonds and considered by financial institutions as they assess investments and develop financial products. However, as with the other policy options discussed above, more complex policy needs to be accompanied by stronger governance and green finance is no exception.

5.5 Gaps and recommendations for future research

The potential for successful policy implementation is currently limited by gaps in our knowledge of the detailed mechanics of relevant approaches in practice. Along with the gaps identified in prior chapters, this analysis should be prioritized in future research. Addressing these gaps could improve how policies are implemented on an operational basis.

5.5.1 Analysis of conservation credit approach

Gap identified from this analysis
The use of a conservation credit which accounts for multiple ecosystem services (rather than just carbon) could be an appropriate choice for stable forests globally and in the case study countries analyzed here. However, the approach on how to apply a stacking or conservation credit on an operational basis is not well-developed in literature or through policy examples.

Recommended next step
Futher research into how a stacked conservation credit could be applied in different contexts globally and at a national level is needed.

Outcome
A conservation credit could be successfully used to fund protection of stable forests once an operational framework is established.

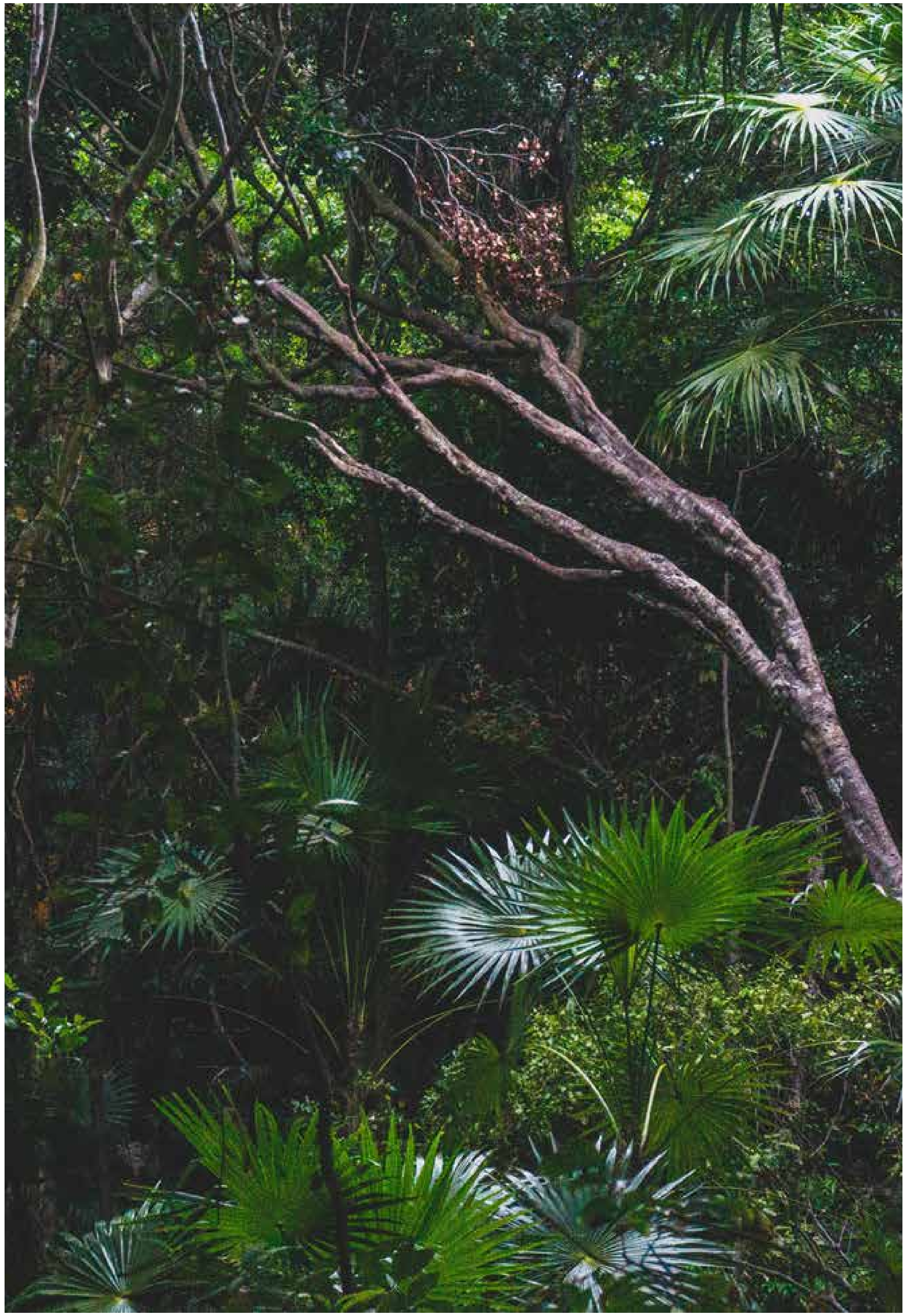
20 In April 2021 a coalition of private companies, Emergent Forest Finance, and donor governments launched the LEAF Coalition to stimulate use of the ART TREES standard for REDD+. In response, Indonesia's national focal point for the UNFCCC issued a letter explaining why Indonesia cannot join the coalition (FORESTHINT.NEWS, 2021).

5.5.2 Analysis of potential for Stable Forest Fund

Gap identified from this analysis
A new "Stable Forest Fund" could be created under the mandate of the Parties to the UNFCCC and CBD. This could occur jointly or separately under the conventions and could be managed by the the Global Environment Facility, the Green Climate Fund, or a multilateral development bank. However, establishing such a fund would require international support and a more detailed understanding of how it could be legitimately operationalized.

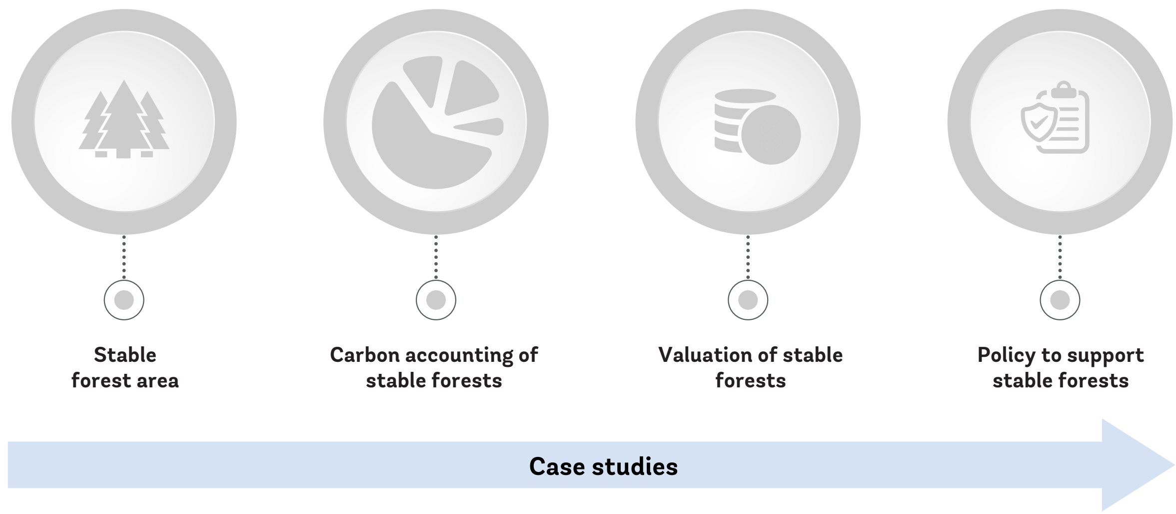
Recommended next step
Futher research into and consideration of how a stable forest fund could be established and implemented is needed.

Outcome
A stable forest fund could be used to provide reliable funding to improve protection for stable forests, complementing existing efforts to protect forests rather than duplicating efforts.



Chapter 6:

Stable forests in case study countries



SUMMARY

Overview

Five case study countries were analyzed through literature review and spatial analysis to inform conclusions relevant to stable forest area, losses, value, and policy solutions: Georgia, Guyana, Indonesia, Liberia, and Republic of Congo. Case studies allow a deeper dive into country context and how it can impact stable forests. This chapter presents an overview of the methods and key results before presenting each case study.

Key findings

- The asset value of carbon contributed the most to the total asset value of stable forests of the four ecosystem services analyzed.
- A conservation credit approach, connected to domestic policy, could be used to allow consistent monitoring and valuation of stable forests in all case study countries.
- Governance, regulation, and institutional capacity are common themes impacting stable forests in all case study countries.

6.1. Case study overview

6.1.1. Methodology

In each country, analysis was broadly divided into four parts:

1. **Spatial analysis of stable forests:** presentation of stable forest area, loss rates, and stable forest overlap with protected area.
2. **Ecosystem services provided by stable forests:** evaluation of carbon removals and stocks in stable forests and non-carbon benefits provided by stable forests, specifically focusing on biodiversity, hydrological benefits, and NTFUs.
3. **Economic potential of stable forests:** estimates of the current a) asset value, b) maintenance value, and c) annual equivalent benefit of a policy to reduce emissions from deforestation (RED) for carbon, biodiversity, NTFUs, and hydrological services in stable forests.
4. **Recommended policy approaches:** an analysis of international and domestic policy options, particularly focusing on EFTs, PES, and protected areas (three policy objectives chosen in coordination with the World Bank), as well as key policy recommendations moving forward.

A detailed description of how case study countries were selected, the methodology used, and supplementary results are in Annex C.

Spatial analysis of stable forests

The spatial analysis of stable forests in case study countries differed slightly from the global analysis described in Chapter 2 of this report; this is described in more detail in Annex C.2.1. The definition of stable forests does not rely on the 1 km distance-from-edge criterion described above. Instead, it is defined on a country-by-country basis based on historical deforestation patterns (from 2000 to 2019) at different distances from the forest edge. At-risk forests in case study countries are defined as **forests in 0.5 km distance bands in which more than 10% of total deforestation occurred** between 2000 and 2019. Stable forest canopy is specified according to the respective country's own definition of forest cover, rather than assuming 25% canopy cover to be the decisive proportion as in the global analysis. Therefore, stable forest area results in the case study country analysis may differ slightly from any national stable forest data presented in Chapter 2 or Annex B.

Hydrological benefits provided in terms of drought risk and flood risk were analyzed spatially and overlaid with stable forest area, as was biodiversity intactness. There was no spatial layer of NTFU importance available for all case study countries.

Economic valuation of stable forests

To value stable forests in case study countries, we follow the general approach to value ecosystem services described in Chapter 4. We supplemented the analysis with additional literature review of valuation studies for the relevant region and country. Greater detail on methodology is given in Annex C.2.2. The current a) asset value, b) maintenance value, and c) annual equivalent benefit of a policy to reduce emissions from deforestation (RED) of 1) carbon, 2) biodiversity, 3) NTFUs, and 4) hydrological services in stable forests are estimated in this analysis. This includes an estimate of the per hectare value based on the 2019 area of stable forests. Some of the key valuation concepts used throughout the case studies are presented in the box in Chapter 4 and several key aspects of the methodology are outlined below.

Projections used for RED policy valuation

The present value of a RED policy is calculated based on avoiding future deforestation in the 2019 stable forest area. To make a future projection of deforestation in areas that are currently stable forests, it is assumed that the same area of stable forest is ultimately deforested annually in the future as has been deforested over the past five years. The degree of deforestation varies depending on the distance the stable forest site was from the nearest edge in 2010. Annex C.4.5 has an example demonstrating this for Guyana. These varying rates by distance band are used in this projection. It is assumed that a constant area is deforested each year for each distance band. This analysis does not include the value of preventing the conversion of stable forest to at-risk forest or the degradation that this might involve. There is insufficient understanding of how this conversion links to or results in degradation (other than that these forests are more susceptible to deforestation and degradation) and therefore this could merit further research.

Analysis to value carbon

For the purposes of this project, the asset value of carbon is calculated at two different carbon prices, \$14 t CO_2e and \$40 t CO_2e. This is because currently, the World Bank recommends a social cost of carbon of \$40 t CO_2e, rising at 2.25% yr^{-1} (Stiglitz and Stern, 2017). However, market prices are lower. For instance, forest offset prices in California are around \$14 t CO_2e, while in New Zealand they are \$16 t CO_2e. For this analysis, \$14 t CO_2e is used.

Note that for this analysis, leakage for all countries is assumed to be zero.

Analysis to value biodiversity

Two approaches, as outlined in Annex C.2, are used to value any potential change in biodiversity due to deforestation of area that was stable forest in 2010 in each case study country.

- **Approach 1: Theory of Island Biogeography**

  The first approach uses the theory of island biogeography (TIB) to estimate the change in species abundance that would occur as stable forest area declines over time. The value per hectare of biodiversity is then adjusted proportionally downward to reflect this loss. Thus, when deforestation occurs, two factors cause a reduction in aggregate biodiversity value: a loss of forest area and a reduction in the value of the remaining forest areas due to the resulting reduction in species abundance. A more detailed description of the changes in species abundance using this approach is outlined using Guyana as an example country in Annex C.4.5.2.

- **Approach 2: MSA**

  The second approach to measure biodiversity is to calculate a change in MSA for the stable forest area in 2019 (MSA_p) based on the loss of aggregate forest area and the change in patch sizes of forests, and then combine these measures to determine the effective loss of forest from the stable forest region, following FAO (2020). An example of this approach for Guyana, with more detailed descriptions of changes in patches and MSA values, can be found in Annex C.4.5.2.

6.1.2. Case study results overview

An overview of key statistics in case study countries is presented in the table below.

Table 7. Overview of case study country statistics

Country	Stable forest area (ha) (% of forest area)	Stable forest net loss, 2000–2019	% Stable forests protected	Carbon stocks in stable forests (Mt C)	Asset value of stable forests (billion \$)	Annual maintenance value of stable forests (billion \$ yr^{-1})
Georgia	388,596 (12.4%)	18.2%	13.9%	103	4.9–8.4	0.18–0.30
Guyana	11,373,310 (60.7%)	25.8%	11.7%	3,087	153.7–446.2	5.5–16.1
Indonesia	32,043,277 (24.4%)	49.0%	24.9%	13,363	526–1,014	18.9–36.5
Liberia	592,729 (7.7%)	84.6%	41.0%	172	9.3–17	0.34–61
Republic of Congo	10,965,916 (57.2%)	38.4%	69.9%	3,619	191–364	6.9–13.1

Addressing and assessing degradation should be a priority for follow-up work given the current limitation in knowledge on degradation of at-risk forests. Because stable forest losses are mostly due to fragmentation and changing edges, this could have subsequent consequences on infectious disease risk and pathogen spillover to humans that could result in epidemics or pandemics such as the recent COVID-19 pandemic. Land conversion, particularly at intermediate levels, is associated with higher risks of pathogen spillover (Faust et al., 2018).

The loss of forest—and stable forest—was driven by factors that varied across countries. In Guyana, where mining is a dominant driver of forest loss, there was greater deforestation in patches more than 5 km from the forest edge relative to other countries. This could threaten stable forest farther from the edge and could be driven by practices such as mining in sporadic patches deeper into the forest. In Indonesia, where deforestation is predominantly commodity-driven, there were much higher rates of deforestation in stable forests. Meanwhile, Liberia is experiencing extremely rapid overall losses of both stable and at-risk forests due to recent economic development and more limited governance capacity. Georgia, on the other hand, has stronger governance in place and has experienced lower stable forest losses. These could be examples of different typologies of countries and how they experience stable forest loss, although greater in-depth analysis of more countries would be needed to evaluate this.

The asset value of carbon contributed the most to the total asset value of stable forests of the four ecosystem services analyzed. It was highest in Georgia (where 90% of the stacked asset value was due to carbon), followed by Republic of Congo (88%), Liberia (86%), Indonesia (85%), and Guyana (79%).

A wide range of recommended policy approaches analyzed for case study countries are outlined in the table below. In all case study countries, a conservation credit approach, connected to domestic policy, could be used to allow consistent monitoring and valuation of stable forests (as discussed in Chapter 5). Governance, regulation, and institutional capacity are common themes in all case study countries. These factors affect a country's ability to conserve stable forests, and thus understanding current conditions is key in developing future strategies to protect stable forests more effectively.

Table 8. Case study country key policy recommendations

Country	Policy recommendations to protect stable forests
Georgia	• REDD+ and Article 9.1 are not relevant policy mechanisms because Georgia is an upper-middle-income country. • Protected areas may be an effective option thanks to stronger governance than in other case study countries. • PES or EFTs could be connected to protected area policy.
Guyana	• There is scope for Guyana to protect stable forest under the Paris Agreement and CBD. • PES and protected areas could be considered (and be a focal point of international support). • EFTs need further research to better assess feasibility. • Creating a PES scheme linked to Guyana's Sovereign Wealth Fund is recommended.
Indonesia	• An urgent focus on reducing the conversion of stable forest to at-risk forest (along with deforestation of all forests) is needed. • Forest governance needs to be significantly strengthened to support protected areas. • Increased attention on forest governance is needed for PES, as there is long-term support for PES despite the weak regulatory framework. • EFTs may be the most promising policy option to support stable forests in Indonesia.
Liberia	• There are opportunities for Liberia to protect stable forests under Articles 5, 6.2, 6.8, and 9.1 of the Paris Agreement. • Forest governance needs to be improved as protected areas do not effectively protect stable forests. • Given governance challenges, large-scale, policy-driven market mechanisms will be difficult to implement although more localized approaches may be possible. • EFTs could be considered alongside other fiscal reform and technical assistance.
Republic of Congo	• There are opportunities for the Republic of Congo to protect stable forests under Articles 5, 6.2, 6.8, and 9.1 of the Paris Agreement. • Protected areas could be made more effective with improvements in connectivity, but forest governance needs to be fundamentally improved. • Given governance challenges, large-scale policy-driven market mechanisms will be difficult to implement, but more localized approaches may be possible. • More research is needed to understand the feasibility of using oil or other fiscal transfers to structure an EFT to conserve stable forests.

6.1.3. Gaps and recommendations for future research

The gaps and recommendations identified in previous chapters also apply to case study countries. For example, there is a need to assess the value of stable versus at-risk forests at a case study level, as there is a need for further research into the drivers of stable forest loss. The gap identified in 4.4.1 regarding the potential undervaluation of non-carbon ecosystem services also applies to case study countries. Other key recommendations emerging from the case study analysis are listed below.

Stable forest loss and disease risk

Gap identified from this analysis

This analysis focuses on four main ecosystem services: carbon storage and sequestration, biodiversity, hydrological services, and NTFUs. However, forest fragmentation is a key driver of increasing exposure of pathogens to humans, which can result in epidemics or pandemics such as the COVID-19 pandemic. Although there is evidence suggesting the greatest risk of pathogen spillover occurs at intermediate levels of deforestation (Faust et al. 2018), there is a limited understanding of how stable forest loss, which is driven in part by fragmentation, could contribute to this risk.

Recommended next step

Further research is needed on the effects of deforestation and degradation on disease risk in different locations and in different forest types.

Outcome

Understanding the links between stable forest loss and disease risk could help prevent public health crises in the future.

Country typology analysis

Gap identified from this analysis

Countries that conform to different typologies may experience stable forest loss accordingly, as demonstrated by the initial analysis here using case study countries. For example, countries experiencing high levels of mining, countries with high development and limited deforestation, or countries with high commodity-driven deforestation may each have typical stable forest loss profiles.

Recommended next step

Further analysis of countries under different typologies is needed to determine how these country characteristics affect stable forest losses.

Outcome

Focusing on country typologies would allow more targeted efforts to conserve stable forests in areas where they are under greatest threat.

6.2. Georgia

Stable forest area: Georgia has 388,596 ha of stable forests (12.4% of forests). It has experienced low stable forest deforestation (0.11% from 2000 to 2019) and some net stable forest loss (18.2%). Data suggests protection helps prevent some conversion of stable forests to at-risk forests.

Ecosystem services: Stable forests store 103.1 Mt C and sequester approximately 0.64 Mt CO2e yr^{-1}. Biodiversity is highly intact, stable forests likely provide important erosion benefits, and there is a greater proportion of stable forests than at-risk forests in lower drought risk watersheds.
Economic potential: The value of stable forests is estimated to range from $4,904 million to $8,398 million for the four ecosystem services valued. The annual maintenance value of stable forests ranges from $177 million to $302 million yr^{-1} and the annual value of reducing deforestation is $200,000 to $400,000.

Recommended policy approaches: Because Georgia is an upper-middle-income country, international collaboration should focus on Articles 6.2 and 6.8 of the Paris Agreement and collaboration under the CBD. This could include collaboration via "conservation credits" linked to domestic efforts to stop loss of stable forests. Georgia has stronger governance than other case study countries, which increases the likelihood that protected areas may be more effective to protect stable forests. PES and EFTs could be connected to protected area policy or enacted on their own to help incentivize local community and local government support to maintain stable forests.

6.2.1. Country overview

Georgia is a small Eurasian country with significant natural resources. It is classified as an upper-middle-income country with a declining population of 3.72 million (falling by 0.17% yr^{-1}) (World Bank, 2020c). Mountains occupy 80% of its land area, ranking it as one of the 15 most mountainous countries in the world (Lovera, 2008). Its GDP and GNI in current US dollars per capita in 2019 were $4,769 and $4,740, respectively, and have grown steadily. Georgia is an emerging market economy, and agriculture, forestry and fishing comprise just 7.4% of its GDP (Geostat, 2020) but forests play a vital role in meeting energy needs: 8–12% of all Georgia's energy is provided by fuelwood (UNFCCC, 2019). There is therefore a high dependency on natural resources, particularly by rural populations, of which 80% use wood for heating and cooking (World Bank, 2015b). Forests cover approximately 40% of Georgia's territory and are unevenly distributed throughout different regions (ENPI East FLEG II, 2014). Georgia's forests are highly biodiverse and are considered one of Conservation International's 36 Biodiversity Hotspots (CEPF, 2004). 21% of plants in Georgia are endemic to this region, which holds 4,400 native species of vascular plants and 380 non-native species (Slodowicz et al., 2018).

Deforestation in Georgia is mostly driven by harvesting and land use conversion through commodity driven deforestation (GFW, 2020a). Logging rates currently exceed forest growth rates, while demand for woodfuel is also a strong driver of deforestation (World Bank, 2015b). Since 2001, Georgia has experienced a 0.32% decrease in forest cover (GFW, 2020a). Although Georgia has a relatively low annual deforestation rate, its forest cover is too low for it to be classified as an HFLD country and it is a country with a high HDI. Georgia has not submitted a REDD+ FREL, but has committed to increase sustainable forest management practices, increase afforestation/reforestation, and expand protected forest areas in its INDC (Ministry of Environment and Natural Resources Protection of Georgia, 2015).

6.2.2. Stable forest area

Stable forest area and loss

Stable forests in Georgia

Area: 388,596 ha

% of country: 5.6%

% of forest: 12.4%

Deforestation, 2000–2019: 0.11%

Net loss, 2000–2019: 18.2%

Deforestation of both at-risk and stable (following conversion to at-risk) forests in Georgia is very low, although there was a significant conversion of stable forest to at-risk forest from 2000 to 2019. Since 2000, Georgia has experienced hardly any deforestation more than 0.5 km from the forest edge. The rate of net loss of stable forests in Georgia decreased from the period 2000–2010 to 2010–2019 (dropping from a loss of 1.4% to 0.6% yr^{-1}), suggesting policies and national initiatives to manage forests may have been effective in reducing advancing forest edges. Relative to other regions in Georgia, Abkhazia, a partially recognized autonomous republic in northwestern Georgia, has the greatest stable forest area and one of the lowest rates of loss (10.2%) from 2000 to 2019. However, this region has not been under the Georgian government's control since the 1990s and therefore its stable forest areas are under different conditions and the same policy options may not apply. Meanwhile, regions such as Samtskhe-Javakheti and Kvemo Kartli have small areas of stable forests yet suffered high stable forest losses. These results suggest that the largest patches of stable forest are more stable and therefore are vital to protect. Five regions (Abkhazia, Imereti, Guria, Ajaria, and Racha-Lechkhumi-Kvemo Svaneti) could also be considered HFLD, given their forest cover above 50% and low deforestation rates. Aside from Abkhazia, for which local solutions may be necessary, these regions could be prioritized by national policymakers to maintain HFLD status.

Stable forests in protected areas

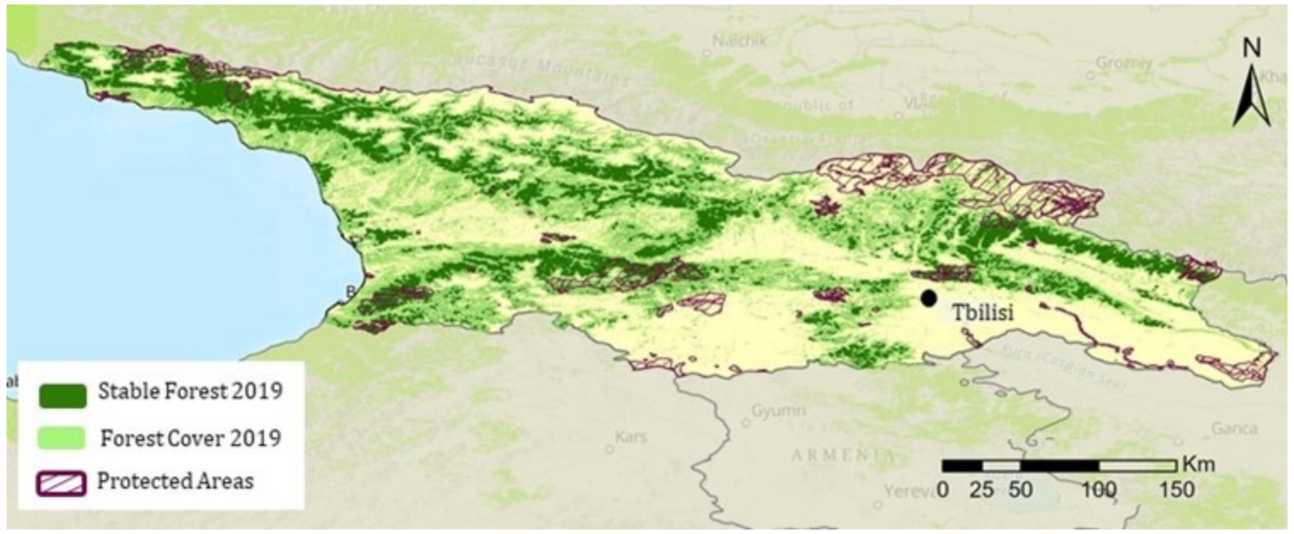
Although stable forests make up 12.4% of forest area in Georgia, 18.5% of forests in protected areas are stable forests. All protected stable forests are in government-managed areas. Protected stable forests had similar deforestation rates (following conversion to at-risk forest) to non-protected areas but have experienced slightly lower net losses of stable forests compared to non-protected areas (15.55% versus 18.59% from 2000 to 2019; see Annex C.3). Deforestation is already extremely limited in Georgia, so this data suggests protection provides some help to prevent the conversion of stable forests to at-risk forests.

Table 9. Forest and non-forest area in Georgia in 2000, 2010, and 2019

Land classification	Area (ha)		
	2000	2010	2019
At-risk forest	2,673,156	2,731,873	2,749,485
Stable forest	474,955	408,795	388,596
All forest	3,148,111	3,140,668	3,138,081
Non-forest	3,827,598	3,835,041	3,837,628

% stable forests which are protected: 13.9%
% protected forests which are stable: 18.5%

Figure 13. Map of stable forests in Georgia



6.2.3 Carbon potential

Stable forest C stocks: 103.1 Mt C

Stable forest removals: 0.64 Mt CO2e yr^{-1}

The proportion of Georgia's carbon stored in SOC is 59.3%, compared to 31.2% in AGB and 9.3% in BGB. This high proportion of SOC storage is probably due to lower AGB within temperate zones, which are less carbon-dense than tropical forests. Stable forests store 20% more in AGB and BGB and 15.3% more in SOC than at-risk forests, likely given the greater exposure of at-risk forests to degradation. However, degradation is not analyzed here. Abkhazia, the region which has the greatest stable forest area, also has the highest total carbon storage per hectare. Temperate mountain systems account for 71% of sequestration even though they comprise 59.3% of Georgia's stable forests. If the annual rate of net stable forest loss from 2019 to 2030 were to change by the same amount as it did between the period 2000–2010 to 2010–2019, stable forests would sequester 0.63 Mt CO_2e in 2030 and would have a carbon stock of 100.7 Mt C. This does not mean the difference in carbon stock is lost as emissions or that the difference in sequestration would be forgone removals, as at-risk forests may continue to sequester and store this carbon.

6.2.4 Non-carbon benefits

Biodiversity

- The average biodiversity intactness index for stable and at-risk forests is 98.2% and 97.7%, respectively, suggesting biodiversity is highly intact (Figure 14).
- Invasive species and pests pose threats to diversity in stable forests and at-risk forests alike (Patarkalashvili, 2017; Slodowicz et al., 2018; Thalmann et al., 2015).
- High endemism is concentrated in central Georgia and northwestern Abkhazia, correlating with regions with the greatest stable forest area, signaling their potentially high conservation value.

Hydrology

- 46% of stable vs. 25% of at-risk forests are in extremely high riverine flood risk areas (Figure 15).
- 36% of stable vs. 16% of at-risk forests are in low or low-medium drought risk areas (Figure 16).
- Because roughly 97% of forests are on mountain slopes, any deforestation in Georgia holds elevated risk of landslides, floods, and erosion (ENPI East FLEG II, 2014).
- Erosion is a major problem on deforested steep slopes, which also results in a decrease of water retention capacity (Metreveli, 2002).

Non-timber forest uses

- There are over 100 species of edible mushrooms; 150 species used for fruit, nuts, berries, or bark; 60 species used for veterinary purposes; and over 110 species used medicinally (Metreveli, 2002).
- Because most forest area in Georgia is above 1,000 m and on steep slopes, forest product exploitation can be difficult and has not met its full potential (Patarkalashvili, 2016).

