

Federative Republic of Brazil

#### **Dilma Roussef**

President

## **Michel Temer**

Vice-president

## **Ministry of the Environment**

#### Izabella Teixeira

Minister

### Francisco Gaetani

**Deputy Minister** 

### Francisco J. B. Oliveira

Director, Department of Policies to Fight Deforestation

### Leticia Guimarães

Manager, Climate Change and Forests

Organization: Leticia Guimarães (MMA) and Antonio C. Martinez Sanches (MMA).

Graphic Design: Gráfica e Editora Movimento

**Contributors:** Monique Ferreira Sacardo (MMA) and Alexandre Avelino (MMA).

**Special thanks to:** Working Group of Technical Experts on REDD+, United Nations Framework Convention on Climate Change Secretariat and Felipe Ferreira (Ministry of External Relations).

This publication has been edited under the responsibility of the Department of Policies to Fight Deforestation of the Brazilian Ministry of the Environment.

Ministry of the **Environment** 



# **FOREWORD**

Climate change presents a critical global challenge that needs to be dealt with through the multilateral process. Brazil strongly supports the international regime established under the United Nations Framework Convention on Climate Change (UNFCCC) and is committed to its strengthening by means of an ambitious, universal and equitable agreement in Paris that sets a clear path towards meeting the goal of holding the increase in global average temperature below 2°C above pre-industrial levels.

In September 2015, the Brazilian Government gave a clear demonstration of the country's serious intent to contribute to climate change mitigation and adaptation. Brazil's Intended Nationally Determined Contribution (INDC) sets forward an economy wide absolute target of reducing its greenhouse gas emissions by 37% below 2005 levels in 2025 and 43% by 2030. Actions in the land use change and forest sector will be key to achieve the 2025 and the 2030 objectives.

Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+) is a means for the implementation of Brazil's INDC. Brazil is a megadiverse country with about 60% of its territory covered by forests. Between 2004 and 2014, the country has reduced deforestation in the Amazon biome by 82%, while also reducing poverty and promoting social inclusion without negatively impacting the country's GDP.

International technical cooperation and financial support can significantly enhance the effectiveness of REDD+ actions. We are particularly grateful, in this respect, to the Norwegian government, as well as to other donors, which have put forward significant financial contributions to the Amazon Fund.

Brazil was the first country to implement the Warsaw Framework for REDD+. In September 2015, we successfully completed the verification process of REDD+ results achieved in the Amazon biome, 2.9 Gt CO<sub>2</sub>e between 2006 and 2010. We are now in the final stages for the approval of our National REDD+ Strategy and investments will be made with the proceeds of REDD+ payments for the establishment of a large-scale plan for the enhancement of forest carbon stocks in Brazil, as the country transitions from net source to net sink.

This publication is a compilation of Brazil's submissions to the UNFCCC as part of the implementation of the Warsaw Framework for REDD+. We hope that this can be a useful resource to other developing countries implementing REDD+, as well as an inspiration for donors and investors seeking to incentivize effective climate change mitigation actions in developing countries.

We wish you all a pleasant reading!

Brasília, November, 2015.

Carlos Augusto Klink

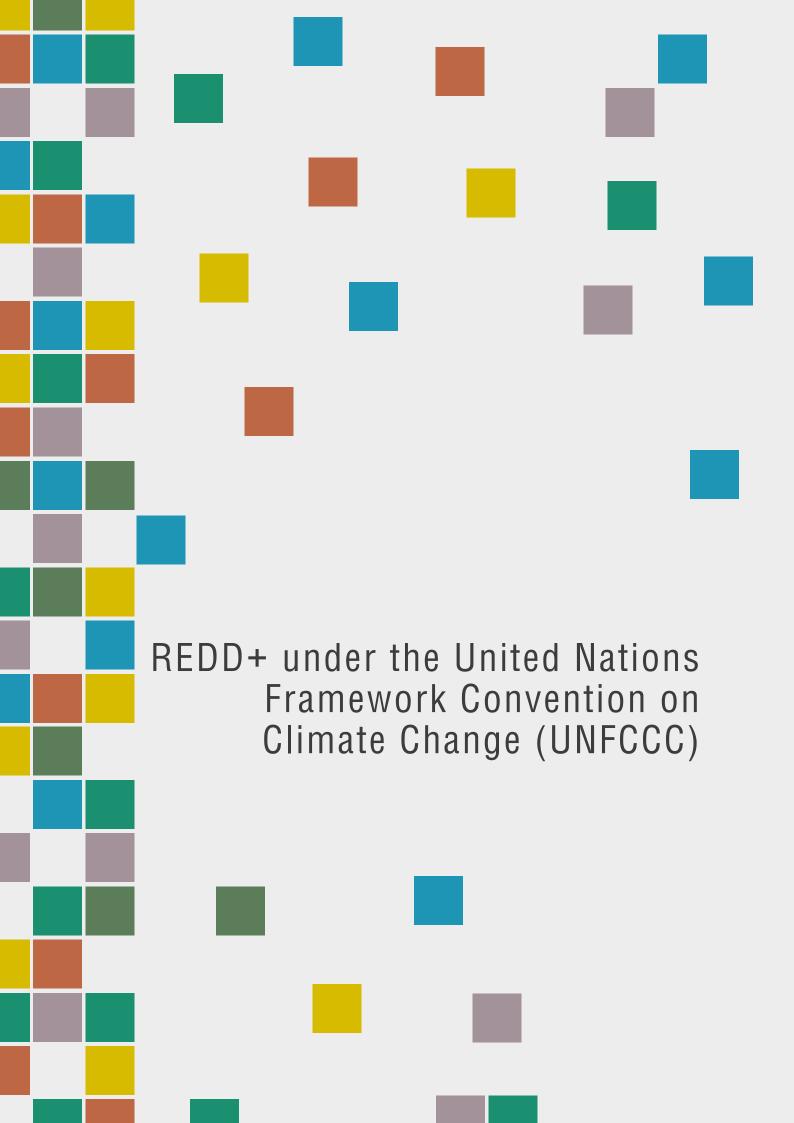
Secretary of Climate Change and Environmental Quality

Ministry of the Environment of Brazil

Carlos A. Klink

# TABLE OF CONTENTS

REDD+ under the United Nations Framework Convention on Climate Change (UNFCCC)	6
The implementation of the Warsaw Framework for REDD+ by Brazil	16
Brazil's submission of a Forest Reference Emission Level (FREL) for reducing emissions from deforestation in the Amazonia biome for REDD+ results-based payments under the UNFCCC	18
Report of the technical assessment of the proposed forest reference emission level of Brazil submitted in 2014	110
Brazil's submission of a Technical Annex for Reducing Emissions from Deforestation in the Amazonia biome for REDD+ results-based payments under the UNFCCC	128
Technical report on the technical analysis of the technical annex to the first biennial update report of Brazil submitted in accordance with decision 14/CP.19, paragraph 7, on 31 December 2014	152
Summary of information on how the Cancun safeguards were addressed and respected by Brazil throughout the implementation of actions to reduce emissions from deforestation in the Amazon biome between 2006 and 2010	166



Under the United Nations Framework Convention on Climate Change (UNFCCC), discussions on a framework to provide incentives to developing countries for reducing emissions from deforestation began in 2005 at the 11<sup>th</sup> session of the Conference of the Parties (COP), in Montreal, Canada. In 2010, the COP agreed on policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+). The logic of incentives for REDD+ consists of payments that are made *ex-post*, based on results already achieved through the implementation of policies in the forest sector.

In 2013, after eight years of discussions, the Parties reached an agreement on a set of rules and procedures that enables mitigation efforts from developing countries in the forest sector to be recognized and rewarded through results-based payments. The **Warsaw Framework for REDD+** (WFR) (decisions 9-15/CP.19) was the main outcome from the 19<sup>th</sup> session of the COP to the UNFCCC (COP-19), to a large extent concluding the negotiations on REDD+ and providing the necessary definitions for its implementation.

The structure defined by the WFR was designed to be "flexible enough to accommodate a large variety of circumstances and capabilities of developing countries, while at the same time establishing a robust and clear framework for a results-based approach for financing mitigation actions in the forest sector. REDD+ under the UNFCCC is the outcome of a delicate balance between stringency of requirements to obtain financial support and flexibility to allow broad participation, while at the same time keeping consistency with other obligations under the Convention and with other relevant international agreements."

The progressive character of REDD+ is another aspect that has been designed taking into account the large variety of circumstances and capabilities of developing countries. According to **decision 1/CP.16** REDD+ activities "should be implemented in phases, beginning with the development of national strategies or action plans, policies and measures, and capacity-building, followed by the implementation of national policies and measures and national strategies or action plans that could involve further capacity-building, technology development and transfer and results-based demonstration activities, and evolving into results-based actions that should be fully measured, reported and verified". The phased approach is also clear in the guidelines for technical submissions, which are subject to a facilitative assessment processes, allowing improvements to be made over time (this will be further detailed ahead).

Assurance that mitigation results have indeed been achieved is a fundamental element for a results-based payment scheme. The processes for assessing the Forest Reference Levels and/or Forest Reference Emission Levels (FRL/FREL) decision 13/CP.19 and for Measuring, Reporting

Voigt, C., & Ferreira, F. The Warsaw Framework for REDD+: Implications for National Implementation and Access to Results-based Finance. IN: Special Issue: The Legal Aspects of REDD+ Implementation: Translating the International Rules into Effective National Frameworks? Carbon & Climate Law Review, Volume 9, Issue 2 (2015). pp. 113 - 129

and Verifying (MRV) REDD+ results **decision 14/CP.19** are essential to reduce uncertainties and to provide an adequate level of confidence in the system, with a view to attract scaled-up investments.

In addition to defining technical rules and procedures, which will be discussed in more detail ahead, the WFR stated that support for REDD+ must be adequate and predictable and may come from "wide variety of sources, public and private, bilateral and multilateral, including alternative sources". The WFR places the **Green Climate Fund** in a key role for channeling and catalyzing financial resources for REDD+. <sup>3</sup>

**Decision 10/CP.19** invites interested Parties to designate a national entity or focal point to serve as a liaison with the secretariat and the relevant bodies under the Convention. This relationship includes technical and methodological interchanges and the receipt of results-based payments and/or appointment of other entities to do so (that can be defined by each national entity or focal point in a sovereign manner). The national authorities meet on a voluntary basis, in parallel to the UNFCCC negotiations, to discuss issues related to coordination of support for the implementation of REDD+ activities.

Developing countries willing to receive payments for REDD+ results must submit their FRL/FREL to undergo an assessment by two Land Use Land Use Change and Forestry (LULUCF) experts appointed by the UNFCCC. This evaluation process is conducted annually, following the procedures set out by **decision 13/CP.19**. The mitigation results will be measured against this reference level and reported on a Technical Annex to the Biennial Update Report (BUR). This Technical Annex also includes the REDD+ activities selected by the developing country, the calculation of results, information on the national forest monitoring system, institutional roles, among other information.

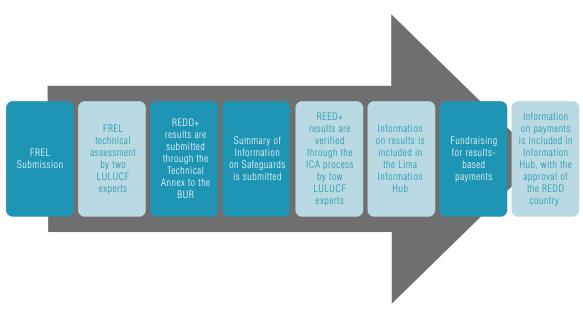
It is important to note that the framework for REDD+ has evolved towards a non-market-based approach. REDD+ related market-based approaches may be developed in the future. This discussion may be a topic for the market mechanisms negotiations. Another important clarification is the fact that results-based REDD+ payments do not generate offset units to fulfill developed countries' mitigation commitments under the UNFCCC.

The process - from reference level submission, on to its assessment, the technical annex submission, up to the recognition of REDD+ results from developing countries - should last an average of 16 months (Figure 1).

Decision 9/CP.19, paragraph 1; decision 2/CP.17, paragraph 65.

<sup>3</sup> Decision 9/CP.19, paragraph 5.

Figure 1. REDD+ process under the UNFCC



Note: In orange actions to be taken by REDD+ countries, in blue actions to be taken by the Secretariat.

The following sections detail the procedures to be followed by developing countries who wish to obtain recognition of their REDD+ results under the UNFCCC and payments for their performance.

### NATIONAL REDD+ STRATEGY OR ACTION PLANS

A National Strategy or Action Plan for REDD+ is a requirement for developing countries willing to undertake REDD+ activities under the UNFCCC. This instrument should provide the governance structure necessary for the effective implementation of REDD+ actions. The structure should be designed to promote coordinated efforts in the forest sector and related areas in order to facilitate the achievement of the intended mitigation results. There is a considerable degree of flexibility for developing countries to define their national REDD+ strategies, to accommodate the diversity with regards to capabilities and national circumstances.

The national REDD+ strategy should address a series of issues, inter alia, drivers of deforestation and forest degradation, land tenure, forest governance, gender considerations and the safeguards. In addition to that, it should ensure full and effective participation of relevant stakeholders including indigenous peoples and local communities.

## **FOREST MONITORING SYSTEM**

**Decision 1/CP.16**, requests Parties aiming to undertake REDD+ activities, in the context of the provision of adequate and predictable support, to develop a robust and transparent national forest monitoring system for the monitoring and reporting of REDD+ activities. If appropriate, subnational monitoring and reporting of REDD+ activities is allowed, as an interim measure.

**Decison 11/CP.19** refers to **decision 4/CP.15** in providing the guidance for the establishment of national forest monitoring systems. The combination of remote sensing and ground-based forest carbon inventory approaches and the most recent IPCC guidance and guidelines should be the basis for estimating anthropogenic forest-related greenhouse gas (GHG) emissions by sources, and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes.<sup>4</sup>

**Decision 11/CP.19** adds that a "robust national forest monitoring systems should provide data and information that are transparent, consistent over time, and are suitable for measuring, reporting and verifying anthropogenic forest-related emissions [...] and [be] consistent with guidance on measuring, reporting and verifying nationally appropriate mitigation actions by developing country Parties agreed by the Conference of the Parties". <sup>5</sup>

# **MEASUREMENT, REPORTING AND VERIFICATION (MRV)**

AMRV system is essential to the results-based approach of REDD+. Such system should ultimately ensure that the mitigation results have been achieved, providing confidence to any entity willing to pay for REDD+ results. **Decision 9/CP.19** defined that REDD+ actions should be fully MRVed in accordance with **decision 13/CP.19**, on the assessment of FRL/ FREL, and **decision 14/CP.19**, on the modalities for the MRV of REDD+ results. These two decisions form the core of the MRV process and since "REDD+ results are to be measured in relation to their reference level, both decisions are closely interrelated; [establishing], in practical terms, one continuous process."

After the assessment of the reference levels, REDD+ results should be:

- 1. measured against the assessed reference level, in tonnes of carbon dioxide equivalent per year;
- 2. reported through a technical annex to the BUR;
- 3. verified through the International Consultation and Analysis (ICA) process agreed upon in descison2/CP.17.

The ICA process includes two steps: the first is a technical analysis of BURs by a team of technical experts, which includes consultation with the submitting country, and the second is a facilitative sharing of views. The technical analysis component is conducted by a team of two LULUCF

<sup>4</sup> Decision 11/CP.19, paragraph 2.

<sup>5</sup> Decision 11/CP.19, paragraph 3.

Voigt, C., & Ferreira, F. The Warsaw Framework for REDD+: Implications for National Implementation and Access to Results-based Finance. IN: Special Issue: The Legal Aspects of REDD+ Implementation: Translating the International Rules into Effective National Frameworks? Carbon & Climate Law Review, Volume 9, Issue 2 (2015). pp. 113 - 129

experts from the UNFCCC roster, one from a developing country and one from a developed country Party, their task is analyzing the information and producing a summary report. The facilitative sharing of views consists of a workshop open to all Parties conducted by the **Subsidiary Body of Implementation** for discussion on the submission and its summary report. The ICA will occur on a biannual basis.

# FOREST REFERENCE LEVEL AND/OR FOREST REFERENCE EMISSION LEVELS (FRL/FREL) SUBMISSION AND ASSESSMENT

The WFR has defined what information fully MRVed means, by establishing the procedures for submitting the FRL/FREL and for verifying the results presented.

Several previous COP decisions agreed nevertheless have also defined important aspects related to the reference levels. **Decision 4/CP.15** determines that developing countries should establish their FRL/FREL transparently, taking into account historic data, and adjusting for national circumstances. Paragraph 71 of **decision 1/CP.16** requests developing countries aiming to undertake REDD+ activities, in the context of the provision of adequate and predictable support and in accordance with national circumstances and respective capabilities, to develop a national reference level or, if appropriate, as an interim measure, subnational reference levels.

During the COP-17 discussions on reference levels progressed significantly. **Decision 12/CP.17** agreed that a step-wise approach might be useful, enabling the improvement of the submissions overtime by incorporating better data, refining methodologies and, where appropriate, including additional pools. Another definition was that reference levels should maintain consistency with the anthropogenic GHG emissions by sources and removals by sinks as presented by the country's National GHG Inventory.

The Annex to **decision 12/CP.17** provides detailed guidelines for reference level submissions. Developing country Parties should, to the extent possible, include transparent, complete and accurate information in their submissions (in order to allow for reconstruction and to enable its technical assessment), consistent with the approach agreed by the COP. Developing country Parties should also provide information on the methodologies and procedures used in the construction of the FRL/FREL. The information should be consistent with the most recent IPCC guidelines.

Each FRL/FREL submission will be subject to a technical assessment. This is a facilitative process, which aims to increase transparency and build capacity of developing countries. The LULUCF experts appointed by the UNFCCC Secretariat should assess: the consistency between the FRL/FREL and the data from the GHG inventory and explanations on how the historical data have been used; the extent to which information provided was transparent, complete, consistent, and accuracy; whether a description of relevant policies and plans have been provided; activities, pools and gases included; the definition of forest used; and, where appropriate, details about assumptions about future changes to policies.

This process, from submission to the technical assessment report, should take an average of nine months. If elements that demand further improvement are identified by the UNFCCC experts in a FRL/FREL, in coordination with the submitting country, improvements can be made throughout the assessment phase or in future submissions, taking into account the capabilities of each country.

## **REDD+ TECHNICAL ANNEX SUBMISSION AND ASSESSMENT**

**Decision 14/CP.19** established the process through which developing countries can present their REDD+ results to the UNFCCC and have such results verified (the V in MRV). The results should be presented via REDD+ Technical Annex to the BUR, and should include:

- Summary information from the final report containing each corresponding assessed FRL/ FREL (decision 13/CP.19);
- Results in tonnes of carbon dioxide equivalent per year;
- Demonstration that the methodologies used to produce the results are consistent with those used to establish the assessed FRL/FREL:
- ❖ A description of national forest monitoring systems and the institutional roles and responsibilities for the MRV of the results (decision 11/CP.19);
- Necessary information which allows for the reconstruction of results;
- ❖ A description of how the IPCC guidelines were applied and evidence that the monitoring system is consistent with decision 4/CP.15.

The verification of REDD+ results will be carried out by LULUCF experts appointed by the Secretariat in a transparent manner, as part of the ICA process of the BUR, pursuant to <u>Decision 14/CP.19.</u> The experts' final report must contain: the Technical Annex, the Technical Annex Assessment, the elements to be improved identified as part of the facilitative process, comments and responses from the Parties.<sup>7</sup> As a whole, the process of verifying REDD+ results through the assessment of the Technical Annex and its verification should last an average of seven months.

# THE CANCUN SAFEGUARDS, THE SAFEGUARDS INFORMATION SYSTEM AND THE SUMMARY OF INFORMATION

The Cancun safeguards are guidelines that aim at enhancing the positive while reducing the negative impacts of REDD+ activities. REDD+ actions must anticipate risks and set measures to predict, minimize, mitigate or deal with negative impacts from a given activity.

Decision 14/CP.19, paragraph 14.

**Decision 1/CP.16** establishes that REDD+ activities should promote and support the following set of social and environmental safeguards:

- (a) That actions complement or are consistent with the objectives of national forest programs and relevant international conventions and agreements;
- (b) Transparent and effective national forest governance structures, taking into account national legislation and sovereignty;
- (c) Respect for the knowledge and rights of indigenous peoples and members of local communities, by taking into account relevant international obligations, national circumstances and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration on the Rights of Indigenous Peoples;
- (d) The full and effective participation of relevant stakeholders, in particular indigenous peoples and local communities, in the actions referred to in paragraphs 70 and 72 of this decision;
- (e) That actions are consistent with the conservation of natural forests and biological diversity, ensuring that the actions referred to in paragraph 70 of this decision are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits:
- (f) Actions to address the risks of reversals;
- (g) Actions to reduce displacement of emissions.

With a clear goal of providing transparency throughout the implementation of REDD+ actions, **decision 1/CP.16** requests developing countries to develop a system for providing information on how all of the safeguards are being addressed and respected. **Decision 12/CP.17** complements by defining that the Safeguards Information System (SIS) should:

- (a) Be consistent with the guidance identified in decision 1/CP.16;
- (b) Provide transparent and consistent information that is accessible by all relevant stakeholders and updated on a regular basis;
- (c) Be transparent and flexible to allow for improvements over time;
- (d) Provide information on how all of the safeguards are being addressed and respected;
- (e) Be country-driven and implemented at the national level;
- (f) Build upon existing systems, as appropriate.

A summary of information on how all the Cancun safeguards are being addressed and respected is another requirement for developing countries to obtain and receive results-based payments. The summary should be submitted periodically along with the national communications from to the UNFCCC. Decision 12/CP.19 states that developing country Parties should start providing the summary of information after the start of the implementation of REDD+ activities and that a summary of information should be part of the following submissions of national communications. Countries may also, on a voluntary basis, submit an updated summary of information to be posted on the REDD+ Web Platform on the UNFCCC website. Decision 9/CP.19 clarifies that developing countries seeking to obtain and receive results-based payments should provide their most recent summary of information before they can receive any results-based payment.

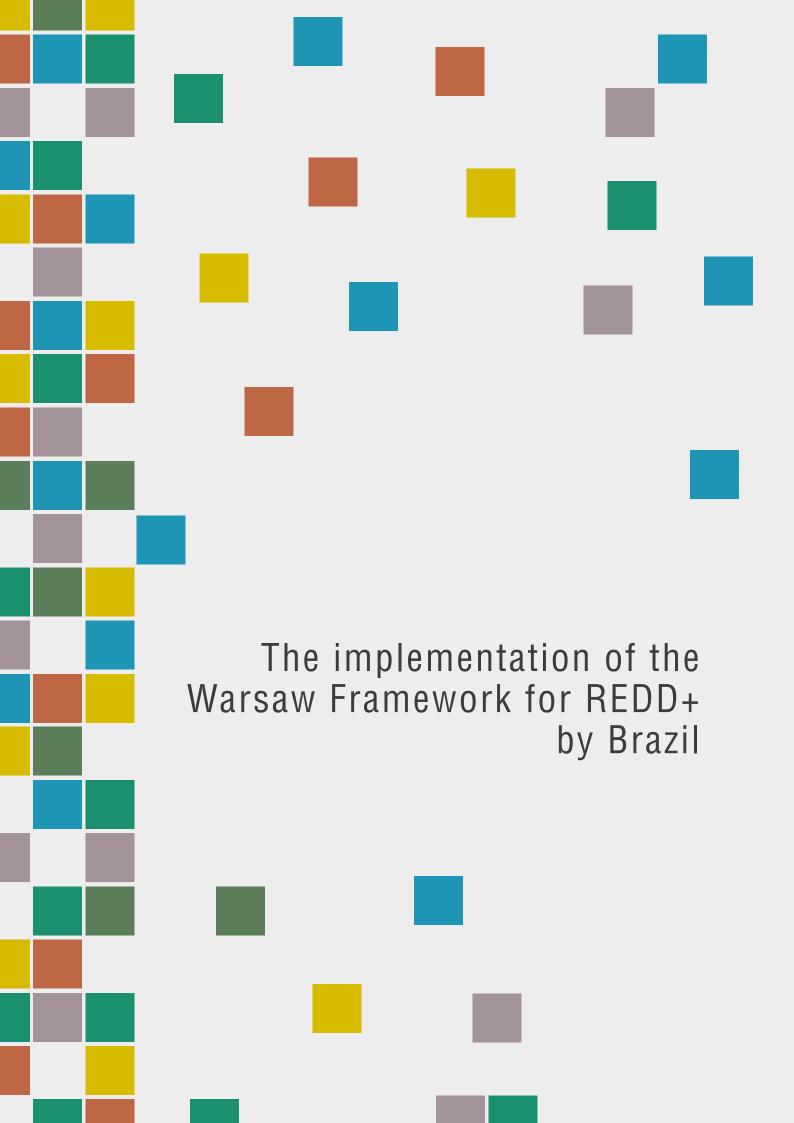
## THE LIMA REDD+ INFORMATION HUB

The WFR established an information hub, under the UNFCCC REDD+ Web Platform (decision 9/CP.19), later named the Lima REDD+ Information Hub - during COP-20. The purpose of the Lima Info Hub is to increase transparency on REDD+ actions, on the corresponding payments, as well as on information related to the requirements to obtain and receive results-based finance. Once the MRV process is finalized, and all the documentation regarding REDD+ results and the requirements for obtaining results-based payments are available, these will be published, along with the respective assessment report, in the Lima REDD+ Information Hub. It should be underlined that, according to decision 9/CP.19, the insertion of information on results-based payments in the Lima Info Hub is to be done "in consultation with the developing country Party concerned, taking into full account decision 10/CP.19, paragraph 2".

The Lima REDD+ Information Hub should contain:

- (a) The results for each relevant period expressed in tonnes of carbon dioxide equivalent per year and a link to the technical report referred to in decision 14/CP.19, paragraph 14;
- (b) The assessed forest reference emission level(s) and/or forest reference level(s) expressed in tonnes of carbon dioxide equivalent per year and a link to the final report of the technical assessment team referred to in decision 13/CP.19, paragraph 18;
- (c) The summary of information on how all of the safeguards referred to in decision 1/ CP.16, appendix I, are being addressed and respected, as referred to in decisions 12/ CP.19 and 12/CP.17, chapter I;
- (d) A link to the national strategy or action plan as referred to in decision 1/CP.16, paragraph 71(a), as appropriate;
- (e) Information on the national forest monitoring system, as provided in the technical annex referred to in decision 14/CP.19.

The Lima REDD+ Information Hub, by compiling all the relevant documentation related to REDD+ results-based payments requirements, provides developing countries with the opportunity to showcase their results to potential donors, with due international recognition. This platform mitigates the risk of double counting of results and of payments made for these results. It can also serve as a tool to enhance the sharing of information to improve the coordination of actions and support.



Brazil's efforts to control deforestation in the Amazon biome over the last 10 years have been coupled with strong commitment and engagement in REDD+ negotiations under the UNFCCC. When the Warsaw Framework for REDD+ was established in December 2013, Brazil was ready to take immediate steps to begin its implementation.

On 6 June, 2014, during the Bonn Climate Change Conference, Brazil became the first developing country to submit its FREL, for reducing emissions from deforestation in the Amazon biome, to the UNFCCC. Brazil's FREL defines the reference period and the scale against which REDD+ results are measured on a historical or projected perspective. It is a fundamental component for assessing the actual impact of REDD+ policies and measures.

Between August and November 2014, Brazil's FREL went through a technical assessment by two LULUCF experts appointed by the UNFCCC Secretariat. It was a facilitative technical exchange to assess the degree to which the information presented by Brazil was in accordance with the guidelines established by UNFCCC decisions. The report on the technical assessment of the FREL was concluded and published by 1 December 2014. The assessment team concluded that the information used by Brazil in constructing its FREL is transparent and complete and is in overall accordance with the guidelines for submission of information on FREL.

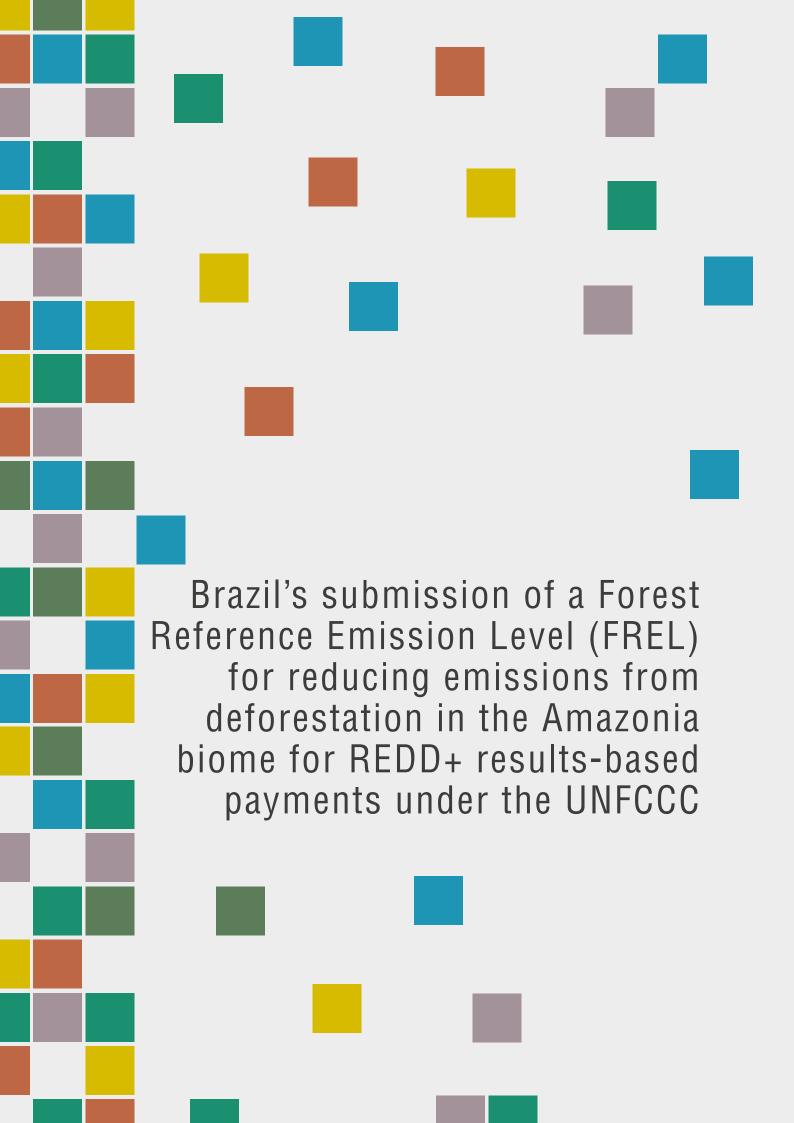
Brazil's REDD+ Technical Annex to the BUR was submitted to the UNFCCC in December 2014. The document presents the results achieved in reducing emissions from deforestation in the Amazon biome between 2006 and 2010. The document underwent the ICA process by LULUCF experts in 2015 and the **technical report from the ICA** was published in September 2015.

The Summary of information on how the Cancun safeguards were addressed and respected by Brazil throughout the implementation of actions to reduce emissions from deforestation in the Amazon biome between 2006 and 2010 was submitted in via the REDD+ Web Platform in May 2015, in accordance with decision 9/CP.19.

Brazil is currently developing its **REDD+ Safeguards Information System (SISREDD+)** in accordance with UNFCCC guidelines, to provide the relevant information to all stakeholders in a transparent, accessible and timely manner.

Finally, **Brazil's National REDD+ Strategy (ENREDD+)** is currently at its final stage for approval and should enter into force in 2016. Its overall objective is to contribute to climate change mitigation by eliminating illegal deforestation, while promoting the recovery of forest ecosystems and the development of a low carbon sustainable forest economy with socio-economic and environmental benefits.

The following sections of this publication bring, in full, all the submissions previously described, as well as the respective technical assessment reports published by the UNFCCC as part of the implementation of the Warsaw Framework for REDD+ by Brazil.



#### Coordination:

Ministry of the Environment (MMA)

Ministry of Science, Technology and Innovation (MCTI)

## Working Group of Technical Experts on REDD+:

Leticia Guimarães, Ministry of the Environment (MMA)

Alexandre Santos Avelino, Ministry of the Environment (MMA)

Monique Sacardo Ferreira, Ministry of the Environmen (MMA)

Thelma Krug, Ministry of Science, Technology and Innovation, National Institute for Space Research (MCTI/INPE)

Dalton de Morisson Valeriano, Ministry of Science, Technology and Innovation, National Institute for Space Research (MCTI/INPE)

Luis Eduardo Pinheiro Maurano, Ministry of Science, Technology and Innovation, National Institute for Space Research (MCTI/INPE)

Alberto Waingort Setzer, Ministry of Science, Technology and Innovation, National Institute for Space Research (MCTI/INPE)

Jean Pierre Henry Balbaud Ometto, Ministry of Science, Technology and Innovation, National Institute for Space Research (MCTI/INPE)

Niro Higuchi, Ministry of Science, Technology and Innovation, National Institute of Amazon Research (MCTI/INPA)

Philip Martin Fearnside, Ministry of Science, Technology and Innovation, National Institute of Amazon Research (MCTI/INPA)

Adriana dos Santos Siqueira Scolastrici, Foundation of Space Science, Applications and Technology (FUNCATE)

Ricardo Ribeiro Rodrigues, Luiz de Queiroz College of Agriculture (ESALQ), University of São Paulo (USP)

Edson Eyji Sano, Ministry of the Environment, Brazilian Institute of the Environment and Renewable Natural Resources (MMA/IBAMA)

Joberto Veloso de Freitas, Ministry of the Environment, Brazilian Forest Service (MMA/SFB)

Laerte Guimarães Ferreira Jr., Federal University of Goiás (UFG)

Rosana Clara Victória Higa, Ministry of the Agriculture, Livestock and Supply, Brazilian Enterprise for Agricultural Research (MAPA/EMBRAPA)

Heloisa Aparecida Belleza Ferreira, Ministry of the Agriculture, Livestock and Supply, Brazilian Enterprise for Agricultural Research (MAPA/EMBRAPA)

Heloísa Sinátora Miranda, University of Brasilia (UnB)

Mercedes Maria da Cunha Bustamante. Rede Clima

# TABLE OF CONTENTS

Introduction	25
Area and activity covered by the FREL	25
a)Information that was used in constructing the FREL	30
b) Complete, transparent, consistent and accurate information used in the construction of the FREL	44
b.1. Complete Information	44
b.2. Transparent Information	46
b.3. Consistent Information	60
b.4. Accurate Information	63
c) Pools, gases and activities included in the construction of the FREL	66
c.1. Activities included	66
c.2. Pools included	68
c.3. Gases included	71
d) Forest definition	72
References	76
Annexes	84

# **FIGURES**

Figure 1. Distribution of the six biomes in the Brazilian territory	26
Figure 2. State boundaries and boundaries of the Amazonia biome	26
<b>Figure 3</b> ; The relative contribution of the sectors Energy, Industrial Processes and LULUCF to the total CO2 emissions at year 2000; and the relative contribution of the Brazilian biomes to the total LULUCF emissions from Brazil	27
Figure 4. Aggregated deforestation (in yellow) until year 2012 in the Legal Amazonia and the Amazonia, Cerrado and Pantanal biomes	30
Figure 5. Landsat coverage of the Brazilian Legal Amazonia area	38
Figure 6. Pictoral representation of Step 1	39
Figure 7. Pictoral representation of Step 2	39
Figure 8. Pictoral representation of Step 3 and Step 4	40
Figure 9. Pictoral representation of Brazil's Forest Reference Emission Level	43
Figure 10. A sample of a window to download the information generated by PRODES	47
Figure 11. RADAMBRASIL Vegetation map of the Amazonia biome with the distribution of its 38 volumes	48
Figure 12. Distribution of the RADAMBRASIL sample plots	49
Figure 13. Histogram and observed data (A) and histogram with carbon values in the aboveground biomass (B) per CBH in Amazonia biome	54
Figure 14. Representation of forest degradation in a portion of a Landsat image	67
Figure 15. Percent distribution of the main soil types in the Amazonia basin	69
Figure 16. Brazil's soil classification system	70
<b>Figure 17</b> . (A) Extension of burned pastures (2002 – 2008) in the Brazilian biomes; (B) CO2, CH4, N2O and CO emissions (in Mt CO2-eq) for the Amazonia biome in the same period.	79
Diotito iti tito saitto portou	∠

# **TABLES**

<b>Table 1</b> . Annual area deforested and associated mean gross CO2 emissions from deforestation in the Amazonia biome from 1996 to 2010	43
Table 2. Forest types considered in the Amazonia biome	50
Table 3. Identification of the forest types sampled by RADAMBRASIL	51
<b>Table 4</b> . Carbon densities (tC ha-1) in living biomass (aboveground and belowground, including palms and vines; and litter mass) for the Amazonia biome, by forest type and RADAMBRASIL volume, following the set of rules in Step 5	57
<b>Table 5</b> . Carbon density for the vegetation typologies in the Amazonia biome           estimated from the literature and references consulted	58
Table 6. Brazil's forest monitoring systems for the Amazonia biome	67
<b>Table 7</b> FRA 2010 vegetation typolologies included in this FRFI	74

# **BOXES**

Box 1. Forest and deforestation in the Amazonia biome	28
Box 2. Approaches to estimating deforestation in the Amazonia biome	32
Box 3. Choice of the Allometric Equation to Estimate Aboveground Biomass	36
<b>Box 4</b> . Emissions from gross deforestation as presented in the Second National GHG Inventory and in the submission of Brazil's FREL	
<b>Box 5</b> . Carbon map uncertainties – analyzing the literature	66
Box 6. The rationale behind the non-inclusion of dead wood in Brazil's FREL	71
Rox 7 Estimates of CO2 and non-CO2 emissions of GHG	72

# ANNEXES

Annex I: Additional information	85
I. Amazonian Gross Deforestation Monitoring Project – PRODES	85
II. PPCDAm: Action Plan for the Prevention and Control of Deforestation in the Legal Amazonia	90
Annex II: Examples to support this FREL submission	92
I. Example of the calculation of adjusted deforestation increment and associated CO2 emission for the year 2003	92
II. Example of the calculation of the carbon density associated with a forest type	98
Annex III: The development of FRELs for other REDD+ activities in the Amazonia biome	.101
I. Degradation in the Amazon biome: available historical data and forest	
monitoring systems	.101
Annex IV: The development of FRELs for other biomes	.106
I. From subnational to national (all biomes)	.106
II. Deforestation and degradation in the Cerrado biome	.107
III. Enhancement of forest carbon stocks in the Atlantic Forest biome	.109

# INTRODUCTION

Brazil welcomes the opportunity to submit a forest reference emission level (FREL) for a technical assessment in the context of results-based payments for *reducing emissions from deforestation* and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+) under the United Nations Framework Convention on Climate Change (UNFCCC).

In February 2014, the Ministry of the Environment of Brazil (MMA) created a Working Group of Technical Experts on REDD+ through the Ministerial Ordinance No. 41. This Working Group, formed mainly by experts from renowned Brazilian federal institutions in the area of climate change and forests, provided inputs for the development of this submission of the Brazilian government to the United Nations Framework Convention on Climate Change (UNFCCC).

Brazil underlines that the submission of FRELs and/or forest reference levels (FRLs) and subsequent Technical Annexes to the Biennial Update Report (BUR) with results are voluntary and **exclusively for the purpose of obtaining and receiving payments for REDD+ actions**, pursuant to decisions 13/CP.19, paragraph 2, and 14/CP.19, paragraphs 7 and 8.

This submission, therefore, does not modify, revise or adjust in any way the nationally appropriate mitigation actions currently being undertaken by Brazil pursuant to the Bali Action Plan (FCCC/AWGLCA/2011/INF.1), neither prejudges any nationally determined contribution by Brazil in the context of the protocol, another legal instrument or an agreed outcome with legal force under the Convention currently being negotiated under the Ad Hoc Working Group on the Durban Platform for Enhanced Action.

## **AREA AND ACTIVITY COVERED BY THE FREL**

Brazil recalls paragraphs 11 and 10 of Decision 12/CP.17 (FCCC/CP/2011/9/Add.2) that respectively indicate that a subnational FREL may be developed as an interim measure, while transitioning to a national FREL; and that a step-wise approach to a national FREL may be useful, enabling Parties to improve the FREL by incorporating better data, improved methodologies and, where appropriate, additional pools.

Brazil proposes through this submission a subnational FREL for the Amazonia biome (refer to *Figure 1)* that comprises approximately 4,197,000 km<sup>2</sup> and corresponds to 49.29 per cent of the national territory<sup>1</sup> (refer to *Figure 2*).

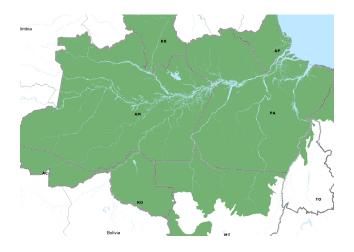
As presented in Figure 1, in addition to the Amazonia biome, the national territory has five other biomes: Cerrado (2,036,448 km2 – 23.92 per cent of the national territory), Mata Atlântica (1,110,182 km2 – 13.04 per cent of the national territory), Caatinga (844,453 km2 – 9.92

The **national FREL** to be submitted by Brazil in the future for each REDD+ activity selected will be calculated as the sum of the FRELs constructed for each of the six biomes in the national territory (refer to **Figure 1**).



*Figure 1*: Distribution of the six biomes in the Brazilian territory. Source: IBGE, 2011.

This will allow the country to assess and evaluate the effect of the implementation of policies and measures developed at the biome level (refer to *Annex I, Part II*, for details of the Action Plan to Prevent and Control Deforestation in the Legal Amazonia (PPCDAm); *Annex IV, Part II, Box 4* for the Action Plan to Prevent and Control Deforestation and Forest Fires in the Cerrado (PPCerrado); and *Annex IV, Part III* for information on the Atlantic Forest.



*Figure 2*: State boundaries and boundaries of the Amazonia biome. Source: MMA (2014) based on IBGE (2010).

per cent of the national territory), Pampa (176,496 km2-2.07 per cent of the national territory), and Pantanal (150,355 km2-1.76 per cent of the national territory) (BRASIL, 2010, Volume 1, Table 3.85).

Considering the significant relative contribution of the net  $\mathrm{CO}_2$  emissions from Land Use, Landuse Change and Forestry (LULUCF) to the total national net  $\mathrm{CO}_2$  emissions; and the significant contribution of the Amazonia biome to the total  $\mathrm{CO}_2$  emissions from LULUCF (refer to *Figure 3*), **Brazil deemed appropriate to initially focus its actions in the forest sector through "***reducing emissions from deforestation***" in the Amazonia biome, as an interim measure, while transitioning to a national strategy that will include all biomes.** 

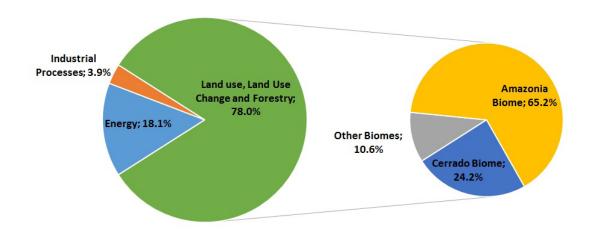


Figure 3: The relative contribution of the Energy, Industrial Processes and LULUCF sectors to the total CO<sub>2</sub> emissions at year 2000² (excluding waste)³; and the relative contribution of the Brazilian biomes to the total LULUCF emissions (excluding liming) from Brazil. **Source:** BRASIL, 2010, Volume 1, Part 2, Chapter 2.

Regardless of the fact that this FREL submission for REDD+ results-based payments includes only  ${\bf CO_2}$  emissions from gross deforestation in the Amazonia biome (see **Box 1** below for details), preliminary information is provided in **Annex IV, Part II, Box 4** for the Cerrado and in **Annex IV, Part III** for the Atlantic Forest, to indicate efforts already under development in Brazil to transition to a national FREL.

This submission includes emissions from the following carbon pools: above and below-ground biomass, and litter. The non-inclusion of the dead wood and the soil organic carbon pools (mineral and organic soils) are dealt with in **section c.2**.

The Guidelines for the preparation of national communications from Parties not included in Annex I to the Convention in the Annex of Decision 17/ CP.8 states that non-Annex I Parties shall estimate national GHG inventories for the year 1994 for the initial national communication or alternatively may provide data for the year 1990. For the second national communication, non-Annex I Parties shall estimate national GHG inventories for the year 2000 (UNFCCC, 2002).

The relative contributions of CO2 emissions from waste to the total CO2 emissions in 2000 was less than 1 per cent (0.006 per cent) and hence have been excluded from Figure 2. The relative contribution of CO2 emissions from liming to the total CO2 emissions from the LULUCF sector in 2000 was also less than 1 per cent (0.7 per cent) and hence also excluded from Figure 2.

#### BOX 1: FOREST AND DEFORESTATION IN THE AMAZONIA BIOME

The National Institute for Space Research (INPE) through the Amazonian Gross Deforestation Monitoring Project (PRODES) annually assesses gross deforestation in "primary" forests in Legal Amazonia with a minimum mapping unit of 6.25 hectares (for details refer to *Annex I*, *Part I*, *BOX 1*). PRODES forest definition includes all vegetation types of Evergreen Forest Formations in the Legal Amazonia and forest facies of other formations such as Savanna and Steppe, which are generally classified as "Other Wooded Land" according to the Food and Agriculture Organization of the United Nations (FAO) classification system (see *Section d* of this submission for more information on the definition of forest adopted by Brazil). The presence of these facies in the Amazonia biome is not significant. However, when deforestation occurs in any of these facies, the associated emissions are calculated using their corresponding carbon density, provided in *Tables 4* and *5*.

