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# Emerging approaches to Forest Reference Emission Levels and/or Forest Reference Levels for REDD+

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# UN-REDD PROGRAMME

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The UN-REDD Programme is the United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD+) in developing countries. The Programme was launched in 2008 and builds on the convening role and technical expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). The UN-REDD Programme supports nationally-led REDD+ processes and promotes the informed and meaningful involvement of all stakeholders, including Indigenous Peoples and other forest-dependent communities, in national and international REDD+ implementation.

# Emerging approaches to Forest Reference Emission Levels and/or Forest Reference Levels for REDD+

October 2014

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# Executive summary

One of the elements countries need to develop to participate in REDD+ is a Forest Reference Emission Level and/or Forest Reference Level (FREL/FRL). The UNFCCC has defined FREL/FRLs as benchmarks for assessing each country's performance in implementing REDD+ activities. The purpose of this document is to inform countries seeking to develop FREL/FRLs for REDD+ with an overview of different approaches to FREL/FRLs and an analysis showing some emerging trends. The approaches presented are in most cases in a preliminary design phase and were developed and proposed by countries in the context of demonstration activities. FREL/FRL examples described in this document pertain to the following countries: Brazil, Chile, Costa Rica, the Democratic Republic of Congo, Ghana, Guyana, Mexico, Nepal, the Republic of Congo and Viet Nam. This document relies on publicly available information (in many cases from Emission Reductions Program Idea Notes, or ER-PINs, from the Forest Carbon Partnership Facility's website) and in some instances, complemented with information provided by country representatives. When available, the Annex will also include UNFCCC submissions. In some cases, as for Brazil, it may illustrate how FREL/FRL approaches can evolve in a country. Preliminary findings from summarizing different FREL/FRL approaches indicate that most countries opt for a stepwise approach, as suggested in Decision 12/CP.17, initially including a limited number of REDD+ activities and carbon pools, although many countries express their intention to expand the scope of their FREL/FRL as more complete and better quality data becomes available. Furthermore, it appears that most countries have chosen to initially elaborate a subnational FREL/FRL, as an interim measure and as allowed by Decision 12/CP.17.

This publication will be reviewed and updated periodically to ensure broad dissemination of new country examples and emerging trends and information on lessons learned.

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# Acronyms

| | |
|---|---|
| AD | Activity Data |
| AGB | Above Ground Biomass |
| BGB | Below Ground Biomass |
| BNDES | Brazilian Development Bank |
| CBM-CFS3 | Carbon Budget Model of the Canadian Forest Sector |
| CDM | Clean Development Mechanism |
| CF MF | Carbon Fund Methodological Framework |
| $CH_4$ | Methane |
| CI | Combined Incentives |
| $CO_2e$ | Carbon Dioxide equivalent |
| COFA | Guidance Committee of the Amazon Fund |
| COP | Conference of the Parties of the UNFCCC |
| CTFA | Technical Committee of the Amazon Fund |
| DRC | Democratic Republic of Congo |
| EF | Emission Factor |
| ER program | Emission Reductions program (term used by FCPF) |
| ERPA | Emission Reduction Payment Agreement (term used by FCPF) |
| ER-PIN | Emission Reductions Program Idea Note (term used by FCPF) |
| FACET | Monitoring the forests of Central Africa using remotely sensed data sets |
| FCPF | Forest Carbon Partnership Facility |
| FREL | Forest Reference Emission Level |
| FRL | Forest Reference Level |
| GCF | Green Climate Fund |
| GHG | Greenhouse Gas |
| GRIF | Guyana REDD+ Investment Fund |
| ha | hectares |
| HFLD | High Forest Cover, Low Deforestation Country |
| HWP | Harvested Wood Products |
| INPE | Brazilian National Institute for Space Research |
| IPCC | Intergovernmental Panel on Climate Change |

| | |
|---|---|
| ISFL | BioCarbon Fund's Initiative for Sustainable Forest Landscapes |
| JICA | Japan International Cooperation Agency |
| Landsat | Land Satellite (US Satellite series) |
| LiDAR | Light Detection and Ranging |
| MAD-MEX | Mexico's Activity Data Monitoring System |
| MEFDD | Ministry of Forest Economy and Sustainable Development of the Republic of Congo |
| MMA | Ministry of the Environment of Brazil |
| MRV | Measuring, Reporting and Verifying |
| $MtCO_2e$ | Million tonnes of $CO_2$ equivalent |
| $N_2O$ | Nitrous Oxide |
| NDVI | Normalized Difference Vegetation Index |
| NFI | National Forest Inventory |
| PDSA | Agriculture Sector Development Plan of the Republic of Congo |
| PES | Payments for Environmental Services |
| PRODES | Project for Monitoring Deforestation in the Legal Amazon |
| PRONAFOR | Mexican National Forestry Programme |
| REDD+ | Reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries |
| REM | Germany's REDD Early Movers program |
| SFM | Sustainable Forest Management |
| SOC | Soil Organic Carbon |
| tC | Tonnes of Carbon |
| $tCO_2e$ | Tonnes of $CO_2$ equivalent |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UN-REDD | The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation |
| VCS | Verified Carbon Standard |
| VCS-JNR | Verified Carbon Standard-Jurisdictional and Nested REDD+ |

# CHAPTER 1
# Introduction

## 1.1 Rationale of this publication

**The aim of this document is to help inform countries seeking to develop REDD+ forest reference emission levels and/or forest reference levels (FREL/FRLs) by providing a regularly updated overview of approaches developed under demonstration activities and submission(s) to UNFCCC. Thus, this document presents a range of approaches and methodological options taken to construct REDD+ FREL/FRLs.**

The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation (UN-REDD) works at the national and global levels to support the development and implementation of REDD+ activities and international consensus-building on the REDD+ process. Consistency with the United Nations Framework Convention on Climate Change (UNFCCC) is one of the guiding principles of the UN-REDD Programme.

To date, the UNFCCC Conference of the Parties (COP) has agreed on four decisions[1] related to forest reference emission levels and forest reference levels (FREL/FRLs) for REDD+, providing guidance for developing countries on 1) modalities for FREL/FRLs including guidelines for submission of information[2]; and 2) on the technical assessment of FREL/FRL submissions[3].

The purpose of this document is to provide examples of emerging approaches to FREL/FRL development adopted in different contexts, including for demonstration activities by countries seeking to take actions to reduce GHG emissions or enhance forest carbon stocks in the forest sector. The document shows that a range of different approaches, data sets and methodologies are being proposed by countries, at both national and subnational scales. Analysis is provided on technical features in the early development of FREL/FRLs. The list of country examples presented in this publication is not complete; not every country working on their FREL/FRL methodology is included in the analysis, which aims to be illustrative of the diversity of approaches taken rather than comprehensive. To date, only one country submitted a FREL under the UNFCCC which is why most examples are related to FREL/FRLs prepared for demonstration activities. This document will be regularly updated with additional information, including UNFCCC submissions of FREL/FRLs as they become available.

## 1.2 Introduction to Forest Reference Levels

Countries aiming to undertake REDD+ activities[4] under the UNFCCC are required to develop the following elements (Decision CP.16/1/Add. 1/par. 71):

> **(a) A national strategy or action plan;**
> **(b) A national forest reference emission level and/or forest reference level**[5] or, if appropriate, as an interim measure, subnational forest reference emission levels and/or forest reference levels, in accordance with national circumstances, and with provisions contained in decision 4/CP.15 [methodological guidance for activities relating to REDD+], and with any further elaboration of those provisions adopted by the Conference of the Parties;
> **(c) A robust and transparent national**[2] **forest monitoring system** for the monitoring and reporting of the [REDD+] activities ...
> **(d) A system for providing information on how the safeguards** ...are being addressed and respected throughout the implementation of the [REDD+] activities...

1 Decisions relevant to development of forest FREL/FRLs are: 4/CP.15, 1/CP.16, 12/CP.17, and 13/CP.19.
2 Decision 12/CP.17, Section II and Annex.
3 Decision 13/CP. 19 and Annex.
4 The five REDD+ activities, defined for the first time in Decision 1/CP.16, are: a. Reducing emissions from deforestation; b. Reducing emissions from forest degradation; c. Conservation of forest carbon stocks; d. Sustainable management of forests; and e. Enhancement of forest carbon stocks.
5 In accordance with national circumstances, national forest reference emission levels and/or forest reference levels could be a combination of subnational forest reference emissions levels and/or forest reference levels.

The UNFCCC COP has defined forest reference emission levels and/or forest reference levels (FREL/FRLs) as: "*...benchmarks for assessing each country's performance in implementing* [REDD+] *activities.*[6]

Four decisions[7] taken by the Conference of the Parties (COP) provide guidance on REDD+ FREL/FRLs. Key points made on the scale, scope, and other requirements for the construction of FREL/FRLs suggest they should:

- **Be expressed in tonnes of carbon dioxide equivalent per year**[8]**.** In other words other metrics, such as forest loss area, are not acceptable as FREL/FRLs under the UNFCCC.
- **Maintain consistency with national GHG inventories**[9]**.** Countries should not be using incompatible data, land cover maps, etc. for construction of FREL/FRLs. If the forest definition used for the FREL/FRL construction is different than the one used in the national GHG inventory, an explanation should be provided of why and how it differs. Consistency with national GHG inventories also means using the Intergovernmental Panel on Climate Change (IPCC) guidance and guidelines[10] as a basis for estimating forest-related GHG emissions by sources and removals by sinks, forest carbon stocks, forest area and forest area changes[11]**.**
- **Be established transparently, providing information and rationale on FREL/FRL development**[12]**.** Countries are expected to submit information on data used for the FREL/FRL construction, including historic data and details on national circumstances, and if adjusted they should submit details on how national circumstances were considered. The description of data sets, approaches, methods and models, if applicable and assumptions used, descriptions of relevant policies and plans as appropriate, should be transparent, complete, consistent and accurate.
- **Allow for a step-wise approach**[13]**.** The decision enables developing countries to improve FREL/FRLs over time by incorporating better data, improved methodologies and, where appropriate, additional pools. It also suggests countries should update their FREL/FRLs periodically to take into account new knowledge, trends or any modification of scope and methodologies.
- **Allow for the use of subnational FREL/FRLs as an interim measure**[14]**.** Countries using subnational FREL/FRLs as an interim measure are expected to make a transition over time to a national forest FREL/FRL.

**Note on FREL/FRL terminology:** In UNFCCC COP decisions the term forest reference emission levels and/or forest reference levels (FREL/FRLs) is used. Though the UNFCCC does not explicitly specify the difference between a FREL and a FRL, the most common understanding is that a FREL includes only emissions from deforestation and degradation, where as a FRL includes both emissions by sources and removals by sinks, thus it includes also enhancement of forest carbon stocks. Some financing initiatives use different terminology, for example, the Forest Carbon Partnership Facility (FCPF) Carbon Fund Methodological Framework uses the term Reference Level. In this document when referring to published information (e.g. Emission Reductions Program Idea Notes, or ER-PINs), we use the same terminology used by the country, otherwise we use the generic term forest reference level or the acronym FREL/FRL.

6 UNFCCC, Decision 12/CP.17, paragraph 7.
7 Decisions relevant to development of forest FREL/FRLs are: 4/CP.15, 1/CP.16, 12/CP.17, and 13/CP.19.
8 UNFCCC, Decision 12/CP.17, paragraph 7.
9 UNFCCC, Decision 12/CP.17, paragraph 8.
10 As agreed by Parties to the UNFCCC. Currently developed countries must use the 2006 guidelines. According to Annex III of Decision 2/CP.17 developing countries should use the IPCC 1996 Guidelines plus the 2000 and 2003 Good Practice Guidance. Presumably developing countries who wish to do so may use the IPCC 2006 Guidelines.
11 The Methods and Guidance document produced by the Global Forest Observations Initiative (http://www.gfoi.org/methods-guidance-documentation) provides a systematic description of the link between IPCC guidance and guidelines and REDD+ activities.
12 UNFCCC, Decision 12/CP.17, paragraph 9 and Annex.
13 UNFCCC, Decision 12/CP.17, paragraph 10.
14 UNFCCC, Decision 12/CP.17, paragraph 11.

## 1.3 What is the purpose of Forest Reference Levels?

As agreed by the COP[15], FREL/FRLs are benchmarks for assessing each country's performance in implementing REDD+ activities. More broadly, FREL/FRLs may be relevant to assess country performance in contributing to mitigation of climate change through actions related to their forests. There could be several reasons for developing FREL/FRLs:

- Countries may wish to access results-based payments. According to UNFCCC decisions, results-based payments require a forest reference level[16].
- Countries may wish to assess progress on the outcomes of the policies and measures taken to mitigate climate change in the forestry sector for domestic reasons[17].
- Countries may wish to contribute to international mitigation through REDD+ actions under the UNFCCC.

It is possible that a single FREL/FRL can be prepared for more than one of the reasons cited. A country may also consider using different FREL/FRLs for different or combined reasons. An illustration of FREL/FRL examples is provided in below Figure 1.

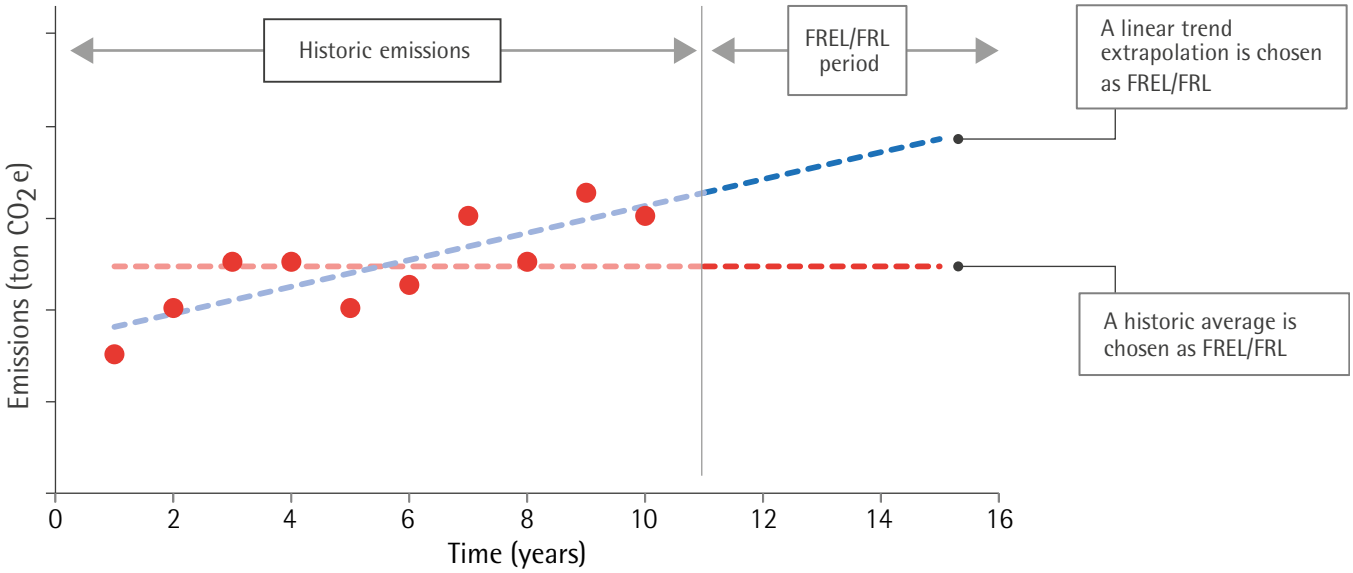


**FIGURE 1 Example of two FREL/FRL construction methods. The assessment of performance in implementing REDD+ against the FREL/FRL could be used for finance, for a mitigation contribution or for domestic purposes.**

## 1.4 Forest Reference Levels to seek payments for REDD+ results

The COP has provided guidance for the development (modalities) of FREL/FRLs and guidelines for their submission (Decision 12/CP.17) and their technical assessment (Decision 13/CP.19). The guidance for submissions and technical assessment will be further addressed in a forthcoming UN-REDD technical publication on FREL/FRL development. The most common reason for developing a REDD+ FREL/FRL is to access international finance linked to positive performance (or results) from implementing REDD+ actions. There is currently no operational financing mechanism under the UNFCCC that provides payments for REDD+ results, although the COP has agreed to a number of requirements that could assist in the operationalization of such a mechanism.

The UNFCCC has established the Green Climate Fund (GCF) (decision 1/CP.16) to support projects, programmes, policies and other activities in developing country Parties, and may provide results-based payments for REDD+ in the future. Yet, some uncertainty on REDD+ finance remains. A financing mechanism for REDD+ could be associated with a new climate

15 Decision 12/CP.17
16 Decision 9/CP.19, paragraph 11b and Decision 13/CP.19, paragraph 2
17 In the context of the UNFCCC it is not required to specifically monitor outcomes of policies and measures, but rather the results of REDD+ implementation in terms of emissions by sources and/or absorption by sinks, expressed in tonnes of $CO_2$e.

agreement (to be negotiated by 2015 and to come into force by 2020), could be created prior to such a new agreement (e.g. through the GCF), or financing may be part of a more fragmented system, where multiple countries create demand for emission reductions through national regulatory systems.

In the meantime, in addition to bilateral agreements, several specific programmes focus on finance for results-based REDD+ actions, including:

a) The Forest Carbon Partnership Facility (FCPF) Carbon Fund[18]

b) Germany's REDD Early Movers program (REM)[19]

c) The BioCarbon Fund's Initiative for Sustainable Forest Landscapes (ISFL)[20]

Each of these initiatives is designed to test results-based payments as part of Phase 2[21] of REDD+, i.e. demonstration activities, at the subnational or national scale. The FCPF and REM are focused on testing REDD+ payments, while the ISFL is a relatively new fund focused on landscape approaches, private sector engagement, and tackling agricultural drivers. The approach and requirements for forest reference levels may differ for each of these initiatives and a forest reference level developed under one initiative is not necessarily compatible under another. To date only the FCPF Carbon Fund has explicit guidance, found in its Methodological Framework (CF MF), for the development of Reference Levels[22]. One third party independent standard exists for jurisdictional (and nested) REDD+ and is being piloted by several countries (or jurisdictions within countries), created by the Verified Carbon Standard (VCS) and called the Jurisdictional and Nested REDD+ requirements (**VCS-JNR**[23]). Often these standards and initiatives provide additional requirements to what is specified under UNFCCC; an overview of each is given in Box1. Table 1 compares various forest reference level requirements under UNFCCC and under these key initiatives.