For a more detailed description of non-carbon benefits in Georgia, see Annex C.3.

6.2.5 Valuation of ecosystem services

The value of ecosystem services (Table 10) ranges from \$5.0 to \$8.4 billion. A large share (80%) of the value in Georgia is derived from the carbon asset, but this is smaller than in the other case study countries, largely because the per hectare values for NTFUs for Georgia are large. The higher NTFU value derives from the relatively large income per capita in Georgia compared to the other case study countries and the resulting higher recreational use values. Given the limited deforestation recorded over the study period in areas of stable forests in Georgia, the annual value of a policy to reduce emissions from deforestation over the next 10 years is very small, amounting to < \$1 ha^{-1} yr^{-1}.

Figure 14. Biodiversity intactness index within stable forests of Georgia

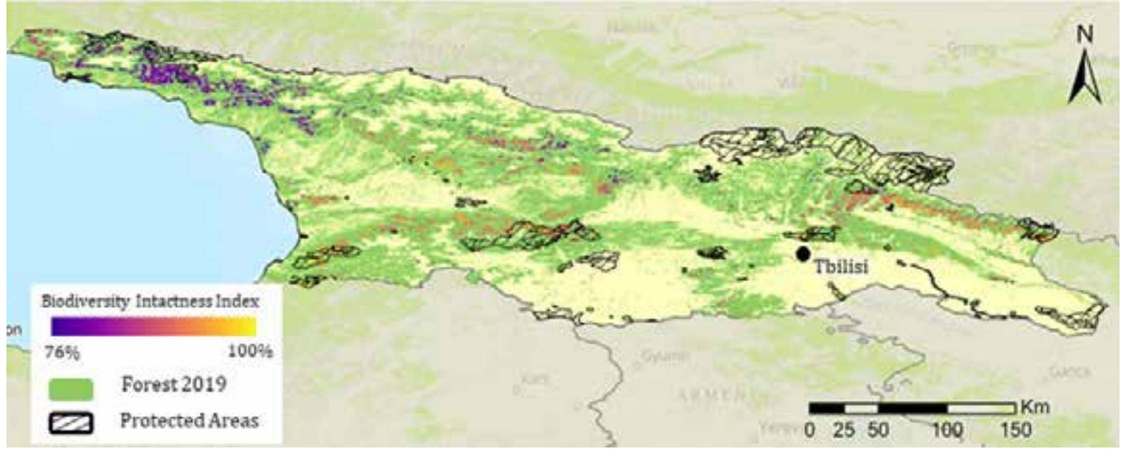


Figure 15. Riverine flood risk within Georgia derived from WRI aqueduct dataset

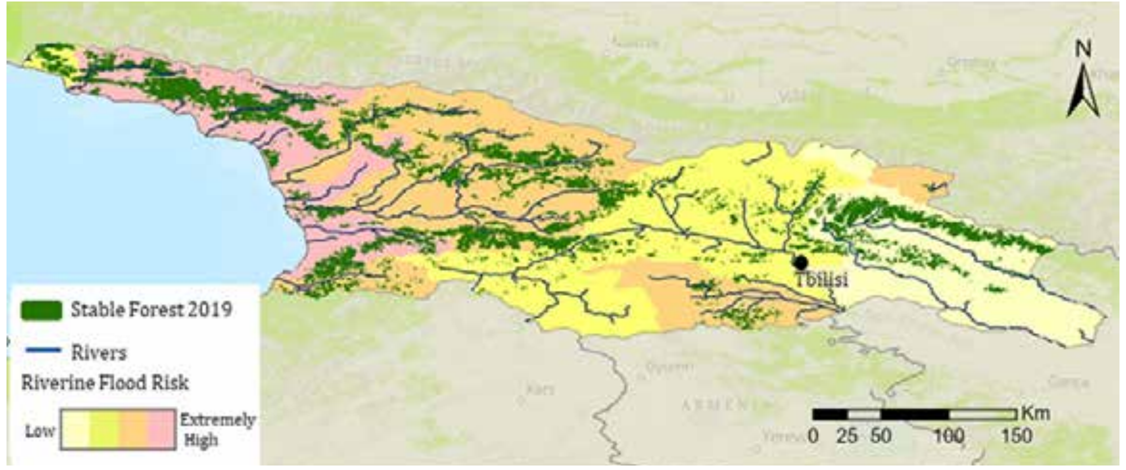


Figure 16. Drought risk within Georgia, derived from WRI aqueduct dataset

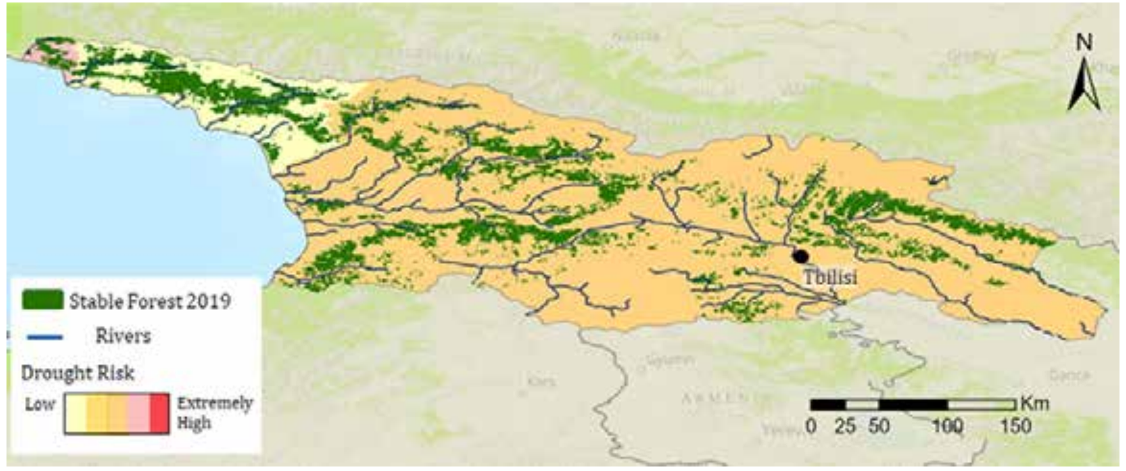


Table 10. Summary values for asset and present value for a 10-year policy to reduce emissions from deforestation (RED) in 2019 stable forest areas. The annual equivalent RED benefit includes only the benefits accrued over the 10-year period. Carbon price range \$14-\$40 t CO_2e and r=0.05. \$ ha^{-1} based on area of stable forests in 2019.

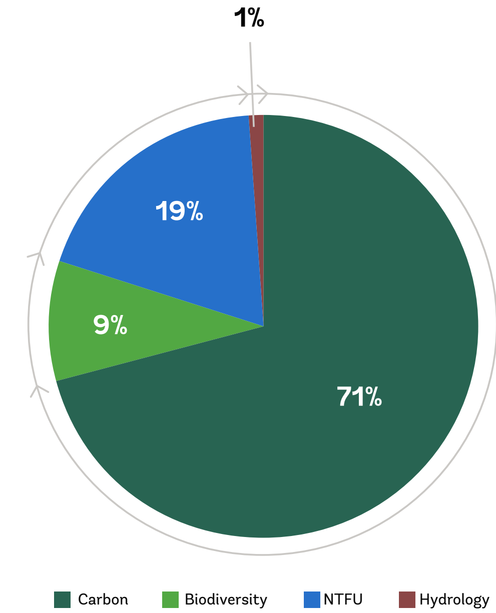
	Asset (\$ millions)	Annual Maintenance (\$ millions yr^{-1})	Annual equivalent RED benefit (\$ millions yr^{-1})
Carbon	\$3,494–\$6,987	\$126–\$252	\$0.1–\$0.3
Biodiversity	\$417–\$418	\$15–\$15	\$0.01–\$0.02
NTFU	\$940.3	\$33.9–\$33.9	\$0.04
Hydrology	\$52.8	\$1.9–\$1.9	\$0
Total	\$4,904–\$8,398	\$177–\$302	\$0.2–\$0.4
Total (\$ ha^{-1})	\$12,620–\$21,611	\$454–\$778	\$0.51–\$1.03

Carbon valuation

The value of the carbon asset in Georgia is defined by the relatively large soil organic storage component, as well as the continued accumulation of carbon in stable forests. At \$14 t CO_2e, the asset value is \$3.5 billion, of which 34% would be lost soil carbon in the coming decades if deforestation of stable forests (following conversion to at-risk forest) were to occur. Within this calculation, an additional \$0.5 billion in benefits accrues due to growth and other processes in Georgia. The higher values in the table above are driven by a higher carbon price of \$40 t CO_2e. The maintenance value ranges from \$177 to \$302 million yr^{-1}.

The historical rate of deforestation of stable forests (following conversion to at-risk forest) is extremely low in Georgia at only 0.004% yr^{-1} from 2015 to 2019. At this rate, there would only be 157 ha of lost forest in 2019 stable forest areas by 2029. The policy benefit of avoiding this deforestation is \$0.2 billion at \$14 t CO_2e, or \$0.4 billion at \$30 t CO_2e, implying a very modest annual benefit associated with a RED policy.

Figure 17. Asset share of ecosystem services provided by stable forests (\$14 t CO_2e)



Biodiversity

For the biodiversity valuation, a value of \$1076 ha^{-1} derived from Siikamaki et al. (2021) is used in this study (this is significantly larger than the temperate forest average estimate from de Groot et al. (2012)). Given the slow rate of predicted future deforestation, the policy benefit of avoiding this deforestation to maintain biodiversity is less than \$100,000 yr^{-1} using either approach to calculate the change in biodiversity value. There is little projected future change in forest area or sizes of existing patches.

Non-timber forest uses

The value of NTFUs is estimated from Siikamaki et al. (2021) to be \$2419.86 ha^{-1}. This includes both recreational activity and collection of non-wood forest products. For Georgia, the greatest value lies in recreational uses, consequent upon the level of income enjoyed there. The value from Siikamaki et al. (2021) is considerably larger than the average value for temperate forests in de Groot et al. (2012) (\$123 ha^{-1}).

Hydrological value

The value of hydrological services is estimated from Siikamaki et al (2021) to be \$136 ha^{-1}. This is smaller than the estimate in de Groot et al. (2012) for temperate forests (\$1179 ha^{-1}).

6.2.6 Policy analysis

> ***Policy objectives:***
> 1. Slow and halt conversion of stable forest to at-risk forest.
> 2. Reduce deforestation of all forests.

To successfully protect and enhance stable forests, policy should aim to slow and halt the conversion of stable forest to at-risk forest and reduce deforestation of all forests. The analysis above shows the conversion of stable forest to at-risk forest is a greater threat to Georgia's forests than deforestation. Policy to address the loss of stable forest should be a priority. This should be supported by domestic policy that recognizes the value of stable forests. Improving forest governance and reducing deforestation are still important, but governance efforts should focus on maintaining stable forests—particularly in protected areas. These overarching policy objectives find some alignment with existing international and domestic policy, particularly for protected areas.

International alignment

Georgia is an upper-middle-income country. Unlike other case study countries, REDD+ and Article 9.1 are therefore not appropriate policy mechanisms to support Georgia's stable forests under the Paris Agreement. However, all parties to the Paris Agreement have an obligation to conserve and enhance carbon sinks (subject to their national circumstances, see Article 5.1) and Georgia is still able to collaborate with other countries on mitigation and adaptation efforts under Articles 6.2 and 6.8. Georgia has made a conditional commitment under the Paris Agreement to develop sustainable forest management and expand protected areas to 20% of its territory. This can be contrasted to Georgia's Aichi Targets under the CBD, where the country committed to establish protected areas over at least 12% of terrestrial and inland water areas by 2020. See Annex C.3 for more details.

Both the Paris Agreement and CBD create opportunities for Georgia to collaborate with other countries to support its stable forests. This could include collaboration on a "conservation credit" approach that allowed consistent monitoring and valuation of stable forests that could be connected to domestic policy. There is a clear opportunity to collaborate on protected areas, which can be linked to mitigation, adaptation, and/or biodiversity attributes of stable forests.

Domestic alignment

Nearly all forests in Georgia are owned by the state and managed by the National Forest Agency. On May 22, 2020, the Parliament of Georgia approved a new Forest Code that introduced four management categories—Protective, Protected, Recreational or Agricultural—to which forest districts are assigned based on natural and socioeconomic value (*Forest Code of Georgia*, 2020; Georgia Today, 2020). Forests remain under centralized government management, but under the new Code management may be shared with communities, municipalities, private agricultural entities, or the Church (*Forest Code of Georgia*, 2020; Georgia Today, 2020). Georgia has made meaningful improvements in government effectiveness, regulatory quality, rule of law and control of corruption between 2000 and 2019, and the low levels of deforestation may well be related to these developments.

Three domestic options to protect stable forests are discussed in this national and international context: i) protected areas, ii) market mechanisms, and iii) EFTs. Detailed descriptions of domestic policy can be found in Annex C.3.

Protected areas

Georgia has 89 protected areas that cover 9% of its terrestrial lands and 0.7% of marine areas (UNEP-WCMC et al., 2020). These protected areas contain nearly 292,500 ha of forest and more than 54,000 ha of stable forest (see Annex C.3), but many key habitats fall outside protected areas, which do not form a connected network. Although protected areas underwent low levels of deforestation, the transition from stable to at-risk forest still occurred and this could be reduced. Protected areas could be more efficiently conserved with improved governance and planning, encompassing management, monitoring and local community engagement (Forest Department, 2014).

There is scope to expand protected areas in Georgia to align with its conditional commitments under the Paris Agreement. Expanding protected areas to 20% of terrestrial lands would also exceed the CBD's 2020 Aichi Targets and represent an important step towards the draft post-2020 Global Biodiversity Framework currently being discussed under the CBD. Public participation should be a routine feature of the development and management of protected areas, but this does not always occur, and protected area legislation "fails to regulate compensation and incentivizing mechanisms for local communities" (Forest Department, 2014; Matcharashvili, 2012).

Market mechanisms

Georgia's NDC is silent on the use of market mechanisms under the Paris Agreement, but the country has expressed an interest in payment for ecosystem service (PES) schemes and carbon markets to conserve biodiversity in the context of the CBD (see Annex C.3). There is no experience with national level PES, but some examples of Clean Development Mechanism and voluntary market carbon projects.

For a PES scheme to be effective, it would need to prevent the transition from stable forest to at-risk forest through links with forest management and governance efforts that could achieve this. A PES scheme could be linked to recent shifts to decentralize management of forests and thereby provide additional local incentives to maintain stable forests. Because most of the loss of stable forests has occurred in smaller patches, regions of the country that are at greatest risk in this respect should be identified and prioritized.

Ecological fiscal transfers

Georgia has one of the most centralized fiscal and public finance systems of any post-communist country, and it is becoming more centralized (Janský & Palanský, 2020). Forest governance is also centralized, but under the new 2020 Forest Code, autonomous republics and municipalities are directed to develop management plans for forests. Autonomous republics are also directed to create financing measures for their forests (*Forest Code of Georgia*, 2020). This suggests the possibility of considering EFTs as part of the code's implementation.

If an EFT policy is based on the area of stable forest under management in each region Kakheti would receive the most payments (other than Abkhazia, which has the greatest forest area but might not be included in an EFT policy). Regions with the smallest areas of stable forest saw the highest losses (such as Samtskhe-Javakheti and Kvemo Kartli). Additional support may be needed—or a fiscal transfer calculation that is not simply linked to number of hectares—to maintain the remaining patches, which are under increased threat.

Key findings and recommendations

The analysis of change in stable forest area provides new evidence that Georgia's forests are under pressure from human impact. Deforestation rates remain very low, but there is a significant loss of forests classified as stable forest due to a change in distance to forest edge. The causes behind these shifts are not assessed, but the forest appears to be becoming more fragmented; this could be due to expansion of the road network, agricultural encroachment, or both. Forest patch analysis revealed that almost all fragmentation occurred in patches smaller than 100 ha.

The economic analysis demonstrates that there is substantial asset value in Georgia's stable forests, but this is not evenly distributed across regions. As with other countries, most of this value takes the form of stored carbon. This analysis has not captured the lost value of the transition from stable forest to at-risk forest, although this could also entail significant losses in value from carbon, biodiversity, hydrological services, and NTFUs. The economic analysis also highlights the significant difference between the underlying value of stable forests as an asset and the much smaller annual value of stopping deforestation in areas that had been stable forest (and were deforested following conversion to at-risk forest). The present value of reducing deforestation of stable forest (following conversion to at-risk forest) only represents an annual equivalent of 0.002% to 0.003% of the asset. This significantly undervalues stable forests and the ecosystem services that asset provides to Georgia and the world. Adding maintenance payments based on area of stable forest would support recognition of the true value inherent to conserving stable forest.

There is scope for Georgia to collaborate with other countries to protect stable forest under the Paris Agreement and CBD, in a manner connected to domestic policies. As Georgia is not a developing country, this collaboration is limited to Articles 6.2 and 6.8 of the Paris Agreement. Given that the concept of a "conservation credit" is not linked to REDD+ per se, but instead a more general approach to valuing stable forests, this approach should still be possible in Georgia. The different approaches to value stable forests —as an asset, the annual maintenance cost, or present value based on stopping deforestation (following conversion to at-risk forest)—provide a price range that should be the starting point for international and domestic policy discussions on actual payments for protecting stable forests. One approach is to spatially separate maintenance payments and payments to stop deforestation. The value of reducing deforestation is associated with areas under imminent threat of deforestation, typically the forest edge, and it does not capture conversion of stable forest to at-risk forest. When focused on areas that are at risk of imminent deforestation, per hectare reduced deforestation payments approach the per hectare asset value (that is, $15,855 per ha at $14/t CO_2e). Annual maintenance payments are lower per hectare ($571 at $14/t CO_2e) and could be associated with maintaining stable forest areas under threat of fragmentation rather than deforestation. This represents the maintenance value of the ecosystem services that these forests provide. Payments could be structured based on hectares of stable forest, or reductions in stable forest loss with such payments used to support domestic policy or local efforts that protect stable forest.

Domestic policy reform could be funded (entirely or in part) through international support linked to the Paris Agreement and/or CBD. The different approaches to value stable forests can be linked to domestic policy and local implementation. Georgia has stronger governance than other case study countries, as noted above, and this increases the likelihood that protected areas and other government-led efforts to protect stable forests may be more effective. Establishing and enhancing protected areas are a tempting policy option to protect stable forests, especially as there is a clear connection to Georgia's commitments under the Paris Agreement and future evolution of the CBD. Protected area maintenance payments could be based on hectares of stable forest under management and maintaining this stable forest over time. These payments could help improve the governance of protected areas such that local communities are included and are motivated to ensure its efficacy. PES and EFTs could be connected to protected areas or enacted on their own to help incentivize local community and local government support to maintain stable forests outside protected areas. EFTs could be linked to recent legislation that decentralizes some forest governance. Both PES and EFTs could use stable forest maintenance value as a starting point, along with higher targeted payments to reduce deforestation pressures in areas under imminent threat of deforestation.

6.3 Guyana

Stable forest area: Guyana has 11,373,310 ha of stable forests (60.7% of forests). It has experienced low stable forest deforestation from 2000 to 2019 (0.51%) but high net stable forest loss (25.8%). Stable forests in protected areas had considerably lower deforestation rates and net stable forest loss relative to those that were not protected.

Ecosystem services: Stable forests store 3.09 Gt C and sequester approximately 20.6 Mt CO2e yr^{-1}. Biodiversity is highly intact in all forests, stable forests provide key sedimentation benefits, and there are fewer stable forests in high flood risk watersheds than at-risk forests.

Economic potential: The value of stable forests is estimated to range from $153.7 to $446.2 billion for the four ecosystem services valued. The annual maintenance value of stable forests ranges from $5.5 to $16.1 billion yr^{-1} and the annual value of reducing deforestation is $52.2 to $161.5 million.

Recommended policy approaches: There is scope for Guyana to collaborate with other countries to protect stable forest via Articles 5, 6.2, 6.8 and 9.1 of the Paris Agreement and the CBD. This could include collaboration via "conservation credits" linked to domestic efforts to stop loss of stable forests. PES and protected areas are familiar policy instruments that could be considered to help protect and restore Guyana's stable forests. EFTs need further research to better assess feasibility. Given Guyana's new-found oil wealth, creating a PES scheme linked to its Sovereign Wealth Fund is recommended. International support could focus on supporting the establishment and governance of PES and protected areas.

6.3.1 Country overview

Guyana has a population of 786,559, and a population density of just four people per square kilometer (World Bank, 2020c). It is considered an upper-middle-income country with a GDP per capita of $6,955.9 (World Bank, 2020c), which has rapidly increased over the past 15 years. Agriculture, forestry, fishing, mining and quarrying, manufacturing, and construction are the biggest sectors of the economy (FAO, 2015), though oil's dominance is growing. In 2015, Guyana discovered oil offshore and, as of September 2020, it had 18 offshore wells and had sold its first shipment (AP News, 2020; Ministry of Natural Resources, 2020).

Forests cover approximately 85% of the country and are one of Guyana's most valuable natural assets. Guyana is part of the Guiana Shield, which comprises ecosystems globally recognized for their rich biodiversity, high rates of species endemism, and high percentage of uninterrupted tropical forest (UNDP, 2015). Approximately 50% of vascular plants and 25% of animals are considered endemic (Ellenbroek, 1996), and intact forest covers 90% of the Guiana Shield (Government of Guyana, 2015). Annual deforestation rates in Guyana have historically been low, ranging from 0.02 to 0.079% since 1992 (Government of Guyana, 2015). Its low population density and annual population growth rates (0.48% in 2019; World Bank, 2020c) are probably contributory factors here. Because Guyana is highly forested with low deforestation, it has long been considered an HFLD country. However, deforestation may increase to meet growing demands for agriculture, timber, minerals, and area for human settlements. Due to significant mineral deposits underlying parts of the forest, mining is the primary driver of deforestation, contributing to 60% of deforestation from 1990 to 2009 and over 90% between 2009 and 2012 (Government of Guyana, 2015). Shifting agriculture and other built infrastructure pose additional threats to forests.

At the international level, Guyana has unconditionally committed to continue and improve SMF in its INDC (Government of Guyana, 2016). However, Guyana's most recent forest reference level does not include any "plus" activities (conservation, enhancements, or SMF) (Government of Guyana, 2015).

6.3.2 Stable forest area

Stable forest area and loss

Stable forests in Guyana

Area: 11,373,310 ha

% of country: 54.5%

% of forest: 60.7%

Deforestation, 2000–2019: 0.51%

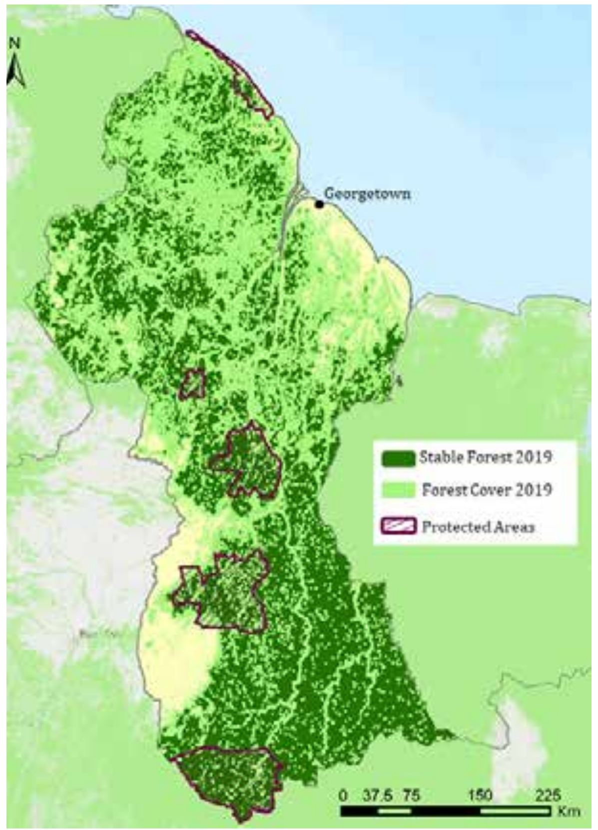
Net loss, 2000–2019: 25.8%

Stable forests cover more than half of Guyana but face increasing losses. Proportionally, more stable forest area was lost from 2010 to 2019 (15.2%) than over the previous 10-year period (12.5%). Deforestation rates also rose, following conversion to at-risk forest (0.013% yr^{-1} from 2000 to 2010, rising to 0.024% yr^{-1} from 2010 to 2019). These rates may not directly correlate to each other because deforestation may affect entire small patches of stable forest and result in no corresponding conversion to at-risk forest, or deforestation may be concentrated in one area along the forest edge and therefore only cause limited conversion to at-risk forest near that edge. Although deforestation and net change in stable forest area are still low, the doubling of deforestation rates may serve as an alarming sign. Targeted conservation efforts may reduce the accelerating rate of stable forest loss. The high percentage of change in stable forest area from 2000 to 2019 due to a conversion from stable to at-risk forest suggests significantly expanding forest edges or division into smaller patches. This in turn suggests that stable forest loss is more associated with degradation (but degradation is not considered in this analysis). Demerara-Mahaica, a small northern region that is the country's most populous and contains the capital, has the greatest deforestation and net change of stable forest area. Upper Takutu-Upper Essequibo in the southwest and East Berbice-Corentyne on the eastern border have the lowest net changes of stable forest area and deforestation (following conversion to at-risk forest), as well as the greatest areas of stable forests.

Stable forests in protected areas

Stable forests in protected areas had considerably lower deforestation rates (following conversion to at-risk forest) and net stable forest loss relative to those that were not protected (see Annex C.4). Almost the entirety of deforestation of formerly stable forests occurred outside protected areas (97.7%). Protected areas have nonetheless experienced some reductions in stable forests, driven by conversion to at-risk forest due to the changing position of forest edges. Stable forests in Guyana are protected by indigenous peoples, government, and other sources. Areas protected by indigenous peoples had the lowest reduction in net stable forest from 2000 to 2019, although this could be because this area is more remote (in the southernmost part of the country). On the other hand, government-managed areas had the greatest stable forest area reclassified as at-risk and therefore could benefit from more support to minimize stable forest losses.

Figure 18. Map of stable forests in Guyana



% stable forests which are protected: 11.7%

% protected forests which are stable: 75.4%

Table 11. Forest and non-forest area in Guyana in 2000, 2010, and 2019

Land classification	Area (ha)		
	2000	2010	2019
At-risk forest	3,587,721	5,438,895	7,354,284
Stable forest	15,335,654	13,417,894	11,373,310
All forest	18,923,375	18,856,789	18,727,594
Non-forest	1,959,436	2,026,022	2,155,217

6.3.3 Carbon potential

Stable forest C stocks: 3.09 Gt C

Stable forest removals: 20.6 Mt CO2e yr^{-1}

Stable forests store an estimated 30.7% more carbon in AGB and BGB than at-risk forests in Guyana, and 3.2% more in SOC. At-risk forests may be more susceptible to degradation than stable forests, but this analysis cannot investigate degradation as the carbon map used is a snapshot of only one point in time. The estimate of 0.49 t C $ha^{-1} yr^{-1}$ removals in stable forests is lower than comparable values from the literature for mature, humid, tropical forests in Latin America (0.71 ± 0.34 t C $ha^{-1} yr^{-1}$) (Phillips et al., 1998) and tropical forests with over 100 t C ha^{-1} in carbon stock (0.78 ± 0.23 t C $ha^{-1} yr^{-1}$) (Baccini et al., 2017). This appears to suggest removals estimates from this analysis may be conservative. If the annual rate of net stable forest loss from 2019 to 2030 were to change by the same amount as it did from the period 2000–2010 to 2010–2019, stable forests would sequester 15.4 Mt CO_2e in 2030 and would have a carbon stock of 2.31 Gt C. This does not mean the difference in carbon stock is lost as emissions or that the difference in sequestration would be forgone removals, as at-risk forests may continue to sequester and store this carbon.

6.3.4 Non-carbon benefits

Biodiversity
- The average biodiversity intactness index for stable and at-risk forests in Guyana is 94.3% and 95.3% respectively, suggesting Guyana has retained most of its biodiversity (Figure 19).
- Some studies have noted secondary forest, young forest, or plots with some disturbance in Guyana have greater biodiversity than primary forest or undisturbed forests, linked to competitive exclusion and a high range of pioneer species in disturbed areas (Ter Steege & Hammond, 2001; Van Andel, 2001).

Hydrology
- 42% of stable versus 60% of at-risk forests are in extremely high riverine flood risk areas (Figure 20).
- 90% of stable versus 82% of at-risk forests are in low or low-medium drought-risk watersheds (Figure 21).
- Reducing deforestation from mining and conversion to agriculture could reduce sediments by 143.5 t sed ha^{-1} yr^{-1} and 12.6 t sed ha^{-1} yr^{-1}, respectively (Netzer et al., 2014).
- Many of Guyana's high elevation areas, which may have steeper slopes, correlate with stable forest area in the southeast, which could provide additional erosion control and runoff benefits.

Non-timber forest uses
- Even in low-diversity forests, a study found 106 species with potential non-timber uses in Guyana (Johnston, 1997).
- Areas of high NTFP value do not seem to correlate with stable forests, likely due to a lack of human population (R. Neugarten et al., 2020). NTFP potential may be high in these regions even if their current importance is low.

For a more detailed description of non-carbon benefits in Guyana and additional maps, see Annex C.4.