At the beginning of PRODES in 1988, a map containing the boundary between Forest – Non-Forest was created based on existing vegetation maps and spectral characteristics of forest in Landsat satellite imagery. In 1987, all previously deforested areas were aggregated in a map (including deforestation in forest areas that in 1987 were secondary forests) and classified as *deforestation*. Thereafter, on a yearly basis, deforestation in the Amazonia biome has been assessed on the remaining annually updated Forest.

For the purposes of PRODES, the areas of Non-Forest are not monitored (regardless of being managed or unmanaged following the IPCC definition of managed land $^1$  (IPCC, 2006). Deforestation occurring in Forest land (managed or unmanaged) is monitored and the associated  $\mathrm{CO}_2$  emission calculated assuming instantaneous oxidation at the year deforestation occurs. Hence, the accumulated gross deforestation in the Brazilian Amazonia never decreases at each new assessment.

Another system developed and implemented by INPE and the Brazilian Enterprise for Agriculture (EMBRAPA) tracks the dynamics of land cover after deforestation, including to Secondary Forest. This system, referred to as *TerraClass*, maps the land use dynamics in areas that have been previously deforested in the Amazonia biome: (http://www.inpe.br/cra/projetos\_pesquisas/terraclass2010.php and http://www.inpe.br/noticias/noticia.php?Cod\_Noticia=3302).

The  $\mathrm{CO}_2$  removed from the atmosphere by Secondary Forest is not taken into account in the construction of this FREL due to the dynamics of Secondary Forest in Brazil. In Amazonia, approximately 20 per cent of the land deforested is abandoned to regrow (Secondary Forest), thus accumulating carbon. However, this Secondary Forest may eventually be cut again (thus losing all the carbon accumulated) to be converted to cropland or grassland, and normally remains in the new land-use category for a few years before abandonment. In this case, the gains and losses of carbon in Secondary Forests balance out, justifying why Brazil opted to report emissions from **gross deforestation** and not **net deforestation**.

### BOX 1 CONTINUATION: FOREST AND DEFORESTATION IN THE AMAZONIA BIOME

The Brazilian deforestation time series from PRODES relate only to deforestation in primary forests that may or may not have been impacted by human activities or natural events but has not shown a **clear cut** pattern in the satellite imagery. Hence, areas previously logged, whenever identified in the satellite imagery as **clear cut**, are included as deforestation in PRODES.

Areas under selective logging activities are monitored under another project developed by INPE (DETEX – *Detection and Mapping of Selective Logging Activities Project*) that is presently undergoing new developments to discriminate impact levels and, if feasible, between authorized and non-authorized logging. Data for DETEX are already available since 2008 but are still aggregated in a single class.

Deforestation of other than primary forest is reported in the National GHG Inventory of Brazil. However, given Brazil's national circumstances (one of the largest primary tropical forests in the world) and considering the marginal contribution of emissions from conversion of these other types of forests to the total emission from deforestation in Amazonia (1.57 per cent – refer to *Table 3.98* in the Second National GHG Inventory), these other forest types (*planted forests – Rev; Secondary Forests, Sec*) have not been included in Brazil's FREL.

**Section c** in this submission (*Pools, gases and activities included in the construction of the FREL*) provides more detailed information regarding other pools and gases.

**Annex III** (Development of FRELs for other REDD+ activities in the Amazonia biome) provides some preliminary information regarding forest degradation and introduces some ongoing initiatives to estimate the associated emissions, so as not to exclude significant activities from consideration.

There is recognition of the need to continue to improve the estimates of emissions associated with REDD+ activities, pools and gases. However, the material in the Annexes to this submission is not meant for results-based payments.

Brazil followed the guidelines for submission of information on reference levels as contained in the Annex to Decision 12/CP.17 and structured this submission accordingly, i.e.:

- a) Information that was used in constructing a FREL;
- b) Complete, transparent, consistent, and accurate information, including methodological information used at the time of construction of FRELs;
- c) Pools and gases, and activities which have been included in FREL; and
- d) The definition of forest used in the construction of FREL.

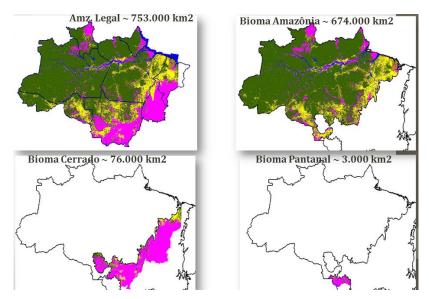
Details are provided below.

## A) INFORMATION THAT WAS USED IN CONSTRUCTING THE FREL

The construction of the FREL for *reducing emissions from deforestation* in the Amazonia biome was based on INPE's historical time series for gross deforestation in the **Legal Amazonia**<sup>4</sup> using Landsat-class satellite data on an annual, wall-to-wall basis since 1988.

The Legal Amazonia encompasses three different biomes: the entire Amazonia biome; 37 per cent of the Cerrado biome; and 40 per cent of the Pantanal biome. *Figure 4* shows the aggregated deforestation up to 2012 in the Legal Amazonia, per biome (in yellow). Up to 2012, about 12 per cent of the total accumulated deforestation in the Legal Amazonia occurred in the Cerrado and Pantanal biomes, mainly in the early 1990's.

For the construction of the FREL for the Amazonia biome, the areas from the Cerrado and Pantanal biomes in the Legal Amazonia have been excluded.



**Figure 4:** Aggregated deforestation (in yellow) up to year 2012 in the Legal Amazonia, and in the Amazonia, Cerrado and Pantanal biomes. Forest in green; Non-Forest in pink; water bodies in blue. **Source:** INPE (2014b).

The area of the deforestation polygon by forest type (in km² or hectares) is the *activity data* necessary for the application of the first order approximation to estimate emissions<sup>5</sup> as suggested in the IPCC Good Practice Guidance for Land Use, Land-use Change and Forestry (GPG LULUCF) (IPCC, 2003). These areas have been obtained from PRODES time series data (modified to consider only deforestation in the Amazonia biome) and the vegetation map from the Brazilian Institute for Geography and Statistics (IBGE). The fact that satellite data from optical systems (e.g., Landsat) are the basic source of information to identify new deforestation events every

The Legal Amazonia is an area of approximately 5,217,423 km² (521,742,300 ha) that covers the totality of the following states: Acre, Amapá, Amazonas, Pará, Rondônia, Roraima and Tocantins; and part of the states of Mato Grosso and Maranhão.

<sup>5 &</sup>quot;In most first order approximations, the "activity data" are in terms of area of land use or land-use change. The generic guidance is to multiply the activity data by a carbon stock coefficient or "emission factor" to provide the source/or sink estimates." (IPCC, 2003; section 3.1.4, page 3.15).

year, and considering that the presence of clouds may impair the observation of deforestation events under clouds, requires the application of an approach to deal with the estimation of the areas of primary forest under clouds that may have been deforested so as not to underestimate the total deforestation at any year (refer to **Box 2** for alternative approaches to estimate the area of gross deforestation in the Amazonia biome). This is in line with good practice as defined in GPG LULUCF (IPCC, 2003).

# BOX 2: APPROACHES TO ESTIMATE THE AREA OF GROSS DEFORESTATION IN THE AMAZONIA BIOME

There are several approaches to estimate the area deforested and each **may** lead to different results. The total deforested area **may** be different if calculated as deforestation increment, or deforestation rate, or adjusted deforestation increment. To further clarify the above, the text that follows explains the different approaches and terminologies used throughout this submission.

- 1. Deforestation Polygons (at year t): refer to new deforestation events identified from the analysis of remotely sensed data (satellite images) at year t as compared to the accumulated deforestation mapped up to year t-1. Each deforestation polygon is spatially identified (geocoded), has accurate shape and area representations, and has an associated date of detection (the date of the satellite image from which it was mapped). For each year, a map containing all deforestation polygons (deforestation map) is made available in shapefile format for PRODES (and hence, for the Amazonia biome, after exclusion of the areas associated with the Cerrado and Pantanal biomes) at (http://www.obt.inpe.br/prodesdigital/cadastro.php). This map does not include deforestation polygons under cloud covered areas. However, the deforestation map also renders spatially explicit distribution of the cloud covered areas.
- 2. Deforestation Increment (at year t): refers to the sum of the areas of all observed deforestation polygons within a given geographical extent. This geographical extent may be defined as the boundaries of a satellite scene which has the same date as the deforestation polygons mapped on that scene; or the entire Amazonia biome, for which the deforestation increment is calculated as the sum of the individual deforestation increment calculated for each scene that covers the biome. The deforestation increment may underestimate the total area deforested (and associated emissions), since it does not account for the area of deforestation polygons under clouds.
- 3. Adjusted Deforestation Increment (at year t): this adjustment is made to the deforestation increment at year t-1 (or years t-1 and t-2, etc., as applicable) to account for deforestation polygons in areas affected by cloud cover and that are observable at time t. It is calculated according with Equation 1:

# BOX 2 CONTINUATION: APPROACHES TO ESTIMATE THE AREA OF GROSS DEFORESTATION IN THE AMAZONIA BIOME

$$Inc_{adj(t)} = Inc_{(t)} - \sum_{\Delta=1} A_{C-(t-\Delta)(t)} + \sum_{\Delta=1} \frac{A_{C-(t-\Delta)(t)}}{\Delta + 1} + \sum_{\Omega=1} \frac{A_{C-(t+\Omega)(t)}}{\Omega + 1}$$
Equation 1

where:

 $Inc_{adj(t)}$  = adjusted deforestation increment at year t, km<sup>2</sup>

 $Inc_{(t)}$  = deforestation increment at year t, km<sup>2</sup>

 $A_{\mathcal{C}_{(t-\Delta),(t)}}$  = area of the deforestation polygons observed (cloud-free) at year t over cloud-covered areas at year t- $\Delta$ ; km $^2$ . Note that when  $\Delta=1$ ,  $A_{\mathcal{C}_{(t-1),(t)}}$  equals the area of the deforestation polygons observed at year t over cloud-covered areas at year t-1 (but which were under cloud-free at year t-2); for  $\Delta=2$ ,  $A_{\mathcal{C}_{(t-2),(t)}}$  equals the area of the deforestation polygons observed at year t over an area that was cloud-covered at both years t-1 **and** t-2.

 $A_{\mathcal{C}_{(t+\Omega)}(t)}$  = area of the deforestation polygons observed at year t+ $\Omega$  over cloud-covered areas at year t, km². Note that when  $\Omega=1$ , the term  $A_{\mathcal{C}_{(t+1)}(t)}$  provides the area of the deforestation polygons observed at year t+1 over the area that was cloud-covered at year t, when  $\Omega=2$ , the term  $A_{\mathcal{C}_{(t+2)}(t)}$  provides the area of the deforestation polygons observed at year t+2 over the area that was cloud-covered at years t and t+1.

 $\Delta$  = number of years that a given area was persistently affected by cloud cover prior to year t but was observed at year t,  $\Delta$  =1, 2, ....

 $\Omega$  = number of years until a given area affected by cloud cover at year t is observed in subsequent years (i.e., is free of clouds);  $\Omega = 1,2,...$ 

As an example, suppose that the area of the deforestation increment observed at year,  $Inc_{(t)}$ , is 200 km² and that 20 km² of this occurred over primary forest areas that were cloud covered at year t-1 (but are cloud-free at year t). Since these 20 km² may accumulate the area of the deforestation polygons under clouds at year t-1 and the area of the deforestation polygons that occurred at year t, the deforestation increment **may overestimate** the total area deforested area (and associated emissions) at year t.

# BOX 2 CONTINUATION: APPROACHES TO ESTIMATE THE AREA OF GROSS DEFORESTATION IN THE AMAZONIA BIOME

The adjusted deforestation increment  $Inc_{adj(t)}$  at year t evenly distributes the total area of the deforestation polygons observed at year t under the cloud-covered area at year t-1 (or before, if the same area was also cloud covered at year t-2, for instance) among years t-1 and t. Hence, the adjusted deforestation increment at year t is 190 km² (200 – 20/2) and not 200 km², assuming that there were no cloud-covered areas at year t (in which case the adjusted deforestation increment at year t would be adjusted by  $\sum_{\Omega=1}^{A_{C}} \frac{A_{C}(t+\Omega)(t)}{\Omega+1}$  where  $A_{C}(t+\Omega)(t)$  = area of the deforestation polygons observed at year t+  $\Omega$  over cloud-covered areas at year t; and  $\Omega$  is the number of years that a given area affected by cloud cover at year t is observed (i.e., is free of clouds).

The rationale behind **Equation 1** is to remove from the deforestation increment the area to be distributed among the years  $(-\sum_{\Delta=1}^{\infty}A_{C\ (t-\Delta)(t)})$  and then add back the portion allocated to year t  $\left(\sum_{\Delta=1}^{\infty}\frac{A_{C\ (t-\Delta)(t)}}{\Delta+1}\right)$ . The last term of the equation refers to the area distributed from subsequent years (or year) over cloud covered areas at year t.

**1. Deforestation Rate** (at year *t*): was introduced in PRODES to sequentially address the effect of **cloud cover**; and, if necessary, the effect of **time lapse** between consecutive images. The deforestation rate aims at reducing the potential under or over-estimation of the deforested area at year *t*. The presence of cloud-covered areas in an image at year *t* impairs the observation of deforestation polygons under clouds, and may lead to an **underestimation** of the area deforested; while the presence of clouds in previous years (e.g., at year *t*-1) may lead to an **overestimation** of the area deforested if all deforestation under clouds at year *t*-1 is attributed to year *t*.

This **over** or **under-estimation** may also occur if the dates of the satellite images used in subsequent years are not adjusted. To normalize for a one year period (365 days) the time lapse between the images used at years t and t+1, the rate considers a reference date of August 1<sup>st</sup> and projects the cloud corrected increment to that date, based on a model that assumes that the deforestation pace is constant during the dry season and zero during the wet season. Refer to **Annex I**, **Part I** for more information on PRODES methodology for calculating the deforestation rate.

As an example of cloud correction, suppose that the primary forest area in an image is 20,000 km2 and that 2,000 km2 of this occurred over primary forest areas that were cloud covered. Suppose also that the observed deforestation increment is 180 km2. As part of the calculation of the rate, it is assumed that the proportion of deforestation measured in the cloud-free forest area (18,000 km2) is the same as that in the area of forest under cloud (2,000 km2). Therefore the proportion 180/18,000 = 0.01 is applied to the 2,000 km2, generating an extra 20 km2 that is added to the observed deforestation increment. In this case, the cloud corrected increment is 200 km2.

# BOX 2 CONTINUATION: APPROACHES TO ESTIMATE THE AREA OF GROSS DEFORESTATION IN THE AMAZONIA BIOME

### **IMPORTANT REMARKS:**

- 1. Note that at any one year, an estimate based on the adjusted deforestation increment may be higher or lower than the rate of gross deforestation.
- For the sake of verifiability, this submission introduces a slight change in the methodology used in PRODES to estimate the annual area deforested. PRODES methodology to annualize observed deforestation and to take into account unobserved areas due to cloud cover is not directly verifiable unless all the estimates are adjusted backwards.
- 3. The approach applied in this submission relies on a verifiable deforestation map and does not annualize the time lapse between consecutive scenes. It deals with the effect of cloud cover by equally distributing the area of the deforestation polygons observed at year *t* over cloud-covered areas at year *t*-1 (or to years where that area was persistently cloud covered) among years *t* and *t*-1.
- 4. The use of the adjusted deforestation increment to estimate the area deforested and associated gross emissions is deemed to be more appropriate for REDD+, due to the verifiability.

**Annex II, Part I**, provides an example of the application of the adjusted deforestation increment approach to estimate the area deforested at year 2003, as presented in **Table 1**.

In addition to the area of the annual gross deforestation by forest type, another fundamental element to estimate the associated emission is the *emission factor* that, here, consists of the carbon density associated with each forest type considered in this submission, consistent with the Second National GHG Inventory (in tonnes of carbon per unit area, tC ha<sup>-1</sup>) (refer to *Tables 4* and *5*). *Annex II, Part II* provides a table with the description of the sub-classes included under each forest type contained in this FREL submission. The forest types addressed in this submission are in line with those in Fearnside (2004) presented on *Table 2* (*Forest Types in the Brazilian Amazonia*).

The carbon density per unit area was estimated using an allometric equation developed by Higuchi *et al.*, (1998) from the National Institute for Amazonia Research (INPA), to estimate the aboveground fresh mass<sup>6</sup> of trees from distinct forest types<sup>7</sup> in the Amazonia biome as well as data from the scientific literature, as necessary (refer to **Box 3** and **section b.2**).

<sup>6</sup> Hereinafter referred simply as aboveground fresh biomass.

These forest types, or vegetation classes, totaled 22 and were derived from the Vegetation Map of Brazil (1:5,000,000), available at: ftp://ftp.ibge.gov.br/Cartas\_e\_Mapas/Mapas\_Murais/, last accessed on May 5th, 2014.

### BOX 3: CHOICE OF THE ALLOMETRIC EQUATION TO ESTIMATE ABOVEGROUND BIOMASS

Four statistical models (linear, non-linear and two logarithmic) selected from thirty-four models in Santos (1996) were tested with data from 315 trees destructively sampled to estimate the aboveground fresh biomass of trees in areas near Manaus, Amazonas State, in the Amazonia biome (central Amazonia). This area is characterized by typical dense "terra firme" moist forest in plateaus dominated by yellow oxisols.

In addition to the weight of each tree, other measurements such as the diameter at breast height, the total height, the merchantable height, height and diameter of the canopy were also collected. The choice of the best statistical model was made on the basis of the largest coefficient of determination, smaller standard error of the estimate, and best distribution of residuals (Santos, 1996).

For any model, the difference between the observed and estimated biomass was consistently below 5 per cent. In addition, the logarithm model using a single independent variable (diameter at breast height - DBH) produced results as consistent as and as precise as those with two variables (DBH and height) (Higuchi, 1998).

Silva (2007) also demonstrated that the total fresh weight (above and below-ground biomass) of primary forest can be estimated using simple entry (DBH) and double entry (DBH and height) models and stressed that the height added little to the accuracy of the estimate. The simple entry model presented percent coefficient of determination of 94 per cent and standard error of 3.9 per cent. For the double entry models, these values were 95 per cent and 3.7 per cent, respectively. It is recognized that the application of the allometric equation developed for a specific area of Amazonia may increase the uncertainties of the estimates when applied to other areas.

In this sense, the work by Nogueira *et al.* (2008) is relevant to be cited here. Nogueira *et al.* (2008) tested three allometric equations previously published and developed for dense forest in Central Amazonia (CA): Higuchi *et al.* (1998), Chambers *et al.* (2001) and Silva (2007). All three equations developed for CA tend to overestimate the biomass of the smaller trees in South Amazonia and underestimate the biomass of the larger trees. Despite this, the total biomass of the sampled trees estimated using the equations developed for CA was similar to those obtained in the field (-0,8%, -2,2% e 1,6% for the equations from Higuchi *et al.*, 1998; Chambers *et al.*, 2001 and Silva, 2007, respectively, due to the compensation of under and over-estimates for the small and larger trees. However, when the biomass per unit area is estimated using the equations developed for the CA, the estimates were 6.0 per cent larger for the equations from Higuchi *et al.* (1998); 8.3 per cent larger for Chambers *et al.* (2001); and 18.7 per cent for Silva (2007).

The input data for applying Higuchi *et al.* (1998) allometric equation have been collected during the RADAM (RADar in AMazonia) Project (later also referred to as RADAMBRASIL project or simply RADAMBRASIL)<sup>8</sup>. RADAMBRASIL collected georeferenced data from 2,292 sample plots<sup>9</sup> in Amazonia (refer to *Figure 11* for the spatial distribution of the sample plots), including circumference at breast height (CBH) and height of all trees above 100 cm. More details regarding the allometric equation are presented in *section b.2*.

The FREL proposed by Brazil in this submission uses the IPCC methodology as a basis for estimating changes in carbon stocks in forest land converted to other land-use categories as described in the GPG LULUCF (IPCC, 2003). For any land-use conversion occurring in a given year, GPG LULUCF considers both the carbon stocks in the biomass immediately before and immediately after the conversion.

Brazil assumes that the biomass immediately after the forest conversion is zero and does not consider any subsequent  $\mathrm{CO}_2$  removal after deforestation (immediately after the conversion or thereafter). This assumption is made since Brazil has a consistent, credible, accurate, transparent, and verifiable time-series for gross deforestation for the Legal Amazonia (and hence, for the Amazonia biome), but has limited information on subsequent land-use after deforestation and its dynamics.

The text that follows provides detailed information about the construction of Brazil's FREL.

The basic data for estimating annual gross emissions from deforestation in the Amazonia biome derives from the analysis of remotely sensed data from sensors of adequate spatial resolution (mostly Landsat-5, of spatial resolution up to 30 meters). Images from the Landsat satellite acquired annually over the entire Amazonia biome (refer to *Figure 5*), on as similar as possible dates are selected, processed and visually interpreted to identify new deforestation polygons since the previous assessment (for details regarding the selection, processing and analysis phases, refer to *Annex I*, *Part I*). This generates, for each image in the Amazonia biome a map with spatially explicit (georeferenced) deforestation polygons since the previous year.

<sup>8</sup> The RADAMBRASIL project was conducted between 1970 and 1985 and covered the entire Brazilian territory (with special focus in Amazonia) using airborne radar sensors. The results from RADAMBRASIL Project include, among others, texts, thematic maps (geology, geomorphology, pedology, vegetation, potential land use, and assessment of natural renewable resources), which are still broadly used as a reference for the ecological zoning of the Brazilian Amazonia.

<sup>9</sup> Also referred in this submission as sample units, consisting of a varied number of trees.

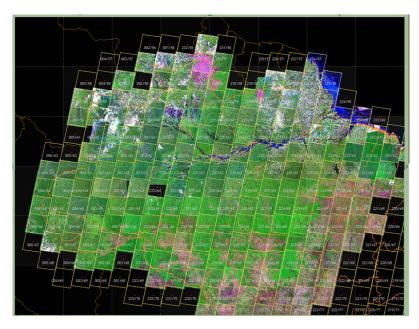


Figure 5: Landsat coverage of the Brazilian Legal Amazonia area. Source: PRODES, 2014

The next step in the process for estimating emissions from deforestation in the Amazonia biome consists of overlaying this deforestation map with the "carbon map" containing the carbon densities associated with distinct forest types in the Amazonia biome. Each deforestation polygon in a given image is associated with a RADAMBRASIL volume, a forest type and associated carbon density. Note that the same forest type may have a different carbon density depending on the RADAMBRASIL volume. This is due to variability in soil types, climatic conditions and flood regime for riparian vegetation in the Amazonia biome.

The carbon map is the same as the one used to estimate the emissions from forest conversion in the Second National GHG Inventory (details of the carbon map are provided in **Section b.2**).

**Figures 6** to **8** present the sequence followed to estimate the total emission from deforestation for any year in the period from 1996 to 2010, used in the construction of the FREL.

Due to the fact the digital (georeferenced) information on the annual deforestation polygons only became annually available from 2001 onwards; that for the period 1998-2000 inclusive, only an aggregated digital map with the deforestation increments for years 1998, 1999 ad 2000 is available; and that no digital information is available individually for years 1996 and 1997, the steps and figures below seek to clarify how the estimate of the total  $\mathrm{CO}_2$  emission was generated for each year in the period 1996 to 2010.

In order to simplify the presentation, **Steps 1** to **4** assume that all the images used to identify the deforestation polygons were cloud free. Under this assumption, the **adjusted deforestation increment** is equal to the **deforestation increment**, and both are equal to the sum of the areas of the deforestation polygons mapped. In the presence of cloud cover, then the deforested areas are calculated following the **adjusted deforestation increment** approach described in **Box 2**.

**Step 1:** identification of the available maps with deforestation polygons, as follows: (i) map with the aggregated deforestation until 1997; aggregated deforestation polygons for 1998-2000; and individual maps with deforestation polygons for each year in the period 2001 to 2010 (inclusive).

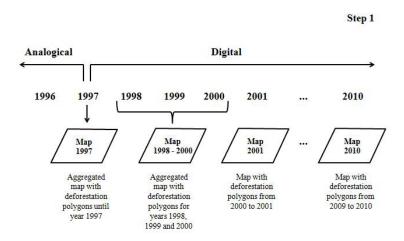


Figure 6: Pictoral representation of Step 1.

**Step 2:** integration of the map with the deforestation polygons (**Step 1**) with the carbon map in a Geographic Information System (GIS). For each year, a database containing each deforestation polygon and associated forest type (as well as RADAMBRASIL volume) is produced and is the basis for the estimation of the gross emissions from deforestation (in tonnes of carbon) which, multiplied by 44/12, provide the total emissions in tonnes of  $CO_2$ .

For the period 1998-2000, the total  $CO_2$  emissions refer to those associated with the aggregated deforestation polygons for years 1998, 1999 and 2000 that, when divided by 3, provide the average annual  $CO_2$  emission.

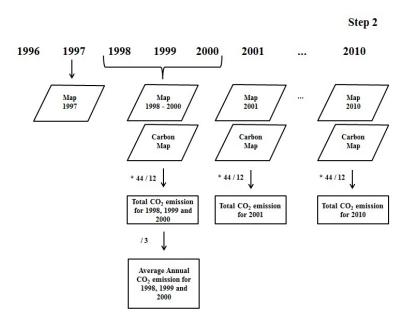
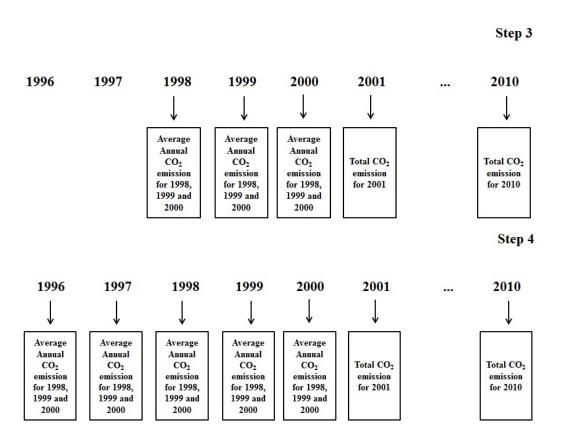


Figure 7: Pictoral representation of **Step 2**.

**Step 3:** indicates the estimated  $CO_2$  emissions for each year from 1998 (inclusive) until 2010; and **Step 4:** indicates the  $CO_2$  emissions for years 1996 and 1997.



*Figure 8:* Pictoral representation of *Step 3* and *Step 4*.

### The next step is only applicable in case of the presence of cloud cover at year t.

**Step 5:** After the deforestation increment and associated emission have been estimated for year *t*, an analysis is made of the areas that were cloud covered in the previous year(s), for which information on deforestation is available at year *t*. The area of the observed deforestation polygons at year *t* that occur under the cloud covered area(s) at year *t*-1 is removed from the increment calculated for year *t* and evenly distributed (summed) to the increment calculated for year *t*.

As an example, suppose that the area of the deforestation polygons at year *t* that fall under a cloud-covered area at year *t*-1 is 100 km². For the calculation of the *adjusted deforestation increment* for years *t* and *t*-1, these 100 km² are subtracted from the increment calculated for year *t* and evenly distributed between years *t* and *t*-1 (i.e., 50 km² is added to the observed increment for year *t*-1, and 50 km² is added to the "reduced" increment for year *t*. In case the area observed at year *t* was cloud covered at years *t*-1 **and** *t*-2, then one third of the 100 km² is evenly distributed (summed) to the increment calculated for years *t*, *t*-1, and *t*-2. Hence, the deforestation increment at year *t* can be reduced due to the distribution of some area to previous years, but may also increase due to the distribution of areas at year *t*+1 over cloud covered areas at year *t*. The areas and associated emissions indicated in *Table 1* are the areas presented as adjusted deforestation increment and their associated emissions.

# **Estimating emissions from deforestation polygons**

for each deforestation polygon i, the associated  $CO_2$  emission is estimated as the product of its area and the associated carbon density in the living biomass<sup>10</sup> present in the forest type affected by deforestation (refer to **Equation 2**).

Equation 2:

$$GE_{i,i} = A_{i,i} \times EF_i \times 44/12$$

**Equation 2** 

where:

 $GE_{i,j} = CO_2$  emission associated with deforestation polygon *i* under forest type *j*;  $tCO_2$ 

 $A_{i,j}$  = area of deforestation polygon i under forest type j; ha

 $EF_j$  = carbon stock in the living biomass of forest type j in deforestation polygon i per unit area; tC ha<sup>-1</sup>

44/12 is used to convert tonnes of carbon to tonnes of  ${\rm CO_2}$ 

For any year t, the total emission from gross deforestation, GE, is estimated using **Equation 3**:

$$t_{i} = \sum_{i=1}^{N} \sum_{j=1}^{p} GE_{i,j}$$
 Equation 3

where:

GE  $_t$  = total emission from gross deforestation at year t, tCO $_2$ 

 $GE_{i,j} = CO_2$  emission associated with deforestation polygon i under forest type j;  $tCO_2$ 

N = number of new deforestation polygons in year t (from year t-1 and t); adimensional

p = number of forest types, adimensional

For any period P, the mean annual emission from gross deforestation,  $MGE_p$ , is calculated as indicated in **Equation 4**:

$$MGE_{p} = \frac{\sum_{t=1}^{T} GE_{t}}{T}$$
 Equation 4

Living biomass, here, means above and below-ground biomass, including palms and vines, and litter mass.

where:

 $MGE_p$ = mean annual emission from gross deforestation in period p;  $tCO_2$   $yr^1$ 

 $GE_t$  = total emission from gross deforestation at year t, tCO<sub>2</sub>

T = number of years in period p; adimensional.

#### BRAZIL'S FREL FROM GROSS DEFORESTATION IN THE AMAZONIA BIOME

The FREL proposed by Brazil is a dynamic mean of the CO2 emissions associated with gross deforestation since 1996, updated every five years, using the best available historical data and consistent with the most recent National GHG Inventory submitted by Brazil to the UNFCCC at the time of the construction of the FREL.

1. This base year was chosen by the Working Group of Technical Experts on REDD+ so as to leave out the high deforestation peak in 1995 and also to maintain consistency with other initiatives in Brazil, including the Action Plan to Prevent and Control Deforestation in the Legal Amazonia (see *Annex I, Part I* for details), the National Climate Change Policy<sup>11</sup> and the Amazon Fund (www.amazonfund.gov.br).

The dynamic nature of Brazil's FREL is meant to reflect the effects of policies and plans implemented in the Amazonia biome<sup>12</sup>, as well as improvements in data quality and availability.

# BRAZIL'S FREL DOES NOT INCLUDE ASSUMPTIONS ON POTENTIAL FUTURE CHANGES TO DOMESTIC POLICIES.

In summary, for results based payments the following applies:

- For results obtained in the period from 2006 to 2010, inclusive, the FREL is equal to the mean annual CO<sub>2</sub> emissions associated with gross deforestation (calculated as adjusted deforestation increment) from the period 1996 to 2005, inclusive (refer to *Figure 9* and *Table 1*).
- For results obtained in the period from 2011 to 2015, inclusive, the FREL is equal to the mean annual CO<sub>2</sub> emissions associated with gross deforestation (calculated as adjusted deforestation increment) from 1996 to 2010, inclusive (refer to *Figure 9* and *Table 1*).
- For results obtained in the period from 2016 to 2020, the FREL is equal to the mean annual CO<sub>2</sub> emissions associated with gross deforestation (calculated as adjusted deforestation increment) from 1996 to 2015, inclusive.

For more information on the Presidential Decree no. 7390 of December 9, 2010 see: http://www.planalto.gov.br/ccivil\_03/\_Ato2007-2010/Decreto/D7390.htm, last accessed on September 18th, 2014.

<sup>12</sup> For details regarding relevant policies and plans for the Amazonia biome, refer to Annex I, Part II.



**Figure 9.** Pictoral representation of Brazil's FREL, where (A) refers to the mean annual  $\rm CO_2$  emissions from the period 1996 to 2005 (1,106,027,616.63 t $\rm CO_2$ ); (B) refers to the mean annual  $\rm CO_2$  emissions from the period 1996 to 2010 (907,959,466.33 t $\rm CO_2$ ).

**Table 1**. Adjusted deforestation increments and associated emissions (in tC and t CO<sub>2</sub>) from gross deforestation in the Amazonia biome, from 1996 to 2010.

YEAR	ADJUSTED DEFORESTATION INCREMENT (ha)	EMISSIONS FROM GROSS Deforestation (tC)	${\rm CO_2}$ EMISSIONS FROM GROSS DEFORESTATION (t ${\rm CO_2}$ )
1996	1,874,013.00	267,142,749.24	979,523,413.88
1997	1,874,013.00	267,142,749.24	979,523,413.88
1998	1,874,013.00	267,142,749.24	979,523,413.88
1999	1,874,013.00	267,142,749.24	979,523,413.88
2000	1,874,013.00	267,142,749.24	979,523,413.88
2001	1,949,331.35	247,899,310.88	908,964,139.89
2002	2,466,603.88	363,942,942.80	1,334,457,456.93
2003	2,558,846.30	375,060,876.74	1,375,223,214.70
2004	2,479,429.81	376,402,076.09	1,380,140,945.68
2005	2,176,226.17	317,420,001.73	1,163,873,339.68
2006	1,033,634.15	157,117,398.10	576,097,126.38
2007	1,087,468.65	165,890,835.62	608,266,397.26
2008	1,233,037.68	181,637,813.29	666,005,315.39
2009	596,373.64	99,365,584.69	364,340,477.19
2010	583,147.53	93,929,048.84	344,406,512.43
1996 - 2005			1,106,027,616.63
1996 - 2010			907,959,466.33

The areas presented in *Table 1* are the *adjusted deforestation increments* of gross deforestation estimated for the Amazonia biome. Note that those from PRODES correspond to the *rate* of gross deforestation estimated for the Legal Amazonia. The grey lines in *Table 1* correspond to years for which data are only available in analogic format. For any year in the period from 1996 to 2010, gross  $CO_2$  emissions from deforestation have been calculated following *Steps 1-4* in *Figures 6 to 8*, and *Step 5*.

REDD+ decisions under the UNFCCC value the constant improvement of data sets and information over time. It is not expected that countries will submit their information to the UNFCCC only when and if they have the most accurate data available for all significant pools. Brazil understands that the most important element before accuracy is to ascertain consistency and transparency of the data submitted.

Brazil is investing considerable human and financial resources to improve its historical data sets. INPE has a project to expand Digital PRODES to years before 2001 which will allow for the spatial analysis of deforestation and lead to more precise estimates for years before 2000. With the improved data, Brazil will submit a revised FREL to the UNFCCC.

# B) COMPLETE, TRANSPARENT, CONSISTENT AND ACCURATE INFORMATION USED IN THE CONSTRUCTION OF THE FREL

# **b.1. Complete Information**

**Complete** information, for the purposes of REDD+, means the provision of information that allows for the reconstruction of the FREL.

The following data and information were used in the construction of the FREL and are available for download at <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a>:

- (1) All the satellite images used to map the deforestation polygons in the Amazonia biome from 1996 to 2010.
- (2) Accumulated deforestation polygons until 1997 (inclusive), presented in a map hereinafter referred to as the *digital base map* (see *Annex I*, *Part I* for more details).
- (3) Accumulated deforestation polygons for years 1998, 1999 and 2000 mapped on the *digital base map*.
- (4) Annual deforestation polygons for the period from 2001 to 2010, inclusive (*annual maps*).

**IMPORTANT REMARK 1**: All maps referred to in (2), (3) and (4) above are available in shapefile format ready to be imported into a Geographical Database for analysis. All satellite images referred to in (1) above are provided in full resolution in geotiff format. Any individual deforestation polygon can be verified against the corresponding satellite image.

**IMPORTANT REMARK 2**: The maps referred to in (2), (3) and (4) above are a subset of those produced by INPE for PRODES (for additional information see <a href="http://www.obt.inpe.br/prodes/index.php">http://www.obt.inpe.br/prodes/index.php</a>) and refer only to the Amazonia biome, the object of this submission. The information in (2) and (3) above are provided in a single file.

- (5) The deforestation polygons by forest type attributes and RADAMBRASIL volume;
- 6. For each year, the deforestation polygons are associated with the corresponding forest type and RADAMBRASIL volume. These files are large and are thus presented here only for year 2003<sup>13</sup>, the year that has been used to exemplify the calculation of the adjusted deforestation increment (refer to **Box 2** and **Annex II**, **Part I**).
- 7. It is worth noting that for all since 2001, the stratification of the deforestation polygons by forest type attributes and RADAMBRASIL volume indicated that deforestation concentrates mostly in the so called "Arc of Deforestation" (a belt that crosses over RADAMBRASIL volumes 4, 5, 16, 20, 22 and 26 refer to **Figure 11**), and marginally affects forest types in RADAMBRASIL volumes associated with higher carbon densities.
- 8. The information that allows for the calculation of the adjusted deforestation increments for years 2001, 2002, 2003, 2004 and 2005 is available at: <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a>. Annex II, Part I provides an example of the calculation of the adjusted deforestation increment for year 2003 (see "calculo\_def\_increment\_emission\_2003" thought the FTP. file available at: <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a>).
- 9. A map with the carbon densities of different forest types in the Amazonia biome (carbon map), consistent with that used in the Second National GHG Inventory, the latest submitted by Brazil to the UNFCCC at the time of construction of the FREL.
- 10. Samples of the relevant14 RADAMBRASIL data that have been used as input to the allometric equation by Higuchi et al. (1998). They are generated from the original RADAMBRASIL database, which is the basis for the construction of the carbon map. Consultation with the Working Group of Technical Experts on REDD+ led to the understanding that there may be cases of apparent inconsistencies in carbon densities

For year 2003, a total of 402,176 deforestation polygons have been identified. For each deforestation polygon in the file, the following information is provided: the State of the Federation it belongs (uf); the RADAMBRASIL volume (vol); the associated forest type (veg) and the associated area (in ha).

The original RADAMBRASIL data for the volumes where deforestation occurs most frequently (CBH, forest type, RADAMBRASIL volume) are provided at: <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a>, as RADAMBRASIL sample units data.

within a forest type due to specific circumstances of the sample unit. This is part of the natural heterogeneity of the biomass density distribution in tropical vegetation.

# **b.2. Transparent Information**

This section provides more detailed information regarding the items indicated in **section b.1**.

# Regarding (1): Satellite Imagery

As previously indicated **(section a)**, remotely sensed data is the major source of information used to map deforestation polygons every year. The availability of all satellite images used since 1988 allows for the verification and reproducibility of annual deforestation polygons over primary forest in the Amazonia biome as well as the cloud-covered areas.

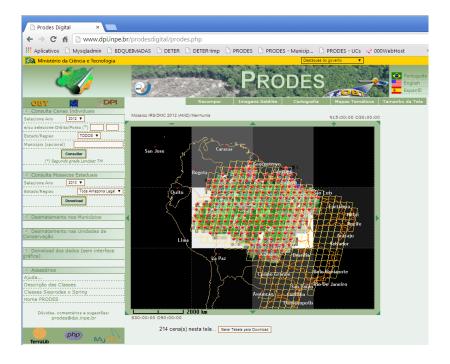
Note that since the beginning of year 2003, INPE adopted an innovative policy to make satellite data publicly available online. The first step in this regard was to make available all the satellite images from the China-Brazil Earth Resources Satellite (CBERS 2 and CBERS 2B) through INPE's website (http://www.dgi.inpe.br/CDSR/). Subsequently, data from the North American Landsat satellite and the Indian satellite Resourcesat 1 were also made available. With this policy INPE became the major distributor of remotely sensed data in the world.

# Regarding (2), (3) and (4): Deforestation polygons

All deforestation polygons15 mapped for the Amazonia biome (i.e., aggregated until 2007; aggregated for years 1998, 1999 and 2000; and annual from 2001 until 2010) are available at <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a>.

Note that this information is a subset of that made available since 2003 by INPE for PRODES at <a href="https://www.obt.inpe.br/prodes">www.obt.inpe.br/prodes</a>. At this site, for each satellite image (see (1) above), a vector map in shapefile format is generated and made available, along with all the previous deforestation polygons, the areas not deforested, the hydrology network and the area of non-forest. For PRODES, this information is provided for each State of the Federation and for the Legal Amazonia. Figure 10 shows the screen as viewed by the users when accessing INPE's website to download images and data.

The information for PRODES is also available for the Legal Amazonia are publicly available since 2003 at INPE's website (<a href="www.obt.inpe.br/prodes">www.obt.inpe.br/prodes</a>).



**Figure 10.** A sample of a window to download the information generated by PRODES. Source: **www.obt.inpe.br/prodes** 

# Regarding (5): Deforestation polygons by forest type and RADAMBRASIL volume

In order to ensure transparency in the calculation of the annual adjusted deforestation increment and associated emission provided in **Table 1**, a file that associates each deforestation polygon with its forest type and corresponding RADAMBRASIL volume has been generated for each year since 2000. Since these files are large in size, the file for 2003, containing 402,176 deforestation polygons is made available at <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a>, as tab "2003" in file "calculo\_def\_increment\_emission\_2003.xls".

## Regarding (6): Information for the calculation of the adjusted deforestation increment

The information to calculate the annual adjusted deforestation increment is provided in the website <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a> for years 2001, 2002, 2003, 2004 and 2005 (shapefiles

It is important to note that the availability of data from similar spatial resolution sensors to Landsat is reducing the need for adjustments, as deforestation under cloud-covered areas is assessed using alternative satellite data.

<sup>&</sup>quot;SPAgregado2012 CO2AmazoniaCompleto pol split1",

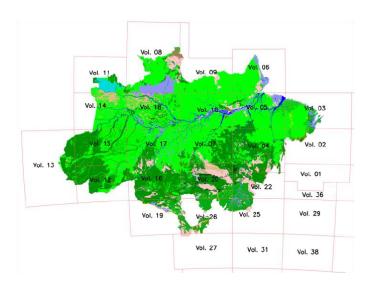
<sup>&</sup>quot;SPAgregado2012\_CO2AmazoniaCompleto\_pol\_split2" and

<sup>&</sup>quot;SPAgregado2012\_CO2AmazoniaCompleto\_pol").

# Regarding (7): Carbon map

The map with the biomass density of living biomass (including palms and vines) and litter mass used to estimate the CO2 emissions from deforestation in **Table 1** is the same as that used in the Second National GHG Inventory to estimate CO2 emissions from conversion of forest land to other land-use categories.

As already mentioned, the carbon map was constructed using an allometric equation by Higuchi et al. (1998) and data (diameter at breast height derived from the circumference at breast height) collected by RADAMBRASIL on trees in the sampled plots, as well as data from the literature, as necessary. The data collected by RADAMBRASIL were documented in 38 volumes distributed as shown in **Figure 11** over the RADAMBRASIL vegetation map (refer to footnote 9). RADAMBRASIL data is provided for the relevant volumes at: <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a>



*Figure 11*: RADAMBRASIL Vegetation map of the Amazonia biome with the distribution of its 38 volumes. *Source:* BRASIL, 2010.

#### Regarding (8): RADAMBRASIL data

RADAMBRASIL collected a significant amount of data for each one of the 2,292 sample units. The relevant RADAMBRASIL data is provided for the sample units in the relevant RADAMBRASIL volumes at site <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a>, i.e., the volumes most affected by deforestation (volumes 4, 5, 16, 20, 22 and 26) and the information relevant for this submission, particularly CBH.

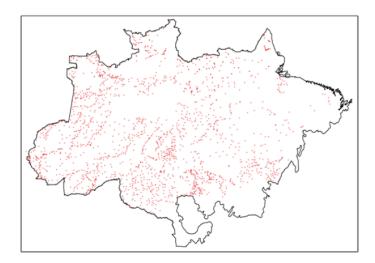
# ADDITIONAL INFORMATION ON RADAMBRASIL DATA AND CONSTRUCTION OF THE CARBON MAP

All the RADAMBRASIL sample plots with relevant data for this submission consisted of transects of 20 meters by 500 meters (hence, 1 hectare). *Figure 12* presents the distribution of the RADAMBRASIL sample plots in the biome Amazonia.

RADAMBRASIL collected data on trees with circumference at breast height above 100 cm in 2,292 sample plots. For the Second National GHG Inventory, some of these sample plots were eliminated if:

- after the lognormal fit, the number of trees per sample unit contained less than 15 or more than 210 trees (less than 1 per cent of the samples);
- the forests physiognomies were not found in the IBGE (Brazilian Institute for Geography and Statistics) charts; and
- no geographical information on the location of the sample unit was available.

The application of this set of rules led to the elimination of 582 sample plots from analysis (BRASIL, 2010).



*Figure 12.* Distribution of the RADAMBRASIL sample plots. *Source:* BRASIL, 2010

The steps below are meant to facilitate the understanding regarding the construction of the carbon map:

- 1. Reclassification of the forest types defined for the Amazonia biome, consistent with those contained in the Second National GHG Inventory.
- 2. Identification of RADAMBRASIL sample units in the RADAMBRASIL vegetation map.
- 3. Application of the allometric equation (Higuchi *et al.*,1998) to the data collected in the sample units for the specific forest type, to estimate the aboveground fresh mass from DBH (*Equation 5*).
- 4. Conversion of aboveground fresh mass to dry mass and then to carbon in dry mass (*Equation 6*).

