

GUIDE TO INCLUDING NATURE IN NATIONALLY DETERMINED CONTRIBUTIONS

**A checklist of information and accounting
approaches for natural climate solutions**

GUIDE TO INCLUDING NATURE IN NATIONALLY DETERMINED CONTRIBUTIONS

A checklist of information and accounting approaches for natural climate solutions

September 2019

Contributing authors: Erin Beasley (CI), Lisa Schindler Murray (TNC), Jason Funk (LUCKI), Breanna Lujan (EDF), Kiryssa Kasprzyk (NWF), David Burns (NWF)

Acknowledgements: We wish to express our appreciation to the following individuals for their inputs, feedback and review: Maggie Comstock (CI), Diana Movius (Climate Advisers), John Verdieck (TNC), Peter Graham (Climate Advisers), Stephanie Wang (WCS), Nicole Desantis (UNDP), Carly Shonbrun-Siege (CI), and Sarah Bryan (TNC)



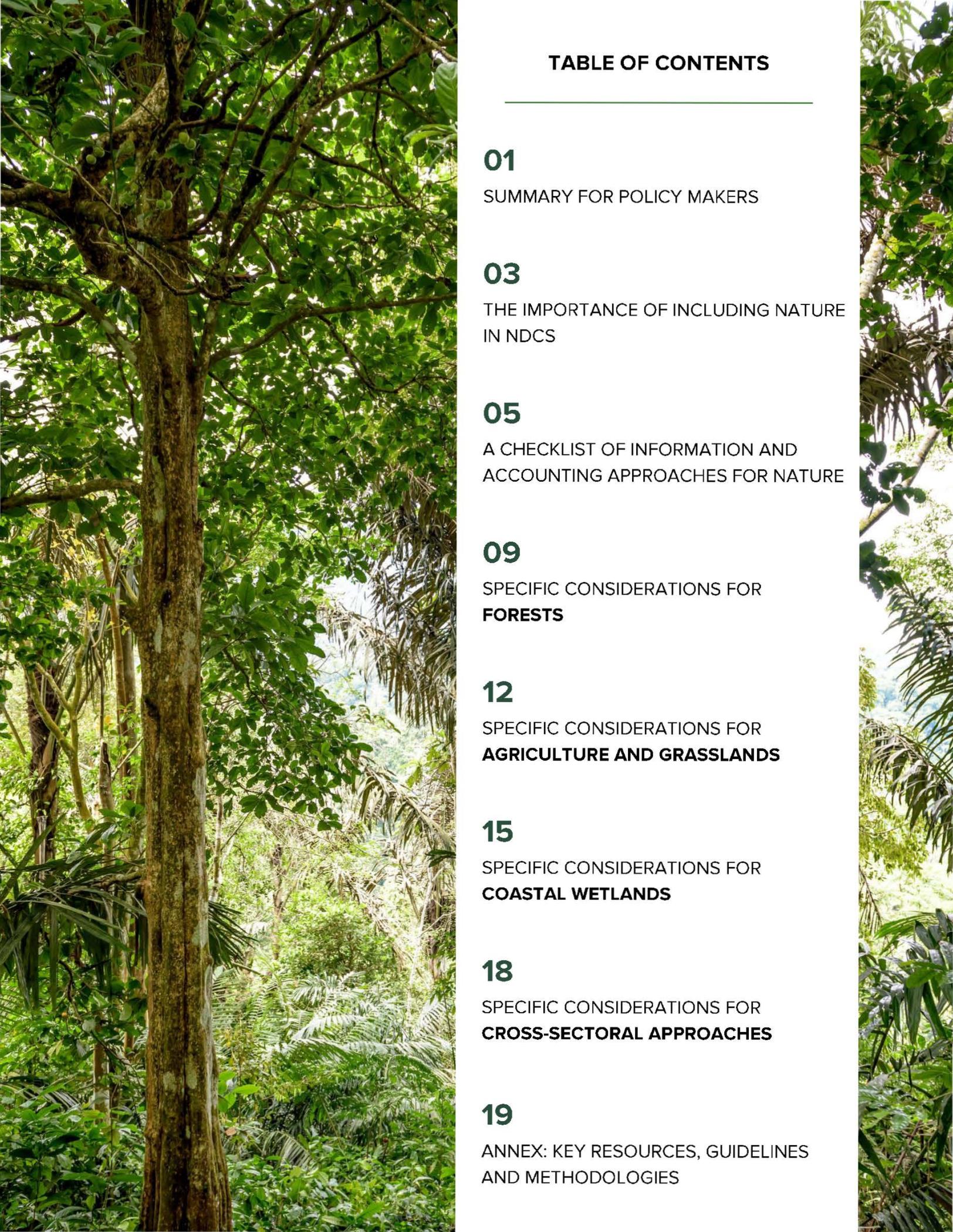


TABLE OF CONTENTS

01

SUMMARY FOR POLICY MAKERS

03

THE IMPORTANCE OF INCLUDING NATURE
IN NDCS

05

A CHECKLIST OF INFORMATION AND
ACCOUNTING APPROACHES FOR NATURE

09

SPECIFIC CONSIDERATIONS FOR
FORESTS

12

SPECIFIC CONSIDERATIONS FOR
AGRICULTURE AND GRASSLANDS

15

SPECIFIC CONSIDERATIONS FOR
COASTAL WETLANDS

18

SPECIFIC CONSIDERATIONS FOR
CROSS-SECTORAL APPROACHES

19

ANNEX: KEY RESOURCES, GUIDELINES
AND METHODOLOGIES

SUMMARY FOR POLICYMAKERS

Key messages for action

Parties to the Paris Agreement should use the guidance on NDCs provided by the UNFCCC Katowice Climate Change Package,¹ or “Paris Rulebook,” to consider climate action across all NDC sectors. The Rulebook lays out requirements of information and accounting approaches for NDCs.

Parties should specifically consider opportunities to increase their climate ambition through natural climate solutions by updating or adding detailed targets, policies and/or measures, or improving the information used in their NDC.

Parties may integrate existing efforts related to natural climate solutions from other national commitments. These commitments on conservation, biodiversity, sustainable development, restoration, and more may be used to strengthen the information provided in the NDC.

This guide provides options to build from and enhance the NDC throughout the revision cycles in a way that is consistent with guidance and categories for activities previously developed through the UNFCCC. It is not required to address the entirety of the checklist shared in this guide before including natural climate solutions in an NDC.

What are natural climate solutions?

Natural climate solutions are activities that increase climate change mitigation from nature and may include the adaptation benefits of these activities. In this guide, “natural climate solutions” are interchangeable with terms like nature-based solutions,² the land sector, and the agriculture, forestry and other land use sector (AFOLU),³ to the extent that they refer to the mitigation efforts associated with these sectors. Nature-based solutions also deliver strong results for adaptation and resilience which are not detailed here.