## Box 1. Overview of initiatives providing finance or guidance for measuring REDD+ results

**The Forest Carbon Partnership Facility's Carbon Fund:** The FCPF Carbon Fund is currently the largest multilateral fund with the intent to buy REDD+ emission reductions. The Fund aims to sign Emission Reduction Purchase Agreements (ERPAs), or advance commitments to purchase emission reductions. The Carbon Fund has developed a Methodological Framework[20] that provides criteria and indicators related to requirements for creating Emission Reductions that would be sold to Carbon Fund contributors.

**Germany's REDD Early Movers (REM)[21]:** REM is a global programme for REDD designed to reward pioneers in forest conservation and strengthen performance-based payments for demonstrated emission reductions by providing finance for countries that have already taken independent action towards mitigating climate change. It aims to assist in closing funding gaps and actively counter the frustrations related to the pace of the current REDD process of engaged partner countries (Early Movers). To date, Germany has signed one agreement with Acre (Brazil) but continues seeking "early movers" to finance.

**The Verified Carbon Standard's Jurisdictional and Nested REDD+ (VCS-JNR)[22]:** VCS is an independent carbon standard and the first to issue verified REDD credits (in 2011). It is currently the dominant independent forest carbon standard used in voluntary markets (57% market share). More recently, it created rules to account for emission reductions at the jurisdictional level and to manage "nested" projects integrated into national or subnational frameworks. The standard is being piloted by a number of countries and subnational entities. This document does not include forest reference levels prepared under VCS-JNR.

18 http://www.forestcarbonpartnership.org/carbon-fund
19 http://www.bmz.de/en/publications/topics/international_cooperation/FlyerREDD_lang.pdf
20 http://www.biocarbonfund-isfl.org/
21 Decision 1/CP16, paragraph 73, decides that activities undertaken by Parties should be implemented in phases. Phase 2 entails implementing demonstration activities to test and refine the methodologies, action plans and policies and measures defined during Phase 1.
22 The FCPF Carbon Fund uses the term 'reference level' for a forest reference level
23 http://www.v-c-s.org/JNR
24 The Carbon Fund Methodological Framework can be found at: https://www.forestcarbonpartnership.org/sites/fcp/files/2014/MArch/March/FCPF%20Carbon%20Fund%20Methodological%20Framework%20Final%20Dec%2020%202013.pdf
25 Information about REM can be found at: http://www.bmz.de/en/publications/topics/climate/FlyerREDD_lang.pdf
26 Information based on VCS-JNR program documents: http://v-c-s.org/program-documents/find-program-document

TABLE 1 Comparison of REDD+ forest reference level requirements

| Elements of FREL/ FRLs | UNFCCC | FCPF Carbon Fund | VCS-JNR | REDD Early Movers |
|---|---|---|---|---|
| **Scope – Activities** | One or more of the five defined REDD+ activities; significant activities should not be excluded; justification of why omitted activities were deemed not significant. | Deforestation required; degradation required (using best available data) where such emissions are greater than 10% of total; carbon stock enhancement voluntary. | Jurisdictions may choose from: Reduced Emissions from Deforestation and Degradation (REDD); Improved Forest Management (IFM); or Afforestation, Reforestation and Revegetation (ARR). | Focus is on deforestation. Over time the scope may be broadened to degradation, but no current intent to support carbon stock enhancement. |
| **Scope - Pools** | Significant pools should not be excluded; justification of why omitted pools were deemed not significant. | All significant pools (i.e. pools representing more than 10% of total); exclusion also allowed if demonstrated to be conservative. | All significant pools (i.e. pools representing more than 10% of total); exclusion allowed if conservative. | Not specified. |
| **Scale** | National or subnational as an interim measure. | National or "*of significant scale and aligns with one or more jurisdiction or a national government-designated area (e.g. eco-region)*". | National, subnational / jurisdictional, and nested programs / projects. | National or subnational/ biome level following a jurisdictional approach (methodology applied should be compatible with national strategy and policy goals). |
| **Reference period and number of data points required** | Not specified. | About 10 (and up to 15 maximum) years long; end date is most recent date prior to 2013 for which forest cover data is available; number of points not specified. | 8-12 year period for historical average; or 10 years for historical trend; at least 3 points required. | Not specified |
| **Monitoring requirement** | Data and information provided in an annex to the biennial update reports (BURs). | Activity data must be determined twice in the 5 year crediting period. | Monitoring and verification must be conducted at least every 5 years. | Not specified. |
| **Updating procedures** | Updated periodically taking into account new knowledge, trends and modification of scope or methods. | Purchases of ERs are only for 5 years during which no update is expected. | Jurisdictional baselines are fixed for 5-10 years and subsequently updated with the same periodicity. | Not specified. |
| **Emission factors** | Not specified. | IPCC Tier 2 or higher methods used to establish emission factors; in exceptional cases Tier 1 may be considered. | Use of Tier 2 or higher methods required, except for pools that represent less than 15% of total carbon stock (default data may be used). | Not specified, but supports use of conservative approaches including carbon content estimates. |
| **Representation of land** | Not specified | Approach 3 required for deforestation; other sinks and sources may use alternative methods. | Approach 3 required for deforestation; degradation/enhancement may be monitored using direct (e.g. remote sensing) or indirect (e.g. timber harvesting data). | Not specified. |
| **Uncertainty/ Accuracy threshold** | No thresholds are provided for the accuracy of data. | Sources of uncertainty are identified and assessed; uncertainties related to activity data and emission factors are quantified. Based on the level of uncertainty, a prescribed amount of emission reductions are placed in a buffer reserve. | Methodology should provide a means to estimate a 90 or 95% confidence interval. Where a 90% confidence interval is applied and the width of the confidence interval exceeds 20% of the estimated value or where a methodology applies a 95% confidence interval and the width exceeds 30%, an appropriate deduction shall be applied. | Not specified. |
| **Possibility to adjust from historical data?** | Allows "adjustment for national circumstances"; no further guidance provided. | FREL/FRLs should not exceed average annual emissions over the reference period. An exception is made for countries with high forest cover and historically low deforestation to allow for upward adjustments. An adjustment of the Reference Level above the average annual historical emissions during the Reference Period may not exceed 0.1%/year of Carbon Stocks. | Use of UNFCCC baseline or at least two alternative baseline scenarios must be developed: (1) historical annual average over an 8 to 12 year period; and (2) historical trend based on changes over at least 10 years. Modeled adjustments reflecting national or subnational circumstances may be presented. The jurisdiction must determine the most plausible baseline and justify its selection. | Prefers usage of historical deforestation data (not projections) to ensure transparency and credibility. |
| **Other requirements** | Consistency with national GHG inventory submissions (including forest definition used). Methodological IPCC Guidance and guidelines to be used as adopted or encouraged by the COP. | Strives to be consistent with UNFCCC guidance: Consistency with UNFCCC submissions of national GHG inventory (including forest definition used). Methodological IPCC guidance and guidelines to be used. | VCS requires independent, third party verification of results. | Expects significant "own contribution" based on country capacity. |

## 1.5 Explanation of case studies contained in this document

There are few existing forest reference levels in developing countries to date and nearly all have been created for accessing finance under different initiatives. Those in operation (i.e. receiving results-based payments against the forest reference level) include one developed by Brazil[27] (for the Amazon Fund), one created in the context of a bilateral negotiation between a donor and recipient country (the Norway-Guyana Letter of Intent), and one agreed by a jurisdiction and donor country (Acre's participation in Germany's REM program).

There are a number of FREL/FRLs under development. The examples provided in this document are based primarily on publicly available information, and the largest number of publicly available examples are found in the preliminary development of Reference Levels contained in the Emission Reduction Program Idea Notes (ER-PINs) submitted to the FCPF Carbon Fund. They are not yet considered finalized and may be changed in the Emission Reduction Program Document, which is required prior to signing an Emission Reduction Payment Agreement. Furthermore, countries may be developing different approaches at the national level alongside the approaches presented here.

To be accepted by the Carbon Fund, Reference Levels must adhere to the Carbon Fund Methodological Framework[28] (CF MF). In particular, the CF MF states that *"The Reference Level does not exceed the average annual historical emissions over the Reference Period. For a limited set of ER Programs, the Reference Level may be adjusted upward by a limited amount above average annual historical emissions. For any ER Program, the Reference level may be adjusted downward"*.[29] While the UNFCCC does not provide details on what is considered to be an adjustment in the creation of the FREL/FRL, under the CF MF an upward adjustment is considered anything above the 10 year historical average of estimated emissions. Such an upward adjustment is, under the CF MF, only allowed for countries with high forest cover and whose deforestation rates have been historically low (i.e. high forest cover, low deforestation countries—or HFLDs).[30] Due to this CF MF requirement, the majority of the examples taken from ER-PINs use a historic average except in the case of the DRC which qualifies as an HFLD country.

In summary, choices of FREL/FRL approach and the data used may depend strongly on the country context, including its rate of deforestation, availability of data, technical capacity, financial resources, governance structure and size of the country. It is important to note that FREL/FRLs presented in this document sometimes follow requirements which may be more specific than the guidance provided by UNFCCC. In some cases, in the context of different multilateral and bilateral initiatives, FREL/FRLs were developed before the guidance provided at COP19 (Warsaw).

27 The Brazilian state of Acre, which has signed an agreement with the German Government for financing through the REM program, uses the same methodology and data as the Amazon Fund, so is not covered in this paper.
28 The Carbon Fund Methodological Framework can be found at: https://www.forestcarbonpartnership.org/carbon-fund-methodological-framework
29 Criterion 13 in the Methodological Framework.
30 Indicator 13.2(i) in the Methodological Framework.



# CHAPTER 2
# Examples of REDD+ Forest Reference Levels

*Developing countries are at various stages of REDD+ forest reference level development.*

As of October 2014, Brazil is the only country that has submitted a REDD+ FREL to the UNFCCC (this example, as the first one formally submitted under the UNFCCC, is summarized in an annex to this document). A technical assessment of this submission is expected to provide feedback on this first UNFCCC submission before the end of 2014.

One country (Guyana), and two subnational jurisdictions (Acre state and the Amazon biome in Brazil), have operational forest reference emission levels—i.e. programs that have received payments for performance against such levels from a financing initiative. Several other countries have submitted an Emission Reductions Program Idea Note (ER-PIN) or presented early ideas to the FCPF Carbon Fund.

**TABLE 2. Comparison of selected operational and emerging REDD+ forest reference levels (as of October 2014)**

| | | | | |
|---|---|---|---|---|
| **Submission to UNFCCC** | Brazil* | | | |
| **Operational under different initiatives (not UNFCCC)** | Brazil - Amazon Fund* | Guyana* | Acre | |
| **ER-PIN in Carbon Fund pipeline** | Chile*<br>Guatemala<br>Peru | Costa Rica*<br>Indonesia<br>Rep. of Congo* | DRC*<br>Mexico*<br>Viet Nam* | Ghana*<br>Nepal* |
| **Early ideas presented to Carbon Fund** | Cambodia<br>Indonesia | Colombia<br>Madagascar | Ethiopia<br>Peru | Guatemala |

*Countries whose forest reference levels are summarized in more detail in the sections following. ER-PIN whose FRL are summarized in more detail in the sections following were those accepted into the pipeline prior to Sept 2014.

Many other countries and subnational jurisdictions are developing REDD+ forest reference levels. Most are in early stages with only initial views on how forest reference levels in their respective countries might be developed. Not surprisingly, countries with operational forest reference levels have more information available, with a higher level of detail, on the approach being employed, justification as to how the choice was made, methodologies and data used, and how performance is verified against the forest reference level. For this reason, we summarize here both Brazil and Guyana's approaches as well as the countries that have submitted ER-PINs to the FCPF Carbon Fund and been accepted into its pipeline: Chile, Costa Rica, DRC, Ghana, Guatemala, Indonesia, Mexico, Nepal, Peru, the Republic of Congo and Viet Nam. More examples may be added in future revisions to this document. Project based approaches are not covered in this document.

## 2.1 Brazil: A 10-year rolling average for the Amazon Fund

Brazil, a country with high technical, human and resource capacities has chosen one of the simplest approaches to establish the baseline (Brazil uses the term baseline for the Amazon Fund, the term FREL refers to Brazil's UNFCCC submission) used to initiate a national demonstration fund for REDD+, referred to as the Amazon Fund. The baseline was developed as part of the Amazon Fund's "rules for fundraising" and has been used to stimulate contributions through the establishment of a credible and transparent baseline used as a reference for payments based on reduced gross emissions from deforestation in the Brazilian Amazon. More recently, Brazil has submitted a forest reference emission level (FREL) to the UNFCCC—becoming the first country to do so. Information on the submitted FREL is provided in Annex A. The description of the Amazon Fund baseline is included in this document as an example of how a country may develop a forest reference emission level or forest reference level for use in demonstration programs prior to refining a FREL/FRL for submission to the UNFCCC.

**Approach:** Brazil's approach to establishing the baseline under the Amazon Fund was based on *an historical average of gross emissions from deforestation over a 10-year period*. The baseline is recalculated every 5 years, creating a "rolling average" (see figure below). For example: the baseline for 2011-2015 is calculated as the average of the annual gross deforestation from 2001-2010; the baseline for 2016-2020 as the average of the annual gross deforestation from 2006-2015.

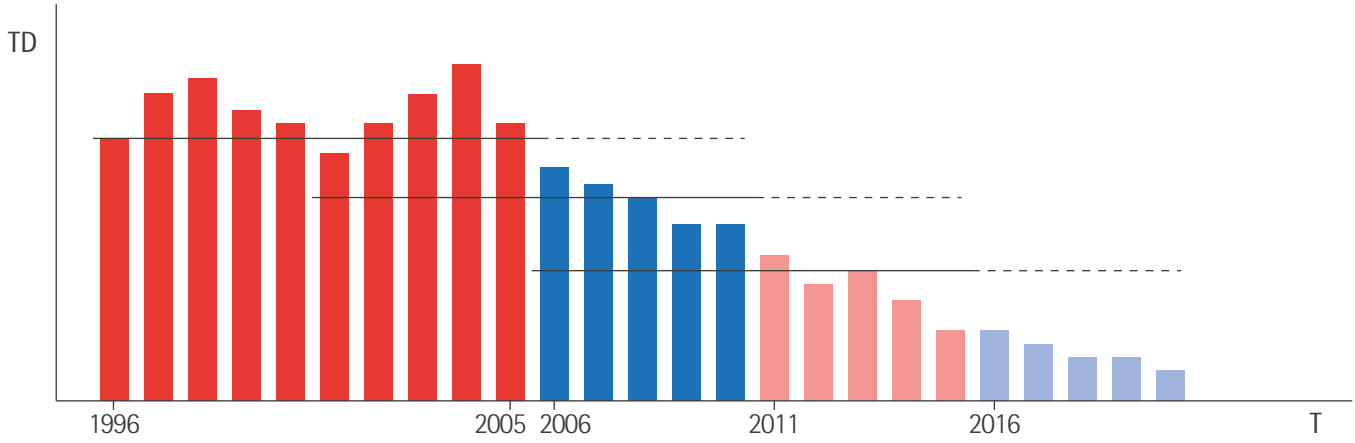


**FIGURE 2. Representation of the calculation model of deforestation reduction for calculation of the reduction of emissions**

Source: BNDES, 2009.

The calculation of the reduced emissions from deforestation is the following[31] (BNDES, 2012):

$$ED = (TDM - TD) * tC/ha$$

ED = Reduced carbon emissions deriving from deforestation, in tons of carbon (tC)
TDM = Average deforestation rate (in hectares)
TD = Annual deforestation rate for the period (in hectares)
tC/ha = Tons of carbon per hectare of forest

**Scale:** The baseline was established for primary forest in the Brazilian Legal Amazon region, a region that covers an area of 520 million hectares and includes five federal states—Acre, Amapa, Amazonas, Pará and Roraima—and portions of Rondônia, Mato Grosso, Maranhão and Tocantins.

**Scope:** The baseline includes only emissions from gross deforestation.

**Datasets and/or methodologies used:** Data are generated through the combination of activities and data gathering by the National Institute for Spatial Research (INPE) and the Ministry of the Environment of Brazil (MMA).

- **Measuring land use change (activity data):** Estimates of the annual rate of gross deforestation (in $km_2$) derive from the analysis of remotely sensed data at 30 meters spatial resolution, are the basic data from PRODES (Project for Monitoring Deforestation in the Legal Amazon) developed at the National Institute for Space Research (INPE) Project on an annual and wall-to-wall basis since 1988. The minimum area mapped by PRODES is 6.25 hectares (BNDES, 2012).
- **Emission factors:** Until 2011, the baseline for the Amazon Fund adopted a single, average carbon stock for aboveground biomass in the primary forests in the Brazilian Amazonia, conservatively set as 100tC/ha. However, upon recommendation by the Technical Committee of the Amazon Fund (CTFA), this estimate was raised to 132.2tC/ha in 2012, to include below-ground biomass. The Amazon Fund Activity Report (BNDES, 2012) suggests that this value can still be considered conservative given specialized literature suggests a range of between 130 and 320 tC/ha for the Amazon biome.
- **Expected improvements:** Currently PRODES allows Brazil only to monitor gross deforestation, defined as clear cut. It does not include areas affected by forest degradation (such as forest fires or selective logging). The CTFA suggests that further refinements—such as implementing degradation and/or improving carbon estimates—be implemented in the future as higher resolution data become available.

**Verification process:** The Ministry of the Environment (MMA) is responsible for preparing an annual technical note with the calculation of the reduced emissions from gross deforestation based on data produced by INPE. The CTFA meets once a year to review the methodology used and to verify that the estimated emission reductions from gross deforestation

31 Note that TDM is the average deforestation rate (in hectares) for the 10-year period that comprises the reference period for the baseline (e.g. 2001-2010), while TD is the actual rate of deforestation in each year (e.g. 2011, 2012, 2013, 2014 and 2015) for which reduced carbon emissions (ED) are calculated.

calculated by the Ministry of Environment are correct. The Ministry of Environment then sends the report to the Brazilian Development Bank (BNDES, the administrator of the Amazon Fund), that then sets the amount of allowable contributions to the Fund based on the results achieved and a pre-defined agreed carbon price of $\$5/tCO_2$.