- 1) Inclusion of the carbon density of trees with CBH less than 100 cm (considering that RADAMBRASIL collected data only on trees with CBH larger than 100 cm) (*Equation 7*).
- 2) Inclusion of carbon of palms and vines (*Equation 8*).
- 3) Inclusion of carbon of belowground biomass and litter (*Equation 9*).
- 5. Application of extrapolation rules to estimate the carbon density associated with the forest types in each RADAMBRASIL volume, noting that the same forest type in different volumes may have different values.
- 6. Literature review to estimate the carbon density in forest types not sampled by RADAMBRASIL.

Each of the above steps is now detailed.

**Step 1:** Reclassification of the forest types defined for the Amazonia biome, consistent with those of the Second National GHG Inventory.

The forest types in the Amazonia biome have been defined taking into account the availability of reliable data, either from RADAMBRASIL or from the literature to estimate their associated carbon density. As such, twenty two forest types<sup>16</sup> were considered, consistent with the forest types in the Second National GHG Inventory of Greenhouse Gases submitted by Brazil to the UNFCCC. *Table 2* provides the list of forest types considered.

**Table 2:** Forest types<sup>17</sup> considered in the Amazonia biome (see Table 7 in section C).

DESCRIPT	ION (IBGE VEGETATION TYPOLOGIES)
Aa	Alluvial Open Humid Forest
Ab	Lowland Open Humid Forest
As	Sub-montane Open Humid Forest
Cb	Lowland Deciduous Seasonal Forest
Cs	Sub-montane Deciduous Seasonal Forest
Da	Alluvial Dense Humid Forest
Db	Lowland Dense Humid Forest
Dm	Montane Dense Humid Forest
Ds	Sub-montane Dense Humid Forest
Fa	Alluvial Semi-deciduous Seasonal Forest

Also referred to in this document as forest types or forest physiognomies.

Some forested facies present in major Vegetation Formations, such as Savanna and Steppe are also included as "Forests" in the PRODES map. These are generically classified as "Other wooded land" according to FAO classification system for National Forest Inventories. As an example, Dense Arboreous Savanna and Dense Arboreous Steppe are considered Forest in this map in the same way as the dominant Ombrophyllous Forest Formation. Therefore PRODES may map deforestation in areas classified as FAO's "Other Wooded Land" vegetation, but the occurrence of these is not significant, as the example provided in Annex II shows.

DESCRIPT	ION (IBGE VEGETATION TYPOLOGIES)
Fb	Lowland Semi-deciduous Seasonal Forest
Fm	Montane Semi-deciduous Seasonal Forest
Fs	Sub-montane Semi-deciduous Seasonal Forest
La	Forested Campinarana
Ld	Wooded Campinarana
Pa	Vegetation with fluvial influence and/or lake
Pf	Forest Vegetation Fluviomarine influenced
Pm	Pioneer influenced Marine influenced
Sa	Wooded Savannah
Sd	Forested Savannah
Та	Wooded Steppe Savannah
Td	Forested Steppe Savannah

Step 2: Identification of RADAMBRASIL samples units in the RADAMBRASIL vegetation map.

The information collected by RADAMBRASIL on the sample units (refer to *Figure 12*) did not include the associated forest types. It did, however, include the coordinates of the sampled trees which, when plotted against the RADAMBRASIL vegetation map, led to the identification of the corresponding forest type (refer to *Figure 11*). Data from RADAMBRASIL sample plots were not available for all 22 forest types, as indicated in *Table 3* (see <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a> for more information on the vegetation subclasses contained in this map).

**Table 3:** Identification of the forest types sampled by RADAMBRASIL.

DESCRIPTION (IBGE VEGETATION TYPOLOGIES) SOURCE			
Aa	Aluvial Open Humid Forest	RADAMBRASIL	
Ab	Lowland Open Humid Forest	RADAMBRASIL	
As	Submontane Open Humid Forest	RADAMBRASIL	
Cb	Lowland Deciduos Seasonal Forest		
Cs	Submontane Deciduous Seasonal Forest		
Da	Alluvial Dense Humid Forest	RADAMBRASIL	
Db	Lowland Dense Humid Forest	RADAMBRASIL	
Dm	Montane Dense Humid Forest	RADAMBRASIL	
Ds	Submontane Dense Humid Forest	RADAMBRASIL	

DESCRIPTIO	DESCRIPTION (IBGE VEGETATION TYPOLOGIES) SOURCE					
Fa	Alluvial Semi deciduous Seasonal Forest					
Fb	Lowland Semi-deciduous Seasonal Forest					
Fm	Montane Semi-deciduous Seasonal Forest					
Fs	Submontane Semi deciduous Seasonal Forest					
La	Forested Campinarana	RADAMBRASIL				
Ld	Wooded Campinarana	RADAMBRASIL				
Pa	Vegetation with fluvial influence and/or lake					
Pf	Forest Vegetation Fluviomarine influenced					
Pm	Pioneer influenced Marine					
Sa	Wooded Savannah					
Sd	Forested Savannah					
Та	Wooded Steppe Savannah					
Td	Forested Steppe Savannah					

**Step 3:** Application of the allometric equation (Higuchi *et al.*,1998), to the data collected in the sample units for the specific forest type, to estimate the aboveground fresh mass from DBH.

The allometric equation used in the construction of the carbon map (Higuchi *et al.*, 1998)<sup>18</sup> is applied according with the diameter at breast height (DBH)<sup>19</sup> of the sampled trees, as indicated in *Equation*  $5^{20}$  below:

For DBH ≥ 20 cm

 $\ln P = -0.151 + 2.170 \times \ln DBH$ 

**Equation 5** 

where:

P = aboveground fresh biomass of a sampled tree; kg

DBH = diameter at breast height of the sampled tree; cm

Higuchi, N.; dos Santos, J.; Ribeiro, R.J.; Minette, L.; Biot, Y. (1998) Biomassa da Parte Aérea da Vegetação da Floresta Tropical Úmida de Terra-Firme da Amazônia Brasileira. Acta Amazonica 28(2):153-166.

<sup>19</sup> For the conversion of CBH to DBH, the CBH was divided by 3.1416.

Higuchi (1998) provided two allometric equations: one for trees with DBH between 5cm and 20 cm; and another for trees with DBH larger than 20 cm. Since RADAMBRASIL only collected data on trees with DBH above 20 cm, only one of the equations is provided here (as Equation 5).

Step 4: Conversion of aboveground fresh mass to dry mass and then to carbon in dry mass

For each sampled tree, the associated carbon density in the aboveground dry biomass was calculated from the aboveground fresh biomass of the tree from **Step 3**, applying **Equation 6**:

$$C_{(CBH > 100 \text{ cm})} = 0.2859 \times P$$
 Equation 6

where:

P = aboveground fresh biomass of a sampled tree; kg

 $C_{(CBH>100\,cm)}$  = carbon in the aboveground dry biomass of a tree with CBH>100cm; kg

**IMPORTANT REMARK:** the value 0.2859 is applied to convert the aboveground fresh biomass to aboveground dry biomass; and from aboveground dry biomass to carbon. Silva (2007) also derived values for the average water content in aboveground fresh biomass (0.416  $\pm$  2.8 per cent) and the average carbon fraction of dry matter (0.485 $\pm$ 0.9 per cent) which are very similar to those used by Higuchi *et al.* (1994) after Lima *et al.* (2007), equal to 0.40 for the average water content in aboveground fresh biomass and 0.47 for the average carbon fraction of dry matter. The IPCC default values are 0.5 tonne dry matter/tonne fresh biomass (IPCC 2003); and 0.47 tonne carbon/tonne dry matter (IPCC 2006, Table 4.3), respectively

The carbon densities of all trees in a sample unit (1 hectare) were summed up to provide an estimate of the total carbon stock in aboveground biomass for that sample,  $AC_{(CBH>100cm)}$ .

**Step 4a:** Inclusion of the carbon density of trees with CBH less than 100 cm (considering that RADAMBRASIL collected data only on trees with CBH larger than 100 cm).

Due to the fact that the RADAMBRASIL only sampled trees with circumference at breast height (CBH) above 100 cm (corresponding to diameter at breast height of 31.83 cm), an extrapolation factor was applied to the average carbon stock of each sampled unit to include the carbon density of trees with CBH smaller than 100 cm. This was based on the extrapolation of the histogram containing the range of CBH values observed in all sample units and the associated total number of trees (in intervals of 10 cm).

**Figure 13** show the histograms used and the observed data (CBH and associated total number of trees), as well as the curves that best fit the observed data (shown in green). The extrapolation factor was applied to the total carbon stock in each sample unit,  $AC_{(CBH > 100 \text{ cm})}$ , as indicated in **Equation 7**.

$$C_{\text{(total)}} = 1.315698 \times AC_{\text{(CBH > 100 cm)}}$$

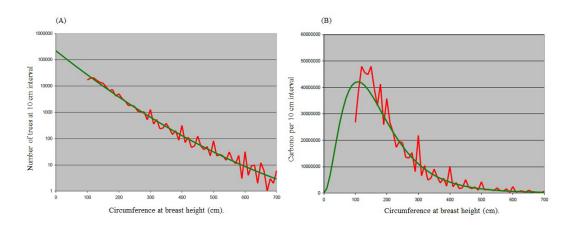
**Equation 7** 

where:

 $C_{\text{(total)}}$  = total carbon stock of all trees in a sample unit; tC ha<sup>-1</sup>

 $AC_{(CBH > 100 \text{ cm})}$  = total carbon stock in a sample unit from trees with CBH > 100 cm; tC ha<sup>-1</sup>

**IMPORTANT REMARK:** the adequacy of this extrapolation was verified comparing data (biomass of trees in experimental areas in Amazonia) in a study by Higuchi (2004). In this study, the relationship between the aboveground biomass of all trees with DBH < 20 cm and those with DBH > 20 cm varied between 3 and 23 per cent, depending on the area. The average value was 10.1 per cent. On the other hand, applying the methodology presented here (developed by Meira Filho (2001), available in BRASIL, 2010) for DBH=20 cm (instead of CBH equals to 100 cm), the value 9.4 per cent is obtained, consistent with the value found by Higuchi (2004)



**Figure 13.** Histogram and observed data (A) and histogram with carbon values in the aboveground biomass (B) per CBH in Amazonia biome. Source: BRASIL, 2010, from BRASIL 2004 (developed by Meira Filho and Higuchi) Note: The red line represents observed data and the green line represents the best fit curve.

# Step 4b. Inclusion of carbon of palms and vines.

In addition to the biomass from trees in the sampled units (regardless of their DBH value), the biomass from palms and vines, normally found in the Amazonia biome, have also been included. This inclusion was a response to the public consultation conducted for the First National GHG Inventory, part of the Initial National Communication of Brazil to the UNFCCC.

Silva (2007) has estimated that the biomass of palms and vines represent 2.31 and 1.77 per cent of the total aboveground biomass.

Hence, these values have been applied to  $C_{(total)}$  in **Equation 7** to obtain the total aboveground carbon in the sample as shown in **Equation 8**:

$$C_{aboveground} = 1.3717 \times AC_{(CBH > 100 cm)}$$

**Equation 8** 

where:

 $C_{aboveground}$  = the carbon stock in aboveground biomass in a sample unit (including carbon in all trees, palms and vines), tC ha<sup>-1</sup>

 $AC_{(CBH > 100 \text{ cm})}$  = total carbon stock in a sample unit from trees with CBH > 100 cm; tC ha<sup>-1</sup>

Step 4c: Inclusion of carbon in belowground biomass and litter.

Silva (2007) estimated that the contribution of thick roots and litter to the fresh weight of living vegetation was 27.1 per cent (or 37.2 of the aboveground weight) and 3.0 per cent, respectively. The inclusion of carbon from these pools as indicated in **Equation 9** provides an estimate of the total carbon stock in the sample unit:

$$C_{\text{total, SU}} = 1.9384 \times AC_{(CBH > 100 \text{ cm})}$$

**Equation 9** 

where:

 $C_{\text{total, SU}}$  = total carbon stock in living biomass (above and below-ground) for all trees, palms and vines in the sample unit; tC ha<sup>-1</sup>;

 $AC_{(CBH > 100 \text{ cm})}$  = total carbon stock in a sample unit from trees with CBH > 100 cm; tC ha<sup>-1</sup>.

**IMPORTANT REMARK:** *Equation 9* already includes <u>step 4a</u> and <u>step 4b</u>. Hence, to generate the total carbon stock in living biomass and litter it is only necessary to apply Equations 4, 5 and 8. *Annex II, Part II* presents an example of the application of these equations to derive the carbon stock for one specific volume of RADAMBRASIL (volume 13) and a specific forest type (DS).

**Step 5:** Application of extrapolation rules to estimate the carbon density associated with the forest types in each RADAMBRASIL volume, noting that the same forest type in different volumes may have different values.

The application of *Steps 3* and *4* (or equivalently, the application of Equations 5, 6 and 9 which integrates Equations 7 and 8) produces estimates of carbon density in living biomass (including trees with CBH < 100cm, palms and vines) and litter mass for the data collected by RADAMBRASIL. These sample estimates, gathered from different forest types in different locations, did not necessarily cover every vegetation type in each RADAMBRASIL volume (see *Figure 12*).

Hence, a set of rules was created to allow for the estimation of carbon densities for each vegetation type considered, as described below.

- ❖ Rule 1. For a given forest type in a specific RADAMBRASIL volume, if there were corresponding sample plots (where Steps 3, 4 and 7 are applied to each tree to estimate the associated carbon density), the carbon density for that forest type was calculated as the sum of the carbon density associated with each tree in the sample plot. For instance, suppose that volume v has 2 sample plots (sample plot 1, with 60 trees, and sample plot 2, with 100 trees) associated with forest type Aa. For sample plot 1, the sum of the carbon stock associated with each one of the 60 trees is calculated, say ASP1; for sample plot 2, the corresponding sum for the 100 trees was also calculated, say ASP2. The carbon density for forest type Aa in volume 1 was calculated as (ASP1+ ASP2)/2 (highlighted in green in *Table 4*).
- ❖ Rule 2. For a given forest type in a specific RADAMBRASIL volume, if there were no corresponding sample plots in that volume, then the carbon density for that forest type, for that volume, was calculated as the weighted average (by number of samples per sample plot) of the total carbon stock in each sample plot in the neighboring volume(s) (using a minimum of one and maximum of eight volumes). For instance, suppose that volume v has neighboring volumes v1, v2 and v3 with 2, 5 and 3 sample plots associated with forest type Aa. For each sample plot, the total carbon stock, say ASP1, ASP2 and ASP3, was calculated as in Rule 1 above. The carbon stock for forest type Aa in volume v, was then calculated as follows: (2\* ASP1 + 5\*ASP2 + 3\* ASP3)/10 (highlighted in blue in Table 4).
- ❖ Rule 3. For a given forest type in a specific RADAMBRASIL volume, if there were no corresponding sample plots in that volume nor in the neighboring volumes, but there are samples plots in the neighbors to the neighboring volumes (second order neighbors), then the total carbon stock for that forest type in the specific volume is the average of the total carbon stock calculated from the second order neighbors. For instance, assume that there are no sample plots associated with forest type Aa in volume v and its neighboring volumes v1, v2 and v3, and that volumes v4, v5, v6, v7 and v8 (second order neighbors) have 2, 4, 6, 3 and 5 sample plots associated with forest type Aa. Then, the carbon stock for forest type Aa in volume v was calculated applying Rule 2 to the second order neighbors (highlighted in pink in *Table 4*).

The example provided in **Annex II** applies rule 1 as described above.

Table 4: Carbon densities (tC ha<sup>-1</sup>) in living biomass (aboveground and belowground, including palms and vines; and litter mass) for the Amazonia biome, by forest type and RADAMBRASIL volume, following the set of rules in Step 5. Note: Rule one: green, Rule 2: blue, Rule 3: pink. Source: BRASIL, 2010

RADAMBRASIL				Fores	Forest Fisionomy (tC/ ha)	C/ ha)			
Volume	Aa	Αb	As	Da	qQ	Dm	SQ	La	ГР
2	98.24	154.55	110.06	182.98	176.10	139.03	169.35	183.00	
3	98.24	154.55	129.28	137.85	161.01	139.03	275.37	183.00	
4	94.88	154.55	129.28	119.67	154.59	139.03	148.30	183.00	
5	108.33	154.55	146.82	213.85	185.15	109.69	230.13	183.00	
9	123.75	154.55	133.99	131.82	222.39	109.69	213.55	183.00	
7	159.51	160.29	180.66	142.58	153.42	139.03	175.71	262.99	
8	146.97	197.91	73.64	270.89	163.92	149.50	138.56	183.00	183.00
6	127.61	213.37	112.13	262.68	157.38	109.69	184.64	262.99	
10	141.81	169.49	146.45	174.03	149.54	147.77	171.21	262.99	262.99
11	154.71	197.91	158.20	166.72	168.13	83.74	144.81	114.31	114.31
12	144.32	150.69	116.14	164.35	157.42	139.03	161.84	183.00	
13	144.76	144.62	139.24	168.64	153.25	104.05	121.02	160.43	160.43
14	154.71	177.28	173.89	157.86	174.17	104.05	142.46	160.43	160.43
15	172.81	164.36	156.03	171.77	154.38	104.05	155.40	228.80	
16	165.70	136.14	156.76	175.73	188.14	139.03	175.02	183.00	
17	136.09	159.17	157.15	175.64	165.53	104.05	159.63	228.80	
18	162.92	213.37	150.61	174.79	158.01	139.03	140.48	262.99	262.99
19	150.22	147.92	135.72	170.56	159.40	139.03	154.78	183.00	
20	150.61	151.80	117.97	169.39	163.05	139.03	123.29	183.00	183.00
22	148.74	154.55	97.40	137.67	153.42	139.03	145.55	183.00	
25	155.84	154.55	113.12	172.77	162.51	139.03	127.87	183.00	
26	165.70	136.14	130.49	175.73	188.14	139.03	153.93	183.00	

**Step 6:** Literature review to estimate the carbon density in forest types not sampled by RADAMBRASIL

A literature review was conducted to fill in the gaps for which RADAMBRASIL had not estimated the associated carbon density. *Table 5* presents the carbon density estimated from the literature and makes reference to the literature used.

The weighted average carbon density for the Amazonia biome is 151.6 tC ha<sup>-1</sup>. Eighty-four per cent of the carbon density of the forest types defined for the Amazonia biome was estimated using sample data from RADAMBRASIL. The remaining 16 per cent were derived from literature review.

**Table 5:** Carbon density for the vegetation typologies in the Amazonia biome estimated from the literature and references consulted<sup>21</sup>

DE	ESCRIPTION (IBGE VEGETATION TYPOLOGIES)	TC HA-1	REFERENCE*
Cb	Lowland Deciduos Seasonal Forest	116.27	1
Cs	Submontane Deciduous Seasonal Forest	116.27	1
Fa	Alluvial Semi deciduous Seasonal Forest	140.09	2
Fb	Lowland Semi-deciduous Seasonal Forest	140.09	2
Fm	Montane Semi-deciduous Seasonal Forest	140.09	2
Fs	Submontane Semi deciduous Seasonal Forest	140.09	2
Pa	Vegetation with fluvial influence and/or lake	105,64	2
Pf	Forest Vegetation Fluviomarine influenced	98,16	2
Pm	Pioneer influenced Marine influenced	94,48	2
Sa	Wooded Savannah	47,1	3
Sd	Forested Savannah	77,8	3
Ta	Wooded Steppe Savannah	14,41	4
Td	Forested Steppe Savannah	30,1	4

There was no single rule applied to estimate the carbon content presented in Table 5 (e.g., simple average of values in the literature). Some of these values refer to literature for the Cerrado biome but were deemed appropriate for the forest type considered (refer to footnote 15).

#### Note \*:

- 1 Britez, R.M. et al., 2006
- 2 Barbosa, R.I. and Ferreira, C.A.C., 2004 Barbosa, R.I. and Fearnside, P.M., 1999
- 3 Abdala, G. C. et al., 1998

Andrade, L. A.; Felfili, J. M.; Violati, L., 2002

Araújo. L. S., 2010

Araújo, L. S. et al., 2001

Barbosa, R. I. & Fearnside, P. M., 2005

Batalha, M.A., Mantovani, W & Mesquita Junior, 2001

Bustamante, M. M. da C. & Oliveira, E. L. de, 2008

Castro, E. A., 1996

Castro, E. A., & Kauffman, J. B., 1998

Costa, A. A. & Araújo, G. M., 2001

Delitti, W. B. C. & MEGURO, M., 2001

Delitti, W. B. C.. Pausas, J. & Burger, D. M. 2001

Delitti, W. B. C., Meguro, M. & Pausas, J. G., 2006

Durigan, G., 2004

Fearnside, P. M. et al., 2009

Fernandes, A. H. B. M., 2008

Gomes, B. Z., Martines, F. R. & Tamashiro, J. Y., 2004

Grace, J. et al., 2006

Kauffman, J. B., Cummings & D. L. & Whard, D. E., 1994

Kunstchik, G., 2004

Meira Neto, J. A. A. & Saporeti-Junior, A. W., 2002

Martins, O. S., 2005

Ottmar, R. D. et al., 2001

Paiva, A. O. & Faria, G. E., 2007

Pinheiro, E. da S., Durigan, G. & Adami, M., 2009

Resende, D., Merlin, S. & Santos, M. T., 2001

Ronquim, C. C., 2007

Salis, S. M., 2004

Santos, J. R., 1988

Santos, J. R. et al., 2002

Schaefer, C. E. G. *et al.*, 2008

Silva, F. C., 1990

Silva, R. P., 2007

Vale, A. T. do & Felfili, J. M., 2005

Valeriano, D. M. & Biterncourt-Pereira, M. D., 1988

4 Fearnside, P.M. et al., 2009

Barbosa, R.I. and Fearnside, P.M., 2005

Graça, P.M.L.A., 1997 apud Fearnside, 2009

The information provided in this submission allows for the reconstruction of Brazil's FREL. One should bear in mind that the exact value may not be necessarily reproduced due to rounding errors and the impressive amount of data being dealt with<sup>22</sup>. *Annex II* presents the example of the independent reconstruction for year 2003. With this explanation, Brazil considers the submission to be complete and transparent.

# **b.3. Consistent Information**

Paragraph 8 in Decision 12/CP.17 requires that FRELs shall be established maintaining consistency with anthropogenic forest related greenhouse gas emissions by sources and removals by sinks as contained in the country's National GHG Inventory.

Brazil applied the IPCC definition of consistency (IPCC, 2006)<sup>23</sup>, in the sense that the same methodologies and consistent data sets are used to estimate emissions from deforestation in the FREL construction and in the National GHG Inventory.

At the onset, Brazil clarifies that the estimation of emissions by sources and removals by sinks in the Second National GHG Inventory followed the methodological guidance contained in the IPCC Good Practice Guidance for Land Use, Land-use Change and Forestry (IPCC, 2003).

Moreover, Brazil adopted approach 3 for land representation, meaning that all the land conversions and lands remaining in a same land-use category between inventories are spatially explicit. The basis for all activity data in the Second National GHG Inventory as well as the assessment of deforestation for the purposes of this submission rely on the use of remotely sensed data of same spatial resolution (Landsat-class, up to 30 meters).

Also, the same national institutions and team engaged in the development of the LUCF estimates for the First National GHG Inventory and LULUCF estimates for the Second National GHG Inventory has been in charge of the annual estimation of the rate of gross deforestation for PRODES, ensuring an even greater consistency between the estimates for the National GHG Inventory and those used for the generation of PRODES data, which are the *basis* for estimating the gross  $\mathrm{CO}_2$  emissions from deforestation for the Amazonia biome reported here. Furthermore, the experts from the institutions responsible for the development of the National GHG Inventory and the PRODES data are also part of the Working Group of Technical Experts on REDD+ that supported the development of this FREL submission and its quality control.

It is to be noted that the reporting of LULUCF under Brazil's Second National GHG Inventory covered the period 1994 to 2002 and incorporated some improvements relative to the Initial Inventory (1990-1994). The Second National GHG Inventory includes land-use transition areas and net CO<sub>2</sub> emissions for each individual biome for the period 1994 to 2002. Hence, the figures

An independent reconstruction of the data in Table 1 for years 2003, 2004 and 2005 led to the following results: for year 2003: difference in area (0.168 per cent) and in CO2 emission (2.52 per cent); for year 2004: difference in area (0.93 per cent) and in CO2 emission (3.67 per cent); and for year 2005, difference in area (0.00 per cent) and in CO2 emission (2.42 per cent). The independent reproduction applied the values in Tables 4 and 5 as they are presented, while the original data was generated with more decimal places.

Consistency means that an inventory should be internally consistent in all its elements over a period of years. An inventory is consistent if the same methodologies are used for the base year and all subsequent years and if consistent data sets are used to estimate emissions or removals from sources or sinks. An inventory using different methodologies for different years can be considered to be consistent if it has been estimated in a transparent manner taking into account the guidance in Volume 1 on good practice in time series consistency (IPCC Glossary, 2006).

provided in the Second National GHG Inventory<sup>24</sup> for the area deforested in both managed and unmanaged forest land represent the area converted or maintained in the same land-use category for the 8-years interval between years 1994 and 2002.

In addition, the figures provided in the Second National GHG Inventory took into account both the emissions from the conversion to a new land-use category as well as removals from this new category. The Amazonia biome data presented in this submission refers only to gross emissions. The emissions associated with forest land converted to other land-use categories in the Second National GHG Inventory and those estimated for gross deforestation in this submission are based on the same carbon map introduced in **section b.2** (**Steps 1 to 6**).

# BOX 4: EMISSIONS FROM GROSS DEFORESTATION AS PRESENTED IN THE SECOND NATIONAL GHG INVENTORY AND IN THE SUBMISSION OF BRAZIL'S FREL

**Table 3.97** from the Second National GHG Inventory provides the following information for the Amazonia biome:

For the area of primary forest converted to other land uses:

- ❖ Total managed and unmanaged primary forest land (FM and FNM, respectively) converted to other land uses from 1994 to 2002, inclusive = 164,997.14 km².
- The average annual primary forest land area converted to other land uses from 1994 to 2002, inclusive = 164,997.14/8 = 20,624.64 km<sup>2</sup>.

The corresponding data in this submission is as follows:

- ❖ Total area of primary forest deforested (adjusted deforestation increment) for all years from 1996 to 2002, inclusive = 137.860.00 km².
- ightharpoonup The average annual area deforested in this period is 137,860.00/7 = 19,694.29 km<sup>2</sup>.

Note that in the calculation of the average annual area converted to other land uses in the Second National GHG Inventory, the total area is divided by 8 (annual changes from 1994 to 2002: 1994-1995; 1995-1996; ... 2001-2002); whereas for the calculation of the average in this submission, the total deforested area is divided by 7 (data for every year since 1996 until 2002).

Table 3.97 (Land-use transition areas identified in the Amazon biome from 1994 to 2002); and Table 3.98 (Net CO2 emissions in the Amazon biome from 1994 to 2002).

**IMPORTANT REMARK**: the areas and associated emissions provided in the transition matrices in the Second National GHG Inventory (*Table 3.97* and *Table 3.98*, respectively) have not been generated using the annual PRODES data. The analysis was carried out only for two years (1994) and (2002), and the area changes were not adjusted for the different dates and/ or the presence of clouds (note that a reporting category has been introduced in the transition matrix, referred to as *areas not observed due to cloud cover*).

The difference between the average annual area deforested (adjusted deforestation increment) from the submission and the average annual area of forest land converted to other land-uses from the Second National GHG Inventory is 930.36 km². This corresponds to a percent difference of 4.72 per cent relative to the average annual area deforested in the period 1996 to 2002 presented in this submission.

**Regarding the emissions**: The table below provides the  $CO_2$  emissions reported in the Second National GHG Inventory for the period 1994 and 2002 inclusive (**Table 3.98**) from conversion of Forest Land (FNM and FM) to Grassland (Ap), Cropland (Ac), Settlements (S), Reservoirs (R) and Others (O) which total 8,175,002,260.0  $tCO_2$ . Thus, the average annual emission is 1,021,875,828.5  $tCO_2$  yr<sup>1</sup>. The table below also provides the  $CO_2$  emissions for years 1996 to 2002 inclusive, estimated for this submission, which total 7,141,038,666.2  $tCO_2$ , providing an annual average emission of 1,020,148,380.9  $tCO_2$  yr<sup>1</sup>. The difference between the average annual emission from the National Communication and the submission is thus nearly zero.

Forest la		Ap	Ac	S	Res	О	Total emissions from 1994 to 2002 (tCO2)	Average annual emissions from 1994 to 2002 (tCO2)
Second	FNM	6,882,784,770.0	904,422,860.0	11,047,800.0	5,610,690.0	4,605,170.0	8,175,002,260.0	1,021,875,282.5
Inventory **	FM	322,777,250.0	39,564,070.0	1,101,070.0	145,090.0	2,943,490.0	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	1,021,071,2011
	1996	979,523,413.9					Total emissions	Average annual
	1997	979,523,413.9					from 1996 to 2002 - FREL	emissions from 1996 to 2002 -
FREL	1998	979,523,413.9					(tCO2)	FREL (tCO2)
	1999	979,523,413.9						
	2000	979,523,413.9					7,141,038,666.2	1,020,148,380.9
	2001	908,964,139.9						
	2002	1,334,457,456.9						
Percent Diffe	rence							0.17%

Grassland (Ap), Cropland (Ac), Settlements (S), Reservoirs (R) and Others (O).

Hence, Brazil considers that the percent difference is indicative of results that are very similar despite the minor (but consistent) change in the methodology used for the purposes of the Second National GHG Inventory and the one applied to this submission. It is important to note that the **source** for the activity data and the emission factors are consistent, the first being based on the analysis of remotely sensed data and the second in the same carbon map used in the Second National GHG Inventory.

<sup>\*\*</sup> Note that the emissions in Table 3.98 in the Second National GHG Inventory are reported in Gg CO2, and have been converted to t CO2 in the present table.

## **b.4. Accurate Information**

# **b.4.1. Activity Data**

The definition of deforestation adopted for PRODES and maintained in the FREL (i.e., clear cut), in conjunction with the annual wall-to-wall assessment of deforestation based on satellite imagery of high spatial resolution (up to 30 meters) allows deforestation polygons to be identified and mapped with very high accuracy. No ground truth is required for the Amazonia biome since there is an unequivocal identification of the clear cut patches in the Landsat imagery from one year to another. Only new polygons of deforestation are mapped each year on the aggregated deforestation map containing deforestation up to the previous year.

In addition, with the advent of new processing tools and greater availability of satellite data, the gaps of observation in the Landsat imagery due to the presence of clouds are being filled with data from other satellites with sensors of similar spatial resolution to Landsat (e.g., ResourceSat, DMC, CBERS). This ensures that the **observation coverage** of the Amazonia biome is as comprehensive as possible every year.

Note that all the land defined as forest, regardless of being managed or unmanaged according to the managed land definition in the GPG LULUCF (and with more clarity in the 2006 IPCC Guidelines) is included in the annual assessments. Hence, even if clear cut on unmanaged land is identified, it automatically becomes part of the managed forest land database, adding to the total area deforested. Regardless of the fate of the clear cut patches on unmanaged land (converted or not to other land-use categories), the area and its associated emission are added to the total deforested area and the total CO<sub>2</sub> emissions in the year that clear cut occurs.

Finally, the fact that PRODES is conducted by a consistent team of technicians every year and is subject to rigorous quality control and quality assurance by INPE's researchers adds to the accuracy of the activity data, estimated by expert judgment to be around 5 per cent. Quality checks are carried out on a daily basis by INPE's Coordinator of the Amazonia Program who checks the quality of the work, the consistency of the image classification among the different interpreters, and provides guidance to FUNCATE<sup>25</sup>'s coordinator, as necessary.

The classification focus only in the identification of the clear cut patches from the previous year and is analyzed and mapped on the screen (visual interpretation). The coordinator of PRODES at FUNCATE is a person knowledgeable in remote sensing (has a Doctorate degree from INPE) and is responsible for ensuring that the work is delivered to INPE with the quality expected in a timely manner. All data are properly archived, with copies maintained at both INPE and FUNCATE. The work by FUNCATE is conducted through a contract with INPE with clear Terms of Reference. Most importantly, since all data (images and annual maps) are publicly available since 2003, it allows the reconstruction of the deforestation increments by other stakeholders (usually NGOs, State Environmental Secretaries) and hence is verified by independent sources. Furthermore PRODES data are used as reference for many initiatives of global forest monitoring such as the ones conducted by the NASA/University of Maryland and the European Commission.

The Foundation of Space Science, Applications and Technology (FUNCATE) was founded in 1982 with the objective of contributing to Brazil's scientific and technological development. For more information see: <a href="http://www.funcate.org.br/">http://www.funcate.org.br/</a>

## **b.4.2. Emission Factors**

The emission factors used in the construction of the FREL are the carbon densities in the living biomass (including palms and vines) and litter mass, as contained in the carbon map used by Brazil on its Second National GHG Inventory (refer to **section b.1** and the carbon map for the Amazonia biome).

Brazil does not yet have a nationally wide forest inventory in place. Some states have already implemented their forest inventory following the National Forest Inventory (NFI) design developed jointly by the Brazilian Forest Service (SFB) and the FAO<sup>26</sup> but data are not yet available at national level. There is an expectation that by 2017 all states will have implemented their forest inventories, consistent with the National Forest Inventory<sup>27</sup>.

RADAMBRASIL data used in the construction of the carbon map is the most comprehensive forest ground data available in Brazil up to now. It is difficult to assess the uncertainty of the data collected by many different teams. The carbon map has been constructed using the RADAMBRASIL data as input data to the allometric equation by Higuchi *et al.* (1998) to relate aboveground fresh biomass with carbon densities developed using ground data collected in Central Amazonia. As mentioned in *Box 3*, the use of this allometric equation to estimate the aboveground fresh biomass in South Amazonia (SA) led to a difference of 6 per cent when contrasted with the biomass estimated from ground data collected in SA.

Regarding uncertainties associated with other variables in Higuchi *et al* (1998) equation, the following uncertainties estimated by Silva (2007) for the water and carbon content in fresh and dry biomass provide a first approximation to the uncertainties of these values as used by Higuchi *et al* (1998), .

- (1) The average water content of 41.6 percent represents the weighted average of water in the following components from trees: (1) trunk (water content of 38.8 per cent and contribution to total biomass of 58.02 per cent); (2) thick branch (water content of 40.6 per cent and contribution to total biomass of 12.48 per cent); (3) thin branch (water content of 44.9 per cent and contribution to total biomass of 12.78 per cent); (4) leaves (water content of 59.7 per cent and contribution to total biomass of 2.69 per cent); (5) thick roots (water content of 48.9 per cent and contribution to total biomass of 3.06 per cent); (6) thin roots (water content of 44.5 per cent and contribution to total biomass of 11.59 per cent). The 95 per cent confidence interval for the average percent water content is 41.6 ± 2.8. The value used in *Equation 6* (40.0 per cent is within this confidence interval).
- (2) The average carbon content of 48.5 per cent represents the weighted average of the following components from trees (dry mass): (1) trunk (carbon content of 48.5 per

For more information see: http://www.fao.org/forestry/17847/en/bra/, last accessed on April 4th, 2014.

The Brazilian Forest Service (SFB) of the Ministry of the Environment of Brazil (MMA) is currently working in the development of the first National Forest Inventory of Brazil, an extensive forest plot network in a 20 x 20 km grid in some parts of the country, with finer-scale grids in vegetation transition areas and highly heterogeneous landscapes (http://ifn.florestal.gov.br/), estimated to be finalized only by the end of 2017. The work will include the development of allometric equations for different forest types, expanding the number of permanent plots and identifying and addressing information gaps. This will become a very important database in the near future (Ometto, 2014).

cent and contribution to total dry biomass of 85.98 per cent); (2) thick roots (carbon content of 47.0 per cent and contribution to total biomass of 11.59 per cent); (6) thin roots (carbon content of 45.7 per cent and contribution to total biomass of 3.06 per cent). The 95 per cent confidence interval for the average percent carbon content is  $48.5 \pm 0.9$ .

(3) Regarding the uncertainties related to the biomass of palms and vines, Silva (2007) estimated that these are high (73.0 and 57.0 per cent, respectively). However, their contribution to the average total aboveground biomass is only 4.0 per cent, the largest contribution being from the trees themselves (94.0 per cent). Hence, the contribution of the biomass of palms and vines to the biomass uncertainty is low.

Other uncertainties associated with the carbon map may arise from other sources, including the following:

- (1) data collection, sampling design;
- (2) aggregated forest type;
- (3) rules used to estimate the carbon density of the forest types per RADAMBRASIL volume.

It is difficult to associate uncertainties to most of these elements. RADAMBRASIL data, for instance, was collected under strenuous circumstances in the 70s, by different teams. Also, by that time the technologies that exist today were not available or accessible (GPS, for example).

The aggregation of the diverse forest types in Amazonia in forest classes may also generate uncertainties, but these are difficult to access without a proper Forest National Inventory. This is one area where improvements may be expected in the medium term.

A recent paper by Ometto *et al.*, (2014) (refer to *Box 5*) addresses *Amazon forest biomass density maps: tackling the uncertainty in carbon emission estimates* and provides comparison with other biomass maps for Amazonia from the literature. It concludes stating that the methodology used to construct the carbon map, based on the RADAM data (1:1,000,000) "resulted in large differences in biomass with respect to the other maps, and large changes in biomass between adjacent surveyed areas and regions (corresponding to different RADAM volumes) with the carbon map." And continues to say that "the large apparent disparities in biomass calculated for the carbon map were not propagated into  $CO_2$  emissions as the deforestation front in the analysis had not advanced to these areas." Indeed, the analysis of the deforestation polygons (per volume and forest type) for years 2002 to 2005 have consistently shown that deforestation concentrates mainly in the so called "Arc of Deforestation", corresponding to RADAM volumes 4, 5, 16, 20, 22 and 26 (refer to Figure 11). In addition, even within these volumes, the forest types affected by deforestation have been very consistent<sup>28</sup>.

In 2003, 2004, and 2005, the percentage of the deforestation increments falling in these volumes was 69 per cent, 70 percent, and 76 per cent, respectively. The forest types most affected by deforestation in RADAM volume 4, for instance, were As and Ds (99 per cent in 2003; 98.8 per cent in 2004 and 97 per cent in 2005). In volume 16, 90.6 per cent and 98 per cent of the increments fell under forest types Ab and As; and 96.9 per cent in Ab, As and Ds in 2003.

## BOX 5: CARBON MAP UNCERTAINTIES - ANALYZING THE LITERATURE

Estimating the uncertainty associated with the carbon map is extremely complex. There are several carbon maps for the Amazonia biome published in the literature. Most of them constructed using satellite data, including the airborne LIDAR data and plot information. Some incorporate only aboveground biomass, whereas others include living biomass and others pools.

The accuracy of the map can be assessed in case adequate and representative ground datasets for calibration are available. This may exist in some areas in Amazonia but do not exist for the entire Amazonia biome. The literature on uncertainties tend to indicate that the largest uncertainties for REDD+ activities relate to the spatial distribution of biomass and to the spatial pattern of forest cover change, rather than to total globally o nationally summed carbon density.

Edward TA Mitchard, Sassan S Saatchi, Alessandro Baccini, Gregory P Asner, Scott J Goetz, Nancy L Harris and Sandra Brown. Uncertainty in the spatial distribution of tropical forest biomass: a comparison of pan-tropical maps (2013).

A more recent paper (Ometto *et al.*, 2014) examines the influence of the use of different biomass maps on uncertainty in carbon emission calculations due to land cover change in recent years and in future scenarios. Five maps are compared (Saatchi *et al.* (2007; 2011); Nogueira *et al.* (2008); MCT (2010); and Baccini *et al.* (2012). Some results indicate that the map used in the FREL (MCT (2010) and that from Nogueira *et al.* (2008) have similar spatial distribution of the biomass density classes.

The paper indicates that the methodology used in the Second National GHG Inventory, based on the RADAM data resulted in large differences in biomass with respect to the other maps, and large changes in biomass between adjacent surveyed areas and regions (corresponding to different RADAM data sheets) within the map.

Ometto, J.P.; Aguiar, A.P.; Assis, T.; Soler, L.; Valle, P.; Tejada, G.; Lapola, D.M.; Meir, P. Amazon forest biomass density maps: tackling the uncertainty in carbon emission estimates. Climatic Change (2014) 124:545-560. DOI 10.1007/s10584-014-1058-7

Work is underway to assess and reduce uncertainties and this process will contribute to the improvement of the data in future submissions.

# C) POOLS, GASES AND ACTIVITIES INCLUDED IN THE CONSTRUCTION OF THE FREL

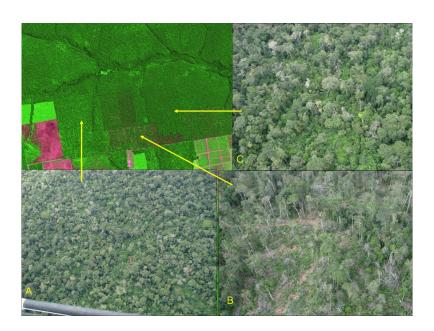
## c.1. Activities included

Brazil's FREL includes only the activity "Reducing Emissions from Deforestation" in the Amazonia biome, using the PRODES data as a basis. In addition to the systematic assessment of deforestation in the Brazilian Amazonia, Brazil has developed other systems to track forest degradation and logging in forest management plans in the Amazonia biome (**Table 6**).

**Table 6:** Brazil's forest monitoring systems for the Amazonia biome

	Satelite and Resolution	Data update	Minimum area mapped	Type of activity mapped	Objective and History
PRODES	LANDSAT TM, CBERS CCD (30 m)	Annually	6.25 ha	Clear cut	Annual deforestation rates (since 1988)
DEGRAD	LANDSAT TM, CBERS CCD (30 m)	Annually	6.25 ha	Degradation	Monitor areas in the process of degradation (since 2008)

Brazil has, through INPE, implemented since 2008 a system to assess the areas affected by degradation in the Amazon biome, through the use of satellite imagery of the same spatial resolution as that used to assess deforestation increments (Landsat, up to 30 meters). This system, referred to as DEGRAD, provides detailed maps of areas under a degradation process (refer to *Figure 14*).



**Figure 14.** Representation of forest degradation in a portion of a Landsat image: A) degradation of moderate intensity, regeneration after logging patios still evident; B) degradation of high-intensity, large proportion of exposed soil; C) degradation of light intensity, evidence of openings for road access. **Source.** DEGRAD, INPE, 2014

These areas have not been subject to clear cut and hence have not been included in PRODES figures. Brazil provides some information regarding DEGRAD in *Annex III*.

The time series is still too short to allow a better understanding of the degradation process. It is expected that this understanding improves with time, as new data becomes available, allowing for the future submission of a FREL for degradation.

## c.2. Pools included

The pools included in this FREL are those used in the construction of the carbon map, i.e, living biomass (above and below-ground) and litter.

Following the IPCC Good Practice Guidance for LULUCF (IPCC, 2003, Section 3.2.1.3, p. 338) consideration here will be carried out for the two types of soil carbon pools: (i) the organic fraction of mineral forest soils and (ii) organic soils.

In relation to the mineral forest soils, there are several publications in Brazil addressing changes in carbon stock in mineral soils from conversion of forest to pasture or agriculture in Amazonia. As already mentioned, Brazil does not have data on the dynamics of forest conversion for all years in the period considered in the construction of the FREL. However, there are two sources of information that were used as proxies to estimate the fate of the forest converted to other uses.

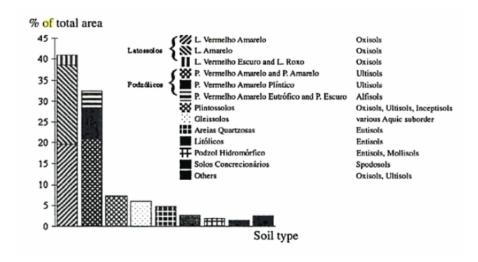
The first of these is the Second National GHG Inventory that has a spatially explicit database for the conversions of forest (managed and unmanaged) to other land-use categories from 1994 to 2002, per biome. The land cover/use for these two years was mapped using Landsat as the main source of data. The data in *Tables 3.97* (Land-use transition areas identified in the Amazon biome from 1994 to 2002 (hectares)) can provide an estimate of the forestland converted to grassland and cropland, the two major forest land conversions in Amazonia. Considering the total area of Forest Land converted to Grassland - Ap; Cropland – Ac; Settements – S; Wetlands - Res; and Other Land in *Table 3.97*, which totals 16,500,461 hectares, the area converted to Grassland and Cropland is 14,610,248 hectares and 1,846,220 hectares, corresponding to 88.5 per cent and 11.2 per cent, respectively.

The second source of information on transition of forest to other land use categories is *TerraClass*<sup>29</sup>, a more recent project carried out by INPE, which has estimated forest transitions for years 2008 and 2010. For these two years, 80.3 per cent and 80.0 per cent, respectively, have been converted to grassland (exposed soil grassland; clean grassland; dirty grassland; regeneration with pasture). Hence, the two sources consistently indicate that the major Forest Land conversion is to Grassland, including cattle ranching, abandoned grassland etc.

With this assumption in mind, a literature review was carried out to assess the impact of the conversion of native forest to pasture on the soil organic carbon pool. It is important to bear in mind that the literature review cited here is limited, and may not be representative of all situations that may occur in Amazonia. Brazil will intensify efforts to improve the understanding of the changes in carbon stock in the soil organic carbon pool, including by expanding the literature review and by stimulating new research. One of the issues that make the assessment of changes in the soil organic carbon pool relates to the timing of the changes, which may not occur immediately after the conversion. Normally the process may take years before a change can be detected.