Enhanced ambition from countries is urgently needed to achieve the goals of the Paris Agreement as well as the ultimate goal of the UNFCCC. **Climate action from nature, or natural climate solutions,⁴ including forests, agriculture, grasslands, and coastal wetlands,⁵ has the potential to provide over one-third of global reductions of greenhouse gas emissions,⁶ ensure the integrity of ecosystems and ecosystem services and contribute key adaptation benefits.** Currently, these natural climate solutions are underrepresented in countries’ existing Nationally Determined Contributions (NDCs). To harness this potential and enhance ambition, NDCs should fully integrate natural climate solutions so that these important climate actions may be prioritized for implementation and support.

¹ United Nations Framework Convention on Climate Change. 2019. <https://unfccc.int/process-and-meetings/the-paris-agreement/paris-agreement-work-programme/katowice-climate-package>

² Nature-based solutions are defined by the International Union for the Conservation of Nature as “actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.”

³ AFOLU refers to “agriculture, forestry, and other land use” as defined by the Intergovernmental Panel on Climate Change in the 2006 guidelines for greenhouse gas inventories.

⁴ See examples of natural climate solutions in the list below.

⁵ This includes coastal, mangroves and peatland ecosystems. This guide does not focus on freshwater wetlands.

⁶ Griscom, B. W., et al. (2017). Natural climate solutions. *Proceedings of the National Academy of Sciences*, 114 (44), 11645-11650.

WHAT'S IN THIS GUIDE

Checklist of what to include in the NDC. A checklist of information and accounting is meant to serve as a tool for national-level decision-makers to fully consider nature as a part of their NDC.

National case studies. Short descriptions of country experiences highlight examples for including natural climate solutions in NDCs.

Recommendations for specific categories of natural climate solutions. Considerations specific to climate actions in forests, agriculture, grasslands, coastal wetlands, and cross-sectoral approaches.

Resource annex. Additional resources and methodologies to consider when revising NDCs to incorporate natural climate solutions.

Examples of natural climate solutions:⁷

Reforestation	Restoration of mangroves and coastal ecosystems
Avoided deforestation or degradation	Peatland restoration
Natural forest management	Avoided degradation, including mangroves and peatlands
Sustainable forest management	Biochar
Reducing drivers of deforestation	Cropland nutrient management
Conservation and protected areas	Conservation agriculture
Improved forest plantations	Trees in croplands (eg. agroforestry, windbreaks)
Avoided woodfuel harvest	Improved grazing management (eg. silvopasture)
Fire management	
Restoration of degraded lands	

⁷ Adapted from Griscom, et al. (2017). Natural climate solutions.



THE IMPORTANCE OF INCLUDING NATURE IN NDCS

Under Article 4 of the Paris Agreement on climate change, signatory countries (Parties) are committed to developing and regularly updating their own NDCs towards the achieving collective goals for addressing climate change. The first intended NDCs (INDCs) were submitted in 2015, before the full terms and rules of the Agreement had been finalized. Subsequently, Parties agreed to develop additional guidance about what information the NDCs should include.⁸ The Paris Agreement calls for a revised or recommunicated NDC before the post-2020 implementation period, and in light of the additional guidance in the Paris Rulebook and other developments, many Parties now find it worthwhile to revise their original NDCs with this guidance in order to demonstrate enhanced ambition.

The revision of NDCs is an opportunity to update plans based on new scientific and best-practice guidance (such as the IPCC 2006 guidelines and relevant supplements such as on wetlands), include a wider scope of mitigation activities, and add details about policies, actions and measures. Article 5 of the Paris Agreement highlights the importance of forests and other natural ecosystems to achieve the global goals on climate, and after the Paris Agreement was signed in 2015, scientific understanding has deepened about the role that nature has in climate mitigation and adaptation. Research shows that natural climate solutions, sometimes referred to as land sector activities or nature-based solutions, could deliver more than one-third of the climate mitigation needed by mid-century and keep warming below 2 degrees Celsius.⁹ This significant potential has been under-recognized by most

⁸ UNFCCC Decision 4/CMA.1 including Annex 1. Retrieved from: https://unfccc.int/sites/default/files/resource/cma2018_03a01E.pdf

⁹ Griscom, B. W., et al. (2017). Natural climate solutions. *Proceedings of the National Academy of Sciences*, 114 (44), 11645-11650.

Parties: only a few NDCs contain sufficient detail about the role of the land sector¹⁰ in spite of the fact that a majority of countries reference the land sector in broad terms.¹¹

The set of natural climate solutions outlined by Griscom et al.¹² includes several land-use types already used by Parties in their emissions inventories and national communications to the UNFCCC: forests, croplands, grasslands, wetlands, and others. Parties can incorporate these activities in their NDCs while still using the traditional categories and guidance that have been developed for the UNFCCC¹³. This ensures that Parties can maintain consistency with past reporting and policy efforts without needing to create new systems or request additional guidance from the IPCC. The most recent guidance from the IPCC, the 2006 Guidelines on National Greenhouse Gas Inventories (and the 2019 Refinement to these

guidelines), can be used to support policy goals for nature in Parties' NDCs in a way that is entirely consistent with their historical inventory reporting.

The relevance of the existing guidance and the potential contribution from natural climate solutions may not have been fully recognized by many Parties. This document synthesizes the current state of understanding to raise awareness and pave the way for Parties to consider using nature in revised NDCs. This guide is a quick reference to the resources available to countries as they consider how to utilize natural climate solutions to achieve their climate goals. The rest of this document recommends all the issues that a Party will need to consider and to indicate where Parties can find further detail about how to proceed once they have considered these issues.



¹⁰ Petersen, K., Braña Varela, J. (2015). NDC analysis: an overview of the forest sector. *World Wide Fund for Nature (WWF)*. 1-10. http://d2ouvy59p0dg6k.cloudfront.net/downloads/r2_wwf_indc_brief.pdf

¹¹ Strohmaier, R., et al. (2016). The agriculture sectors in the Intended Nationally Determined Contributions: analysis. *Environment and Natural Resources Management Working Paper*, (62). Retrieved from: <http://www.fao.org/3/a-i5687e.pdf>

¹² Griscom, et al. (2017). Natural climate solutions. *PNAS*.

¹³ Some activities from Griscom et al. address the *conversion* from one land-use category to another, such as the avoided conversion of forest or other native habitat to agricultural use. Other activities can occur *within* a land-use category, via resource and production management, for example employing natural forest management and nutrient management in agriculture.

A CHECKLIST OF INFORMATION FOR NATURE IN NDCS

The Paris Rulebook guidance on the information and accounting approaches for NDCs applies to *all sectors*, including actions from natural climate solutions, and is summarized below in Box 1. **This checklist includes independent recommendations prepared by the authors which apply to all categories of natural climate solutions within an NDC.** More detailed considerations are presented in later sections for climate action from forests, agriculture and grasslands, coastal wetlands, and cross-sectoral approaches.