**Comments on Brazil's approach:**

- **Simplicity.** Brazil's baseline approach is simple, including only one of the five REDD+ activities (reduction in deforestation) considered to be the most significant relative to the total national emissions. It follows an easy-to-implement methodology based on changes in primary forest cover and a single default value (average carbon stock per ha in biomass).
- **Strong country ownership.** The design and implementation of the Amazon Fund, assessment of data to construct the baseline, and monitoring and reporting is done entirely by the Brazilian Government.
- **High degree of transparency.** INPE has made all data freely and publicly available (on the internet since 2002). This has allowed civil society and other stakeholders to contribute to the improvement of the data and to monitor progress and has assisted enforcement of regulations to protect forests.
- **De-linkage of emission reductions from disbursement of funds.** Rather than making payments to communities or land/forest owners per ton of emissions of gross deforestation reduced on lands they own or manage, the Amazon Fund allows BNDES to focus its funding allocation on areas where it is needed most. This is done by setting criteria for projects—not carbon projects, but activities that contribute to policies that reduce deforestation—that can then apply for money from the Fund. For example, the 2012 report, developed by BNDES in coordination with the MMA, suggests that funding will focus on combatting unauthorized forest fires and burn-offs, as well as enhancing co-benefits such as biodiversity, environmental management and economic development. Funding decisions are made by the Guidance Committee of the Amazon Fund (COFA), a committee that includes participation from Brazilian states and civil society.
- **It is conservative in estimating actual emission reductions.** The conservative methodology (e.g. use of a conservative emission factor) does not provide potential access for funding the full amount of emission reductions from deforestation actually achieved. Given that this approach is being revised (see Annex A), it could in the future.

## 2.2 Chile: Including degradation through a step-wise approach

Chile is preparing six demonstration activities (jurisdictional approaches) which are being piloted simultaneously. However, to date there are two areas that have a higher level of progress: one (for the Mediterranean eco-region; regions of Valparaíso-Metropolitana and O´Higgins) is following guidance from VCS JNR, while the other (for the temperate eco-region; regions from Maule to Los Ríos) is using the Carbon Fund Methodological Framework (CF MF). The reference level[32] described in this section is the one recently proposed to the FCPF Carbon Fund using the CF MF. In Chile, the majority of emissions are related to forest degradation, not deforestation. Apart from assessing deforestation, Chile is therefore developing a methodology to assess its performance in reducing emissions from degradation.

**Approach:** Chile is proposing a step-wise approach for the inclusion of forest degradation. First historical emission estimates are developed based on official statistics on the consumption of logs and firewood, and on fires. This information will then be spatially distributed in the form of degradation polygons in maps.

**Scale:** The ER program area encompasses Chile's temperate rainforests, spread across the geopolitical regions of Maule, Biobío, Araucanía, Los Ríos, and Los Lagos (Figure 3). The total area measures 16,522,077 ha, with 8,439,338 ha of forest cover. Of the forested area, 2,700,759 ha correspond to plantations of exotic species, mainly of Pines and Eucalyptus. The forests in the ER program area represent 51% of the total national forest area and 92% of the total national exotic species plantation area.

32 Chile's ER-PIN (March 2014) refers most often to a Reference Level, so that is the term used here.

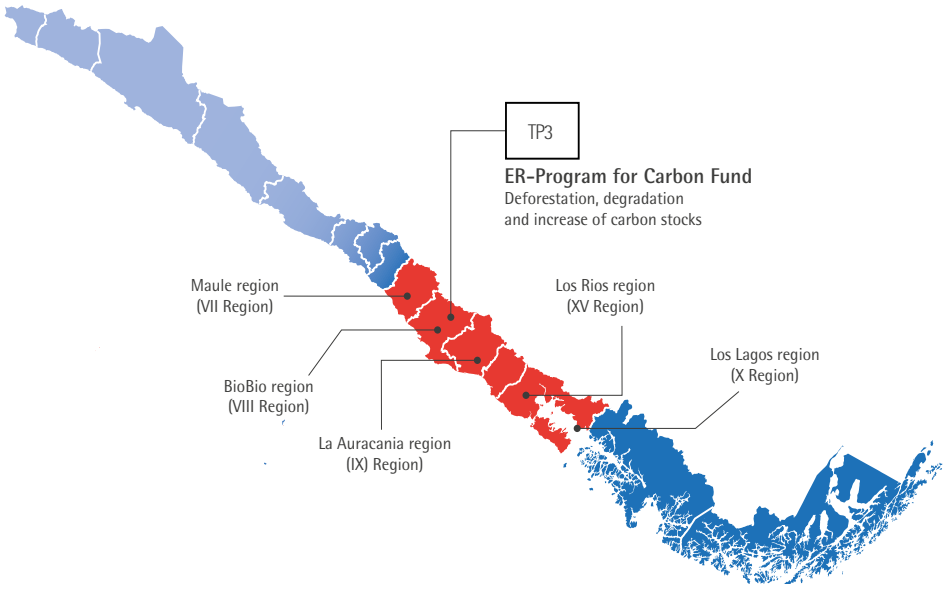


**FIGURE 3. Location of the area proposed for Chile's ER program: the temperate eco-region (consisting of 5 administrative regions)**

Source: Chile ER-PIN, 2014.

**Scope:** Deforestation, degradation and the increase of carbon stocks (afforestation and restoration of degraded native forests). Three pools were included in the present accounts of the ER program: above-ground biomass, below-ground biomass, and dead wood (though for degradation by fire or firewood extraction only above-ground biomass is counted). Litter and soil organic carbon were not included due to lack of national data and to use the same information available in the third update of the national greenhouse gas inventory that will probably be presented officially to the UNFCCC in the Conference of the Parties 20 (COP20).

**Forest definition:** Chile uses the forest definition submitted to the Clean Development Mechanism, which applies a minimum area of 0.5 hectares and a minimum tree cover of 10% for arid and semi-arid conditions and 25% for more favourable conditions.

**Datasets and/or methodologies used:** Chile emphasizes the importance of maximum consistency between its GHG inventory and the reference level establishment and therefore proposes the use of its Land Registry (Catastro) of Native Vegetation sources.

- **Measuring land use change (activity data):** The activity data presented to the CF on deforestation and afforestation is derived from Chile's Land Registry (*Catastro*) of Native Vegetation sources dating back to 1997 and subsequent updates (see Table 3). In 1997, the Land Registry produced a detailed cartographic representation with the aid of a thematic mapping of land use, vegetation and forests throughout the national continental territory. This required the interpretation of 50 thousand aerial photographs. Access to more advanced technology has, over time, made it possible to develop a methodology for correcting errors caused by instruments that were used in the initial phase. Degradation is assessed with statistics on consumption of logs and firewood and on forest fires (see Table 4). The reference period chosen by Chile is 15 years from 1998-2012, and it uses the same reference period for all activities.
- **Emission factors:** Carbon stock estimates are derived applying a set of commercial and allometric volume equations to inventory data and official statistics (Table 4). For land use changes Chile is using the stock-change method, while for degradation activities, the gains and losses method is used. Chile's approach to estimating EF can be considered Tier 2.

**TABLE 3. Years of Land Registry (*Catastro*) updates by region.**

| Regions | Base year | First update | Second update | Third update |
|---|---|---|---|---|
| El Maule | 1997 | 1999 | 2009 | |
| Bio Bio | 1997 | 1998 | 2008 | |
| Araucanía | 1997 | 2007 | 2014 | |
| Los Ríos | 1997 | 1998 | 2006 | 2014 |
| Los Lagos norte | 1997 | 2006 | 2013 | |
| Los Lagos sur | 1997 | 1998 | 2013 | |

Source: Chile ER-PIN, 2014.

**TABLE 4. Overview of activity data and emission factor estimation per REDD+ activity included in the reference level**

| Activity | Activity Data | Emission Factors |
|---|---|---|
| Deforestation | Land Registry (forest to non-forest) | Inventory of wood energy and carbon, a set of commercial and allometric volume functions for calculating biomass and carbon. |
| Degradation | Land Registry (coverage levels) and statistics on consumption of logs and firewood and on forest fires where possible with spatial representation. | Inventory of wood energy and carbon, a set of commercial and allometric volume functions for calculating biomass and carbon.<br>Inventory data provided by the Forestry Institute (INFOR), Universities, among others. |
| Forestation | Land Registry (non-forest to forest) and statistics on forest plantations. | A set of commercial and allometric volume functions for calculating biomass and carbon. Using several rotations in the case of plantations.<br>In the future, agreements with companies with forest plantations that can provide data on them permanently. |

Source: Chile ER-PIN, 2014.

The REL (historical annual average) for deforestation is 615,541.54 $tCO_2e$, for the period 1998-2012. The main change in land use affecting emissions is the change from native forest land to pastureland (85 % of the total deforestation).

Degradation estimates included in the ER-PIN are degradation by commercial timber harvesting, fuelwood extraction and fire in native forest lands, and the conversion of native forest to forest plantations of exotic species (see Table 5). Forest land is sub-divided into native forests and plantations as done in the third revision of the GHG inventory most likely to be submitted in December 2014 (COP20). Degradation only occurs in native forest lands. CONAF declared some years ago that all forest fires in Chile are anthropogenic in nature, thus all fire events in native forests are considered human induced forest degradation. The change analysis of forest cover classes from one time period to the next showed differences that cannot be explained by degradation as such, but is likely to be associated with different technologies used according to the updating dates of the Land Registry. Chile is still exploring how to spatially link emissions from degradation activities based on changes in native forest cover percentage provided by analysis of the Land Registry. A different approach for the spatial identification of degradation is tested for the demonstration activity in the Mediterranean eco-region (undertaken under the VCS JNR) which explores the use of Landsat series (support of high-resolution hyperspectral images), with additional Normalized Difference Vegetation Index (NDVI) information to estimate changes in forest cover percentage. The method tested is based on a regression between NDVI and tree cover using input data from field validations and high spatial resolution images, so that tree cover changes can be derived from Landsat (medium resolution) imagery.

Table 5 shows that the forest degradation REL (the historical annual average) is around 15 $MtCO_2e$, or >20 times more than the estimated annual emissions from deforestation over the reference period.

**TABLE 5. Summary of average annual emissions from degradation during the reference period 1998–2012**

| Temperate Forests Jurisdiction | | | | |
|---|---|---|---|---|
| Category of land use | | Emission subcategories | | Annual losses of $CO_2$ by biomass removal |
| Initial land use | Land use during the reporting year | | | (metric tons $CO_2$ yr-1) |
| NFL | NFL | Loss of carbon through consumption of logs from native forest | | 1 511 784.86 |
| NFL | NFL | Loss of carbon through consumption of firewood from native forest | | 9 324 381.41 |
| NFL | NFL | Loss of carbon as a result of forest fires | | 2 565 025.98 |
| | | **TOTAL** | | **13 401 192.25** |
| Initial land use | New land use | Average annual change in carbon stocks in above- and below-ground biomass (metric tons $CO_2$ yr-1) | Average annual change in carbon stocks in dead wood (metric tons $CO_2$ yr-1) | Total average annual change in carbon stocks (metric tons $CO_2$ yr-1) |
| NFL | FTP | 1 234 481.88 | 643 756.92 | **1 878 238.80** |
| **TOTAL DEGRADATION** | | | | **15 279 431.06** |

Source: Chile ER-PIN, 2014.

**Comments on Chile's approach:**

- **Gradual shift to spatial representation of degradation.** Emissions from forest degradation are significant in Chile and therefore cannot be omitted. Currently, Chile is deriving degradation emission estimates from official statistics to be fully consistent with the emissions and removals reported in its (upcoming) national GHG inventory. However, Chile is exploring advanced methods to spatially locate the statistics-derived degradation estimates on maps
- **Consistency over accuracy.** Even though Chile may have more detailed data with higher accuracy available from local studies, it is opting to use national official data to assure full consistency of the REL with the emissions and removals reported in the GHG inventory.

## 2.3 Costa Rica: A Mosaic Approach

Costa Rica is a pioneer of payment for environmental services (PES). Since 1997, it has implemented a program that provides payments for forest protection and restoration that resulted in the preservation and restoration of almost a quarter of Costa Rica's land area. The program is largely financed through domestic fuel tax revenues. Costa Rica has proposed a REDD+ program to the Forest Carbon Partnership Facility's Carbon Fund that builds on its experience with PES and assumes a reference level that would only compensate the country for additional activities beyond its existing policies and programs.

Costa Rica is currently in the process of redesigning its National Reference Level where instead of the mosaic approach described here and proposed in the ER-PIN, it will apply an approach that estimates the impact of multiple forest-related policies and measures. This is a more conventional and less complicated approach for a national Reference Level, which seeks to account for early REDD+ actions. The emission reduction program referred to below, including its approach, scope, data and methods used, will be modified accordingly.

**Approach:** Because Costa Rica already has in place a PES system, the REDD+ activities that Costa Rica intends to implement, linked to avoided deforestation and activities to enhance carbon stock, would focus on expanding the system already in place to an additional 341,946 hectares of private lands and indigenous territories. The Figure below denotes a scenario (in blue) that illustrates carbon stocks in the absence of the PES program, a scenario with the PES program and the expected additional carbon stocks if the new actions under the REDD+ program were to be implemented. The proposed reference level for the ER program (2010-2020) is equivalent to the forest carbon stock on December 31, 2009.

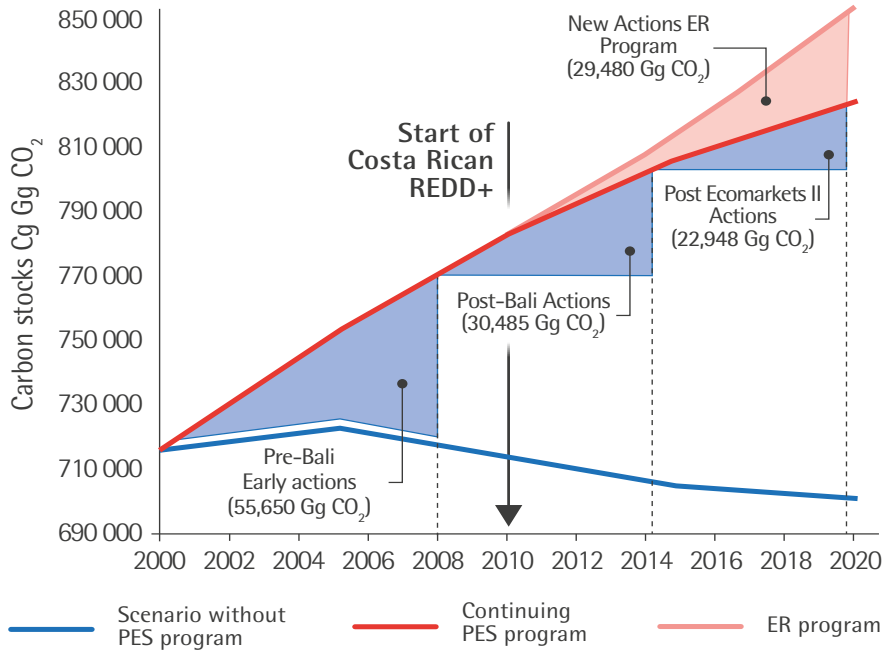


**FIGURE 4. Illustration of Costa Rica's reference level construction**

Source: Costa Rica ER-PIN, 2012.

**Scale:** Because activities are limited to particular land use types (see table 4), Costa Rica's Emission Reduction program will encompass a mosaic of lands within the national country boundary, i.e. a set of parcels of varying sizes, mostly less than 50 hectares each on private lands or indigenous territories. The program is implemented at the national level, under the same modality as the country's PES program. In this regard, the program is nested into a nation-wide measurement, monitoring, and possibly even accounting system (still to be determined).

**Scope:** The REDD+ activities included in the reference level are deforestation and enhancement of forest carbon stocks. Costa Rica has put forth six different REDD+ options based on land tenure

type (see Table 6) based on different activities and different types of land ownership. These are linked to the activities included in the reference level (through regeneration, establishment of forest plantations, or shift in use of harvested wood toward more long-lived products). It has calculated the mitigation potential of the following REDD+ options:

**TABLE 6. Description of six different REDD+ options considered in the Costa Rica ER-Program.**

| Option | Land Tenure | Emission reduction option | PES Area (ha) | ton $CO_2$ |
|---|---|---|---|---|
| A | Private Forests and Indigenous Territories | Incorporation of additional PES area for avoided deforestation in old growth forest | 107 600 | 8 540 929 |
| B | Private Forests | Incorporation of additional PES area for avoided deforestation in mid-regenerated forests | 19 191 | 628 952 |
| C | Private Forests | Incorporation of additional PES area for carbon capturing in new private regenerated forests | 124 282 | 6 505 287 |
| D | Private Forests | Incorporation of additional PES area for carbon capturing in new plantation forests | 72 132 | 8 019 422 |
| E | Indigenous Territories | Incorporation of additional PES area for carbon capturing in new regenerated forests in Indigenous Territories | 18 742 | 785 370 |
| F | Doesn't apply | Carbon storage in harvested wood products (HWP) by increasing wood consuption | - | 5 000 000 |
| | | **Total** | **341 946** | **29 479 960** |

Source: Costa Rica ER-PIN, September 16 2012

**Forest definition:** The definition submitted to the CDM (minimum canopy cover of 30%, minimum height of 5 meters, minimum size of 1 hectare) is used as a preliminary definition for its REDD+ program, but Costa Rica has also reserved the right to change the definition and revise its reference level once a final decision is made and adopted.

**Datasets and/or methodologies used:** Costa Rica is using preliminary estimations of deforestation and regeneration between 2000 and 2005.[33] Its national inventory for the LULUCF sector has been developed following the reporting requirements of Annex I Parties under the UNFCCC.

- **Measuring land use change (activity data):** Changes in forest area are assessed following the IPCC's Approach 3 for land representation (IPCC 2003). Costa Rica has an operational wall-to-wall system based on 30 m resolution Landsat forest cover maps, with a sampling approach to assess historical deforestation rates.[34] For the historical analysis, land use was reclassified from more detailed classes into three basic categories: forest, secondary forest and other use. Land use change dynamics since 1980 were studied (permanence and regeneration of forest) to determine the different forest successional stages and establish the mean age of regeneration during the preliminary reference period of 2000-2005.
- **Emission factors:** Carbon stock estimates for dry and wet forests are derived from sub-national data. Coarse carbon stock change estimates were derived from the combination with activity data as described above, assuming that forests reach full maturity at 35 years. The carbon pools considered are above ground biomass only.
- **Potential refinements:** Costa Rica is exploring the use of LiDAR; this airborne mapping method will be combined with the information from the forest inventory to reduce costs, improve accuracy, and reduce the uncertainty of the estimate of the change in the carbon. The goal is to reduce total propagated uncertainties below 20% for emission estimates. It is also hoped to provide estimates on emissions from degradation, which are currently excluded. The historic reference period will be expanded from 5 to 10 years (2000-2010). Costa Rica will also assess the possibility of including soil organic carbon.

33 Costa Rica's ER-PIN was submitted prior to the adoption of the Carbon Fund Methodological Framework, which requires a reference period of about 10 years, ending on the most recent date prior to 2013, for which forest-cover data is available.

34 When the ER-PIN was prepared, no studies had been conducted to evaluate the extent of anthropogenic degradation of biomass in Costa Rican forests. Costa Rica expects the implementation of the MRV system of the REDD Strategy to help estimate the forest degradation rate in the country.