A large area of the Amazonia biome (approximately 75 per cent) is covered by Latossolos (Oxisols) and Podzólicos (Ultisoils and Alfisols) (Cerri *et al.* (1999), following Jacomine and Camargo (1996)). The remainder falls into seven soil divisions (refer to *Figure 15*).

<sup>29</sup> 



*Figure 15:* Percent distribution of the main soil types in the Amazonia basin. *Source:* Cerri *et al.*, 1999.

Regarding the changes in the soil organic carbon pool from conversion of forest to grassland (pasture), part of the literature indicates that there is a loss of carbon in the first years of conversion, generally followed by full recovery of the soil organic carbon. In some cases, an increase in soil carbon can occur, particularly in the superficial soil layer. A summary of some of the literature consulted in described below.

Fearnside and Barbosa (1998) showed that trends in soil carbon were strongly influenced by pasture management. Sites that were judged to have been under poor management generally lost soil carbon, whereas sites under ideal management gained carbon. Salimon *et al.* (2007) concluded that the soils under pasture present larger carbon stocks in the superficial soil layer where approximately 40 to 50 per cent of the carbon originated from grasses at depth 0 to 5 cm. In deeper layers, the contribution of the remaining carbon from the primary forest is larger, notably in those soils with greater clay content.

Cerri *et al.* (2006) carried out a literature review on this issue and concluded that approximately two thirds of the pasture in Amazonia exhibited an increase in carbon stock in soil relative to the native vegetation. It estimated equilibrium organic matter levels by running the models for a period of 10,000 years. Then, the models were run for 100 years under pasture. Century and Roth predicted that forest clearance and conversion to well managed pasture would cause an initial decline in soil carbon stocks, followed by a slow rise to levels exceeding those under native forest. The only exception to this pattern was found for the chronosequence called Suia-Missu, where the pasture is degraded rather than well managed like the other chronosequences.

Costa *et al.*, (2009) concluded that there was no significant difference in the soil carbon stocks under vegetation, degraded pasture and productive pasture, at different land use time and different depth. The authors also conclude that after 28 years of use with well managed pasture, approximately 62 per cent of the soil organic carbon still derives from the original forest until 30 cm depth.

Fernandes *et al.* (2007) concluded that the incorporation of carbon by the pasture occurs gradually in increasing depth through time, and that the layer 0-10 cm apparently reached an equilibrium state after 10 years (around 9.8 tonnes per hectare). For the other layers, differences can still be observed in the stocks in areas of 10 and 20 years, this difference being largest at 40 cm depth. In the layer 0-20 cm the carbon stock in 10.8 tonnes per hectare in the soil with native vegetation; 15.1 and 17.3 tonnes per hectare for pastures of 10 and 20 years, respectively. These values represent an increase of 40 and 60 per cent in relation to the soil under native vegetation, respectively.

Trumbore *et al.* (1995) reported soil carbon losses in overgrazed pasture but soil carbon gains from fertilized pasture in the Amazon region. Neil *et al.* (1997) suggested that degraded pastures with little grass cover are less likely to accumulate soil carbon because inputs to soil organic carbon from pasture roots will be diminished, but that might not be true in more vigorous regrowth of secondary forest. Greater grazing intensity and soil damage from poor management would, in all likelihood, cause soil carbon losses.

Finally, Neill *et al.* (1997) when examining carbon and nitrogen stocks in seven chronosequences, each consisting of an intact forest and pastures of different ages created directly from cleared forest (7 forests, 18 pastures), along a 700-km transect in the southwestern Amazon basis indicated that when site history was controlled by considering only pastures formed directly from cleared forest, carbon and nitrogen accumulation was the dominant trend in pasture soils.

In relation to organic soils, emissions from deforestation associated with organic soils (Organossolos) were not included in this submission since the presence of these types of soils in Brazil is not considered significant, as indicated in *Figure 16*. Furthermore these types of soil are not located in the areas most affected by deforestation (Arch of Deforestation).

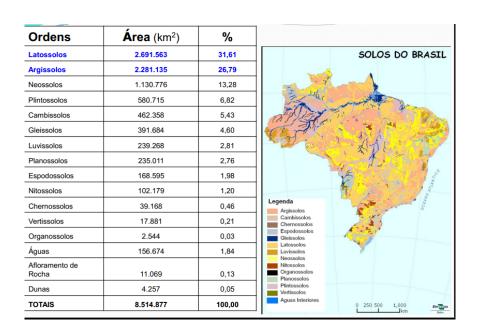


Figure 16: Brazil's soil classification system Source: EMBRAPA, 2006

Ideally, more studies are needed to determine with more certainty how significant the changes in the soil organic carbon pool are following conversion of Forest Land. Considering the above information, the soil organic carbon pool has not been included in the construction of the FREL proposed by Brazil in this submission.

#### BOX 6: THE RATIONALE BEHIND THE NON-INCLUSION OF DEAD WOOD IN BRAZIL'S FREL

Regardless the occurrence of the deforestation activity, dead wood (necromass) will be present in forest land, due to normal mortality or increased due to disturbance events. Part of the carbon in the necromass will be incorporated in the soil organic carbon and the remaining will be emitted to the atmosphere through time.

It may take several decades for the carbon in the necromass to be fully emitted, slowly in the first years. Hence, emissions from the decomposing necromass follow an exponential model with small emissions in the first years, followed by decomposition emissions for some decades. This would be the expected natural process of emissions from dead wood (standing and lying necromass constituted of coarse woody debris (trunks, stumps, branches, twigs), which the literature indicates to be of high error of estimation. In addition, one expects regeneration of the necromass from recruitment and increment (succession process initiated by pioneer species, followed by species of slow growth).

In the case of deforestation (defined here as clear cut), emissions from dead wood are instantaneous instead of spaced in time. So, when reducing emissions from deforestation, one is not avoiding emissions from dead wood (since this is a natural process) – the issue is related only to the time when the emissions are released to the atmosphere. Some types of disturbances can increase the amount of necromass (e.g., droughts, insect infestation) and related emissions, but this would have to be modeled under assumptions of future potential disturbances, an approach which Brazil is not following presently.

#### c.3. Gases included

This FREL only includes  $CO_2$  emissions. Non- $CO_2$  emissions in the Amazonia biome are normally associated with the recurrent burning of tree residues left on the ground after the deforestation activity; or with wild fires, which are not very common.

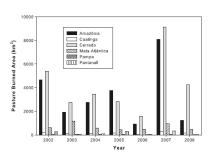
Emissions resulting from the burning of tree residues and other organic matter present on the ground are directly related to the deforestation activity. Hence, the decrease of deforestation, *per se*, will lead to a decrease not only in  $CO_2$  emissions but also in non- $CO_2$  emissions associated with fire (during the forest conversion and post-conversion).

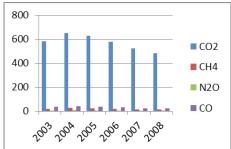
The most common conversion of forest in Amazonia is to pasture for cattle ranching (IBGE, 2009). Pasture burning is the prevalent type of fire in Amazonia on an area basis. The majority (80 to 90 per cent) of the fire emissions derive from deforestation in Amazonia and Cerrado (*Box 7*).

#### BOX 7: ESTIMATES OF CO2 AND NON-CO2 EMISSIONS OF GHG

Bustamante *et al.* (2012) have provided estimates of  $CO_2$  and non- $CO_2$  emissions of greenhouse gases (including  $CO_2$ ,  $CH_4$ ,  $N_2O$ , CO,  $NO_x$ ) associated with deforestation, burning for pasture establishment, and pasture maintenance in the period from 2003 to 2008 (inclusive).

**Figure 17** bellow shows the area of fire for pasture establishment and maintenance in all Brazilian biomes from 2003 to 2008 inclusive, and the associated  $CO_2$ ,  $CH_4$ ,  $N_2O$  and CO emissions (in Mt  $CO_{2-e0}$ ) for the Amazonia biome.





**Figure 17.** (A) Extension of burned pastures (2002 – 2008) in the Brazilian biomes; (B)  $CO_2$ ,  $CH_4$ ,  $N_2O$  and CO emissions (in Mt  $CO_{2-eq}$ ) for the Amazonia biome in the same period. **Source**: Bustamante *et al.*, 2012.

For the conversion of  $CH_4$ ,  $N_2O$  and CO to  $CO_{2\text{-eq}}$ , the global warming potential values used were 21, 310 and 2, respectively. Relative to the average  $CO_2$  emissions in the period, the average  $CH_4$ ;  $N_2O$  and CO emissions represented 3.4 per cent; 1.0 per cent; and 5.9 per cent, respectively (IPCC, 2001).

Brazil decided not to include non-CO<sub>2</sub> gases in the construction of its FREL as a mean to be conservative. However, it may reconsider this decision when improved data becomes available.

# **D) FOREST DEFINITION**

Brazil is a country of continental dimensions and with a large diversity of forest types. The forest definition broadly applicable in Brazil is that reported to the FAO for the Global Forest Resources Assessments (FRA), reproduced below:

"Forest is defined as land spanning more than 0.5 hectare with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. Land not classified as "Forest", spanning more than 0.5 hectare; with trees higher than 5 meters and a canopy cover of 5-10 percent, or trees able to reach these thresholds in situ; or with a combined cover of shrubs, bushes and trees above 10 percent are classified as "Other Wooded Land".

These two categories (*Forest* and *Other Wooded Land*) do not include land that is predominantly under agricultural or urban land use.

The classification of vegetation typologies into the categories of "Forest" and "Other Wooded Land" used by FAO was defined by Brazilian experts involved in the preparation of the FRA 2015.

It is to be noted that the number of vegetation typologies under "Forest" for the purposes of FRA is much larger than the aggregated forest types defined for the purposes of this submission (*Table 7*), the reason being the need to have a basis for estimating the carbon density in the forest types defined.

Table 7. FRA 2010 vegetation typologies included in this FREL (in grey).

Aa	Alluvial Open Humid Forest			
Ab	Lowland Open Humid Forest			
	•			
Am	Montane Open Humid Forest			
As	Submontane Open Humid Forest			
Ca	Alluvial Deciduous Seasonal Forest			
Cb	Lowland Deciduous Seasonal Forest			
Cm	Montane Deciduous Seasonal Forest			
Cs	Submontane Deciduous Seasonal Forest			
Da	Alluvial Dense Humid Forest			
Db	Lowland Dense Humid Forest			
Dl	High montane Dense Humid Forest			
Dm	Montane Dense Humid Forest			
Ds	Submontane Dense Humid Forest			
Ea	Tree Steppe			
EM	Transition Steppe / Mixed Humid Forest			
EM	Transition Steppe / Seasonal Forest			
Fa	Alluvial Semi deciduous Seasonal Forest			
Fb	Lowland Semi deciduous Seasonal Forest			
Fm	Montane Semi deciduous Seasonal Forest			
Fs	Submontane Semi deciduous Seasonal Forest			
La	Wooded Campinarana			
Ld	Forested Campinarana			
LO	Transition Campinarana / Humid Forest			
M	Mixed Humid Forest:			
Ma	Alluvial Mixed Humid Forest			
Ml	Montane Mixed High Humid Forest			
Mm	Montane Mixed Humid Forest			
Ms	Submontane Mixed High Humid Forest			
NM	Transition Seasonal Forest / Mixed Humid Forest			
NP	Transition Seasonal Forest / Pioneer Formations			
OM	Transition Humid Forest / Mixed Humid Forest			
ON	Transition Humid Forest / Seasonal Humid Forest			
Pa	Vegetation Fluvial and / or Lacustrine Influenced			
Pfm	Forest Vegetation Fluviomarine influenced			
Pma	Forest Vegetation Marine Influenced			
Sa	Wooded Savannah			
Sd	Forested Savannah			
SM	Transition Savannah / Mixed Humid Forest			
SN	Transition Savannah / Seasonal Forest			
SO	Transition Savannah / Humid Forest			
SP	Transition Savannah / Pioneer Formations (Restinga)			
ST	Transition Savannah / Steppe Savannah			
STN	Transition Savannah / Steppe Savannah / Seasonal Forest			
Ta	Ta - Wooded Steppe Savannah			
Td	Forested Steppe Savannah			
TN	Transition Steppe Savannah / Seasonal Forest			
	Forest Plantations			
	Secondary Vegetation in Forestry areas			
L	1 , 6,			

For the Amazonia biome, the historical time-series available for deforestation has been constructed assuming a clear cut pattern (exposed soil) and does not follow strictly the definition used for the FRA. However, the boundaries of forest/non-forest were based on the definition applied in the FRA report.

Hence, deforestation for the Amazonia biome is not associated with thresholds, but simply with canopy cover equals to zero. Any situation in which forest falls below the thresholds of the FAO definition but still does not have canopy cover equals to zero is characterized as forest degradation and treated as such under the DEGRAD.

Since the basis for the estimation of the carbon densities in the different forest types was the RADAMBRASIL sample plots and vegetation map, it would not be logical to disaggregate the estimates to accommodate a larger set of forest types.

### **REFERENCES**

ABDALA, G. C.; CALDAS, L. S.; HARIDASAN, M.; EITEN, G., 1998. Above and belowground organic matter and root:shoot ratio in Cerrado in Central Brazil. Brazilian Journal of Ecology, v.2, p.11-23.

ANDRADE, L. A.; FELFILI, J. M.; VIOLATI, L., 2002. Fitossociologia de uma área de Cerrado denso na RECOR-IBGE, Brasília, DF. Acta Botanica Brasílica, V.16, n.2, p.255-240.

ARAÚJO, L.S., SANTOS, J.R., KEIL, M., LACRUZ, M.S.P., KRAMER, J.C.M., 2001. Razão entre bandas do SIR-C/ X SAR para estimativa de biomassa em áreas de contato floresta e cerrado. In: X Simpósio Brasileiro de Sensoriamento Remoto - 21-26 abril, 2001, Foz de Iguaçu, Paraná. X Simpósio Brasileiro de Sensoriamento Remoto, Instituto Nacional de Pesquisas Espaciais (INPE).

Asner, G.P., Keller, M., Pereira, R., Zweede, J., Silva, J.N.M., 2004. Canopy damage and recovery after selective logging in Amazonia: field and satellite studies. Ecological Applications 14, 280–298.

BARBOSA, R. I. & FERREIRA, C. A. C., 2004. Biomassa acima do solo de um ecossistema de "campina" em Roraima, norte da Amazônia Brasileira. Acta Amazonica, v. 34(4):577-586.

BARBOSA, R.I.; FEARNSIDE, P.M., 1999. Incêndios na Amazônia brasileira: estimativa da emissão de gases do efeito estufa pela queima de diferentes ecossistemas de Roraima na passagem do Evento El Niño (1997/98). Acta Amazonica 29 (4): 513-534.

BATALHA, M.A.; MANTOVANI, W; MESQUITA JÚNIOR, H.N. Vegetation structure in Cerrado physiognomies in South-Eastern Brazil. Brazilian Journal of Biology, v.61, n.3, p 475-483, 2001

BRASIL, 1975. Ministério das Minas e Energia. Departamento Nacional de Produção Mineral. Projeto RADAMBRASIL.

BRASIL, 2004. Comunicação Nacional Inicial do Brasil à Convenção-Quadro das Nações Unidas sobre Mudança do Clima — Brasília: Ministério da Ciência e Tecnologia, Coordenação Geral de Mudanças Globais de Clima, 2004. Available at: <a href="http://unfccc.int/resource/docs/natc/brazilnc1e.pdf">http://unfccc.int/resource/docs/natc/brazilnc1e.pdf</a>, last accessed on May 30th, 2014.

BRASIL, 2009. Lei N° 12.187, de 29 de dezembro 2009. Institui a Política Nacional sobre Mudança do Clima - PNMC e dá outras providências. Available at: http://www.planalto.gov.br/ccivil\_03/\_ato2007-2010/2009/lei/l12187.htm, last accessed on March 24th, 2014.

BRASIL, 2010. Segunda Comunicação Nacional do Brasil À Convenção-Quadro das

Nações Unidas sobre Mudança do Clima. — Brasília: Ministério da Ciência e Tecnologia, Coordenação Geral de Mudanças Globais de Clima, 2010. 2.v. CDU 551.583(81). Available at:

http://www.mct.gov.br/upd\_blob/0213/213909.pdf, last accessed on March 24th, 2014.

BRASIL, 2014. Estratégia Nacional de REDD+ do Brasil (2014-2020). In press.

BRITEZ, R. M.; BORGO, M.; TIEPOLO, G. FERRETI, A.; CALMON, M. HIGA, R., 2006. Estoque e incremento de carbono em florestas e povoamentos de espécies arbóreas com ênfase na Floresta Atlântica do Sul do Brasil. Dados eletrônicos. Colombo - PR: Embrapa Florestas (CD ROM).

BUSTAMANTE, M. M. da C. & OLIVEIRA, E. L. de, 2008. Impacto das Atividades Agrícolas, Florestais e Pecuárias nos Recursos Naturais. In: Savanas: desafios e estratégias para o equilíbrio entre sociedade, agronegócio e recursos naturais, Capítulo 18. Embrapa, Editores Técnicos, Planaltina, GO, p. 647-669.

Bustamante, M.M.C.; Nobre, C.A.; Smeraldi, R.; Aguiar, A.P.D.; Barioni, L.G.; Ferreira, L.G.; Longo, K.; May, P.; Pinto, A.S.; Ometto, J.P.H.B. (2012) Estimating greenhouse gas emissions from cattle raising in Brazil. Climatic Change 115:559-577. DOI 10.1007/s 10584-012-0443-3.

Carvalho, J.L.N.; Avanzi, J.C.; Silva, M.L.N.; de Mello, C.R.; Cerri, C.E.P. (2010) Potencial de sequestro de carbono em diferentes biomas do Brasil (in English, Potential of soil carbono sequestration in diferent biomes of Brazil). Literature Review. Ver. Bras. Ciênc. Solo, volume 34, número 2. Available from <a href="http://www.scielo.br/scielo.php?script=sci\_arttext&pid=S0100-06832010000200001&lng=en&nrm=iso">http://dx.doi.org/10.1590/S0100-06832010000200001</a>

CASTRO, E. A. & KAUFFMAN, J. B., 1998. Ecosystem structure in the Brazilian Cerrado: a vegetation gradiente of aboveground biomass, root mass and consumption by fire. Journal of Tropical Ecology, v.14, p.263-283.

CASTRO, E. A., 1996. Biomass, nutrient pool and response to fire in the Brazilian cerrado. Masters Dissertation, Oregon State University.

Cerri, C., Bernoux, M., arroways, d., feigl, b. j., Piccolo, M.C., 2000. Carbon stocks in soils of the Brazilian Amazon. In: Lal, R., Kimble, J.M.,

CERRI, C.E.P.; CERRI, C.C.; BERNOUX, M.; VOLKOFF, B. & RONDÓN, M.A. Potential of soil carbon sequestration in the Amazonian Tropical Rainforest. In: LAL,

CERRI, C.C.; BERNOUX, M.; ETCHEVERS, J. & CERRI, C.E.P. Carbon sequestration in soils of Latin America. New York, Haworth, 2006. p. 245-266.

CHAMBERS, J., ASNER, G., MORTON, D., ANDERSON, L., SAATCHI, S., ESPIRITO SANTO, F., PALACE, M., SOUZAJR, C. 2007. Regional ecosystem structure and function: ecological insights from remote sensing of tropical forests. Trends in Ecology & Evolution 22:8, 414-423 Online publication date: 1-Aug-2007.

CHAMBERS, J.Q., SANTOS, J., RIBEIRO, R.J., HIGUCHI, N., 2001. Tree damage, allometric relationship, and above-ground net primary production in central Amazon forest. Forest Ecology and Management 152, 73-84.

COSTA, A.A.; ARAUJO, G. M., 2001. Comparação da vegetação arbórea de Cerradão e de Cerrado na Reserva do Panga, Uberlândia, Minas Gerais. Acta Botânica Brasílica, v.15, n.1, p. 63-72.

Costa, O.V.; Cantarutti, R.B.; Fontes, L.E.F.; da Costa, L.M.; Nacif, P.G.S.; Faria, J.C. (2009) Estoque de Carbono do Solo sob Pastagem em Área de Tabuleiro Costeiro no Sul da Bahia. Part of a doctorate thesis by the first author in Soils and Plant Nutrition, Universidade Federal de Viçosa. (in English, Soil Carbon Stock under Pasture in Coastal Area at the South of Bahia).

DELITTI, W.B.C., PAUSAS, J. & BURGER, D.M. 2001. Belowground biomass seasonal variation in two Neotropical savannahs (Brazilian Cerrados) with different fire histories. Annals of Forest Science 7:713-722.

DELITTI, W.B.C.; MEGURO, M. & PAUSAS, J. G., 2006. Biomass and mineralmass estimates in a "cerrado" ecosystem. Revista Brasil. Bot., V.29, n.4, p.531-540, out.-dez. 2006.

DELITTI, W.B.C.; MEGURO, M., 1984. Biomassa e mineralomassa do campo cerrado de Mogi-Guaçu, SP. Ciência e Cultura 6:612.

DURIGAN, G., 2004. Estimativas de estoque de carbono na vegetação natural do Estado de São Paulo. Centro de Gestão e Estudos Estratégicos — CGEE, Prospecção Tecnológica, Mudança do Clima, Estudo 4- Oportunidades de Negócios em segmentos produtivos nacionais.

embrapa, 2006. Sistema Brasileiro de Classificação dos Solos. 2a Ed. Brasilia, DF. 2006. Disponível em: <a href="http://www.agrolink.com.br/downloads/sistema-brasileiro-de-classificacao-dos-solos2006.pdf">http://www.agrolink.com.br/downloads/sistema-brasileiro-de-classificacao-dos-solos2006.pdf</a> e <a href="http://clic.cses.vt.edu/IUSS1.4/Anjos\_L\_H-Evolution-Brazilian-Soil-Classification-System.pdf">http://clic.cses.vt.edu/IUSS1.4/Anjos\_L\_H-Evolution-Brazilian-Soil-Classification-System.pdf</a>

Fearnside, P. M. 2000 Global warming and tropical land-use change: greenhouse gas emissions from biomass burning, decomposition and soils in forest conversion, shifting cultivation and secondary vegetation Clim. Change 46 115–58

Fearnside, P.M. 2004. Biomassa das florestas amazônicas brasileiras. Anais do Seminário Emissão x Sequestro de CO2: uma nova oportunidade de negócios para o Brasil. Companhia Vale do Rio Doce, Rio de Janeiro.

FEARNSIDE, P. M., RIGHI, C.A., GRAÇA, P. M. L. A., KEIZER, E. W. H., CERRI, C., Nogueira, E.M., BARBOSA, R. I., 2009. Biomass and Greenhouse-Gas Emissions from Land-Use Change in Brazils Amazonian "Arc of Deforestation": The states of Mato Grosso and Rondônia. Forest Ecology and Management, v.258, p.1968 - 1978.

Fearnside, P.M. and R.I. Barbosa. 1998. Soil carbon changes from conversion of forest to pasture in Brazilian Amazonia. Forest Ecology and Management 108(1-2): 147-166.

FERNANDES, A. H. B. M.; SALIS, S. M. de; FERNANDES, F. A.; CRISPIM, S. M. A., 2008. Estoques de Carbono do Estrato Arbóreo de Cerrados no Pantanal de Nhecolândia. Comunicado Técnico 68, Embrapa Pantanal, Corumbá, MS. ISSN 1981-7231.

Fernandes, F.A.; Cerri, C.C.; Fernandes, A.H.B.M. (2007) 13C and the Soil Organic Carbon Dynamics in Cultivated Pasture in the Pantanal Sul-Mato-Grossense. Boletim de Pesquisa e Desenvolvimento 74. EMBRAPA. ISSN 1981-7215.

FRA 2010. Global Forest Resource Assessment 2010. Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/forestry/fra/fra2010/en/ last accessed on May 23rd, 2014.

GOMES, B.Z.; MARTINES, F. R.; TAMASHIRO, J. Y., 2004. Estrutura do Cerradão e da transição entre Cerradão e floresta paludícola num fragmento da International Paper do Brasil Ltda., em Brotas, SP. Revista Brasileira de Botânica, v. 27, n. 2, p. 249-262.

GRACE, J.; SAN JOSÉ, J.; MEIR, P; MIRANDA, H. S.; MONTES, R. A., 2006. Productive and carbon fluxes of tropical savannas. Journal of Biogeography 33, 387-400.

Higuch, N.; Santos, J.M.; Imanaga, M.; Yoshida, S. 1994. Aboveground Biomass Estimate for Amazonian Dense Tropical Moist Forests, Memoirs of the Faculty of Agriculture, Kagoshima, 30(39); 43-54.

Higuchi, N. Dos Santos, J., Ribeiro, R.J., Minette, L., Biot, Y. 1998. Aboveground biomass of the Brazilian Amazon rainforest. Acta Amazonica 28 (2), 153-166.

Higuchi, N., Chambers, J. dos Santos, J., Ribeiro, R.J., Pinto, A.C.M., da Silva, R. P., 2004. Dinâmica e balanço do carbono da vegetação primária da Amazônia Central. Floresta 34 (3)

IBAMA, 2014. Projeto de Monitoramento do Desmatamento dos Biomas Brasileiros por Satélite – PMDBBS. Available at: http://siscom.ibama.gov.br/monitorabiomas/, last accessed on March 24th, 2014.

IBGE, 2011. Censo Demográfico 2010: Características gerais da população. Instituto Brasileiro de Geografia e Estatística. Available on: <a href="http://www.ibge.gov.br/home/estatistica/populacao/censo2010/default\_resultados\_universo.shm">http://www.ibge.gov.br/home/estatistica/populacao/censo2010/default\_resultados\_universo.shm</a>, last accessed on March 24th, 2014.

IBGE, 2012. Manual técnico da vegetação brasileira. 2a edição revisada e ampliada. Rio de Janeiro, 2012. ISSN 0103-9598. Available at: <a href="mailto:ttp://geoftp.ibge.gov.br/documentos/recursos\_naturais/manuais\_tecnicos/manual\_tecnico\_vegetacao\_brasileira.pdf">ttp://geoftp.ibge.gov.br/documentos/recursos\_naturais/manuais\_tecnicos/manual\_tecnico\_vegetacao\_brasileira.pdf</a>, last accessed on April 4th, 2014.

INPE, 2013. Metodologia para o Cálculo da Taxa Anual de Desmatamento na Amazônia Legal. PRODES: Available at: <a href="http://www.obt.inpe.br/prodes/metodologia\_TaxaProdes.pdf">http://www.obt.inpe.br/prodes/metodologia\_TaxaProdes.pdf</a>, last accessed on March 24th, 2014.

INPE, 2014a. DEGRAD: Mapeamento da Degradação Florestal na Amazônia Brasileira. Avaliable on: <a href="http://www.obt.inpe.br/degrad/">http://www.obt.inpe.br/degrad/</a>, last accessed on March 24th, 2014.

INPE, 2014b. PRODES: Monitoramento da Floresta Amazônica Brasileira por Satélite. Available at: http://www.obt.inpe.br/prodes/index.php,last accessed on March 24th, 2014.

IPCC, 2001. Third Assessment Report: Climate Change 2001. Working Group I: The Scientific Basis. Available at: <a href="http://www.grida.no/publications/other/ipcc\_tar/">http://www.grida.no/publications/other/ipcc\_tar/</a>, last accessed on May 30th, 2014.

IPCC, 2003. Good Practice Guidance for Land Use, Land Use Change and Forestry. Edited by Jim Penman, Michael Gytarsky, Taka Hiraishi, Thelma Krug, Dina Kruger, Riita Pipatti, Leandro Buendia, Kyoko Miwa, Todd Ngara, Kiyoto Tanabe and Fabian Wagner. Avaliable at: http://www.

ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf\_contents.html, last accessed on March 24th, 2014.

IPCC, 2006. Guidelines for National Greenhouse Gas Inventories. Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan. Avaliable at: <a href="http://www.ipcc-nggip.iges.or.jp/public/2006gl/">http://www.ipcc-nggip.iges.or.jp/public/2006gl/</a>, last accessed on April 4th, 2014.

Jacomine, P. K. T. and Camargo, M. N. 1996. Classificação pedológica nacional em vigor. P. 675 – 689. In. V. H. Alvarez, L. E. F. Fontes and M. P. F. Fontes (eds.), Solo nos Grandes Domínios Morfoclimáticos do Brasil e o Desenvolvimento Sustentado. SBCS-UFV, Viçosa, MG, Brazil.

KAUFFMAN, J. B.; CUMMINGS, D. L.& WHARD, D.E., 1994. Relationships of fire, biomass and nutrient dynamics along a vegetation gradient in the Brazilian Cerrado. Journal of Ecology, 82, 519-531.

KUNSTCHIK, G., 2004 Estimativa da biomassa vegetal lenhosa em Cerrado por meio de sensoriamento remoto óptico e de radar. Tese (doutorado) - Instituto de Biociências, USP.

Lima, A.J.N.; Teixeira, L.M.; Carneiro, V.M.C.; dos Santos, J.; Higuchi, N. Biomass stock and structural analysis of a secondary forest in Manaus (AM) region, ten years after clear cutting followed by fire. Acta Amaz. vol.37 no.1 Manaus 2007, ISSN 0044-5967.

MARTINS, O. S., 2005. Determinação do potencial de sequestro de carbono na recuperação de matas ciliares na região de São Carlos – SP. Tese (Doutorado) - Universidade Federal de São Carlos, São Carlos : UFSCar, 136 p.

Matricard, E.A.T.; Skole, D.L. Pedlowski, M.A.; Chomentowski, W.; Fernandes. L.C 2010 Assessment of tropical Forest degradation by selective logging and fire using Landsat imagery. Remote Sensing of Environmet 114. 1117-1129.

MEIRA NETO, J. A. A.; SAPORETI-JÚNIOR, A. W. Parâmetros fitossociológicos de um Cerrado no Parque Nacional da Serra do Cipó, MG. Revista Árvore, v. 26, p. 645-648, 2002.

Miranda, S. C. 2012. Variação espacial e temporal da biomassa vegetal em áreas de Cerrado. Tese de Doutorado em Ecologia. Programa de Pós Graduação em Ecologia, Universidade de Brasília. 142p.

Mitchard, TA E., Saatchi, S., Baccini, A., Asner, G. P., Goetz, S. J., Harris, N. L., and Brown, S. 2013. Uncertainty in the spatial distribution of tropical forest biomass: a comparison of pantropical maps. Carbon Balance and Management, SpringerOpen Journal. Available at: http://www.cbmjournal.com/content/8/1/10, last accessed on October 29th, 2014.

MMA, 2013. Plano de Ação para Prevenção e Controle do Desmatamento na Amazônia Legal (PPCDAm): 3ª fase (2012-2015) pelo uso sustentável e conservação de florestas. 174 p. Available on: <a href="http://www.mma.gov.br/florestas/controle-e-preven%C3%A7%C3%A3o-do-desmatamento/plano-de-a%C3%A7%C3%A3o-para-amaz%C3%B4nia-ppcdam">http://www.mma.gov.br/florestas/controle-e-preven%C3%A7%C3%A3o-do-desmatamento/plano-de-a%C3%A7%C3%A3o-para-amaz%C3%B4nia-ppcdam</a>, last accessed on March 24th, 2014.

- Monteiro, A., Lingnau, C., Souza, C.M., 2007. Object-based classification to detection of selective logging in the Brazilian Amazon. Revista Brasileira de Cartografia 225 -234.
- Neill, C., Melillo, J. M., Steudler, P. a., Cerri, c. c., Moraes, j. f. l., Piccolo, m. c., and Brito, M. 1997. Soil carbon and nitrogen stocks following forest clearing for pasture in the southwestern Brazilian Amazon. Ecological Applications 7:1216–1225.
- NOGUEIRA. E.M., FEARNSIDE, P.M., NELSON, B.W., BARBOSA, R.I., KEIZER, E.W.H., 2008. Estimates of forest biomass in the Brazilian Amazon: New allometric equations and adjustments to biomass from wood-volume inventories. Forest Ecology and Management 256, 1853-1867.
- Ometto, J. P., Aguiar, A. P., Assis, T., Soler, L., Tejada, G. Lapola, D., Meir, P. 2014. Amazon forest biomass density maps: tackling the uncertainty in carbon emissions estimates. Climatic Change, Springer Science. DOI 10.1007/s10584-014-1058-7.
- OTTMAR, R. D.; VIHNANEK, R. E.; MIRANDA, H. S.; SATO, M. N.; ANDRADE, S. M. A., 2001. Stereo photo series for quantifying Cerrado fuels in Central Brazil. Washington: USDA: USAID; Brasília, DF: UnB, 2001. V. 1. il.
- PAIVA, A.O.; FARIA, G.E.. Estoques de carbono do solo sob cerrado sensu stricto no Distrito Federal, Brasil. Revista Trópica-Ciências Agrárias e Biológicas, v.1, p. 60-65, 2007.
- PINHEIRO, E. da S.; DURIGAN, G.; ADAMI, M., 2009. Imagens Landsat e QuickBird são capazes de gerar estimativas precisas de biomassa aérea de Cerrado? Marcos Adami Anais XIV Simpósio Brasileiro de Sensoriamento Remoto, Natal.
- RESENDE, D.; MERLIN, S. & SANTOS, M.T., 2001. Sequestro de carbono: Uma experiência concreta. Instituto Ecológica. Palmas.
- RONQUIM, C.C.. Dinâmica espaço temporal do carbono aprisionado na fitomassa dos agroecossistemas no nordeste do Estado de São Paulo. Campinas: Embrapa Monitoramento por Satélite, 2007. 52p. (Embrapa Monitoramento por Satélite. Documentos, 63).
- Saatchi, S. S., Harris, N. L., Brown, S., Lefsky, M., Mitchard, E. T. A., Salas, W., Zutta, B. R., Buermann, W., Lewis, S. L., Hagen, S., Petrova, S., White, L., Silman, M., Morel, A. 2011. Benchmark map of forest carbon stocks in tropical regions across three continents. Proc. Natl. Acad. Sci. U.S.A. 108, 9899.
- Saatchi, S. S., Houghton, R. A., Dos Santos Alval, R.C., Soares, A. J. V., Yu, Y. (2007) Distribution of aboveground live biomass in the Amazon basin. Glob Chang Biol 13(4):816–837.
- Salimon, C. I.; Wadt, P.G.S.; de Melo, W. F. Dinâmica do Carbono na Conversão de Floresta para Pastagens em Argissolos da Formação Geológica Solimões, no Sudoeste da Amazônia. Revista de Biologia e Ciências da Terra, ISSN 1519-5228, Volume 7, Número 1, 2007. (in English, Carbon Dynamics of the Pasture-Forest Conversion in Siltisoils from Solimões Geologic Formation in Southwestern Amazon)

SALIS, S.M. Distribuição das espécies arbóreas e estimativa da biomassa aérea em savanas florestadas, pantanal da Nhacolândia, Estado do Mato Grosso, do Sul. Tese (Doutorado) - Universidade Estadual Júlio de Mesquita Filho, Rio Claro, 2004

Santos, J. 1996. Análise de modelos de regressão para estimar a fitomassa da floresta tropical úmida de terra firme da Amazonia brasileira. Tese de Doutorado, Universidade Federal de Viçosa, 121 p.

SANTOS, J. R., 1988. Biomassa aérea da vegetação de cerrado, estimativa e correlação com dados do sensor Thematic Mapper do satélite Landsat. PhD Thesis, Universidade Federal do Paraná, Brazil.

SANTOS, J.R., LACRUZ, M.S.P., ARAÚJO, L.S., KEIL, M., 2002. Savanna and tropical rainforest biomass estimation and spatialization using JERS-1 data. International Journal of Remote Sensing 23, 1217-1229.São José dos Campos, São Paulo, Brazil.

SCHAEFER, C. E. G. R.; AMARAL, E. F.; MENDONÇA, B. A. F. de; OLIVEIRA, H.; LANI, J. L.; COSTA, L. M. FERNADES FILHO, E. I., 2008. Soil and vegetation carbon stocks in Brazilian Western Amazonia: relationships and ecological implications for natural landscapes. Environ Monit Assess (2008) 140:279-289.

Shimabukuro et al. 2004. Deforestation detection in Brazilian Amazon region in a near real time using Terra MODIS daily data. Geoscience and Remote Sensing Symposium, 2004. IGARSS '04. Proceedings. 2004 IEEE International (Volume:5) 20-24 Sept. 2004, 10.1109/IGARSS.2004.1370436.

SILVA, F.C. Compartilhamento de nutrientes em diferentes componentes da biomassa aérea em espécies arbóreas de um cerrado. 1990. 80 f. Dissertação (Mestrado em Ecologia) Universidade de Brasília, Brasília, 1990.

SILVA, R. P. 2007. Alometria, estoque e dinâmica da biomassa de florestas primárias e secundárias na região de Manaus (AM). Tese de Doutorado. Universidade Federal do Amazonas (UFAM), Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus. 152 p. CDD 19. ed. 634.95.

SOS/INPE, 2012. Atlas dos Remanescentes Florestais da Mata Atlântica: Período 2011-2012. Relatório Técnico. Available on: <a href="http://www.sosma.org.br/wp-content/uploads/2013/06/atlas\_2011-2012\_relatorio\_tecnico\_2013final.pdf">http://www.sosma.org.br/wp-content/uploads/2013/06/atlas\_2011-2012\_relatorio\_tecnico\_2013final.pdf</a>, last accessed on March 24th, 2014.

Souza, C.M., Roberts, D. a., Cochrane, M. a., 2005. Combining spectral and spatial information to map canopy damage from selective logging and forest fires. Remote Sensing of Environment 98, 329–343.

Stewart, B.A. (Eds.), Global Climate Change and Tropical Ecosystems. Crc Press Inc, Boca Raton, pp. 33-50.

Trumbore, S.E., Davidson, E.A., de Camargo, P.B., Nepstad, D.C. and Martinelli, L.A. (1995). Belowground cycling of carbon in forests and pastures of Eastern Amazonia. Global Biogeochemical Cycles 9: doi: 10.1029/95GB02148. issn: 0886-6236.

UNFCCC, 2002. Decision 17/ CP. 8. Guidelines for the preparation of national communications from Parties not included in Annex I to the Convention. FCCC/CP/2002/7/Add.2 ANNEX, p. 4-12. Available at: <a href="http://unfccc.int/resource/docs/cop8/07a02.pdf#page=2">http://unfccc.int/resource/docs/cop8/07a02.pdf#page=2</a>, last accessed on March 3rd, 2014.

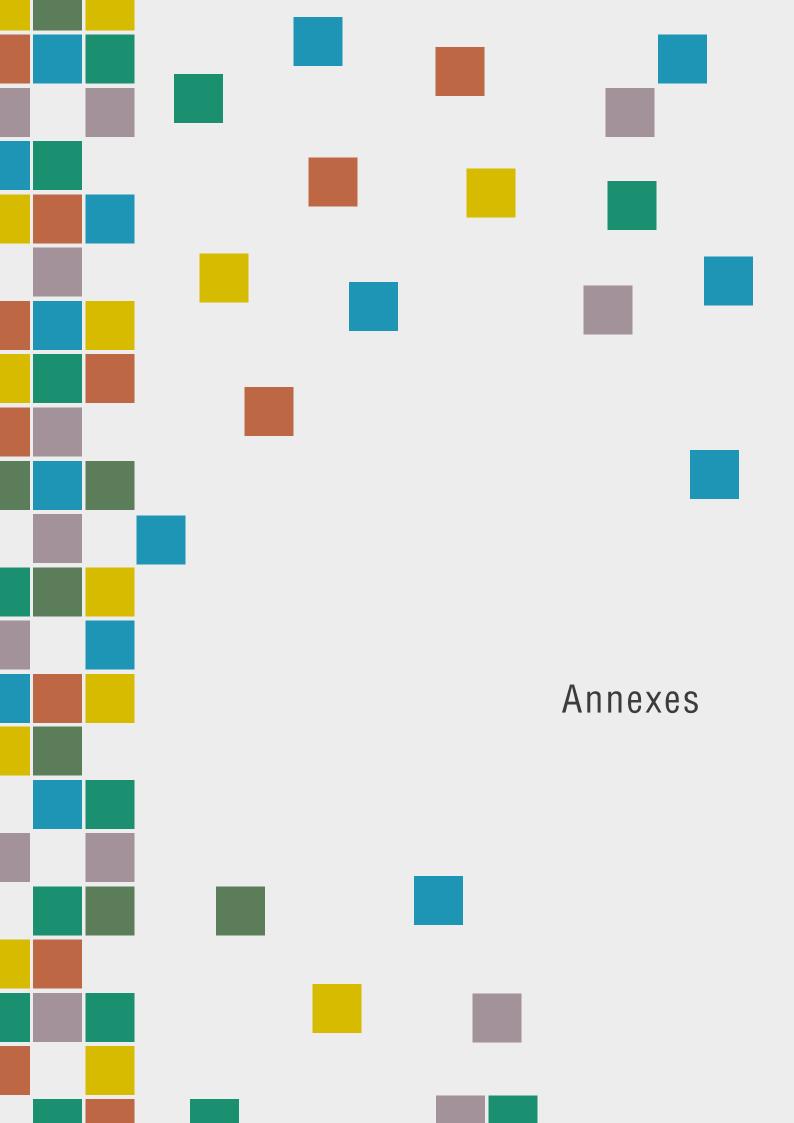
UNFCCC, 2011. Annex. Guidelines for submissions of information on reference levels. In. Decision 12/ CP. 17. Guidance on systems for providing information on how safeguards are addressed and respected and modalities relating to forest reference emission levels and forest reference levels as referred to in decision 1/CP.16. FCCC/CP/2011/9/Add.2. p. 19. Available at: http://unfccc.int/resource/docs/2011/cop17/eng/09a02.pdf#page=16, last accessed on March 3rd, 2014.

UNFCCC, 2013. Decision 13/ CP.19. Guidelines and procedures for the technical assessment of submissions from Parties on proposed forest reference emission levels and/or forest reference levels. FCCC/CP/2013/10/Add.1. p. 34-38. Available at: http://unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf, last accessed on March 3rd, 2014.

VALE, A. T. do & FELFILI, J. M., 2005. Dry biomass distribution in a cerrado sensu strict site in Central Brazil. R. Árvore, Viçosa-MG, v.29, n.5, p.661-669.

VALERIANO, D. M. & BITENCOURT-PEREIRA, M. D., 1988. Relationship between spectral reflectance and phytomass of the ground layer community of neotropical savanna (cerrado). Archives of the photogrammetric and remote sensing commission VII, 27 (B10), 649-657.

Verbruggen, A., W. Moomaw, J. Nyboer, 2011: Annex I: Glossary, Acronyms, Chemical Symbols and Prefixes. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available on <a href="http://www.ipcc.ch/pdf/special-reports/srren/SRREN\_Annex\_Glossary.pdf">http://www.ipcc.ch/pdf/special-reports/srren/SRREN\_Annex\_Glossary.pdf</a>, last accessed on March 24th, 2014.



## ANNEX I: ADDITIONAL INFORMATION

#### 1. AMAZONIAN GROSS DEFORESTATION MONITORING PROJECT - PRODES

PRODES is part of a larger program (Amazonia Program) developed at the National Institute for Space Research (INPE) that monitors gross deforestation in the Legal Amazonia<sup>30</sup> since 1988. It uses satellite imagery to identify new deforestation polygons every year in areas of *primary forest*. Deforestation is associated with clear-cut activities, normally associated with the conversion of forest land to other land-use categories. Gross deforestation is assessed annually, on a wall-to-wall basis, encompassing the analysis of approximately 215 Landsat images, aided by additional Landsat class data (CBERS/CCD, REsourcSat/LISS3 and DMC) to reduce the incidence of cloud cover, with the minimum mapping area of 6.25 hectares.

#### **BOX 1: PRODES MINIMUM MAPPING AREA**

PRODES was set in 1988 to map deforestation over hardcopy prints of Landsat images at the 1:250,000 scale. Consistent data for gross deforestation are available on an annual basis since 1988. Minimum mapping unit was defined as 1 mm², which is equivalent to 6.25 ha in the surface. Since 2008, deforestation polygons with area larger than 1 ha and under are retrieved in a separate dataset and registered as PRODES deforestation as they coalesce to a size larger than 6.25 ha. The first three years of this dataset are inflated by past deforestations. However, for all years since 2011 the total area (in km²) of small deforestation polygons stabilizes at values around 500 km² yr¹, (642 km² in 2011, 390 km² in 2012 and 479 km² in 2013). The consistency of the PRODES time series is ensured by using the same deforestation definition, same minimum mapping area, similar satellite spatial resolution², same Forest/Non-Forest vegetation boundaries, and same methodological approach to analyze the remotely sensed data at every new assessment.

Forest areas affected by forest degradation that do not have a clear-cut pattern in the satellite imagery are not included in PRODES. A separate project, named DEGRAD (refer to *Annex III* for more information), is carried out by INPE to address forest degradation. This ensures the consistency of the PRODES deforestation time series over time.

The Legal Amazonia covers the totality of the following states: Acre (AC), Amapá (AP), Amazonas (AM), Pará (PA), Rondônia (RO), Roraima (RR) and Tocantins (TO), Mato Grosso (MT) and part of the state of Maranhão (MA), totalizing approximately 5.217.423 km² (521.742.300 ha).

At the start of PRODES, deforestation polygons were identified by visual interpretation on false color composites of Landsat imagery at the scale of 1:250,000 and mapped on overlays that contained the aggregated deforestation up to the previous year. Subsequently these deforestation polygons were manually digitized in a Geographic Information System (GIS) developed by INPE. This analogical approach to assess deforestation (*Analog PRODES*) was employed from 1988 until 2002.