Figure 19. Biodiversity intactness index within stable forests of Guyana

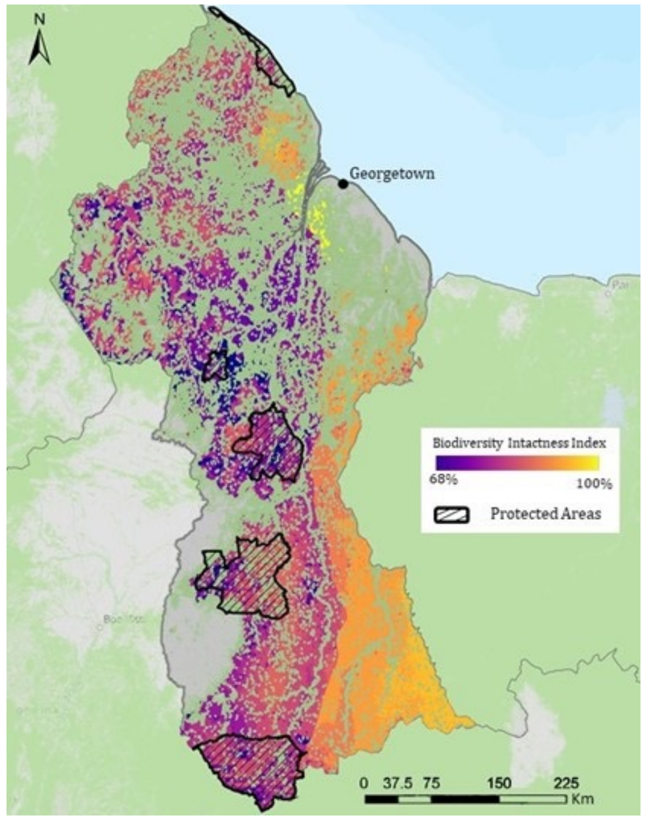
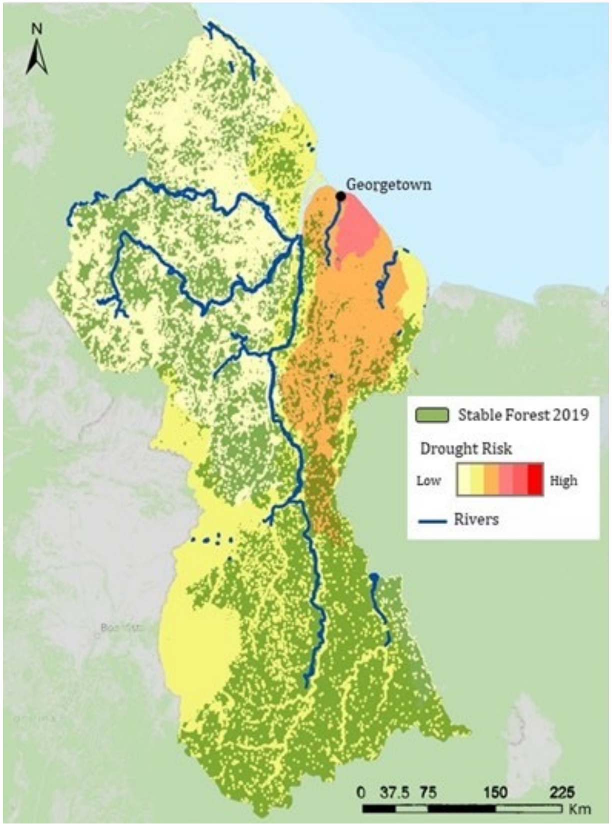


Figure 20. Riverine flood risk within Guyana derived from WRI aqueduct dataset

Figure 21. Drought risk within Guyana, derived from WRI aqueduct dataset



6.3.5 Valuation of ecosystem services

The value of ecosystem services (Table 12) ranges from \$153.7 to \$446.2 billion in Guyana, or \$13,514 to \$39,232 ha^{-1}. Most (97%) of the asset value of the stable forest asset in 2019 lies in the carbon asset (Figure 22). Hence, emissions in Guyana have a substantial impact beyond Guyana's borders. The other values are relatively local in nature. Deforestation of Guyana's forest areas that were stable in 2010 reduces harvesting of NTFPs and other uses within the 2019 stable forest area but is not assumed to have an impact in forests elsewhere. The same assumption holds true for hydrology and biodiversity. Of course, there may be unknown links between forest loss in stable forests of Guyana and global hydrological systems or biodiversity, but these links have not been established in the literature and thus are not considered here.

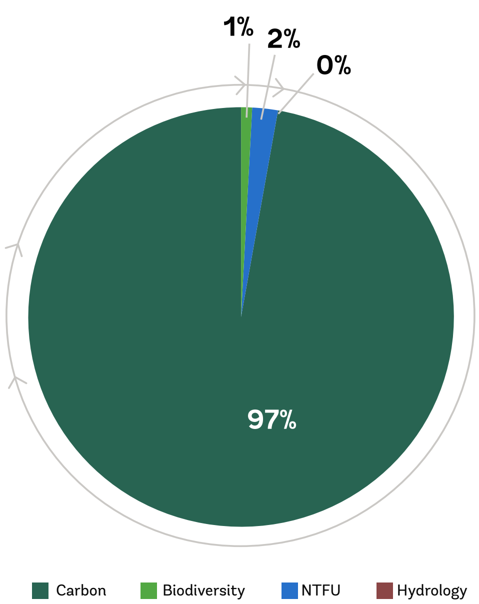
Table 12. Summary values for asset and present value for a 10-year policy to reduce emissions from deforestation (RED) in 2019 stable forest areas. The annual equivalent RED benefit includes only the benefits accrued over the 10-year period. Carbon price range \$14-\$40 t CO_2e and r=0.05. \$ ha^{-1} based on area of stable forests in 2019.

	Asset (\$ billions)	Annual Maintenance (\$ billions yr^{-1})	Annual equivalent RED benefit (\$ millions yr^{-1})
Carbon	\$149.9–\$442.4	\$5.4–\$15.9	\$51–\$160.1
Biodiversity	\$0.8	\$0	\$0.1–\$0.3
NTFU	\$2.4	\$0.1	\$0.9–\$0.9
Hydrology	\$0.6	\$0	\$0.2–\$0.2
Total	\$153.7–\$446.2	\$5.5–\$16.1	\$52.2–\$161.5
Total (\$ ha^{-1})	\$13,514–\$39,232	\$484–\$1,416	\$5–\$14

Carbon valuation

The carbon asset valuation combines the total value of stored carbon in stable forests plus future accumulation over 10 years to estimate the total value if this carbon were lost. The low end of the range, \$149.9, uses a carbon price of \$14 per t CO_2e, while the higher valuation, \$442.4 billion, uses \$40 per t CO_2e. These estimates are the benefits associated with keeping this carbon out of the atmosphere. The annual maintenance component of this is \$5.4 to \$15.9 billion yr^{-1}.

Figure 22. Asset share of ecosystem services provided by stable forests (\$14 t CO_2e)



There is little evidence that the entire stock of the stable forest in Guyana is at risk of loss, either to anthropogenic or non-anthropogenic drivers. Based on a future projection of deforestation (following conversion to at-risk forest) in stable forests using the area of deforestation over the past five years, the total stable forest area deforested over the next 10 years is projected to be 40,527 ha. The gross carbon projected to be lost from deforestation in areas that were previously stable over 10 years is 59.8 million t CO_2e, although the gross accumulation due to natural processes amounts to 206.3 million t CO_2e. As a result, the net carbon stock rises by 146.5 million t CO_2e. When the estimated carbon lost to deforestation (59.8 million t CO_2e) is valued with a constant carbon price of \$14 per t CO_2e, the present value of stopping deforestation in stable forests is \$0.4 billion. If the social cost of carbon of \$40 per t CO_2e, rising at 2.25% yr^{-1} is used, the present value of halting stable forest deforestation (following conversion to at-risk forest) is \$1.2 billion. The annual value of holding carbon in stable forests in Guyana over a 10-year period is \$51 million yr^{-1} at \$14 per tonne, and \$160.1 million yr^{-1} when the initial carbon price is \$40 per tonne.

Leakage

For this analysis, leakage is assumed to be zero. Several recent studies from tropical Latin America, including Guyana, have found leakage is effectively zero in carbon projects and programs (see Fortmann et al., 2017; Roopsind et al., 2019). These studies have not addressed potential leakage due to timber harvesting, which due to its market characteristics (for example, being mostly driven by international markets), could encourage more leakage or shifting of harvesting to other locations (Sohngen & Brown, 2004).

Biodiversity

For the biodiversity valuation, the value of \$71.86 ha^{-1} derived from Siikamaki et al. (2021) is used. Although the entire area of stable forests in Guyana, and thus this entire asset value, is not likely to be lost in the near future, the asset value is the potential loss that would occur if all stable forests in Guyana were immediately deforested following conversion to at-risk forest. All patches in stable forests in Guyana in 2010 and 2019 were larger than 1,000 ha, which is important for the MSA approach. While forest area declines, the existing patches remain in the same patch size band. Using the MSA approach, the effective area of forest with the full biodiversity value of \$71.86 is predicted to fall by 16,138 ha over the 10-year period.

Non-timber forest uses

The value of NTFUs is calculated to be \$212.46 from Siikamaki et al. (2021). This is lower than the average tropical value used elsewhere in the study because Siikamaki et al. (2021) predict lower recreational and non-timber forest product values for Guyana due to relatively low population density and low income per capita.

Hydrological value

The value of hydrological services is calculated to be \$48.43 ha^1 based on estimates in Siikamaki et al. (2021). A further literature review was conducted to determine if additional studies have been undertaken, but none considered the value of hydrological services provided by forests in Guyana.

6.3.6 Policy analysis

> ***Policy objectives:***
> 1. Slow and halt conversion of stable forest to at-risk forest.
> 2. Reduce deforestation of all forest.

To successfully protect and enhance stable forests, policy should aim to slow and halt the conversion of stable forest to at-risk forest and reduce deforestation of all forests. The analysis above underlines the need for greater efforts to reduce the conversion of stable forest to at-risk forest. This should be supported by policy that recognizes the value of stable forests along with efforts to improve governance. This could include working with Amerindian communities to increase their role in forest management. These overarching policy objectives are aligned with existing international and domestic policy.

International alignment

The Government of Guyana recognizes the inherent value of its forests and has made commitments to sustainably manage its forests under the Paris Agreement. Guyana could collaborate with other countries to provide financial and technical support to protect and maintain stable forests under Article 5, 6.2, 6.8 or 9.1 of the Paris Agreement. This can include nonmarket approaches and nonmarket results-based finance with a focus on the adaptation and non-carbon benefits of stable forests. This could include collaboration on a "conservation credit" approach that allowed consistent monitoring and valuation of stable forests that could be connected to domestic policy. The collaboration should support the two connected objectives (see text box) and be linked to CBD targets.

The amount of territory designated as protected falls short of the Aichi targets under the CBD and other Aichi targets, such as subsidy reform, are missing in national plans. This creates an opportunity to increase engagement and commitment under the CBD draft post-2020 Global Biodiversity Framework and domestic implementation. See Annex C.4.6 for more details.

Domestic alignment

Forests in Guyana are either i) managed by Guyana Forestry Commission, with some licensed out to timber companies under concession; ii) designated as protected or research areas; or iii) managed as Amerindian Titled lands, which is the largest private ownership in Guyana (Republic of Guyana, 2018).

Three domestic policy options to protect stable forests are discussed in this national and international context: i) protected areas; ii) market mechanisms; and iii) EFTs. Detailed descriptions of domestic policy can be found in Annex C.4.6.

Protected areas

Current protected areas are effective at preventing deforestation but have been less effective at preserving stable forest losses, which have decreased by approximately 15% within protected areas from 2000 to 2019 (see Annex C.4). The transition from stable to at-risk forest may indicate future loss of forest is more likely. Increasing the number—and effectiveness—of protected areas to maintain stable forest could help expand and maintain the size of stable forest patches and Guyana's contribution to the post-2020 framework under the CBD. Establishing and maintaining larger protected areas will also help to maintain (or increase) the higher biodiversity value associated with larger patch sizes. Government-managed protected areas had higher net stable forest losses (and therefore higher conversion of stable forest to at-risk forest) compared to Amerindian-managed protected areas (see section above). An expansion of protected areas could include an increase in areas under management by Amerindian authorities along with strengthening management of existing government-managed areas. This could be linked to new commitments under the CBD, along with the Paris Agreement. Amerindian-managed areas can also be connected to other domestic policy options.

Market mechanisms

Broader payment for ecosystem service (PES) schemes are the most adaptable and flexible and GHG offset markets are the most constrained. Guyana's experience with REDD+ shows its willingness to participate in national market mechanisms to protect its forests. The recent oil discoveries and creation of a Sovereign Wealth Fund could be linked to a domestic PES scheme to achieve both policy objectives in the text box above. Given the greatest economic value is associated with stored carbon, this could be an initial metric to trigger PES. To be most effective at maintaining stable forests, a PES scheme would need to focus on preventing the transition from stable to at-risk forest and be linked to forest management and governance efforts that could achieve this. This could include expansion of Amerindian managed protected areas discussed above. Additional payments could be correlated to the size of stable forest patches to capture the increased biodiversity value of larger patches and to incentivize their protection. Given the lower per hectare value of biodiversity, payments should not be based solely on patch-size MSA valuation. International support for Guyana could be directed towards helping establish such a scheme with a focus on ongoing good governance.

Ecological fiscal transfers

EFTs have not been used in Guyana to date, and the central management of forests by the Guyana Forestry Commission would make it difficult to tie allocation of government funding to the regions to maintenance of stable forest. However, given the large areas of forest managed as Amerindian land, strengthening local Amerindian governance of forests and connecting this to direct transfers from the federal government could be considered. If the indicators used to trigger payments incorporate a stable forest definition, they could be designed to meet both policy objectives. This could also be linked to the PES scheme discussed above, with similar indicators used to estimate payments.

Key findings and recommendations

The analysis of changes to stable forest area provides new evidence that Guyana's forests are under pressure from human impact. Deforestation rates remain low, but there is a significant loss of forests classified as stable forest that is due primarily to reduction of distance to forest edge. The causes behind these shifts are not assessed, but the forest appears to be becoming more fragmented; this could be due to expansion of the road network, mining, agricultural encroachment, or a combination of all these factors.

The economic analysis above demonstrates there is substantial asset value in Guyana's stable forests. This translates into economic losses when this forest is lost and, conversely, substantial benefits when the forest is protected and enhanced, with most of this value captured in the global good of stored carbon. This analysis has not captured the lost value of the transition from stable forest to at-risk forest, although this could also generate significant losses in value from carbon, biodiversity, hydrological services, and NTFUs. The economic analysis also highlights the significant difference between the underlying value of stable forests as an asset and the much smaller annual maintenance value or value of stopping deforestation. The present value of reducing deforestation of stable forest (following conversion to at-risk forest) is only an annual equivalent value of 0.146% to 0.021% of the asset. This significantly undervalues stable forests as an asset and the ecosystem services it provides to Guyana and the world. Adding maintenance payments based on area of stable forest would support recognition of the true value inherent to conserving stable forest.

There is scope for Guyana to collaborate with other countries to protect stable forest under Articles 5, 6.2, 6.8 and 9.1 of the Paris Agreement and the CBD, which can be connected to domestic policies. This includes collaboration via "conservation credits" or other forms of bilateral assistance that could support domestic policy reform. The different approaches to value stable forests—as an asset, the annual maintenance cost, or present value based on stopping deforestation (following conversion to at-risk forest)—provide a price range that should be the starting point of international and domestic policy discussions on actual payments for protecting stable forests. One approach is to spatially separate maintenance payments and payments to stop deforestation. The value of reducing deforestation is associated with areas under imminent threat of deforestation, typically the forest edge, and it does not capture conversion of stable forest to at-risk forest. When focused on areas that are at risk of deforestation, per hectare reduced deforestation payments approach the per hectare asset value (that is, \$16,609 per ha at \$14/t CO_2e). Annual maintenance payments are lower per hectare (\$598 at \$14/t CO_2e) and could be associated with maintaining stable forest areas under threat of fragmentation rather than deforestation. This represents the maintenance value of the ecosystem services that these forests provide. Payments could be structured based on hectares of stable forest, or reductions in stable forest loss, with such payments used to support domestic policy or local efforts that protect stable forest.

PES and protected areas are familiar policy instruments that could be considered to help protect and restore Guyana's stable forests. EFTs need further research to better assess feasibility. Given Guyana's new-found oil wealth, it is recommended that a PES scheme be created and linked to its Sovereign Wealth Fund, using per hectare maintenance payments to stop stable forest fragmentation and loss. This fund could also support the creation of new protected areas, which may include new or strengthened Amerindian management or governance.

These broad policy options should be complemented by further country-specific policy analysis and options to address local drivers of forest loss. Good governance is required across all three policy options, and while Guyana has made recent improvements to control corruption, similar improvements have not been observed in other aspects of governance such as government effectiveness, regulatory quality, and rule of law (see Worldwide Governance Indicators in Annex C.4). International support could therefore focus on supporting the establishment and governance of PES and protected areas.

6.4 Indonesia

Stable forest area: Indonesia has 32,043,277 ha of stable forests (24.4% of forests). It experienced high stable forest deforestation from 2000 to 2019 (7.3%) and high net stable forest loss (49.0%). Protected areas experience four times less deforestation than non-protected areas, but still have high rates of deforestation and net stable forest loss.

Ecosystem services: Stable forests store 13.36 Gt C and sequester approximately 47.7 Mt CO2e yr^{-1}. Stable forests have high biodiversity intactness, reduce erosion, provide many NTFUs, and help mitigate El Niño seasons. Peat stable forests are particularly beneficial in reducing fire risk, saltwater intrusion, and drought risk.
Economic potential: The value of stable forests in Indonesia is estimated to range from $526 to $1,014 billion for the four ecosystem services valued. The annual maintenance value of stable forests ranges from $18.9 to $36.5 billion yr^{-1}, and the annual value of reducing deforestation lies between $1,381 and $4,078 million.

Recommended policy approaches: Policy approaches should have an urgent focus on reducing the conversion of stable forest to at-risk forest along with deforestation of all forests. This could include collaboration via "conservation credits" linked to domestic efforts to stop loss of stable forests. However, protected areas do not effectively protect forests from deforestation and fragmentation. Forest governance needs to be improved, and a combination of stopping encroachment into protected areas, focusing on climate smart and regenerative agriculture of existing migrants, and some encouragement of out-migration from protected areas could be considered. Increased attention and focus on forest governance are also needed for PES policy to be more effective. EFTs may be the most promising policy option to support stable forests in Indonesia as they can directly connect local government budgets with protection of stable forests.

6.4.1 Country overview

Indonesia is the largest archipelagic state in the world, composed of 13,466 islands (CIA, 2020). Indonesia has a population of 270.2 million and is the world's fourth most populous nation with a declining population growth rate of just 1.1% in 2019 (World Bank, 2020b). Java, the island where 58% of the population lives, is the most population dense island in the world (World Bank, 2015a). Indonesia is an upper-middle-income country with a steadily increasing GDP per capita of $4,135 in 2019 and has a growing influence as the largest economy in Southeast Asia (World Bank, 2020c). It has a resource-driven economy (World Bank, 2015a), which has spurred growth but also rapid deforestation and environmental damage (OECD, 2019a).

Indonesia has a wealth of forest resources, and forests covered 60% of the country in 2016 (MoEF, 2016). Its forests are some of the world's most biodiverse: Indonesia covers just 1.3% of the world's area, but holds 11% of all plant species, 10% of mammal species, and 16% of bird species (FWI/GFW, 2002). Indonesia also holds the world's largest area of tropical peat forests, covering roughly 14.9 million ha mostly on the islands of Sumatra, Kalimantan, and Papua (Wahyunto et al., 2014): these are essential for carbon sequestration and host unique biodiversity (OECD, 2019a). Unfortunately, Indonesia lost 0.6–1.2 million ha of forest annually from 2005 to 2016 (OECD, 2019a). Deforestation is predominantly commodity-driven, with shifting agriculture and forestry contributing to a lesser extent (GFW, 2020c). Among these, illegal logging and conversion of forest to fiber or oil palm plantations are key drivers. From 2000 to 2010, just 45% of forest losses occurred on lands where industrial concessions were granted, suggesting that illegal deforestation is rampant (Abood et al., 2015). Fires are also major threats to peatland forests (OECD, 2019a).

Due to its high rates of deforestation, Indonesia is not considered an HFLD country. To address rapid deforestation, the Indonesian government implemented a moratorium on forest clearance and peatland conversion outside concessions in 2011 (Murdiyarso et al., 2011). This has had mixed effects: in Central Kalimantan, the moratorium has not been effective in changing community decision making or company behavior (Suwarno et al., 2018), although overall rates of deforestation in Indonesia have recently been declining (GFW, 2020c). In its INDC, Indonesia committed to unconditionally cut 26% of its GHG emissions by 2020, including through sustainable forest management and restoring degraded ecosystems to reduce emissions from forests, especially relying on financial support from REDD+ (Republic of Indonesia, 2016a). Indonesia has not included sustainable management of forest or conservation activities in its FREL (Republic of Indonesia, 2016b).

6.4.2 Stable forest area

Stable forest area and loss

Deforestation within stable forests increased significantly from 2000–2010 to 2010–2019, from approximately 0.26% to 0.74% yr^{-1}, while net stable forest loss remained relatively stable at approximately 3% yr^{-1}. If overall deforestation continues to grow at similar rates every 10 years—an increase of more than 250%—stable forests will be under serious threat. Rates of deforestation in at-risk forests averaged 1.21% yr^{-1} from 2000 to 2019. This is visible in the movement of edges and therefore conversion of stable forest to at-risk forest. Every region in Indonesia lost at least one-third of its stable forests between 2000 and 2019. Papua, Indonesia's largest and easternmost province bordering Papua New Guinea, has the greatest remaining area of stable forest, while Bangka Belitung (89.6%), Kepulauan Riau (83.4%), and Riau (81.5%) have witnessed the greatest net losses of stable forests since 2000.

Stable forests in Indonesia
Area: 32,043,277 ha
% of country: 17.4 %
% of forest: 24.4%
Deforestation, 2000–2019: 7.3%
Net loss, 2000-2019: 49.0%

Table 13. Forest and non-forest area in Indonesia in 2000, 2010, and 2019

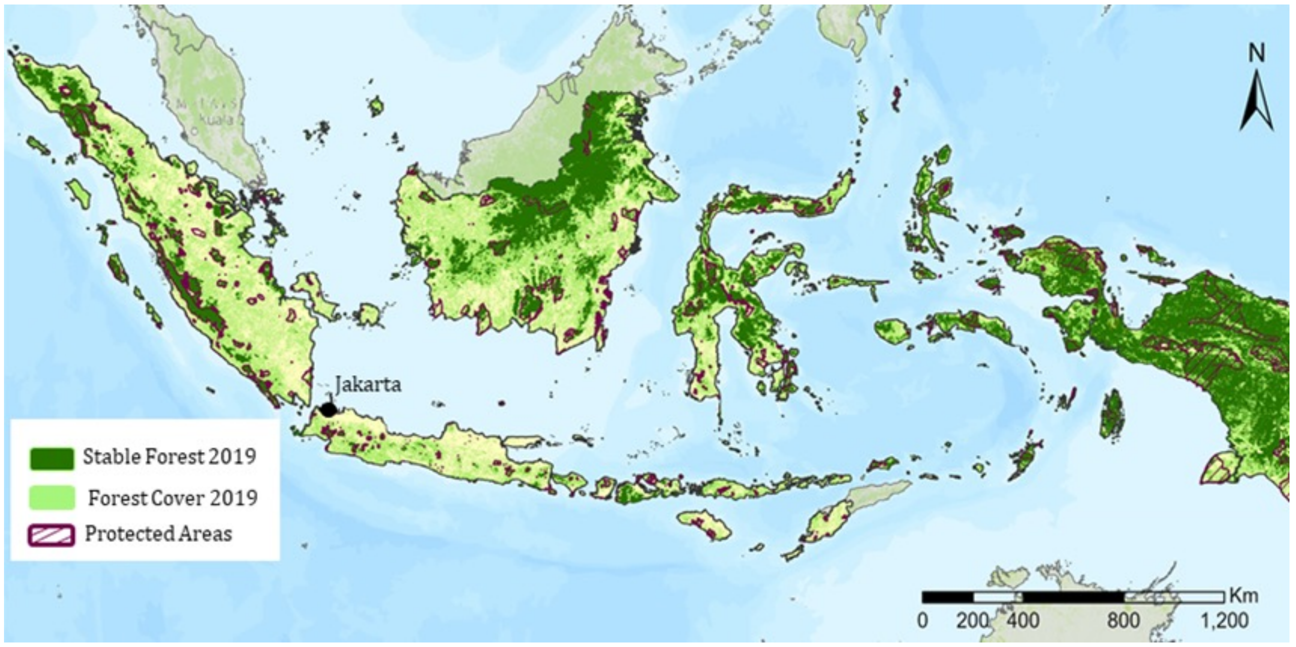
Land classification	Area (ha) 2000	2010	2019
At-risk forest	95,060,292	101,803,284	99,376,313
Stable forest	62,826,277	44,147,165	32,043,277
All forest	157,886,569	145,950,449	131,419,590
Non-forest	26,691,034	38,627,154	53,158,013

Stable forests in protected areas

Stable forests comprise more than half of protected forests and most protected stable forests are in government-managed areas. Forest and stable forests outside protected areas were deforested by 18.54% and 8.54% respectively from 2000 to 2019. Forests and stable forests inside protected areas were deforested by 4.64% and 2.19% respectively over the same period, with equivalent rates of forest loss and slightly higher rates of stable forest loss in government-managed protected areas than in other types of protected area (see Annex C.5). Net loss of stable forest was 34.93% in protected areas and 52.41% in non-protected areas. Forests and stable forest in protected areas experience a quarter of the deforestation compared to non-protected areas, but the highest rate of overall deforestation in protected areas among the case studies and the second highest rate of stable forest loss.[21] There could also be significant forest degradation occurring in protected areas that is not captured in this analysis.

% stable forests which are protected: 24.9%
% protected forests which are stable: 41.6%

Figure 23. Map of stable forests in Indonesia



6.4.3 Carbon potential

Stable forests store a high proportion of carbon in soil (45.8%), likely due to Indonesia's carbon-rich peat forests. Stable forests in the province with the most peatland forests, Riau, store 317 t C ha^{-1} in SOC, far exceeding the national stable forest average of 194 t C ha^{-1}. Carbon stocks in AGB and SOC in stable forests store on average 23.4% and 43.6% more carbon than at-risk forests per hectare, respectively. Stable forests may be in higher density forest areas, but also overlap with some of the country's peat forests, which have high SOC density. If the annual rate of net stable forest loss from 2019 to-2030 were to change by the same amount as it did from the period 2000–2010 to 2010–2019, stable forests would sequester 31.2 Mt CO_2e in 2030 and would have a carbon stock of 8.7 Gt C. This does not mean the difference in carbon stock is lost as emissions or that the difference in sequestration would be forgone removals, as at-risk forests may continue to sequester and store this carbon.

Stable forest C stocks: 13.36 Gt C

Stable forest removals: 47.7 Mt CO2e yr^{-1}

21 Liberia's protected areas experienced a 2.85% deforestation rate and 66.04% net loss of stable forests between 2000 and 2019.

Biodiversity
- The average biodiversity intactness index for stable and at-risk forests in Indonesia is 98.9% and 92.9%, respectively, suggesting there is a high correlation between high biodiversity intactness and stable forests (Figure 25).
- Several studies have shown primary, natural, or undisturbed forests have higher biodiversity and endemism than other forest types in Indonesia and therefore may be more valuable to preserve (Brearley et al., 2004; Kessler et al., 2005; Waltert et al., 2004).

Hydrology
- 73% of stable versus 67% of at-risk forests are in extremely high riverine flood risk areas (Figure 26).
- 65% of stable versus 47% of at-risk forests are in watersheds with medium-high or greater risk of drought (Figure 27).
- Wetland forests, including peatlands, have largely remained intact (Margono et al., 2014), suggesting many may be stable forests helping reduce fire risk, saltwater intrusion, and drought risk (Hergoualc›h et al., 2018; Silvius & Suryadiputra, 2005; Taufik et al., 2020).
- Primary forests in five provinces each prevented 2.3 to 38 billion kg of soil from eroding per year (UNORCID, 2015).
- Fragmented forests were found to be less able to mitigate hot and dry El Niño seasons, which trigger fires and droughts (Curran et al., 2004).
- Stable forests are generally at higher elevations, which could provide additional erosion control.

Non-timber forest uses
- Indonesia's rich biodiversity provides a wide range of NTFUs, including food, materials, medicine, and tools.
- Villagers tend to harvest NTFPs from managed forest over primary forest, given their higher density of NTFPs and relative ease of access (Lawrence et al., 1995).
- Some studies have inventoried certain areas of natural forest and mature forests and found 202–234 useful species (de Rozario, 2020).

For a more detailed description of non-carbon benefits in Indonesia and additional maps, see Annex C.5.

6.4.5 Valuation of ecosystem services

The value of ecosystem services (Table 14) ranges from $526 to $1,014 billion in Indonesia, or $16,415 to $31,648 ha^{-1}. Roughly 93% of the value is derived from the carbon asset. In Indonesia, the deforestation rate over the past five years in stable forests (following conversion to at-risk forest), at 0.29% yr^{-1}, is relatively high compared to that of the other case study countries. This implies a large annual value of a policy that reduces emissions from deforestation accordingly—estimated at $1.4-$4.1 billion yr^{-1}, or $43.11 to $127.26 ha^{-1} yr^{-1}.

Table 14. Summary values for asset and present value for a 10-year policy to reduce emissions from deforestation (RED) in 2019 stable forest areas. The annual equivalent RED benefit includes only the benefits accrued over the 10-year period. Carbon price range $14-$40 t CO_2e and r=0.05. $ ha^{-1} based on area of stable forests in 2019.