- **Consider natural climate solutions across the following categories.** * These should be considered to integrate nature in an NDC:
 - Forests
 - Agriculture & grasslands
 - Coastal wetlands
 - Cross-sectoral approaches such as natural climate solutions combined with infrastructure, energy, transportation or other sectors

* See specific considerations for each category starting on page 9.
- **Describe how natural climate solutions fit into the NDC.** Opportunities for specific climate actions from nature vary by ecosystem type, geography, and country. Parties can note their reasons for including nature in their NDC and describe the relevance of including these activities. These reasons could include:
 - Maintaining the most updated data
 - Expanding to all sources of emissions and sinks
 - Ensuring accurate inventory information
 - Enhancing ambition
 - Reflecting national priorities
- **Communicate sector-specific reference points, when applicable.** These reference points should be consistent with the national greenhouse gas inventory.
- **Use conditionality to increase ambition or signal support needed.** Developing countries may consider using conditional targets to increase the ambition of their NDC, to signal readiness, or to indicate support needed, for example, for natural climate solutions. Conditionality is not explicitly defined in the Paris Agreement, but some countries elect to utilize this approach. For example, some countries have indicated that higher ambition from REDD+ would be possible if financial or technical support is provided.
- **Explain long-term efforts.** Many natural climate solutions may involve time frames that are longer than the NDC implementation period in order to maintain or reach their full climate benefit.¹⁴ These long-term efforts, such as investments in conservation or restoration, could be included, and countries should note in the NDC how these long-term efforts are also taken into account in the greenhouse gas inventory.

¹⁴ For example, countries may have efforts underway for restoration or forest management that occur over several decades. These long-term efforts in the land sector can still be reflected as ongoing efforts within a five-year NDC.

- **Use IPCC guidelines to define emissions categories.**¹⁵ According to the UNFCCC guidance, any relevant categories of emissions without IPCC guidelines should be defined within the NDC. There is flexibility in the Paris Rulebook for countries to use a stepwise approach to increase accuracy in future NDCs, with the understanding that Parties should strive toward complete coverage and that once categories are included, their inclusion should be continued. Sufficient information should be provided to reconstruct any country-specific methodologies.
- **Prepare sector-specific targets for nature.** Targets for climate action within an NDC may be sector specific and should include information on the relevant gases from that sector. The types of targets for natural climate solutions can be the same as for other sectors (see Box 2.)¹⁶ Targets for natural climate solutions should consider relevant time frames for emissions and removals occurring from human activity (e.g. peatland conversion).
- **Show consistency between the NDC and GHG inventory.** The UNFCCC guidance on NDCs indicates that any differences of definitions or categories between the NDC and GHG inventory should be explained in the NDC. For example, if the inventory uses a managed lands approach for forests, then the activities or targets within the NDC should be consistent with that approach.¹⁷ According to the Paris Rulebook, if these two documents are not consistent, this should be explained in the NDC.

Box 1. Information and accounting guidance agreed by the UNFCCC¹⁸

When updating or preparing future NDCs, countries should look to agreed guidance on the information and accounting that should be included in NDCs for all sectors, including nature. Key topics covered by this guidance include:

Information

- Reference point
- Period of implementation
- Scope and coverage
- Planning processes
- Assumptions and methodologies
- Ambition
- Contribution towards global goals of the Paris Agreement

Accounting

- Approaches & metrics assessed by IPCC
- Consistency between NDC communication & implementation
- Inclusion of all categories of emissions and removals
- Explanations of any excluded emissions

Box 2. Types of NDC targets¹⁹

Reduction relative to business as usual, or baseline scenario target

Base year emissions target

Fixed level target

Intensity target

Trajectory/Peak target

Non-greenhouse gas (GHG) targets, action-based targets, mitigation policies and measures

¹⁵ See Annex for a list of relevant guidelines.

¹⁶ Fransen, T., et al. (2017). Enhancing NDCs by 2020: Achieving the goals of the Paris Agreement. Retrieved from: <https://www.wri.org/publication/ndc-enhancement-by-2020>

¹⁷ Eggleston, S. (2010). Revisiting the use of managed land as a proxy for estimating national anthropogenic emissions and removals. In *IPCC's Task Force on Inventories expert meeting, Aguila* (Vol. 29, No. 11). Retrieved from: https://www.ipcc-nggip.iges.or.jp/public/mtdocs/pdfiles/0905_MLP_Report.pdf

¹⁸ Summarized for brevity following [Annex I and Annex II of UNFCCC decision 4/CMA.1](#)

¹⁹ Each of these targets is further described in Levin, K., et al. (2015). Designing and preparing Intended Nationally Determined Contributions (INDCs). WRI/ UNDP. Retrieved from: http://mitigationpartnership.net/sites/default/files/indcs_may27_v2.pdf

■ **Highlight planning processes that include nature.**

Parties may use their NDC to provide information and build from planning processes relevant to climate action. Many activities from nature may already be included in these plans. We recommend that the NDC be consistent with other national documents, such as REDD+ strategies, monitoring and safeguards, or the Forest Reference Emission Level/Forest Reference Level (FREL/FRL), and cross-reference them. Policies and planning processes that support decreased emissions or enhanced sinks from forests, agriculture and grasslands, coastal wetlands, or other sectors, broadly include:

- Sustainable development plans
- Low-carbon development strategies
- Land use planning
- Nationally Appropriate Mitigation Actions (NAMA)
- National Adaptation Plan (NAP)
- REDD+
- National Biodiversity Strategies and Action Plan (NBSAP)
- Conservation strategies
- Bonn Challenge commitments
- National mangrove plans
- Hydrological or watershed management strategies
- Marine spatial planning

■ **Describe participation.** Identify key stakeholders or consultation processes related to planning for climate action from natural climate solutions in forests, agriculture and grasslands, coastal wetlands or cross-sectoral approaches. Cross-ministerial coordination and information-sharing is needed to ensure that natural climate solutions achieved through cross-sectoral approaches, such as infrastructure, are reflected in the NDC. Key stakeholders could include:

- National ministries, departments, and coordinating bodies (For example: Environment, Forests, Climate Change, Agriculture/Livestock, Fisheries, Planning, Economy, Finance)
- Sub-national and local governments
- Academic and research institutions
- Private sector platforms
- Sector-specific platforms such as for REDD+
- Civil society organizations, nongovernmental organizations
- Smallholder farmers
- Historically marginalized populations
- Women, youth
- Indigenous peoples and local communities
- International development partners

Box 3. A rights-based approach to consultation

As part of the recommended planning processes in the checklist, countries should follow best practices and national legislation for consultation. Some countries have adopted Convention 169 of the International Labor Organization which includes the right to consultation. Best practice for natural climate solutions also recognizes the principle of Free, Prior and Informed Consent (FPIC), which refers to the right of local communities and indigenous peoples to give or withhold their consent for any action that would affect their lands, territories or rights.