Due to the increased computing capability built by INPE, it was possible to transition to digital annual assessments of deforestation (*Digital PRODES*) after 2000, which was preceded by a 1997 *digital base map*. *Digital PRODES* maintains full consistency with the *Analog PRODES* data. This includes consistency with the forest boundaries in *Analog PRODES* and the aggregated deforestation polygons. Despite the evolution to a digital assessment, the identification of the deforestation polygons continued to be carried out through visual interpretation in the screen and not through digital classification methods<sup>31</sup>. This ensured even greater consistency between the *Analog* and *Digital PRODES*.

Due to the large volume of analogic data when *Digital PRODES* started, INPE decided to map the deforestation polygons from years 1998 to 2000 on an aggregated deforestation map until 1997 (*digital base map*). Hence, the deforestation polygons for these years were lumped into a single digital database, with no discrimination of the specific year when deforestation occurred. From year 2000 onwards, the deforestation polygons have been annually assessed and included in the *Digital PRODES* database. The *Digital PRODES* allows for the visualization of the deforestation polygons every year, in a single file. Thus, the geographical expansion of deforestation, as well as its spatial pattern, can be assessed and monitored.

In summary, the **digital database** does not have individual deforestation information for years prior to 1997, inclusive; it has information for years 1998 to 2000 in an aggregated format; and information (deforestation polygons) for all years since 2000 on an annual basis.

Digital PRODES allowed INPE to make available through the web the deforestation maps in vector format, as well as all the satellite images used, thus ensuring full transparency to the public in general. Since 2003, INPE began to publish the annual deforestation rate in the web, together with all the satellite imagery used to generate the information, and the maps with the identification of deforestation polygons. Annually INPE provides for the download of approximately 215 Landsat satellite images of Landsat5/7/8 (or similar data as CBERS/CCD, REsourceSat/LISS3 and DMC). Each image is accompanied by the associated map containing all past deforestation.

INPE continuously improves its tools to better manage large-scale projects such as PRODES. Its latest development, the TerraAmazon, is a system that manages the entire workflow of PRODES, annually storing approximately 600 images (e.g., Landsat, CBERS, DMC, Resourcesat). It performs geo-referencing, pre-processing and enhancement of images for subsequent analysis in a multi-task, multi-processing environment. The database stores and manages approximately 4 million polygons.

There are some steps that are followed until the deforestation increments are identified in the satellite imagery. These are now detailed:

<sup>31</sup> INPE has developed alternative methodologies to identify deforestation increments in satellite imagery (e.g., linear mixture model, Shimabukuro et al., (2004). However, the visual assessment demonstrated to be simpler and more efficient).

#### **IMAGES SELECTION**

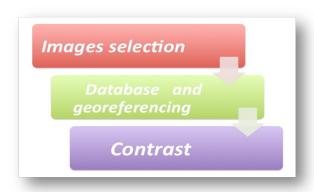
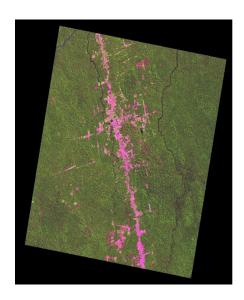


Figure a. 1: Steps prior to identification of the deforested polygons.

The first step consists of selecting the images to be used. For this, a query is conducted directly from INPE's Image Generation Division (DGI) site (http://www.dgi.inpe.br/siteDgi\_EN/index\_EN.php) to identify (preferably) Landsat images (or similar) for the year of interest (usually corresponding to the months of July and August), with minimal cloud cover, better visibility and a suitable radiometric quality.

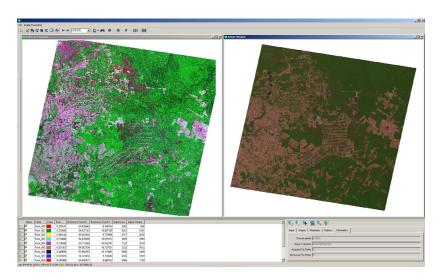
Satellite imagery available in the DGI are usually pre-processed for geometric correction and made available in UTM projection. *Figure a.2* shows an image from Landsat 5 selected in the DGI library.



*Figure a.2:* Landsat 5 (pathrow 227/65) of 01/07/2002 - Color composite Red, Green, Blue for bands 5,4,3, respectively, available on the DGI catalog .

#### DATABASE AND GEOREFERENCING

The next step consists of image geo-referencing, which is carried out through visual collection of at least nine control points evenly distributed in coherent features (rivers, roads intersection) in the image to be geo-referenced. INPE uses as reference data the orthorectified Landsat mosaic for the year 2000, produced by Geocover NASA project (https:// zulu.ssc.nasa.gov / MrSID). The geo-referencing is carried out by linear matrix transformation of first or second order, depending on the image quality, with transformation parameters obtained by least-square method applied to the set of control points.



**Figure a.3:** An example of control points collection.

#### CONTRAST ENHANCEMENT

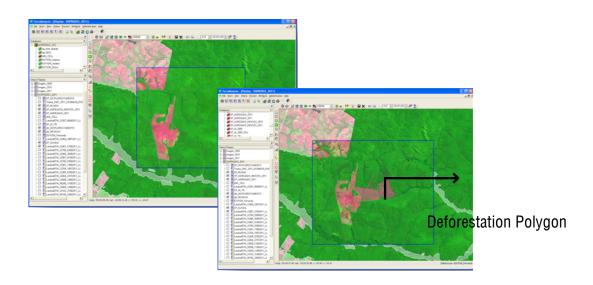
Finally, the technique of contrast enhancement may be applied to improve the quality of the images under the subjective criteria of the human eye. The contrast between two objects may be defined as the ratio between their average gray levels.

The goal at this step is to increase the contrast to facilitate the visual discrimination of objects in the image.

#### CALCULATING DEFORESTATION RATES BASED ON DEFORESTATION INCREMENTS

Deforestation rate calculations are elaborate, and have as a basis the information on deforestation increments. The simple sum of the mapped, observed deforestation polygons, is the deforestation increment.

Deforestation Increments	Deforestation Rates	
Value measured by image interpretation Calculated for each pair of LANDSAT image Indicating the date of image acquisition	Value is estimated Interpolated to a reference date (August 1 <sup>st</sup> ) Takes into account the area covered by clouds	



It should be noted that up to 2000, the Landsat TM scenes 222/61 and 222/62 were never considered by PRODES since they were persistently covered by clouds. In 2001, it was possible to observe these scenes. It was then verified that a large area was cleared in these scenes, leading to a high deforestation increment at that year (2001). This implies that there will be a substantial difference between increments and rates in years before 2001.

In early 2000s, there was a predilection for scenes without clouds, even when they were taken many days before the date of reference (August 1<sup>st</sup>). A limit to the number of days for the analysis of scenes was only later defined as a measure to avoid the discrepancy between deforestation rates and deforestation increment. In 2004, INPE decided to select only the images with dates as close as possible to the next reference date, so that after 2005/2006, the discrepancies between deforestation rates and deforestation increment became very small.

#### COMPARING THE EMISSIONS ESTIMATES: DEFORESTATION RATES VS. ADJUSTED INCREMENTS

Deforestation rates were not the basis for the FREL calculations. The FREL was calculated based on adjusted deforestation increments and these are two different approaches. Brazil's FREL is conservative because it uses only historical data and is dynamics through time (which is not required in any REDD+ decision).

PRODES maps up to 2001 were analogic and constrained the integration with the carbon map adopted in this FREL. As an exercise, the annual  $CO_2$  emissions per year were calculated taking as a basis the deforestation rates from PRODES and applying the average carbon stock per unit area (tC ha<sup>-1</sup>). This was done to assess the average difference in  $CO_2$  emissions using the annual rates of gross deforestation from PRODES and the emission estimates presented in this submission for years 1996 – 2005 based on the adjusted increments. The formula used was:

Deforestation rate (ha)/year \* 151.6 tC/ha \* 44/12

	Deforestation (km2)	Deforestation (ha)	Emission PRODES (tCO2) (Mean = 151,6 tC/ha)	Emission FREL (tCO2)
1996	18.161	1.816.100	1.009.509.453	979.523.414
1997	13.227	1.322.700	735.244.840	979.523.414
1998	17.383	1.738.300	966.263.027	979.523.414
1999	17.259	1.725.900	959.370.280	979.523.414
2000	18.226	1.822.600	1.013.122.587	979.523.414
2001	18.165	1.816.500	1.009.731.800	908.964.140
2002	21.651	2.165.100	1.203.506.920	1.334.457.457
2003	25.396	2.539.600	1.411.678.987	1.375.223.215
2004	27.772	2.777.200	1.543.752.907	1.380.140.946
2005	19.014	1.901.400	1.056.924.880	1.163.873.340
Mean			1.090.910.568	1.106.027.617
Diffe rence				1,39%

The average emissions from 1996 through 2005, using PRODES rates was  $1,090,910,568 \ \text{tCO}_2$ . The average emissions from 1996 through 2005 presented in the FREL was  $1,106,027,617 \ \text{tCO}_2$ . Since the FREL uses the average emissions of 10 years, these differences balance out at the end, being only 1.4 per cent.

## 2. PPCDAM: ACTION PLAN FOR THE PREVENTION AND CONTROL OF DEFORESTATION IN THE LEGAL AMAZONIA

The process of deforestation in Legal Amazonia is not homogeneous, presenting distinct spatial and temporal features. It is estimated that by 1980, the accumulated gross deforestation reached approximately 300,000 km², corresponding to approximately 6 per cent of the total forest area in Legal Amazonia. Deforestation during the 80's and 90's added about 280,000 km² to this figure. In the early years of the past decade, the pace of deforestation changed, and the accumulated deforestation reached approximately 670,000 km² in 2004, corresponding to approximately 16 per cent of the total forest area in Legal Amazonia.

This changed pace of deforestation led the Federal Government to establish, in 2003, a Permanent Interministerial Working Group (GPTI – Grupo Permanente de Trabalho Interministerial) through Decree s/n, July 3<sup>rd</sup>, to identify and promote coordinated actions aimed at reducing deforestation rates in Legal Amazonia. The GPTI was coordinated by the Chief of Staff of the Presidency until 2013 and is currently being coordinated by the Ministry of the Environment (MMA).

The GPTI was responsible for the development of the Action Plan for the Prevention and Control of Deforestation in the Legal Amazonia – PPCDAm, created in 2004, and which identified a number of measures, policies and actions to reverse the deforestation trend.

Since 2004, the Federal Government has been working in coordination with the various stakeholders, including state and municipal governments as well as the civil society, to promote a sustainable model of forest resource use and agricultural practices. PPCDAm is structured in three thematic axis that direct government actions towards reducing deforestation: i) Land Tenure and Territorial Planning; ii) Environmental Monitoring and Control, and iii) Fostering Sustainable Production Activities.

Since 2004, deforestation in Legal Amazonia has significantly decreased, reaching 6,418 km<sup>2</sup> in the period 2010-2011. In 2012, gross deforestation reached its lowest historical value of 4,656 km<sup>2</sup>. In 2013, a pre-estimate based on a set of Landsat images indicates that deforestation has increased to 5,843 km<sup>2</sup>. Despite this increase, this value was the second lowest in the PRODES time-series.

The Brazilian government is developing and implementing a modular system (SMMARE, *Modular System for Assessing and Monitoring GHG Emission Redutions* - Sistema Modular de Monitoramento e Acompanhamento das Reduções das Emissões de Gases de Efeito Estufa) to monitor actions and GHG emission reductions to be achieved through the Brazilian Climate Change Mitigation Plan. This system also aims at supporting the analysis and management of the mitigation actions implemented by Brazil. It is presently under development by MMA.

During the period from 2004 until 2011, the decrease in gross deforestation has been mostly attributable to Environmental Monitoring and Control actions, due to the implementation of the Deforestation Detection at Almost Real Time (DETER – *Detection in Real Time* - Detecção em Tempo Real<sup>32</sup>) integrated with planning and supervision. Land Tenure and Territorial Planning were also key areas for achieving results during this period, through the establishment of Conservation Units and demarcation of Indigenous Lands.

The change in the pattern of deforestation (from large to small annual increments) increased the cost of the monitoring initiatives, limited by both human and budgetary resources. The occurrence of deforestation polygons of size smaller than 6,25 hectares increased the need for investments on Land Tenure and Territorial Planning and on the Development for Sustainable Production Activities. It is under this context that the Action Plan for the Prevention and Control of Deforestation in the Legal Amazonia (MMA, 2013), a key operational plan for the implementation of Brazil's National REDD+ Strategy (2014-2020), initiated its third phase of implementation (2012-2015).

#### **RELEVANT LINKS:**

Brazil's Action plan to reduce deforestation in the Legal Amazonia area (PPCDAm): <a href="http://www.mma.gov.br/redd/index.php/en/legal-framework/national/ppcdam">http://www.mma.gov.br/images/arquivo/80120/PPCDAm/\_FINAL\_PPCDAM.PDF</a>

In 2004 INPE launched DETER, a quick monthly survey that maps both clear cut areas as well as areas undergoing forest degradation. DETER uses the MODIS sensor of the Terra / Aqua satellite and the WFI Sensor of the satellite CBERS, with spatial resolution of 250 m. It only detects deforestation in areas larger than 25 ha. DETER was designed as an early warning system to support surveillance and control of deforestation for the Legal Amazonia. To facilitate and streamline surveillance operations by different entities, the information is presented stratified by municipality, state, IBAMA's operative basis and protected areas. This system can only be used as an indicator of trends in annual deforestation, not as a means for calculating annual deforestation rates. For more information see: http://www.obt.inpe.br/deter/

# ANNEX II: EXAMPLES TO SUPPORT THIS FREL SUBMISSION

All excel files mentioned in this example are available in its complete form through the link: <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a>.

## 1. EXAMPLE OF THE CALCULATION OF ADJUSTED DEFORESTATION INCREMENT AND ASSOCIATED CO., EMISSION FOR THE YEAR 2003

The file "calculo\_def\_increment\_emission\_2003" presents, for year 2003, the area of the deforestation polygons by forest type and RADAMBRASIL volume (activity data); and the carbon density associated with each polygon (emission factor) necessary for the calculation of the deforestation increment that precedes the calculation of the adjusted deforestation increment and the associated emissions (data in Table 1 of the submission). It results from data in tab "2003" in the file "calculo\_def\_increment\_emission\_2003" that presents individual information for each of the 402,175 deforestation polygons identified in Landsat satellite imagery at year 2003.

Lines 3 to 32 provide, for each forest type (line) and RADAMBRASIL volume (column) the total area of the deforestation polygons that fall under the corresponding line and column. For instance, the value 1,205.9 ha in row 5, column C, refers to the sum of the areas indicated in *tab* "2003" associated with forest type AA and RADAMBRASIL volume 3. The area deforested in each volume is presented in line 32 and columns B to X, respectively; and the total area (*deforestation increment*) presented in cell Y32 (2,781,345 hectares or 27,813 km²). Column Y, lines 5 to 30 provide the area deforested per forest types, and columns Z and AA provide the ratio and percent contribution of each forest type to the deforestation increment. In column AA, the cells shaded in yellow refer to the forest types in *Table 4* (75.6 per cent); those in orange, to the forest types in *Table 5* (23.8 per cent); and those in blue, to "new" forest types (refer to *Box 1*) (0.4 per cent). From column AA it can be observed that approximately 84 per cent of the deforestation polygons occurred in only four forest types (25 per cent in forest type As; 15 per cent in Db; 27 per cent in Ds; and 17 per cent in Fs).

#### BOX 2: ADDITIONAL "FOREST TYPES"

As a result of the technical assessment and disaggregation of the data by forest type and RADAMBRASIL volume, it was observed that few deforestation polygons fell over forest types that were not included in **Tables 4** and **5**, as follows: Lb (campinarana = 21.63 tC ha-1); Lg (campinarana gramíneo-lenhosa, depression = 25.31 tC ha-1); Rm (refúgio montano = 6.55 tC ha-1); Sg (savanna gramíneo-lenhosa, campo =16.30 tC ha-1) and Sp (cerrado parque; savanna parque = 24.10 tC ha-1).

The contribution of these forest types to the deforestation increment and associated emission is minor and highlighted in blue in column AA. For instance, for 2004 these forest types contributed 0.36 per cent to the deforestation increment and to 0.015 per cent of the total  $CO_2$  emissions; in 2005, the contribution to the deforestation increment was 0.29 per cent, and 0.011 per cent to the total emissions.

Lines 34 to 61 provide the carbon densities per forest type and RADAMBRASIL volume used to estimate the emissions associated with the deforestation polygons (as per **Table 4**, **Table 5** and **BOX 2** above).

Lines 64 to 91 provide, for each volume and forest type, the area of the deforestation polygons (as per data in lines 5 to 31); associated carbon densities (as per lines 36 to 61); and associated emission (in tC) (resulting from the product of the areas and carbon densities). For example, for volume 2:

- (i) column A, lines 65 to 91 (A65 A 91) reproduces the area of the deforestation polygons provided in B5 B30 (activity data);
- (ii) B65 B92 reproduces the carbon densities presented in B36 B61 (emission factor);
- (iii) C65-C91 provides the product between the activity data in column A and the emission factor in column B.

Line 92 provides, for each RADAMBRASIL volume, the area of the deforestation polygons (highlighted in green) and the associated emissions (highlighted in yellow). The deforestation increment observed in 2003 was **2,781,345 ha** (BS 92) or 27,813.45 km2 (BS 93); and the total emission was **411,592,418 tC** (BS 95) or 1,509,172,201 tCO2 (BS 96). Note that the deforestation increment is the same as that obtained from the sum of the individual areas of the 402,176 deforestation polygons in file "**Disaggregation 2003**", column G (in hectares).

The complete excel file, available through the link (http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information) also contains some interesting information.

Lines 94 to 118, column A, for instance, reproduce the areas presented in line 92 for all volumes (highlighted in green) and the deforestation increment in line 118 (2,781,345 ha); columns B and C for the corresponding lines present the ratio between the area deforested for each

volume and the deforestation increment (total observed area deforested) and the corresponding percentage, respectively. It is to be noted that deforestation events do not occur evenly among the RADAMBRASIL volumes, but concentrate mainly (69.7 per cent) in volumes 4, 5, 16, 20, 22 and 26. From the figure provided in lines 96-118, columns F to M (corresponding to Figure 11 in the text of the submission) it can be seen that these volumes cover the area of the "Arc of Deforestation" in the Amazonia biome. The concentration of the deforestation polygons in these volumes is also observed for other years.

If the information on these volumes is individualized (see lines 120-150 for volume 4; lines 153-181 for volume 5; lines 184-212 for volume 16; lines 215-244 for volume 20; lines 247-276 for volume 22; and lines 279-307 for volume 26), then column F provides the forest types most affected by deforestation events in these relevant volumes. One notes that in all these volumes, the largest percentage of the deforestation polygons fell over at least 2 and at most 3 out of the 22 (+5) forest types. For **volume 4**, 99.0 per cent of the deforestation polygons fell over forest types AS and DS; for **volume 5**, 91.87 per cent over DB and DS; for **volume 16**, 96.86 per cent over forest types AS, DS and FS; for **volume 22**, 96.32 per cent over AS, FS and SD; and finally for **volume 26**, 84.85 over forest types AS and FS. Hence, none of the deforestation polygons fell over "new" deforestation types (refer to **Box 1** above) and most fell over forest types with data from RADAMBRASIL sample units (**Table 4** – forest types AB, AS, DS, DB) and few over forest types with data from the literature (**Table 5** – FS and SD).

The diagrams in columns H to AB, lines 120 - 308 show the range of the carbon densities associated with the corresponding forest type, from the lowest to the highest value. The arrows indicate the value of the carbon density used.

Note that the figure provided in BS 93 for the deforestation increment (in km2) is not the same as that presented in Table 1 for year 2003. The difference is explained by the fact that in 2002 some satellite images were cloud covered and the adjusted deforestation increment approach was applied (refer to Box 2 of the FREL's main text).

The file "verification\_2003\_area\_emissao" provides the data necessary to calculate the adjusted deforestation increment and associated CO2 emissions. It includes information over cloud-covered area and the distribution of areas among years, so as not to under or overestimate the total area deforested at any year (refer to **Box 2** of the FREL's main text).

Lines 6 to 68, columns A to J, provide information on the following: (i) satellite image of interest (i.e., the Path/Row information on the Landsat images for which adjustment will be applied to the associated deforestation increment); (ii) the area of the deforestation polygons observed in 2003 over areas that were cloud covered in 2002; (iii) the forest types associated with the deforestation polygons observed in 2003 over areas cloud covered in 2002; (iv) the associated RADAMBRASIL volume.

For instance, the value **28,068.05** ha in line 8 column I represents the sum of the areas of the deforestation polygons observed at year 2003 over areas that were cloud-covered at years 2002 and 2001 in **Landsat Path/Row 225/59**. This area concentrated in **volume 6** of RADAMBRASIL and the deforestation polygons were associated with forest types AA, DA, DB, PA, PF, SA, SD, SG and SP, as indicated in lines 9 to 18. **Tab "22559"** in the file **"verification\_2003\_area\_emissao"** 

gives the list of the deforestation polygons (a total of 3,441) stratified by forest type, and the associated areas (in column G, in hectares) and emissions (in column E, in tC) for this satellite scene. The emission associated with the deforestation polygons falling in forest type AA, for instance, are calculated using the carbon density for forest type AA in volume 6 in **Table 4** (123,75 tC), totaling 3,295,357.34 tC (refer to **BOX 3** below). Due to the fact that these polygons fell over an area in the satellite imagery that was cloud-covered in 2002 and 2001, the area of 28,068.05 ha and corresponding emission of 3.295.357,34 tC was evenly distributed among the deforestation increment for 2002 and 2001. This implied the division of these values by 3, resulting in a shared area of 9,356.02 ha and shared emission of 1,098,452.45 tC. So, the original area of 28,068.05 ha is subtracted from the 2003 deforestation increment (2,781,345.04 ha) and replaced by 9,356.02 ha. This value is added to the deforestation increment of 2002 and 2001.

#### **BOX 3: INDEPENDENT VERIFICATION**

For the sake of verifiability, the original data for Landsat scene 225/59 have been reproduced in tab "22559" in file "verification 2003 area emissao" for all forest types. Refer to lines 2-262 columns I to P for forest type AA (carbon density = 123.75 tC, **Table 4**); to lines 2-783 columns Q to X for forest type DA (carbon density = 131.82 tC, Table 4); to lines 2-600 columns Z to AG for forest type DB (carbon density = 222.39 tC, **Table 4**); to lines 2-405 columns AI to AP for forest type PA (carbon density = 105.64 tC, **Table 5**); to lines 2-140 columns AR to AY for forest type PF (carbon density = 98.16 tC, **Table 5)**; to lines 2-14 columns BA to BH for forest type SA (carbon density = 47.10 tC, **Table 5**); to lines 2-380 columns BJ - BQ for forest type SD (carbon density = 77.8 tC, **Table 5)**; to lines 2-28 columns BS to BZ for forest type SG (carbon density = 16.3 tC, **Box 1**, Additional Forest Types); and to lines 2-447 columns CB to CI for forest type SP (carbon density = 24.10 tC, Box 1, Additional Forest Types). Note that the values highlighted in yellow (emissions) and green (area) in lines 263 (for AA); 784 (for DA); 601 (for DB); 406 (for PA); 141 (for PF); 15 (for SA); 381 (for SD); 29 (for SG); and 448 (for SP) correspond to the figures presented for Landsat scene 225/59 in columns F (for emissions) and G (for area) for forest types AA (line 9); DA (line 10); DB (line 11); PA (line 12); PF (line 13); SA (line 15); SD (line 16); SG (line 17); and SP (line 18). Note that the columns shaded in grey for each forest type (column P, X, AG, AP, AY, BH, BQ, BZ, and CI for forest types AA, DA, DB, PA, PF, SA, SD, SG, and SP, respectively is the verification column for the emissions. It results from the multiplication of the area (in hectares) by the carbon densities corresponding to the forest type in **Table 4**, **Table 5** or **Box 1** above (Additional Forest Types). Note that the original emissions (highlighted in yellow) and those reproduced independently (highlighted in grey) most likely due to the number of decimal places used for the carbon densities. The original data (area and emissions) originate from the database and has its own internal functions (decimal places, order of applying operations, etc.). However, the numbers have been closely reproduced.

The same procedure applies for Landsat scenes 224/60; 225/63; 226/58; 226/59; 226/60; 226/61; 226/62; 226/63; and 227/58 which, together, present and area of **368,979.57** ha of observed

deforestation polygons at year 2003 that was cloud covered in the previous year or years. distributed as follows: scenes 224/60, **35.67 ha**; 225/59, **28,068.05 ha**; 225/63, **24,355.22 ha**; 226/58, **5,248.91** ha; 226/59, **85.74** ha; 226/60, **6,483.50** ha; 226/61, **4,457.58** ha; 226/62, **218,283.72** ha; 226/63, *8*1,960.44 ha; and 227/58, 0.72 ha. These observed area in 2003 were cloud-covered in 2002 or 2002 and 2001, as follows: scenes 224/60, cloud-covered in 2002; 225/59, cloud-covered in 2001 and 2002; 225/63, cloud-covered in 2002; 226/58, cloud-covered in 2002; 226/59, cloud-covered in 2002; 226/60, cloud-covered in 2001 and 2002; 226/61, cloudcovered in 2002; 226/62, cloud-covered in 2001 and 2002; 226/63, cloud-covered in 2002; and 227/58, cloud-covered in 2002. Note that part of the area 368,979.57 ha is subtracted from the observed deforestation increment at year 2003 and is distributed among years 2001 and/or 2002, as applicable. Column J shows the portion of this area that is summed to the deforestation increment calculated for years 2001 and/or 2002 (corresponding to the area to be subtracted from the deforestation increment calculated for year 2003). Half of the area indicated in column J line 6 for scene 224/60 (17.84 ha) is added to the 2002 deforestation increment and half remains in the 2003 deforestation increment; one third of the area indicated in column J line 8 for scene 225/59 (9.356.02 ha) is added to the 2001 deforestation increment; one third is added to the 2002 deforestation increment and one third remains in the 2003 deforestation increment.

The table below shows the distribution of the area of the deforestation polygons observed in 2003 under cloud-cover areas in the satellite images in 2002 or 2001 and 2002.

	2003	2002	2001	Total area
224/60	17.84	17.84		35,67
225/59	9,356.02	9,356.02	9,356.02	28.068,05
225/63	12,177.61	12,177.61		24.355,22
226/58	2,624.46	2,624.46		5.248,91
226/59	42.87	42.87		85,74
226/60	2,161.17	2,161.17	2,161.17	6.483,50
226/61	2,228.79	2,228.79		4.457,58
226/62	72,761.24	72,761.24	72,761.24	218.283,72
226/63	40,980.22	40,980.22		81.960,44
227/58	0.36	0.36		0,72
TOTAL	142,350.57	142,350.57	84,278.43	368,979.57

The figures above show that out of the area of **368,979.57** ha associated to deforestation polygons observed in 2003 over areas that were cloud covered in years 2002 or 2001 and 2002, **142,350.57** ha was attributed to year 2003; **142,350.57** ha was attributed to year 2001, thus implying the addition of these quantities to the deforestation increment calculated for these years.

Relating these values to **Equation 1** in the submission:

The value  $\emph{368,979.57}$   $\emph{ha}$  corresponds to term. $\sum_{\Delta=1}A_{CC(t-\Delta),(t)}$ 

The value 142,350.57 ha corresponds to term

$$\sum_{\Delta=1}^{Y} \frac{A_{CC(t-\Delta),(t)}}{\Delta+1} = \frac{A_{CC(t-1),(t)}}{2} + \frac{A_{CC(t-2),(t)}}{3} = \frac{116,144.29}{2} + \frac{252,835.28}{3}$$

= 58,072.14 + 84,278.43 = 142,350.57

The value 116,144.29 refers to term  $A_{CC(t-1),(t)}$  and the value 252,835.28 to term in  $A_{CC(t-2),(t)}$  **Equation 1**.

The value *116,144.29 ha* corresponds to the sum of the areas associated with Landsat scene 224/60 (35.67 ha); 225/63 (24,355.22 ha); 226/58 (5,248.91 ha); 226/59 (85.74 ha); 226/61 (4,457.58 ha); 226/63 (81,960.44 ha). The area *252,835.28 ha* is associated to Landsat scenes 225/59 (28,068.05 ha); 226/60 (6,483.50 ha) and 226/62 (218,283.72 ha).

The term  $\sum_{\Omega=1}^{Y} \frac{A_{CC(t+\Omega),(t)}}{\Omega+1} = 0$ , since there were no cloud-covered areas in 2003 (thus, not requiring distribution of area from 2004 to 2003).

Turning now to the **distribution of the emissions** associated with the areas transferred to years 2002 or 2001 **and** 2002.

Lines 2-81, columns Q to W provide the verification of the emissions reported in the information from lines 3 to 68, columns A to I. The emissions are estimated using the carbon densities per unit area (tC ha<sup>-1</sup>) provided in **Tables 4** and **5** and **BOX 1** in the Annex, and hence it is to be expected that the numbers do not completely match due to the number of decimal places used and order of the functions performed.

The emissions associated with each satellite image are summarized in lines 1 to 23, columns L to 0 (the totals presented originate from the calculations performed in columns Q to W – values highlighted in yellow -individually or totals). The emissions associated with the deforestation polygons in 2003 over areas that were cloud covered in year 2002 or 2001 and 2002 totaled **74,179,069.36** tC. Column X indicates how this area will be distributed among years 2002 and 2001 (divide by 2 in case the area was cloud-covered in 2002; divide by 3 if the area was cloud-covered in years 2001 and 2002, and was observed in 2003). Column Y provides the individual values to be reallocated.

The table below shows the distribution of the emissions associated with the deforestation polygons observed in 2003 under cloud-cover areas in the satellite images in 2002 or 2001 and 2002.

	2003	2002	2001	Total emissions
224/60	3,302.22	3,302.22		6,604,44
225/59	1,097,478.97	1,097,478.97	1,097,478.97	3,292,436.91
225/63	2,329,889.95	2,329,889.95		4,659,779.9
226/58	574,005.21	574,005.21		1,148,010.42
226/59	9,467.20	9,467.20		18,934.40
226/60	325,830.63	325,830.63	325,830.63	977,491.89
226/61	409,717.70	409,717.70		819,435.40
226/62	16,286,514.94	16,286,514.94	16,286,514.94	48,859,544.82
226/63	7,198,338.73	7,198,338.73		14,396,677.46
227/58	76.88	76.88		153.76
TOTAL	28,234,622.43	28,234,622.43	17,709,824.54	74,179,069.40

Columns AB and AC, rows 2 to 21 show a summary of the verification of the adjusted deforestation increment and corresponding emissions, where it can be observed that the differences were minor, given the different mode of calculation adopted in this example and that carried out for this submission.

## 2. EXAMPLE OF THE CALCULATION OF THE CARBON DENSITY ASSOCIATED WITH A FOREST TYPE

This example aims at facilitating the understanding of the application of **Equations 5**, **6** and **9** in the main text of the submission. The original RADAMBRASIL data will be applied, *i.e.*, the values of the circumference at breast height (CBH) collected on the sample units to the allometric equation by Higuchi *et al.*, 1998. The objective in this example is to reproduce the carbon density per unit area presented for forest type **Ab** in RADAMBRASIL **volume 18** (refer to **Table 4** of the submission).

#### File "equations 569 volume18 Ab"

contains the data necessary to reproduce the carbon density for forest type Ab in volume 18, equal to 213.37 tC (Table 4).

#### Column A – Circumference at Breast Height (CBH)

For sample unit 1 : lines 4 to 73 For sample unit 2 : lines 77 to 113 For sample unitt 3: lines 117 – 201

For sample unit 4: lines 206 – 263

**Column B – Conversion of CBH to Diameter at Breast Height (DBH)** (by multiplying by 3,1416 (refer to footnote 21 in the submission) or multiplying by 113/355:

**Columns C**, **D**, E and **F** refer to the data necessary to apply the allometric equation **(Equation 5)** reproduced below.

 $\ln P = -0.151 + 2.170 \times \ln DBH$ 

**Equation 5** 

Column C – Natural logarithm of the DBH values (In DBH)

Column D – Product of column C by 2.170

Column E - Value in column D - 0.151

Column F – Transforming natural logarithm of P (In P) into P

Column G – Applying Equation 6, reproduced below, multiplying data in column F by 0,2859

 $C_{(CBH > 100 cm)} = 0.2859 \times P$ 

**Equation 6** 

Column H – Transforming the data provided in kg of fresh biomass in column G to tonnes, by multiplying by 1,000.

**Column H, line 74** – Total carbon stock in sample unit 1, necessary for application of *Equation* 9, reproduced below. It is the sum of the carbon stock of all trees in the sampling plot.

$$C_{total, SU} = 1.9384 \times AC_{(CBH > 100 cm)}$$

**Equation 9** 

where:

 $C_{\text{total, SU}}$  = total carbon stock in living biomass (above and below-ground) for all trees, palms and vines in the sample unit; tC ha<sup>-1</sup>;

 $AC_{(CBH > 100 \text{ cm})}$  = total carbon stock in a sample unit from trees with CBH > 100 cm; tC ha<sup>-1</sup>

**Column H**, **line 75** – Product of the value in column H, line 76 by 1,9384 to obtain the total carbon stock in living biomass (above and below-ground) for all trees, lianas and palms in sample unit 1.

Repetition of the steps above for the three other sample units: the total carbon stock in living biomass (above and below-ground, including vines and palms) for all trees in sample units 2, 3 and 4 are provided in Column H, lines 115, 203 and 265, respectively.

Since there were four sample units in Volume 18 for forest type Ab, *Rule 1* in *Step 5* (*Step 5*: Application of extrapolation rules to estimate the carbon density associated with forest types in each volume of RADAMBRASIL) can be used to generate the average carbon stock for forest type Ab in that volume.

Following *Rule 1*, the simple average of the values in column I lines 75, 115, 203, and 265 is presented in **Column B**, line 276.

This example is available at: <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a>

# ANNEX III: THE DEVELOPMENT OF FRELS FOR OTHER REDD+ ACTIVITIES IN THE AMAZONIA BIOME

## 1. DEGRADATION IN THE AMAZON BIOME: AVAILABLE HISTORICAL DATA AND FOREST MONITORING SYSTEMS

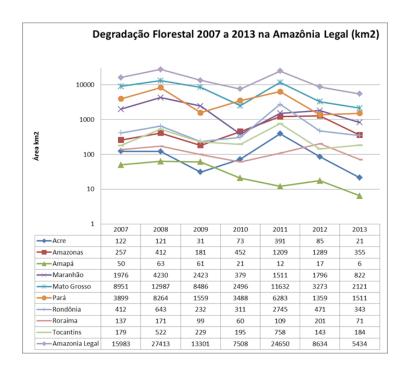
INPE has developed a system, referred to as DEGRAD, to map the occurrence and monitor the fate of degraded areas in the Legal Amazonia using satellite imagery (Landsat-class, up to 30 meters spatial resolution). INPE plans to maintain this system as part of the Amazonia Program to create a long enough time series to allow the dynamics and fate of degraded forests to be better understood.

DEGRAD maps mostly forest fire scars that occur predominantly in previously logged sites and areas under logging activities characterized by widespread damage to the forest canopy. The identification of degraded forest areas is carried out through visual interpretation of color composites of Landsat-class data (multispectral with resolution up to 30 m) where the conspicuous damage to the forest canopy by forest fire and rampant traditional forest exploitation is clear. Part of the selectively logged areas are abandoned and left to regenerate<sup>33</sup>.

For DEGRAD, a time series with annual data for the period 2007 to 2013 is available (**Figure b.1.**), based on the same set of images used for PRODES for these years. DEGRAD is performed independently each year, without taking into account the record of degraded forests from previous years, identifying only the updates of the deforested areas recorded by PRODES.

The maps generated by DEGRAD, with evidence of forest degradation, are also publicly available as part of INPE's policy of open data distribution (http://www.obt.inpe.br/degrad/).

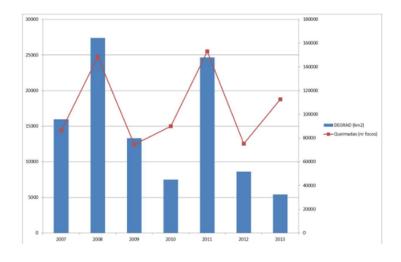
FUNCATE provided the figures of their assessment of selective logging areas in Legal Amazonia, as follows: 2011 = 9 000 km2; 2012 = 7.200 km2 and 2013 = 6 000 km2. These figures summarize the total area identified using Landsat satellite images over Legal Amazonia, and may include logging that occurred in previous years. The figures show a systematic decrease in the selectively logged area from 2011 to 2013, and this may be related to the conversion of previously mapped areas to deforestation (captured by PRODES), degradation (captured by DEGRAD) or regenerated (leaving no degradation scar in the image) -see also dos Santos et al. (2001) for the fate of selectively logged areas from 1988 – 1998 (Multitemporal TM-Landsat data applied to the Study of the Dynamics of Selective Logging in Amazonia - Dados multitemporais TM/Landsat applicados ao estudo da dinâmica de exploração madeireira na Amazônia. Anais X SBSR, 21 a 26 de abril 2001, p. 1751-1755.



*Figure b.1*: Forest degradation in Legal Amazonia from 2007 to 2013. Distribution of the area under forest degradation in Legal Amazonia (in km²). *Source*: INPE, DEGRAD, 2014.

It has been noted that there is a close relationship between the increase of the degraded forest area and the increase of fire occurrences in years impacted by drought, due to the vulnerability of forest areas to fire due to the presence of dry, easily combustible material (dry litter).

DEGRAD clearly indicates that the forest degradation process is closely associated to climatic conditions in a given year, such as unusually hot years (e.g., 2007 and 2010). A lagged effect of extreme events on forest degradation has also been observed (e.g., an extremely dry year leading to increased fire occurrences in subsequent year or years).



*Figure b.2.* Relationship between fire occurrences and degradation in the Legal Amazonia from 2007 to 2013. *Source:* INPE, 2014.

The causal relationship between the reduction in deforestation in some areas and the increase in forest degradation in others is difficult to be established, if not impossible.

INPE has monitored, through PRODES, the areas mapped by DEGRAD to assess the extent to which the areas affected by forest degradation in one year are converted to clear cut in subsequent years. *Table b.1* presents data for DEGRAD and for PRODES from 2007 to 2013.

Table b.1. Percentage of the areas identified as degraded by DEGRAD and subsequently converted to clear cut (deforestation) and included in PRODES, from 2007 to 2012.

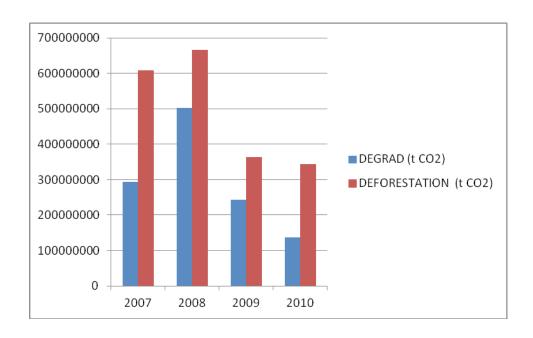
% conversion of the area degraded (DEGRAD) to clear cut (PRODES)		PRODES (year)					
		2008	2009	2010	2011	2012	2013
ar)	2007	12	2	2	2	1	2
(year)	2008		1	2	1	1	1
D (	2009			2	2	2	2
RA	2010				3	1	2
DEGR	2011					2	4
D	2012						4

The major challenge of monitoring and addressing forest degradation adequately (in particular in relation to the anthropogenic contribution to the associated emissions) lies in the ability to accurately assess the changes of carbon stock in the areas affected by degradation, particularly aboveground biomass. Degradation may have different intensities, from very low (where few trees are removed) to very high (where, *most likely*, the land will be deforested at some point in time).

DEGRAD time series is not long enough to allow a good understanding of the degradation process and hence, for Brazil to include the REDD+ activity "Reducing Emissions from Forest Degradation" in this submission. It is expected that this understanding improves with time, as new data become available. Forest degradation has not been included in the construction of this FREL, to ensure a conservative approach for REDD+ results-based payments.

The data indicates that, on average, the emissions associated with forest degradation in the Amazonia biome, from 2007 to 2010 inclusive, are approximately 59.0 per cent of those from deforestation. It is to be noted that the pattern of emissions from deforestation and forest degradation show some correspondence in the time series from 2007 to 2010 (a decrease in one is followed by a decrease in the other, and vice versa), as can be seen from *Figure b.3*.

In the calculation of the percentage indicated above (see *IMPORTANT REMARK* below), it was assumed that the average loss of carbon in the areas affected by degradation was 33 per cent (consistent with the value in the Second National GHG Inventory). This percentage was assumed for the loss of carbon from selective logging and may not represent the average loss for forests impacted by degradation events in general.



**Figure b.3.** Emissions (in tCO<sub>2</sub>) from deforestation and from forest degradation in the Amazonia biome for years 2007 to 2010, inclusive.

**IMPORTANT REMARK 1**: The emissions from forest degradation have been estimated using the area of forest degradation identified in DEGRAD (refer to *Figure b.1*); the mean carbon density in forest types in the Amazonia biome (151.6 tC ha<sup>-1</sup> - refer to *section b.2* in the main text of this submission); and an estimate of the average carbon loss from forest degradation of 33 per cent, after Asner *et al.*, 2005 and consistent with the Second National GHG Inventory. An expert judgement from the SFB indicated a similar estimate for selectively logged areas. For information on this issue in the Second National Inventory, refer to BRASIL (2010); Chapter 3, page 228.

**IMPORTANT REMARK 2**: The data and information on forest degradation already available for Amazonia is indicative of the complexities ahead to include emissions from forest degradation in a future FREL submission. Part of these complexities will arise from limited understanding of the dynamics of forest degradation processes. Unlike deforestation which is an activity normally associated with conversion of forest to other land uses, forest degradation may result from natural extreme events (such as droughts that intensify the vulnerability of forests to fire, for instance) that may result in emissions which will be balanced by the subsequent uptake of CO2 from the atmosphere when the agent of degradation is eliminated. Forest degradation identified in a specific year in satellite imagery may not be identifiable in subsequent years. Other areas of forest degradation may be subject to continuous degradation pressure (intensification of selective logging activities, for instance), culminating to deforestation (clear cut). Under this situation, it will be important not to double count emissions from deforestation and from forest degradation, if both activities are included in the FREL. For the present submission, the use of the same carbon density per unit area for areas deforested, regardless of the underlying process of deforestation, does not pose a concern. However, addressing this issue if emissions from forest degradation are included in the FREL may be a challenge. Another challenge is related to the estimation of the fraction of carbon lost from degradation processes, which may require intensive ground data information. Finally, additional complexities may arise depending on the own definition of forest degradation applied in the country.

## ANNEX IV: THE DEVELOPMENT OF FRELS FOR OTHER BIOMES

#### 1. FROM SUBNATIONAL TO NATIONAL (ALL BIOMES)

As an interim measure, Brazil considered in this submission a FREL for *Reducing Emissions from Deforestation* in the Amazonia biome. This is due to the fact that Brazil has a historical time-series for deforestation that is consistent, credible, accurate, transparent, and verifiable for the Legal Amazonia area (and hence, the Amazonia biome).

Brazil is concentrating efforts to develop as good a time series for forest degradation for the Amazonia biome so as to have reliable and consistent data and information that will support the decision on how emissions from forest degradation should be addressed in future REDD+ submission. Meanwhile, INPE continuously monitors forest degradation to assess if the reduction of deforestation is not leading to an increase in forest degradation activities (*displacement of emissions*) – refer to *Annex III*.

Investments have already started in Brazil to expand the forest monitoring system developed for Legal Amazonia to other biomes by assessing deforestation in all biomes for years 2009, 2010 and 2011. It is expected that by 2015 Brazil will have a national monitoring system to monitor deforestation in all biomes, on an annual basis.

The idea is to develop FRELs for the remaining biomes in order of emissions importance, the Cerrado biome being the second in this respect (refer to **section II** of this Annex). **Table c.1** presents the relative importance of the Brazilian biomes to the average annual  $CO_2$  emissions from deforestation, estimated from the Second National Inventory.

**Table c.1:** Average annual gross CO<sub>2</sub> emissions from forest (managed + unmanaged) converted to other land uses. **Source**: Adapted from Tables 3.98, 3.100, 3.102, 3.104, 3.106, 3.108, Second National Inventory, BRASIL (2010).

Biomes	Annual Average Gross CO2 Emissions from Deforestation (Gg) (1994-2002)	Relative Importance (%)
Amazonia	1,021,875.28	70.21
Cerrado	287,728.50	19.77
Caatinga	42,193.09	2.90
Mata Atlantica	87,337.30	6.00
Pantanal	16,363.03	1.12
Pampa	41.94	0.00
TOTAL	1,455,539.14	100

#### 2. DEFORESTATION AND DEGRADATION IN THE CERRADO BIOME

The Cerrado biome is the richest savanna in the world in terms of biodiversity. This biome provides fundamental local and global environmental services, and since the 1970s faces high pressure from deforestation due to mechanized agriculture, livestock and charcoal production to meet the demand of the steel industry. Cerrado is a strategic biome for both economic and environmental reasons and also for food security.