	Asset ($ billions)	Annual Maintenance ($ billions yr^{-1})	Annual equivalent RED benefit ($ millions yr^{-1})
Carbon	$488.1–$976.1	$17.6–$35.1	$1258.5–$3,965.2
Biodiversity	$7.8–$7.9	$0.3	$35.4–$25.1
NTFU	$28.2–$28.2	$1	$82.2–$82.2
Hydrology	$1.9–$1.9	$0.1	$5.4–$5.4
Total	$526–$1,014.1	$18.9–$36.5	$1,381.5–$4,077.9
Total ($ ha^{-1})	$16,415–$31,648	$590–$1,139	$43.11–$127.26

Figure 24. Asset share of ecosystem services provided by stable forests ($14 t CO2e)

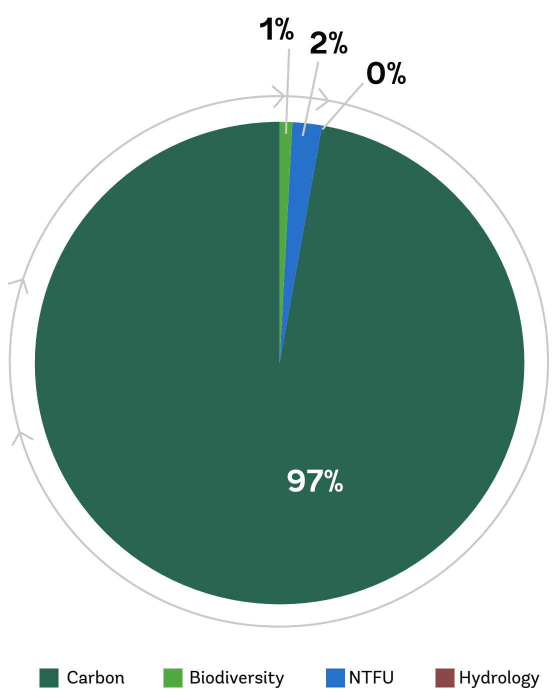


Figure 25. Biodiversity intactness index within stable forests of Indonesia

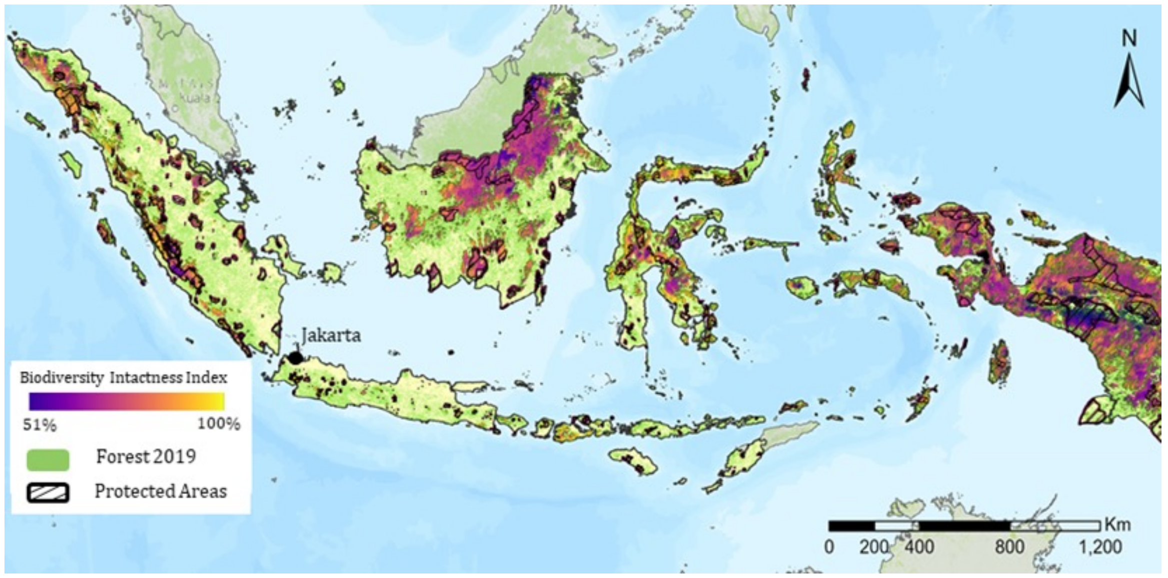


Figure 26. Riverine flood risk within Indonesia derived from WRI aqueduct dataset

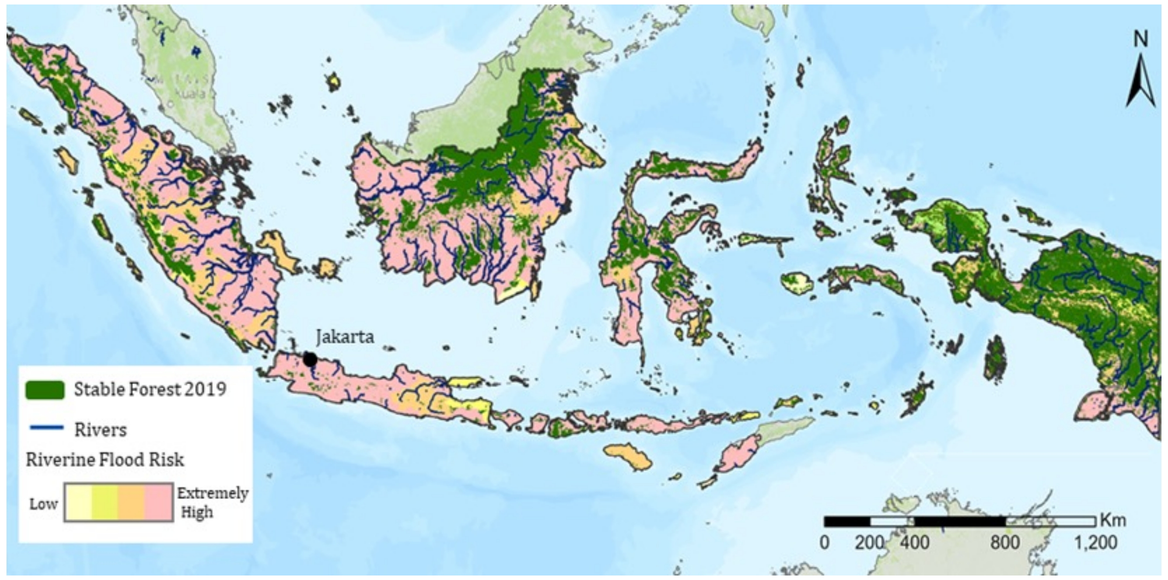
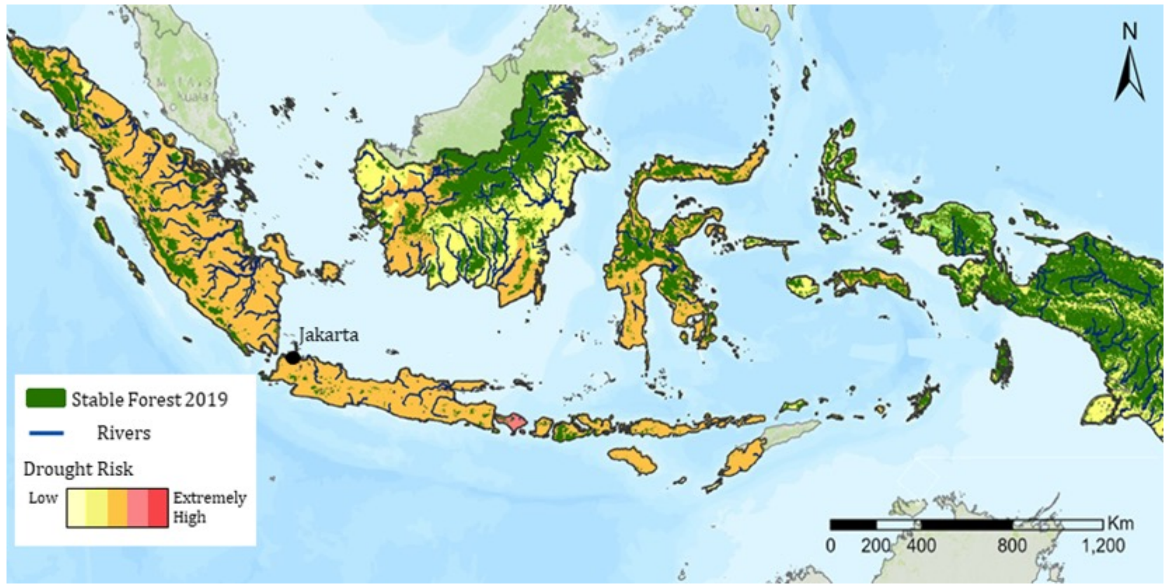


Figure 27. Drought risk within Indonesia, derived from WRI aqueduct dataset



Carbon valuation

The value of the carbon asset in Indonesia is split between aboveground and belowground components, with the soil component being the largest at >700 t CO_2e ha^{-1}. The rate of accumulation of carbon, however, is modest in Indonesia, at 1.5 t CO_2e ha^{-1} yr^{-1} or \$21 ha^{-1} yr^{-1}, at a carbon price of \$14 t CO_2e. Using the annual maintenance concept, or the annual expenditure that would be required to maintain the physical asset if this asset were like other physical assets used in the economic system, an estimated \$17.6 to 35.1 billion yr^{-1} should be spent to ensure the asset remains intact and the carbon in place. Based on the historical rate of stable forest deforestation (following conversion to at-risk forest) in Indonesia, an estimated 932,985 ha of 2019 stable forest areas would be deforested by 2029. The policy benefit of avoiding this future deforestation in stable forests following conversion to at-risk forests is \$1,561 million yr^{-1} at \$14 t CO_2e to \$4,229 million yr^{-1} at \$40 t CO_2e.

Biodiversity

For the biodiversity valuation, the value of \$245.27 ha^{-1} from Siikamaki et al. (2021) is used. With the loss of 932,985 ha over the 10-year projection period, the value per hectare declines to around \$240 ha^{-1}. The annual loss of biodiversity value ranges from \$25 million yr^{-1} to \$35 million yr^{-1}.

Non-timber forest uses

The value of NTFUs is \$881.10 based on Siikamaki et al. (2021) for non-wood forest products and recreation.

Hydrological value

The value of hydrological services is \$58 ha^{-1} based on Siikamaki et al. (2021).

6.4.6 Policy analysis

To successfully protect and enhance stable forests, policy should aim to slow and halt the conversion of stable forest to at-risk forest and reduce deforestation of all forests. The analysis above shows at-risk forests are under substantial threat of deforestation, and stable forests are being rapidly converted to at-risk forest at an alarming pace. Policy in Indonesia should urgently focus on reducing the conversion of stable forest to at-risk forest along with deforestation of all forests. Stronger forest governance is needed to achieve these objectives. This includes improved governance within protected areas as well as attention to unprotected forests. This will help improve the effectiveness of market mechanisms and EFTs.

International alignment

Policy objectives:
1. Slow and halt conversion of stable forest to at-risk forest.
2. Reduce deforestation of all forest.

Most of Indonesia's emissions (63%) are from land use change, peat, and forest fires, and REDD+ is an important component of its Nationally Determined Contribution (NDC) to the Paris Agreement. Indonesia's NDC is silent on markets but is open to REDD+ results-based payments along with other forms of financial and technical support. This creates clear opportunities for Indonesia to collaborate with other countries to protect stable forests under Articles 5, 6.2, 6.8 and 9.1 of the Paris Agreement. This could include collaboration on a "conservation credit" approach that allowed consistent monitoring and valuation of stable forests that could be connected to domestic policy. A conservation credit approach could focus on stable forest areas not under threat of deforestation that would otherwise fall outside traditional REDD+ approaches. A REDD+ FREL was submitted to the UNFCCC in 2016 and almost 49 million t CO_2e yr^{-1} in reductions (2013–2017) was reported in 2019.

Indonesia's contributions to the CBD's Aichi targets did not include any quantified protected area targets. This creates an opportunity to increase engagement and commitments to protected areas with stable forests under the CBD's draft post-2020 Global Biodiversity Framework and domestic implementation.

Domestic alignment

Environmental protection and management in Indonesia is handled at national, provincial, and municipal (or regency) levels. Government at each level is responsible for developing environmental inventories that account for ecological diversity, population distribution, natural resources, and other attributes at the respective geographic scale (Law No. 32/2009 Environmental Protection and Management, 2009). However, most forests in Indonesia are owned by the government and managed by public administrators or held by businesses with limited ownership rights (World Resources Institute, n.d.). National, provincial, and regency/municipal governments are empowered to create parks to protect forest and to plant and preserve trees (Law No. 32/2009 Environmental Protection and Management, 2009). Communities recognized under customary law have the right to use forest products, implement local forestry laws that do not contradict national laws, be informed about forest management and be compensated for forest loss (Center for Forestry Planning and Statistics Ministry of Forestry, 2009).

Three domestic policy options to protect stable forests are discussed in this national and international context: i) protected areas; ii) market mechanisms; and iii) EFTs. Detailed descriptions of domestic policy and the international policy context can be found in Annex C.5.

Protected Areas

Indonesia has 733 protected areas that cover 12–15% of its terrestrial landscape and 3–8% of its marine areas (Juffe-Bignoli et al., 2014; Protected Planet, 2020). Protected areas do not effectively protect forests from deforestation and degradation. Intensive logging and agro-industrial land development—especially for palm oil—are the main drivers of protected-area deforestation (Curran et al., 2004; Margono et al., 2014), with the expansion of logging and palm oil plantations into protected areas due to weak governance and decentralized regulation (Curran et al., 2004; Soehartono & Mardiastuti, 2014). The Ministry of Forestry has found park management to be ineffective nationwide (Darajati et al., 2016; Soehartono & Mardiastuti, 2014). Management concerns in protected areas typically include: unclear legal standing, regional conflicts and population pressures, poor planning, insufficient human and financial resources from the government, among other governance issues (Darajati et al., 2016; Forest Watch Indonesia, 2014).

The spatial analysis of forest and stable forest losses in protected areas presented above reflects this research. However, while the findings above also show that deforestation in protected areas is the highest among all case study countries, it is substantially lower than in unprotected forests. This could indicate that there is some protective benefit at slowing deforestation, but the high transition from stable to at-risk forest in protected areas evidences widespread human impact and fragmentation within protected areas. The analysis above also does not capture forest degradation, so total forest impact in protected areas may be higher than the deforestation rates above imply.

For protected areas to be more effective, forest governance needs to be significantly reformed and strengthened. This topic needs further research, but the solution will probably entail a combination of: i) stopping encroachment into protected areas, ii) focusing on encouraging climate-smart and regenerative agriculture with existing migrants inside protected areas, and iii) some encouragement of out-migration from protected areas over time. Any out-migration should be encouraged through policy and economic incentives to "pull" people out of protected areas rather than coercive "push" policies or forced relocation. Policies to encourage voluntary relocation to non-protected areas should ensure that suitable alternative territory is identified and that this land allows permanent occupation rights for migrants and provides better access to economic opportunities conducive to an improved quality of life. The principles of free, prior, and informed consent should also be incorporated into any voluntary migration policies. International support should focus on working with the Government of Indonesia and local stakeholders to chart the best path forward to restore and protect protected areas, ensuring that any new protected areas are established correctly.

Market mechanisms

Indonesia has hosted payment for ecosystem service (PES) projects since 2001, with most PES projects focused on carbon and watershed protection (Ningsih et al., 2020). In 2016 there were 14 acts, laws and regulations related to PES, but many had not been made operational at the national level at the time (Amalia & Syahril, 2016). The legal and institutional framework has been criticized as poorly defined (Fripp, 2014), with contradictions in how state regulations define ecosystem services (Ningsih et al., 2020). Corruption, collusion, and the exclusion of public participation have further undermined regulation and policymaking (Pham et al., 2013). As a result, the efficacy of PES projects in Indonesia is criticized due to: i) unclear, insecure and contested land tenure, ii) a lack of understanding of schemes, and iii) poor local enforcement, among other factors (Fripp, 2014; Pham et al., 2013; Resosudarmo et al., 2014; Suich et al., 2017).

Despite this weak regulatory framework, there is long-term support for PES schemes by buyers and facilitating organizations (Suich et al., 2017). The governance challenges that affect PES are similar to those that can undermine the successful administration of protected areas; therefore increased attention and focus on forest governance is likewise needed for PES to be more effective.

Ecological fiscal transfers

EFT schemes are currently being debated and developed in Indonesia, with examples found at the national, provincial, and local government levels.

National-level instruments are referred to as 'central-to-local' EFTs (TANE, acronym in Bahasa Indonesian). TANE reforms under consideration include revenue sharing levies from deforestation activities and special allocation funds for forest and mangrove rehabilitation, among others. Proposed indicators for monitoring and evaluation of EFTs include environment quality, air and water indices, and regular evaluation of biodiversity, protected areas and sustainable management areas (Mecca et al., 2020).

Some provincial-to-local and regency-to-local EFT schemes have been adopted. EFTs are of greatest interest to provinces and regencies with high natural resource stocks, such as forest-rich Kalimantan and Papua. A coalition of local governments and civil society groups are pushing the central government to adopt EFTs by demonstrating that local governments are willing to adopt these provincial and regional EFTs first (personal correspondence with lead author of Mecca et al. 2020).

The Village Development Index (IDM, for *Indeks Desa Membangun*) is another existing fiscal transfer scheme to provide support from the central government to local governments and communities (Mecca et al., 2020). The IDM can be spent on ecological measures—and includes rewards for waste reduction and some ecological measures—but does not specifically incentivize sustainable practices. The IDM contains some sustainability indicators, but there are gaps in local-level indicators (Mecca et al., 2020; Sutiyono et al., 2018).

EFTs may be the most promising policy option to support stable forests in Indonesia as they can directly connect government budgets with protection of stable forests. This creates direct incentives for those entities responsible for forest governance. EFTs could be combined with PES to ensure local stakeholders are also directly involved in payments that could be programmed in parallel to government EFTs.

Key findings and recommendations

The analysis of changes to stable forest area provides new evidence that Indonesia's forests are under more pressure from human impact than previously understood. Deforestation rates were known to be high in Indonesia, but the research presented above highlights a significant loss of stable forests reclassified to at-risk forest. Of all the case study countries, Indonesia experienced the highest rate of deforestation of its stable forests (7.30%, followed by Liberia at 7.25%), and the second highest level of stable forest loss overall (49%, compared to 84.5% in Liberia). The causes behind these shifts are not assessed, but the forest is apparently becoming more fragmented; this could be due to expansion of the road network, logging, agricultural encroachment, or a combination of any or all of those factors.

The economic analysis demonstrates that there is substantial asset value in Indonesia's stable forests. This translates into economic losses when this forest is lost, or, conversely, substantial benefits when the forest is protected and enhanced, with most of this value captured in the global good of stored carbon—especially peat. Although this analysis has not captured the lost value of the transition from stable forest to at-risk forest, it should be borne in mind that this could also generate significant losses in value from carbon, biodiversity, hydrological services, and NTFUs.

The economic analysis also highlights the significant difference between the underlying value of stable forests as an asset and the smaller annual maintenance value, or the value of stopping deforestation in stable forest areas after partial conversion to at-risk forest. The present value of reducing deforestation of stable forest represents an annual equivalent of 0.4% to 0.27% of the asset. This is higher than in other case study countries due to higher deforestation rates in stable forests in Indonesia, but it still significantly undervalues stable forests as an asset and the ecosystem services they provide to Indonesia and the world. Adding maintenance payments based on area of stable forest would support recognition of the true value inherent to conserving stable forest. There is scope for Indonesia to collaborate with other countries to protect stable forest under the Paris Agreement and CBD, which can be connected to domestic policies. This includes collaboration via "conservation credits" or other forms of bilateral assistance that could support domestic policy reform.

The different approaches to value stable forests—as an asset, the annual maintenance cost, or present value based on stopping deforestation (following conversion to at-risk forest)—provide a price range that should be the starting point of international and domestic policy discussions on actual payments for protecting stable forests. One approach is to spatially separate maintenance payments and payments to stop deforestation. The value of reducing deforestation is associated with areas under imminent threat of deforestation, typically the forest edge, and it does not capture conversion of stable forest to at-risk forest. When focused on areas that are at risk of imminent deforestation, per hectare reduced deforestation payments approach the per hectare asset value (that is, \$17,960 per ha at \$14/t CO_2e depending on the presence of peat). Annual maintenance payments are lower per hectare (\$646 at \$14/t CO_2e) and could be associated with maintaining stable forest under threat of fragmentation rather than deforestation. This represents the maintenance value of the ecosystem services that these forests provide. Payments could be structured based on hectares of stable forest, or reductions in stable forest loss with such payments used to support domestic policy or local efforts that protect stable forest.

The efficacy of PES and protected areas are weakened by common governance challenges. Improving forest and land use governance should therefore be a policy priority to strengthen protected areas and PES efficacy. Without these improvements in governance, both options will be challenging to implement. There is scope to explore public–private or non-state options for both, whereby non-state actors provide additional technical assistance and capacity to address local drivers of forest loss and thereby protect and maintain protected areas or other sites with stable forest in return for PES payments. This should only occur alongside broader governance reforms to address systemic drivers of deforestation. EFTs are a more promising policy that is being actively debated within Indonesia and should be supported. Payments to protect stable forests could be structured as fiscal transfers, with per hectare payments to main stable forest. These broad policy options also need to be complemented by further country specific policy analysis and options to address national and local circumstances.

6.5 Liberia

Stable forest area: Liberia has 592,729 ha of stable forests (7.7% of forests). It has experienced high stable forest deforestation from 2000 to 2019 (7.3%) and very high net stable forest loss (84.6%), indicating high fragmentation. Protected stable forests experience almost six times less deforestation than non-protected stable forests, but still have very high rates of deforestation and stable forest loss.
Ecosystem services: Stable forests store 171.6 Mt C and sequester approximately 2.0 Mt CO2e yr^{-1}. Stable forests have high biodiversitya intactness and support threatened forest species. They overlap with areas with lower riverine flood risk and areas important to sedimentation control and freshwater provision.

Economic potential: The value of stable forests is estimated to range from $9.3 to $17 billion for the four ecosystem services valued. The annual maintenance value of stable forests ranges from $335 to $612 million yr^{-1} and the annual value of reducing deforestation is $7.2 to $19.9 million.

Recommended policy approaches: Liberia needs support to meet its NDC, reduce emissions from forests, and meet CBD goals. This creates opportunities to collaborate under Articles 5, 6.2, 6.8 and 9.1 of the Paris Agreement. This could include collaboration via "conservation credits" linked to domestic efforts to stop loss of stable forests. However, protected areas do not effectively protect forests from deforestation and fragmentation. Forest governance needs to be improved, and all relevant options examined as a matter of urgency, including a combination of stopping encroachment into protected areas, focusing on climate smart and regenerative agriculture of existing migrants, and some encouragement of out-migration from protected areas. Given governance challenges, large-scale, policy-driven market mechanisms will be difficult to implement although more localized approaches may be possible. EFTs could be considered alongside other fiscal reform and technical assistance.

6.5.1 Country overview

Liberia has a population of 4.9 million, with a high growth rate of 2.43% in 2019 (World Bank, 2020c). Years of civil conflict until 2003 limited development. The country ranks 175th out of 189 countries in the UNDP HDI (UNDP, 2019). Although Liberia is rich in resources including iron, timber, diamonds, gold, and fertile soil (World Bank, 2018a), it remains one of the world's poorest countries, with a GDP per capita of just $621.8 (World Bank, 2020c).

Forests play a vital role in Liberia. Commercial timber production contributes approximately 10% to the national economy; charcoal and firewood production account for another 11%. As a third of the population lives in forested areas, many Liberians rely on forest products (World Bank, 2018b). Liberia also holds 40% of the Upper Guinea Forest (Liberia and the European Union, 2014), a biodiversity hotspot (CEPF, 2015). Forest biodiversity in Liberia is increasingly under threat: 89 animal species are classified as threatened (Republic of Liberia, 2017). Even though Liberia is the most forested country in West Africa, pressure on forests has increased since the end of the civil conflict (World Bank, 2018b). Liberia's low population and slow infrastructure development during conflict years may explain the country's low deforestation relative to neighbors such as Sierra Leone and Côte d'Ivoire (The Government of Liberia, 2019). Nevertheless, it has still witnessed an 18% decrease in tree cover since 2000 (GFW, 2020b) and is not considered an HFLD country. Large-scale drivers of deforestation are agriculture, mining, and commercial logging, and smaller scale drivers consist of shifting cultivation, pit sawing, and woodfuel consumption (The Government of Liberia, 2019). Others note shifting cultivation covers 50% of agricultural land and is therefore a major driver (GFW, 2020b).

Although Liberia recognizes the importance of forests and REDD+ in its INDC and identifies forest-related adaptation opportunities, it does not specify a mitigation commitment for the forestry sector (Republic of Liberia, 2018). Liberia has not included sustainable management of forests or conservation in its Forest Reference Level, two REDD+ activities particularly relevant to stable forests. It has, however, defined stable forests as "forest lands that are primary and with very limited human interference," without invasive species and mostly with 75% to 100% canopy cover. It has also defined conservation as the maintenance of intact forest. These definitions could be relevant to crediting stable forests under REDD+ in Liberia in the future (The Government of Liberia, 2019).

6.5.2 Stable forest area

Stable forest area and loss

Stable forests in Liberia

Area: 592,729 ha

% of country: 6.2%

% of forest: 7.7%

Deforestation, 2000–2019: 7.3%

Net loss, 2000–2019: 84.6%

There are only small patches of stable forests remaining in Liberia. Deforestation of both at-risk forests and stable forests from 2000 to 2019 was very high, as was the conversion of stable forest to at-risk forest. The rate of deforestation in stable forests (following conversion to at-risk forest) was over 13 times higher from 2010 to 2019 than over the previous decade, increasing from 0.14% to 1.84% yr^{-1}. Net losses of stable forest due to the conversion of stable to at-risk forest remained approximately constant over this same period. This is likely because the higher deforestation that occurred from 2010 to 2019 removed entire patches of stable forests and therefore did not have subsequent edge effects on remaining stable forest patches, meaning that as deforestation rates increased, net loss of stable forest area may not increase at the same rate. The northwestern region of Gbarpolu has the greatest stable forest area and has also witnessed the lowest loss rates in the country, which still exceeded 70% from 2000 to 2019. The rapid losses of stable forests are alarming, as soon all forests may be considered at-risk. Although such an outcome may provide more straightforward financing opportunities for these at-risk forests, it implies losing the benefits that stable forests provide.

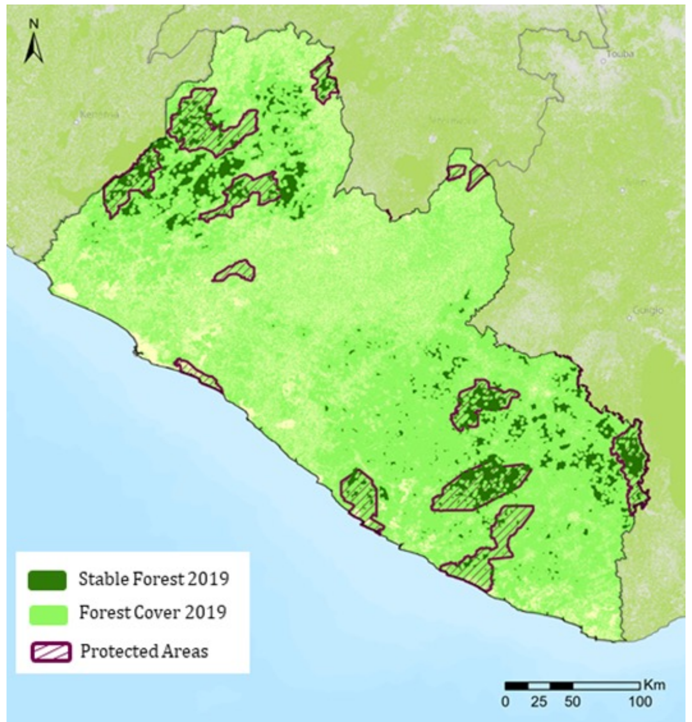
Table 15. Forest and non-forest area in Liberia in 2000, 2010, and 2019

Land classification	Area (ha)		
	2000	2010	2019
At-risk forest	95,060,292	101,803,284	99,376,313
Stable forest	62,826,277	44,147,165	32,043,277
All forest	157,886,569	145,950,449	131,419,590
Non-forest	26,691,034	38,627,154	53,158,013

Stable forests in protected areas

Protected areas are predominantly national parks, although there are also three nature reserves and five Ramsar Sites (IUCN & UNEP-WCMC, 2014). Stable forests are three times more likely than at-risk forests to be in designated protected areas, and all protected stable forests are government-managed. There are 19 protected areas found in the northwest and southeast of the country. Liberia's protected areas had the second highest rate of deforestation (following conversion to at-risk forest) and highest rate of stable forest loss of all case study countries. [22]Protected areas saw lower rates of all forest deforestation (2.85%) and loss of stable forests (66.04%) than non-protected forest and stable forest (19.87% and 88.80%, respectively; see Annex C.6). However, these rates remain extremely high even within protected areas. Some degradation in protected areas is not captured here. Alarmingly high rates of stable forest loss are observed in protected areas; this is clearly indicative of substantial human impact from fragmentation and encroaching edges even if the effect is not recorded as deforestation.

Figure 28. Map of stable forests in Liberia



% stable forests which are protected: 41.0%

% protected forests which are stable: 25.5%

6.5.3 Carbon potential

Stable forest C stocks: 171.6 Mt C

Stable forest removals: 2.0 Mt CO2e yr^{-1}

Stable forests have 19.1% greater AGB and BGB carbon stocks on a per hectare basis than at-risk forests, although SOC stocks per hectare are roughly equivalent. Of Liberia's carbon stocks, 10.6% is stored in SOC, compared to 67.8% and 21.6% in AGB and BGB, respectively. This low ratio of SOC storage is likely due to the comparatively high AGB in Liberia's tropical forests. Gbarpolu, the region with the greatest stable forest area, also has the highest total carbon stock on a per hectare basis. If the annual rate of net stable forest loss from 2019 to 2030 were to change by the same amount as it did from the period 2000–2010 to 2010–2019, stable forests would sequester 0.95 Mt CO_2e in 2030 and would have a carbon stock of 80.2 Mt C. This does not mean the difference in carbon stock is lost as emissions or that the difference in sequestration would be forgone removals, as at-risk forests may continue to sequester and store this carbon.