Consultation is an important part of planning processes to promote the effective participation of diverse stakeholders in the prioritization of natural climate solutions.

Modified from Conservation International. (2019). Free, prior and informed consent in context. Retrieved from: <https://www.conservation.org/projects/free-prior-and-informed-consent-in-context>

A CHECKLIST OF ACCOUNTING FOR NATURE IN NDCs

- **Include all sectors from previous NDCs.** Following the UNFCCC guidance on NDCs, once a sector or activity is added, it should remain in future NDCs.
- **Address all relevant greenhouse gases.** Based on the accounting guidance for NDCs, countries should account for emissions reductions from natural climate solutions in alignment with IPCC guidelines²⁰, and they should account for anthropogenic emissions and removals of all relevant greenhouse gases, independently of each other. Relevant gases for natural climate solutions include carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O).
- **Use the IPCC guidelines.** If a country is using approaches to account for land-sector emissions other than those agreed by the IPCC, these approaches should be noted in the NDC. Further resources on accounting approaches for each category of natural climate solutions are included in the Annex of this document.
- **Maintain reporting clarity.** For clarity in reporting, we recommend that Parties use the NDC to explain any inconsistencies in estimating sources and sinks from natural climate solutions between the NDC, greenhouse gas inventory, and NDC implementation. Note accounting approaches used for any specific category of emissions, especially if they differ from the IPCC guidelines.

Connections to other parts of the Paris Agreement

This document focuses on the information needed to incorporate nature into NDCs and does not go into detail on other parts of the Paris Agreement such as transparency, adaptation communications or cooperative approaches. These other topics are also relevant to natural climate solutions as a pathway to increased action on climate change. For example, within the transparency framework an understanding of the biennial transparency reports (BTRs) should inform the integration of nature into national climate planning and NDCs. Further, while not required in the NDC, we recommend that countries consider ways to track progress that comprehensively match the sectors and activities described in the NDC. This will aid in the preparation of the BTRs. Further, the national climate planning process will benefit from the creation of strong institutional linkages between the accounting information of an NDC and the BTR process/system. Other resources are available and forthcoming on these valuable topics.²¹

²⁰ Countries may find it useful to prioritize their emissions categories using a Key Categories analysis. Detailed instructions for Key Categories analysis can be found in the [2006 IPCC Guidelines for National GHG Inventories, Vol. 1, Chapter 4](#).

²¹ Herold, A., Böttcher, H. (2018). Accounting of the land-use sector in nationally determined contributions (NDCs) under the Paris Agreement. GIZ GmbH. Retrieved from: https://www.transparency-partnership.net/system/files/document/Guide%20Accounting%20of%20land-use%20sector%20in%20NDCs%28vf%29_20181010.pdf



FORESTS

Why are forests relevant to NDCs?

Forests play a lead role in the terrestrial component of the global climate system. Nearly 4 billion hectares of forest worldwide are constantly exchanging carbon with the atmosphere, with as much as 25% of annual carbon emissions absorbed by forests every year.²² They represent an astonishing reservoir of carbon, currently holding over 1200 gigatons of carbon²³ – a figure that increases by several gigatons every year. If all this carbon were released, it would generate emissions more than ten times greater than the remaining carbon budget to stay below 1.5 degrees.²⁴

Incredibly, forests could do even more to mitigate climate change. A recent estimate suggests that nearly another billion hectares of forest could be added or restored without jeopardizing food security²⁵ – an effort that could

double the terrestrial sink through 2050.²⁶ Countries can do a great deal to protect, expand, manage, and restore forests to activate this potential, and including forest-related activities in NDCs is an appropriate way to articulate and potentially enhance this contribution to the global climate goals.

Unfortunately, forests are constantly threatened both by deforestation as well as the impacts of climate change. Climate change can increase the frequency and intensity of droughts, flood events, pest outbreaks, and wildfires -- all of which can have devastating consequences for forests, releasing their stored stocks of carbon and temporarily, or permanently, stalling their ability to sequester carbon from the atmosphere.²⁷ If these impacts and actions are allowed to proceed unabated, they could overwhelm efforts to reduce emissions in other sectors. Thus, proper forest protection and management are critical for climate action.

²² Pan, Y. et al. (2011). A large and persistent carbon sink in the world's forests. *Science* 333: 988-993. DOI: 10.1126/science.1201609.

²³ Food and Agriculture Organization of the United Nations (FAO). (2015). *Global Forest Resources Assessment (FRA) 2015. How are the World's Forests Changing?* Rome: FAO. <http://www.fao.org/forest-resourcesassessment/past-assessments/fra-2015/en/>. 2nd ed.

²⁴ IPCC (Intergovernmental Panel on Climate Change). (2018). *Special Report, Global Warming of 1.5° C (SR15)*.

²⁵ Bastin, J. F., et al. (2019). The global tree restoration potential. *Science*, 365 (6448), 76-79.

²⁶ Griscom, et al. (2017). Natural climate solutions. *PNAS*.

²⁷ For an example of this, scientists now warn of a "tipping point" in the Amazon basin: a degree of deforestation at which the region will no longer be able to generate its own rainfall and therefore cease to support rainforest ecosystems, as published in Viscidi, L., et al. (2019). How to save the Amazon Rain Forest. In *The New York Times*. Retrieved from: <https://nyti.ms/2YfQMpE>

Human communities are indelible and fundamental to many forest ecosystems. Indigenous and local communities have sustainably managed forests for generations, in many cases with a sophisticated understanding of the dynamics of the forest. This understanding will be vital to ensure the ecological functions of forests, even as their management and biophysical conditions undergo changes. We recommend that national policies, articulated in NDCs, should be crafted in open consultation with the full range of forest stakeholders and should reflect their input.

Scientific evidence and practical experience have proven the climate benefits of a wide variety of activities that can conserve existing forests, enhance forest carbon stocks, and increase forest extent, making them readily applicable to NDCs as part of countries' mitigation contributions. In most cases, these activities also deliver adaptation benefits, as well as cross-cutting benefits for biodiversity and communities.

Considerations specific to the inclusion of forests in NDCs

■ Sector-specific targets and goals for forests.

- The quantified methodology for recognizing forest protection, conservation, or avoided emissions.
- For countries who do not consider restoration under REDD+, inclusion of restoration in the NDC should be consistent with the accounting approaches in the greenhouse gas inventory.
- Specific overall targets for REDD+ can be included explicitly in an NDC. If applicable, the relationship between the NDC target(s) (conditional and unconditional) and the country's REDD+ activities.
- If applicable, include information about FREL/FRL.