The Cerrado landscape is a mosaic of different vegetation types, ranging from grasslands to forestlands, corresponding to a gradient of woody cover (Eiten (1972), Castro & Kauffman (1998)). The structural diversity of vegetation types in the Cerrado involves a wide spectrum of total biomass (Miranda *et al.*, 2014). Available data highlight the importance of woodland savannas as carbon sinks, particularly the belowground pool (soil and root system) (Miranda *et al.* (2014); Abdala (1993)).

## a. Available historical data, forest monitoring systems and related uncertainties

Only recently forest monitoring systems other than that developed for Legal Amazonia have started to be developed in Brazil. In 2002, the project *Monitoring Deforestation in Brazilian Biomes by Satellite* was created and had as a starting point the vegetation map generated for the PROBIO/MMA project ("time zero map") containing the historical natural vegetation changes that occurred in the Cerrado biome up to 2002, based on the analysis of remotely sensed data. New changes from 2002 to 2008 were also identified through visual interpretation of satellites images (CBERS and Landsat).

The presently available data for deforestation in the Cerrado biome consist of the deforestation mapped from 2002 and 2008, followed by and annual assessments of the rate of deforestation for 2009 and 2010. The analysis of these data indicates a downward trend in the loss of natural vegetation in this biome. The determination of the accuracy of these estimates is still under way.

The mapping of deforestation from 2002 to 2008 was contracted, and presented some distortions that were not readily identified. For years 2008, 2009 and 2010, the analysis of satellite imagery to identify new deforestation was carried out by the technical team at IBAMA, which was, to a great extent, able to correct the distortions. For example, some deforestation that occurred prior to 2008 was mapped in either one of years 2008, 2009 or 2010, thus overestimating the deforestation associated with these years.

Recognizing this problem, the Brazilian government is now working to rebuild the time series for this biome, having as a reference the methods used for PRODES for the Legal Amazonia. One of the initiatives to produce environmental information for the Cerrado biome is funded by the Forest Investment Program, FIP.<sup>34</sup>

The Brazil Investment Plan comprises coordinated actions by three Ministries (Environment; Science, Technology & Innovation; and Agriculture and Livestock and Food Supply) focused on building synergies in order to maximize the impact of a larger set of policies aimed at reducing deforestation in the Cerrado biome through (1) improving environmental management in areas previously impacted by Human actions; and (2) producing and disseminating environmental information at the biome scale.

The analysis of the data available so far does not indicate an increase in deforestation in the Cerrado biome as a result of the significant reduction of deforestation in the Amazonia biome. This risk is mitigated by policies in place to tackle deforestation in the Cerrado biome (see **BOX 4** below).

## BOX 4. ACTION PLAN FOR PREVENTION AND CONTROL OF DEFORESTATION IN THE CERRADO AND BURNING – PPCERRADO

The overall goal of PPCerrado is to promote the continuous reduction of deforestation and forest degradation, as well as the incidence of unwanted forest fires in the Cerrado biome, through joint actions and partnerships between federal, state and municipal governments, civil society, business sector and universities. PPCerrado actions include the promotion of sustainable activities and the monitoring of private rural properties through the Rural Environmental Registry - CAR, considered one of the main instruments for environmental management of the Forest Code.

In the Cerrado, deforestation drivers are related to agriculture, cattle ranching and the demand for charcoal, mainly for the steel industry. Reconciling the binomial production/environmental protection is the great challenge for the Cerrado biome, considering its legal constraints (e.g., legal reserve of 20 per cent, as defined by the Forest Code) and the high demand for the occupation of lands, particularly for agriculture production.

The positive results already achieved for reducing deforestation in the Cerrado biome are viewed with caution by the Federal Government, since there is no systematic monitoring of deforestation in the biome as there is for the Amazonia. In order to bridge this gap in deforestation data for the Cerrado, a system for annual monitoring and for early warnings is being developed under the PPCerrado.

For more information see: http://www.mma.gov.br/redd/index.php/en/legal-framework/national/ppcerrado

The loss of natural vegetation of the Cerrado biome is often associated with the use of fire. According to the National Information System about Fires (Sisfogo)<sup>35</sup>, about 90 per cent of the fires are human related. In 2010 alone, 74,120 hot spots were detected, of which 70 per cent were located in areas of native vegetation<sup>36</sup>. Data on degradation in Cerrado has a high degree of variability and uncertainty<sup>37</sup>.

Despite its relevance to the profile of emissions in Brazil, estimation of degradation by fire still depends on the development of land cover monitoring tools. Historical data series of burned areas in the Cerrado biome are not yet available.

Sisfogo is an online automated tool available for the management of early warnings and records of forest fires and controlled biomass burning. It is powered by various institutions working in the control of fires, prevention and combating forest fires. Available for public access on: http://siscom.ibama.gov.br/sisfogo/

<sup>36</sup> INPE has an operational program to Monitor Fires and Biomass Burning using satellite data, that also provides for the estimation of the risk of fire. Data for Central and South America, Africa and Europe, are updated every three hours, every day of the year. Access to this information is free for users, available online on: http://www.inpe.br/queimadas/.

<sup>37</sup> More information about actions in other Brazilian biomes is presented in Annex II.

Initiatives in coordination between INPE and the MMA seek to provide the means for the development of automated tools so that these data become regularly available. Brazil is also working on the historical time series of burned areas between 2000 and 2013, which will allow for the development of the FREL for degradation by fire for the Cerrado biome.

Another source of uncertainty for estimating emissions in this biome relates to the estimation of biomass for different regions and vegetation types. The Second National GHG Inventory used distinct biomass for different types of Cerrado vegetation as available from the national scientific literature. For example, for estimating the biomass of forest type Savanna Woodland, eleven different sources were consulted. To obtain the total biomass, expansion factors were applied to consider dead organic matter and belowground biomass (root-to-shoot ratio), having as a basis default data in the GPG-LULUCF (IPCC, 2003). Despite the existence of national data for carbon pools, as in Miranda (2012), there is great variability in the literature depending on the methods used and the areas under investigation.

Brazil is continuously working to improve its database and aims to provide FRELs for deforestation for the Cerrado biome in the next submission. For now, information is provided here only to demonstrate the ongoing efforts by Brazil to expand its coverage of REDD+ to the national level.

### 3. ENHANCEMENT OF FOREST CARBON STOCKS IN THE ATLANTIC FOREST BIOME

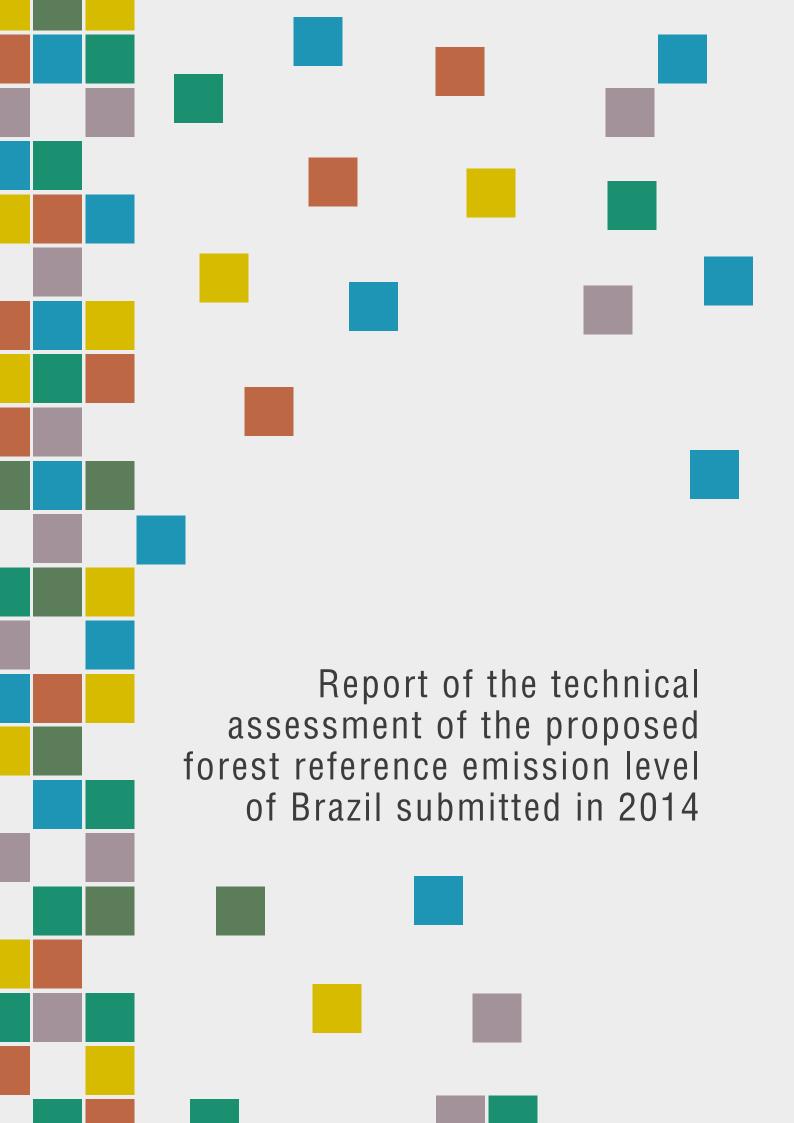
The Atlantic Forest is the most threatened biome in Brazil: there are only 7.9 per cent of remaining forests fragments over 100 hectares. In case all the small fragments of natural forest over 3 acres are included, this reaches 13.32%<sup>38</sup>. Data from 2005 to 2008 show that the level of deforestation for that period was a total of 1,030 km², an average of 340 km² per year. In the period between 2008 and 2010, about 208 km² of native forest were cleared, representing a drop in deforestation from the previous period (SOS/INPE, 2010). Although deforestation has dropped in recent years, it is still of concern for this biome.

After habitat loss, the second major threat to Atlantic Forest is its high degree of fragmentation. This leads to high vulnerability to disturbance (by fire, edge effects, etc.) and high degree of isolation of natural populations of the biome.

This has motivated investments from governmental and non-governmental entities in initiatives to promote the restoration of this biome.

The estimation of  ${\rm CO_2}$  removals from restoration is of paramount importance to monitor mitigation efforts that occur in this biome. However, unlike what is observed with clear-cut logging (or even forest degradation), the identification of growing stocks through remotely sensed data is still questionable and lies as a research theme.

Brazil is investing on the development of monitoring tools and protocols in the field of restoration, which so far occurs only at the project level.





### **United Nations**

Climate Change

Framework Convention on

FCCC/TAR/2014/BRA

Distr.: General 1 December 2014

English only

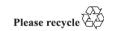
### Summary

This report covers the technical assessment of the submission of Brazil, on a voluntary basis, on its proposed forest reference emission level (FREL), in accordance with decision 13/CP.19 and in the context of results-based payments. The FREL proposed by Brazil covers the activity "reducing emissions from deforestation", which is one of the activities included in decision 1/CP.16, paragraph 70. In its submission, Brazil has developed a subnational FREL for the Amazonia biome, with the aim of transitioning to a national FREL in the future. The assessment team notes that the data and information used by Brazil in constructing its FREL are transparent and complete, and are in overall accordance with the guidelines contained in the annex to decision 12/CP.17. This report contains the assessed FREL and a few areas identified by the assessment team for further technical improvement, according to the scope of the technical assessment in the annex to decision 13/CP.19.

Ministry of the Environment note: This is a reproduction in full of the UNFCCC report, the page numbers had to be altered to follow the sequence of this publication. The modifications made in the original content are strictly design-related. The original report can be found at: http://unfccc.int/resource/docs/2014/tar/bra01.pdf

GE.14-23164 (E)









I. Introduction and summary	113
A. Overview	113
B. Proposed forest reference emission level	114
II. Data, methodologies and procedures used in the construction of the proposed forest reference emission level	116
How each element in the annex to decision 12/CP.17 was taken into account in the construction of the forest reference emission level	116
III Conclusions	124

### I. INTRODUCTION AND SUMMARY

### A. OVERVIEW

- 1. This report covers the technical assessment (TA) of the submission of Brazil on its proposed forest reference emission level (FREL),¹ submitted on 6 June 2014 in accordance with decisions 12/CP.17 and 13/CP.19. The TA took place (as a centralized activity) from 25 to 29 August 2014 in Bonn, Germany, and was coordinated by the UNFCCC secretariat.² The TA was conducted by two land use, land-use change and forestry experts from the UNFCCC roster of experts³ (hereinafter referred to as the assessment team (AT)): Mr. Giacomo Grassi (European Union) and Mr. Walter Oyhantçabal (Uruguay). In addition, Ms. Estefania Ardila Robles, an expert from the Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention, participated as an observer⁴ during the centralized activity in Bonn.
- 2. In response to the invitation by the Conference of the Parties (COP) and in accordance with the provisions of decision 12/CP.17, paragraphs 7–15, and its annex, Brazil submitted its proposed FREL on a voluntary basis. This proposed FREL is one of the elements<sup>5</sup> to be developed in the implementation of the activities referred to in decision 1/CP.16, paragraph 70. The COP decided that each submission of a proposed FREL and/or forest reference level, as referred to in decision 12/CP.17, paragraph 13, shall be subject to a TA in the context of results-based payments, pursuant to decisions 13/CP.19, paragraphs 1 and 2, and 14/CP.19, paragraphs 7 and 8.
- 3. In this context, Brazil underlined that the submission does not modify, revise or adjust in any way the nationally appropriate mitigation actions currently being undertaken by Brazil, nor does it prejudge any nationally determined contribution by Brazil in the context of the Durban Platform for Enhanced Action.
- 4. The objective of this TA was to assess the degree to which information provided by Brazil was in accordance with the guidelines for submissions of information on FRELs<sup>6</sup> and to offer a facilitative, non-intrusive, technical exchange of information on the construction of the FREL, with a view to supporting the capacity of Brazil for the construction and future improvement of FRELs, as appropriate.<sup>7</sup>

The submission of Brazil can be found at <a href="http://unfccc.int/8414">http://unfccc.int/8414</a>>.

<sup>2</sup> Decision 13/CP.19, annex, paragraph 7.

<sup>3</sup> Decision 13/CP.19, paragraphs 7 and 9.

<sup>4</sup> Decision 13/CP.19, paragraph 9.

<sup>5</sup> Decision 1/CP.16, paragraph 71(b).

<sup>6</sup> Decision 12/CP.17, annex.

<sup>7</sup> Decision 13/CP.19, annex, paragraph 1(a) and (b).

- 5. The TA of the FREL submitted by Brazil was undertaken in accordance with the guidelines and procedures for the TA of submissions from Parties on proposed FRELs and/or forest reference levels as contained in the annex to decision 13/CP.19. This report on the TA was prepared by the AT following the guidelines and procedures in the same decision.
- 6. Following the process contained in the guidelines and procedures of the same decision, a draft version of this report was communicated to the Government of Brazil. The facilitative exchange during the TA allowed Brazil to provide clarifications and information that were considered by the AT in the preparation of this report.<sup>8</sup> As a result of the facilitative interactions with the AT during the TA session, Brazil submitted a modified version on 31 October 2014, which took into consideration the technical inputs by the AT. The modifications improved the clarity and transparency of the submitted FREL, without need to alter the approach used to construct the proposed FREL. This TA report was prepared based on the context of the modified FREL submission. The modified submission that contains the assessed FREL and the original submission are available on the UNFCCC website.<sup>9</sup>

### **B.** PROPOSED FOREST REFERENCE EMISSION LEVEL

7. The FREL proposed by Brazil is a dynamic mean of the carbon dioxide  $(CO_2)$  emissions associated with gross deforestation since 1996, updated every five years, using data from the Brazilian National Institute for Space Research (INPE), Ministry of Science, Technology and Innovation, gross deforestation monitoring system. Brazil indicated that a dynamic approach was adopted voluntarily with the aim of incorporating the progress achieved over time with the implementation of policies and measures to reduce deforestation in the Amazonia biome. The FREL presented in the modified submission, with the aim of accessing payments for REDD-plus<sup>10</sup> results from 2006 to 2010, is the mean annual emissions from gross deforestation in the Amazonia biome for the period 1996–2005 and corresponds to 1,106,027,617 tonnes of carbon dioxide (t  $CO_2$ ). For results in the period 2011–2015, the FREL is the mean annual emissions from gross deforestation in the Amazonia biome for the period

B Decision 13/CP.19, annex, paragraphs 1(b), 13 and 14.

<sup>9 &</sup>lt;a href="http://unfccc.int/8414">http://unfccc.int/8414</a>>.

<sup>10</sup> REDD-plus refers to the five activities in decision 1/CP.16, paragraph 70: reducing emissions from deforestation, reducing emissions from forest degradation, conservation of forest carbon stocks, sustainable management of forests and enhancement of forest carbon stocks in developing countries.

This figure has been modified from the one in the original submission based on the technical exchange of information between Brazil and the AT. This modified figure was provided to the AT during the assessment session in Bonn. See figure 9 and table 1 of the modified FREL submission.

1996–2010, and corresponds to 907,959,466 t  $\rm CO_2$ . The entire time series 1996–2010 and the mean emissions from gross deforestation in the Amazonia biome are presented in table 1 of the modified submission and were considered in the TA.

- 8. In decision 1/CP.16, paragraph 70, the COP encourages developing country Parties to contribute to mitigation actions in the forest sector by undertaking a number of activities, as deemed appropriate by each Party and in accordance with their respective capabilities and national circumstances, in the context of the provision of adequate and predictable support. The FREL proposed by Brazil, on a voluntary basis, for a TA in the context of results-based payments, covers the activity "reducing emissions from deforestation", which is one of the five activities included in paragraph 70 of this decision. Pursuant to paragraph 71(b) of the same decision, Brazil has developed a subnational FREL (for the Amazonia biome) with the aim of transitioning to a national FREL in the future, incorporating all biomes in the country. According to the submission, the Amazonia biome covers 4,197,000 km2, corresponding to almost half (49.29 per cent) of the national territory, and is responsible for 50.8 per cent of the net CO2 emissions of Brazil in 2010 (second national communication of Brazil, 2010<sup>13</sup>). In this submission, Brazil applies a step-wise approach to its development of the FREL, in accordance with decision 12/CP.17, paragraph 10. The step-wise approach enables Parties to improve the FREL by incorporating better data, improved methodologies and, where appropriate, additional pools.
- 9. The proposed FREL includes the pools "above-ground biomass", "below-ground biomass" and "litter", while "dead wood" and "soil organic carbon" are not included. Regarding greenhouse gases (GHGs), the submission includes CO2.
- 10. The annex to the modified submission was not subject to the TA and includes preliminary information on the ongoing work on the development of FRELs for other activities and biomes: (i) forest degradation in the Amazonia biome (annex III of the modified FREL submission) and (ii) Cerrado and Mata Atlântica biomes (annex IV of the modified FREL submission).

<sup>12</sup> See previous footnote.

At the time of the TA, the second national communication of Brazil to the UNFCCC was the latest available. The second national communication can be found at <a href="http://unfccc.int/2979">http://unfccc.int/2979</a>>.

## II. DATA, METHODOLOGIES AND PROCEDURES USED IN THE CONSTRUCTION OF THE PROPOSED FOREST REFERENCE EMISSION LEVEL

## HOW EACH ELEMENT IN THE ANNEX TO DECISION 12/CP.17 WAS TAKEN INTO ACCOUNT IN THE CONSTRUCTION OF THE FOREST REFERENCE EMISSION LEVEL

## 1. Information that was used by the Party in the construction of the forest reference emission level

11. For the construction of the FREL of the Amazonia biome, Brazil used the methodology provided in the 2003 Intergovernmental Panel on Climate Change *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF) as a basis for estimating changes in carbon stocks in forest land converted to other land-use categories. Accordingly, the gross emissions from deforestation were estimated from 1996 onwards by combining activity data (i.e. the area of annual gross deforestation) with the appropriate emission factors (i.e. CO2 emissions associated with the corresponding forest type).

12. The activity data used for the construction of the FREL in the Amazonia biome were based on a historical time series from INPE. Through PRODES.<sup>14</sup> INPE has been assessing annual gross deforestation<sup>15</sup> in the Legal Amazonia<sup>16</sup> since 1988 using Landsat-class satellite data on a wallto-wall basis, with a minimum mapping unit of 6.25 ha. The areas included in the Legal Amazonia but not in the Amazonia biome (i.e. areas from the Cerrado and Pantanal biomes) were excluded from the construction of the FREL. Activity data (area deforested) are available in analogue format until 1997 and in digital format from 1998 onwards. Only since 2001 are data in digital format available annually. No ground truth was required for the Amazonia biome owing to the unequivocal identification of the clearcut patches. In response to technical input by the AT, Brazil clarified that gross deforestation under cloud-covered areas has been estimated, so as not to under- or overestimate deforestation in any particular year, by using an approach (adjusted deforestation increment) that evenly distributes the area of the deforestation polygons observed in the satellite image for the first time over previously cloud-covered areas over the year of the observation and all previous year(s) with persistent cloud cover in the same area.

13. With regard to the emission factors, the carbon stock of the different forest types in the Amazonia biome was estimated by combining sample-plot information (i.e. circumference at breast height (CBH)) from

PRODES is the gross deforestation monitoring programme in Amazonia; <www.obt.inpe.br/prodes>.

<sup>15</sup> Brazil considers as deforestation any clear cut in areas of primary forests.

<sup>16</sup> According to the submission, the Legal Amazonia (5,217,423 km2) is 24.3 per cent bigger than the Amazonia biome.

RADAMBRASIL,<sup>17</sup> with various equations<sup>18</sup> to convert CBH into total carbon stock in living biomass (above and below ground, including palms and vines and small trees) and litter. Country-specific data for the water content in fresh biomass and carbon content in dry matter, as well as carbon in litter, vines and palms, were also used. Based on this information, and complemented by data from the literature,<sup>19</sup> a carbon density map including 22 different forest types was constructed. Brazil assumed that the biomass immediately after forest conversion was zero and did not consider any subsequent CO<sub>2</sub> removal after deforestation.

14.To estimate annual emissions from deforestation, the following procedure was applied: the area of each deforested polygon under a certain forest type and RADAMBRASIL volume was multiplied by the emission factor (i.e. carbon density in tonnes of carbon per hectare (t C/ha)) of the corresponding forest type and RADAMBRASIL volume and by 44/12 (to convert carbon into CO2). Then, for each year, the emissions from all the areas deforested were summed up. An adjustment was applied to consider deforestation under clouds.

# 2. Transparency, completeness, consistency and accuracy of the information used in the construction of the forest reference emission level

## Methodological information, including description of data sets, approaches and methods

15.The construction of the FREL in the Amazonia biome was based on a historical time series of gross deforestation developed by INPE for the Legal Amazonia. Maps and estimates of gross deforestation since 2003 are available on the INPE website. According to Brazil's modified submission, the deforestation areas for the Legal Amazonia have been obtained from PRODES and "adjusted to consider only deforestation within the Amazonia biome". In assessing the extent to which the FREL is consistent with the information and descriptions provided by the Party, the AT compared the time series of deforestation in the FREL (for the Amazonia biome) with PRODES deforestation rate data (for the Legal Amazonia) available on the INPE website and in figure a.2 of annex 1 of the FREL submission. Based on this comparison, it was noted that for several years (1996–2003 and 2005), gross deforestation in the Amazonia biome, which is a subset area of the Legal Amazonia, was larger than that in the whole of the Legal Amazonia.

<sup>17</sup> The RADAMBRASIL project, conducted between 1970 and 1985, collected geo-referenced data from 2292 sample plots, including CBH and height of all trees above 100 cm in CBH.

<sup>18</sup> Equations 5 to 9 in the modified FREL submission.

<sup>19</sup> Refer to table 5 in the modified submission for literature and references consulted.

<sup>20 &</sup>lt;a href="http://www.obt.inpe.br/prodes/index.php">http://www.obt.inpe.br/prodes/index.php</a>>.

16.In response to this observation. Brazil clarified that in the period 1996–2010, emissions from deforestation in the Legal Amazonia were approximately 4 per cent higher than in the Amazonia biome. Furthermore, in the modified submission, Brazil's clarification on this difference in the data sets was that there were several approaches for estimation of the areas deforested and the associated emissions from gross deforestation. While data from PRODES express the "rate" of gross deforestation (adjusting for cloudcovered areas and reference satellite imagery dates), the FREL submission introduces a different approach based on adjusted gross deforestation "increment", which adjusts for cloud cover. As explained in the modified submission of the FREL (box 2), the main differences between "deforestation rates" and "adjusted deforestation increments" are the temporal observation window and a different procedure for cloud correction. As a result, for single years, an estimate of deforestation based on adjusted increments may be higher or lower than the deforestation estimated based on the rate. Brazil clarified that the use of adjusted deforestation increments to estimate emissions from gross deforestation provides a more accurate, verifiable figure for the deforested area through time, as the analysis is carried out retrospectively, and deforestation increments can be redistributed over time. The AT notes the effort made by Brazil to improve the cloud correction of the activity data. The AT considers that the additional information provided by Brazil in the modified submission considerably increases the transparency of the proposed FREL and clarifies the difference between FREL and PRODES data.

17. Digital deforestation maps are used to enable association of each deforestation polygon with the carbon stocks of the corresponding forest type. According to the FREL submission, digital information on deforestation is available only from 1998 onwards (aggregated for the period 1998-2000, and on a yearly basis thereafter), while data for 1996 and 1997 are only available in analogue format. To overcome this limitation in the data (i.e. to combine the correct emission factor with certain activity data), Brazil assigned the average emissions of the period 1998-2000 to the years 1996 and 1997. According to the FREL submission, 1996 was selected as the starting year for the FREL, in order to leave out the high deforestation that occurred in 1995 and also to maintain consistency with other initiatives and policies in Brazil. The AT notes that information provided for the years 1996 and 1997 is less accurate (as the data were not based on measured data) and less consistent over the time series compared to the time series constructed from 1998 onwards. In response to this observation, Brazil indicated that it is seeking to complete the annual digital time series with data from

1996 to 2000, and that this will improve the accuracy of the estimates provided in the submission for the years 1996 and 1997,<sup>21</sup> as well as for the individual years 1998, 1999 and 2000. Overall, the AT considers that a better estimation of deforestation estimates for the years 1996–1997 (i.e. through the digitalization of the deforestation maps) is an area for future technical improvement. Alternatively, in future FREL submissions, Brazil could provide information showing that the current estimates for 1996–1997, as assessed in this report, are conservative.

18. In addition, the AT sought a number of clarifications on the estimation of activity data from Brazil. The most important were:

- Brazil's submission specified that the minimum mapped (a) deforestation area was 6.25 ha, but little information was provided on the rationale behind this value and on possible underestimation of emissions from deforestation (i.e. for deforested areas below this threshold). In the modified FREL submission (box 1, annex I), Brazil explained that in 1988, PRODES started to map deforestation over hard copy prints of Landsat images at the 1:250,000 scale. The minimum mapping unit was defined as 1 mm2, which is equivalent to 6.25 ha on the surface. The digital PRODES data maintained this threshold to ensure consistency of the time series. Since 2008, the small deforestation patches under the minimum mapping area are monitored by INPE, and are retrieved later by PRODES if they evolve into an area larger than 6.25 ha. The AT commends Brazil for the effort and encourages Brazil to continue monitoring small deforestation events and to provide information on the extent of deforestation areas that are not retrieved later by PRODES, with the aim of showing that no significant deforestation is excluded from the FREL;
- (b) In response to a request for clarification by the AT, in the modified FREL submission, Brazil clarified that PRODES considers deforestation not only as the clear cuts in "intact" primary forest, but also as the clear cuts in areas of primary forest that may have been previously subjected to a process of degradation (e.g. selective logging). The emissions from deforestation of these areas are estimated using the same carbon map. The AT notes that the carbon density of the areas previously subjected to selective logging is likely to be lower than the carbon density of corresponding intact primary forests. As a consequence, the AT notes that for these areas the emission estimates used in the construction of the FREL include both the emissions from deforestation (clear cuts) and the emissions from degradation processes that occurred previously. The AT acknowledges the complexity of separating emissions between the two activities. Furthermore, the modified FREL submission clarified that

the extent of degraded area that is subsequently deforested is small (see table b.1 in annex III of the modified FREL submission). The AT notes that, whenever emissions from degradation are included in future FREL submissions, Brazil will have to define a methodology to avoid double counting of emissions reported under degradation and deforestation;

(c) In response to a question from the AT, Brazil clarified that the deforestation of secondary forests (i.e. areas previously detected as deforested by PRODES (at any point in time since 1988) and which subsequently regained tree cover) is not included in the FREL. Landuse dynamics, including secondary vegetation, is tracked by a separate project by INPE (TerraClass<sup>22</sup>). According to Brazil, the rationale for not including these emissions in the FREL submission is that gains and losses should balance out in these areas (i.e. both the emissions from deforestation of secondary forests and any removals associated with the forest regrowth are excluded from the FREL, owing to the dynamics of secondary forests in Brazil). The modified FREL submission (box 1) clarified that approximately 20 per cent of the land deforested is abandoned to regrowth (i.e. secondary forests), and that deforestation of areas other than primary forest represents a marginal contribution (1.57) per cent) to the total emissions from deforestation. The AT commends Brazil for providing this information.

19. The AT notes that the "carbon map" used in the FREL, based on the RADAMBRASIL database combined with an allometric equation (to relate above-ground fresh biomass to carbon densities), represents a significant effort aimed at recognizing the heterogeneity in carbon densities within the Amazonia biome, and commends Brazil for this. Nevertheless, the AT noted that: (i) table 4 of the FREL submission (i.e. carbon densities in different forest types and volumes) shows some apparent inconsistencies<sup>23</sup> and (ii) the allometric equation used was not developed for the entire Amazonia, and hence it could not be completely representative of all areas.

20.In response to these observations, Brazil explained that the apparent inconsistencies in the carbon map are partly associated with the specific circumstances of the region (e.g. soil types, climatic conditions and flood regimes), and noted that the widely used RADAMBRASIL database is the best information available. Furthermore, Brazil indicated that the carbon map can be expected to improve in the future (e.g. with the new data from the first national forest inventory of Brazil, estimated to be finalized by 2017). Overall, the AT commends Brazil for the information

<sup>22 &</sup>lt;a href="http://www.inpe.br/cra/ingles/project\_research/terraclass2010.php">http://www.inpe.br/cra/ingles/project\_research/terraclass2010.php</a>>.

For example: (i) the carbon densities of the forest types "La" (forested campinarana) and "Ld" (wooded campinarana), typically associated with a rather low or open vegetation, appear very high and (ii) in some cases, for a given volume, an "open" forest type has a higher carbon density than the corresponding "dense" forest type.

provided in the revised FREL submission on ongoing efforts to estimate carbon densities, including detailed information on uncertainties. The AT commends Brazil for continuing to work on updating and improving the carbon map, noting it as an area for future technical improvement.

21. The AT noted that the emission factors used varied along the time series. To understand the reason for this variation, the AT asked Brazil to provide information on annual deforestation area by forest type. In response to this request, Brazil provided a very detailed example for the year 2003 (in annex II of the modified FREL submission) showing how emissions from deforestation were calculated. This example includes data on deforestation areas by forest type, RADAMBRASIL volume and the associated carbon densities. The AT commends Brazil for this huge effort. The AT also notes that providing basic information on deforestation area (e.g. by forest type only) for all years would further improve the transparency and reproducibility of future FREL submissions.

22.In addition, the AT considers that the information provided in the modified FREL submission on "verification activities" performed (e.g. comparison of the carbon map with data from the scientific literature) is useful, because it helps to build confidence in the estimated emissions.

### Description of relevant policies and plans, as appropriate

23.As the proposed FREL is based entirely on historical data, no assumptions about future changes to domestic policies have been included in the FREL submission. Annex I, section II, of the submission provides a description of the Action Plan for the Prevention and Control of Deforestation in the Legal Amazonia.

## 3. Pools, gases and activities included in the construction of the forest reference emission level

24.According to decision 12/CP.17, subparagraph (c) of the annex, reasons for omitting a pool and/or activity from the construction of the FREL should be provided, noting that significant pools and/or activities should not be excluded.

25. The pools included in the FREL are those that were available from the construction of the carbon map that used information from RADAMBRASIL. These pools are living biomass (above and below ground) and litter. Dead wood and soil organic carbon were not included.

26. Changes in soil carbon can be significant when forest land is converted to grassland or cropland. Brazil explained in its submission that it does not have data on the dynamics of forest conversion for all years in the period considered in the FREL. However, Brazil mentioned two sources of information that were used as proxies to estimate the fate of soil carbon during forest conversion to other uses. First is the GHG inventory included in Brazil's second national communication (2010),<sup>24</sup> which includes data from a spatially explicit database for conversion to other lands from 1994 to 2002 per biome, including the Amazonia. This source shows clearly that the main conversion in this period was from forest land to grassland (88.5 per cent). The second source of information is TerraClass, which estimated forest transitions for 2008 and 2010, according to which, the dominant conversion for 2008 and 2010 is again from forest land to grassland (approximately 80 per cent). Given this information, Brazil carried out a literature review<sup>25</sup> to assess the impact of forest conversions to pasture on soil organic carbon stocks. This literature review indicates that, while generally there is a loss of carbon after the first years of conversion, the subsequent trend is strongly influenced by pasture management, with carbon levels under pasture being lower, similar to or even higher than those under native forests. The soil depth and the timespan considered also influence this analysis. The conclusion by Brazil is that the available literature has limitations and may not be representative of many situations that might occur in the Amazonia biome. Brazil will intensify efforts to better understand the dynamics of carbon in soils after conversion, including expanding the literature review and stimulating new research, bearing in mind that changes may not occur rapidly after the conversion and that they are dependent on pasture management. The AT considers that the exclusion of soil organic carbon is adequately justified by Brazil and commends the efforts to obtain better information on this pool in the future, with the aim of including it as part of the step-wise approach.

27.Regarding emissions from organic soils, in the modified FREL submission, Brazil provided information on the distribution of main soil types in the Amazonia basin. It was noted that no histosols were present. The AT concludes that emissions from organic soils when gross deforestation occurs are likely to be insignificant and their non-inclusion is justified.

28. With regard to emissions from dead wood, the AT requested clarification on the reasons for the omission of this pool. In response to this question, in its modified submission, Brazil explained that the rationale

<sup>24</sup> Refer to footnote 13 for web link to the second national communication.

<sup>25</sup> Refer to the modified submission for the literature on this matter cited by Brazil.

behind the non-inclusion of this pool was based on the consideration that emissions from dead wood are not avoided when deforestation is reduced, as they are part of the natural process of decomposition (i.e. "the issue is related only to the time when the emissions are released"). The AT considers that when deforestation occurs, there are emissions from dead wood to the atmosphere that would need to be estimated. Furthermore, the AT notes that the IPCC good practice guidance for LULUCF provides a method for estimating carbon stock changes in dead wood (refer to chapter 3.4.1.2.1 for forest land converted to grassland: dead wood "should be assumed oxidized following land conversion") and the corresponding default emission factor (refer to table 3.2.2: 18.2 t C/ha for dead wood stock in tropical forests). The AT considers the treatment of emissions from dead wood (i.e. the inclusion of this pool or the provision of more information justifying its omission) as an area for future technical improvement of the FREL.

29. The FREL includes CO2 emissions. Brazil explained in its submission that emissions from gases other than  ${\rm CO_2}$  (non- ${\rm CO_2}$  gases) in the Amazonia biome are normally associated with the recurrent burning of tree residues left on the ground after deforestation activities. The exclusion of non-CO2 gases is justified by Brazil as a means to be conservative, because a decrease of deforestation is associated with a decrease of non- ${\rm CO_2}$  gases. Brazil indicated that it may revisit this approach if it considers that the data available are reliable and consistent. In addition, in box 7 of the modified FREL submission, Brazil provides information on available estimates of non-CO2 gases associated with pasture establishment. The information in box 7 shows that there are activity data of burned pastures at least for the period 2002–2008 and emission estimates for the period 2003–2008. The AT considers the treatment of non-CO2 gases as an area for future technical improvement to maintain consistency with the GHG inventory included in the national communication.

30. Brazil provided information on forest degradation in annex 2 of the original FREL submission; this was for information purposes as degradation was not included in the FREL. The AT commends Brazil for sharing this information in the annex. Noting that the annex is for information purposes and not part of the assessment, the AT observed that the value of emissions from degradation shown in figure b.2 in the annex is expressed in carbon and not CO2 (i.e. values should be multiplied by 44/12). This was corrected in Brazil's modified FREL submission (Annex III, figure b.3). As a consequence, for the period 2007–2010, the emissions associated with degradation in the Amazonia biome in the modified submission correspond to approximately 59 per cent of the emissions from deforestation.

<sup>26</sup> In addition, the GHG inventory included in the second national communication reports non-CO2 GHG emissions from biomass burning after forest conversion to agricultural uses for the period 1990–2005.

31. The AT acknowledges that Brazil included the most significant activity (reducing emissions from deforestation) of the five activities identified in paragraph 70 of decision 1/CP.16, in accordance with national capabilities and circumstances. The AT notes that other activities could also be significant in the Amazonia biome, in particular, degradation (see para, 30 above). According to Brazil, the time series available for degradation is too short to allow adequate understanding of the degradation process. The AT notes that, based on the data currently available, degradation trends are not uniform; but overall, for the Amazonia biome, there has been a decreasing trend in forest degradation in recent years. Furthermore, according to Brazil, the increase in degradation in specific years (e.g. in 2008 and 2011; see figure b.1 in annex III of the modified FREL submission) may be associated with very dry conditions in the previous year. Overall, based on the available information (figure b.3 in annex III of the modified FREL submission), for the entire Amazonia biome, there is no clear evidence that a decrease in deforestation is associated with an increase in degradation. Therefore, the AT notes that the current exclusion of degradation from the FREL appears to be conservative. Overall, the AT commends Brazil for the information provided in annex III of the modified FREL submission, which is already a good starting point for understanding the dynamics of degradation, and for the continuous process in place to improve the quality of these estimates. The AT acknowledges the intention expressed by Brazil to: (i) continue monitoring forest degradation to assess whether the reduction of deforestation is leading to an increase in forest degradation activities (displacement of emissions) and (ii) include emissions from degradation in future FREL submissions when new, adequate data and better information become available.

### 4. Definition of forest

32.Brazil provided in its submission the definition of forest used in the construction of the FREL. This definition is the same as the one that the Party uses in its national GHG inventory (i.e. minimum area of 0.5 ha, height of 5 m or more and at least 10 per cent canopy cover).

### III. CONCLUSIONS

33. The information used by Brazil in constructing its FREL for deforestation in the Amazonia biome is transparent and complete and is in overall accordance with the guidelines for submission of information on FRELs (as contained in the annex to decision 12/CP.17).

34. The AT acknowledges that Brazil included in the FREL the most significant activity, the most important biome and the most significant

pools in terms of emissions from forests. In doing so, the AT considers that Brazil followed decision 1/CP.16, paragraph 70, on activities undertaken, paragraph 71(b), on elaboration of a subnational FREL as an interim measure, and decision 12/CP.17, paragraph 10, on implementing a stepwise approach. The AT commends Brazil for the information provided on the ongoing work into the development of FRELs for other activities, as well as for other biomes as steps towards a national-level FREL.

35.As a result of the facilitative interactions with the AT during the TA session, Brazil submitted a modified submission that took into consideration the technical inputs by the AT. The AT notes that the transparency and completeness of information improved significantly in the modified FREL submission, without the need to alter the approach or values used to construct the FREL, and commends Brazil for the efforts made. The new information provided in the modified submission, including through the data made available on websites<sup>27</sup> and the examples on how estimates of  $\mathrm{CO}_2$  emissions from deforestation were calculated, increased the reproducibility of FREL calculations.

36. The AT notes that, overall, the FREL maintains consistency, in terms of sources for the activity data and the emission factors, with the GHG inventory included in Brazil's national communication. <sup>28</sup>

37. Pursuant to paragraph 3 of the annex to decision 13/CMP.19, the AT identified the following areas for future technical improvement:

- (a) Digitalization of deforestation maps: it was noted that estimates of deforestation for the years 1996–1997 are less accurate than the rest of the time series. The AT considers that a better estimation of estimates for the years 1996–1997 may be achieved through digitalization of the deforestation maps;
- (b) Continuation of improvement of the carbon map: the AT acknowledges the significant efforts made thus far by Brazil to assess the spatial distribution in carbon densities in the Amazonia biome and commends Brazil for continuing to work on updating and improving the carbon map based on new and improved ground data from its first national forest inventory.

38.In assessing the pools and the gases included in the FREL, pursuant to paragraph 2(f) of the annex to decision 13/CP.19, the AT notes that the current omissions of pools and gases is likely to be conservative in the context of the FREL. Nevertheless, the AT identified the following additional areas for future technical improvement:

<sup>27</sup> See the modified FREL submission for the websites referred to by Brazil.

<sup>28</sup> In reference to the scope of the TA, decision 13/CP.19, annex, paragraph 2(a).

- (a) Treatment of emissions from dead wood (i.e. the inclusion of this pool or the provision of more information on the justification of its omission);
- (b) Treatment of non-CO2 gases, to maintain consistency with the GHG inventory included in the national communication.

39.In assessing the activities included in the FREL<sup>29</sup>, the AT considers that degradation is a significant activity based on the estimates provided by Brazil. The justification provided by Brazil to omit this activity is that the time series available is too short to allow an adequate understanding of the degradation process. Based on the available information, the AT notes that, so far, there is no evidence of displacement of emissions (i.e. decreased deforestation in the Amazonia biome resulting in increasing degradation). In addition, the AT notes that the current exclusion of degradation appears to be conservative in the context of constructing the FREL. Overall, the AT considers better understanding of the relationship between degradation and deforestation as an area for future technical improvement of the FREL. The AT notes that, when emissions from degradation are included in the FREL. Brazil will need to demonstrate how double counting of emissions included under degradation and deforestation is avoided (e.g. for forests that were subject to selective logging and subsequently clear cut).

40. The AT acknowledges and welcomes the intention expressed by Brazil to:

- (a) Continue monitoring degradation, in order to assess whether the reduction of deforestation is leading to the displacement of emissions, and to include emissions from degradation in future FREL submissions when new, adequate data and better information become available;
- (b) Extend the FREL to other biomes, as a part of efforts to move towards a national FREL;
- (c) Continue the ongoing efforts on monitoring complex forest cover change dynamics in the Amazonia biome (including forest regrowth, deforestation of secondary forest and deforestation of previously degraded areas) and of small deforestation events, with the aim of showing that no significant deforestation area is excluded in future FREL submissions.

41.In conclusion, the AT commends Brazil for showing a strong commitment to continuous improvement of its FREL estimates, in line with the step-wise approach. A number of areas for future technical improvements of Brazil's FREL have been identified in this report. At the same time, the AT acknowledges that these improvements are subject to national capabilities and policies, and notes the importance of adequate and predictable support<sup>30</sup>. The AT also acknowledges that the assessment process was an opportunity for a rich, open, facilitative and constructive technical exchange of information with Brazil.

Decision 13/CP.19, annex, paragraph 1(b), and decision 12/CP.17, paragraph 10.



### **Coordination:**

Ministry of the Environment (MMA)

Ministry of Science, Technology and Innovation (MCTI)

### Working Group of Technical Experts on REDD+:

Leticia Guimarães, Ministry of the Environment (MMA)

Alexandre Santos Avelino, Ministry of the Environment (MMA)

Monique Sacardo Ferreira, Ministry of the Environmen (MMA)

Thelma Krug, Ministry of Science, Technology and Innovation, National Institute for Space Research (MCTI/INPE)

Dalton de Morisson Valeriano, Ministry of Science, Technology and Innovation, National Institute for Space Research (MCTI/INPE)

Luis Eduardo Pinheiro Maurano, Ministry of Science, Technology and Innovation, National Institute for Space Research (MCTI/INPE)

Alberto Waingort Setzer, Ministry of Science, Technology and Innovation, National Institute for Space Research (MCTI/INPE)

Jean Pierre Henry Balbaud Ometto, Ministry of Science, Technology and Innovation, National Institute for Space Research (MCTI/INPE)

Niro Higuchi, Ministry of Science, Technology and Innovation, National Institute of Amazon Research (MCTI/INPA)

Philip Martin Fearnside, Ministry of Science, Technology and Innovation, National Institute of Amazon Research (MCTI/INPA)

Adriana dos Santos Siqueira Scolastrici, Foundation of Space Science, Applications and Technology (FUNCATE)

Ricardo Ribeiro Rodrigues, Luiz de Queiroz College of Agriculture (ESALQ), University of São Paulo (USP)

Edson Eyji Sano, Ministry of the Environment, Brazilian Institute of the Environment and Renewable Natural Resources (MMA/IBAMA)

Joberto Veloso de Freitas, Ministry of the Environment, Brazilian Forest Service (MMA/SFB)

Laerte Guimarães Ferreira Jr., Federal University of Goiás (UFG)

Rosana Clara Victória Higa, Ministry of the Agriculture, Livestock and Supply, Brazilian Enterprise for Agricultural Research (MAPA/EMBRAPA)

Heloisa Aparecida Belleza Ferreira, Ministry of the Agriculture, Livestock and Supply, Brazilian Enterprise for Agricultural Research (MAPA/EMBRAPA)

Heloísa Sinátora Miranda, University of Brasilia (UnB)

Mercedes Maria da Cunha Bustamante, Rede Clima

## TABLE OF CONTENTS

1. Introduction	131
Summary of information from the final report of the FREL for reducing emissions from deforestation in the Amazonia biome	132
3. Results in tonnes of CO2eq per year, consistent with the assessed FREL for the Amazonia biome	135
4. Demonstration that the methodologies used to produce the results are consistent with those used to establish the assessed FREL	137
5. A description of national forest monitoring systems and the institutional roles and responsibilities for measuring, reporting and verifying the results	137
5.1. The Amazonian Gross Deforestation Monitoring Project – PRODES	137
5.2. Roles and responsibilities for measuring, reporting and verifying (MRV) the results	148
6. Necessary information that allows for the reconstruction of results	149
7. A description of how the elements contained in Decision 4/ CP.15, paragraph 1(c) and (d), have been taken into account	150
7.1. To use the most recent IPCC guidance and guidelines	150
7.2. To establish, according to national circumstances and capabilities, robust and transparent national forest monitoring systems	150

### 1. INTRODUCTION

Brazil welcomes the opportunity to submit a Technical Annex to its Biennial Update Report (BUR) in the context of results-based payments for *reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries* (REDD+) under the United Nations Framework Convention on Climate Change (UNFCCC).