**Comments on Costa Rica's approach:**

- **Additional efforts identified.** Costa Rica's approach indicates that the emission reductions and carbon stock enhancements it wishes to achieve through participation in the FCPF Carbon Fund will be in addition to those generated by existing policies and programs (see Figure 4: Costa Rica is only asking for payments for results from new actions).
- **Good understanding of uncertainties, leakage and permanence.** Costa Rica has calculated the uncertainty for all the activity data and emission factors that it plans to use in its emission estimates (and, in addition, provides total propagated error). Its presentation to the Carbon Fund also includes plans to mitigate reversal risks and potential displacement of emissions.
- **The mosaic approach may not suit many REDD+ countries.** The decision to focus REDD+ activities on small parcels of distributed lands (versus drawing a boundary around a larger jurisdiction) is suitable for Costa Rica—given its existing PES system that provides coverage over much of the country—but may not be easy to implement in other countries, particularly those with large land areas.

## 2.4 Democratic Republic of Congo: Aggregating Multiple RELs

DRC is a high forest cover, low deforestation (HFLD) country, currently undergoing major socio-economic changes, which has led to an influx of investments. Because of this, according to DRC it is difficult to rely solely on historical data to predict future deforestation. The DRC is using the Mai Ndombe region as its first demonstration pilot and is in the process of developing a subnational forest Reference Emission Level (REL)[35] for this future province. The information below is preliminary and based on the revised ER-PIN submitted to the FCPF Carbon Fund in May 2014.

**Approach:** The DRC has proposed a multiple land-use strata approach that adopts separate reference emission levels, using different methodologies, for each strata: legal logging concessions (where logging activities, considered in the ER-PIN as planned degradation, would occur), areas outside legal logging concessions (where planned and unplanned deforestation would be measured), and a conservation concession. DRC's approach also incentivizes tree planting and natural regeneration –in any of the strata- by allowing credits to be generated for activities in a clearly delineated area where sequestration is above the Business as usual (BAU) case. It aggregates these RELs to create a single, provincial reference level. The justification for such an approach is to incentivize actors to be responsible for their specific use of the land. The expectation is that actors will be rewarded for reductions in emissions for which they are responsible.

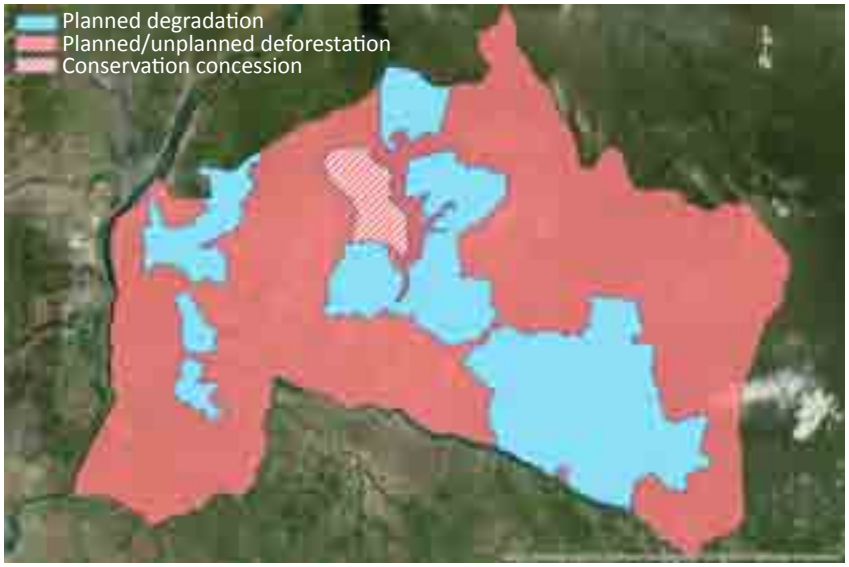


**FIGURE 5. Illustration of DRC's multiple REL construction for the Mai Ndombe region**

Source: DRC ER-PIN presentation, 2014.

**Scale:** The DRC is pursuing a provincial-level pilot for the Mai Ndombe region, which is 12.5 million hectares.

**Scope:** The following REDD+ activities are proposed for inclusion in the reference level: deforestation (unplanned and planned), degradation (planned) and enhancement of carbon stocks (through afforestation/reforestation). Unplanned degradation (e.g. caused by fuelwood collection, charcoal production, farming activities) is excluded from the FREL calculation, since according to DRC it is too difficult and costly to measure.

**Forest definition:** The DRC has submitted to the Kyoto Protocol (for participation in CDM) a definition of forest as giving a minimum canopy cover of 30%, a minimum

35 DRC's ER-PIN (Section 11, as revised in May 2014) refers most often to a Reference Emission Level or REL, so that is the term used here.

height of 3 meters and a minimum size of 0.5 hectare. However, the ER-PIN derives forest area and forest area change from Hansen *et al.* (2013) tree cover data, applying a forest/non-forest threshold of 50% crown cover. Furthermore, Hansen *et al.* data applies a minimum tree height of 5 instead of 3 meters. The ER-PIN therefore states that it sets more conservative thresholds for the definition of forest than the definition of the DRC.

**Datasets and/or methodologies used:**

**Measuring land use change (activity data):** To measure unplanned historical deforestation, Hansen *et al.* data (2013) is used; for planned degradation (in logging concessions), a modeling approach is used to estimate carbon stock loss which is based on the annual allowable cut and estimated post-harvest regrowth. Emissions related to the creation of logging roads and skid trails were assessed using Hansen *et al.* data (2013).

**Emission factors:** Currently carbon stock estimates for primary and secondary forests have been derived from peer-reviewed literature, or directly measured (e.g. by project proponents such as Wildlife Works Carbon); however, a Carbon Map & Model project, using LiDAR and new forest biomass ground measurements, will result in a carbon stock map covering the Mai Ndombe region with an anticipated accuracy of 80-83%.

Each of the reference (emission) levels calculated for different land uses will be aggregated into a single reference level for the province, plus an adjustment (described below):

$$\text{REL for FCPF Carbon Fund} = \text{REL}_{\text{UNDEF}} + \text{REL}_{\text{PLDEG}} + \text{REL}_{\text{AR}} + \text{REL}_{\text{CC}} + \text{Adjustment}$$

**TABLE 7. Methods of estimation of the RELs for the different strata**

| Strata | Description | Method of estimation | Activity |
|---|---|---|---|
| Unplanned deforestation | Administratively unplanned conversion of forest (i.e. no forest management plans or administrative records) | The ER-PIN used remote sensing (i.e. Hansen *et al.*, 2013 data) to estimate average land use change over a 10-year reference period; which data set will be used for a final REL is still under consideration; unplanned deforestation is also addressed by an adjustment. | Deforestation |
| Planned deforestation | Associated with documented development plans, e.g. roads, hydropower, urban spread, etc. | Difficult to spatially separate from unplanned deforestation in the historical data, so addressed by an adjustment which will be validated using infrastructure plans during design phase of the ER-Program. | Deforestation |
| Planned degradation | Logging in industrial forest concessions | Modelled approach used to estimate expected emissions based on allowable annual cut of each concession. | Degradation |
| Conservation concession | Lac Mai Ndombe REDD+ Project managed by Wildlife Works Carbon | Addressed by an adjustment. | Conservation |
| Afforestation | Tree planting and assisted natural regeneration | Set to zero since there was insignificant tree planting or assisted natural regeneration in the past. | Enhancement |

Source: DRC ER-PIN, 2014.

**The Adjustment:** The FCPF Carbon fund allows high forest cover, low deforestation (HFLD) countries to make an adjustment to their historic average emissions, which does not exceed 0.1% of total forest carbon stocks in the ER program area. The DRC has made three separate strata adjustments which jointly sum up to 0.1% of the total carbon stock in the program area:

1. **Unplanned deforestation adjustment:** The ER-PIN suggests that post-conflict macroeconomic conditions, in particular the magnitude of current and expected population growth, strongly suggest that the past is a poor predictor of the future Therefore, the DRC proposes a $\text{REL}_{\text{UNDEF}}$ adjustment which represents 0.069% of carbon stocks in the historical unplanned deforestation stratum. The adjustment is a preliminary modelled estimate of potential new forest areas opened, obtained by combining population projections up to 2020 and locally-derived estimates for hectares deforested for subsistence slash and burn agriculture per household and the fallow duration.
2. **Planned deforestation adjustment:** The ER-PIN suggests expected infrastructure development such as roads, village development, mining, and oil palm plantations will be better predicted by management plans rather than historical data. This adjustment is therefore obtained from official infrastructure development plans (e.g. plans for road construction, village development, extension of mining and creation of oil palm plantations) which will undergo due diligence prior to consideration (e.g. license approval letters).

3. **Conservation concession adjustment:** The Wildlife Works Carbon conservation concession is considered as an early action, avoided deforestation project and is therefore expected to have insignificant deforestation in the past. Past deforestation inside the conservation concession was assessed with Hansen *et al.* (2013) data to maintain consistency with other land use strata. The adjustment on top of this to account for the avoided deforestation was initially quantified by measuring historical emissions in a comparable reference area outside the ER-PIN boundaries (where the VCS similarity criteria apply). However, considering the adjustments already made in the other strata, the approximated adjustment following the VCS methodology made the sum of adjustments exceed 0.1% of the total carbon stock in the ER Program Area. Therefore, the final $REL_{CC}$ adjustment was set as the difference between the adjustments in the other strata and 0.1% of the total carbon stock in the ER program area, thus making the combined adjustments sum up to the mentioned 0.1% limit set by the Carbon Fund Methodological Framework.

**Comments on DRC's approach:**

- **Strong linkage between benefits/liabilities and actors on the ground.** Creating separate reference levels for each land use and rewarding actors directly related to such land uses can provide more direct incentives to community level actors. This requires not only development of multiple forest reference levels based on varying land use types, but also a balancing act between multiple actors to ensure equity in how the forest reference levels are constructed, since they are directly tied to future benefit sharing under the program.
- **The opportunity to demonstrate how a "nested" program can work in practice.** The aggregation of multiple RELs to create a jurisdictional REL, plus monitoring and reporting of performance at multiple levels, will make Mai Ndombe one of the first pilots of a nested approach. In addition, Mai Ndombe is the only ER program, of those highlighted in this document, to include a REDD+ project validated by a third party standard (i.e. Wildlife Works Carbon's Conservation Concession has been validated by the Verified Carbon Standard).
- **Inclusion of planned degradation.** The DRC is proposing to use a modelled approach based on the annual allowable cut in each legal timber concession to calculate its REL for historical degradation. Each concession's REL would then be used to provide incentives for concession owners, giving them the opportunity to implement (and be rewarded for) emission-reduction activities.
- **Matching data from Hansen *et al.*, (2013) with the national forest definition.** DRC is challenged to convert tree cover (change) estimates from Hansen *et al.* data into forest area (change) estimates that conform to the national definition. When submitting a FRL/FREL under the UNFCCC, in case there is a difference in the definition of forest used in the national greenhouse gas inventory or in reporting to other international organizations, an explanation of why and how the definition used in the construction of forest reference emission levels and/or forest reference levels was chosen should be provided.

## 2.5 Ghana: An agroforestry-based REDD+ program

Ghana's Cocoa Forest REDD+ Program is the first REDD+ program to suggest the inclusion of agroforestry. The proposed Forest Reference Level is a simple historical average activity data multiplied by emission factor approach to assess the performance of a multi-institutional, public-private sector, programmatic REDD+ approach to reducing degradation and deforestation driven by agricultural expansion. The ER Program is being designed to cover a period of 20 years, while recognizing the Carbon Fund is currently expected to end by 2020.

**Approach:** The development by Ghana of a National Forest Measurement, Reporting and Verification (MRV) System includes the development of a National Forest Reference Level (FRL) [36]. The National FRL is being developed based on eco-zones in Ghana (9 in total), as broad strata for which FRLs are or will be developed. The proposed FRL currently covers 5 eco-zones and the remaining 4 eco-zones will be added over time. An initial FRL for the Cocoa Forest REDD+ Program area has been proposed to the Carbon Fund in Ghana's ER-PIN, although it is anticipated that the FRL will be amended during the ER Program design stage and as the current National FRL is being developed.

**Scale:** The Cocoa Forest REDD+ Program area is defined by the boundaries of 5 eco-zones within which the main cocoa growing areas of Ghana exist. It covers approximately 5.9 million hectares and falls (partially) onto 5 of Ghana's administrative regions, including Eastern Region, Central Region, Ashanti Region, Western Region and the Brong-Ahafo Region.

36 Ghana's ER-PIN submission to the FCPF Carbon Fund, on which this section is based, uses the term "National FRL".

**Scope:** The initial FRL only includes deforestation (Table 8). Due to limitations for detecting forest degradation in Ghana, this activity is currently not included in the FRL. Forest degradation is anticipated to be a significant source of emissions in the ER Program area, causing gradual carbon loss in an estimated 67% of the forest land[37] within the ER Program. It is the objective of the MRV program to develop an approach using proxy data and some direct measurements to estimate emissions related to degradation and to include this in the National Forest MRV system. The carbon pools included are AGB and BGB. Reforestation is currently not yet included in the FRL (see Table 8) but this may be added in the design phase.

**Forest definition:** Ghana's REDD+ forest definition defines forest as having 15% canopy cover, trees of 5 meters height, and covering a minimum area of 1 ha. Shaded cocoa meeting these thresholds is considered open forest under this definition therefore Ghana's REDD+ forest definition does not exclude forest cover areas which are predominantly under agricultural use.

**Datasets and/or methodologies used:** Key design decisions have not yet been agreed; however the main elements of the MRV system are to develop an MRV system consistent with the use of IPCC Tier 2 for emission factors, and Approach 3 for land representation.

- **Measuring land use change (activity data):** The historical rates of forest cover change were established from available wall-to-wall classified satellite remote sensing data for the years 2000 and 2010. Additional data points were not available to inform the preliminary FRL; however it is anticipated that during the Design Phase additional data points will be integrated, including a post-2010 assessment of deforestation.
- **Emission factors:** IPCC Tier 2 emission factors or higher methods are used to estimate emissions, and the uncertainty for each emission factor will be documented. For the purpose of the ER-PIN, Ghana-specific data on aboveground biomass and belowground biomass has been developed for three strata with varying carbon stock in the above ground biomass pool:
  - » Closed forest (Intact forest)
  - » Open forest (Degraded forest and shaded cocoa farms)
  - » Cropland (Deforested landscape containing no-shade cocoa or food crops)

The Cocoa Forest REDD+ Program distinguishes two main forest types, closed forest and open forest. Closed forest covers just over 1.5 million ha in the program area and constitutes intact forest. Open forest represents degraded forests, secondary forests, and shaded cocoa farms, and covers approximately 3.1 million ha. The preliminary estimate of the average deforestation rate (1.4%/year) is equivalent to the loss of 28.5 $MtCO_2e$ per year (Table 8).

**TABLE 8. Forest Reference Emission Level for Cocoa Forest REDD+ Program for 2016–2035 (no annual variations)**

| | |
|---|---|
| **Total Area of Deforestation (ha/year)** | 82 168 |
| **Area of Deforestation in Closed Forest (ha/year)** | 26 932 |
| **Area of Deforestation in Open Forest (ha/year)** | 55 236 |
| **Emissions from Deforestation in Closed Forest ($tCO_2e$/year)** | 15 306 408 |
| **Emissions from Deforestation in Open Forest ($tCO_2e$/year)** | 17 640 520 |
| **Residual Carbon Stock (cropland) ($tCO_2e$/year)** | -4 458 986 |
| **Total Emissions from Deforestation ($tCO_2e$/year)** | 28 487 942 |

Source Ghana ER-PIN 2014

The estimate of total expected emission reductions, based on an estimate of successfully reducing the rate of deforestation by 45% over the lifetime of the program, less a 15% risk buffer, and not including any reduction in forest degradation or increase in reforestation over the 20 year lifetime, is 216.7 $MtCO_2e$.

37 Ghana's ERPIN: *"Emissions from forest degradation have not yet been quantified, although it is estimated from canopy cover analysis in 2010 that activities on approximately 3.1 million hectares or 67% of the forest land within the ER Program area is subject to gradual carbon stock loss"* (from land use chance 2000-2010 study). Degradation in Ghana's ER-PIN area is mainly caused by conversion to cocoa.

**Comments on Ghana's approach:**

- **Considering shaded cocoa as open forest** allows Ghana to include productive landscapes in REDD+ and in this way balance the high opportunity cost of cocoa plantations. This allows for what Ghana refers to as a landscape approach instead of only receiving REDD+ benefits for forest conservation.
- **No distinction between natural secondary forest and shaded cocoa.** Degraded natural forest and shaded cocoa are both grouped as 'open forest'. The suggested grouping would not monitor loss of natural secondary forest in case it is converted to shaded cocoa.
- **Stepwise approach.** Ghana is starting with a straightforward and transparent approach, with the aim to expand the scope of REDD+ activities following future data availability and its capacity to monitor the activities at the national level, if and when cost-effective methodologies become available. Ghana's approach ensures that its national capacity allows for its implementation while it may improve data and expand scope over time in a stepwise approach. Since Ghana indicated degradation to be a significant activity, it will have to provide at least a conservative estimate when submitting a FREL/FRL to the UNFCCC.

## 2.6 Guyana: Combined Incentives reference level in partnership with Norway

Guyana, through its partnership with Norway, is using a provisional national reference level[38] that guides the amount of payment Norway contributes to the Guyana REDD+ Investment Fund. To date, Norway has made three contributions to the Guyana REDD+ Investment Fund (GRIF) based on verified results as compared to the Combined Incentives (CI) reference level described below. In parallel to the use of this approach, Guyana is evaluating deforestation and degradation drivers and how various scenarios may be developed to establish a future reference level.

**Approach:** As a high forest cover low deforestation (HFLD) country, a purely historical reference level was not feasible for Guyana. Therefore, Guyana and Norway agreed on the use of a CI approach, whereby payments are made—in a sliding scale—based on a separate crediting (or payments) baseline (see Figure 6) based on the current deforestation rate. First, a payment calculation baseline is established as a midway point between the rate of deforestation in Guyana from 2000-2009 (0.03%) and the average deforestation rate for developing countries between 2005 and 2009 (0.52%), or a payment calculation baseline of 0.275%. A benchmark level of emissions is set as the deforestation rate in 2010 (0.056%). If Guyana exceeds this rate in any given year, payments are reduced on a sliding scale, up to a maximum deforestation rate of 0.1%, at which point there are no payments made.