22 Indonesia had the highest rate of deforestation (4.64%) and second highest loss of stable forest (34.93%) within protected areas between 2000 and 2019.

6.5.4 Non-carbon benefits

Biodiversity
- The average biodiversity intactness index for stable and at-risk forests is 93% and 90.8%, respectively, suggesting biodiversity is slightly higher within stable forests but highly intact in all forests (Figure 29).
- Liberia holds many key biodiversity areas and undisturbed and primary forests are essential to maintain populations of threatened forest species such as chimpanzees, elephants, and duikers (CEPF, 2015; Republic of Liberia, 2017; Tweh et al., 2015).

Hydrology
- 73% of at-risk forests are in extremely high riverine flood risk areas while 100% of stable forests are in high riverine flood risk areas (Figure 30).
- Most forests are in low-medium drought risk watersheds (Figure 31).
- Liberia's stable forests are generally found in higher elevations within fragmented forests, which could provide additional erosion control and runoff benefits.
- Stable forests appear to overlap with areas identified as important contributors to sedimentation control and freshwater provision (Conservation International, 2017; Pollini et al., 2018).

Non-timber forest uses
- 99% of Liberians depend on woodfuel, a NTFU acting as a major driver of de-forestation (Republic of Liberia, 2017).
- A study of commercialized non-wood forest products found 6 of 18 products could only be collected in primary forests (USAID, 2009).
- Areas of high NTFP value do not broadly seem to correlate with stable forests, likely due to a lack of human population (R. Neugarten et al., 2020). NTFP poten-tial may be high in these regions even if their current importance is low.

For a more detailed description of non-carbon benefits in Liberia and additional maps, see Annex C.6.

Figure 29. Biodiversity intactness index within stable forests of Liberia

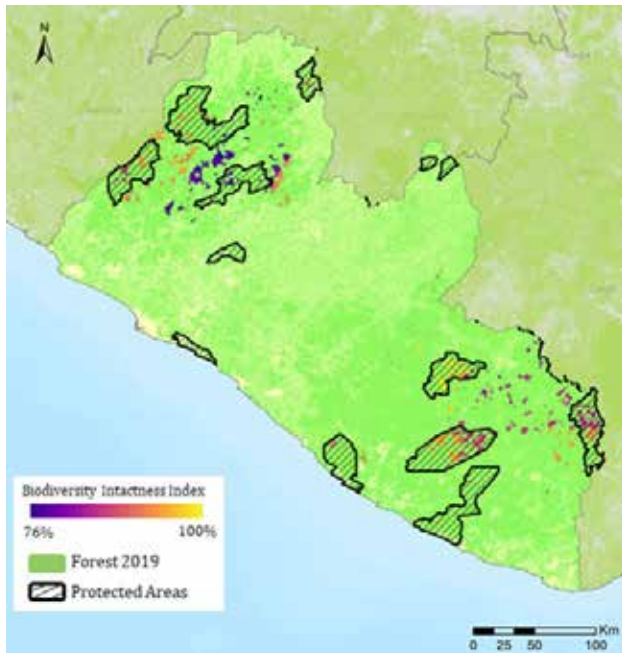


Figure 30. Riverine flood risk within Liberia, derived from WRI aqueduct dataset

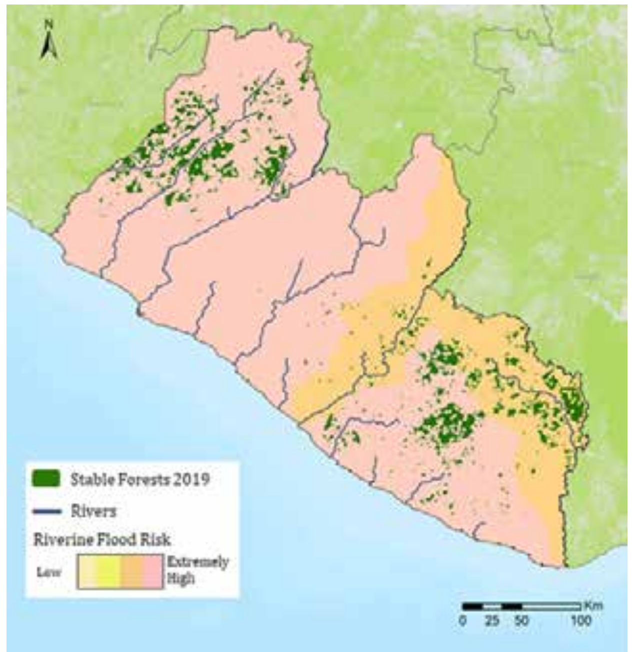
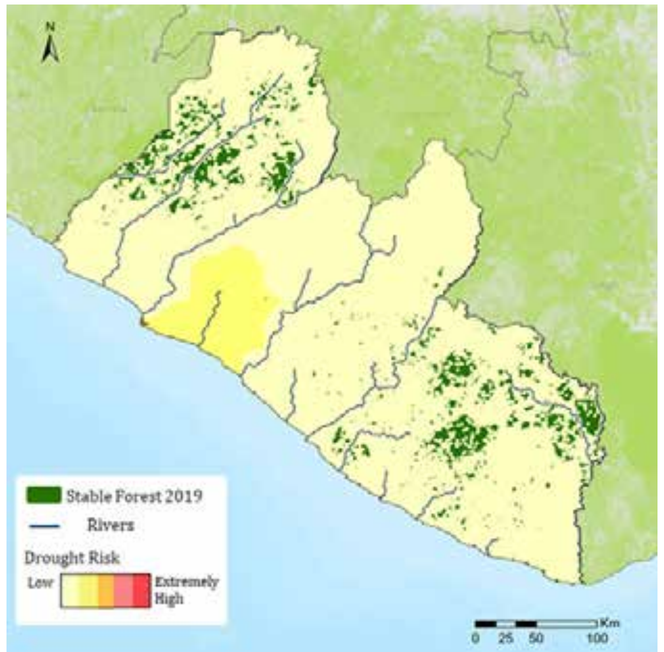


Figure 31. Drought risk within Liberia, derived from WRI aqueduct dataset



6.5.5 Valuation of ecosystem services

The value of ecosystem services (Table 16) ranges from \$9.3 to \$17 billion, or \$15,690 to \$28,681 ha^{-1}. Around 84% of the value is derived from the carbon asset. The rate of deforestation in stable forests is 0.08% yr^{-1} over the past five years, suggesting modest future losses. The annual value of a policy to reduce emissions from deforestation is estimated to range from \$12.15 to \$33.57 ha^{-1} yr^{-1}.

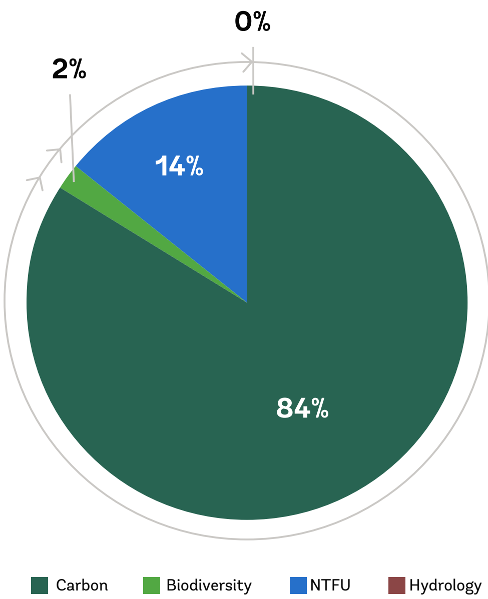
Table 16. Summary values for asset and present value for a 10-year policy to reduce emissions from deforestation (RED) in 2019 stable forest areas. The annual equivalent RED benefit includes only the benefits accrued over the 10-year period. Carbon price range \$14-\$40 t CO2e and r=0.05. \$ ha^{-1} based on area of stable forests in 2019.

	Asset (\$ billions)	Annual Maintenance (\$ millions yr^{-1})	Annual equivalent RED benefit (\$ millions yr^{-1})
Carbon	\$7.8–\$15.5	\$281–\$558	\$5.9–\$18.7
Biodiversity	\$0.2	\$7	\$0.2- \$0.3
NTFU	\$1.3	\$47	\$1
Hydrology	\$0	\$0	\$0
Total	\$9.3–\$17	\$335–\$612	\$7.2–\$19.9
Total (\$ ha^{-1})	\$15,690–\$28,681	\$565–\$1,033	\$12.15–\$33.57

Carbon valuation

The value of the carbon asset in Liberia is mostly found in the live tree biomass component. Stable forests accumulate carbon every year at a rate of 1.2 t CO_2 ha^{-1} yr^{-1}, or \$17 ha^{-1} yr^{-1}, at a carbon price of \$14 t CO_2e. Using the annual maintenance concept, or the annual expenditure that would be required to maintain the physical asset, if this asset were like other physical assets used in the economic system, an estimated \$281 to \$558 million yr^{-1} should be spent to ensure the asset remains intact and the carbon in place. The historical rate of deforestation in stable forest areas was 0.08% yr^{-1} from 2015 to 2019, suggesting that in the future, 4,540 ha of 2019 stable forest would be deforested by 2029. The policy benefit of avoiding this future deforestation is \$5.9 million yr^{-1} at \$14 t CO_2e to \$18.7 million yr^{-1} at \$40 t CO_2e.

Figure 32. Asset share of ecosystem services provided by stable forests (\$14 t CO2e)



Biodiversity

For the biodiversity valuation, we used \$353 ha^{-1} from Siikamaki et al (2021). With the loss of 4,540 ha over the 10-year projection period, the value per hectare declines modestly in the island biogeography approach to valuation. The annual loss of biodiversity value with this approach is around \$0.2 million yr^{-1}. The value of lost biodiversity is larger under the MSA approach (\$0.3 million yr^{-1}) because of the losses of area in larger patches, although patches are relatively small in Liberia to begin with.

Non-timber forest uses

The value of NTFUs is \$2,203 ha^{-1} from Siikamaki et al. (2021). This relatively high value is derived from a high value for both recreational uses and non-wood forest product extraction.

Hydrological value

The value of hydrological services is assumed to be \$28 ha^{-1} based on Siikamaki et al. (2021).

6.5.6 Policy analysis

To successfully protect and enhance stable forests, policy should aim to slow and halt the conversion of stable forest to at-risk forest and reduce deforestation of all forests. The analysis above shows all forests in Liberia are under substantial threat of deforestation, and stable forest is being rapidly converted to at-risk forest at an alarming pace. Policy in Liberia should urgently focus on reducing the conversion of stable forest to at-risk forest along with deforestation of all forests. These overarching policy objectives find some alignment with existing international and domestic policy. However, all domestic policy actions will be challenged by weak governance, which will undermine the efficacy of protected areas and any market mechanisms unless addressed. EFTs face other challenges but could be considered along with other fiscal reform and technical assistance.

Policy objectives:
1. Slow and halt conversion of stable forest to at-risk forest.
2. Reduce deforestation of all forest.

International alignment

Liberia's most recent estimate of its national emissions reports that it was a net carbon sink in 2000, with land use, land use change, and forestry (LULUCF) removing approximately 96.8 million t CO_2e in 2000. Liberia's 2018 NDC made conditional commitments to reduce emissions from the energy, transport, and waste sectors; it includes fuel-efficient stoves and large-scale biomass to energy projects within its energy goals. Forest protection, reforestation and restoration of degraded lands are included as adaptation objectives only. The NDC includes markets with a focus on infrastructure. Liberia submitted a REDD+ FREL to the UNFCCC in 2019 that covers deforestation and degradation but excludes conservation and enhancement. The FREL reports annual forest emissions from two priority landscapes to be 31.4 and 10.7 million t CO_2e yr^{-1} based on a 2009–2018 reference period. The contrast with the 2000 estimate of national LULUCF removals highlights the GHG impact of Liberia's forest loss since 2000.

The *National Forestry Reform Law* (2006) and *Act for the Establishment of a Protected Forest Areas Network* (2003) commits Liberia to conserve 30% of its national forests; this was communicated to the CBD as part of its Aichi Targets. Liberia estimated that this represented a commitment to protect 1.5 million hectares of forest at the time (The Government of Liberia, 2019). The analysis of forest cover in protected areas (see Annex C.6) finds 285,616 ha of forest within terrestrial protected areas in 2019. Liberia's sixth national report to the CBD acknowledges its protected areas are falling short of the 30% forest conservation commitment and suggests that Liberia could meet the target if forest management by indigenous communities is recognized and supported by the government (Republic of Liberia, 2019).

Liberia needs support to meet its NDC and reduce emissions from REDD+, with clear connections between Liberia's adaptation goals and the conservation of stable forest. This creates opportunities for international collaboration under Articles 5, 6.2, 6.8 and 9.1 of the Paris Agreement. This could include collaboration on a "conservation credit" approach that allowed consistent monitoring and valuation of stable forests that could be connected to domestic policy. A conservation credit approach could focus on stable forest areas not under threat of deforestation that would otherwise fall outside traditional REDD+ approaches. This can be connected to support to meet Aichi targets, along with any new targets that may be agreed under the post-2020 framework under the CBD.

Domestic alignment

The Forestry Development Authority (FDA) is a state-owned enterprise responsible for both forest conservation and harvest and is the primary forest management authority in Liberia (Hasnain et al., 2020; Johnson, 2015). A 2020 World Bank Group report found that FDA staff are under-paid, lack capacity to effectively carry out their duties, and feel pressure to collect "informal fees" and not report corruption (Hasnain et al., 2020). The FDA, the Ministry of Lands, Mines and Energy, and the Ministry of Agriculture are responsible for granting forest concessions (Rodriguez, 2017) and communities can also secure forest concessions under the 2009 *Community Rights Law* (Global Witness, 2018; Pollini et al., 2018). As a result, forestry, agricultural, and mining concessions cover almost half of Liberia's territory (Rodriguez, 2017). Procedural irregularities and lack of coordination have led to overlaps of mineral exploration licenses, commercial agricultural concessions, Private Use Permits, Community Forest Management Agreements, and proposed protected areas (Johnson, 2015; Rodriguez, 2017). These challenges in forest governance reflect broader governance challenges in Liberia, which has consistently ranked in the bottom 10 percent for government effectiveness between 2000 and 2019. It has further governance challenges with regulatory quality and control of corruption (see Annex C.6).

Three domestic policy options to protect stable forests are discussed in this national and international context: i) protected areas; ii) market mechanisms; and iii) EFTs. Detailed descriptions of domestic policy can be found in Annex C.6.

Protected Areas

When Liberia established its protected areas network and committed to cover 30% of the country's forests, protected areas covered 2% of land area and represented 8% of Liberia's Biodiversity Priority Areas (BPAs) and 4% of forest areas. By 2017, Liberia expanded its protected areas to cover 4% of its land area, 11% of BPAs, and 6% of forest areas (R. A. Neugarten et al., 2020). If all currently proposed PAs were enacted, approximately 13% of Liberia's total land area would be covered (R. Neugarten et al., 2017; Pollini et al., 2018).

The findings in the analysis of protected areas above highlight the human impacts within protected areas. Timber is one of Liberia's most important exports and the forestry sector contributes 10% of the country's GDP (Onzere et al., 2020; USAID LTS Team, 2019). Economic development and growing settlements around protected areas put pressure on them. People enter protected areas to hunt, extract timber and NTFPs. Growing economic activity leads to the construction of roads and in-migration, which further attracts settlement and increases pressures on protected areas (Greengrass, 2016; R. Neugarten et al., 2020; Pollini et al., 2018). Activities that are important sources of income in rural communities but degrade forests—such as bushmeat trade, artisanal mining and small-scale chainsaw or pit saw logging—are largely unregulated (Greengrass, 2016; Pollini et al., 2018; Rodriguez, 2017).

Social impact assessments have been conducted for at least three proposed protected areas pursuant to the protected area regulations and national commitments (Johnson, 2015). However, establishing new protected areas is difficult. The formal establishment (gazettement) of protected areas may displace communities who resettled in forest areas following Liberia's internal conflicts (Cavanagh, 2018). Economic dependence on forest resources, unclear land tenure, and lack of validation of community land claims have been cited as barriers to expanding protected areas and gazettement (Onzere et al., 2020; Johnson, 2015; Pollini et al., 2018).

The *Community Rights Law of 2009* created a separate legal framework for communities to secure forest concessions and the rights to manage their forests independently from the government or private logging concessions (Global Witness, 2018; Pollini et al., 2018). The Forestry Development Authority has demarcated seven community forests, with the intention of establishing 10 more (Republic of Liberia, 2019). However, concerns have been raised about effectiveness of community forests in terms of conservation. There are reports of elite capture of the community forest benefits (Global Witness, 2018; Mukpo, 2019) and logging companies negotiating with community leaders to finance Authorized Forest Community applications in exchange for permission to log forests within community territories without government oversight (Beevers, 2016; Global Witness, 2018; Mukpo, 2019).

Maintaining current protected areas is clearly a challenge within Liberia and any expansion of protected areas—either government-run or community-based—will be difficult. This topic needs further research, but the solution will probably entail a combination of: i) stopping encroachment into protected areas, ii) focusing on encouraging climate-smart and regenerative agriculture with existing migrants inside protected areas, and iii) some encouragement of out-migration from protected areas over time. Any out-migration should be encouraged through policy and economic incentives to "pull" people out of protected areas, rather than coercive "push" policies or forced relocation. Policies to encourage voluntary relocation to non-protected areas should ensure that suitable alternative lands are identified and that this land allows permanent occupation rights for migrants and provides better access to economic opportunities conducive to an improved quality of life. The principles of free, prior, and informed consent should also be incorporated into any voluntary migration policies. International support should focus on working with the Government of Liberia and local stakeholders to chart the best path forward to restore and genuinely protect ostensibly protected areas, ensuring that any new protected areas are established correctly.

Market mechanisms

Liberia has minimal experience with GHG offset projects and nascent experience with environmental market law and policy, but implementation and efficacy are unclear. Mining companies are required to use biodiversity offsets under the 2014 *Mining Act*, and there have been proposals to develop a national biodiversity offset scheme to help fund protected areas. However, it is unclear if this has been implemented. Liberia is also participating in REDD+ initiatives including the Forest Carbon Partnership Facility, a bilateral agreement with Norway for USD$150 million if emissions are reduced and submitting a FREL to the UNFCCC. Liberia is currently engaging in readiness activities and has not yet met any reduction targets agreed with Norway or elsewhere.

Given Liberia's governance challenges, large-scale policy driven market mechanisms will be difficult to implement. More localized approaches may be possible but will need to contend with broader forest governance challenges that risk overwhelming any localized efforts.

Ecological fiscal transfers

Political, fiscal, and administrative powers in Liberia are highly centralized (Al-Bakri Nyei, 2014; Geegbae Dukuky & Wreh, 2018). It has been argued that overcentralization inhibits democracy and socioeconomic development in Liberia, and there are civil society movements to decentralize aspects of state governance (Al-Bakri Nyei, 2014; Geegbae Dukuky & Wreh, 2018). There is no evidence that EFTs have been used in Liberia to date, and fiscal centralization makes it difficult to transfer funds from the central government to counties (World Bank, 2019). However, some fiscal decentralization transfers are used to allocate funding to counties. Fiscal decentralization transfers include County Development Funds to support local development projects and Social Development Funds for counties that host concession companies (Liberia Ministry of Finance and Development Planning, 2020).

More research is needed on this policy option, but a combination of EFTs and international support to strengthen forest governance could be considered in Liberia. Conditional fiscal transfer payments to entities responsible for forest governance should help incentivize improved governance, but this will need to be matched with additional technical assistance to promote effective and equitable governance reform.

Key findings and recommendations

The analysis of changes to stable forest area provides new evidence that Liberia's forests are under even more

pressure from human impact than previously understood. Deforestation rates were known to be high in Liberia, but the new research presented above highlights a significant loss of forests reclassified from stable to at-risk forest. Liberia had the highest deforestation rate of all case study countries (18.08%), second highest rate of stable forest deforestation (following conversion to at-risk forest) (7.25%, thus just behind Indonesia's 7.30%), and the highest rate of stable forest loss overall (84.5%, which is significantly higher than the second-highest in Indonesia at 49%). The causes behind these shifts are not assessed, but the forest is apparently becoming more fragmented; this could be due to expansion of the road network, logging, fuel wood extraction, agricultural encroachment, or a combination of all these factors.

The economic analysis demonstrates that there is substantial asset value in Liberia's stable forests, although significantly less than in other case study countries. This translates into economic losses when this forest is lost or, conversely, substantial benefits when the forest is protected and enhanced, with most of this value captured in the global good of stored carbon. This analysis has not captured the lost value of the transition from stable forest to at-risk forest, although this could also generate significant losses in value from carbon, biodiversity, hydrological services, and NTFUs. For example, 100% of stable forests are in high riverine flood risk areas, which could provide greater economic benefit than the data sets used to calculate the value of hydrological services capture.

The economic analysis also highlights the significant difference between the underlying value of stable forests as an asset and the smaller annual maintenance payments or value of stopping deforestation (following conversion to at-risk forest). The present value of reducing deforestation of stable forest represents an annual equivalent value of 0.07% to 0.1% of the asset. This significantly undervalues stable forest as an asset and the ecosystem services it provides to Liberia and the world. Adding maintenance payments based on area of stable forest would support recognition of the true value inherent to conserving stable forest.

There is scope for Liberia to collaborate with other countries to protect stable forest under the Paris Agreement and CBD, which can be connected to domestic policies. This includes collaboration via "conservation credits" or other forms of bilateral assistance that could support domestic policy reform. The different approaches to value stable forests—as an asset, the annual maintenance cost, or present value based on stopping deforestation (following conversion to at-risk forest)—provide a price range that should be the starting point of international and domestic policy discussions on actual payments for protecting stable forests. One approach is to spatially separate maintenance payments and payments to stop deforestation. The value of reducing deforestation is associated with areas under imminent threat of deforestation, typically the forest edge, and it does not capture conversion of stable forest to at-risk forest. When focused on areas that are at risk of imminent deforestation, per hectare reduced deforestation payments approach the per hectare asset value (that is, $15,353 per ha at $14/t CO_2e). Annual maintenance payments are lower per hectare ($553 at $14/t CO_2e) and could be associated with maintaining stable forest areas under threat of fragmentation rather than deforestation. This represents the maintenance value of the ecosystem services that these forests provide. Payments could be structured based on hectares of stable forest or reductions in stable forest loss, with such payments used to support domestic policy or local efforts that protect stable forest.

Liberia's protected areas are undermined by governance challenges, and Liberia has limited experience with PES. Improving forest and land use governance should therefore be a policy priority to strengthen protected areas and PES efficacy. Without these improvements in governance, both options will be challenging to implement as government policy. There is scope to explore public–private or non-state options for both, whereby non-state actors provide additional technical assistance and capacity to address local drivers of forest loss and thereby protect and maintain protected areas or other sites with stable forest in return for PES payments. This should only occur alongside broader governance reforms to address systemic drivers of deforestation. EFTs may be challenging to implement but should be considered as part of any broader fiscal reform. These broad policy options also need to be complemented by further country-specific policy analysis and options to address national and local circumstances.

6.6 Republic of Congo

Stable forest area: Republic of Congo (RoC) has 10,965,916 ha of stable forests (57.2% of forests). It has experienced low stable forest deforestation from 2000 to 2019 (1.3%) but still relatively high net stable forest loss (38.4%). Deforestation of all forest and net stable forest loss is less in protected areas than in non-protected forests.
Ecosystem services: Stable forests store 3.62 Gt C and sequester approximately 37.6 Mt CO_2e yr^{-1}. Stable forests have slightly higher biodiversity intactness than at-risk forests and likely provide significant erosion and climate benefits, although more hydrological research is needed here.

Economic potential: The value of stable forests is estimated to range from $191 to $364 billion for the four ecosystem services valued. The annual maintenance value of stable forests ranges from $6.9 to $13.1 billion yr^{-1} and the annual value of reducing deforestation is $104 to $308 million.

Recommended policy approaches: RoC needs support to meet its international commitments, creating opportunities to collaborate under Articles 5, 6.2, 6.8 and 9.1 of the Paris Agreement. This could include collaboration via "conservation credits" linked to domestic efforts to stop loss of stable forests. However, protected areas do not effectively protect forests from deforestation and fragmentation. Protected areas could be made more effective, with improvements in connectivity with surrounding forests, but forest governance needs to be fundamentally improved. Options to do so will include a combination of stopping encroachment into protected areas, focusing on climate smart and regenerative agriculture of existing migrants, and some encouragement of out-migration from protected areas. Given RoC's governance challenges, large-scale policy driven market mechanisms will be difficult to implement, but more localized approaches may be possible. More research is needed to understand the feasibility of using oil or other fiscal transfers to structure an EFT to conserve stable forests.

6.6.1 Country overview

The Republic of Congo (RoC) is a highly forested nation in the Congo Basin. It has a population of 5.38 million. With over 70% of the population living in five cities, RoC is among the 20 least densely populated countries, with just 15.4 people per square kilometer (World Bank, 2020c). RoC is a lower-middle income country and had a GDP per capita of $2,280 in 2019 (World Bank, 2020c). The country's GDP is mostly derived from oil production (approximately 60%) while the forestry sector contributes a further 5.6% of GDP (République du Congo, 2018).

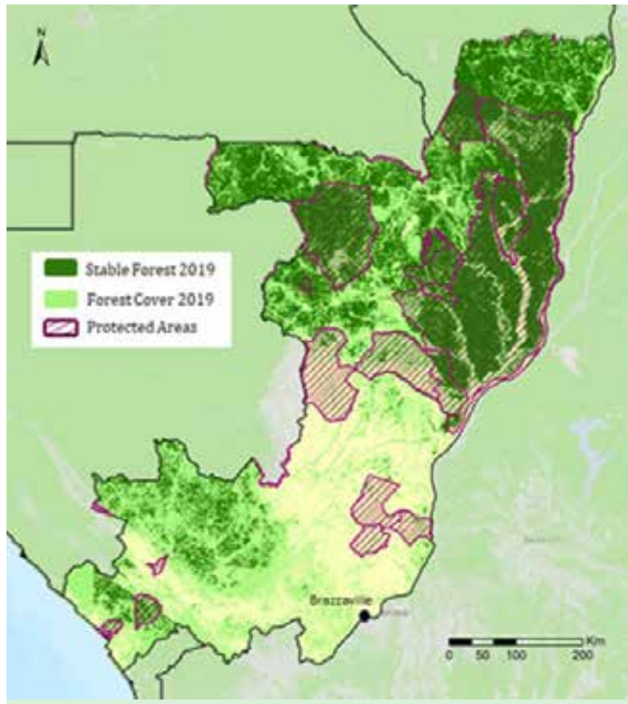
Forests cover 69% of the country's land area (République du Congo, 2017), contributing to RoC's rich natural resources. The country is highly biodiverse, holding at least 5,100 plant species, 200 mammal species, 676 bird species, 151 reptile species, 355 fish species, and 74 amphibian species (UNEP et al., 2014). The population is reliant on forest biodiversity for NTFUs such as wood energy, hunting, food, and medicine (République du Congo et al., 2015). Although RoC is considered an HFLD country, its forests are under threat from shifting cultivation, demand for wood energy, illegal logging, and urban development due to population growth (GFW, 2020c; République du Congo, 2017). A high population growth rate (2.56%) could exacerbate pressure on forest resources in the future (World Bank, 2020c). Deforestation currently accounts for 81% of emissions in the country and in its NDC RoC has committed to increase forest carbon sequestration and decrease deforestation to 20% of its current level, conditional on REDD+ implementation (République du Congo, 2015). RoC has already established many concession areas to encourage sustainable practices and reduce deforestation, giving it the greatest area per capita of Forest Stewardship Council land worldwide (République du Congo, 2017). RoC's FREL accounts only for deforestation and degradation but proposes including other activities such as SMF and conservation in later versions (République du Congo, 2017).

6.6.2 Stable forest area

Stable forest area and loss

Stable forests are a dominant feature in RoC, comprising over half the country's forests. Although there has been minimal stable forest deforestation (following conversion to at-risk forest), there was a significant conversion of stable forest to at-risk forest from 2000 to 2019. Net stable forest loss remained fairly consistent from the first to the second decade of this century, while deforestation of stable forest increased over the same period from an annual rate of 0.03% to 0.14%. The high stable forest area lost due to conversion of stable to at-risk forest (Table 17) suggests significantly encroaching forest edges or division into smaller patches. The northernmost and densely forested province of Likouala has the greatest stable forest area and the second lowest net stable forest losses from 2000 to 2019. Notably, the provinces with stable forest area of more than 1 million ha in 2000 and stable forest losses exceeding 50% from 2000 to 2019 (Lékoumou and Niari) are both near Pointe Noire and Brazzaville, the country's biggest cities.

Figure 33. Map of stable forests in Republic of Congo



Stable forests in Republic of Congo
Area: 10,965,916 ha
% of country: 33.3%
% of forest: 57.2%
Deforestation, 2000–2019: 1.3%
Net loss, 2000–2019: 38.4%

Table 17. Forest and non-forest area in Republic of Congo in 2000, 2010, and 2019

Land classification	Area (ha)		
	2000	2010	2019
At-risk forest	95,060,292	101,803,284	99,376,313
Stable forest	62,826,277	44,147,165	32,043,277
All forest	157,886,569	145,950,449	131,419,590
Non-forest	26,691,034	38,627,154	53,158,013

Stable forests in protected areas

% stable forests which are protected: 69.9%
% protected forests which are stable: 77.9%

Most stable forests fall within designated protected areas (69.9%). Stable forests also account for a higher proportion of protected forests (77.9%) than of all forests (57.2%). Deforestation of all forest and net stable forest loss are less in protected areas (1.51% and 19.89% respectively) compared to non-protected forests (3.52% and 50.84%). However, protected areas managed by the government appear to have higher rates of forest and stable forest loss (5.55% and 51.8%) than experienced elsewhere under other forms of protected area management (1.34% and 19.39%) and areas not under any form of protection (1.53% and 19.34%; see Annex C.7). This finding needs further research as the governance type of several large, protected areas is not reported, and if they were included as "government-managed," then the losses within government-managed areas would decline. Non-reported areas include areas classified as either a National Park, Nature Reserve, Ramsar Site, UNESCO Biosphere Reserve, or World Heritage Site, which collectively had a stable forest loss rate of 19.3%. Among other governance areas, 17.5% is under collaborative governance in either a National Park, Community Reserve, or Wildlife Sanctuary, with a net stable forest loss rate from 2000 to 2019 of 19.6%. Some degradation in protected areas may not be captured in these statistics.