Brazil underlines that the submission of this Technical Annex with REDD+ results is voluntary and exclusively for the purpose of obtaining and receiving payments for REDD+ actions, pursuant to Decisions 13/CP.19, paragraph 2, and 14/CP.19, paragraphs 7 and 8<sup>1</sup>.

This submission, therefore, does not modify, revise or adjust in any way the nationally appropriate mitigation actions (NAMAs) currently being undertaken by Brazil pursuant to the Bali Action Plan (FCCC/AWGLCA/2011/INF.1), neither prejudges any nationally determined contribution (NDC) by Brazil in the context of the protocol, another legal instrument or an agreed outcome with legal force under the Convention currently being negotiated under the Ad Hoc Working Group on the Durban Platform for Enhanced Action.

This submission was developed by the Brazilian government with the support of the Working Group of Technical Experts on REDD+, created in February 2014 by the Ministry of the Environment of Brazil (MMA) through the Ministerial Ordinance No. 41.

This Technical Annex presents the results from reducing emissions from deforestation in the Amazonia biome, measured against the forest reference emission level (FREL) presented by Brazil to the UNFCCC in June 2014<sup>2</sup>. Brazil's FREL submission went through a technical assessment from July to November of 2014 by two LULUCF experts appointed by the UNFCCC Secretariat. Brazil's final FREL and the report of the technical assessment can be found at the UNFCCC REDD web platform (http://unfccc.int/methods/redd/items/8414.php).

This Technical Annex for REDD+ was developed following the guidelines of Decision14/ CP. 19 and contains the following elements:

- 1. Summary of information from the final report containing each corresponding assessed forest reference emission level;
- 2. Results in tonnes of CO<sub>2</sub>eq per year, consistent with the assessed FREL;
- 3. Demonstration that the methodologies used to produce the results are consistent with those used to establish the assessed FREL;
- 4. A description of national forest monitoring systems and the institutional roles and responsibilities for measuring, reporting and verifying the results;

Decision 14/ CP 19, paragraph 7, "requests developing country Parties seeking to obtain and receive payments for results-based actions, when submitting the data and information referred to in paragraph 3 above, through the biennial update reports, to supply a technical annex as per decision 2/CP.17, annex III, paragraph 19". Paragraph 8, "underlines that the submission of the technical annex referred to in paragraph 7 above is voluntary and in the context of results-based payments".

<sup>2</sup> For more information see: http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information, last accessed on November 19th, 2014.

- 5. Necessary information that allows for the reconstruction of results;
- 6. A description of how the elements contained in Decision 4/ CP.15, paragraph 1(c) and (d), have been taken into account<sup>3</sup>.

The elements of Brazil's Technical Annex for REDD+ are presented below.

## 2. SUMMARY OF INFORMATION FROM THE FREL FOR REDUCING EMISSIONS FROM DEFORESTATION IN THE AMAZONIA BIOME

Brazil's FREL, submitted on a voluntary basis for a technical assessment in the context of results based payments, covers the activity 'reducing emissions from deforestation" in the Amazonia biome<sup>4</sup>, the most significant of the five activities included in paragraph 70 of Decision 1/CP.16.

Brazil applied a step-wise approach to the development of its FREL, in accordance with Decision 12/CP.17, paragraph 10, and has presented a subnational FREL with the aim of transitioning to a national FREL in the future, by incorporating other biomes and activities. The step-wise approach enables Parties to improve the FREL by incorporating better data, improved methodologies and, where appropriate, additional pools.

Brazil used the 2003 Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance for Land Use, Land-use Change and Forestry as a basis for estimating changes in carbon stocks from forest land converted to other land-use categories.

Accordingly, the gross emissions from deforestation were estimated from 1996 onwards by combining activity data (i.e. the area of annual gross deforestation per forest type considered) with the appropriate emission factor (i.e. carbon densities associated with the forest types considered). Regarding the pools, the submission considers aboveground biomass, belowground biomass and litter. Dead wood and soil organic carbon (for mineral and organic soils) were not considered to be significant sources. Regarding greenhouse gases, the submission includes gross CO<sub>2</sub> emissions.

The basis for the activity data used in the construction of the FREL for the Amazonia biome was the historical time series from the National Institute for Space Research (INPE), Ministry of Science, Technology and Innovation (MCTI). INPE, through the Amazonian Gross Deforestation Monitoring Project — PRODES, has been assessing annual gross deforestation in the Legal Amazonia since 1988 using Landsat-class satellite data on a wall-to-wall basis, with a minimum mapping unit of 6.25 hectares. The areas from the Cerrado and Pantanal biome in the Legal

Decision 4/ CP.15, paragraph 1, "requests developing country Parties, on the basis of work conducted on the methodological issues set out in decision 2/CP.13, paragraphs 7 and 11, to take the following guidance into account for activities relating to decision 2/CP.13, and without prejudging any further relevant decisions of the Conference of the Parties, in particular those relating to measurement and reporting: (c) To use the most recent Intergovernmental Panel on Climate Change guidance and guidelines, as adopted or encouraged by the Conference of the Parties, as appropriate, as a basis for estimating anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes; (d) To establish, according to national circumstances and capabilities, robust and transparent national forest monitoring systems and, if appropriate, sub-national systems as part of national monitoring systems that: (i) Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes; (ii) Provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities; (iii) Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties."

<sup>4</sup> The Amazonia biome covers 4,197,000 km2, corresponding to almost half (49.29 per cent) of the territory, and is responsible for 50.8 percent of the national net CO2 emissions of Brazil in 2000 (Second National Communication, BRASIL, 2010).

Amazonia were excluded from the construction of the FREL. Data on deforestation are available in analogue format until 1997 and in digital format from 1998 onwards.

With regard to the emission factors, the carbon density associated with the different forest types in the Amazonia biome were estimated by combining sample-plot information from RADAMBRASIL, with various equations to convert circumference at breast height (CBH) into total carbon stock in living biomass (above and below-ground) and litter. Based on this information, and complemented by data from the literature, a carbon density map including 22 different forest types was constructed. Brazil assumed that the biomass immediately after the forest conversion to other land uses is zero and does not consider any subsequent CO<sub>2</sub> removal after deforestation.

To estimate annual emissions from deforestation, the following procedure was applied: the area of each deforested polygon under a certain forest type was multiplied by the emission factor (i.e. carbon density in tonnes C/ha) of the corresponding forest type and by 44/12 (to convert carbon into  $CO_2$ ). Then, for each year, the emissions from all the areas deforested were summed up.

Brazil's FREL is a dynamic mean of the CO<sub>2</sub> emissions associated with gross deforestation since 1996, updated every five years, using the best available historical data and consistent with the most recent National GHG Inventory submitted by Brazil to the UNFCCC at the time of the construction of the FREL.

This base year was chosen by the Working Group of Technical Experts on REDD+ so as to leave out the high deforestation peak in 1995 and also to maintain consistency with other initiatives in Brazil, including the Action Plan to Prevent and Control Deforestation in the Legal Amazonia (PPCDAm)<sup>5</sup>, the National Climate Change Policy<sup>6</sup> and the Amazon Fund<sup>7</sup>.

The dynamic nature of Brazil's FREL is meant to reflect the effects of policies and plans implemented in the Amazonia biome, as well as improvements in data quality and availability.

### Brazil's FREL does not include assumptions on potential future changes to domestic policies.

In summary, for results based payments the following applies:

- For results obtained in the period from 2006 to 2010, inclusive, the FREL is equal to the mean annual CO<sub>2</sub> emissions associated with gross deforestation (calculated as adjusted deforestation increment) from the period 1996 to 2005, inclusive (refer to *Figure 1* and *Table 1*).
- For results obtained in the period from 2011 to 2015, inclusive, the FREL is equal to the mean annual CO<sub>2</sub> emissions associated with gross deforestation (calculated as adjusted deforestation increment) from 1996 to 2010, inclusive (refer to *Figure 1* and *Table 1*).

For results obtained in the period from 2016 to 2020, the FREL is equal to the mean annual CO<sub>2</sub> emissions associated with gross deforestation (calculated as adjusted deforestation increment) from 1996 to 2015, inclusive.

For details regarding relevant policies and plans for the Amazonia biome see: http://www.mma.gov.br/redd/index.php/en/environmental-policies-related-to-redd/deforestation-reduction, last accessed on November 19th, 2014.

For more information on the Presidential Decree no. 7390 of December 9, 2010 see: http://www.planalto.gov.br/ccivil\_03/\_Ato2007-2010/Decreto/D7390.htm, last accessed on September 18th, 2014.

<sup>7</sup> For more information on the Amazon Fund see: www.amazonfund.gov.br, last accessed on November 4th, 2014.

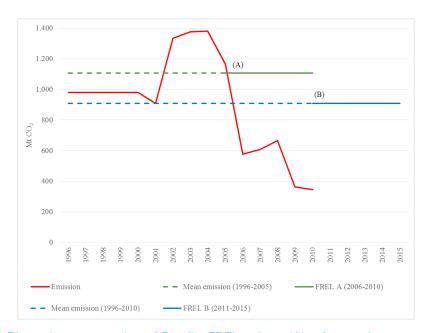


Figure 1: Pictoral representation of Brazil's FREL, where (A) refers to the mean annual  $\rm CO_2$  emissions from the period 1996 to 2005 (1,106,027,616.63 t $\rm CO_2$ ); (B) refers to the mean annual  $\rm CO_2$  emissions from the period 1996 to 2010 (907,959,466.33 t $\rm CO_2$ ).

**Table 1:** Adjusted deforestation increments and associated emissions (in tC and t CO<sub>2</sub>) from gross deforestation in the Amazonia biome, from 1996 to 2010<sup>8</sup>.

YEAR	ADJUSTED DEFORESTATION INCREMENT (ha)	EMISSIONS FROM GROSS DEFORESTATION (tC)	CO <sub>2</sub> EMISSIONS FROM GROSS DEFORESTATION (tCO <sub>2</sub> )
1996	1,874,013.00	267,142,749.24	979,523,413.88
1997	1,874,013.00	267,142,749.24	979,523,413.88
1998	1,874,013.00	267,142,749.24	979,523,413.88
1999	1,874,013.00	267,142,749.24	979,523,413.88
2000	1,874,013.00	267,142,749.24	979,523,413.88
2001	1,949,331.35	247,899,310.88	908,964,139.89
2002	2,466,603.88	363,942,942.80	1,334,457,456.93
2003	2,558,846.30	375,060,876.74	1,375,223,214.70
2004	2,479,429.81	376,402,076.09	1,380,140,945.68

The grey lines in Table 1 correspond to years for which data are only available in analogic format. For any year in the period from 1996 to 2010, gross CO2 emissions from deforestation have been calculated following Steps 1-4 in Figures 6 to 8, and Step 5 presented in Brazil's FREL available through the UNFCCC REDD web platform (http://unfccc.int/methods/redd/web\_platform/items/4531.php). Brazil is investing considerable human and financial resources to improve its historical data sets. INPE has a project to expand Digital PRODES to years before 2001 which will allow for the spatial analysis of deforestation and lead to more precise estimates for years before 2000. With the improved data, Brazil will submit a revised FREL to the UNFCCC. REDD+ decisions under the UNFCCC value the constant improvement of data sets and information over time. It is not expected that countries will submit their information to the UNFCCC only when and if they have the most accurate data available for all significant pools. Brazil understands that the most important element before accuracy is to ascertain consistency and transparency of the data submitted.

1996 - 2010			907,959,466.33
1996 - 2005			1,106,027,616.63
2010	583,147.53	93,929,048.84	344,406,512.43
2009	596,373.64	99,365,584.69	364,340,477.19
2008	1,233,037.68	181,637,813.29	666,005,315.39
2007	1,087,468.65	165,890,835.62	608,266,397.26
2006	1,033,634.15	157,117,398.10	576,097,126.38
2005	2,176,226.17	317,420,001.73	1,163,873,339.68

The areas presented in *Table 1* are the *adjusted deforestation increments* of gross deforestation estimated for the Amazonia biome. Note that those from PRODES correspond to the *rate* of gross deforestation estimated for the Legal Amazonia. See *Box 2* for detailed explanation of the differences between these two approaches.

## 3. RESULTS IN TONNES OF CO<sub>2</sub>EQ PER YEAR, CONSISTENT WITH THE ASSESSED FREL FOR THE AMAZONIA BIOME

Decision 14/ CP. 19 paragraph 3, "decides that the data and information used by Parties in the estimation of anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes, as appropriate to the activities referred to in decision 1/CP.16, paragraph 70, undertaken by Parties, should be transparent, and consistent over time and with the established forest reference emission levels and/or forest reference levels in accordance with decision 1/CP.16, paragraph 71(b) and (c) and chapter II of decision 12/CP.17".

 $\mathrm{CO_2}$  emissions from gross deforestation in the Amazonia biome from 1996 to 2010 were calculated for Brazil's FREL using the methodology presented in the previous section. For this Technical Annex, the results for years 2006 to 2010 were calculated simply by subtracting the reference value for that period of 1,106,027,616.63  $\mathrm{tCO_2}$  from the emissions for each year from 2006 to 2010. So for year t, the reduced emissions from deforestation were as follows:

REDD+ (t) = FREL (1996-2005) – Gross emissions from deforestation at year t; (tCO<sub>2</sub>)

As an example, the emission reductions in 2006 correspond to:

 $1,106,027,616.63 \text{ tCO}_2 - 576.097.126,38 \text{ tCO}_2 = 529.930.490,25 \text{ tCO}_2$ 

The total result achieved by Brazil in reducing emissions from gross deforestation in the Amazonia biome from 2006 to 2010, was the sum of the results achieved for each year of the period, i.e.  $2,971.02 \, MtCO_2 \, (Figure \, 2)$ .

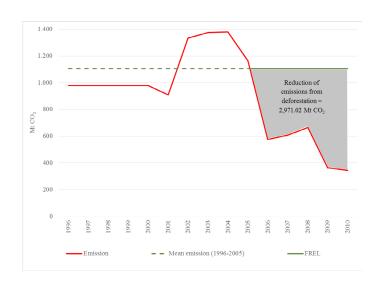


Figure 2: REDD+ results from 2006 to 2010 calculated based on the FREL submitted to the UNFCCC in June 2014

**Table 2:** Annual REDD+ results in tonnes of  $CO_2$  from 2006 to 2010

Year	EMISSIONS FROM GROSS DEFORESTATION (tCO <sub>2</sub> )	FREL (1996-2005, tCO <sub>2</sub> )	REDD+ RESULTS (2006 -2010, tCO <sub>2</sub> )
1996	979.523.413,88	1.106.027.616,63	
1997	979.523.413,88	1.106.027.616,63	
1998	979.523.413,88	1.106.027.616,63	
1999	979.523.413,88	1.106.027.616,63	
2000	979.523.413,88	1.106.027.616,63	
2001	908.964.139,89	1.106.027.616,63	
2002	1.334.457.456,93	1.106.027.616,63	
2003	1.375.223.214,70	1.106.027.616,63	
2004	1.380.140.945,68	1.106.027.616,63	
2005	1.163.873.339,68	1.106.027.616,63	
2006	576.097.126,38		529.930.490,25
2007	608.266.397,26		497.761.219,37
2008	666.005.315,39		440.022.301,24
2009	364.340.477,19		741.687.139,44
2010	344.406.512,43		761.621.104,20
TOTAL	2.971.022.254,49		

# 4. DEMONSTRATION THAT THE METHODOLOGIES USED TO PRODUCE THE RESULTS ARE CONSISTENT WITH THOSE USED TO ESTABLISH THE ASSESSED FREL

The calculation of the REDD+ results presented in this Technical Annex uses the same methodology, the same data set and the same information used for Brazil's FREL for the Amazonia biome.

Accordingly, the emissions from gross deforestation in the Amazon biome between 2006 and 2010 had already been presented by Brazil on its FREL that was subjected to a technical assessment.

As presented in the previous section, the results between 2006 and 2010 were measured as the average annual  $CO_2$  emissions from gross deforestation in the Amazonia biome between 1996 and 2005, i.e. **1,106,027,616.63 tCO**<sub>2</sub> minus emissions at year t.

# 5. A DESCRIPTION OF NATIONAL FOREST MONITORING SYSTEMS AND THE INSTITUTIONAL ROLES AND RESPONSIBILITIES FOR MEASURING, REPORTING AND VERIFYING THE RESULTS:

### **5.1. The Amazonian Gross Deforestation Monitoring Project – PRODES**

Brazil has a consistent, credible, accurate, transparent, and verifiable time-series for gross deforestation for the Legal Amazonia (and hence, for the Amazonia biome). PRODES is part of a larger program (Amazonia Program) developed at INPE to monitors gross deforestation in the Legal Amazonia. It uses satellite imagery to identify new deforestation polygons every year in areas of *primary forest*. Deforestation is associated with clear-cut activities, normally associated with the conversion of forest land to other land-use categories. Gross deforestation is assessed annually, on a wall-to-wall basis, encompassing the analysis of approximately 215 Landsat images, aided by additional Landsat class data (CBERS/CCD, REsourcSat/LISS3 and DMC) to reduce the incidence of cloud cover, with the minimum mapping area of 6.25 hectares (*Box 1*).

The Legal Amazonia covers the totality of the following states: Acre (AC), Amapá (AP), Amazonas (AM), Pará (PA), Rondônia (RO), Roraima (RR) and Tocantins (TO), Mato Grosso (MT) and part of the state of Maranhão (MA), totalizing approximately 5.217.423 km² (521.742.300 ha)

### **BOX 1: PRODES MINIMUM MAPPING AREA**

PRODES was set in 1988 to map deforestation over hardcopy prints of Landsat images at the 1:250,000 scale. Consistent data for gross deforestation are available on an annual basis since 1988. Minimum mapping unit was defined as 1 mm<sup>2</sup>, which is equivalent to 6.25 ha in the surface.

Since 2008, deforestation polygons with area larger than 1 ha and under are retrieved in a separate dataset and registered as PRODES deforestation as they coalesce to a size larger than 6.25 ha.

The first three years of this dataset are inflated by past deforestations. However, for all years since 2011 the total area (in km²) of small deforestation polygons stabilizes at values around 500 km² yr¹, (642 km² in 2011, 390 km² in 2012 and 479 km² in 2013).

The consistency of the PRODES time series is ensured by using the same deforestation definition, same minimum mapping area, similar satellite spatial resolution<sup>1</sup>, same Forest/Non-Forest vegetation boundaries, and same methodological approach to analyze the remotely sensed data at every new assessment.

Forest areas affected by forest degradation that do not have a clear-cut pattern in the satellite imagery are not included in PRODES. A separate project, named DEGRAD is carried out by INPE to address forest degradation. This ensures the consistency of the PRODES deforestation time series over time.

At the start of PRODES, deforestation polygons were identified by visual interpretation on false color composites of Landsat imagery at the scale of 1:250,000 and mapped on overlays that contained the aggregated deforestation up to the previous year. Subsequently these deforestation polygons were manually digitized in a Geographic Information System (GIS) developed by INPE. This analogical approach to assess deforestation (*Analog PRODES*) was employed from 1988 until 2002.

Due to the increased computing capability built at INPE, it was possible to transition from an **analogical** approach to a **digital** annual assessments of deforestation (*Digital PRODES*) after 2000, which was preceded by a 1997 **digital base map**, and an aggregated deforestation assessment for years 1998-2000.

Digital PRODES maintains full consistency with the Analog PRODES data. This includes consistency with the forest/non-forest boundaries in Analog PRODES and the aggregated deforestation polygons. Despite the evolution to a digital assessment, the identification of the deforestation polygons continued to be carried out through visual interpretation in the screen and not through digital classification methods<sup>10</sup>. This ensured even greater consistency between the Analog and Digital PRODES.

Due to the large volume of analogic data when *Digital PRODES* started, INPE decided to map the deforestation polygons from years 1998 to 2000 on an aggregated deforestation map until 1997

<sup>10</sup> INPE has developed alternative methodologies to identify deforestation increments in satellite imagery (e.g., linear mixture model, Shimabukuro *et al.*, (2004). However, the visual assessment demonstrated to be simpler and more efficient).

(*digital base map*). Hence, the deforestation polygons for these years were lumped into a single digital database, with no discrimination of the specific year when deforestation occurred. From year 2000 onwards, the deforestation polygons have been annually assessed and included in the *Digital PRODES* database. The *Digital PRODES* allows for the visualization of the deforestation polygons every year, in a single file. Thus, the geographical expansion of deforestation, as well as its spatial pattern, can be assessed and monitored.

In summary, the **digital database** does not have individual deforestation information for years prior to 1997, inclusive; it has information for years 1998 to 2000 in an aggregated format; and information (deforestation polygons) for all years since 2000 on an annual basis.

Digital PRODES allowed INPE to make available through the web the deforestation maps in vector format, as well as all the satellite images used, thus ensuring full transparency to the public in general. Since 2003, INPE began to publish the annual deforestation rate in the web, together with all the satellite imagery used to generate the information, and the maps with the identification of deforestation polygons (http://www.obt.inpe.br/prodes/index.php). Annually INPE provides for the download of approximately 215 Landsat satellite images of Landsat5/7/8 (or similar data as CBERS/CCD, REsourceSat/LISS3 and DMC). Each image is accompanied by the associated map containing all past deforestation.

INPE continuously improves its tools to better manage large-scale projects such as PRODES. Its latest development, the TerraAmazon, is a system that manages the entire workflow of PRODES, annually storing approximately 600 images (e.g., Landsat, CBERS, DMC, Resourcesat). It performs geo-referencing, pre-processing and enhancement of images for subsequent analysis in a multi-task, multi-processing environment. The database stores and manages approximately 4 million polygons.

There are some steps that are followed until the deforestation increments are identified in the satellite imagery. These are now detailed:

### **IMAGES SELECTION**

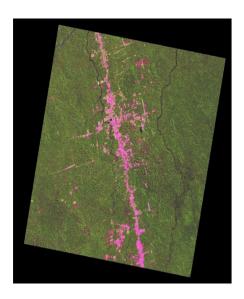


**Figure 3:** Steps prior to identification of the deforested polygons.

The first step consists of selecting the images to be used. For this, a query is conducted directly from INPE's Image Generation Division (DGI) site (http://www.dgi.inpe.br/siteDgi\_EN/index\_EN.php) to

identify (preferably) Landsat images (or similar) for the year of interest (usually corresponding to the months of July and August), with minimal cloud cover, better visibility and a suitable radiometric quality.

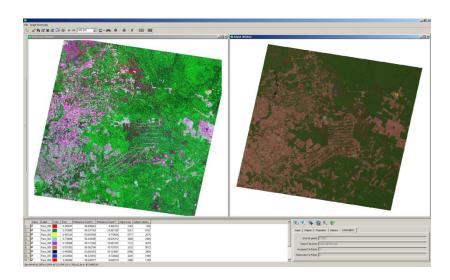
Satellite imagery available in the DGI are usually pre-processed for geometric correction and made available in UTM projection. *Figure a.2* shows an image from Landsat 5 selected in the DGI library.



*Figure 4:* Landsat 5 (pathrow 227/65) of 01/07/2002 *Note*: Color composite Red, Green, Blue for bands 5,4,3, respectively, available on the DGI catalog.

### DATABASE AND GEOREFERENCING

The next step consists of image geo-referencing, which is carried out through visual collection of at least nine control points evenly distributed in coherent features (rivers, roads intersection) in the image to be geo-referenced. INPE uses as reference data the orthorectified Landsat mosaic for the year 2000, produced by Geocover NASA project (https://zulu.ssc.nasa.gov/MrSID). The geo-referencing is carried out by linear matrix transformation of first or second order, depending on the image quality, with transformation parameters obtained by least-square method applied to the set of control points.



**Figure 5:** An example of control points collection.

### CONTRAST ENHANCEMENT

Finally, the technique of contrast enhancement may be applied to improve the quality of the images under the subjective criteria of the human eye. The contrast between two objects may be defined as the ratio between their average gray levels.

The goal at this step is to increase the contrast to facilitate the visual discrimination of objects in the image.

### ACTIVITY DATA FOR BRAZIL'S TECHNICAL ANNEX AND FREL

The area of the deforestation polygon by forest type (in km<sup>2</sup> or hectares) is the *activity data* necessary for the application of the first order approximation to estimate emissions<sup>11</sup> as suggested in the IPCC Good Practice Guidance for Land Use, Land-use Change and Forestry (GPG LULUCF) (IPCC, 2003).

These areas have been obtained from PRODES time series data (modified to consider only deforestation in the Amazonia biome) and the vegetation map from the Brazilian Institute for Geography and Statistics (IBGE).

The fact that satellite data from optical systems (e.g., Landsat) are the basic source of information to identify new deforestation events every year, and considering that the presence of clouds may impair the observation of deforestation events under clouds, requires the application of an approach to deal with the estimation of the areas of primary forest under clouds that may have been deforested so as not to underestimate the total deforestation at any year (refer to **Box 2** for alternative approaches to estimate the area of gross deforestation in the Amazonia biome). This is in line with good practice as defined in GPG LULUCF (IPCC, 2003).

<sup>&</sup>quot;In most first order approximations, the "activity data" are in terms of area of land use or land-use change. The generic guidance is to multiply the activity data by a carbon stock coefficient or "emission factor" to provide the source/or sink estimates." (IPCC, 2003; section 3.1.4, page 3.15).

### BOX 2: APPROACHES TO ESTIMATE THE AREA OF GROSS DEFORESTATION IN THE AMAZONIA BIOME

There are several approaches to estimate the area deforested and each **may** lead to different results. The total deforested area **may** be different if calculated as deforestation increment, or deforestation rate, or adjusted deforestation increment. To further clarify the above, the text that follows explains the different approaches and terminologies used throughout this submission.

- (a) **Deforestation Polygons** (at year *t*): refer to new deforestation events identified from the analysis of remotely sensed data (satellite images) at year *t* as compared to the accumulated deforestation mapped up to year *t-1*. Each deforestation polygon is spatially identified (geocoded), has accurate shape and area representations, and has an associated date of detection (the date of the satellite image from which it was mapped). For each year, a map containing all deforestation polygons (deforestation map) is made available in shapefile format for PRODES (and hence, for the Amazonia biome, after exclusion of the areas associated with the Cerrado and Pantanal biomes) at (http://www.obt.inpe.br/prodesdigital/cadastro.php). This map does not include deforestation polygons under cloud covered areas. However, the deforestation map also renders spatially explicit distribution of the cloud covered areas.
- (b) Deforestation Increment (at year t): refers to the sum of the areas of all observed deforestation polygons within a given geographical extent. This geographical extent may be defined as the boundaries of a satellite scene which has the same date as the deforestation polygons mapped on that scene; or the entire Amazonia biome, for which the deforestation increment is calculated as the sum of the individual deforestation increment calculated for each scene that covers the biome. The deforestation increment may underestimate the total area deforested (and associated emissions), since it does not account for the area of deforestation polygons under clouds.
- (c) Adjusted Deforestation Increment (at year t): this adjustment is made to the deforestation increment at year t-1 (or years t-1 and t-2, etc., as applicable) to account for deforestation polygons in areas affected by cloud cover and that are observable at time t. It is calculated according with **Equation 1**:

$$Inc_{adj(t)} = Inc_{(t)} - \sum_{\Delta=1} A_{C-(t-\Delta)(t)} + \sum_{\Delta=1} \frac{A_{C-(t-\Delta)(t)}}{\Delta + 1} + \sum_{\Omega=1} \frac{A_{C-(t+\Omega)(t)}}{\Omega + 1}$$
 Equation 1

where:

 $Inc_{adj(t)}$  = adjusted deforestation increment at year t, km<sup>2</sup>

 $Inc_{(t)}$  = deforestation increment at year t, km<sup>2</sup>

 $A_{\mathcal{C}_{(t-\Delta)(t)}}$  = area of the deforestation polygons observed (cloud-free) at year t over cloud-covered areas at year t- $\Delta$ ; km $^2$ . Note that when  $\Delta=1$ ,  $A_{\mathcal{C}_{(t-1)(t)}}$  equals the area of the deforestation polygons observed at year t over cloud-covered areas at year t-1 (but which were under cloud-free at year t-2); for  $\Delta=2$ ,  $A_{\mathcal{C}_{(t-2)(t)}}$  equals the area of the deforestation polygons observed at year t over an area that was cloud-covered at both years t-1 **and** t-2.

 $A_{\mathcal{C}-(t+\Omega),(t)}$  = area of the deforestation polygons observed at year  $t+\Omega$  over cloud-covered areas at year t, km². Note that when  $\Omega=1$ , the term  $A_{\mathcal{C}-(t+1),(t)}$  provides the area of the deforestation polygons observed at year t+1 over the area that was cloud-covered at year t, when  $\Omega=2$ , the term  $A_{\mathcal{C}-(t+2),(t)}$  provides the area of the deforestation polygons observed at year t+2 over the area that was cloud-covered at years t and t+1.

 $\Delta$  = number of years that a given area was persistently affected by cloud cover prior to year t but was observed at year t,  $\Delta$  =1, 2, ....

 $\Omega$  = number of years until a given area affected by cloud cover at year t is observed in subsequent years (i.e., is free of clouds);  $\Omega$  = 1,2, ...

As an example, suppose that the area of the deforestation increment observed at year t,  $Inc_{(t)}$ , is 200 km² and that 20 km² of this occurred over primary forest areas that were cloud covered at year t-1 (but are cloud-free at year t). Since these 20 km² may accumulate the area of the deforestation polygons under clouds at year t-1 and the area of the deforestation polygons that occurred at year t, the deforestation increment **may overestimate** the total area deforested area (and associated emissions) at year t.

The adjusted deforestation increment  $Inc_{adj(t)}$  at year t evenly distributes the total area of the deforestation polygons observed at year t under the cloud-covered area at year t-1 (or before, if the same area was also cloud covered at year t-2, for instance) among years t-1 and t. Hence, the adjusted deforestation increment at year t is 190 km² (200 - 20/2) and not 200 km², assuming that there were no cloud-covered areas at year t (in which case the adjusted deforestation increment at year t would be adjusted by  $\sum_{\Omega=1} \frac{A_{\mathcal{C}_{-}(t+\Omega)(t)}}{\Omega+1} \text{ where } A_{\mathcal{C}_{-}(t+\Omega)(t)} = \text{area of the deforestation polygons}$  observed at year t+  $\Omega$  over cloud-covered areas at year t, and  $\Omega$  is the number of years that a given area affected by cloud cover at year t is observed (i.e., is free of clouds).

The rationale behind **Equation 1** is to remove from the deforestation increment the area to be distributed among the years  $(-\sum_{\Delta=1} A_{\mathcal{C}-(t-\Delta)\cdot(t)})$  and then add back the portion allocated to year  $t\left(\sum_{\Delta=1} \frac{A_{\mathcal{C}-(t-\Delta)\cdot(t)}}{\Delta+1}\right)$ . The last term of the equation refers to the area distributed from subsequent years (or year) over cloud covered areas at year t.

(1) **Deforestation Rate** (at year *t*): was introduced in PRODES to sequentially address the effect of **cloud cover**; and, if necessary, the effect of **time lapse** between consecutive images. The deforestation rate aims at reducing the potential under or over-estimation of the deforested area at year *t*. The presence of cloud-covered areas in an image at year *t* impairs the observation of deforestation polygons under clouds, and may lead to an **underestimation** of the area deforested; while the presence of clouds in previous years (e.g., at year *t*-1) may lead to an **overestimation** of the area deforested if all deforestation under clouds at year *t*-1 is attributed to year *t*.

This **over** or **under-estimation** may also occur if the dates of the satellite images used in subsequent years are not adjusted. To normalize for a one year period (365 days) the time lapse between the images used at years t and t+1, the rate considers a reference date of August 1<sup>st</sup> and projects the cloud corrected increment to that date, based on a model that assumes that the deforestation pace is constant during the dry season and zero during the wet season. Refer to **Annex I**, **Part I** for more information on PRODES methodology for calculating the deforestation rate.

As an example of cloud correction, suppose that the primary forest area in an image is  $20,000 \text{ km}^2$  and that  $2,000 \text{ km}^2$  of this occurred over primary forest areas that were cloud covered. Suppose also that the observed **deforestation increment** is  $180 \text{ km}^2$ . As part of the calculation of the rate, it is assumed that the proportion of deforestation measured in the cloud-free forest area  $(18,000 \text{ km}^2)$  is the same as that in the area of forest under cloud  $(2,000 \text{ km}^2)$ . Therefore the proportion 180/18,000 = 0.01 is applied to the  $2,000 \text{ km}^2$ , generating an extra  $20 \text{ km}^2$  that is added to the observed deforestation increment. In this case, the **cloud corrected increment** is  $200 \text{ km}^2$ .

# **IMPORTANT REMARKS:**

- 1. Note that at any one year, an estimate based on the adjusted deforestation increment may be higher or lower than the rate of gross deforestation.
- For the sake of verifiability, this submission introduces a slight change in the methodology used in PRODES to estimate the annual area deforested. PRODES methodology to annualize observed deforestation and to take into account unobserved areas due to cloud cover is not directly verifiable unless all the estimates are adjusted backwards.
- 3. The approach applied in this submission relies on a verifiable deforestation map and does not annualize the time lapse between consecutive scenes. It deals with the effect of cloud cover by equally distributing the area of the deforestation polygons observed at year *t* over cloud-covered areas at year *t*-1 (or to years where that area was persistently cloud covered) among years *t* and *t*-1.
- 4. The use of the adjusted deforestation increment to estimate the area deforested and associated gross emissions is deemed to be more appropriate for REDD+, due to the verifiability.

### CALCULATING DEFORESTATION RATES BASED ON DEFORESTATION INCREMENTS.

Deforestation rate calculations are elaborate, and have as a basis the information on deforestation increments. The simple sum of the mapped, observed deforestation polygons, is the deforestation increment.

**Table 3:** Deforestation increments vs deforestation rates **Source**: INPE, 2014

Deforestation Increments	Deforestation Rates
<ul> <li>Value measured by image interpretation</li> </ul>	❖ Value is estimated
<ul> <li>Calculated for each pair of LANDSAT image</li> </ul>	Interpolated to a reference date (August 1st)
Indicating the date of image acquisition	❖ Takes into account the area covered by clouds

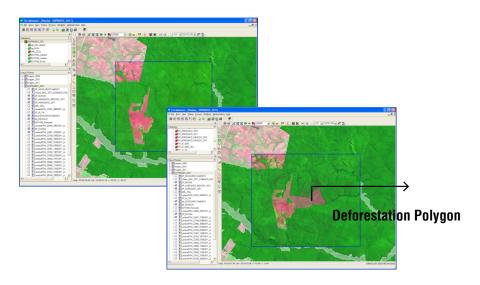


Figure 6: Deforestation polygon as shown by PRODES Source: INPE, 2014

It should be noted that up to 2000, the Landsat TM scenes 222/61 and 222/62 were never considered by PRODES since they were persistently covered by clouds. In 2001, it was possible to observe these scenes. It was then verified that a large area was cleared in these scenes, leading to a high deforestation increment at that year (2001). This implies that there will be a substantial difference between increments and rates in years before 2001.

In early 2000s, there was a predilection for scenes without clouds, even when they were taken many days before the date of reference (August 1st). A limit to the number of days for the analysis of scenes was only later defined as a measure to avoid the discrepancy between deforestation rates and deforestation increment. In 2004, INPE decided to select only the images with dates as close as possible to the next reference date, so that after 2005/2006, the discrepancies between deforestation rates and deforestation increment became very small.

## COMPARING THE EMISSIONS ESTIMATES: DEFORESTATION RATES VS. ADJUSTED INCREMENTS

Deforestation rates were not the basis for the FREL calculations. The FREL was calculated based on adjusted deforestation increments and these are two different approaches. Brazil's FREL is conservative because it uses only historical data and is dynamics through time (which is not required in any REDD+ decision).

PRODES maps up to 2001 were analogic and constrained the integration with the carbon map adopted in this FREL. As an exercise, the annual  $CO_2$  emissions per year were calculated taking as a basis the deforestation rates from PRODES and applying the average carbon stock per unit area (tC ha<sup>-1</sup>). This was done to assess the average difference in  $CO_2$  emissions using the annual rates of gross deforestation from PRODES and the emission estimates presented in this submission for years 1996 – 2005 based on the adjusted increments. The formula used was:

# Deforestation rate (ha)/year \* 151.6 tC/ha \* 44/12

Table 4: Emission estimates from deforestation rate vs emission estimates from the FREL

	Deforestation (km2)	Deforestation (ha)	Emission PRODES (tCO2) (Mean = 151,6 tC/ha)	Emission FREL (tCO2)
1996	18.161	1.816.100	1.009.509.453	979.523.414
1997	13.227	1.322.700	735.244.840	979.523.414
1998	17.383	1.738.300	966.263.027	979.523.414
1999	17.259	1.725.900	959.370.280	979.523.414
2000	18.226	1.822.600	1.013.122.587	979.523.414
2001	18.165	1.816.500	1.009.731.800	908.964.140
2002	21.651	2.165.100	1.203.506.920	1.334.457.457
2003	25.396	2.539.600	1.411.678.987	1.375.223.215
2004	27.772	2.777.200	1.543.752.907	1.380.140.946
2005	19.014	1.901.400	1.056.924.880	1.163.873.340
Mean			1.090.910.568	1.106.027.617
Difference				1,39%

The average emissions from 1996 through 2005, using PRODES rates was  $1,090,910,568 \text{ tCO}_2$ . The average emissions from 1996 through 2005 presented in the FREL was  $1,106,027,617 \text{ tCO}_2$ . Since the FREL uses the average emissions of 10 years, these differences balance out at the end, being only 1.4 per cent.

The use of adjusted increments to estimate emissions from gross deforestation provides a more accurate figure for the deforested area through time.

# 5.2. Roles and responsibilities for measuring, reporting and verifying (MRVing) the results

Table 5: Roles and responsibilities for REDD+ MRV

MRV	Instrument/ Project	Responsible Institution	Roles	Additional Information
Measuring		Foundation of Science, Application and Space Technologies (FUNCATE)	Calculating emission reductions from deforestation in the Amazonia biome based on the adjusted deforestation increments and the carbon map from RADAMBRASIL project.	http://www. funcate.org.br/
	Amazon Program	INPE, MCTI	Verifying the calculations done by FUNCATE	http://www.obt. inpe.br/prodes/ index.php
Reporting	Working Group of Technical Experts on REDD+	MMA MCTI	Providing technical inputs for REDD+ submissions to the UNFCCC and ensuring its quality control.	http://www.mma. gov.br/redd/index. php/en/
	Modular System for Monitoring and Tracking Greenhouse Gases Emission Reductions (SMMARE)	MMA	Tracking and reporting on the implementation of PPCDAm actions that lead to emission reductions. A tool to provide information, in particular in relation to the mitigation actions (NAMAs) implemented in each mitigation plan and its associated methodologies and assumptions, the progress made in their implementation and information on domestic measurement, reporting and verification.	www.mma.gov.br
Verifying	International Consultation and Analysis	UNFCCC	Verifying the submissions from Parties, by appointing two LULUCF experts to assess the FREL submissions and the technical annexes.	http://unfccc. int/methods/ redd/redd_ web_platform/ items/4531.php

# 6. NECESSARY INFORMATION THAT ALLOWS FOR THE RECONSTRUCTION OF RESULTS

**Complete** information, for the purposes of REDD+, means the provision of the following information that allows for the reconstruction of the FREL and this Technical Annex.

Below is a description of the information that allows for the reconstruction of the results. Links to the database and information that allows for the reconstruction of results was detailed in **Section b.1** of Brazil's FREL and are available through the website: <a href="http://www.mma.gov.br/redd/index.php/pt/forest-reference-emission-levels/the-submission-of-brazilian-forest-reference-emission-levels">http://www.mma.gov.br/redd/index.php/pt/forest-reference-emission-levels</a>

- (1) All the satellite images used to map the deforestation polygons in the Amazonia biome from 1996 to 2010.
- (2) Accumulated deforestation polygons until 1997 (inclusive), presented in a map hereinafter referred to as the *digital base map* (see *Annex I*, *Part I* for more details).
- (3) Accumulated deforestation polygons for years 1998, 1999 and 2000 mapped on the *digital base map*.
- (4) Annual deforestation polygons for the period from 2001 to 2010, inclusive (*annual maps*).

**IMPORTANT REMARK 1:** All maps referred to in (2), (3) and (4) above are available in shapefile format ready to be imported into a Geographical Database for analysis. All satellite images referred to in (1) above are provided in full resolution in geotiff format. Any individual deforestation polygon can be verified against the corresponding satellite image.

**IMPORTANT REMARK 2:** The maps referred to in (2), (3) and (4) above are a **subset** of those produced by INPE for PRODES (for additional information see **http://www.obt.inpe.br/prodes/index.php)** and refer only to the Amazonia biome, the object of this submission. The information in (2) and (3) above are provided in a single file.

(5) The **deforestation polygons by forest type attributes and RADAMBRASIL volume**; For each year, the deforestation polygons are associated with the corresponding forest type and RADAMBRASIL volume. These files are large and are thus presented here only for year 2003<sup>12</sup>, the year that has been used to exemplify the calculation of the adjusted deforestation increment (refer to **Box 2** and **Annex II, Part I**).

It is worth noting that for all since 2001, the stratification of the deforestation polygons by forest type attributes and RADAMBRASIL volume indicated that deforestation concentrates mostly in the so called "Arc of Deforestation" (a belt that crosses over RADAMBRASIL volumes 4, 5, 16, 20, 22 and 26 – refer to **Figure 11**), and marginally affects forest types in RADAMBRASIL volumes associated with higher carbon densities.

For year 2003, a total of 402,176 deforestation polygons have been identified. For each deforestation polygon in the file, the following information is provided: the State of the Federation it belongs (uf); the RADAMBRASIL volume (vol); the associated forest type (veg) and the associated area (in ha).

- (6) The information that allows for the calculation of the adjusted deforestation increments for years 2001, 2002, 2003, 2004 and 2005 is available at: http://mma.gov.br/redd/index.php/pt/forest-reference-emission-levels/spatial-information. Annex II, Part I provides an example of the calculation of the adjusted deforestation increment for year 2003 (see "calculo\_def\_increment\_emission\_2003" thought the FTP. file available at: http://mma.gov.br/redd/index.php/pt/forest-reference-emission-levels/spatial-information).
- (7) A map with the carbon densities of different forest types in the Amazonia biome (carbon map), consistent with that used in the Second National GHG Inventory, the latest submitted by Brazil to the UNFCCC at the time of construction of the FREL.
- (8) Samples of the relevant<sup>13</sup> RADAMBRASIL data that have been used as input to the allometric equation by Higuchi *et al.* (1998). They are generated from the original RADAMBRASIL database, which is the basis for the construction of the carbon map. Consultation with the Working Group of Technical Experts on REDD+ led to the understanding that there may be cases of apparent inconsistencies in carbon densities within a forest type due to specific circumstances of the sample unit. This is part of the natural heterogeneity of the biomass density distribution in tropical vegetation.

# 7. A DESCRIPTION OF HOW THE ELEMENTS CONTAINED IN DECISION 4/ CP.15, PARAGRAPH 1(C) AND (D), HAVE BEEN TAKEN INTO ACCOUNT

# 7.1. Use of the most recent IPCC guidance and guidelines

Brazil's FREL and its respective Technical Annex use the IPCC methodology as a basis for estimating changes in carbon stocks in forest land converted to other land-use categories as described in the GPG LULUCF (IPCC, 2003). For any land-use conversion occurring in a given year, GPG LULUCF considers both the carbon stocks in the biomass immediately before and immediately after the conversion.

As stated on the previous sections, the area of the deforestation polygon by forest type (in km<sup>2</sup> or hectares) is the activity data necessary for the application of the first order approximation to estimate emissions as suggested in the IPCC Good Practice Guidance for Land Use, Land-use Change and Forestry (GPG LULUCF) (IPCC, 2003).

# 7.2. Establish, according to national circumstances and capabilities, robust and transparent national forest monitoring systems

The activity data used for the construction of the FREL and as a basis for calculating the results presented in this Technical Annex was the historical time series from PRODES (for details refer to **Section 5.1** above).

PRODES forest definition includes all vegetation types of Evergreen Forest Formations in the Legal Amazonia and forest facies of other formations such as Savanna and Steppe, which are generally

The original RADAMBRASIL data for the volumes where deforestation occurs most frequently (CBH, forest type, RADAMBRASIL volume) are provided at: <a href="http://mma.gov.br/redd/index.php/pt/forest-reference-emission-levels/spatial-information">http://mma.gov.br/redd/index.php/pt/forest-reference-emission-levels/spatial-information</a>, as RADAMBRASIL sample units data.

classified as "Other Wooded Land" according to the Food and Agriculture Organization of the United Nations (FAO) classification system. The presence of these facies in the Amazonia biome is not significant. However, when deforestation occurs in any of these facies, the associated emissions are calculated using their corresponding carbon density from the RADAMBRASIL carbon map.