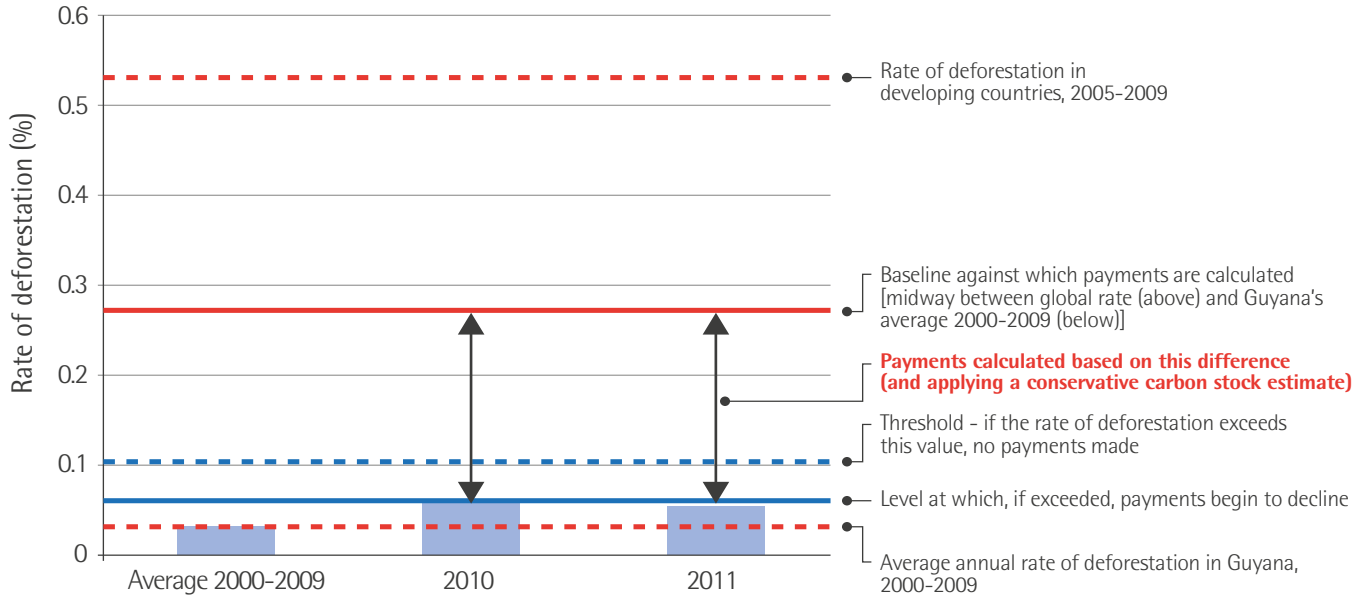


FIGURE 6. Guyana's Combined Incentives reference level

38 The term "reference level" is used, consistent with the Norway-Guyana Joint Concept Note.

Several key features of the Guyana-Norway agreement include:

- **The use of interim performance indicators:** This has allowed Guyana to start implementation immediately, and receive payments for results, while establishing a Measuring, Reporting and Verification (MRV) system. These indicators are included in the Joint Concept Note[39] agreed between Guyana and Norway. An example of these indicators is observed deforestation compared to the agreed reference level.
- **An agreed Roadmap to building a national MRV system.** The roadmap was created in consultation with stakeholders and includes: a national implementation strategy, status of current activities and capacities, requirements for the MRV system, a capacity gap assessment, and a roadmap including an institutional framework for implementation (Guyana Forestry Commission, 2009).

**Scale:** National level – coverage of the entire territory of Guyana, which is 21.5 million hectares. Forest cover is 87% of the territory, 73% of which is state-owned forests.

**Forest definition:** Minimum 30% tree cover, minimum height of 5 meters, over a minimum area of 1 hectare.

**Scope:** In the first two years of operation, the reference level has only included deforestation. However, the calculation of payments will subtract increased emissions from degradation on a tonne-by-tonne basis. Increased emissions from forest degradation are assessed with agreed indicators and their reference levels, and the subtraction is based on a conservative estimate of carbon density to calculate emissions from degradation. Examples of these degradation indicators are (among others) loss of intact forest landscapes and selective logging activities in natural or semi-natural forest (Office of the president, Republic of Guyana, 2013).

- Conversion of natural forests to tree plantations counts as deforestation with full carbon loss, and forest area converted to new infrastructures including logging roads are also registered as full carbon loss (unless field studies can justify the use of an alternative emission factor(s)).

**Datasets and/or methodologies used:** As a first step, Guyana completed a historic mapping of its forest area and deforestation from 1990 to 2010, based largely on Landsat (30m resolution) time series data. Forest cover as of September 2009 (18.39 million ha) has been used as a benchmark map for monitoring gross deforestation.

- **Measuring land use change (activity data):** The MRV system aims to adopt IPCC's Approach 3 for land representation to allow for the spatially explicit tracking of land use change, including by driver (e.g. mining, infrastructure, forestry). Forest to non-forest changes in Year 1 (2009-2010) were mapped spatially and reported using Landsat imagery. For the assessment in Year 2 (2010-2011), higher resolution (RapidEye, 5m) imagery was used over previously identified change areas, allowing better identification of change boundaries, drivers and areas of forest degradation. Furthermore, to assist with classification of forest change drivers and confirm conversions between land use categories, a number of aerial inspections were conducted.
- **Emission factors:** In the interim period, while the MRV system is being improved, a default value for carbon stocks of 100tC/ha is assumed.
- **Expected improvements:** Guyana expects over time to combine forest degradation and deforestation into a single national reference level. In addition, it expects to use Tier 2 emission factors as such data becomes available and the MRV system improves, and progressively move towards a Tier 3 approach.

**Verification process:** The Joint Concept Note between the Governments of Guyana and Norway sets out how Norway provides financial support to Guyana based on the delivery of results as measured against two sets of agreed indicators: REDD+ Performance and Enabling Activities. Monitoring reports are generated on an annual basis, and performance is independently verified by one or more neutral expert organizations appointed jointly by Guyana and Norway. Once verified, payments are calculated applying an interim carbon price of US$5/ton $CO_2$e.

39 http://www.lcds.gov.gy/images/stories/Documents/Joint%20Concept%20Note%20%28JCN%29%202012.pdf

**Comments on Guyana's approach:**

- **A step-wise and flexible approach.** The reference level agreed between Guyana and Norway allows for continuous improvement over time, including the addition of degradation (as the MRV system is developed) as well as an adjustment in the reference level approach consistent with UNFCCC decisions.
- **High degree of transparency.** Annual reporting on performance indicators and MRV progress is made available online, along with the independent assessments or verification reports.
- **Provision of incentives for a HFLD country.** The CI approach provides an opportunity for Guyana as a historically low deforestation country to receive payments for continued forest conservation.
- **An interim method to account for degradation.** The use of a proxy measure and conservative accounting (i.e. the use of a discount on payments received) is an innovative way to account for emissions while Guyana improves its ability to measure and monitor degradation more accurately.
- **Methodological approach differs from currently available standards and early financing initiatives.** Since the reference level was developed before guidance became available both from UNFCCC and third party standards/ early financing initiatives, the construction methodology of the combined incentives approach differs significantly from available guidance put forth by standards currently in operation (e.g. VCS-JNR), or multilateral funding instruments (e.g. the FCPF Carbon Fund).
- **Consideration of national circumstances.** Guyana expects future emissions to be well above its historically low emissions. Countries like Guyana face the challenge of estimating the magnitude of future emission increases. At the moment, Guyana's developing country average benchmark is not informed by national circumstances per se, but rather by international dynamics. However, Guyana is currently reviewing and redesigning its construction methodology of the reference level.

## 2.7 Mexico: Modeling carbon dynamics

Historic deforestation rates in Mexico fell to 0.24% between 2005 and 2010 (155,000 ha per year) (FAO, 2010). The efforts that the Government of Mexico has undertaken to reduce emissions through the National Forestry Program (PRONAFOR), including the special programs, will serve as a framework for the design and implementation of the Emission Reductions Initiative. Activities to reduce emissions under the initiative will be identified by communities and *ejidos* as priorities for the integrated management of their land and as the activities that, based on their experience, will best address the causes of deforestation and forest degradation. The activities will be carried out by communities and *ejidos* with the support of Implementing Agents and described in Investment Plans (Mexico ER-PIN 2013).

**Approach:** Mexico is testing and developing two different approaches for their reference level construction. One of these approaches is a relatively simple comparison of two national forest inventory (NFI) cycles (2004-2007 and 2009-2013) using a stock-change approach. The other approach, the one used to construct the preliminary Reference Level presented in the ER-PIN, is based on a gains and losses method using the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) (Kurz & Apps, 1999; Kurz *et al.*, 2009) which simulates carbon gains and losses combining empirical data (forest inventory, growth curves, forest management, disturbances) with a process modelling approach (dead organic matter and soil carbon dynamics).

**Scale:** Individual RLs were calculated for five federal states in a nested approach. The five states included in the ER-PIN - Campeche, Chiapas, Jalisco, Quintana Roo, and Yucatán (Table 9) are states with major forested areas subject to significant forest (carbon) loss pressures, high environmental value and development needs, but with the presence of local stakeholders and substantial progress on REDD+ preparation process . Mexico has proposed a top-down approach lead by the federal government for the construction of a national RL which allows for disaggregation into state RLs to ensure consistency in the use of data, methodologies and procedures, while at the same time the disaggregated RLs enable the assessment of the performance of REDD+ activities undertaken at the state level. The nested approach combines national level design with bottom-up state level monitoring.

**TABLE 9. Area of five states where the early REDD+ activities will be implemented.**

| State | Total surface (km²) | Forest cover (km²) |
|---|---|---|
| Jalisco | 77 965.88 | 49 838.80 |
| Chiapas | 73 611.94 | 37 462.19 |
| Campeche | 57 277.33 | 38 305.93 |
| Yucatán | 39 533.02 | 22 256.21 |
| Quintana Roo | 44 556.28 | 25 900.15 |

Source: Mexico ER-PIN, 2013.

**Scope:** Because the implementation of REDD+ in Mexico follows an integrated land management approach favoring Sustainable Rural Development, the RL should include all the activities to be carried out under the Emission Reductions Initiative that are aimed at reducing deforestation and degradation in forests, as well as conserving and increasing forest area and promoting sustainable forest management (SFM). REDD+ activities included in the preliminary RL presented in the ER-PIN include deforestation and carbon stocks enhancement both through forest area increase and growth in young forest stands. Though degradation and SFM may be included in the proposed REDD+ implementation activities, they are not yet fully included in the Reference Level but Mexico is working on its inclusion. $CH_4$ and $N_2O$ will be included in the reference level projections of emissions from forest fires.

**Datasets and/or methodologies used:**

**Measuring land cover changes (activity data):** Mexico's Activity Data Monitoring System (MAD-MEX) uses an explicit geographic approach to generate land cover change information for the entire country on a yearly basis (Gebhardt *et al.*, 2014). Currently Mexico is developing land cover maps for the years 1993, 1995, 1997, 2000, 2003, 2005, 2008, and 2010 through the classification of Landsat images. Starting in 2011, it is using RapidEye with the same methodology to assess deforestation in greater detail but at the same time it is continuing to use Landsat images for a consistent comparison with the historical Landsat images.

**Emission factors:** The stock-change approach Mexico used for its GHG inventory uses Tier 2 emission factor calculations derived from NFI data. The CBM-CFS3 model does not apply average emission factors to estimate emissions/removals of GHG related to a specific activity (e.g. the conversion of secondary forest to cropland), but rather calculates the emissions associated with the activities using non-linear functions that rely mainly on data from the NFI (e.g. volume over age growth curves, biomass expansion factors, dead organic matter decomposition rates). The simulation of carbon dynamics and the associated net emissions is considered a Tier 3 approach. However, concerning the data input of the model, current simulations only use local information for the aboveground biomass (AGB) dynamics and default information to simulate C transfers from live to dead C pools. Therefore some of the input data would be considered Tier 2. In upcoming versions, Mexico expects that all model parameters will be calibrated with data from Mexico, moving to a full Tier 3 approach.

The model simulates the forest carbon dynamics by stratifying the territory based on the intersection of 32 states and 7 ecoregions (resulting in 94 spatial units) (Olguín *et al.*, 2014). Within each spatial unit, carbon dynamics were characterized based on more detailed ecoregion information, forest cover type, forest management condition and whether it is located in an early REDD+ action area (see input data in Figure 7).

Once the CBM-CFS3 was parameterized with local information, a baseline scenario was developed (past GHG emissions/removals) that reflects the dynamics of forest carbon in the study areas for 1993–2011, as a result of the losses and gains in forest cover. To estimate the area affected annually by these processes, the study area was intersected with the 13 land cover classes considered in Mexico´s Activity Data Monitoring System (MAD-MEX). This information was then joined with the ecoregion maps, natural protected areas, managed forest areas and the REDD+ early action areas. Based on this new map transition matrices were generated for each period of change (Olguín *et al.*, 2014).

For the reference level based on the gain and loses method (Figure 8), it was assumed that the annual rate of net change in the forest cover for the historical period (2002-2011) remained constant between 2012 and 2020 (Reference Level scenario). Accordingly, CBM-CFS3 simulates the system behaviour and the emissions related to this assumption of historical average forest area change.

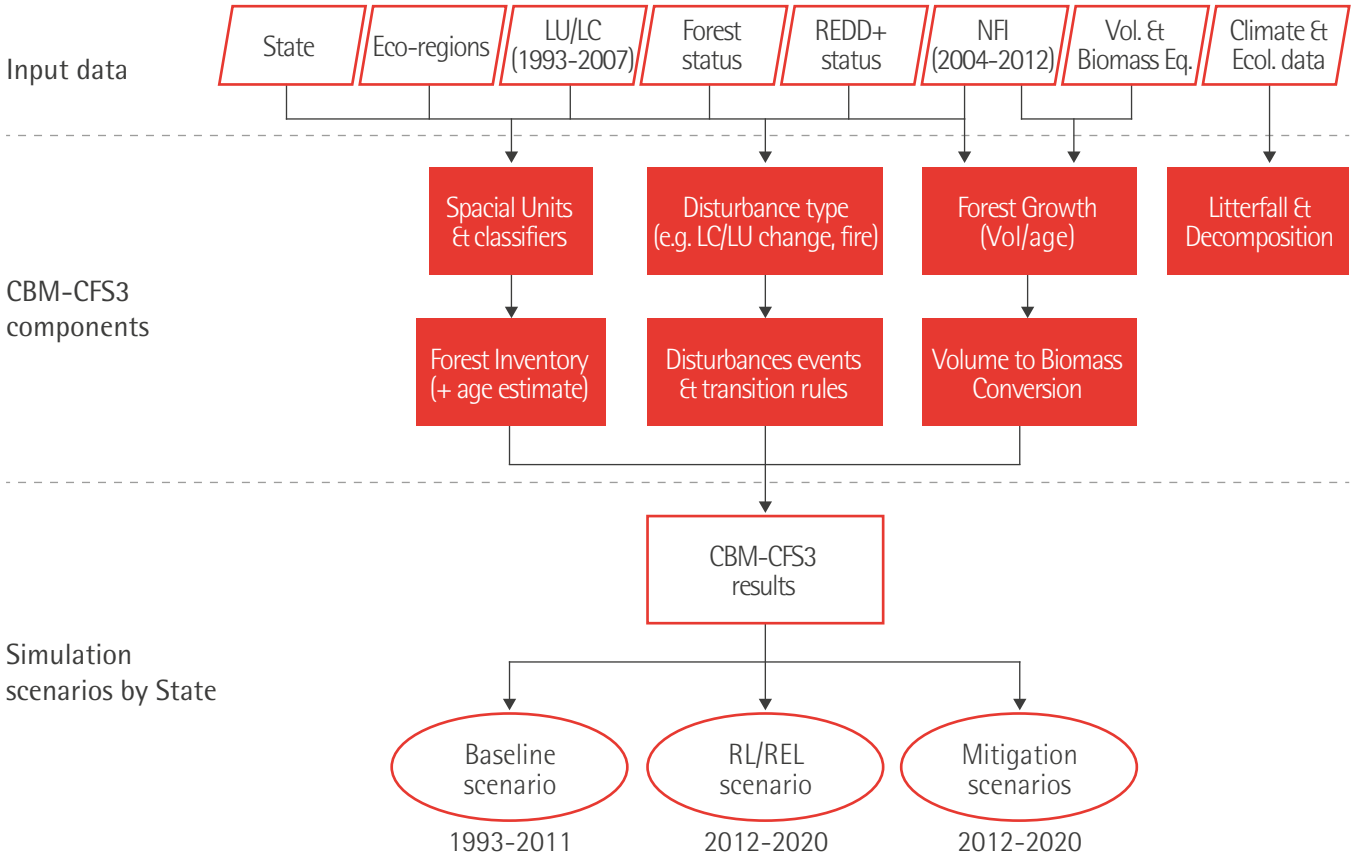


**FIGURE 7. Flow chart showing the sources of information used as input for the CBM-CFS3 simulations**

Source: Mexico ER-PIN, 2013.