6.6.3 Carbon potential

Stable forest C stocks: 3.62 Gt C
Stable forest removals: 37.6 Mt CO2e yr^{-1}

Stable forest carbon stocks hold 50% more AGB and BGB per hectare than at-risk forests, likely because stable forests are farther from anthropogenic activities that may cause degradation in at-risk forests. Stable forests have slightly higher SOC stocks than at-risk forests (7% higher). AGB accounts for 56.7% of stable forest carbon stocks while BGB and SOC contribute 18.0% and 25.4%, respectively. SOC in stable forests may be undervalued in this analysis, which relies on country-reported data from the Global Soil Organic Carbon Map. RoC holds the third greatest amount of peat carbon after Indonesia and the Democratic Republic of Congo (Dargie et al., 2017), most of which is in undisturbed forest likely to be stable (Miles et al., 2017). Studies show soil carbon stock in peat swamp forests in the Congo Basin, which cover 54,700 km^2 in northeastern RoC (roughly 16% of the country), may be higher than that in AGB and BGB (Dargie et al., 2017). However, even though Cuvette holds a large peatland area and had the greatest average SOC stock (103.2 t C ha^{-1}) in this analysis, SOC still accounts for just 31% of total carbon stock in this region. If the annual rate of net stable forest loss from 2019 to 2030 were to change by the same amount as it did from the period 2000–2010 to 2010–2019, stable forests would sequester 24.4 Mt CO_2e in 2030 and would have a carbon stock of 2.3 Gt C. This does not mean the difference in carbon stock is lost as emissions or that the difference in sequestration would be forgone removals, as at-risk forests may continue to sequester and store this carbon.

6.6.4 Non-carbon benefits

Biodiversity

- The average biodiversity intactness index for stable and at-risk forests is 87.5% and 83.8%, respectively, suggesting biodiversity is highly intact (Figure 35).
- Although the country holds great biodiversity, there are still many unknowns due to limited research (de Wasseige et al., 2012; UNEP et al., 2014).
- Forest areas with less human impact, which would correlate with stable forests, have been shown to have different biodiversity (Ifo et al., 2016) and greater species abundance such as monkeys (Bermejo, 1999).

Hydrology

- 55% of stable versus 40% of at-risk forests are in extremely high riverine flood risk areas (Figure 36).
- All forests are in low or low to medium drought risk watersheds (Figure 37).
- Most stable forests are found in the water-rich Congo Basin, which provides important hydrological benefits including control of climate, erosion, and river flow.
- The lack of current research into these systems limits our understanding of how stable forests directly impact them, although Congo Basin forests could significantly affect rainfall as 75–95% of regional rainfall is recycled from forests (Brummett et al., 2008).

Non-timber forest uses

- 90% of wood harvested in the Congo Basin is for woodfuel (Behrendt et al., 2013), which is used by 83.2% of the population for cooking (de Wasseige et al., 2012).
- At least 166 forest plant species are used for food and over 800 have medicinal value (République du Congo et al., 2015).
- Bushmeat hunting is a major NTFU, although it is more intense in regions with more road access (and thus fewer stable forests) (Wilkie et al., 2000).

For a more detailed description of non-carbon benefits in RoC and additional maps, see Annex C.7.

6.6.5 Valuation of ecosystem services

The value of ecosystem services (Table 18) ranges from \$191 to \$364 billion in RoC, or \$17,418 to \$33,148 ha^{-1}. A relatively large share (90%) of the value is derived from the carbon asset. The rate of deforestation in stable forests is low, 0.07% yr^{-1} over the past five years, suggesting modest future losses. The annual value of a policy to reduce emissions from deforestation (following conversion to at-risk forest) is estimated to range from \$9.47 to \$28.04 ha^{-1} yr^{-1}.

Table 18. Summary values for asset and present value for a 10-year policy to reduce emissions from deforestation (RED) in 2019 stable forest areas. The annual equivalent RED benefit includes only the benefits accrued over the 10-year period. Carbon price range \$14-\$40 t CO_2e and r=0.05. \$ ha^{-1} based on area of stable forests in 2019.

	Asset (\$ billions)	Annual Maintenance (\$ billions yr^{-1})	Annual equivalent RED benefit (\$ millions yr^{-1})
Carbon	\$172.5–\$345	\$6.2–\$12.4	\$93.7–\$294.9
Biodiversity	\$8.6–\$8.6	\$0.3–\$0.3	\$3.3–\$5.8
NTFU	\$7.6–\$7.6	\$0.3–\$0.3	\$5.2–\$5.2
Hydrology	\$2.3–\$2.3	\$0.1–\$0.1	\$1.6–\$1.6
Total	\$191–\$363.5	\$6.9–\$13.1	\$103.8–\$307.5
Total (\$ ha^{-1})	\$17,418–\$33,148	\$629–\$1,195	\$9.47–\$28.04

Figure 34. Asset share of ecosystem services provided by stable forests (\$14 t CO_2e)

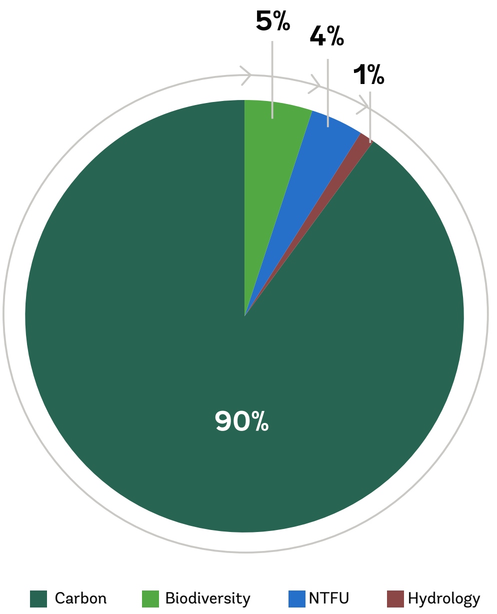


Figure 35. Biodiversity intactness index within stable forests of Republic of Congo

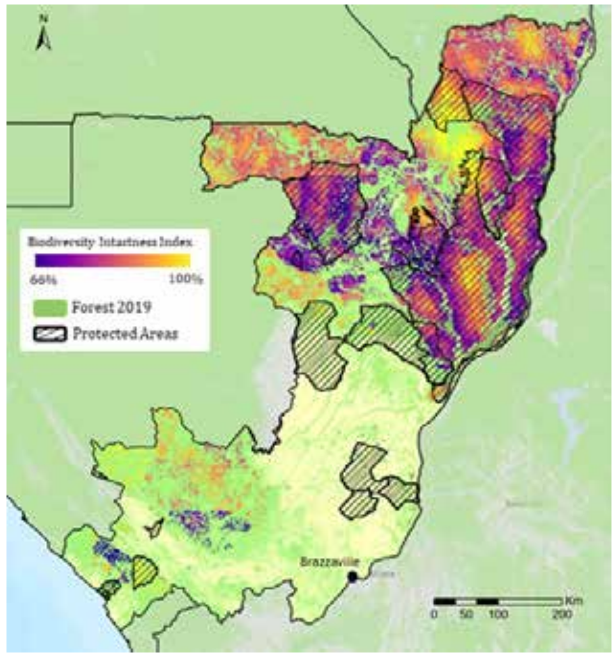


Figure 36. Riverine flood risk within Republic of Congo, derived from WRI aqueduct dataset

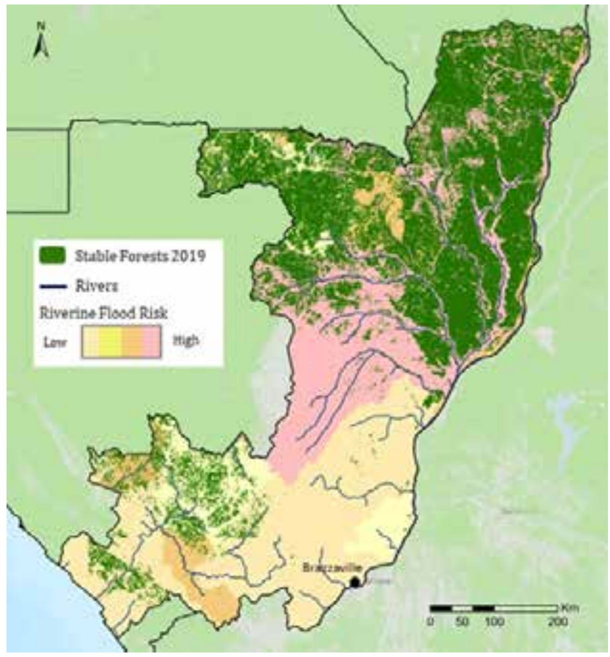
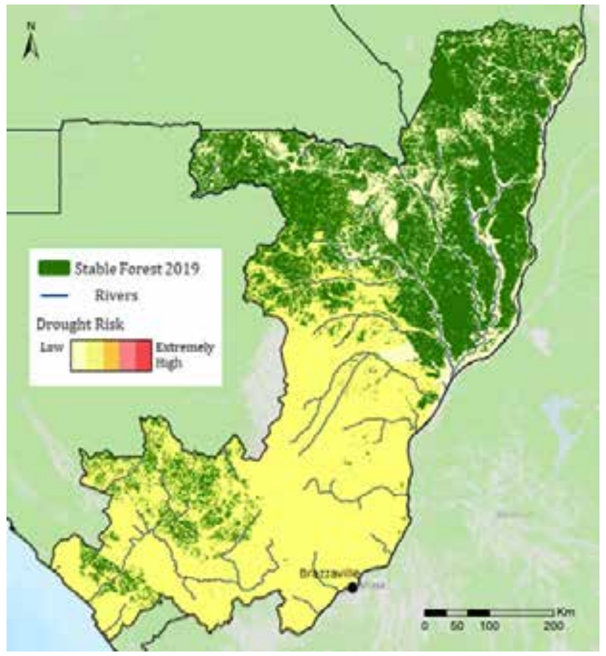


Figure 37. Drought risk within Republic of Congo, derived from WRI aqueduct dataset



Carbon valuation

The value of the carbon asset is mostly found in the AGB component. Stable forests accumulate carbon every year at a rate of 3.4 t CO_2e ha^{-1} yr^{-1}, or \$47 ha^{-1} yr^{-1} at a carbon price of \$14 t CO_2e. Using the annual maintenance concept, or the annual expenditure required to maintain the physical asset if this asset were like other physical assets used in the economic system, an estimated \$6.2 to \$12.4 billion yr^{-1} should be spent to ensure the asset remains intact and the carbon in place. The historical rate of deforestation (following conversion to at-risk forest) in stable forest areas in RoC was 0.07% yr^{-1} from 2015 to 2019, suggesting that in the future, 75,537 ha of 2019 stable forest areas would be deforested by 2029. The policy benefit of avoiding this future deforestation is \$94 million yr^{-1} at \$14 t CO_2e to \$295 million yr^{-1} at \$40 t CO_2e.

Biodiversity

For the biodiversity valuation, we use an estimate of \$272 ha^{-1} from Siikamaki et al. (2021). With the loss of 75,537 ha over the 10-year projection period, the value per hectare declines modestly in the island biogeography approach to valuation. The annual loss of biodiversity value with this approach is around \$3.3 million yr^{-1}. The value of lost biodiversity is about twice as large under the MSA approach because of the losses of area in larger patches, which have disproportionate benefits for biodiversity. As a result of the reduction in larger patch sizes with the projected deforestation, the annual loss is around \$5.8 million yr^{-1}.

Non-timber forest uses

The value of NTFUs is estimated as \$689 ha^{-1} from Siikamaki et al. (2021).

Hydrological value

The value of hydrological services is \$212.46 ha^{-1} from Siikamaki et al. (2021).

6.6.6 Policy analysis

> ***Policy objectives:***
> 1. Slow and halt conversion of stable forest to at-risk forest.
> 2. Reduce deforestation of all forest.

To successfully protect and enhance stable forests, policy should aim to slow and halt the conversion of stable forest to at-risk forest and reduce deforestation of all forests. The analysis above shows that in RoC all forests are under threat from deforestation, but stable forests are being lost due to conversion to at-risk forest at significantly higher rates than overall deforestation. Policy in RoC should focus on efforts to reduce the conversion of stable forest to at-risk forest. This should be supported not merely by recognizing the value of stable forests, but also by improving forest governance as a consequence. These overarching policy objectives are aligned with existing international and domestic policy, but all domestic policy actions will be challenged by weak governance. This is most evident in protected areas, which exceed Aichi area targets but continue to be deforested; this will undermine the efficacy of protected areas and any market mechanisms unless addressed. EFTs could be considered along with other fiscal reform and technical assistance.

International alignment

The country's Nationally Determined Contribution (NDC) to the Paris Agreement contains mitigation commitments to increase forest carbon sequestration and reduce deforestation, including a conditional commitment to reduce unplanned deforestation by 20% with international REDD+ support. RoC submitted its REDD+ FREL to the UNFCCC in 2016 and assessed a level of 46 million t CO_2e yr^{-1}. ROC has not submitted a Biennial Update Report with results (UNFCCC, 2020). The NDC also contains adaptation goals to protect forests and systems sensitive to climate change.

The country's contributions to the Aichi Targets under the CBD reflect the goals and text of Aichi Target 11, that is, RoC committed to conserve at least 17% of terrestrial and inland waterways "through ecologically representative and well-connected networks of effectively and equitably managed protected areas and other effective conservation measures by area, and integrated into the entire landscape." RoC currently has 34

protected areas that cover 37% of the terrestrial landscape (Protected Planet, 2020), so it meets the area objectives. More support may be needed to ensure that these protected areas are effectively and equitably managed.

RoC needs support to meet its international commitments, which create clear opportunities to collaborate with other countries to protect stable forests under Articles 5, 6.2, 6.8 and 9.1 of the Paris Agreement to meet its protected area targets. This could include collaboration on a "conservation credit" approach that allowed consistent monitoring and valuation of stable forests; this could be connected to domestic policy. A conservation credit approach could focus on stable forest areas not under threat of deforestation that would otherwise fall outside traditional REDD+ approaches.

Domestic alignment

The forests in RoC are either state owned or privately owned, with the majority owned by the state. State forests are divided into permanent or non-permanent stands. The permanent stands are divided into Forest Management Units and may include restored forests or plantations. Logging is fully managed by the private sector and the state grants four types of private logging concessions: agreement for industrial processing, agreement for management and processing, permits for timber-cutting in plantations, and special permits (WRI, 2014). In RoC, 80% of forests are classified as production forests and many of those are under concession (Cobb, 2010). In 2014, RoC revised its forest policy to integrate sustainable management, green economy, poverty reduction, welfare, and climate change goals under one vision (Ministry of Forest Economy, 2016).

RoC currently ranks in the bottom 10th percentile on key governance indicators of government effectiveness, regulatory quality, and control of corruption. It has consistently received low rankings on these indicators from 2000 to 2019, with a notable and steady decline in control of corruption between 2005 and 2019 (see Annex C.7).

Three domestic policy options to protect stable forests are discussed in this national and international context: i) protected areas; ii) market mechanisms; and iii) EFTs. Detailed descriptions of domestic policy can be found in Annex C.7.

Protected Areas

RoC has established 34 protected areas that cover 37% of the terrestrial landscape. These include a World Heritage Site, two UNESCO-MAB Biosphere Reserves, 14 Ramsar Sites, and 17 national protected areas (Protected Planet, 2020; République du Congo, 2015). International coordination has been key to support these protected areas, including from the Central African Forests Commission and others. However, the drivers of deforestation[23] put pressure on protected areas. This includes degradation of surrounding ecosystems along with encroachment into the protected areas, which may be due to illegal activities or because protected area and concession boundaries overlap or are unclear (Cannon, 2016, 2019; USFWS, 2018).

It has been proposed that protected areas could be made more effective with improvements in the connectivity between protected areas and surrounding forests, along with improvements in forest monitoring (USFWS, 2018). There are also some concerns that national parks take a "fortress approach" to protection that displaces and dispossesses indigenous (autochthonous) people (Counsell, 2018).

23 The drivers include infrastructure and urban development, industrial logging, industrial-scale palm oil cultivation, mining, shifting agriculture, and fuelwood collection, linked to weak forest governance, lack of policy coordination, poverty, insufficient sustainable economic activities, and population growth.

As noted in the protected area analysis above, more research is needed on deforestation and stable forest loss within different protected areas that vary by governance type. Even so, alarmingly high rates of deforestation and stable forest loss have been recorded within areas under government management. Maintaining current protected areas is clearly a challenge within RoC and any expansion of protected areas—either government or community-based—will be difficult. This topic needs further research, but the solution will probably entail a combination of: i) stopping encroachment into protected areas, ii) focusing on encouraging climate-smart and regenerative agriculture with existing migrants inside protected areas, and iii) some encouragement of out-migration from protected areas over time. Any out-migration should be encouraged through policy and economic incentives to "pull" people out of protected areas rather than coercive "push" policies or forced relocation. Policies to encourage voluntary relocation to non-protected areas should ensure that suitable alternative lands are identified and that this land allows permanent occupation rights for migrants and provides better access to economic opportunities conducive to an improved quality of life. The principles of free, prior, and informed consent should also be incorporated into any voluntary migration policies. International support should focus on working with the Government of RoC and local stakeholders to chart the best path forward to restore and genuinely protect ostensibly protected areas, ensuring that any new protected areas are established correctly.

Market mechanisms

The only experience RoC has with environmental markets relate to REDD+. RoC is participating in the Forest Carbon Partnership Facility and UN-REDD and initiated a public–private partnership with Olam International for a logging concession managed as part of the country's emission reduction program. There is also one voluntary market REDD+ project registered with the Verified Carbon Standard and one voluntary market agroforestry project under development.

Given the country's governance challenges, large-scale, policy-driven market mechanisms will be difficult to implement. More localized approaches may be possible but will need to contend with broader forest governance challenges that risk overwhelming any localized efforts.

Ecological fiscal transfers

There is no evidence of EFTs or other results-based fiscal transfer being used in RoC. However, it may be possible to implement a results-based EFT scheme to encourage local conservation of stable forests. Local governments are dependent on local taxes and three types of transfers from the central government: social transfers, traditional transfers, and oil-related transfers (IMF Country Report 20/26, 2020). The 2021 RoC budget bill also includes CFAF 1.8 billion in development funds for *départements* (subnational divisions). The departmental development fund comprises 50% of the tax collected by the Forest Economy Administration, the tax collected on hydrocarbon extraction, and fees from road transport authorizations or other motor transportation (Republique du Congo, 2020, translated). More research is needed to understand the feasibility of using oil or other fiscal transfers to structure an EFT to conserve stable forests.

Key findings and recommendations

The analysis of changes to stable forest area provides new evidence that RoC's forests are under even more pressure from human impact than previously understood. While 2.79% of all forests were lost between 2000 and 2019, 38.37% of stable forests were lost. This research highlights the more significant loss of forests classified as stable forest. The causes behind these shifts are not assessed, but the forest appears to be becoming more fragmented; this could be due to expansion of the road network, logging, mining, fuel wood extraction, agricultural encroachment, or a combination of any of these factors.

The economic analysis demonstrates there is substantial asset value in RoC's stable forests. This translates into economic losses when this forest is lost, or, conversely, substantial benefits when the forest is protected and enhanced, with most of this value captured in the global good of stored carbon. This analysis has not captured the lost value of the transition from stable forest to at-risk forest, although this could also generate significant losses in value from carbon, biodiversity, hydrological services, and NTFUs.

The economic analysis also highlights the significant difference between the underlying value of stable forests as an asset and the smaller annual maintenance payments or value of stopping deforestation. The present value of reducing deforestation of stable forest (following conversion to at-risk forest) represents an annual equivalent of 0.06% to 0.09% of the asset. This significantly undervalues stable forests as an asset and the ecosystem services they provide to RoC and the world. Adding maintenance payments based on area of stable forest would support recognition of the true value inherent to conserving stable forest.

There is scope for RoC to collaborate with other countries to protect stable forest under the Paris Agreement and CBD; this can be connected to domestic policies. This includes collaboration via "conservation credits" or other forms of bilateral assistance that could support domestic policy reform. The different approaches to value stable forests—as an asset, the annual maintenance cost, or present value based on stopping deforestation (following conversion to at-risk forest)—provide a price range that should be the starting point of international and domestic policy discussions on actual payments for protecting stable forests. One approach is to spatially separate maintenance payments and payments to stop deforestation. The value of reducing deforestation is associated with areas under imminent threat of deforestation, typically the forest edge, and it does not capture conversion of stable forest to at-risk forest. When focused on areas that are at risk of imminent deforestation, per hectare reduced deforestation payments approach the per hectare asset value (that is, $17,627 per ha at $14/t CO_2e). Annual maintenance payments are lower per hectare ($638 at $14/t CO_2e) and could be associated with maintaining stable forest areas under threat of fragmentation rather than deforestation. This represents the maintenance value of the ecosystem services that these forests provide. Payments could be structured based on hectares of stable forest, or reductions in stable forest loss with such payments used to support domestic policy or local efforts that protect stable forest.

The country's protected areas are significantly undermined by governance challenges, with government-managed protected areas experiencing the highest rates of forest loss and loss of stable forest of all land types in RoC—even higher than in unprotected forest. This statistic needs further research and may improve, but it nonetheless signals profound governance challenges that could beset any policy. Improving forest and land use governance should therefore be a policy priority to strengthen protected areas and the country's limited experience with PES. Without these improvements in governance, both options will be challenging to implement as government policy. There is scope to explore public–private or non-state options for both, whereby non-state actors provide additional technical assistance and capacity to address local drivers of forest loss and thereby protect and maintain protected areas or other sites with stable forest in return for PES payments. The analysis of protected areas shows "collaborative governance" of protected areas had the lowest rates of forest loss between 2000 and 2019 (0.33%), but still saw losses of stable forest in line with national averages for protected areas. This highlights the importance of forest governance, and the need for more effort focusing on protecting stable forests in protected areas, alongside broader governance reforms to address systemic drivers of deforestation. EFTs tied to distribution of oil revenue and valuation of maintaining stable forests should be explored as part of any broader governance reform. These broad policy options also need to be complemented by further country specific policy analysis and options to address local drivers of deforestation within local (and national) contexts.

Glossary

Annual equivalent RED benefit: the benefits the country could be paid through traditional programs to reduce emissions from deforestation (and therefore reduce deforestation), estimated in this analysis over a 10-year period after determining the present value of ecosystem services conserved by avoiding (precluding or not experiencing) the reference level deforestation in stable forests. By definition, there is no direct deforestation in stable forests, but there is minimal deforestation—following a conversion from stable to at-risk forest—that would be represented as deforestation in stable forests over the reference period and is used to estimate this value.

Annual maintenance value: the annual amount of resources that would be needed to ensure that the asset value does not decline, estimated as 3.6% of the asset value in this analysis.

Asset value: the present value of the future stream of ecosystem service flows that would be obtained from the stable forest area in 2019 if it were lost, valued with estimates determined to be appropriate for each region or case study country.

At-risk forests: forests that are less than 1 km from the forest edge (globally, or a different distance on a country-specific basis) and therefore are at greater risk of deforestation and degradation.

Conservation credit: a single accounting and payment unit which bundles or aggregates multiple ecosystem services (rather than just carbon) that could be tied to the annual maintenance value of stable forests and used to connect international and domestic policy, generating additional values and incentives to maintain stable forest.

Conversion to at-risk forest: the reclassification of a stable forest area as "at-risk" forest due to a change in the distance of the forest area from the forest edge.

Ecological fiscal transfer (EFT): Budget distribution from a higher to a lower level of government tied to lower-level government achieving environmental targets.

Hinterland forest: "forest patches without and removed from disturbance in near-term history," with a distance from recent stand-replacement forest disturbance of greater than 1 km, a minimum patch size of 100 km^2, a minimum corridor width of 2 km, and a minimum of 12 years without disturbance (Tyukavina et al., 2016).

High-forest low-deforestation (HFLD) country: defined by da Fonseca et al. (2007) as developing countries with more than 50% forest cover and a rate of change in forest area less than the global average based on FAOSTAT data over a 10-year period, and defined by ART as countries with an HFLD score exceeding 0.5 (for further explanation, see TREES 2.0 2021 Public Consultation from ART Secretariat, 2021).

Intact forest landscape: "an unbroken expanse of natural ecosystems within the zone of current forest extent, showing no signs of significant human activity, and large enough that all native biodiversity, including viable populations of wide-ranging species, could be maintained" that are: "larger than 500 km^2; at least 10 km wide at the broadest place (measured as the diameter of the largest circle that can be fitted inside the patch); and at least 2 km wide in corridors or appendages to areas that meet the above criteria" (Potapov et al., 2008).

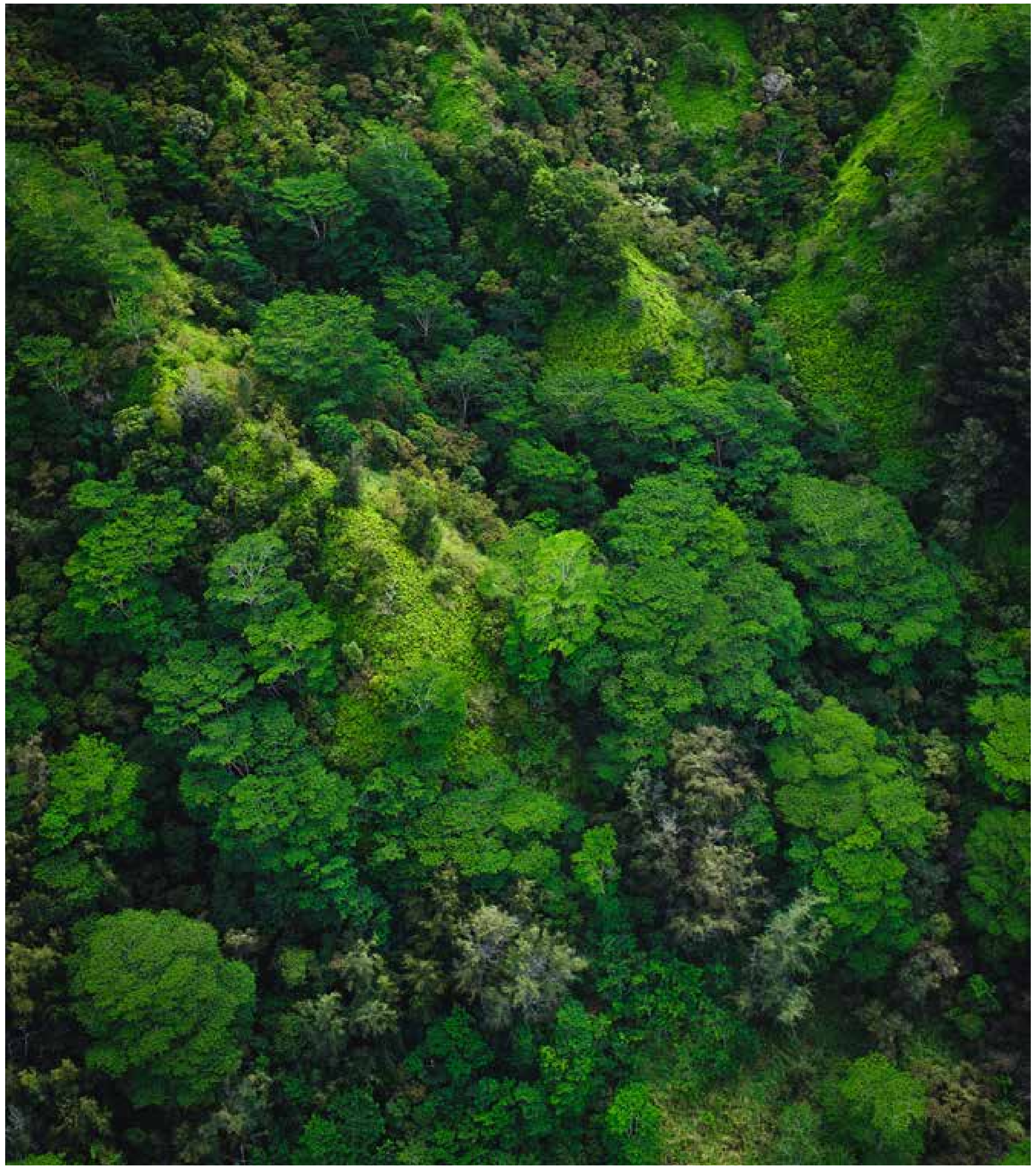
Non-timber forest uses (NTFUs): NTFUs are interpreted broadly in this analysis, including outputs from non-timber forest products (NTFPs) such as food and fuelwood, along with uses such as recreation and tourism.

Primary forest: "naturally regenerated forest of native tree species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed" (FAO, 2020).

REDD+: REDD+ covers five activities: (i) Reducing emissions from deforestation; (ii) Reducing emissions from forest degradation; (iii) Conservation of forest carbon stocks; (iv) Sustainable management of forests; and (v) Enhancement of forest carbon stocks. Activities (i) and (ii) are part of REDD and (iii) – (v) fall under the "+".

Stable forest: defined by Funk et al. (2019) as forests "not already significantly disturbed nor facing predictable near-future risks of anthropogenic disturbance" and specified in this analysis as areas with tree height greater than 5 m, more than 25% tree canopy cover, greater than 1 km distance from forest edge, and with low-to-moderate human pressure determined using the Human Footprint layer.