■ Harvested wood products and natural disturbances.

According to the UNFCCC guidance, Parties are encouraged to account for natural disturbances, and where relevant, account for harvested wood products (HWP) following to the most-recent IPCC guidelines. This accounting is important to fully understand the

overall impact of HWP on emissions and sinks in this category.

■ Measures planned or in progress to facilitate change within specific forestry or conservation activities.

These measures are helpful to suggest how a country will work towards its chosen goals. This could include programs, initiatives, or incentives related to:

- Reducing emissions from deforestation and forest degradation, and forest conservation, sustainable management of forests, and enhancement of forest carbon stocks (REDD+), including prevention of forest conversion to non-forest land uses (e.g., agriculture, mining, development, and other drivers of deforestation), avoided forest degradation, avoided woodfuel harvest and/or selective logging, natural forest management and conservation, and improved forest plantations
- Reforestation
- Fire management
- Increasing technical capacity and financial support
- Investments in research and monitoring systems
- Assessing incentives for forest protection
- Promoting natural regeneration

■ Monitoring systems in place, including social and environmental safeguards.





Country Example - Costa Rica

In its INDC, Costa Rica announced a target to reduce emissions by 25% below 2012 levels by 2030. This reduction includes mitigation and adaptation actions from agriculture and forestry, among others. Costa Rica has “committed to develop its adaptation practice from an ecosystem-based adaptation focus, building on the commitment to increase forest coverage to 60%” while “exploring synergies between adaptation practices and the reduction of emissions through avoided deforestation” by two major areas of action:

Consolidating the National Forestry Finance Fund’s (FONAFIFO) Environmental Services Payments program and the Forest Certification program as a mechanism to promote the sustainable development of forest resources and effective protection of water resources; and

Promoting the National Biological Corridor System and the National Protected Areas System (SINAC).

Improving the governance of the country’s forestry resources will enable Costa Rica to enhance its capacity to generate economic growth along with provision of forest-related goods and services.

Costa Rica’s NDC is available online at:

<https://www4.unfccc.int/sites/NDCStaging/Pages/Search.aspx?k=Costa%20Rica>

See the Annex for key resources and methodologies related to forests.



AGRICULTURE & GRASSLANDS

Why are agriculture and grasslands relevant to NDCs?

Agriculture is a sector that is both vulnerable to climate change, and capable of delivering significant mitigation benefits. Natural grasslands and pastures also provide important carbon sinks, as well as biodiversity and ecosystem services that are key to increasing resilience for agriculture. Options for natural climate solutions include activities to reduce emissions from agriculture and grasslands through a variety of strategies that include good agricultural practices, conservation agriculture, integration of trees, agroforestry, silvopasture, and restoration of degraded lands.²⁸

Farmers and agricultural systems will require additional methods, tools, and technologies to achieve a transformative response to climate change, while ensuring the needs of both food security and smallholder livelihoods. Most Parties recognize the importance of this sector: more than three-quarters of countries included reduced emissions from agriculture in their NDCs.²⁹

Agricultural systems rely on a series of ecosystem functions for their production, such as pollination, water provisioning, soil fertility, pest management, and others. These ecosystem services either occur directly on agricultural lands, or importantly, on forested or protected areas within or around the landscape. Promoting the beneficial relationships between these different types of land use creates benefits for both agricultural production and climate action.



²⁸ Following the IPCC guidelines, mitigation, in the context of agriculture includes actions to reduce emissions from enteric fermentation, manure management, rice cultivation, prescribed burning of savannas and grassland, and from soils, as contained in Strohmaier, R., et al. (2016). The agriculture sectors in the Intended Nationally Determined Contributions: analysis. *Environment and Natural Resources Management Working Paper*, (62).

²⁹ Strohmaier, R., et al. (2016).

Considerations specific to the inclusion of agriculture & grasslands in NDCs

■ Sector-specific targets and goals for agriculture and grasslands.

- Quantified target, including extent, carbon reductions or; intensity reductions; and/or
- Qualitative target, such as improving farmer access to tools, methods and technology, policy changes, increased use of extension services, or incentive programs, increased implementation of good agricultural practices.

■ Monitoring systems in place. These can address:

- Social and environmental safeguards
- Food security indices
- Early warning systems for natural disasters, including pest management
- Ecosystem provisioning services

■ **Adaptation.** Given the high adaptation value from agriculture, for food security, countries may decide to reference agriculture in the adaptation section of their NDC, adaptation communications (AC) or national adaptation plans (NAP). If so, we encourage Parties to include a target for such adaptation efforts as part of the NDC, and Parties should also recognize the mitigation co-benefits of such actions.

■ Measures planned or in progress to facilitate change within specific agricultural activities. To complement the activities listed in Box 1, countries can also reference major programs, initiatives, or incentives related to:

- Prioritizing local land planning for agriculture to avoid forest land conversion
- Increasing carbon stocks on agricultural lands and pastures
- Supporting restoration in riparian areas alongside production
- Conserving and protecting sensitive areas in an agricultural landscape
- Providing technical capacity and financial support for low-carbon approaches in shifting cultivation systems
- Investment in crop research and climate monitoring systems
- Assessing incentives for improved nutrient management
- Promoting good agricultural practices
- Supporting natural regeneration of abandoned agricultural lands





Country Example - Uruguay

Uruguay included a comprehensive and ambitious plan for emissions reductions in agriculture with unconditional and conditional targets for beef production, grassland and crop management and land use, land use change, and forestry by 2025. Uruguay proposed the unconditional adoption of good agricultural practices for grasslands and herd management for 10% of the country's grasslands, and an expanded goal of up to 30% of grasslands if international technical and financial support is provided. These objectives are listed based on the relevant greenhouse gases and are linked to the country's overall targets for climate action. Uruguay included quantified goals for improved dairy farm practices (covering 40% - 75% of all dairy farms) to decrease methane from farm effluent, as well as the implementation of soil conservation practices, crop rotation, cover crops, and the use of native grasses on up to 95% of all agricultural areas. The NDC points to several existing sectoral guidelines and regulations to achieve these goals, including Land-Use and Management Plans, Plans for Soil Use and Management, the Forest Policy, and Forestry and Environmental Management Guidelines.

Uruguay's NDC is available online at:

<https://www4.unfccc.int/sites/NDCStaging/Pages/Search.aspx?k=Uruguay>

See the Annex for key resources and methodologies related to agriculture and grasslands.



COASTAL WETLANDS

Why are coastal wetland (“blue carbon”) ecosystems relevant to NDCs?