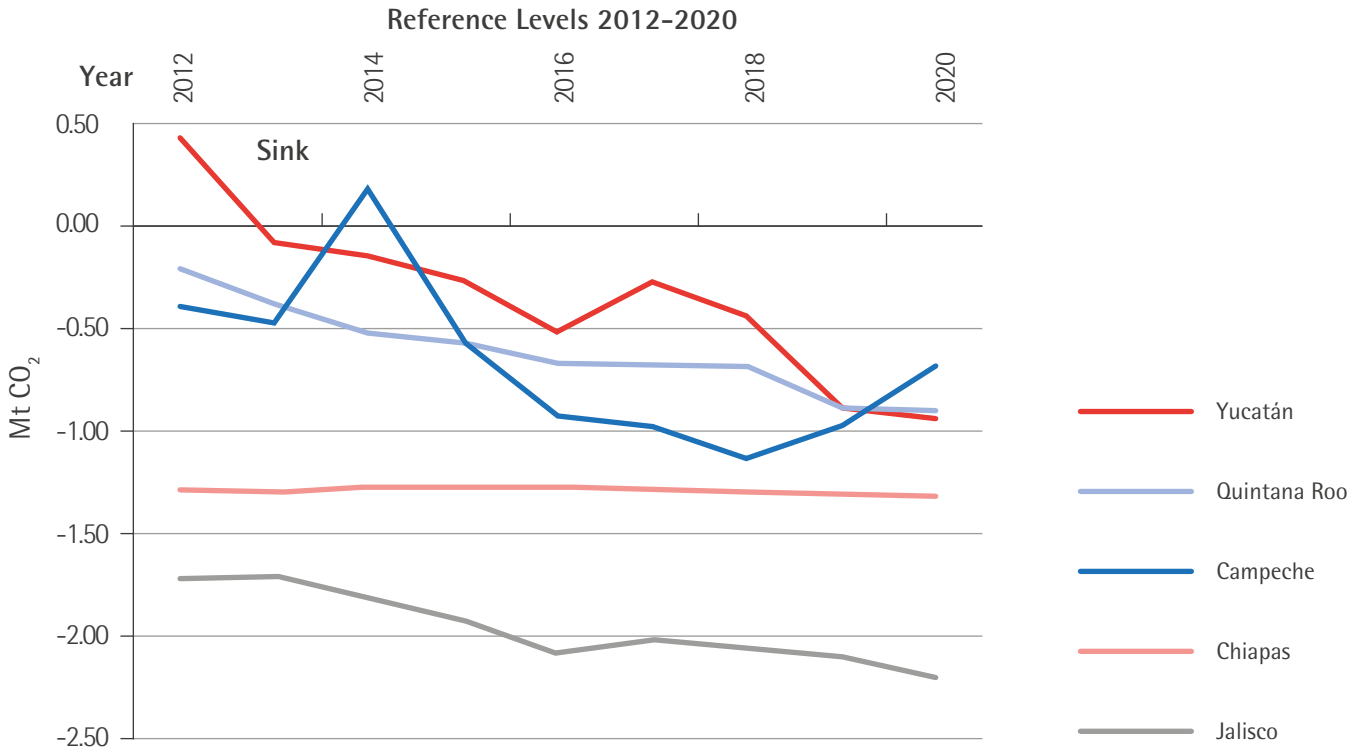


**FIGURE 8. Preliminary Forest Reference levels for the five Mexican states where the Emission Reduction Initiative will be implemented**

Source: Mexico ER-PIN, 2013.

**Comments on Mexico's approach:**

- **Consistency between subnational and national level.** The top-down national RL design and bottom-up activity implementation and monitoring ascertains consistency between the subnational and national level while it allows for monitoring of REDD+ activities implemented at the state level.
- **Testing different approaches to RL construction in demonstration activities.** Mexico is exploring two different approaches to create its reference levels. One approach consists of a comparison of two national forest inventory cycles (2004-2007 and 2009-2013) to estimate EF and overlapping of historic land cover maps to estimate AD in a stock-change approach. Previous national communications used information from the 2004-2007 NFI, following the stock-change approach. The other approach is based on the gains and losses method, which is the approach included in the ER-PIN submitted to the FCPF Carbon Fund. It is important to note that the approach that will be used in the development of the Emission Reduction Initiative could change depending on the results of the analysis of the two approaches. In some preliminary findings from the model development, Mexico has learned that the model requires local empirical information which is not systematic and nationwide. Independent of the approach used to develop the RL, the model can be useful for domestic purposes to generate scenarios and make management decisions. Methodological consistency will be ensured between the emissions and removals reported in the future national GHG inventory submissions and those used in the officially submitted FRL to the UNFCCC.

## 2.8 Nepal: Combining satellite imagery and field measurements to estimate degradation

Nepal has submitted an Emission Reductions Program Idea Note (ER-PIN) to the FCPF Carbon Fund, in which it proposes how it will establish a Reference Level (RL), as well as expected emission reductions from specific REDD+ activities it intends to pursue. The ER-PIN builds on existing experience with alternative sources of energy (e.g. biogas plants and cook stoves), and community and collaborative forestry and protected area management, including benefits sharing arrangements that are provided for, and have been implemented, through the 1993 Forest Act.

**Approach:** Nepal is using an historic average to determine its reference level, based on estimations of both emissions and removals, i.e. calculating gross emissions from deforestation and degradation, and subtracting removals from sequestration through forest regeneration. The basic equation used by Nepal is illustrated below and results in an RL calculation that is expressed in tons of $CO_2$eq per year.

$$\text{Reference level} = \frac{\Sigma Em_{def1} + \Sigma Em_{def2} + \Sigma Em_{def3} + \Sigma Em_{deg} + \Sigma Seq_{reg}}{y}$$

Where,

$\Sigma Em_{def1}$ - is the sum of emissions from deforestation of intact forest over "y" years,
$\Sigma Em_{def2}$ - is the sum of emissions from deforestation of degraded forest over "y" years,
$\Sigma Em_{def3}$ - is the sum of emissions from deforestation of regenerated forest over "y" years,
$\Sigma Em_{deg}$ - is the sum of emissions from forest degradation over "y" years,
$\Sigma Seq_{reg}$ - is the sum of sequestration from regeneration over "y" years,

**Scale:** Nepal is developing RLs at two scales: national and subnational. For this paper we highlight the development of the subnational RL being developed for the Carbon Fund. The scale of the subnational RL is the Terai Arc Landscape, which comprises 12 districts, or a total of 1.18 million hectares of which nearly 80% lies outside protected areas.

**Scope:** The RL includes deforestation, forest degradation and regeneration (enhancement of carbon stocks). Nepal has estimated forest degradation to be 13% of total emissions. Above-ground and below-ground biomass pools are included while the remaining pools (e.g. dead wood, litter, soil organic matter) are excluded. Nepal states that they do not significantly contribute to carbon stock enhancement and including them would increase measurement and monitoring costs.

In addition to the Terai landscape level RL, a district level analysis was conducted to better understand geographic trends and illustrates significant variation in the distribution of forest-related emissions.


**FIGURE 9. Terai Arc landscape (with 12 districts)**

Source: Nepal ER-PIN Annexes, 2014.

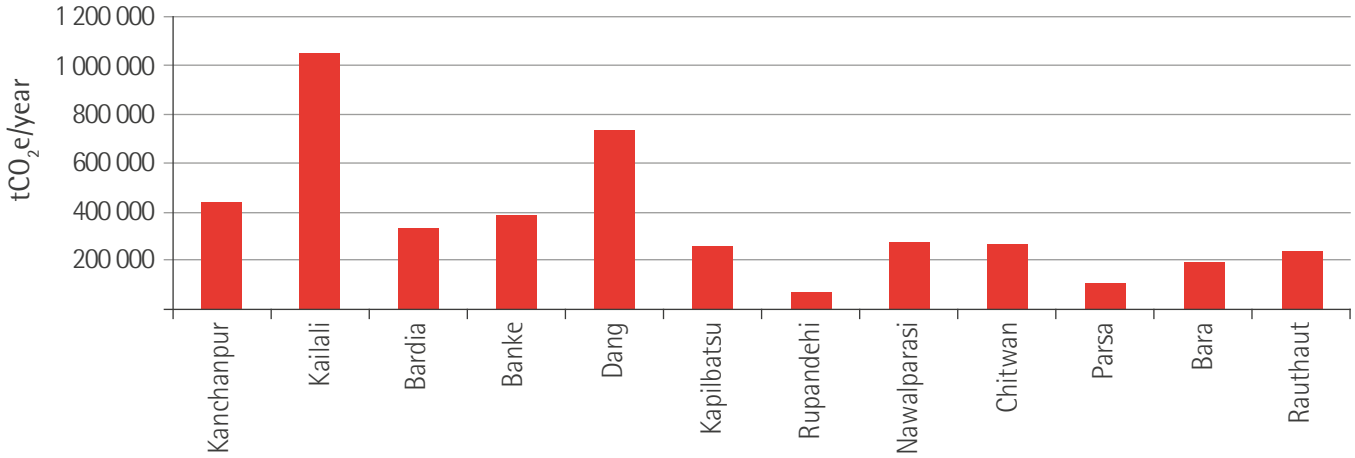


**FIGURE 10. Annual average emissions for Terai Arc Landscape districts between 1999 and 2011**

Source: Nepal ER-PIN Annexes, 2014

**Datasets and/or methodologies used:** Nepal is using airborne-collected LiDAR (covering 5% of the program area), Landsat and other satellite data.

- **Measuring land use change (activity data):** The starting year for measuring land use change is 1999, corresponding to the first year following the first 1994 national forest inventory when Landsat data that meets adequate seasonality and cloud cover standards are available. The end year for the reference period was chosen as 2011, as that is the year LiDAR data collection was conducted. Four time periods (1999-2002, 2002-2006, 2006-2009, 2009-2011) were chosen to measure deforestation (see below) because Landsat 5 imagery that met cloud cover and seasonality requirements were available for 1999, 2002, 2006, 2009 and 2011. The activity data are a change in each forest type from one structural class to another in the given time periods, i.e. Nepal is using spatially explicit land cover change assessment and conversion between classes (i.e. Approach 3 in IPCC Guidelines).

- **Emission factors:** Mean carbon stocks for 4 major forest types (sal[40], sal dominated mixed, other mixed and riverine forests) and 3 structural classes (intact forest, degraded forest and non-forest) are used as a basis for estimating emission factors. Emission Factors are estimated through the correlation of LiDAR-based mean carbon stock values (validated against field data) for each of the strata, although non-forest is assumed to be zero (despite such areas having various amounts of carbon stocks). An IPCC default value for dry tropical natural forests in continental Asia is used for areas where forests are undergoing regeneration.

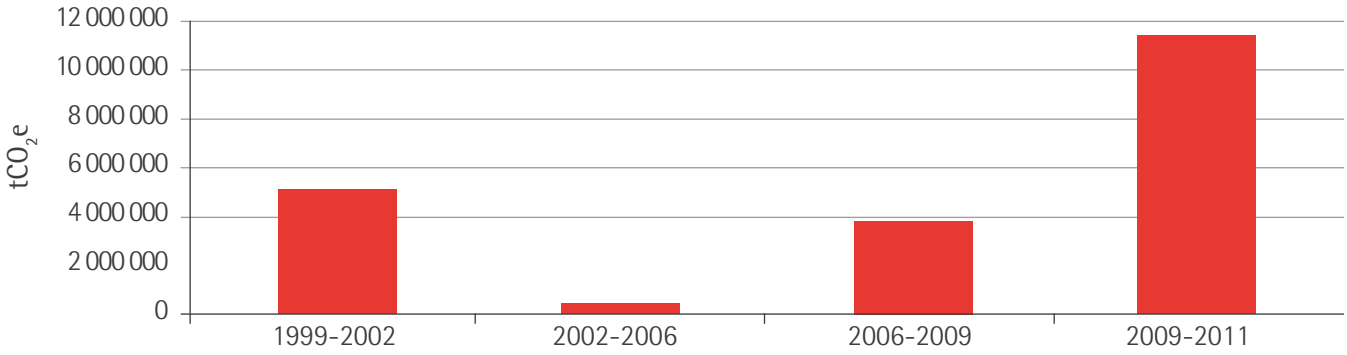


**FIGURE 11. Average annual $CO_2$ Emissions ($tCO_2e$) in the Terai Arc Landscape between 1999 and 2011**
Source: Nepal ER-PIN Annexes, 2014

The average annual emissions over the 12 year period 1999 to 2011 were 4 353 833 $tCO_2eq$/year, which is the proposed RL for the Terai Arc Landscape. Emissions were significantly higher in recent years, for example the average annual emissions in 2009-2011 correspond to 11 412 396 $tCO_2eq$/year, which is 162% higher than the proposed RL.

**Comments on Nepal's approach:**

- **Use of a historic average.** The use of a historic average is simple and compatible with emerging payment for performance systems.
- **Measuring degradation.** Degradation measurements started at a macro-scale (through estimation of closed, medium stocked, and open forests through density classes of 70%, 40% and 10%), but with field verifications this approach was deemed not appropriate. Using fuelwood use as the basis for quantifying emission from degradation was also considered, but this too proved impracticable. The approach submitted in the ER-PIN for measuring degradation is using average carbon stock values of degraded plots derived from field measurements linked to changes in forest structure classes from processed satellite imagery. Whether this is an appropriate methodology to account for degradation remains to be tested. Moreover more specific elements of forest degradation such as lack of regeneration, decreases in species diversity, or soil depletion can only be done through a continuous forest inventory, which can be costly. Nepal expects to do forest carbon monitoring every 5 years depending on the availability of resources.

## 2.9 Republic of Congo: An upwards adjustment based on government plans

The Republic of Congo indicates in the ER-PIN that the Reference Emission Level (REL) shall be designed in the context of the national MRV system, once established. The REL presented in the ER-PIN is preliminary and based on data from a number of studies conducted in the country, as the Republic of Congo has not yet undertaken a specific study to determine its REL for the purpose of the ER Program. The Republic of Congo found a fair amount of variability in these different studies, which it subscribes to different approaches and lack of agreement on fundamental elements such as the forest definition. The Republic of Congo expects that as the ER-PIN process moves forward, this variability will be reduced as elements such as the forest definition, allometric models, national inventories with permanent sample plots, and forest classification are formalized and validated by the Ministry of Forest Economy and Sustainable Development (MEFDD).

40 Sal (*Shorea robusta*) is the dominant species found in most of the Terai region

**Approach:** The Republic of Congo's REL is based on a historical analysis, adjusted upwards to more accurately reflect its unique national circumstances, as the Republic of Congo is a high forest cover, low deforestation (HFLD) country. Clear felling for oil palm and active road building began in 2012 and 2011 respectively, therefore to include these events, the Republic of Congo has chosen a reference period from 2000-2013.

**Scale:** The ER program area is composed of two administrative jurisdictions, namely the departments of Sangha and Likouala. Together they represent an area of 12.36 million hectares, with an average forest cover of 97%. The area is composed of six logging concessions (already granted to concessionaires), nine Forest Management Units for industrial logging and five protected areas.

**Scope:** The activities included in the REL concern planned and unplanned deforestation and planned degradation (see Table 10). The carbon pool considered is above ground biomass. The Republic of Congo considers the exclusion of below ground biomass as being conservative.

**TABLE 10. REDD+ activities and their data sources for the 2000–2013 reference period**

| Land Use Change Activity | Source of Data |
|---|---|
| Unplanned Deforestation ($REL_{UNDEF}$) | 2000-2010 FACET remote sensing data complemented with extrapolated data for 2011-2013 |
| Planned Deforestation ($REL_{PLDEF}$) | Palm oil activities launched since 2011 as confirmed by the Ministry of Agriculture |
| Unplanned Degradation ($REL_{UNDEG}$) | *Not included at this time* |
| Planned Degradation ($REL_{PLDEG}$) | 2002-2011 harvesting data submitted to the MEFDD for tax and compliance purposes and extrapolated data for 2000-2002 & 2011-2013; the latter will be updated during the ER-P design phase. |

Source: Republic of Congo ER-PIN, 2014.

**Forest definition:** The forest definition used in the ER-PIN was agreed to in March 2014 and consists of a minimum crown cover of 30%, a minimum land area of 0.5 hectares, and a minimum tree height of 3 meters.

**Datasets and/or methodologies used:**

- **Measuring land use change (activity data):** Unplanned deforestation is derived from FACET[41] data for 2000-2010, extrapolated to 2013. FACET makes use of an automated "wall-to-wall" remote sensing method, incorporating over 2000 Landsat ETM+ images. Given that the FACET data reveals a trend of increased forest cover loss, applying the annual average of 2000-2010 to 2011-2013 is considered a conservative estimate of unplanned deforestation. Emissions from planned deforestation (oil palm and road expansion) for 2011-2013 are included using estimates based on management plans, National Development Plans, Agriculture Sector Development Plans, and ground verification. Emissions from forest degradation are modelled using official timber harvesting data, including transformation rates, logs exported and the appropriate emission factors.
- **Emission factors:** For the purpose of the ER-PIN, the REL will stratify forest land into primary forest, secondary forest and wetland/swamp forest. The average carbon stock in primary forest is approximated with AGB values from the VCS validated and verified North Pikounda REDD+ project, representing terra firma mixed forest. Carbon stocks in secondary and wetland/swamp forest are adopted from Zapfack *et al.* (2013) who performed *in situ* measurements in Cameroon in similar forests as those in the ER program area.

The preliminary components described above will be aggregated to achieve a single historical REL for the ER program area using the following formula:

$$\text{ER program historic REL} = REL_{UNDEF} + REL_{PLDEF} + REL_{PLDEG}$$

Where:

$REL_{UNDEF}$ = REL of unplanned deforestation
$REL_{PLDEF}$ = REL of planned deforestation
$REL_{PLDEG}$ = REL of planned degradation

The preliminary REL is the historic REL plus an adjustment (see Table 11).

41 French acronym for monitoring the forests of Central Africa using remotely sensed data sets. The algorithms used are developed jointly by South Dakota State University and the University of Maryland (who produced the Hansen *et al.*, 2013 product). Therefore some similarity is expected between the results of FACET and the Hansen *et al.* 2013 data.

TABLE 11. REL calculation per activity plus adjustment

| Historical REL 2000-2013 | Average Annual REL ($tCO_2e$) |
|---|---|
| Historic Unplanned Deforestation ($REL_{UPLDEF}$) | 2 100.051 |
| Historic Planned Degradation ($REL_{PLDEG}$) | 2 851.791 |
| Historic Planned Deforestation ($REL_{PLDEF}$) | 1 206.273 |
| **Total Aggregated Sangha & Likouala Historical REL** | **6 158.115** |
| **Adjustment to REL (0,1% of 2010 carbon Stock)** | **5 112.412** |
| **Total Aggregated Sangha & Likouala REL, including HFLD Upward Adjustment** | **11 270.527** |

Source: Republic of Congo ER-PIN, 2014.

**The adjustment:** The Republic of Congo proposes an adjustment of the REL of 0.1% of the 2010 forest carbon stock in the ER program area, which is the maximum allowed adjustment under the FCPF. This adjustment totals an additional annual emission of 5.1 million tons $CO_2e$ which the Republic of Congo mentions is below what is actually anticipated to occur. A calculation of expected emissions from macro-agricultural projects suggests expected emissions of 5.5 million tons of $CO_2e$ being released annually between 2015-2035. This calculation is based on macro-agricultural zones set out in the Republic of Congo's National Development Plan and the Agriculture Sector Development Plan (PDSA) for Sangha and Likouala. The Republic of Congo furthermore illustrates increasing pressures on forest cover by providing prospects on economic growth, population increase and the expected development in mining.

**Expected improvements:** It is anticipated that future REL studies, conducted during the ER Program design and implementation phase will provide increased precision in relation to activity data and emission factors.