Stacked value of ecosystem services: under the assumption that ecosystem services are additive, the estimated values for these services can be summed to develop an estimate of the asset value of multiple ecosystem services in a specific stable forest area. Stacking often refers to adding together payments for various services, not estimating their underlying economic value. Stacked services could serve as the basis for a conservation credit.



References

Abman, R. (2018). Rule of Law and Avoided Deforestation from Protected Areas. *Ecological Economics*, *146*, 282–289. https://doi.org/10.1016/j.ecolecon.2017.11.004

Abood, S. A., Lee, J. S. H., Burivalova, Z., Garcia-Ulloa, J., & Koh, L. P. (2015). Relative Contributions of the Logging, Fiber, Oil Palm, and Mining Industries to Forest Loss in Indonesia. *Conservation Letters*. https://doi.org/10.1111/conl.12103

Al-Bakri Nyei, I. (2014). Decentralizing the state in Liberia: The issues, progress and challenges. *Stability: International Journal of Security and Development*, *3*(1). https://doi.org/10.5334/sta.eg

Alexandrov, G., & Oikawa, T. (2002). TsuBiMo: a biosphere model of the CO2-fertilization effect. *Climate Research*, *19*, 265–270.

Alkemade, R., Van Oorschot, M., Miles, L., Nellemann, C., Bakkenes, M., & Ten Brink, B. (2009). GLOBIO3: A framework to investigate options for reducing global terrestrial biodiversity loss. *Ecosystems*. https://doi.org/10.1007/s10021-009-9229-5

Alvarez-Garreton, C., Lara, A., Boisier, J. P., & Galleguillos, M. (2019). The Impacts of Native Forests and Forest Plantations on Water Supply in Chile. *Forests*, *10*(6), 473. https://doi.org/10.3390/f10060473

Amalia, M., & Syahril, S. (2016). *Overview of the Payment for Ecosystem Services Implementation in Indonesia*. WorldFish (ICLARM)—Economy and Environment Program for Southeast Asia (EEPSA). http://www.eepseapartners.org/overview-of-the-payment-for-ecosystem-services-implementation-in-indonesia/

Amin, A., Choumert-Nkolo, J., Combes, J. L., Combes Motel, P., Kéré, E. N., Ongono-Olinga, J. G., & Schwartz, S. (2019). Neighborhood effects in the Brazilian Amazônia: Protected areas and deforestation. *Journal of Environmental Economics and Management*, *93*, 272–288. https://doi.org/10.1016/j.jeem.2018.11.006

AP News. (2020, May 2). *Guyana says it has received $60 million in oil revenues*. https://apnews.com/article/ff185b2166a90c93ba26bdc48756ba40

Araujo, C., Bonjean, C. A., Combes, J. L., Combes Motel, P., & Reis, E. J. (2009). Property rights and deforestation in the Brazilian Amazon. *Ecological Economics*, *68*(8–9), 2461–2468. https://doi.org/10.1016/j.ecolecon.2008.12.015

Arima, E. Y., Barreto, P., Araújo, E., & Soares-Filho, B. (2014). Public policies can reduce tropical deforestation: Lessons and challenges from Brazil. *Land Use Policy*, *41*, 465–473. https://doi.org/10.1016/j.landusepol.2014.06.026

ART Secretariat. (2021). *The REDD+ Environmental Excellence Standard (TREES), Version 2.0* (p. 84). Winrock International. https://www.artredd.org/wp-content/uploads/2021/01/TREES-2.0-Public-Consultation-Version-Feb-2021.pdf

Avitabile, V., Herold, M., Lewis, S. L., Phillips, O. L., Aguilar-Amuchastegui, N., Asner, G. P., Brienen, R. J. W., DeVries, B. R., Gatti, R. G., Feldpausch, T. R., Girardin, C., Jong, B. de, Kearsley, E., Klop, E., Lin, X., Lindsell, J., Lopez-Gonzalez, G., Lucas, R., Malhi, Y., … Willcock, S. (2014). Comparative analysis and fusion for improved global biomass mapping. Global Vegetation Monitoring and Modeling, 251–252.

Avitabile, V., Herold, M., Heuvelink, G. B. M., Lewis, S. L., Phillips, O. L., Asner, G. P., Armston, J., Ashton, P. S., Banin, L., Bayol, N., Berry, N. J., Boeckx, P., de Jong, B. H. J., Devries, B., Girardin, C. A. J., Kearsley, E., Lindsell, J. A., Lopez-Gonzalez, G., Lucas, R., … Willcock, S. (2016). An integrated pan-tropical biomass map using multiple reference datasets. *Global Change Biology*, *22*(4), 1406–1420. https://doi.org/10.1111/gcb.13139

Azevedo, A. A., Rajão, R., Costa, M. A., Stabile, M. C. C., Macedo, M. N., Dos Reis, T. N. P., Alencar, A., Soares-Filho, B. S., & Pacheco, R. (2017). Limits of Brazil's Forest Code as a means to end illegal deforestation. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(29), 7653–7658. https://doi.org/10.1073/pnas.1604768114

Baccini, A., Walker, W., Carvalho, L., Farina, M., Sulla-Menashe, D., & Houghton, R. A. (2017). Tropical forests are a net carbon source based on aboveground measurements of gain and loss. *Science*. https://doi.org/10.1126/science.aam5962

Beevers, M. D. (2016). Forest governance and post-conflict peace in Liberia: Emerging contestation and opportunities for change? *Extractive Industries and Society*, *3*(2), 320–328. https://doi.org/10.1016/j.exis.2015.07.007

Behrendt, H., Megevand, C., & Sander, K. (2013). Deforestation Trends in the Congo Basin: Reconciling Economic Growth and Forest Protection, Working Paper 5: Wood-based Biomass Energy. World Bank.

Bermejo, M. (1999). Status and conservation of primates in Odzala National Park, Republic of the Congo. *ORYX*. https://doi.org/10.1017/s0030605300030726

Biodiversity Indicators Partnership. (2011). *Guidance for national biodiversity indicator development and use*. www.bipnational.net.

Brearley, F. Q., Prajadinata, S., Kidd, P. S., Proctor, J., & Suriantata. (2004). Structure and floristics of an old secondary rain forest in Central Kalimantan, Indonesia, and a comparison with adjacent primary forest. *Forest Ecology and Management*. https://doi.org/10.1016/j.foreco.2004.02.048

Brummett, R., Tanania, C., Pandi, A., Ladel, J., Munzimi, Y., Russell, A., Stiassny, M., Thieme, M., White, S., & Davies, D. (2008). Water resources, forests and ecosystem goods and services. In C. de Wasseige, D. Devers, P. de Marcken, R. E. Atyi, R. Nasi, & P. Mayaux (Eds.), *Congo Basin Forests - State of the Forest 2008*. Publications Office of the European Union.

Busch, J., Kapur, A., & Mukherjee, A. (2020). Did India's ecological fiscal transfers incentivize state governments to increase their forestry budgets? *Environmental Research Communications*, *2*(3), 031006. https://doi.org/10.1088/2515-7620/ab817c

Busch, J., & Mukherjee, A. (2018). Encouraging State Governments to Protect and Restore Forests Using Ecological Fiscal Transfers: India's Tax Revenue Distribution Reform. *Conservation Letters*, *11*(2), 1–10. https://doi.org/10.1111/conl.12416

Cannon, J. C. (2016, February 11). *Republic of Congo awards two million hectares of timber concessions*. Mongabay. https://news.mongabay.com/2016/02/republic-of-congo-awards-two-million-hectares-of-timber-concessions/

Cannon, J. C. (2019, July 18). *Congo government opens Nouabalé-Ndoki National Park to oil exploration*. Mongabay. https://news.mongabay.com/2019/07/congolese-government-opens-nouabale-ndoki-national-park-to-oil-exploration/

Cavanagh, C. J. (2018). Enclosure, dispossession, and the green economy: new contours of internal displacement in Liberia and Sierra Leone? *African Geographical Review*, *37*(2), 120–133. https://doi.org/10.1080/19376812.2017.1350989

CDC Biodiversity. (2017). *Global Biodiversity Score: measuring a company's biodiversity footprint. November*. https://www.globio.info/global-biodiversity-score

Center for Forestry Planning and Statistics Ministry of Forestry. (2009). *Indonesia Forestry Outlook Study.* http://www.fao.org/3/am608e/am608e00.pdf

CEPF. (2004). *Caucasus Biodiversity Hostpot Ecosystem Profile.* https://www.cepf.net/sites/default/files/final.caucasus.ep_.pdf

CEPF. (2015). *Guinean Forests of West Africa Biodiversity Hotspot.* https://www.cepf.net/sites/default/files/en_guinean_forests_ecosystem_profile.pdf

Chaplin-Kramer, R., Ramler, I., Sharp, R., Haddad, N. M., Gerber, J. S., West, P. C., Mandle, L., Engstrom, P., Baccini, A., Sim, S., Mueller, C., & King, H. (2015). Degradation in carbon stocks near tropical forest edges. *Nature Communications.* https://doi.org/10.1038/ncomms10158

CIA. (2020). *CIA World Factbook: Indonesia.* https://www.cia.gov/library/publications/the-world-factbook/geos/id.html

Climate Watch. (2020). World Resources Institute. https://www.climatewatchdata.org

Cobb, S. (2010). *FCPF: Review of R-PP of Republic of Congo.* https://www.forestcarbonpartnership.org/system/files/documents/Republic_Congo_R-PP_TAP_Synthesis_review_June_14_2010.pdf

Comini, I. B., Gonçalves Jacovine, L. A., Zanuncio, J. C., & Lima, G. S. (2019). Contribution of conservation units to Ecological ICMS generation for municipalities and environmental conservation. *Land Use Policy*, *86*, 322–327. https://doi.org/10.1016/j.landusepol.2019.05.015

Conservation International. (2017). *Liberia: Mapping Natural Capital.*

Convention on Biological Diversity. (2018). *Decision 14/22. Resource mobilization.*

Convention on Biological Diversity. (2020). *Update of the Zero Draft of the Post-2020 Global Biodiversity Framework*, Note by the Co-Chairs, CBD/POST2020/PREP/2/1, 17 August 2020.

Counsell, S. (2018). *The Congo's Nouabalé-Ndoki National Park: How Indigenous Lands Became an Emblem of Rooseveltian "Wilderness Conservation" in Africa.* CorneredbyPAs.com

Curran, L. M., Trigg, S. N., Mcdonald, A. K., Astiani, D., Hardiono, Y. M., Siregar, P., Caniago, I., & Kasischke, E. (2004). Lowland Forest Loss in Protected Areas of Indonesian Borneo. *Science*, *303*(February), 1000–1003. https://doi.org/10.1126/science.1091714

da Fonseca, G. A. B., Rodriguez, C. M., Midgley, G., Busch, J., Hannah, L., & Mittermeier, R. A. (2007). No Forest Left Behind. *PLoS Biology*, *5*(8), e216. https://doi.org/10.1371/journal.pbio.0050216

Darajati, W., Pratiwi, S., Herwinda, E., Radiansyah, A. D., Nalang, V. S., Nooryanto, B., Rahajoe, J. S., Ubaidillah, R., Maryanto, I., Kurniawan, R., Prasetyo, T. A., Rahim, A., Jefferson, J., & Hakim, F. (2016). *Indonesian Biodiversity Strategy and Action Plan (IBSAP) 2015-2020.* https://www.cbd.int/doc/world/id/id-nbsap-v3-en.pdf

Dargie, G. C., Lawson, I. T., Rayden, T. J., Miles, L., Mitchard, E. T. A., Page, S. E., Bocko, Y. E., Ifo, S. A., & Lewis, S. L. (2019). Congo Basin peatlands: threats and conservation priorities. *Mitigation and Adaptation Strategies for Global Change*, *24*(4), 669–686. https://doi.org/10.1007/s11027-017-9774-8

Dargie, G. C., Lewis, S. L., Lawson, I. T., Mitchard, E. T. A., Page, S. E., Bocko, Y. E., & Ifo, S. A. (2017). Age, extent and carbon storage of the central Congo Basin peatland complex. *Nature.* https://doi.org/10.1038/nature21048

Dasgupta, P. (2021). *The economics of biodiversity: the Dasgupta review.* HM Treasury.

de Groot, R., Brander, L., van der Ploeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein, L., Hussain, S., Kumar, P., McVittie, A., Portela, R., Rodriguez, L. C., ten Brink, P., & van Beukering, P. (2012). Global estimates of the value of ecosystems and their services in monetary units. *Ecosystem Services.* https://doi.org/10.1016/j.ecoser.2012.07.005

de Paulo, F. L. L., & Sobral Camões, P. J. (2019). The adoption of ecological fiscal transfers: An empirical analysis. *Land Use Policy*, *88*, 104202. https://doi.org/10.1016/j.landusepol.2019.104202

de Rozario, J. (2020). *Assessment of policies on non-timber forest products.* https://ntfp.org/wp-content/uploads/2020/10/NTFP_PolicyStudy-Indonesia-Final.pdf

de Wasseige, C., de Marcken, P., Bayol, N., Hiol-Hiol, F., Mayaux, P., Desclée, B., Nasi, R., Billand, A., Defourny, P., & Eba'a Atyi, R. (Eds.). (2012). *The Forests of the Congo Basin - State of the Forest 2010.* Publications Office of the European Union. https://doi.org/10.2788/47210

Deutz, A., Heal, G. M., Niu, R., Swanson, E., Townshend, T., Zhu, L., Delmar, A., Meghji, A., Sethi, S. A., & Tobin-de la Puente, J. (2020). *Financing Nature: Closing the global biodiversity financing gap.*

Dinerstein, E., Vynne, C., Sala, E., Joshi, A. R., Fernando, S., Lovejoy, T. E., Mayorga, J., Olson, D., Asner, G. P., Baillie, J. E. M., Burgess, N. D., Burkart, K., Noss, R. F., Zhang, Y. P., Baccini, A., Birch, T., Hahn, N., Joppa, L. N., & Wikramanayake, E. (2019). A Global Deal for Nature: Guiding principles, milestones, and targets. *Science Advances*, *5*(4), 1–18. https://doi.org/10.1126/sciadv.aaw2869

Droste, N., Ring, I., Santos, R., & Kettunen, M. (2018). Ecological Fiscal Transfers in Europe – Evidence-Based Design Options for a Transnational Scheme. *Ecological Economics*, *147*, 373–382. https://doi.org/10.1016/j.ecolecon.2018.01.031

Droste, Nils, Lima, G. R., May, P. H., & Ring, I. (2017). Municipal Responses to Ecological Fiscal Transfers in Brazil: A microeconometric panel data approach. *Environmental Policy and Governance*, *27*(4), 378–393. https://doi.org/10.1002/eet.1760

Duchelle, A. E., Cromberg, M., Gebara, M. F., Guerra, R., Melo, T., Larson, A., Cronkleton, P., Börner, J., Sills, E., Wunder, S., Bauch, S., May, P., Selaya, G., & Sunderlin, W. D. (2014). Linking Forest Tenure Reform, Environmental Compliance, and Incentives: Lessons from REDD+ Initiatives in the Brazilian Amazon. *World Development*, *55*, 53–67. https://doi.org/10.1016/j.worlddev.2013.01.014

Ellenbroek, A. (1996). Rainforests of the Guyana Shield: Evergreen or Forever Gone? In S. voor N. Bosbouw-Ontwikkelings (Ed.), *The Guyana Shield: Recent Developments and Alternatives for Sustainable Development* (BOS Nieuws).

Ellison, D., Morris, C. E., Locatelli, B., Sheil, D., Cohen, J., Murdiyarso, D., Gutierrez, V., Noordwijk, M. van, Creed, I. F., Pokorny, J., Gaveau, D., Spracklen, D. V., Tobella, A. B., Ilstedt, U., Teuling, A. J., Gebrehiwot, S. G., Sands, D. C., Muys, B., Verbist, B., … Sullivan, C. A. (2017). Trees, forests and water: Cool insights for a hot world. *Global Environmental Change*, *43*, 51–61. https://doi.org/10.1016/j.gloenvcha.2017.01.002

ENPI East FLEG II. (2014). *Forest Dependency in Rural Georgia.* http://www.enpi-fleg.org/site/assets/files/1882/forest_dependency_georgia.pdf

EPA. (2018). *Greenhouse Gas Emissions from a Typical Passenger Vehicle.* Green Vehicle Guide. https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle#:~:text=typical passenger vehicle%3F-,A typical passenger vehicle emits about 4.6 metric tons of,8%2C887 grams of CO2.

FAO. (2013). *Global Ecological Zones (second edition).* http://www.fao.org/geonetwork/srv/en/main.home?uuid=2fb209d0-fd34-4e5e-a3d8-a13c241eb61b

FAO. (2015). *Country profile – Guyana.*

FAO. (2019). *GLOSIS-GSOCmap (v1.5.0) Global Soil Organic Carbon (GSOC) Map.* Global Soil Partnership, Food and Agriculture Organization of the United Nations.

FAO. (2020a). *Biodiversity Integrated Assessment and Computation Tool | B-INTACT – Guidelines.* https://doi.org/10.4060/ca8762en

FAO. (2020b). Ex-Ante Carbon-balance Tool for biodiversity – Guidelines. https://doi.org/10.4060/ca8762en

FAO. (2020c). *Global Forest Resources Assessment 2020 - Main report.* Food and Agriculture Organization of the United Nations (FAO). https://doi.org/10.4060/ca9825en

Faust, C. L., McCallum, H. I., Bloomfield, L. S. P., Gottdenker, N. L., Gillespie, T. R., Torney, C. J., Dobson, A. P., & Plowright, R. K. (2018). Pathogen spillover during land conversion. *Ecology Letters*, *21*, 471–483. https://doi.org/https://doi.org/10.1111/ele.12904

FORESTHINT.NEWS. (2021, April 29). *Indonesia's national focal point to UNFCCC takes stance on the LEAF Coalition.* https://foresthints.news/indonesia-national-focal-point-to-unfccc-takes-stance-on-the-leaf-coalition/

Forest Code of Georgia, (2020). https://matsne.gov.ge/en/document/view/4874066?publication=0

Forest Department. (2014). *National Biodiversity Strategy and Action Plan of Georgia.* https://www.cbd.int/doc/world/gy/gy-nbsap-v3-en.pdf

Forest Watch Indonesia. (2014, December 10). *Potret Keadaan Hutan Indonesia (State of Indonesia's Forest) 2009-2013.* YouTube. https://www.youtube.com/watch?v=zldFxUHTedM&ab_channel=ForestWatchIndonesia

Fortmann, L., Sohngen, B., & Southgate, D. (2017). Assessing the role of group heterogeneity in community forest concessions in Guatemala's Maya Biosphere Reserve. *Land Economics*, *93*(3). https://doi.org/10.3368/le.93.3.503

Fripp, E. (2014). *Payments for Ecosystem Services (PES): A practical guide to assessing the feasibility of PES projects.* Center for International Forestry Research (CIFOR). https://pdfs.semanticscholar.org/0a38/a1a39391d08f47715a6b1b3433e7a83745eb.pdf

Funk, J. M., Aguilar-Amuchastegui, N., Baldwin-Cantello, W., Busch, J., Chuvasov, E., Evans, T., Griffin, B., Harris, N., Ferreira, M. N., Petersen, K., Phillips, O., Soares, M. G., & van der Hoff, R. J. A. (2019). Securing the climate benefits of stable forests. *Climate Policy*, *19*(7), 845–860. https://doi.org/10.1080/14693062.2019.1598838

FWI/GFW. (2002). The State of the Forest: INDONESIA. In *Indonesia Bogor Indonesia Forest Watch Indonesia and Washington DC Global Forest Watch.*

Gedalof, Z., & Berg, A. A. (2010). Tree ring evidence for limited direct CO2 fertilization of forests over the 20th century. *Global Biogeochemical Cycles*, *24*(3). https://doi.org/10.1029/2009GB003699

Geegbae Dukuky, F. J., & Wreh, D.-F. (2018). *Analytical Research of Liberia's National Policy on Decentralization & Local Governance and Its Alignment with the Pro-Poor Agenda for Prosperity and Development.* https://limpac.org/wp-content/uploads/2019/05/NPDLG-PAPD-RESEARCH-ANALYSIS-REPORT.pdf

Geldmann, J., Manica, A., Burgess, N. D., Coad, L., & Balmford, A. (2020). Correction for "A global-level assessment of the effectiveness of protected areas at resisting anthropogenic pressures." *Proceedings of the National Academy of Sciences*, *117*(41), 25945–25945. https://doi.org/10.1073/pnas.2018968117

Georgia Today. (2020, June 4). *Why Georgia's Forest Code is a Progressive Step Forward.* http://georgiatoday.ge/news/21400/Why-Georgia%27s-Forest-Code-is-a-Progressive-Step-Forward

Geostat. (2020). *Gross Domestic Product (GDP).* National Statistics Office of Georgia. https://www.geostat.ge/en/modules/categories/23/gross-domestic-product-gdp

GFW. (2020a). *Global Forest Watch: Georgia Dashboard.* https://www.globalforestwatch.org/dashboards/country/GEO/

GFW. (2020b). *Global Forest Watch: Liberia Dashboard.* https://www.globalforestwatch.org/dashboards/country/LBR

GFW. (2020c). *Global Forest Watch: Republic of Congo Dashboard.* https://www.globalforestwatch.org/dashboards/country/COG/

Global Witness. (2018). *Power to the people? How companies are exploiting community forestry in Liberia* (Issue October).

Government of Guyana. (2015). *The Reference Level for Guyana's REDD+ Program.*

Government of Guyana. (2016). *Guyana's Revised Intended Nationally Determined Contribution.* https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Guyana First/Guyana%27s revised NDC - Final.pdf

Government of Liberia. (2019). *Liberia's Forest Reference Emission Level Submission to the UNFCCC.*

Graham, P. (2017). *Cooperative Approaches for Supporting REDD+: Linking Articles 5 and 6 of the Paris Agreement.* https://www.climateadvisers.com/wp-content/uploads/2013/12/Linking-Art5-and-Art6-2.pdf

Greengrass, E. (2016). Commercial hunting to supply urban markets threatens mammalian biodiversity in Sapo National Park, Liberia. *ORYX*, *50*(3), 397–404. https://doi.org/10.1017/S0030605315000095

Griscom, B. W., Busch, J., Cook-Patton, S. C., Ellis, P. W., Funk, J., Leavitt, S. M., Lomax, G., Turner, W. R., Chapman, M., Engelmann, J., Gurwick, N. P., Landis, E., Lawrence, D., Malhi, Y., Murray, L. S., Navarrete, D., Roe, S., Scull, S., Smith, P., … Worthington, T. (2020). National mitigation potential from natural climate solutions in the tropics. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1794). https://doi.org/10.1098/rstb.2019.0126

Hamrick, K. (2016). *State of Private Investment in Conservation 2016; A Landscape Assessment of an Emerging Market* . https://www.forest-trends.org/wp-content/uploads/2017/03/2016SOPICReport_FINAL_Full-REV.pdf

Hansen, A., Barnett, K., Jantz, P., Phillips, L., Goetz, S. J., Hansen, M., Venter, O., Watson, J. E. M., Burns, P., Atkinson, S., Rodríguez-Buritica, S., Ervin, J., Virnig, A., Supples, C., & De Camargo, R. (2019). Global humid tropics forest structural condition and forest structural integrity maps. *Scientific Data*, *6*(1), 232. https://doi.org/10.1038/s41597-019-0214-3

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., Thau, D., Stehman, S. V., Goetz, S. J., Loveland, T. R., Kommareddy, A., Egorov, A., Chini, L., Justice, C. O., & Townshend, J. R. G. (2013). High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, *342*(6160), 850–853. https://doi.org/10.1126/SCIENCE.1244693

Harenda, K. M., Lamentowicz, M., Samson, M., Chojnicki, B. H., Harenda, K. M., Samson, Á. M., Chojnicki, Á. B. H., & Lamentowicz, M. (2018). The Role of Peatlands and Their Carbon Storage Function in the Context of Climate Change. *Springer, 9783319717876*, 169–187. https://doi.org/10.1007/978-3-319-71788-3_12

Hasnain, Z., Bteddini, L., Kishor, N., Kay, K., & Somani, R. (2020). *Liberia Forestry Development Authority: An Institutional Capacity Assessment.* https://www.profor.info/sites/profor.info/files/Liberia-Forestry-Development-Authority-An-Institutional-Capacity-Assessment.pdf

Hayes, T. M. (2006). Parks, People, and Forest Protection: An Institutional Assessment of the Effectiveness of Protected Areas. *World Development*, *34*(12), 2064–2075. https://doi.org/10.1016/j.worlddev.2006.03.002

Hergoualc'h, K., Atmadja, S., Carmenta, R., Martius, C., Murdiyarso, D., Purnomo, H., (2018). Managing peatlands in Indonesia: Challenges and opportunities for local and global communities. In *Managing peatlands in Indonesia: Challenges and opportunities for local and global communities.* https://doi.org/10.17528/cifor/006449

Hubau, W., Lewis, S. L., Phillips, O. L., Affum-Baffoe, K., Beeckman, H., Cuní-Sanchez, A., Daniels, A. K., Ewango, C. E. N., Fauset, S., Mukinzi, J. M., Sheil, D., Sonké, B., Sullivan, M. J. P., Sunderland, T. C. H., Taedoumg, H., Thomas, S. C., White, L. J. T., Abernethy, K. A., Adu-Bredu, S., … Zemagho, L. (2020). Asynchronous carbon sink saturation in African and Amazonian tropical forests. *Nature.* https://doi.org/10.1038/s41586-020-2035-0

Ibisch, P. L., Hoffmann, M. T., Kreft, S., Pe'Er, G., Kati, V., Biber-Freudenberger, L., DellaSala, D. A., Vale, M. M., Hobson, P. R., & Selva, N. (2016). A global map of roadless areas and their conservation status. *Science*, *354*(6318), 1423–1427. https://doi.org/10.1126/science.aaf7166

Ifo, S. A., Moutsambote, J. M., Koubouana, F., Yoka, J., Ndzai, S. F., Bouetou-Kadilamio, L. N. O., Mampouya, H., Jourdain, C., Bocko, Y., Mantota, A. B., Mbemba, M., Mouanga-Sokath, D., Odende, R., Mondzali, L. R., Wenina, Y. E. M., Ouissika, B. C., & Joel, L. J. (2016). Tree Species Diversity, Richness, and Similarity in Intact and Degraded Forest in the Tropical Rainforest of the Congo Basin: Case of the Forest of Likouala in the Republic of Congo. *International Journal of Forestry Research.* https://doi.org/10.1155/2016/7593681

IMF Country Report 20/26. (2020). *Republic of Congo.* https://doi.org/10.5089/9781513530994.002

IPCC. (2006). Chapter 4: Forest Land. In *2006 IPCC Guidelines for National Greenhouse Gas Inventories.*

IPCC. (2010). *Revisiting the Use of Managed Land as a Proxy for Estimating National Anthropogenic Emissions and Removals: IPCC Expert Meeting Report* (H. S. Eggleston, N. Srivastava, K. Tanabe, & J. Baasansuren (Eds.)). Institute for Global Environmental Strategies. http://www.ipcc-nggip.iges.or.jp

IPCC. (2018). Summary for Policymakers. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, L. E., T. Maycock, M. Tignor, & W. T. (Eds.), *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.* World Meteorological Organization.

IPCC. (2019a). Chapter 4: Forest Land. In *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* (P. R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P.

Vyas, E. Huntley, … M. J. (Eds.)). IPCC. https://doi.org/10.4337/9781784710644

IUCN, & UNEP-WCMC. (2014). The World Database on Protected Areas (WDPA). In *Available at: www.protectedplanet.net.*

Iversen, P., Lee, D., & Rocha, M. (2014). *Understanding land use in the UNFCCC* (May Issue).

Janský, P., & Palanský, M. (2020). Fiscal decentralization and equalization transfers in Georgia: evidence from municipality-level data. *Post-Communist Economies*, *32*(1), 54–76. https://doi.org/10.1080/14631377.2019.1640992

Jha, S., & Bawa, K. S. (2006). Population growth, human development, and deforestation in biodiversity hotspots. *Conservation Biology.* https://doi.org/10.1111/j.1523-1739.2006.00398.x

Johnson, S. (2015). *A National Biodiversity Offset Scheme: A Road Map for Liberia's Mining Sector.* http://www.biodiversityoffsets.net/wp-content/uploads/2015/03/A-National-Biodiversity-Offset-Scheme-for-Liberia.pdf

Johnston, M. (1997). Tree population studies in low-diversity forests, Guyana. II. Assessments on the distribution and abundance of non-timber forest products. *Biodiversity and Conservation.* https://doi.org/10.1023/A:1008859713118

Juffe-Bignoli, D., Bhatt, S., Park, S., Eassom, A., Belle, E. M. S., Murti, R., Buyck, C., Raza Rizvi, A., Rao, M., Lewis, E., MacSharry, B., & Kingston, N. (2014). *Asia Protected Planet Report 2014: Tracking progress towards targets for protected areas in Asia.*

Kessler, M., Keßler, P. J. A., Gradstein, S. R., Bach, K., Schmull, M., & Pitopang, R. (2005). Tree diversity in primary forest and different land use systems in Central Sulawesi, Indonesia. *Biodiversity and Conservation.* https://doi.org/10.1007/s10531-004-3914-7

Kissinger, G. (2015). Fiscal incentives for agricultural commodity production: Options to forge compatability with REDD+. In *UN-REDD Programme Policy Brief* (No. 7; Policy Brief, Issue 7).