Wetlands are natural reservoirs of carbon in the landscape. Historically, human activities such as disturbing, draining, and conversion of wetlands have triggered releases of this stored carbon. Looking forward, activities like protection, rewetting, and restoration of wetlands could be considered for the mitigation component of the NDCs, due to their potential to reduce emissions from past anthropogenic activities and to promote the natural processes that sequester carbon in wetlands. Coastal wetlands – mangrove forests, tidal salt marshes, and seagrass meadows – also known as “blue carbon ecosystems,” along with freshwater wetlands and peatlands, are an essential part of the climate solution. The soils in mangrove forests store approximately 6.4 billion tonnes of carbon globally, representing 49% - 98% of the carbon storage capacity in a mangrove ecosystem. There are significant climate adaptation benefits from blue carbon ecosystems as well including: an increase in improved water quality and fishery production; improved livelihoods through tourism and other coastal jobs; and the protection of coastlines from storm surges, floods and erosion.

This guide focuses on how to include ecosystems in an NDC that are managed within national boundaries, noting that coastal wetlands are often overseen by different ministries than other land sector activities. The checklist

below includes information that could be included in an NDC to better incorporate wetland ecosystems to enhance climate ambition. This list can be viewed as a selection of options to build from and enhance the NDC throughout the revision cycles and no requirement for countries to fulfil all elements before including wetlands into an NDC. Similarly, the IPCC methodologies provided for coastal ecosystems in the annex highlight a tiered approach for carbon accounting based on the available capacity and national circumstances, allowing for greater flexibility and the inclusion of these carbon pools over time.

Considerations specific to the inclusion of coastal wetlands in NDCs

- **Determine extent and geographic scope.** Identifying the extent of the coastal wetlands is the first step in utilizing the IPCC Wetlands Supplement, for which only information on the wetland area is needed and proxies are used to calculate the carbon potential.
- **Sector-specific targets and goals for coastal ecosystems.**
 - Targets for coastal ecosystems can include GHG metrics similarly to forests.
 - For further reporting, non-carbon emissions can be tracked similarly to agriculture, including methane emissions for rewetting and revegetation, and nitrous oxide emissions for aquaculture use.

- In some countries, mangroves may be a part of the country’s REDD+ program if defined as such in the National Forest Definition. In those cases, REDD+ baselines or targets may already include mangroves, and this should be taken into consideration in the preparation of NDCs. Countries that are not doing so, may also consider including soil carbon in their accounting features.
 - Countries may decide to include coastal wetlands (“blue carbon”) in the adaptation section of their NDC. If so, we recommend that countries consider a target for action, and may also recognize the mitigation co-benefits of this action.
- **Adaptation.** Given the high adaptation value from coastal wetlands, such as flood protection, and water and food security, countries may decide to include coastal wetlands in the adaptation section of their NDC, or in adaptation communications (AC) or national adaptation plans (NAP). If so, we encourage Parties to include a target for such adaptation effort as part of the NDC, where applicable, and may also recognize the mitigation co-benefits of such actions.
- **Policies and measures.** Countries could reference existing programs or initiatives that incorporate these ecosystems for climate mitigation or adaptation, such as the following:
- **AFOLU and REDD+.** Depending on each country’s national forest definition, mangrove forests may already be included in the national REDD+ program. In such cases, they may already be included in a national GHG inventory and national forest monitoring system for the aboveground biomass.
 - **Marine Protected Areas (MPAs).** MPAs address protection and conservation of both coasts and marine areas. These designations and existing policies can be useful to incorporate into climate mitigation and/or adaptation actions.
- **Ramsar Convention on Wetlands of International Importance.** Ramsar resolution (XIII.14) promotes the conservation, restoration and sustainable management of coastal blue carbon ecosystems, including encouraging Parties to update their national greenhouse gas inventories to better reflect data for wetlands including carbon storage and fluxes in Ramsar coastal wetland sites.
- **Accounting for wetlands in the NDC.** We recommend the following considerations to help a country describe its work and priorities on coastal wetlands. There is flexibility for countries to choose the information that best represents their efforts:
- **IPCC Wetlands Supplement.** The “2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands,” provides a useful tiered approach to address the different capacities of countries, to build an improved inventory over time. Tier 1 uses the area of the wetland system with associated default data (proxies) to estimate the mitigation value; Tier 2 uses the gain-loss method with country-specific data or the stock-difference method with country-specific emission factors; and Tier 3 is the highest standard, using modelling technology to estimate changes in the carbon stock (biomass) which can be determined by species, ecological zones, and management intensity.
 - **Soil carbon.** Particularly for coastal ecosystems, carbon stored in soils is an important component of ecosystems’ overall carbon sink. For example, a soil depth of 30 centimeters is needed to capture the full mitigation potential of soil organic carbon in coastal wetlands.³⁰ For this reason, we encourage countries to consider soil carbon as part of their BTR and national inventory, although they may find it is not necessary to specify this level of detail in the NDC. A global map of mangrove soil carbon is available in the Annex.

³⁰ Sandermann, J., et al. (2018). “A Global Map of Mangrove Forest Soil Carbon at 30 m Spatial Resolution.” *Environmental Research Letters* 13, no. 5: 055002. Retrieved from: <https://doi.org/10.1088/1748-9326/aabe1c>.



Country Example - Belize

Belize included coastal ecosystems throughout its NDC as part of mitigation, adaptation and long-term climate action through 2030. Their efforts related to coastal ecosystems focus on increasing resilience and reducing vulnerability of livelihoods tourism, sustainable forest management, protected areas management, coastal and marine resources, and water management. The NDC highlights mitigation actions that will produce co-benefits that promote adaptation and resilience to climate change, such as replanting mangroves for mitigation purposes which also protect the coastline against storm surges and erosion.

The NDC includes objectives and corresponding actions to be implemented in the following priority sectors: coastal and marine resources, water resources, tourism, and fisheries and aquaculture. One objective is to protect existing mangroves from deforestation and to restore lost mangroves, which has the potential to turn Belize's mangrove system into a net carbon sink with expected cumulative emissions reduction of up to 379 Gigagrams of CO₂ by 2030. This intersects with the objective of watershed protection, and with the corresponding activity of protecting and restoring mangrove forests. Belize expects to implement these activities by strengthening the capacity of the Belize Coastal Zone Management Authority and Institute and enforcing local laws such as the new Fisheries Resources Bill and implementing the Belize Integrated Coastal Zone Management Plan.

Through the NDC, Belize recognizes the importance of protecting low-lying coastal areas against impact of storms and soil erosion and the role mangrove forests play as nursery grounds for regional fish stocks and maritime ecosystems.

Belize's NDC is available online at :

https://unfccc.int/files/focus/ndc_registry/application/pdf/belize_ndc.pdf

See the Annex for key resources and methodologies related to coastal wetlands.



CROSS-SECTORAL APPROACHES

Why are cross-sectoral approaches relevant to NDCs?