**Comments on the Republic of Congo's approach:**

- **Use of available existing studies while awaiting official nationally adopted data.** While awaiting the Republic of Congo's MRV system to be put in place and officially adopted, the Republic of Congo has based its preliminary REL on available data from a regional initiative (FACET) and detailed *in situ* studies assessing carbon contents in the country (or just across the border). This allows the Republic of Congo to construct a preliminary REL and participate in the FCPF Carbon Fund.
- **Adjustment justified with government plans.** The proposed adjustment by the Republic of Congo based on a calculation of expected emissions from macro-agricultural plans is transparent and constitutes a relatively simple approach to estimate expected future emissions from planned deforestation.
- **Inclusion of planned degradation based on historic timber harvesting data.** The use of modelled emissions based on official timber harvesting and log export data allows the Republic of Congo to include forest degradation in its REL providing incentives for conservation in part of the logging concessions.
- **Consistency of the Forest Definition.** The Republic of Congo adopted a forest definition in the context of REDD+ in March 2014[42] which differs from the forest definition used in the design of its National Forest Inventory[43]. REDD+ seeks to harmonize the definition with the definition adopted by other countries in the region. The Republic of Congo recognizes these issues of inconsistency (as set out in the introduction of this section) and therefore emphasizes that the REL calculations are preliminary pending the official adoption of a national MRV system. The national MRV system should provide data that conforms to the national forest definition.

## 2.10 Viet Nam: Shifting from net emissions to net sequestration

Viet Nam is one of the few tropical forest countries in which forest cover is increasing. However, deforestation and degradation remain a challenge for the country and the total area of natural forest has continued to decline (Thuy et al, 2012). Viet Nam's choice for its proposal to the FCPF Carbon Fund (on which this section is based) is the one region in the country that is still presenting net emissions from forests. In the ER program, Viet Nam will be addressing both the reduction of the emissions from deforestation and forest degradation and the enhancement of carbon removals from forests.

42 Minimum forest cover: 30%, minimum height: 3m, minimum area: .5ha; Republic of Congo, March 2014, Communiqué final des travaux de l'atelier sur la définition de la « forêt » dans le contexte de la REDD+ en République du Congo

43 Minimum forest cover: 10%, minimum height: 5m, minimum area: .5ha; FAO, Septembre 2007, Inventaire Forestier National du Congo: Manuel de Terrain

**Approach:** Viet Nam is calculating its reference level[44] through a simple historic average using data from 2000-2010. The choice of methodology is due to the fact that the analysis of historic data for the program area showed no clear trend in historical emissions or removals over this period and this period coincides with Viet Nam's national forest inventory system.

**Scale:** Viet Nam has proposed the North-Central Agro-Ecological Region, which is 5.1 million hectares or 16% of the total land area of Viet Nam. The region is comprised of six provinces and home to 11 million people (12% of the population). 44% of the program area was forested in 2012, nearly all of which is natural forest.

**Scope:** The activities included in the reference level are deforestation, forest degradation and carbon stock enhancement.

**Forest definition:** The National Forest Inventory defines forests as having a crown cover >10% and an area >0.5 hectare and the minimum tree height is 5 meters for natural forests. For plantations of slow growing species the minimum height is 1.5 meters and 3 meters for plantations with fast growing species.

**Datasets and/or methodologies used:**

- **Measuring land use change (activity data):** Viet Nam started its National Forest Inventory in 1990 and has repeated measurements every 5 years since then. For the ER-PIN, it has proposed using the year 2000 as a start date, therefore using land cover change assessments of cycle 3 (2000-2005, which uses Landsat ETM+ and a field survey on 4,200 sample plots) and cycle 4 (2006-2010, using SPOT-4 and SPOT-5 images and 2,100 sample plots). Viet Nam has calculated the uncertainty of the forest-non forest classification, which is estimated at around 5-10%.
- **Emission factors:** Emissions are estimated by calculating the change of carbon stock for every forest strata between two points in time (i.e. 2000 and 2005, 2006 and 2010). For deforestation, the post-deforestation carbon stock is assumed to be zero (as conversion is typically to bare land, residential areas or agricultural crops). Degradation estimates are based on the change from higher to lower volume contents forest types, i.e. the conversion of evergreen broad leaved forest (rich) to evergreen broadleaved forest (medium or poor) as assessed through imagery classification and ground survey in the sample plots. Similarly, removals or forest enhancement is conversion from lower to higher wood stock forest strata.

Viet Nam's national forest inventory illustrates a country with a high variation in emissions/removals associated with deforestation, degradation, and/or enhancement. The Table below also shows that many regions are reforesting at a higher rate than deforesting, and therefore have net removals over the time period from 2000-2010. The exception is the North Central region, which is Viet Nam's choice for its ER program proposal to the Carbon Fund. Its intent is to shift the region from having net GHG emissions to having net GHG sequestration from forests.

Similar to Nepal, Viet Nam has also calculated net emissions for each of the provinces in the program area.

**TABLE 12. Estimated emissions (+) and removals (–) for 2000–2010 in Viet Nam's agro-ecological regions**

| Agro-eco region | Emissions ($MtCO_2e$) | Removal ($MtCO_2e$) | Net Emissions ($MtCO_2e$) | Average FRL ($MtCO_2e$/year) |
|---|---|---|---|---|
| 1. North West | 79.8 | -133.3 | -53.5 | -5.4 |
| 2. North East | 125.4 | -268.0 | -142.6 | -14.3 |
| 3. Red River Delta | 0.5 | -5.2 | -4.7 | -0.5 |
| **4. North Central** | **160.0** | **-153.0** | **7.0** | **0.7** |
| 5. South Central | 75.5 | -93.2 | -17.7 | -1.8 |
| 6. Central Highland | 116.6 | -141.7 | -25.1 | -2.5 |
| 7. South East | 43.0 | -55.3 | -12.4 | -1.2 |
| 8. Mekong Delta | 16.0 | -19.3 | -3.3 | -0.3 |
| **Whole country** | **616.8** | **-869.1** | **-252.2** | **-25.2** |

Source: Viet Nam ER-PIN, 2014

44 Viet Nam's ER-PIN (May 2014) usually refers to a reference level or REL/FRL. Reference level is the term used here.

TABLE 13. Estimated emissions (+) and removals (-) for the six provinces in North Central region

| Province | Emissions ($MtCO_2e$) | Removals ($MtCO_2e$) | Net Emissions ($MtCO_2e$) | Average FRL ($MtCO_2e$/year) |
|---|---|---|---|---|
| 1. Thanh Hoa | 39.3 | -37.3 | 1.98 | 0.20 |
| 2. Nghe An | 47.1 | -41.3 | 5.85 | 0.58 |
| 3. Ha Tinh | 16.7 | -14.9 | 1.83 | 0.18 |
| 4. Quang Binh | 31.2 | -29.3 | 1.91 | 0.19 |
| 5. Quang Tri | 14.0 | -15.2 | -1.21 | -0.12 |
| 6. Thua Thien Hue | 11.7 | -15.1 | -3.34 | -0.33 |
| **Whole region** | **160.0** | **-153.0** | **7.0** | **0.70** |

Source: Viet Nam ER-PIN, 2014

### Comments on Viet Nam's approach:

- **Use of a historic average.** The use of a historic average is simple and compatible with emerging payment for performance systems and donor preferences.
- **Measuring degradation.** Viet Nam's national forest inventory, which provides area data on 12 different forest types with differing carbon stocks, allows the country to estimate degradation and carbon enhancement using a conversion matrix in a relatively simply manner.
- **Individual provinces are developing reference scenarios.** According to the ER-PIN, efforts to develop forest reference levels funded by different donors with projects in various provinces use more thorough analyses and data with a lower level of uncertainty than the JICA study[45] upon which the ER-PIN reference level is based. However, none of the current provincial level efforts, provide data for the entire North Central region—meaning Viet Nam may need to balance accuracy with consistency. The ER-PIN suggests the JICA study is used as the basis for a preliminary baseline—as it provided the most complete data set for the whole of Viet Nam—that may be improved over time through learning from the provincial studies.
- **Mitigation potential in the near future is largely enhancement.** Viet Nam is transitioning from a deforestation/degradation country to one whose mitigation potential is largely enhancement, rather than avoided emissions.

45 JICA study focused on reference levels for national and regional levels

TABLE 14. Summary of sample approaches of emerging REDD+ Forest Reference Levels in the context of demonstration activities

| | National circumstances | | | | | | Approach and design features | | |
|---|---|---|---|---|---|---|---|---|---|
| | Forest cover[47] | Deforestation rate[48] | Tendency in annual deforestation[49] | | Economic situation[50] | GDP/ capita[51] | Approach | Uses historical average? | Scope |
| | | | From ERPIN | From FRA 2010 | | | | | |
| **Brazil** | High forest cover (63%) | Historically high (-0.42%) | Decreasing | | Upper middle income | $ 15 034 | Based on historical data updated every 5 years: 10-year rolling average | yes | Deforestation |
| **Chile** | Low forest cover (22%) | Historically high but decreasing (-0.23%) at country level | | Decreasing | High income | $ 21 911 | Based on historical data | yes | Deforestation, degradation, enhancement |
| **Costa Rica** | Medium forest cover (51%) | Historically high, but net reforestation over the past 10 years (+0.90) | | Decreasing | Upper middle income | $ 13 872 | Based on historical data, but projected | no, but conservative | Deforestation, enhancement |
| **DRC** | High forest cover (68%) | Historically low-medium (-0.20%) | Increasing | | Least developed country | $ 747 | Aggregation of separate RELs for each land use | no | Deforestation, degradation, enhancement |
| **Ghana** | Low forest cover (22%) | Historically high (-2.19%) | | Decreasing | Lower middle income | $ 3 974 | Based on historical data, 10-year average | yes | Deforestation |
| **Guyana** | High forest cover (77%) | Historically low (0.056%) from ER-PIN | Increasing | | Lower middle income | $ 6 551 | "Combined incentives" including a "cap" on the current rate of deforestation | yes | Deforestation[52] |
| **Mexico[46]** | Low forest cover (33%) though the states in the ER-PIN have high forest cover | Historically high but decreasing (-0.24%) at country level | | Decreasing at the country level | Upper middle income | $ 16 463 | Simulated with a Carbon Model (CBM-CFS3), assuming average historical forest area change | yes | Deforestation, reforestation/ afforestation |
| **Nepal** | Low forest cover (25%) | Historically high but recently slowed down (0%) | Substantial increase over recent years | Decreasing | Low income | $ 2 244 | Based on historical data, 10-year average | yes | Deforestation, degradation and enhancement |
| **Republic of Congo** | High forest cover (66%) | Historically low (-0.05%) | Increasing | | Lower middle income | $ 5 867 | Sum of historical REL and adjustment | no | Deforestation, degradation |
| **Viet Nam** | Medium forest cover (40.7%) | Net reforestation over the past 10 years (+1.08) | Decreasing | | Lower middle income | $ 5 293 | Based on historical data, 10-year average | yes | Deforestation, degradation, enhancement |

46 The information for Mexico in this Table refers to the gains and losses approach (CBM-CFS3 model) as proposed in its 2013 ER-PIN, not to the stock-change approach.

47 Cover percentages are taken from FAO Global Forest Resources Assessment 2010; this data may be different from the MRV data proposed in the ER-PIN's; Viet Nam data source: MARD (2012)

48 Annual change rate 2005-2010 from FAO Global Forest Resources Assessment 2010 unless stated otherwise in the Table; this data may be different from the MRV data proposed in the ER-PIN's

49 Deforestation tendencies are derived from the ERPIN if available. In case the ERPIN didn't provide indications, tendencies in deforestation rates over the last 20 years are obtained from FAO Global Forest Resources Assessment 2010

| Approach and design features | | Activity data | | | Emission factors | | Expected improvements? | |
|---|---|---|---|---|---|---|---|---|
| Scale | Forest definition | Proposed IPCC approach for land representation | GIS data used | Historical period used for FREL/FRL | Tier used | Carbon pools included[53] | | |
| Amazon biome (522M ha) | >0.5 ha, >5m, >10% cover | Approach 3 | PRODES (Landsat and CBERS-2) | 2001-2010 | Tier 1-2 | AGB, BGB | Currently PRODES does not record degradation data but may over time and/or improve carbon estimates | **Brazil** |
| One eco-region = 5 admin. regions (16.5M ha) | >0.5 ha, >25% (>10% for arid and semi-arid climate) | Approach 3 | Land Registry (*Catastro*) | 1998-2012 | Tier 2 | AGB, BGB, dead wood (only AGB for some degradation activities) | Moving from official statistic based degradation estimates to spatially explicit delineation of degradation | **Chile** |
| Mosaic (342,000 ha) – but may monitor across entire country | >1 ha, >5m, >30% cover | Approach 3 | Landsat | 2009 base year | Tier 2 | AGB | Use of LiDAR, reducing uncertainties, adding soil carbon and HWPs | **Costa Rica** |
| Provincial (12.4M ha) | >0.5 ha, >3m, >30% cover | Approach 3 | Hansen *et al* (Landsat-VCF) | 2000-2010 | Tier 2 and Tier 3 (majority of Tier 3) | AGB, BGB (only for some activities), HWP, deadwood (only for some activities) | Will adapt to guidance provided by FCPF Carbon Fund | **DRC** |
| 5 ecozones (5.9M ha) | >1 ha, >5m, >15% cover, includes shaded cocoa | Approach 3 | | 2000-2010 | Tier 2 | AGB, BGB | Will add degradation and move EF Tier 2 to Tier 3. Additional carbon pools may be added. | **Ghana** |
| National (21.5M ha) | >1 ha, >5m, >30% cover | Approach 3 | Landsat, RapidEye | 2010 rate benchmark level | Tier 1 | AGB | Will add degradation, move to Tier 2 and 3 | **Guyana** |
| Five states (29.3M ha) | | Approach 3 | Landsat, RapidEye since 2011 | 2002-2011 | Mainly Tier 3 (with some Tier 2 data inputs) | AGB, BGB, dead wood, litter, SOC | Degradation and SFM will soon be included. In next versions, all model parameters will be calibrated with data from Mexico thus moving to full Tier 3 | **Mexico[46]** |
| Physiographic region (2.3M ha) | >1ha, >10% cover | Approach 3 | Landsat, LiDAR (5%) | 1999-2011 | Tier 2 | AGB, BGB | All 5 carbon pools will be addressed in future iterations | **Nepal** |
| Two departments (12.4M ha) | >0.5 ha, >3m, >30% cover | Approach 3 | FACET (Landsat) | 2000-2010 | Tier 1-2 | AGB | Improved precision AD and EF and move to Tier 3 for EFs | **Republic of Congo** |
| One ecoregion = 6 provinces (5.1M ha) | >0.5 ha, >5m (natural forest), 1.5m for slow growing plantations and 3m for fast growing plantations, >10% cover | Approach 3 | Landsat ETM+, SPOT-4 and SPOT-5 images | 2000-2010 | Tier 2 | AGB, BGB | Planned to develop and improve REL/FRL construction at provincial levels for piloting provinces in UN-REDD phase II and ER program | **Viet Nam** |

50 http://data.worldbank.org/country/ accessed May 2014; GDP is PPP for the year 2013 expressed in current international $

51 Degradation is not included but increased emissions from forest degradation are subtracted from emission reduction calculations based on agreed degradation indicators and their reference levels

52 IPCC 2003 requires countries to account for 5 carbon pools: above ground biomass (AGB), below ground biomass (BGB), dead wood, litter and soil organic carbon (SOC). IPCC 2006 provides guidance (in an annex) to include the harvested wood products (HWP) as a pool. Since under REDD+, countries are not required to use IPCC 2006 (only encouraged), accounting for HWP is voluntary for developing countries.

# CHAPTER 3
# Discussion on REDD+ Forest Reference Level experiences to date

Many countries are in the early stages of forest reference level development. Most of the approaches that have been presented in this document are in their preliminary phase and are developed in the context of demonstration activities. Many such ideas are expected to evolve over time as countries collect more and better data and refine their methodologies based on experience. The following section identifies some emerging trends in FREL/FRL development.

## 3.1 Approaches to Forest Reference Level Construction

Countries included in our analysis are pursuing a range of methodological approaches for the development of forest reference levels, for example: using a historic average, using historic data with adjustments for national circumstances, or projecting expected future emissions. A number of key factors, outlined below, emerge from the analysis of emerging approaches.

- **Historical deforestation rate:** Table 13 shows that countries with historically high deforestation tend to use historic averages. Countries with historically low deforestation rates tend to choose adjusted forest reference levels. Although this may reflect the current guidance provided by the FCPF Carbon Fund.
- **Availability and robustness of data to predict future trends:** An understanding of future trends in forest related emissions requires robust data, a good understanding of the specific drivers of deforestation and forest degradation, and potential modelling capacities. Simulations of future forest emissions by developed countries are generally based on various datasets and historical records (forest inventory, timber records, land-use change surveys, etc.), which most developing countries generally lack. Using a historical average is therefore the most feasible approach for many developing countries for the time being. Nonetheless, historically low deforestation countries are looking for sound ways to develop adjustments for national circumstances as allowed by UNFCCC decisions.

**TABLE 15. Examples of methodologies for forest reference level setting selected by countries**

| Approach | Sample countries | | | |
|---|---|---|---|---|
| Historic average | Brazil<br>Mexico | Chile<br>Viet Nam | Ghana | Nepal |
| Adjusted and/or projected | DRC | Costa Rica | Republic of Congo | |
| Other | Guyana– Combined Incentives | | | |

- **Finding the balance between simplicity and accuracy.** The use of future trend projections to construct forest reference levels may demand extensive data collection if complex modelling approaches are used. Starting with a high level of detail and complexity at the sub-national level may pose challenges when scaling up the approach to the national level. On the other hand some countries have proposed the use of a single emission factor to convert their activity data into emissions. This may result in the loss of detailed information on actual emissions, e.g. no distinction between the loss of highly degraded forest and the loss of primary forest.
- **Variety of ecoregions or land uses in a single country.** Multiple types of forests, land uses and activities may require the collection of specific data and methodologies to estimate carbon emissions and emission reductions. The level of effort across different land use types and/or activities may differ substantially. The Amazon Fund in Brazil has taken one approach that sets an eco-region wide forest reference level and then de-links payments into the Fund (based on a single forest reference emission level) from payments out of the fund (based on need and

a set of defined objectives). On the other hand, some countries have developed multiple forest reference levels based on land use types, or tenure, in order to attribute performance and directly reward land users/managers for taking actions that reduce emissions from forests. An example of this more direct link between the forest reference level and results-based payment for specific activities is the emerging approach in the DRC.