Lange, G.-M., Wodon, Q., & Carey, K. (2018). *The Changing Wealth of Nations 2018 : Building a Sustainable Future.* World Bank. https://doi.org/10.1596/978-1-4648-1046-6

Law No. 32/2009 Environmental Protection and Management, (2009). http://extwprlegs1.fao.org/docs/pdf/ins97643.pdf

Lawrence, D. C., Leighton, M., & Peart, D. R. (1995). Availability and Extraction of Forest Products in Managed and Primary Forest around a Dayak Village in West Kalimantan, Indonesia. *Conservation Biology.* https://doi.org/10.1046/j.1523-1739.1995.09010076.x

Liberia and the European Union. (2014). *Joint Annual Report 2014.* https://www.euflegt.efi.int/documents/10180/211477/Liberia+and+the+EU+Joint+Annual+Report+2014/f77e2e36-989d-4672-9bc1-57c8ed38b8e0

Lima de Paulo, F. L., & Camões, P. J. S. (2019). Ecological Fiscal Transfers for Biodiversity Conservation Policy: A Transaction Costs Analysis of Minas Gerais, Brazil. *Ecological Economics*, *166*, 106425. https://doi.org/10.1016/j.ecolecon.2019.106425

Linacre, N., O'Sullivan, R., Rocha, M. T., Greenhalgh, S., & Ross, D. (2015). *Supporting REDD + in Developing Countries : A Review of Policy Options. April*, 129.

Locatelli, B., & Vignola, R. (2009). Managing watershed services of tropical forests and plantations: Can meta-analyses help? *Forest Ecology and Management*, *258*(9), 1864–1870. https://doi.org/10.1016/j.foreco.2009.01.015

Lovera, M. (2008). Forest and the Biodiversity Convention: Independent Monitoring of the Implementation of the Expanded Programme of Work. *Global Forest Coalition, Amsterdam.*

Luyssaert, S., Schulze, E. D., Börner, A., Knohl, A., Hessenmöller, D., Law, B. E., Ciais, P., & Grace, J. (2008). Old-growth forests as global carbon sinks. *Nature.* https://doi.org/10.1038/nature07276

MacArthur, R., & Wilson, E. (2001). *The theory of island biogeography.* Princeton University Press.

Margono, B. A., Potapov, P. V., Turubanova, S., Stolle, F., & Hansen, M. C. (2014). Primary forest cover loss in indonesia over 2000-2012. In *Nature Climate Change.* https://doi.org/10.1038/nclimate2277

Matcharashvili, I. (2012). *Problems and Challenges of Forest Governance in Georgia.* http://www.greenalt.org/webmill/data/file/publications/Report_Forest_1.pdf

Maxwell, S. L., Evans, T., Watson, J. E. M., Morel, A., Grantham, H., Duncan, A., Harris, N., Potapov, P., Runting, R. K., Venter, O., Wang, S., & Malhi, Y. (2019). Degradation and forgone removals increase the carbon impact of intact forest loss by 626%. *Science Advances, 5*(10), eaax2546. https://doi.org/10.1126/sciadv.aax2546

McFarland, W., Whitley, S., & Kissinger, G. (2015). *Subsidies to key commodities driving forest loss. Implications for private climate finance* (Issue March). www.odi.org

McKinsey & Company. (2020). *Valuing nature conservation.* 49.

Mecca, B., Mafira, T., Muluk, S., & Larasati, L. (2020). *Indeks Desa Membangun Plus (IDM+): Enhancing Direct Incentives for Sustainable Land Use.* Climate Policy Initiative. https://www.climatepolicyinitiative.org/wp-content/uploads/2020/11/Indeks-Desa-Membangun-Plus-IDM_full-report.pdf

Metreveli, K. (2002). *Forest and Forest Products Country Profile: Georgia* (No. 26; Geneva Timber and Forest Discussion Papers). http://www.unece.org/fileadmin/DAM/timber/docs/dp/dp-26.pdf

Michaelowa, A., Espelage, A., & Müller, B. (2019). *Negotiating cooperation under Article 6 of the Paris Agreement.* www.ecbi.org

Miles, L., Ravilious, C., Garcia-Rangel, S., de Lamo, X., Darie, G., & Lewis, S. (2017). Carbon, biodiversity and land-use in the Central Congo Basin Peatlands. *Global Change Biology.*

Millennium Ecosystem Assessment. (2003). *Ecosystems and human well-being: a framework for assessment.* https://doi.org/10.5860/choice.41-4645

Ministry of Environment and Natural Resources Protection of Georgia. (2015). *Georgia's Intended Nationally Determined Contribution Submission to the UNFCCC.* UNFCCC. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Georgia First/INDC_of_Georgia.pdf

Liberia Ministry of Finance and Development Planning. (2020). *National Budget Fiscal Year 2020/2021.*

Ministry of Forest Economy. (2016). *Participatory Self-Assessment of the REDD+ Readiness Package in the Republic of the Congo: Final Report.* https://www.forestcarbonpartnership.org/system/files/documents/R-Package Congo final version EN edited_0.pdf

Ministry of Natural Resources. (2020, September 8). *Statement by the Minister of Natural Resources Hon. Vickram Bharrat, M.P., on Guyana's 18th Offshore Oil Discovery at the Redtail-1 exploration well – Ministry of Natural Resources.* Minister's Speeches. https://nre.gov.gy/2020/09/08/statement-by-the-minister-of-natural-resources-hon-vickram-bharrat-m-p-on-guyanas-18th-offshore-oil-discovery-at-the-redtail-1-exploration-well/

MoEF. (2016). *National Forest Reference Emission Level for Deforestation and Forest Degradation: In the Context of Decision 1/CP.16 para 70 UNFCCC (Encourages developing country Parties to contribute to mitigation actions in the forest sector), Directorate General of C.*

Mukpo, A. (2019, January 23). Liberia's community forestry becoming a front for deforestation: Report. *Mongabay: Global Forests Series.* https://news.mongabay.com/2019/01/liberias-community-forestry-becoming-a-front-for-deforestation-report/

Murdiyarso, D., Dewi, S., Lawrence, D., & Seymour, F. (2011). Indonesia's Forest Moratorium: A Stepping Stone to Better Forest Governance? In *Working Paper.*

Nepstad, D., McGrath, D., Stickler, C., Alencar, A., Azevedo, A., Swette, B., Bezerra, T., DiGiano, M., Shimada, J., Da Motta, R. S., Armijo, E., Castello, L., Brando, P., Hansen, M. C., McGrath-Horn, M., Carvalho, O., & Hess, L. (2014). Slowing Amazon deforestation through public policy and interventions in beef and soy supply chains. In *Science.* https://doi.org/10.1126/science.1248525

Netzer, M., Srinivasan, R., Harris, N., Goslee, K., & Brown, S. (2014). *Incorporating Water Quality as a Cobenefit of Guyana's REDD+ Framework.*

Neugarten, R. A., Moull, K., Martinez, N. A., Andriamaro, L., Bernard, C., Bonham, C., Cano, C. A., Ceotto, P., Cutter, P., Farrell, T. A., Gibb, M., Goedschalk, J., Hole, D., Honzák, M., Kasecker, T., Koenig, K., Larsen, T. H., Ledezma, J. C., McKinnon, M., … Turner, W. (2020). Trends in protected area representation of biodiversity and ecosystem services in five tropical countries. *Ecosystem Services.* https://doi.org/10.1016/j.ecoser.2020.101078

Neugarten, R., Alam, M., Martinez, N. A., Honzak, M., Juhn, D., Larsen, T., Moull, K., Rodriguez, A. M., Wright, T. M., Walsh, L., Donovan, J., Mulbah, P., Valenza, J., Reuter, K., Portela, R., Wade, S., Hole, D., Peralvo, M., Silver, J., & Junker, J. (2017). *Natural Capital Mapping and Accounting in Liberia: Understanding the contribution of biodiversity and ecosystem services to Liberia's sustainable development* (May Issue). https://www.researchgate.net/publication/321304662_Natural_Capital_Mapping_and_Accounting_in_Liberia_Understanding_the_contribution_of_biodiversity_and_ecosystem_services_to_Liberia's_sustainable_development

Neugarten, R., Moull, K., Martinez, N. A., Andriamaro, L., Bernard, C., Bonham, C., Cano, C. A., Ceotto, P., Cutter, P., Farrell, T. A., Gibb, M., Goedschalk, J., Hole, D., Honzák, M., Kasecker, T., Koenig, K., Larsen, T. H., Ledezma, J. C., McKinnon, M., … Turner, W. (2020). Trends in protected area representation of biodiversity and ecosystem services in five tropical countries. *Ecosystem Services, 42,* 101078. https://doi.org/10.1016/j.ecoser.2020.101078

Ningsih, I. K., Ingram, V., & Savilaakso, S. (2020). Voluntary Sustainability Certification and State Regulations: Paths to Promote the Conservation of Ecosystem Services? Experiences in Indonesia. *Forests, 11*(5), 503. https://doi.org/10.3390/f11050503

Nordhaus, W. D. (2017). Revisiting the social cost of carbon. *Proceedings of the National Academy of Sciences of the United States of America, 114*(7), 1518–1523. https://doi.org/10.1073/pnas.1609244114

O'Sullivan, R. (2020). Can cooperation on REDD+ under Article 6 of the Paris Agreement start now, or is further guidance needed? In *Forest Solutions Dialogue Brief* (Issue June). Climate Advisors Trust.

Oakes, N., Leggett, M., Cranford, M., & Vickers, H. (2012). *The Little Forest Finance Book.* www.globalcanopy.org

OECD. (2013). Scaling-up finance mechanisms for biodiversity. In *Scaling-up Finance Mechanisms for Biodiversity.* Organisation for Economic Cooperation and Development (OECD) Publishing. https://doi.org/10.1787/9789264193833-en

OECD. (2019a). Chapter 3. The land-use, ecosystems and climate nexus. In *OECD Environmental Performance Reviews, OECD Green Growth Policy Review of Indonesia 2019.*

OECD. (2019b). *The Post-2020 Biodiversity Framework: Targets, indicators and measurability implications at global and national level.* OECD. http://www.oecd.org/environment/resources/biodiversity/report-the-post-2020-biodiversity-framework-targets-indicators-and-measurability-implications-at-global-and-national-level.pdf

Ongere, S. N., Elwell, N., Carr, E. R., Caron, C., & Bebbington, D. (2020). *Who's Governing Community Forests? Gendered Participation in Liberian Forest Management.* https://www.wri.org/publication/whos-governing-community-forests?downloaded=true

Patarkalashvili, T. (2016). Some problems of forest management of Georgia. *Annals of Agrarian Science, 14*(2), 108–113. https://doi.org/10.1016/j.aasci.2016.04.002

Patarkalashvili, T. (2017). Forest biodiversity of Georgia and endangered plant species. *Annals of Agrarian Science, 15*(3), 349–351. https://doi.org/10.1016/j.aasci.2017.06.002

PBAF Netherlands. (2020). *Paving the way towards a harmonised Carbon Accounting Approach for the Financial Sector.* https://www.abnamro.com/en/images/Documents/040_Sustainable_banking/Publications/PCAF_Report_2017.pdf

Pham, T. T., Brockhaus, M., Wong, G., Dung, L. N., Tjajadi, J. S., Loft, L., Luttrell, C., & Assembe Mvondo, S. (2013). *Approaches to benefit sharing: A preliminary comparative analysis of 13 REDD+ countries* (No. 108). http://www.cifor.org/publications/pdf_files/WPapers/WP108Pham.pdf

Phillips, O. L., Malhi, Y., Higuchi, N., Laurance, W. F., Núñez, P. V., Vásquez, R. M., Laurance, S. G., Ferreira, L. V., Stern, M., Brown, S., & Grace, J. (1998). Changes in the carbon balance of tropical forests: Evidence from long-term plots. *Science, 282*(5388), 439–442. https://doi.org/10.1126/science.282.5388.439

Pollini, B., Miles, L., Ravilious, C., & Gosling, J. (2018). *Using spatial analyses to support REDD+ land-use planning in Liberia* (Prepared on Behalf of the UN-REDD Programme). https://doi.org/10.13140/RG.2.2.29309.20966

Potapov, P., Yaroshenko, A., Turubanova, S., Dubinin, M., Laestadius, L., Thies, C., Aksenov, D., Egorov, A., Yesipova, Y., Glushkov, I., Karpachevskiy, M., Kostikova, A., Manisha, A., Tsybikova, E., & Zhuravleva, I. (2008). Mapping the world's intact forest landscapes by remote sensing. *Ecology and Society.* https://doi.org/10.5751/ES-02670-130251

Protected Planet. (2020). *Explore protected areas and OECMs.* IUCN, UNEP-WCMC. https://www.protectedplanet.net/en/search-areas?geo_type=country

RAISG, Ecosciencia, Gaia Amazonas, Instituto Socioambiental, Instituto del Bien Comun, Woods Hole Research Center, Environmental Defense Fund, & COICA. (2017). *Amazonian Indigenous Peoples Territories and Their Forests Related to Climate Change: Analyses and Policy Options.* http://www.edf.org/sites/default/files/indigenous-territories-barrier-to-deforestation.pdf

Republic of Guyana. (2018). *Revised National Policy Statement 2018.*

Republic of Indonesia. (2016a). *First Nationally Determined Contribution Republic of Indonesia.* https://redd.unfccc.int/files/frel_submission_by__indonesia_final.pdf

Republic of Indonesia. (2016b). *National Forest Reference Emission Level for Deforestation and Forest Degradation.* https://redd.unfccc.int/files/frel_submission_by__indonesia_final.pdf

Republic of Liberia. (2017). *National Biodiversity Strategy and Action Plan-ii, 2017-2025.* https://www.cbd.int/doc/world/lr/lr-nbsap-v2-en.pdf

Republic of Liberia. (2018). *Intended Nationally Determined Contributions.* https://www4.unfccc.int/sites/NDCStaging/Pages/Party.aspx?party=LBR

Republic of Liberia. (2019). *Six National Report.*

Republique du Congo. (2020). *Projet de Loi de Finances pour l'annee 2021.* https://www.cabri-sbo.org/en/documents/the-budget-highlights-of-the-budget-statement-and-economic-policy-of-the-government-of-ghana-for-the-2016-financial-year

République du Congo. (2015). *Contribution Prevue Determinee au Niveau National dans le cadre de la CCNUCC .* https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Congo First/NDC_Congo_RAPPORT.pdf

République du Congo. (2017). *NERF de la République du Congo.*

République du Congo. (2018). *Plan National de Développement.*

République du Congo, UNEP, FEM, & MEFDD. (2015). *Stratégie Nationale et Plan d'Actions sur la Diversité Biologique (Révisé).*

Resor, J. P. (1997). Debt-for-nature swaps: a decade of experience and new directions for the future. *Unasylva, 48*(1). http://www.fao.org/3/w3247e/w3247e00.htm#Contents

Resosudarmo, I. A. P., Atmadja, S., Ekaputri, A. D., Intarini, D. Y., Indriatmoko, Y., & Astri, P. (2014). Does Tenure Security Lead to REDD+ Project Effectiveness? Reflections from Five Emerging Sites in Indonesia. *World Development, 55*(C), 68–83. https://econpapers.repec.org/article/eeewdevel/v_3a55_3ay_3a2014_3ai_3ac_3ap_3a68-83.htm

Ring, I. (2008). Integrating local ecological services into intergovernmental fiscal transfers: The case of the ecological ICMS in Brazil. *Land Use Policy, 25*(4), 485–497. https://doi.org/10.1016/j.landusepol.2007.11.001

Robinson, B. E., Holland, M. B., & Naughton-Treves, L. (2014). Does secure land tenure save forests? A meta-analysis of the relationship between land tenure and tropical deforestation. *Global Environmental Change, 29*, 281–293. https://doi.org/10.1016/j.gloenvcha.2013.05.012

Rocha, S. J. S. S. da, Comini, I. B., Morais Júnior, V. T. M. de, Schettini, B. L. S., Villanova, P. H., Alves, E. B. B. M., Silva, L. B., Jacovine, L. A. G., & Torres, C. M. M. E. (2020). Ecological ICMS enables forest restoration in Brazil. *Land Use Policy, 91*, 104381. https://doi.org/10.1016/j.landusepol.2019.104381

Rodriguez, A. M. (2017). *Liberia Policy Review.* http://mappingnaturalcapital.conservation.org.s3.amazonaws.com/Liberia/Appendix 3 Liberia Policy Review.pdf

Roopsind, A., Sohngen, B., & Brandt, J. (2019). Evidence that a national REDD+ program reduces tree cover loss and carbon emissions in a high forest cover, low deforestation country. *Proceedings of the National Academy of Sciences.* https://doi.org/10.1073/pnas.1904027116

Roth, J., Echeverría, D., & Gass, P. (2019). *Current Status of Article 6 of the Paris Agreement: Internationally Transferred Mitigation Outcomes (ITMOs).*

Salzman, J., Bennett, G., Carroll, N., Goldstein, A., & Jenkins, M. (2018). The global status and trends of Payments for Ecosystem Services. *Nature Sustainability.* https://doi.org/10.1038/s41893-018-0033-0

Santoro, M., Beaudoin, A., Beer, C., Cartus, O., Fransson, J. E. S., Hall, R. J., Pathe, C., Schmullius, C., Schepaschenko, D., Shvidenko, A., Thurner, M., & Wegmüller, U. (2015). Forest growing stock volume of the northern hemisphere: Spatially explicit estimates for 2010 derived from Envisat ASAR. Remote Sensing of Environment, 168, 316–334. https://doi.org/10.1016/j.rse.2015.07.005

Santos Rui, R., Ring, I., Antunes, P., & Clemente, P. (2012). Fiscal transfers for biodiversity conservation: The Portuguese Local Finances Law. *Land Use Policy, 29*(2), 261–273. https://doi.org/10.1016/j.landusepol.2011.06.001

Schimel, D., & Manning, M. (2003). *IPCC Meeting on Current Scientific Understanding of the Processes Affecting Terrestrial Carbon Stocks and Human Influences upon Them.* http://ipcc-wg1.ucar.edu/

Seidl, R., Honkaniemi, J., Aakala, T., Aleinikov, A., Angelstam, P., Bouchard, M., Boulanger, Y., Burton, P. J., De Grandpré, L., Gauthier, S., Hansen, W. D., Jepsen, J. U., Jõgiste, K., Kneeshaw, D. D., Kuuluvainen, T., Lisitsyna, O., Makoto, K., Mori, A. S., Pureswaran, D. S., … Senf, C. (2020). Globally consistent climate sensitivity of natural disturbances across boreal and temperate forest ecosystems. *Ecography*, 43(7), 967–978. https://doi.org/10.1111/ecog.04995

Shahzad, U. (2020). Environmental taxes, energy consumption, and environmental quality: Theoretical survey with policy implications. In *Environmental Science and Pollution Research* (Vol. 27, Issue 20, pp. 24848–24862). Springer. https://doi.org/10.1007/s11356-020-08349-4

Siikamaki, J., Piaggio, M., da Silva, N., Alvarez, I., & Chu, Z. (2021). *Global Assessment of Non-wood Forest Ecosystem Services: A Revision of a Spatially Explicit Meta-Analysis and Benefit Transfer*. Final Report to the Changing Wealth of Nations Report by the World Bank.

Siikamäki, J., Santiago-Ávila, F. J., & Vail, P. (2015). *Global Assessment of Nonwood Forest Ecosystem Services.* WAVES Partnership Working Paper.

Silvius, M. J., & Suryadiputra, N. (2005). Review of policies and practices in tropical peat swamp forest management in Indonesia. *Wetlands International.*

Slodowicz, D., Descombes, P., Kikodze, D., Broennimann, O., & Müller-Schärer, H. (2018). Areas of high conservation value at risk by plant invaders in Georgia under climate change. *Ecology and Evolution.* https://doi.org/10.1002/ece3.4005

Soehartono, T., & Mardiastuti, A. (2014). *National Park Governance in Indonesia: Lessons Learned from Seven National Parks.* https://www.researchgate.net/publication/316240950_National_Park_Governance_in_Indonesia_Lessons_Learned_from_Seven_National_Parks

Sohngen, B., & Brown, S. (2004). Measuring leakage from carbon projects in open economies: A stop timber harvesting project in Bolivia as a case study. *Canadian Journal of Forest Research*, *34*(4). https://doi.org/10.1139/x03-249

Sohngen, B., & Mendelsohn, R. (2003). An optimal control model of forest carbon sequestration. *American Journal of Agricultural Economics*, *85*(2). https://doi.org/10.1111/1467-8276.00133

Stiglitz, J. E., & Stern, N. (2017). *Report of the High-Level Commission on Carbon Prices* (I. Pakulski (ed.)). World Bank.

Streck, C., Howard, A., & Rajão, R. (2017). *Options for Enhancing REDD+ Collaboration in the Context of Article 6 of the Paris Agreement.* https://www.climatefocus.com/sites/default/files/REDDOptionsfinalreport.pdf

Suich, H., Lugina, M., Muttaqin, M. Z., Alviya, I., & Sari, G. K. (2017). Payments for ecosystem services in Indonesia. *Oryx*, *51*(3), 489–497. https://doi.org/10.1017/S0030605316000259

Sutiyono, G., Muluk, S., Mafira, T., & Rakhmadi, R. (2018). *Indonesia's Village Fund: An Important Lever for Better Land Use and Economic Growth at the Local Level: A CPI Report March 2018.* https://climatepolicyinitiative.org/wp-content/uploads/2018/04/Indonesia's-Village-Fund-_-An-Important-Lever-for-Better-Land-Use-and-Economic-Growth-at-the-Local-Level.pdf

Suwarno, A., van Noordwijk, M., Weikard, H. P., & Suyamto, D. (2018). Indonesia's forest conversion moratorium assessed with an agent-based model of Land-Use Change and Ecosystem Services (LUCES). *Mitigation and Adaptation Strategies for Global Change.* https://doi.org/10.1007/s11027-016-9721-0

Taufik, M., Minasny, B., Mcbratney, A. B., Van Dam, J. C., Jones, P. D., & Van Lanen, H. A. J. (2020). Human-induced changes in Indonesian peatlands increase drought severity. *Environmental Research Letters.* https://doi.org/10.1088/1748-9326/ab96d4

Ter Steege, H., & Hammond, D. S. (2001). Character convergence, diversity, and disturbance in tropical rain forest in Guyana. *Ecology.* https://doi.org/10.1890/0012-9658(2001)082[3197:CCDADI]2.0.CO;2

Thalmann, D. J. K., Kikodze, D., Khutsishvili, M., Kharazishvili, D., Guisan, A., Broennimann, O., & Müller-Schärer, H. (2015). Areas of high conservation value in Georgia: present and future threats by invasive alien plants. *Biological Invasions.* https://doi.org/10.1007/s10530-014-0774-2

Turubanova, S., Potapov, P. V., Tyukavina, A., & Hansen, M. C. (2018). Ongoing primary forest loss in Brazil, Democratic Republic of the Congo, and Indonesia. *Environmental Research Letters.* https://doi.org/10.1088/1748-9326/aacd1c

Tweh, C. G., Lormie, M. M., Kouakou, C. Y., Hillers, A., Kühl, H. S., & Junker, J. (2015). Conservation status of chimpanzees Pan troglodytes verus and other large mammals in Liberia: A nationwide survey. In *ORYX.* https://doi.org/10.1017/S0030605313001191

Tyukavina, A., Hansen, M. C., Potapov, P. V., Krylov, A. M., & Goetz, S. J. (2016a). Pan-tropical hinterland forests: Mapping minimally disturbed forests. *Global Ecology and Biogeography*, *25*(2), 151–163. https://doi.org/10.1111/geb.12394

Tyukavina, A., Hansen, M. C., Potapov, P. V., Krylov, A. M., & Goetz, S. J. (2016b). Pan-tropical hinterland forests: Mapping minimally disturbed forests. *Global Ecology and Biogeography.* https://doi.org/10.1111/geb.12394

UNDP. (2015). *Guiana Shield Facility Resource Mobilisation Strategy.*

UNDP. (2018). *The BIOFIN Workbook 2018: Finance for Nature.*

UNDP. (2019). Human development report 2019. In *United Nations Development Program.*

UNDP. (2020). *Human Development Report 2020.* http://hdr.undp.org/sites/default/files/hdr2020.pdf

UNEP-WCMC, IUCN, & NGS. (2020). *Protected Planet Live Report 2020.* https://livereport.protectedplanet.net/

UNEP, République du Congo, & GEF. (2014). *Cinquième Rapport National sur la Diversité Biologique.*

UNFCCC. (2019). *Georgia's Second Biennial Update Report.* https://unfccc.int/sites/default/files/resource/2019.06.13_BUR2_2019_Eng.pdf

UNFCCC. (2020). *Submissions - REDD+.* REDD+ Web Platform. https://redd.unfccc.int/submissions.html?mode=browse-by-country

UNORCID. (2015). *Forest Ecosystem Valuation Study: Indonesia.*

USAID. (2009). *Land Rights and Community Forestry Program: Development of Non-Timber Forest Products in Sinoe and Nimba Counties.*

USAID LTS Team. (2019, May 16). *MAST: Supporting Community Forest Management in Liberia | LandLinks.* LandLinks USAID. https://www.land-links.org/2019/05/mast-supporting-community-forest-management-in-liberia/

USFWS. (2018). *Conserving the Sangha Trinational and Northern Congo Landscape.* http://www.fws.gov/international

Van Andel, T. (2001). Floristic composition and diversity of mixed primary and secondary forests in northwest Guyana. *Biodiversity and Conservation.* https://doi.org/10.1023/A:1012069717077

Venter, O., Sanderson, E. W., Magrach, A., Allan, J. R., Beher, J., Jones, K. R., Possingham, H. P., Laurance, W. F., Wood, P., Fekete, B. M., Levy, M. A., & Watson, J. E. M. (2016). Sixteen years of change in the global terrestrial human footprint and implications for biodiversity conservation. *Nature Communications.* https://doi.org/10.1038/ncomms12558

Vuohelainen, A. J., Coad, L., Marthews, T. R., Malhi, Y., & Killeen, T. J. (2012). The effectiveness of contrasting protected areas in preventing deforestation in Madre de Dios, Peru. *Environmental Management*, 50(4), 645–663. https://doi.org/10.1007/s00267-012-9901-y

Wahyunto, K. N., Ritung, S., & Sulaiman, Y. (2014). Indonesian peatland map: method, certainty, and uses.

Proceeding Lokakarya Kajian Dan Sebaran Gambut Di Indonesia, 81–96.

Waldron, A., Adams, V., Allan, J., Anrell, A., Asner, G., Atkinson, S., Baccini, A., Baillie, H., Balmford, A., Beau, J. A., Brander, L., Brondizio, E., & Bruner, A. (2020). *Protecting 30 % of the planet for nature: costs , benefits and economic implications.*

Walker, W. S., Gorelik, S. R., Baccini, A., Aragon-Osejo, J. L., Josse, C., Meyer, C., Macedo, M. N., Augusto, C., Rios, S., Katan, T., de Souza, A. A., Cuellar, S., Llanos, A., Zager, I., Mirabal, G. D., Solvik, K. K., Farina, M. K., Moutinho, P., & Schwartzman, S. (2020). The role of forest conversion, degradation, and disturbance in the carbon dynamics of Amazon indigenous territories and protected areas. *Proceedings of the National Academy of Sciences of the United States of America*, *117*(6), 3015–3025. https://doi.org/10.1073/pnas.1913321117

Waltert, M., Mardiastuti, A., & Mühlenberg, M. (2004). Effects of land use on bird species richness in Sulawesi, Indonesia. *Conservation Biology*. https://doi.org/10.1111/j.1523-1739.2004.00127.x

Watson, J. E. M., Evans, T., Venter, O., Williams, B., Tulloch, A., Stewart, C., Thompson, I., Ray, J. C., Murray, K., Salazar, A., McAlpine, C., Potapov, P., Walston, J., Robinson, J. G., Painter, M., Wilkie, D., Filardi, C., Laurance, W. F., Houghton, R. A., … Lindenmayer, D. (2018). The exceptional value of intact forest ecosystems. In *Nature Ecology and Evolution* (Vol. 2, Issue 4, pp. 599–610). Nature Publishing Group. https://doi.org/10.1038/s41559-018-0490-x

Wilkie, D., Shaw, E., Rotberg, F., Morelli, G., & Auzel, P. (2000). Roads, development, and conservation in the Congo basin. *Conservation Biology*. https://doi.org/10.1046/j.1523-1739.2000.99102.x

World Bank. (2015a). *Country Partnership Framework for the Republic of Indonesia*. http://documents1.worldbank.org/curated/en/195141467986374707/pdf/99172-REVISED-World-Bank-Indonesia-Country-Partnership-Framework-2016-2020.pdf

World Bank. (2015b). *GEORGIA COUNTRY ENVIRONMENTAL ANALYSIS: Institutional, Economic, and Poverty Aspects of Georgia's Road to Environmental Sustainability*. https://openknowledge.worldbank.org/bitstream/handle/10986/22287/Georgia000Coun0ental0sustainability.pdf?sequence=1&isAllowed=y

World Bank. (2018a). *Country Partnership Framework for the Republic of Liberia FY19-FY24*.

World Bank. (2018b). *Liberia: Country Forest Note*.

World Bank. (2019). *Liberia Gov Constraints to Service Delivery: WASH Sector Financing*. http://documents1.worldbank.org/curated/en/621971561443168401/pdf/Liberia-Gov-Constraints-to-Service-Delivery-WASH-Sector-Financing.pdf

World Bank. (2020a). *Mobilizing Private Finance for Nature*. http://pubdocs.worldbank.org/en/916781601304630850/Finance-for-Nature-28-Sep-web-version.pdf

World Bank. (2020b). *The World Bank in Indonesia: Overview*. https://www.worldbank.org/en/country/indonesia/overview

World Bank. (2020c). *World Bank Open Data*. https://data.worldbank.org/

World Economic Forum. (2019). *The Global Risks Report 2020*. 1–114. http://wef.ch/risks2019

World Resources Institute. (n.d.). *Indonesia*. Retrieved December 7, 2020, from https://www.wri.org/our-work/project/governance-forests-initiative/indonesia

WRI. (2014, January). *Republic of Congo*. Forest Legality Initiative. https://forestlegality.org/risk-tool/country/republic-congo

Yu, Z., Loisel, J., Brosseau, D. P., Beilman, D. W., & Hunt, S. J. (2010). Global peatland dynamics since the Last Glacial Maximum. *Geophysical Research Letters*, *37*. https://doi.org/10.1029/2010GL043584

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