Countries can coordinate across sectors to decrease emissions, including through natural climate solutions. We recommend that these cross-sector climate actions can and should be included in the NDC.

Examples of taking a cross-sectoral approach include: integrating infrastructure planning with conservation goals; promoting sustainable landscape programs between forestry and agriculture; developing policies for compensating impacts of infrastructure development on forests or wetlands; combining natural and built infrastructure for coastal protection, implementing land use planning with ecosystem disaster risk management; or ensuring tree cover for hydropower efficiency.

Considerations specific to the inclusion of cross-sectoral approaches in NDCs

- **Planning processes.** Countries should review existing development plans that link sectors as well as institutional arrangements or agreements, if existing. These planning processes should be the outcome of a joint effort between the relevant ministries and government actors.

- **Allocation between sectors.** In the national GHG inventory, we recommend that Parties should identify how these emissions reductions have been attributed to the relevant sectors.

- **IPCC accounting approaches for bioenergy.** For Parties opting to include energy derived from the use of biological feedstocks (i.e. bioenergy), a variety of accounting approaches have been assessed by the IPCC and should be referenced in the national GHG inventory. Transparency will be key to understanding whether Parties are accurately accounting for the overall change in emissions to the atmosphere.

Importing countries should report on accounting methodology utilized by the exporting country for biomass-based emissions. If the exporting country does not account or utilize a projected baseline that incorporates biomass energy demand, the importing country will need to fully account for the emissions.

If domestic feedstock is used, Parties should reconcile their energy and land-sector accounting approaches, through the use of identical reference points (e.g. historical reference year or period, or BAU) to avoid inter-sectoral leakage.

ANNEX: KEY RESOURCES AND METHODOLOGIES

Accelerating Climate Ambition and Impact: Toolkit for Mainstreaming Nature-Based Solutions into Nationally Determined Contributions

United Nations Development Programme. (2019.) *Accelerating Climate Ambition and Impact: Toolkit for Mainstreaming Nature-Based Solutions into Nationally Determined Contributions*. New York, USA: UNDP. Retrieved from: <https://www.ndcs.undp.org/impact-and-learning/library/nature-based-solutions-for-ndcs-toolkit.html>

The Nature-based Solutions Toolkit captures more than 100 tools and resources on nature-based solutions that can support national decision makers as they enhance their NDCs. This toolkit includes spatial datasets, reports, policy briefs, guidance documents, handbooks, other toolkits, and platforms on NBS for climate mitigation and adaptation.

Accounting of the land-use sector in nationally determined contributions (NDCs) under the Paris Agreement

Herold, A., Böttcher, H. (2018). Accounting of the land-use sector in nationally determined contributions (NDCs) under the Paris Agreement. GIZ GmbH. Retrieved from: https://www.transparency-partnership.net/system/files/document/Guide%20Accounting%20of%20land-use%20sector%20in%20NDCs%28vf%29_20181010.pdf

This Guide describes the specific challenges of the land-use sector related to the estimation of emissions and the accounting towards mitigation targets. It provides an overview of existing accounting modalities for the land-use sector and supplements those by possible new approaches in a way that readers will get an overview of the available options for the accounting of the land-use sector.

2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 4

Intergovernmental Panel on Climate Change. (2019). *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 4*. Intergovernmental Panel on Climate Change. Retrieved from: <https://www.ipcc-nggip.iges.or.jp/home/2019refinement.html>

The 2019 refinement process to the IPCC guidelines is intended to provide an updated view of the latest scientific and technological improvements for national GHG inventories. Volume 4 of the IPCC guidelines focuses on AFOLU. In the case of mangrove forests that meet the definition of forests, and other potential land uses, methodologies to account for GHG emissions from the land sector are included here.

2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 4

Eggleston, S., Buendia, L., Miwa, K., Ngara, T., and Tanabe, K. (eds). (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 4*. Japan: Institute for Global Environmental Strategies on behalf of the Intergovernmental Panel on Climate Change. Retrieved from:

<https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html>

Volume 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories builds upon the 1996 Guidelines to provide guidance on developing annual greenhouse gas inventories within the AFOLU sector.

2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry

Penman, J., Gytarsky, M., Hiraishi, T., Krug, T., Kruger, D., Pipatti, R., Buendia, L., Miwa, K., Ngara, T., Tanabe, K., and Wagner, F. (eds). (2003). *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. Japan: Institute for Global Environmental Strategies for the Intergovernmental Panel on Climate Change. Retrieved from:

<https://www.ipcc-nggip.iges.or.jp/public/gpqlulucf/gpqlulucf.html>

This report provides guidance for nations on developing inventories of carbon stock and greenhouse gas emissions for the land use, land-use change, and forestry sector. Good practice refers to inventories that have reduced uncertainties as much as possible and neither over- nor under-estimate carbon stock.

A Seven-Step Approach for Enhancing Nationally Determined Contributions through Nature-Based Solutions.

United Nations Development Programme. 2019. *A Seven-Step Approach for Enhancing Nationally Determined Contributions through Nature-Based Solutions*. New York, USA: UNDP. Retrieved from:

<https://www.ndcs.undp.org/impact-and-learning/library/nature-based-solutions-for-ndcs-pathway-framework.html>

The document outlines a framework and process for governments to identify potential NBS with the aim of enhancing their climate mitigation and adaptation action in a cost-effective manner and with multiple co-benefits.

UNFCCC Accounting for Forests: What's in and what's out of NDCs and REDD+

Lee, D. and Sanz, M.J. (2017). *UNFCCC Accounting for Forests: What's in and what's out of NDCs and REDD+*. Climate and Land Use Alliance. Retrieved from:

<http://www.climateandlandusealliance.org/wp-content/uploads/2018/10/Policy-brief-NDCs-and-REDD-revised-Sep-6-2017.pdf>

The UNFCCC Accounting for Forests manual provides guidelines for how nations should include greenhouse gas emissions and reductions from forests in their National Determined Contributions and REDD+ reference levels.

EX-Ante Carbon Balance Tool (EX-ACT)

EX-Ante Carbon Balance Tool (EX-ACT). (2019). Food and Agriculture Organization of the United Nations. Retrieved from: <http://www.fao.org/tc/exact/ex-act-home/en/>

The Ex-Ante Carbon Balance Tool is a land-based accounting system that provides estimates of greenhouse gas emissions and carbon stock changes due to agriculture and forestry projects.

Food and Agriculture Organization Statistics Data (FAOSTAT)

Food and Agriculture Organization Statistics Data (FAOSTAT). (2019). Food and Agriculture Organization of the United Nations. Retrieved from: <http://www.fao.org/faostat/en/#data>

FAOSTAT provides country-level data agriculture emissions data broken down by source, such rice cultivation, synthetic fertilizers, and energy use. The data spans from 1961 to present day and allows for country-level comparisons over time.