## 3.2 Scale

Most countries included in this paper have decided to take a step-wise approach to development of a national forest reference level by starting at a subnational scale, with the intent of using experiences at the subnational scale to inform the national REDD+ FREL/FRL. Some have chosen single administrative units (e.g. a province, state, district), while others have chosen an aggregation of administrative units (sometimes not contiguous), or focus on a particular eco-region. This is mostly due to how countries envisage the implementation of REDD+ on the ground in the context of their national circumstances. Reasons for choosing a subnational scale differ from country to country and include:

- authorities for forest and land management may be more effective at a sub-national scale, such as state/district/province level; while forest policies and regulation often arise from central governments, budget allocation and responsibilities for the implementation of REDD+ policies and actions are often assigned to lower, decentralized administrative units;
- technical and/or resource capacity to measure and monitor emissions and implement REDD+ activities may be decentralized and more effective at the subnational level;
- social, political and/or environmental factors that make one region more ready than others;
- choosing boundaries that match a particular type of forest biome where drivers of deforestation may be more comparable as well as the strategy to address these drivers;
- a scale that matches the limited financial resources that are available under the mechanism the country is applying to, for example the FCPF Carbon Fund.

**TABLE 16. Overview of scale of FREL/FRL demonstration activities**

| | Scale | Area (ha) | % of country |
|---|---|---|---|
| **Brazil** | Amazon biome | 420 M | 50 % |
| **Chile** | Temperate eco-region (5 administrative regions) | 16.5 M | 22 % |
| **Costa Rica** | Mosaic– but may monitor across entire country | 0.34 M | 6.7 % |
| **DRC** | Mai Ndombe administrative region | 12.6 M | 5.5 % |
| **Ghana** | 5 eco-zones | 5.9 M | 25 % |
| **Guyana** | National | 21.5 M | 100 % |
| **Mexico** | 5 states, but not contiguous | 29.3 M | 15 % |
| **Nepal** | Terai Arc Landscape, 12 districts | 2.3 M | 15 % |
| **Republic of Congo** | Two departments | 12.4 M | 36 % |
| **Viet Nam** | North-Central Agro-ecological Region, 6 provinces | 5.1 M | 16 % |

For many countries, the development of national strategies, including legal and institutional frameworks and national policies and measures, is at an early stage. At the same time, many countries want to develop pilots at a subnational level to test approaches that can inform a national strategy. For this reason, many countries are considering how to integrate the accounting for smaller scale programmes within a larger scale, jurisdictional (including national) REDD+ accounting. This can help avoid double-counting, and also scaling up over time. Countries that have presented this approach as part of their REDD+ strategy include: Peru, Colombia, Chile, Cambodia, Laos, and DRC, among others.

## 3.3 Scope of activities

Several countries are choosing to start by tackling deforestation only, as it is often the main contributor to emissions and is generally considered easier to measure than, for instance, forest degradation. Most emerging methodologies for existing demonstration activities (e.g. FCPF Carbon Fund) require accounting for deforestation at a minimum. Some countries are including additional forest activities such as enhancement of forest carbon stocks (including regeneration or reforestation).

**TABLE 17. Overview of the selected scope of REDD+ activities in the FREL/FRL**

| | Reduce emissions from deforestation | Reduce emissions from degradation | Enhancement of carbon stocks |
|---|---|---|---|
| **Brazil** | X | | |
| **Chile** | X | X | X |
| **Costa Rica** | X | | X |
| **DRC** | X | X | X |
| **Ghana** | X | | |
| **Guyana** | X | | |
| **Mexico** | X | | X |
| **Nepal** | X | X | X |
| **Republic of Congo** | X | X | |
| **Viet Nam** | X | X | X |

Degradation is often excluded because it is deemed difficult to measure. However, for some countries, it may be the main source of emissions and, in this case, would have to be included in the forest reference level where guidance, such as FCPF Carbon Fund (or COP Decisions), require significant activities, pools and/or gases to be included. While difficult to measure, some countries have proposed, or applied, simplified approaches for estimating degradation in an interim period until they are able to measure degradation. The approaches being explored so far by countries are the use of tabular data (e.g. statistics on timber extraction and related estimated emissions from infrastructure etc., minus related estimated removals from post-harvest regrowth) and attempts to spatially assess degradation by identifying different canopy cover or structural classes and the dynamics between these classes over time. The increase of carbon stock in forest remaining forest may be equally difficult to measure.

## 3.4 Datasets used

### Activity data

All countries described in this document use or aim to use IPCC Approach 3 for the representation of lands to measure deforestation, creating wall-to-wall cover maps. Most countries use freely available Landsat imagery for their historical estimates of deforestation and reforestation or afforestation. The use of Approach 3 is considered an opportunity to improve land use planning. However, the accessibility of high quality remote sensing data remains an issue in many cases. This is due to several reasons, including cost or, in some cases, the ability to obtain sufficient cloud-free images. For degradation, most countries lack historical data on degradation needed to create forest reference emission levels for this activity.

Medium resolution remote sensing data (e.g. Landsat) that is often used to assess historical land cover change has not yet proven to detect historical degradation with sufficient accuracy, while historical data gathered using higher resolution remote sensing sources is scarce and costly. In addition, proxy data sources (e.g. harvesting data, etc.) that may help to assess historical degradation can also be limited in developing countries. Even Annex I countries face the same challenges in measuring GHG emissions and removals in forests remaining forests in their national inventory—the Joint Research

Center estimates uncertainty aggregated across EU member states in the range of 15-20%[53]. For this reason, it is not surprising that many developing countries are starting with deforestation (e.g. Brazil, Guyana) while building systems to more accurately measure degradation. Viet Nam and Nepal are pioneering new approaches to address this challenge, by combining ground measurements of (various) degraded stages of forests with high-resolution remote sensing data. According to the relevant UNFCCC decisions, incomplete accounting is only acceptable as an interim step. Countries do need to pursue complete accounting in all areas and significant activity coverage in the long run.

### Emission factors

The variety of tiers applied to assess emission factors is much higher and ranges from tier 1 to tier 3 approaches and, for some countries, mixed tiers. Some countries (e.g. Brazil, Guyana) start with conservative (low) biome estimates with high uncertainty, which are gradually being replaced by forest inventory based estimates with much lower uncertainty. Most countries only have reliable data on above ground biomass, using IPCC default factors to approximate below ground biomass, as such using a combination of tiers for the different pools in some cases.

To estimate emission factors, many countries stratify their forest to create more or less homogenous groups (strata) with comparable carbon contents. Accordingly, they obtain average carbon content estimates for these strata typically based on ground measured data collected through (national) forest inventories converted to carbon estimates with the help of allometric equations. Table 18 provides an overview of the approximate number of forest strata used to create emission factors.

**TABLE 18 Overview of approximate number of forest strata used for emission factor estimates**

| | Number of forest strata | Forest stratification for emission factor estimates |
|---|---|---|
| **Brazil** | 1 | Single conservative carbon stock estimate |
| **Chile** | At least 2 | Plantations and natural forest |
| **Costa Rica** | Multiple | Two forest types and multiple successional stages |
| **DRC** | 2 | Primary and secondary forests (approximated by canopy cover) |
| **Ghana** | 2 | Open and closed forest |
| **Guyana** | 1 | Single conservative carbon stock estimate |
| **Mexico** | Multiple | No stratification but carbon dynamics and emissions simulated |
| **Nepal** | Multiple (8) | Forest type and structural class (intact, degraded) combinations |
| **Republic of Congo** | 3 | Secondary, primary and swamp forest |
| **Viet Nam** | Multiple (12) | Forest type and cover/structure combinations |

Some countries use, or are exploring the use of, the global dataset on tree cover (2000) and tree cover change (2000-2012) from Hansen *et al.* (2013). These countries are challenged with the conversion of this tree cover (change) data into forest area (change) estimates, and setting the thresholds in this dataset to conform to a country's national forest definition. Bellot *et al.* (2014) found that applying cover thresholds in Indonesian forest definitions to Hansen *et al.* resulted in a major over-estimation of forest area, where the cover threshold had to be set much higher to obtain fair agreement with previous forest area assessments. A country may argue to set a conservative threshold which would underestimate forest cover. However, such a threshold does not necessarily result in a conservative estimate. E.g. Romijn *et al.* (2013) found that applying a higher cover threshold (from the national forest definition) resulted in a 27% higher area of deforestation in Indonesia then the deforestation area assessed when applying a lower cover threshold (from the FAO definition).

The application of IPCC methods to estimating emissions and removals from REDD+ activities may be facilitated by the publication of the Methods and Guidance Document[54] by the Global Forest Observations Initiative. The MGD sets out systematically how emissions and removals from REDD+ activities can be estimated using IPCC methods, and links this to the remotely sensed data made freely available by the space agencies.

53 EU National Inventory Reports 2014, EU-15
54 The MGD can be accessed at http://www.gfoi.org/methods-guidance-documentation

## 3.5 Other challenges countries face

**Limited institutional and human resource capacities.** Some countries have a national forest inventory, but many currently lack an established inventory or a robust, fully developed national forest monitoring systems. For this reason, most countries have not yet developed a forest reference level, but have started by first considering ways to strengthen their capacity to measure emissions, including through the development of historical land use change maps (if not already available), improvement and/or development of emission factors, and strengthening their capacity in remote sensing analysis and GHG inventory management. In some cases, countries are starting with deforestation (only) with the intent of adding forest degradation to the forest reference emission level as more accurate data and methodologies are made available.

**Uncertainty whether the country can perform against the forest reference level.** Some countries have a strong understanding of how actions relate to emission reduction potential. For example, many of the activities intended for implementation in Nepal's ER-PIN have proven successful in the past. The estimation of how such activities can result in potential emission reduction helps provide predictability of revenues that may be generated under demonstration activities such as those under the FCPF Carbon Fund (or other emission-reduction purchasing programs). Other countries that propose new activities and do not have a track-record of past performance are more challenged to estimate future emission reductions. Furthermore, countries with rapidly changing national circumstances are challenged to estimate the extent of future emissions for the forest reference level. A study on national circumstances and how they may impact future emissions may help countries to make these estimates

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# Annex A: Brazil's Submission of a Forest Reference Emission Level to the UNFCCC

In June 2014, Brazil submitted a forest reference emission level (FREL) to the UNFCCC—becoming the first country to do so. In its submission, Brazil states that the FREL has been submitted *"for a technical assessment in the context of results-based payments and does not modify, revise or adjust in any way the national appropriate mitigation actions currently being undertaken by Brazil pursuant to the Bali Action plan ... neither prejudges any nationally determined contribution by Brazil in the context of ... the Ad Hoc Working Group on the Durban Platform for Enhanced Action"*.

In other words, Brazil is employing different reference levels for different purposes, including the following:

1. For the first 5 years of the Amazon Fund, considered to be a **REDD+ demonstration activity**, Brazil developed and utilized an interim baseline, as described in Section 3.1.
2. Brazil has now submitted a **forest reference emission level (FREL) to the UNFCCC explicitly for results-based payments**; this new forest reference level will replace the Amazon Fund baseline.
3. Brazil has also submitted to the UNFCCC a set of **nationally appropriate mitigation actions**[55], which uses a different benchmark to assess performance, i.e. a projection based on historical data;
4. Brazil's FREL submission implies that the country reserves the right to submit a different FREL when considering a **future contribution under a new climate agreement**.

This Annex briefly summarizes the FREL submitted by Brazil to the UNFCCC.

**Approach:** Brazil's forest reference emission level approach is *a historical average of emissions associated with gross deforestation, updated every 5 years, and starting from the year 1996.* For example, for the period 2006-2010, the FREL is equal to the mean annual $CO_2$ emissions from gross deforestation for the period 1996 to 2005, as illustrated in Figure 12 below by FREL (A). For the period 2011-2015, the FREL is equal to the average emissions from 1996 to 2015, illustrated by FREL (B).

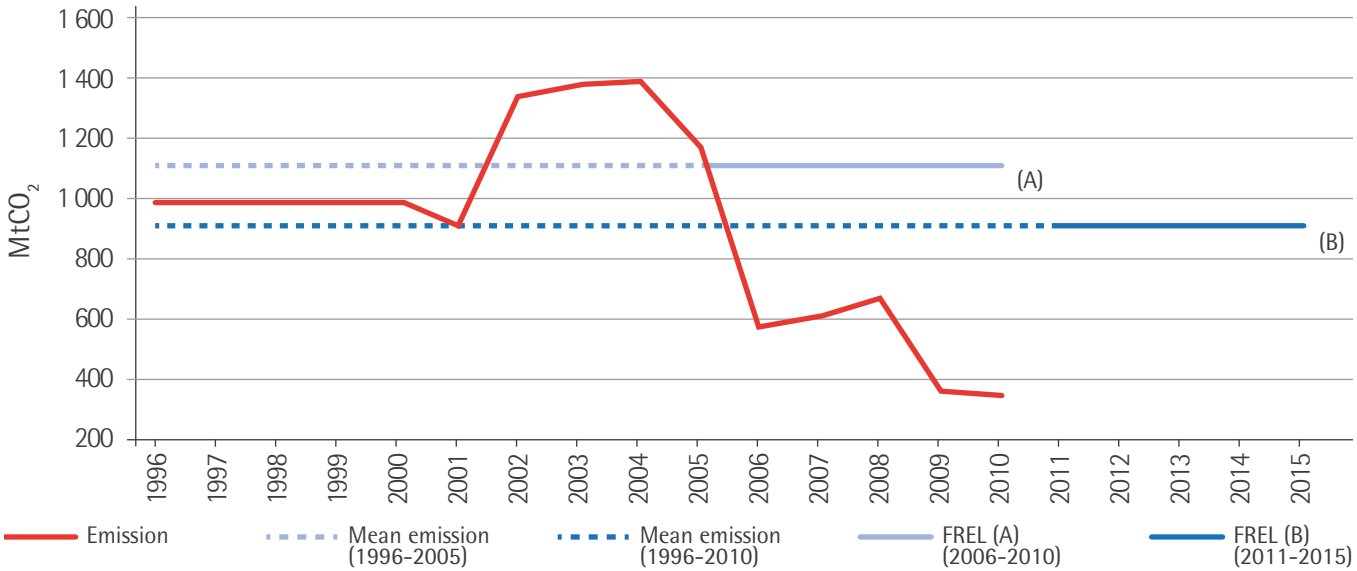


**FIGURE 12. Pictoral representation of Brazil's FREL and annual emission from gross deforestation from 1996 to 2010**

Source: Brazil's Submission to the UNFCCC[56]

55 Brazil's submission to the UNFCCC on January 29, 2010, as part of Appendix II of the Copenhagen Accord in fulfillment of the Bali Action Plan, stated that Brazil's voluntary domestic actions include "reduction in Amazon deforestation (range of estimated reduction: 564 million tons of $CO_2$eq in 2020)" and "reduction in cerrado deforestation (range of estimated reduction: 104 million tons of $CO_2$eq in 2020" as part of an expected overall economy wide reduction of projected emissions by 36.1% to 38.9% . Source: https://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/brazilcphaccord_app2.pdf

56 Brazil's submission to the UNFCCC can be found at: http://unfccc.int/files/methods/redd/application/pdf/20140606_submission_frel_brazil.pdf

**Scale:** Brazil intends to calculate, in the future, a national FREL by summing up six FRELs for different biomes. The FREL submitted in June 2014 covers the Amazonia biome, which is around 420 million hectares covering nearly 50% of the country, and is a different scale from the baseline calculated for the Amazon Fund, which included the entire Legal Amazon (i.e. 520 million hectares, or around 60% of the country). By 2015, Brazil will be systematically monitoring all biomes annually and, over time, will advance the development of FREL submissions to the other five biomes in order of emissions importance.

**Scope:** The FREL includes $CO_2$ emissions from gross deforestation of primary forest and includes above and below-ground biomass and litter carbon pools.

**Datasets and/or approaches used:** Data are generated through the combination of activities and data gathered by the National Institute for Spatial Research (INPE).

- **Assessing land use change (activity data):** Estimates of the area of annual gross deforestation are derived from the analysis of remotely sensed data at 30 meter spatial resolution (mostly Landsat 5). These deforestation areas are obtained from PRODES (Project for Monitoring Deforestation in the Legal Amazon) developed at the National Institute for Space Research (INPE) Project, adjusting to consider only deforestation within the Amazonia biome. Landsat images acquired annually on as similar as possible dates (so as to avoid over or under estimating the deforestation) are selected, processed and visually interpreted to identify new deforestation increments (or deforested polygons) since the previous assessment.
- **Emission factors:** Unlike the Amazon Fund, which uses a single conservative value for the carbon stock in living biomass (as described in Section 3.1), Brazil's FREL uses a carbon map which differentiates the carbon stock in the main forest physiognomies in the Amazonia biome for which reliable data are available. The carbon map is created as follows: Tree measurements are collected in 2292 sample plots and converted to carbon estimates using allometric equations. Extrapolation rules are accordingly applied to estimate the carbon density per associated vegetation type and volume (spatial coverage area) to get wall-to-wall carbon estimates, and missing data are approximated through literature review. The carbon stock per vegetation type has a weighted average of 151.6 tC/ha (the conservative EF estimate for the Amazon Fund was 130 tC/ha).
- **Expected improvements:** Brazil's submission to the UNFCCC provides preliminary information regarding forest degradation and expects improvement in understanding and data availability over time which would allow for the future submission of a FREL.

**TABLE 19. Comparison of characteristics between Brazil's "baseline" for demonstration activity and UNFCCC FREL submission**

| | Brazil Demonstration Activity (Amazon Fund) | Brazil UNFCCC submission |
|---|---|---|
| **Approach and design features** | | |
| **Approach** | Based on historical data updated every 5 years: 10-year rolling average; | Based on historical data updated every 5 years: "Extending" historical average going back to the year 1996 |
| **Uses historical average?** | Yes | Yes |
| **Scope** | Deforestation of primary forest | Deforestation of primary forest |
| **Scale** | Legal Amazon (520M ha) | Amazon biome (420M ha) |
| **Forest definition** | >0.5 ha, >5m, >10% cover | >0.5 ha, >5m, >10% cover |
| **Activity data** | | |
| **IPCC approach for land representation** | Approach 3 | Approach 3 |
| **GIS data used** | PRODES (Landsat and CBERS-2) | PRODES (Landsat and CBERS-2) |
| **Emission factors** | | |
| **Tier used** | Tier 1-2 | Tier 2-3 |
| **Number of forest carbon stock estimates** | Use of single, conservative carbon stock estimate for all forest in legal Amazon; | Use of carbon map consistent with the first and second GHG-inventories |
| **Carbon pools included**[53] | AGB, BGB | AGB, BGB and litter |
| **Expected improvements?** | | |
| Currently PRODES does not record degradation data but may over time improving carbon estimates | | |

57 IPCC 2003 requires countries to account for 5 carbon pools: above ground biomass (AGB), below ground biomass (BGB), dead wood, litter and soil organic carbon (SOC). IPCC 2006 provides guidance (in an annex) to include the harvested wood products (HWP) as a pool. Since under REDD+, countries are not required to use IPCC 2006 (only encouraged), accounting for HWP is voluntary for developing countries.

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