The Carbon Farming Solution: A global toolkit of perennial crops and regenerative agriculture practices for climate change mitigation and food security

Toensmeier, E. (2016). *The Carbon Farming Solution: A global toolkit of perennial crops and regenerative agriculture practices for climate change mitigation and food security*. Chelsea Green Publishing. 512 pp.

The Carbon Farming Solution describes a wide range of farming techniques and approaches that can deliver climate and food security benefits, relevant to agricultural contexts around the world.

The agriculture sectors in the Intended Nationally Determined Contributions: Analysis

Strohmaier, R., Rioux, J., Seggel, A., Meybeck, A., Bernoux, M., Salvatore, M., Miranda, J. and Agostini, A. (2016). *The agriculture sectors in the Intended Nationally Determined Contributions: Analysis*. Environment and Natural Resources Management Working Paper No. 62. Rome: Food and Agriculture Organization of the United Nations. Retrieved from: <http://www.fao.org/3/a-i5687e.pdf>

This analysis describes the prominent role of agriculture in achieving Parties' Intended Nationally Determined Contributions, providing an overview of the inclusion of agriculture in the INDCs, as well as the importance of international support for developing countries.

Role of Agriculture, Forestry, and Other Land Use Mitigation in INDCs and National Policy in Asia

Zelege, A., Phung, T., Tulyasuwan, N., O'Sullivan, R., Lawry, S., and Gnych, S. (2016). *Role of Agriculture, Forestry, and Other Land Use Mitigation in INDCs and National Policy in Asia*. Low Emissions Development Strategy Global Partnership Agriculture, Forestry, and Land Use (AFOLU) Working Group. Retrieved from: <https://www.winrock.org/wp-content/uploads/2016/05/AFOLU-LEDS-Working-Group-Technical-paper-Role-of-AFOLU-mitigation-in-INDCs-and-national-policy-in-Asia-1.0-Feb-25-2016.pdf>

This report describes the importance of including the AFOLU sector in Asian nations' INDCs and analyzes how various Asian nations have included AFOLU in their INDCs and national development plans. INDCs in these nations do not sufficiently include the AFOLU sector and would benefit from integrating Low Emission Development Strategies targeting the AFOLU sector in their revised INDCs.

2013 IPCC Supplement to the 2006 Guidelines for National GHG Inventories: Wetlands

Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). (2014). *2013 IPCC Supplement to the 2006 Guidelines for National GHG Inventories: Wetlands*. Switzerland: Intergovernmental Panel on Climate Change. Retrieved from: <https://www.ipcc-nggip.iges.or.jp/public/wetlands/>

The 2013 Supplement improves the 2006 Guidelines by providing updated information based on new scientific knowledge, as well as extending the content of the Guidelines to cover coastal wetlands, tidal marshes, seagrass meadows, wetlands constructed for wastewater treatment, inland organic soils, and inland wetland mineral soils. Chapter 4: Coastal Wetlands, in particular, describes the blue carbon ecosystems and provides guidance on estimating and reporting anthropogenic GHG emissions and removals from managed coastal wetlands. The Wetlands Supplement has a tiered approach to address the different capacities of countries, thus all countries can utilize the guidance and build out an improved inventory over time.

Coastal Blue Carbon: Methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrass meadows.

Howard, J., Hoyt, S. Isensee, K., Pidgeon, E., Telszewski, M. (eds.) (2014). *Coastal Blue Carbon: Methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrass meadows*. Arlington, Virginia, USA: Conservation International, Intergovernmental Oceanographic Commission of UNESCO, International Union for Conservation of Nature. Retrieved from: <https://www.thebluecarboninitiative.org/manual>

The blue carbon manual was produced to provide methodological guidance and details for blue carbon ecosystems at a level beyond the IPCC aimed at practitioners who would benefit from additional detail on sampling methods, laboratory measures and an analysis of blue carbon stocks and fluxes in order to be able to accurately and completely account for these ecosystems.

World Atlas of Mangroves (version 3.0)

Spalding M, Kainuma M, Collins L. (2010). *World Atlas of Mangroves (version 3.0). A collaborative project of ITTO, ISME, FAO, UNEP-WCMC, UNESCO-MAB, UNU-INWEH and TNC*. London (UK): Earthscan, London. 319 pp. URL: <http://www.routledge.com/books/details/9781844076574>; <http://data.unep-wcmc.org/datasets/5>

This atlas contains a country-level assessment of mangrove ecosystems globally, as well as information on the ecology and health of those habitats and their interaction with humans. The interactive online tool maps the global distribution of mangrove ecosystems.

Coastal blue carbon ecosystems: Opportunities for Nationally Determined Contributions

Herr, D. and Landis, E. (2016). *Coastal blue carbon ecosystems: Opportunities for Nationally Determined Contributions*. Gland, Switzerland: IUCN and Washington, DC, USA: TNC. Retrieved from: https://www.nature.org/content/dam/tnc/nature/en/documents/BC_NDCs_FINAL.pdf

This policy brief reviews the inclusion of blue carbon in the INDCs and NDCs. Nations should consider expand upon their blue carbon mitigation ambitions in order to reach the 2°C target created by the Paris Agreement.

Mangrove Restoration Potential: A global impact highlighting a critical opportunity

Worthington, T. and Spalding, M. *Mangrove Restoration Potential: A global impact highlighting a critical opportunity*. IUCN, The Nature Conservancy, and the University of Cambridge. Retrieved from: <https://www.iucn.org/sites/dev/files/content/documents/mangrove-tnc-report-final.31.10.lowspreads.pdf>

This report describes the process of mapping degraded mangrove ecosystems and the potential benefits from restoration, resulting in the Mangrove Restoration Potential Map. The map allows for a visual representation of global restoration potential for degraded mangroves that can be used in developing climate policy.

Mapping ocean wealth explorer

Mapping ocean wealth explorer. The Nature Conservancy. Retrieved from: <http://maps.oceanwealth.org/>

The Mapping Ocean Wealth Explorer tool is a global data source that provides estimates of benefits provided by mangroves and coral reefs in flood protection annually and from catastrophic storms.

A Global Map of Mangrove Forest Soil Carbon at 30 m Spatial Resolution

Sanderman, J. et al. (2018). "A Global Map of Mangrove Forest Soil Carbon at 30 m Spatial Resolution." *Environmental Research Letters* 13, no. 5 (May 1, 2018): 055002. <https://doi.org/10.1088/1748-9326/aabe1c>.

This article uses a model of mangrove soil carbon measurements, projected globally, to determine the loss of soil carbon due to mangrove loss between the years of 2000 and 2015. The resulting database of mangrove soil carbon data and estimates of soil carbon loss can be used to develop mangrove protection and restoration plans as part of a nation's climate plans.