At the beginning of PRODES in 1988, a map containing the boundary between Forest – Non-Forest was created based on existing vegetation maps and spectral characteristics of forest in Landsat satellite imagery. In 1987, all previously deforested areas were aggregated in a map (including deforestation in forest areas that in 1987 were secondary forests) and classified as *deforestation*. Thereafter, on a yearly basis, deforestation in the Amazonia biome has been assessed on the remaining annually updated Forest.

For the purposes of PRODES, the areas of Non-Forest are not monitored (regardless of being managed or unmanaged following the IPCC definition of managed land (IPCC, 2006). Deforestation occurring in Forest land (managed or unmanaged) is monitored and the associated  ${\rm CO_2}$  emission calculated assuming instantaneous oxidation at the year deforestation occurs. Hence, the accumulated gross deforestation in the Brazilian Amazonia never decreases at each new assessment.

The Brazilian deforestation time series from PRODES relate only to deforestation in primary forests that may or may not have been impacted by human activities or natural events but has not shown a **clear cut** pattern in the satellite imagery. Hence, areas previously logged, whenever identified in the satellite imagery as **clear cut**, are included as deforestation in PRODES. The definition of deforestation adopted for PRODES and maintained in the FREL (i.e., clear cut), in conjunction with the annual wall-to-wall assessment of deforestation based on satellite imagery of high spatial resolution (up to 30 meters) allows deforestation polygons to be identified and mapped with very high accuracy. No ground truth is required for the Amazonia biome since there is an unequivocal identification of the clear cut patches in the Landsat imagery from one year to another. Only new polygons of deforestation are mapped each year on the aggregated deforestation map containing deforestation up to the previous year.

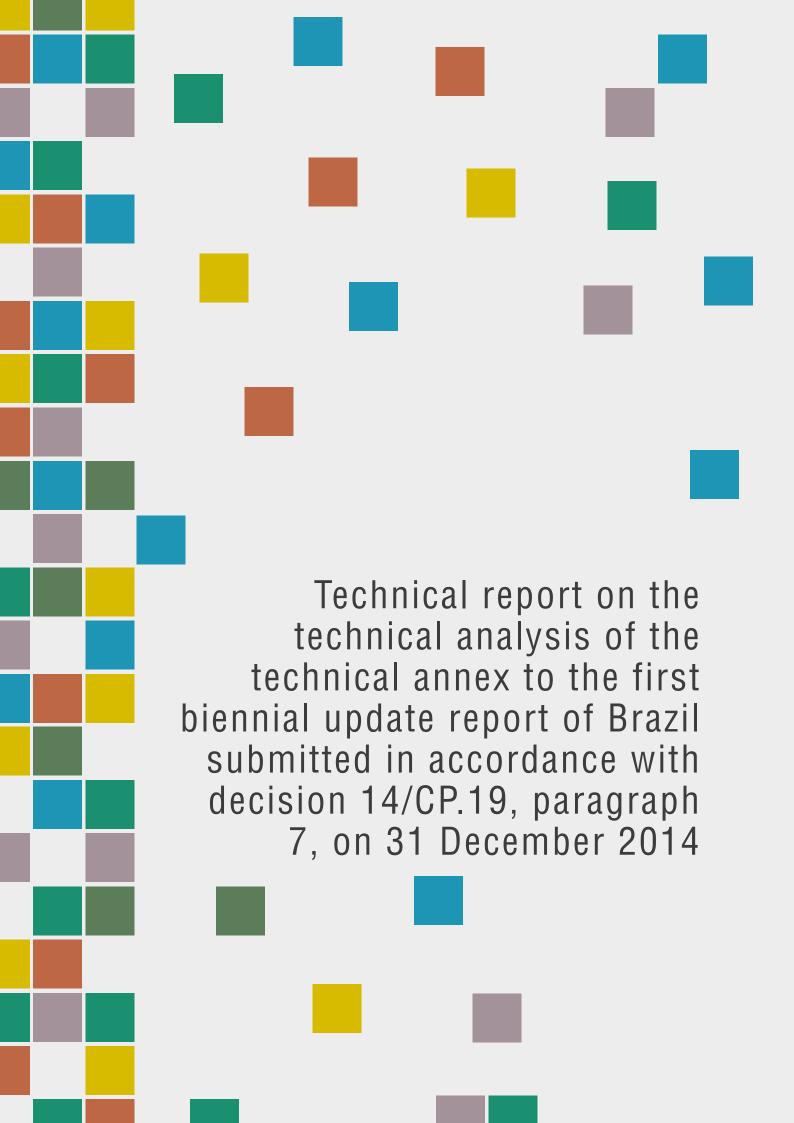
All deforestation polygons<sup>15</sup> mapped for the Amazonia biome (i.e., aggregated until 2007; aggregated for years 1998, 1999 and 2000; and annual from 2001 until 2010) are available at <a href="http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information">http://www.mma.gov.br/redd/index.php/en/forest-reference-emission-levels-frel/spatial-information</a>.

Note that this information is a subset of that made available since 2003 by INPE for PRODES at <a href="https://www.obt.inpe.br/prodes">www.obt.inpe.br/prodes</a>. At this site, for each satellite image (see (1) above), a vector map in shapefile format is generated and made available, along with all the previous deforestation polygons, the areas not deforested, the hydrology network and the area of non-forest.

The experts appointed by the UNFCCC Secretariat noted on their report of the technical assessment of Brazil's FREL that the transparency and completeness of information significantly improved in the final submission and commended Brazil for the efforts taken. According to their report, the information provided in the final FREL submission, including through the data made available in websites and the examples of how estimates of deforestation were calculated, increased the reproducibility of FREL numbers. This Technical Annexes uses of the emissions calculated in the FREL for estimating the REDD+ results achieves in the Amazon biome from 2006 to 2010.

Managed land is land where human interventions and practices have been applied to perform production, ecological or social functions. (IPCC, 2006)

The information for PRODES is also available for the Legal Amazonia are publicly available since 2003 at INPE's website (www.obt.inpe.br/prodes).





# **United Nations**

FCCC/SBI/ICA/2015/TATR.1/BRA



Distr.: General 22 September 2015

English only

# Summary

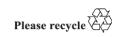
This technical report covers the technical analysis of the technical annex that was submitted on a voluntary basis by Brazil through its first biennial update report, in accordance with decision 14/CP.19. The technical annex covers data and information on the activity "reducing emissions from deforestation", which is one of the activities included in decision 1/CP.16, paragraph 70, and the same subnational territorial forest area as the assessed forest reference emission level proposed by Brazil for the Amazonia biome, with the aim of transitioning to national implementation in the future.

The technical analysis concluded that the data and information provided by Brazil in the technical annex are transparent and consistent over time and with the assessed forest reference emission level that was established in accordance with decision 1/CP.16, paragraph 71(b), and decision 12/CP.17, chapter II.

The data and information provided in the technical annex are in overall accordance with the guidelines contained in the annex to decision 14/CP.19. This report contains the findings of the technical analysis and a few areas identified for further technical improvement, according to decision 14/CP.19, paragraph 14.

Ministry of the Environment note: This is a reproduction in full of the UNFCCC report, the page numbers had to be altered to follow the sequence of this publication. The modifications made in the original content are strictly design-related. The original report can be found at: http://unfccc.int/resource/docs/2015/tatr/eng/bra.pdf







# TABLE OF CONTENTS

I. Introduction, overview and summary	155
a. Introduction	155
b. Process overview	156
c. Summary of results	156
II. Technical analysis of information reported in the technical annex to the	
biennial update report	157
a. Technical annex	157
b. Technical analysis	157
c. Areas identified for technical improvement	163
d. Comments and/or responses by the Party concerned	164
III. Conclusions	164
Annex	165

# I. INTRODUCTION, OVERVIEW AND SUMMARY

# a. Introduction

- 1. This technical report covers the technical analysis (TA) of the technical annex provided in accordance with decision 14/CP.19,¹ included in the first biennial update report (BUR) of Brazil that was submitted on 31 December 2014 in accordance with decision 2/CP.17.² In the technical annex, Brazil provided data and information used in the estimation of anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes resulting from the implementation of the activities referred to in decision 1/CP.16, paragraph 70 (hereinafter referred to as REDD-plus activities).³ The submission of the technical annex is voluntary and in the context of results-based payments.⁴
- 2. In this context, Brazil underlined that the submission of the technical annex through the BUR does not modify, revise or adjust in any way the nationally appropriate mitigation actions currently being undertaken by Brazil pursuant to the Bali Action Plan, and neither prejudges any nationally determined contribution by Brazil in the context of a protocol, another legal instrument or an agreed outcome with legal force under the Convention currently being negotiated under the Ad Hoc Working Group on the Durban Platform for Enhanced Action.
- 3. The TA of the technical annex is part of the international consultation and analysis (ICA) of BURs referred to in decision 2/CP.17, annex IV, paragraph 4. The objective of the ICA is to increase the transparency of mitigation actions and their effects through analysis by a team of technical experts (TTE) in consultation with Brazil and through a facilitative sharing of views, and will result in a separate summary report.<sup>5</sup>
- 4. Brazil submitted a proposed forest reference emission level (FREL), in accordance with decision 13/CP.19, on 6 June 2014, which was subjected to a technical assessment. The assessed FREL was included in the technical annex to the first BUR in accordance with the guidelines contained in the annex to decision 14/CP.19. The findings of the technical assessment are included in a separate report.<sup>6</sup>

Decision 14/CP.19, paragraph 7.

<sup>2</sup> Decision 2/CP.17, paragraph 41(a), and annex III, paragraph 19.

In decision 1/CP.16, paragraph 70, the Conference of the Parties encouraged developing country Parties to contribute to mitigation actions in the forest sector by undertaking the following activities: reducing emissions from deforestation; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks.

<sup>4</sup> Decision 14/CP.19, paragraph 8.

<sup>5</sup> FCCC/SBI/ICA/2015/TASR.1/BRA.

<sup>6</sup> FCCC/TAR/2014/BRA, published on 1 December 2014.

# **b. Process overview**

- 5. The TA of the first BUR took place (as a centralized activity) from 18 to 22 May 2015 in Bonn, Germany, and was undertaken by the following TTE drawn from the UNFCCC roster of experts on the basis of the criteria defined in decision 20/CP.19, annex, paragraphs 2–6: Ms. Selam Kidane Abebe (Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention (CGE) member from Ethiopia), Mr. Rizaldi Boer (Indonesia), Mr. Sangay Dorji (Bhutan), Mr. Takeshi Enoki (CGE member from Japan), Mr. Peter Aarup Iversen (Denmark), Ms. Baasansuren Jamsranjav (Mongolia), Mr. Christoph Streissler (Austria) and Mr. Jongikhaya Witi (South Africa). Mr. Enoki and Mr. Witi were the co-leads. Mr. Boer and Mr. Iversen were the land-use, land-use change and forestry (LULUCF) experts that undertook the TA of the technical annex in accordance with decision 14/CP.19, paragraphs 10–13.
- 6. The TA of the technical annex provided by Brazil was undertaken in accordance with the procedures contained in decisions 2/CP.17, 14/CP.19 and 20/CP.19. This technical report on the TA was prepared by the LULUCF experts of the TTE following decision 14/CP.19, paragraph 14.
- 7. During the TA, the LULUCF experts and Brazil engaged in technical discussions, during which Brazil provided clarifications to questions raised by the experts. These discussions facilitated a common understanding and the identification of the capacitybuilding needs and the areas for technical improvement. Following the TA of the technical annex, the LULUCF experts prepared and shared the draft technical report with Brazil for its review and comment.
- 8. The LULUCF experts responded to and incorporated the comments referred to in paragraph 7 above from Brazil and finalized this technical report in consultation with Brazil.

# c. Summary of results

9. In decision 1/CP.16, paragraph 70, the Conference of the Parties encouraged developing country Parties to contribute to mitigation actions in the forest sector by undertaking a number of activities, as deemed appropriate by each Party and in accordance with their respective capabilities and national circumstances. In the context of results-based payments and in line with decision 12/CP.17, Brazil, on a voluntary basis, proposed a FREL covering the activity "reducing emissions from deforestation" for the purpose of a technical assessment in accordance with decision 13/CP.19 and its annex. The activity was implemented in the Brazilian Amazon biome that makes up 49.29 per cent of the national

territory. The FREL was developed using a dynamic mean of the carbon dioxide (CO2) emissions associated with gross deforestation since 1996, which is updated every five years. Brazil adopted the dynamic approach for incorporating the progress achieved over time with the implementation of policies and measures to reduce deforestation in the Amazonia biome. In its submission of a technical annex through its first BUR, Brazil reported the results from the implementation of activities to reduce emissions from deforestation for the period 2006–2010, which amount to 2,971.02 million tonnes of carbon dioxide equivalent (Mt CO2 eq).

# II. TECHNICAL ANALYSIS OF INFORMATION REPORTED IN THE TECHNICAL ANNEX TO THE BIENNIAL UPDATE REPORT

# a. Technical annex

10. For the technical annex to the BUR submitted by Brazil, see the annex to this report.<sup>7</sup>

# **b. Technical analysis**

- 11. The scope of the TA is outlined in decision 14/CP.19, paragraph 11, according to which the TTE shall analyse the extent to which:
  - a) There is consistency in methodologies, definitions, comprehensiveness and the information provided between the assessed FREL and the results of the implementation of the REDD-plus activities;
  - b) The data and information provided in the technical annex is transparent, consistent, complete and accurate;
  - c) The data and information provided in the technical annex is consistent with the guidelines referred to in paragraph 9 of decision 14/ CP.19; (d) The results are accurate, to the extent possible.
  - d) The results are accurate, to the extent possible.
- 12. The remainder of this chapter presents the results of the TA of the technical annex to the BUR according to the scope outlined in paragraph 11 above.

# 1. Consistency in methodologies, definitions, comprehensiveness and the information provided between the assessed reference level and the results in the technical annex

13.In accordance with paragraph 3 of decision 14/CP.19, the data and information used by Parties in the estimation of anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes related to REDD-plus

Decision 14/CP.19, paragraph 14(a).

activities undertaken by Parties should be transparent, and consistent over time and with the established FRELs and/or forest reference levels in accordance with decision 1/CP.16, paragraph 71(b) and (c), and decision 12/CP.17, chapter II.

14. The LULUCF experts note that Brazil has been consistent in using the same methodologies and definitions for developing the FREL and for estimating the results from the implementation of activities to reduce emissions from deforestation during the period 2006–2010. This includes:

- a) Using consistent methodologies and data to generate activity data on gross deforestation of primary forests, in particular, the same forest monitoring system detecting deforestation as areas with a clear-cut pattern, using the same approach (adjusted deforestation increment) to assess the deforestation area for each year, using the same minimum mapping unit (6.25 ha) and using a spatially explicit identification system for identifying deforestation;
- b) Using consistent methodologies and data to generate emission factors, in particular, the same carbon map and the same stratification of primary forest of the Brazilian Amazon biome into 22 different forest types with different carbon stocks depending on forest type and location;
- c) Including the same three carbon pools: above-ground biomass, below-ground biomass and litter;
- d) Including the same gases: CO2 only;
- e) Covering the same area: the Brazilian Amazon biome of approximately 4,197,000 km2;
- f) Using the assumption that all carbon from the three carbon pools is lost in the year of the deforestation event and not including any subsequent removals of CO2 in the area;
- g) Using a forest definition that is fully consistent with the forest definition used for the construction of the FREL.

15. The LULUCF experts conclude that the presentation of the results from the implementation of the activity on reducing emissions from deforestation is consistent with the assessed FREL for the Amazon biome. The LULUCF experts commend Brazil for ensuring full consistency of the data and methodologies described in the FREL for the years 1996–2005 and in the technical annex with results from the implementation of the activity on reducing emissions from deforestation for the years 2006–2010.

# 2. Transparency, consistency, completeness and accuracy of the data and information provided in the technical annex

16.The LULUCF experts note that in its submission, Brazil provided weblinks to additional information, in particular, to sources of activity data and carbon densities of different forest types. In addition, Brazil provided links to the website for the programme for deforestation assessment in the Brazilian Legal Amazonia (PRODES), which uses remote-sensing images and digital image-processing techniques for monitoring deforestation areas. Additional information for each of the years 2006–2010 can be accessed on this website. The LULUCF experts commend Brazil for these efforts to increase the transparency and ensure the completeness<sup>8</sup> of the data and information provided, allowing for the reconstruction of the results.

17.Referring to decision 12/CP.17, paragraph 8, the FREL shall be established by taking into account decision 4/CP.15, paragraph 7, and maintaining consistency with anthropogenic forest-related greenhouse gas (GHG) emissions by sources and removals by sinks as contained in each country's GHG inventory. The assessment team for the FREL noted that, overall, Brazil's FREL maintains consistency, in terms of sources for the activity data and emission factors, with the GHG inventory included in Brazil's second national communication. The LULUCF experts note that this is also true for the estimated results from the implementation of the activity on reducing emissions from deforestation for the period 2006–2010.

18. The LULUCF experts note that the use of spatially explicit identification of gross deforestation over time as undertaken by Brazil ensures that only gross deforestation of primary forests is included in the estimates and that it makes it possible to accurately track deforestation over time. In the view of the LULUCF experts, Brazil has sufficiently justified that no ground truth was required for estimating activity data or emission factors owing to the unequivocal identification of clear-cut patches using remote sensing and the assumption that all carbon from the three carbon pools included was lost in the year of the deforestation event and that any subsequent CO2 removal was not considered.

19. The LULUCF experts note that Brazil already provided information on uncertainties in its FREL submission in October 2014, and that this remains valid also for the estimated results from the implementation of the activity on reducing emissions from deforestation for the period 2006–2010. This includes: uncertainties associated with the carbon density map, including from data collection; the allometric equations

<sup>8</sup> Complete here means the provision of information that allows for reconstruction of the results.

used for calculating the carbon content; the biomass from smaller trees, palms and vines; the aggregation of forest types; and the rules used to estimate the carbon density of forest type per RADAMBRASIL volume.<sup>9</sup>

20.In response to a question from the LULUCF experts, Brazil clarified that all data (images and annual maps) are publicly available, which allows for reconstruction of the annual increments by stakeholders. Brazil is currently developing a national forest inventory that is expected to provide data that will improve the accuracy of estimates. The LULUCF experts commend Brazil for providing transparent information and continuing to improve the accuracy of estimates.

21. The LULUCF experts conclude that Brazil has provided the necessary information allowing for reconstruction of the results from the implementation of the activity on reducing emissions from deforestation. The data and information provided in the technical annex are considered to be transparent, consistent, complete and accurate to the extent possible.

# 3. Consistency with the guidelines for elements to be included in the technical annex

22.Brazil provided data and information on all the elements according to the guidelines contained in the annex to decision 14/CP.19, namely: summary information from the final report containing the assessed FREL; results in tonnes of carbon dioxide equivalent per year, consistent with the assessed FREL; a demonstration that the methodologies used to produce the results are consistent with those used to establish the assessed FREL (as outlined in chapter II.B.1 above); a description of forest monitoring systems and the institutional roles and responsibilities for measuring, reporting and verifying the results; necessary information that allows for the reconstruction of the results (as outlined in chapter II.B.2 above); and a description of how the elements contained in decision 4/CP.15, paragraph 1(c) and (d), have been taken into account.

23.In its submission, Brazil provided a summary table with results from the implementation of the activity on reducing emissions from deforestation for the years 2006–2010, consistent with the assessed FREL and allowing for reconstruction of the results. The emission reduction results achieved are listed per year in table 2 of the technical annex and amount to a total of 2,971.02 Mt CO2 for the five years covered.

24. The LULUCF experts noted that Brazil provided a description of the forest monitoring system and, in table 5 of the technical annex, a

The RADAMBRASIL project was conducted between 1970 and 1985 and covered the entire Brazilian territory (with a special focus on Amazonia) using airborne radar sensors. The results from the RADAMBRASIL project include texts and thematic maps (geology, geomorphology, pedology, vegetation, potential land use and assessment of natural renewable resources) that are still broadly

summary of the institutional roles and responsibility for the measurement, reporting and verification (MRV) of the results in the technical annex, together with the weblinks for accessing further information. The roles and responsibilities of the agencies and institutions involved in the MRV are transparently provided. During the consultation process, Brazil explained that the team working on the GHG inventory also uses the same tools (e.g. remotely sensed data of the same resolution and minimum mapping area, the same carbon density map, etc.) that are used to compile the data and information for REDD-plus. This helps to ensure greater consistency between the inventory and REDD-plus estimates. In addition, Brazil informed the LULUCF experts that it has also established a multidisciplinary REDD+ Technical Working Group for ensuring good coordination across the agencies involved. The LULUCF experts commend Brazil for sharing this information.

25. The forest monitoring system used is a subnational system covering the Legal Amazonia, which is a slightly larger area than the Amazon biome. The system assesses gross deforestation on an annual basis based on wall-to-wall mapping with a minimum mapping unit of 6.25 ha.

26.According to decision 11/CP.19, paragraph 4(b), the national forest monitoring system (NFMS) should enable the assessment of different types of forest in the country, including natural forest. During the consultation process, Brazil explained that it carried out spatially explicit identification of 22 different forest types using a carbon density map, and that it considers all forests that are included to be natural forests.

27. Referring to decision 1/CP.16, paragraph 71(c), footnote 7, the subnational monitoring and reporting should include: monitoring and reporting of emissions displacement at the national level, if appropriate, and reporting on how displacement of emissions is being addressed; and on the means to integrate subnational monitoring systems into a national monitoring system. In 2015, Brazil started developing an NFMS to monitor deforestation on an annual basis in other biomes beyond the Amazon. For the period 2006–2010, this was not yet in place, but Brazil explained that it had different monitoring initiatives that can provide information on possible displacement inside and outside of the Legal Amazonia area. This included mapping of deforestation for the Cerrado biome between 2002 and 2008, followed by annual assessments of the deforestation rate for 2009 and 2010. The maps for the period 2002-2008 had some distortions that are not readily identifiable, and Brazil is rebuilding the time series of these maps. Preliminary data from annual assessments since 2008 show that deforestation declined in 2009 and 2010. The Cerrado biome is the second most important biome in Brazil in terms of emissions from deforestation: it contributed to approximately 20 per cent of the total CO2 emissions from deforestation in Brazil during the period 1994–2002. The Legal Amazon contributed to approximately 70 per cent of the total CO2 emissions during the same period, according to information from the second national communication.

28. Furthermore, through the DEGRAD programme<sup>10</sup>, Brazil is mapping the occurrence of degraded areas in the Legal Amazonia. Data are available for the period 2007–2010, which indicated that emissions from degradation decreased as emissions from deforestation decreased. While fire is closely associated with climatic conditions in a particular year, there is no causal relationship between reduction in deforestation in some areas and the occurrence of forest degradation. The link to maps generated by DEGRAD, with evidence of forest degradation, is provided on the Brazilian National Institute for Space Research (INPE) website,<sup>11</sup> and can be accessed by the public as part of the INPE policy on open data distribution. The LULUCF experts commend Brazil for the efforts made.

29. The LULUCF experts note that during the period 2006–2010, the forest monitoring system in place did not allow Brazil to fully estimate possible displacement of emissions at the national level. The LULUCF experts looked at available information, such as the harvest data from the Food and Agriculture Organization of the United Nations and the Brazilian Forest Service website, and noted that, thus far, there is no evidence of displacement of emissions. In addition, the annual assessments of the deforestation rate for the years 2009 and 2010 for the Cerrado biome as well as the information on emissions from degradation in the Legal Amazonia for the period 2007–2010 indicated that displacement of emissions has not been a major issue (also refer to paras. 27 and 28 above). Based on this available information, the LULUCF experts note that, so far, there is no evidence of displacement of emissions.

30.Brazil provided a description of how the Intergovernmental Panel on Climate Change (IPCC) guidance and guidelines were taken into account, in accordance with paragraph 1(c) of decision 4/CP.15. For the estimation of emission reduction results in the Amazonia biome, Brazil used a modification of the methodology provided in the 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry for estimation of carbon stocks in forest land converted to other land-use categories, which does not take into account subsequent land use. Accordingly, the gross emissions from deforestation were estimated from 2006 to 2010 by combining activity data (i.e. areas of annual gross

Since 2008, Brazil has, through its National Institute for Space Research (INPE), implemented a system to assess the areas affected by degradation in the Amazon biome, through the use of satellite imagery of the same spatial resolution as that used to assess deforestation increments (Landsat images with a resolution of up to 30 m). This system, referred to as DEGRAD, provides detailed maps of areas undergoing a degradation process.

<sup>11</sup> Available at <a href="http://www.obt.inpe.br/degrad/">http://www.obt.inpe.br/degrad/>.</a>

deforestation) with the appropriate emission factors (i.e. emissions associated with the corresponding forest type).

# 4. Accuracy of the results in the technical annex

31. The LULUCF experts note that the estimation of results from the implementation of the activity on reducing emissions from deforestation in the Brazilian Amazon biome has been undertaken using a transparent and consistent approach. The LULUCF experts commend Brazil for the significant long-term efforts in building up a robust NFMS that is capable of providing transparent estimates of emissions from deforestation.

32.Both the established FREL and the results obtained in the period 2006–2010 from the implementation of the activity on reducing emissions from deforestation are based on the assumption that deforestation takes place in areas with intact forests that have carbon content as determined by the carbon density map. The LULUCF experts note that if the carbon densities in these areas have been lowered before a clear-cut event, for example, due to human activities or forest fires, then emissions from deforestation are most likely overestimated<sup>12</sup>. They also note that, because Brazil has used a consistent methodology for estimating emissions in the establishment of the FREL and the results during the period 2006–2010, the net effect will partially cancel out. Furthermore, Brazil clarified that the extent of the degraded area that is subsequently deforested is small (see table b.1 in annex III of the modified FREL submission).

33. As mentioned in paragraph 19 above, Brazil provided some information related to the uncertainties. However, this information was not used in assessing the uncertainties of the emission estimates. Thus, the effect of these uncertainties on the accuracy of the results from the implementation of the activity on reducing emissions from deforestation could not be assessed. Despite this, and based on the assumptions used, the LULUCF experts conclude that the results are accurate, to the extent possible.

# c. Areas identified for technical improvement

34. The LULUCF experts conclude that the areas for technical improvement identified in the final report on the technical assessment of Brazil's FREL<sup>13</sup> also apply to the provision of information on results from the implementation of the activity on reducing emissions from deforestation. These include the following:

a) Continuation in updating and improving the carbon density map, including through the use of improved ground data from Brazil's first national forest inventory, possibly prioritizing geographic areas

<sup>12</sup> FCCC/TAR/2014/BRA, paragraph 18(b).

<sup>13</sup> FCCC/TAR/2014/BRA.

where deforestation is more likely to occur;

- b) Expansion of the coverage of carbon pools, including improving the understanding of soil carbon dynamics after the conversion of forests to non-forests;
- c) Consideration of the treatment of non-CO2 gases to maintain consistency with the GHG inventory;
- d) Continuation of the improvements related to monitoring of forest degradation;
- e) Expansion of the forest monitoring system to cover additional biomes.

35. Furthermore, the LULUCF experts note that Brazil could consider the use of uncertainty analysis for estimates provided, as encouraged by decision 17/CP.8, annex, paragraph 24.

# d. Comments and/or responses by the Party concerned

36. During the consultation process, Brazil noted that the collection of data related to emissions from forest degradation could be an area with capacity-building needs. Increasing knowledge of the complex dynamics associated with forest degradation could enable Brazil to potentially include the reduction of emissions from forest degradation as a REDD-plus activity in future FREL submissions.

# **III. Conclusions**

- 37. The LULUCF experts conclude that Brazil has reported results from the implementation of one activity, "reducing emissions from deforestation", which is defined as gross deforestation of primary forests, and by following a subnational approach covering the Brazilian Amazon biome representing 49.29 per cent of the national territory. The results include estimates of emissions of CO2 from three carbon pools: above-ground biomass, belowground biomass and litter from gross deforestation identified as clear cuts of a minimum mapping unit of 6.25 ha for the period 2006–2010. The results of the activity were reported using consistent methodologies, definitions, assumptions and information as used for the assessed FREL.
- 38. The LULUCF experts consider that the data and information provided in the technical annex are transparent, consistent, complete and accurate.
- 39. The LULUCF experts further found that the data and information provided in the technical annex are consistent with the guidelines referred to in paragraph 11 of decision 14/CP.19.

40. The results are accurate to the extent possible, based on the assumptions used. The LULUCF experts note that Brazil has initiated a number of programmes to assess possible displacement of emissions while taking steps to implement an NFMS (refer also to paras. 27 and 28 above on areas identified for technical improvement). In addition, they note that, at present, information from monitoring of other forest biomes and degradation in the Amazon biome indicates that displacement of emissions is not a major issue.

41.In conclusion, the LULUCF experts commend Brazil for showing a strong commitment to continuous improvement of its data and information used for producing results, in line with a stepwise approach, which are consistent with those used to establish its assessed FREL. Some areas for future technical improvements have been identified in this report. At the same time, the LULUCF experts acknowledge that these improvements are subject to national capabilities and circumstances, and note the importance of adequate and predictable support<sup>14</sup>. The LULUCF experts also acknowledge that the TA process was an opportunity for a facilitative and constructive technical exchange of views and information with Brazil<sup>15</sup>.

# **Annex**

Technical annex to the biennial update report

Owing to the complexity and length of the submitted technical annex to the biennial update report and in order to maintain the original formatting, the technical annex is not reproduced here. It can be downloaded from the UNFCCC website at

<a href="http://unfccc.int/8722">http://unfccc.int/8722>.</a>

<sup>14</sup> Decision 2/CP.17, paragraph 57.

<sup>15</sup> Decision 14/CP.19, paragraph 13.



# Developed by:

Ministry of the Environment
Secretariat for Climate Change and Environmental Quality
Department of Policies to Combat Deforestation
Climate Change and Forests Division

# Members of the Technical Panel of National Experts on REDD+ Safeguards (2012):

Ana Raquel Garcia Mosque

André Nahur

Alice Thault

Brenda Brito

Camila Pianca

Felipe Almeida

Fernanda Carvalho

Leonardo Hasenclever

Mariana Christovam

Priscilla Feller

Tatiana Vilaca

# TABLE OF CONTENTS

1. Introduction	
3. REDD+ in Brazil	173
3.1. National Context	173
3.2. Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm)	175
3.3. Amazon Fund	179
3.4 Implementation of the Warsaw Framework for REDD+ by Brazil	184
4. The safeguards of Cancun in the Brazilian context	186
5. Existing information systems in Brazil	199
6. Developing and implementing Brazil's National REDD+ Safeguards Information System (REDD+ SIS)	201
Annex I: REDD+ in the Brazilian context	202
Annex II: Amazon Fund's Social and Environmental Safeguards	205
Annex III. Summary of the results from the survey on the information and sources required for the SIS REDD+ and recommendations from the Panel of Experts to the MMA	209

# 1. INTRODUCTION

In November 2013, after eight years of negotiations, the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) defined an international architecture to provide incentives for developing countries to reduce greenhouse gas emissions from deforestation and forest degradation and the role of forest conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+).

The Warsaw Framework for REDD+ (Decisions 9-15 / CP.19) establishes the main international rules and procedures for mitigation efforts in the forest sector by developing countries to be recognized by the UNFCCC and compensated through payments for performance. These decisions present definitions of aspects such as reference levels, national forest monitoring systems, results-based financing, among others.

Several definitions about REDD+ activities were included in previous UNFCCC decisions, particularly in decision 1/CP.16, which is another important milestone for REDD+.

Paragraph 72, decision 1/ CP.16 requests developing country Parties, when developing and implementing their national REDD+ strategies, to address the safeguards[1] detailed in Appendix I, paragraph 2 of decision 1/ CP.16, ensuring the full and effective participation of relevant stakeholders, inter alia indigenous peoples and local communities.

Paragraph 2 in the Appendix I states that developing countries should promote and support the following safeguards during the implementation of the activities referred to in paragraph 70 decision 1/ CP. 16:

- (a) That actions complement or are consistent with the objectives of national forest programs and relevant international conventions and agreements;
- (b) Transparent and effective national forest governance structures, taking into account national legislation and sovereignty;
- (c) Respect for the knowledge and rights of indigenous peoples and members of local communities, by taking into account relevant international obligations, national circumstances and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration on the Rights of Indigenous Peoples;
- (d) The full and effective participation of relevant stakeholders, in particular indigenous peoples and local communities, in the actions referred to in paragraphs 70 and 72 of this decision;
- (e) That actions are consistent with the conservation of natural forests and biological diversity, ensuring that the actions referred to in paragraph 70 of this decision are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits;
- (f) Actions to address the risks of reversals;
- (g) Actions to reduce displacement of emissions.

Decision 1/CP 16 also requests, developing country Parties aiming to undertake REDD+ activities, in the context of the provision of adequate and predictable support, to develop a system for providing information on how the safeguards referred to in appendix I to this decision are being addressed and respected throughout the implementation of these activities.

The development of these safeguards information systems should take into account national circumstances and the respective capabilities of developing countries, whereas acknowledging national sovereignty, the relevant international obligations and agreements, and respecting gender considerations.

Decision 12 / CP.17 states that the national safeguards information systems should [3]:

- (a) Be consistent with the guidance identified in decision 1/CP.16, appendix I, paragraph 1;
- (b) Provide transparent and consistent information that is accessible by all relevant stakeholders and updated on a regular basis;
- (c) Be transparent and flexible to allow for improvements over time;
- (d) Provide information on how all of the safeguards referred to in appendix I to decision 1/CP.16 are being addressed and respected;
- (e) Be country-driven and implemented at the national level;
- (f) Build upon existing systems, as appropriate.

The communication from developing country Parties to the UNFCCC on how the safeguards of Cancun are addressed and respected throughout the implementation of REDD+ will take the form of a summary of information [4], which will be part of the National Communication or may be submitted voluntarily by the country via the REDD+ platform on the UNFCCC website [5]. This submission is a requirement for obtaining results-based payments, according to decision 9 / CP.19, paragraph 4.

This report lays out preliminary information on how the REDD+ safeguards were addressed and respected by Brazil throughout the implementation of initiatives to reduce emissions from deforestation in the Amazon. The sources of information are diverse and were collected at different periods during the implementation of public policies that contributed to Brazil's REDD+ results presented in the REDD+ Annex submitted to the UNFCCC in December 2014.

The information presented in this summary of information on how the Cancun safeguards have been addressed and respected are strictly related to the results achieved by Brazil reducing emissions from deforestation in the Amazon biome between 2006 and 2010, having the period between 1996 to 2005 as reference, the same timeframes referred to in Brazil's Forest Reference Emission Levels to the UNFCCC[6].

The choice of this period is explained by the implementation of the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (Plano de Prevenção e Controle do Desmatamento na Amazônia Legal, PPCDAm), launched in 2004, which to a great extent was responsible for Brazil's emission reductions from deforestation during those years. This

summary also presents information on how the Cancun safeguards were implemented by the Amazon Fund investing the resources received from REDD+ payments since 2009. Additional information on how the safeguards are addressed and respected will be included in the following summaries of information, as the country submits the results achieved reducing emissions from deforestation and forest degradation in other biomes.

Preliminarily, this summary also presents information regarding the process of setting up the national REDD+ Safeguards Information System (SIS REDD+), with a view to provide transparency to this process.

It's worth noting that the summary of information and the SIS REDD+ are two distinct instruments. The first is intended to provide information on the implementation of the Cancun Safeguards with respect to the results for which payments will be claimed. Such document, presented on regular basis, offers a picture of the implementation of the safeguards, focused on REDD+ results, being a requirement to access REDD+ payments. The second is a system that, in Brazil, is still at its early stage of development and should enable the constant monitoring of the implementation of REDD+ safeguards in Brazil.

When the SIS REDD+ becomes fully operational, the country will be able to generate its summary of information from it. For the moment, however, this summary of information on safeguards had as its basis the existing sources of information (information systems, websites, reports, etc.) and the relevant legal and institutional frameworks in place. *Figure 1* below shows schematically the distinction between these two instruments.

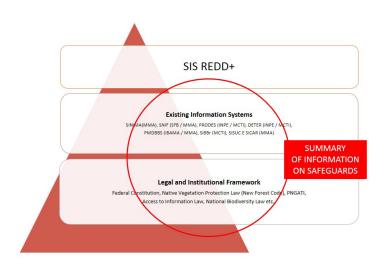


Figure 1: The national REDD+ Safeguards Information System (SIS REDD+) and the Summary of Information on Safeguards as distinct instruments

# 2. METHODOLOGY

This summary of information about how the Cancun safeguards were addressed and respected by Brazil throughout the implementation of REDD+ activities was built on the basis of the *report Survey to identify information and sources to feed the Safeguards Information System,* from April 2013, an internal document to the Ministry of Environment (MMA) developed by a panel of national experts in REDD+ safeguards (Technical Panel) created to provide a preliminary, non exhaustive, survey of information and sources on safeguards.

Most members of this *ad hoc* Technical Panel were from Brazilian civil society organizations and their selection by the MMA was based on their relevant contributions to the safeguards debate and on their availability and willingness to participate. Such format proved to be very effective and should be replicated for the development of the SIS REDD+, allowing interested experts and stakeholders to provide support to the federal government during the REDD+ SIS development process in 2015.

The work for the survey by the Technical Panel on safeguards was carried out on a voluntary basis in the course of the second half of 2012, with four meetings and the preparation of preliminary outcomes.

For identifying the relevant information and its sources, each representative of the Technical Panel had to answer a set of questions aimed at harmonizing their understanding. After that, an exercise was undertaken applying the World Resources Institute (WRI) methodology described in the report "A Framework for Designing a National System to Implement REDD+ Safeguards" [7], which seeks to map the main elements of a national safeguards information system - institutions, objectives, functions and rules. According to this methodology, goals define what the safeguards are meant to achieve. Safeguard functions are the processes by which those goals are achieved, while the rules are the institutions that operationalize the national safeguards system.

The literature consulted had as a basis the national legislation and international agreements, federal policies and programs, administrative processes, forums, committees, existing institutions and systems considered relevant to the implementation of the Cancun safeguards.

This summary was based on information from the survey report prepared by the Technical Panel. A draft of this summary was made available at the REDD+ Brazil website for contributions for two weeks, from 27 October to 7 November, (http://mma. gov.br/redd/index.php/pt/salvaguardas/sum%C3%A1rio-sobre-salvaguardas) to collect inputs from stakeholders and give publicity to the process. The draft was then presented, during a meeting organized by the MMA on November 7, 2014, to the Technical Panel members and other experts referred by them, for quality control purposes. The revised document, with the inputs received through the website and from the meeting, was then forward by the MMA to the Ministry of Science, Technology and Innovation (MCTI), so that it could be incorporated into Brazil's National Communication to the UNFCCC and submitted to the public consultation process conducted by the MCTI. The report was then sent on a voluntary basis to the UNFCCC Secretariat so it could be made available through the web platform as per paragraph 3, decision 12/ CP.19.

It should be noted that this summary of information presents the state of the art of the implementation of the Cancun safeguards by Brazil throughout the implementation of the actions for reducing emissions from deforestation in the Amazon biome (through PPCDAm) between 2006 and 2010 and the projects funded with REDD+ results-based payments received through the Amazon Fund.

This document is a non-exhaustive preliminary assessment of the implementation of the Cancun safeguards by Brazil. The goal is to take the first step towards the creation of an effective dialogue process with the Brazilian society about the implementation of Cancun safeguards and about the creation of the SIS REDD+, acknowledging that its effective implementation should rely on a gradual and participatory approach. This process is still incipient in Brazil and it demands a coordinated structure that enables the full and effective participation of all relevant stakeholders.

# 3. REDD+ IN BRAZIL

# 3.1. National Context

Brazil is a mega diverse country with the largest continuous forested area in the world. Brazilian forests, by providing a variety of goods and environmental services, play important social, economic and environmental roles. About 60% of the country is covered by native vegetation, spread across biomes with particular sets of characteristics.

Table 1: National statistics, reference year 2009. Source: Brazilian Forest Service, SFB, 2010

Total population (2010)	191 million
Total country area	851 million ha
Total forest covered area	516 million ha
Forested area share of total country area	60.7%
Forested area per inhabitant	2.7 ha
Natural forest areas	509.8 million ha
Planted forest areas	6.8 million ha
Federal Protected areas	74 million ha
Indigenous lands	106 million hectares
Registered public forests (2010)	290 million ha
Federal community forests	128 million ha
Public forest under forest concession	146 000 ha

About 78% of Brazil's  $CO_2$  emissions in 2000 came from the land use, land use change and forestry sector (LULUCF) - see *Figure 2*.

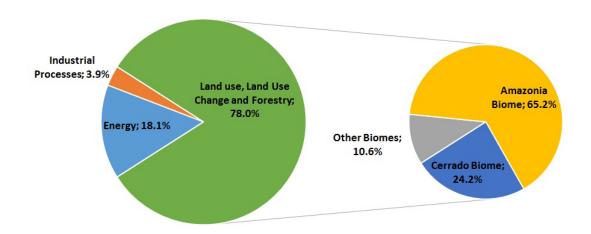


Figure 2: Share of total anthropogenic CO2 emissions by sector in 2000. Source: Second National Communication to the UNFCCC.

According to the Amazonian Gross Deforestation Monitoring Project (PRODES), from the National Institute for Space Research (INPE), MCTI, 2004 had the second highest annual deforestation rate on record in the Legal Amazon, reaching 27,772 km². In the same year, PPCDAm was launched, with the participation of representatives from the Chief of Staff of the Presidency of the Republic, 13 Ministries and the civil society.

Brazil has achieved significant results with its efforts to reduce greenhouse gas emissions from deforestation and forest degradation since 2006. International recognition for these efforts materializes through results-based REDD+ payments. For the purpose of earning the recognition of its REDD+ results under the UNFCCC, Brazil must, *inter alia*, present its National REDD+ Strategy (ENREDD+), undergo evaluation of its reference levels (completed for the reference level for reducing emissions from deforestation in Amazon biome in November 2014), undergo verification process of the results presented in the REDD+ Annex to the Biennial Update Report (BUR) in December 2014 and present a summary of information on how the Cancun safeguards were addressed and respected in the implementation of REDD+ activities as part of its National Communication to the UNFCCC.

The ENREDD+ was developed through a broad and participatory process initiated in 2010. The ENREDD+ aims to coordinate and promote synergies between the National Climate Change Policy (Law no. 12.187 / 2009), the Native Vegetation Protection Act (New Forest Code), the plans to prevent and control deforestation in the biomes (see details on the PPCDAm in the next section) and other laws, policies and regulations that aim to reverse the loss of forests, a government priority.[

**Figure 3** presents an illustration of some of the instruments that are part of the legal and institutional framework for REDD+ in Brazil.



Figure 3: Legal and Institutional Framework for REDD+

In the following sections and throughout this summary, the PPCDAm and the Amazon Fund will be described in detail. These are initiatives from the federal government linked to Brazil's REDD+ results in the Amazon biome since 2006.

# 3.2. Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm)

Brazilian environmental policies take into account the specificities of each biome from its formulation through its implementation. A biome is an eco-region, a set of ecosystems comprising similar vegetation physiognomic characteristics in a given region. The Brazilian biomes are: Atlantic Forest, Amazon, Caatinga, Cerrado, Pantanal and Pampa.

The first biome to have a plan to combat deforestation was the Amazon, the largest rainforest in the world. Brazil has 60% of this biome in its territory. For administrative purposes, the Brazilian government adopts the geographic region known as "Legal Amazon" to develop its initiatives, which includes portions of the Cerrado and the Pantanal biomes. **PPCDAm** is the main framework of actions to protect the Brazilian Amazon rainforest.

The PPCDAm is a tactical-operational plan, created in 2004, which clearly defines the actions, the responsible actors and the goals to be achieved in order to control and prevent illegal deforestation and promote sustainable regional development in the Amazon. It consists of coordinated governmental efforts to facilitate the transition from the predatory growth to a sustainable development model, taking into consideration the importance of keeping forests standing, of its associated natural resources and of the promotion of economic and social means to benefit the 25 million inhabitants of the Amazon.

In order to promote the continuous reduction of deforestation and forest degradation in the Amazon, PPCDAm was structured in three thematic axes that guide government action, namely:

- 1. Land tenure regularization and land use planning;
- 2. Environmental Monitoring and Control; and
- 3. Fostering Sustainable Production Activities.

To implement the actions set out on PPCDAm's three axes, each participating institution channels funds from their own budget or from other sources.

PPCDAm fostered, since its creation, the development of public policies to meet the challenges of reducing illegal deforestation in the Amazon. To achieve such goal, the plan acts as an umbrella for several public policies, programs and initiatives. Among these are the following:

- Plano de Desenvolvimento Regional Sustentável do Xingu –
- PDRS Xingu ("Xingu Sustainable Regional Development Plan");
- Plano Nacional de Promoção das Cadeias de Produtos da Sociobiodiversidade PNPSB ("National Plan for Promoting the Supply Chains of Sociobiodiversity Products");
- Política de Garantia de Preços Mínimos para Produtos da Sociobiodiversidade PGPM-Bio ("Minimum Price Guarantee of socio-biodiversity products Policy");
- Política Nacional de Gestão Territorial e Ambiental das Terras Indígenas PNGATI ("National Policy on Territorial and Environmental Management of indigenous lands");
- Programa Agricultura de Baixa emissão de Carbono ABC ("Low Carbon Emission Agriculture Program");
- ❖ Programa Áreas Protegidas da Amazônia ARPA ("Amazon Region Protected Areas Program");
- Programa de Apoio à Conservação Ambiental Bolsa Verde ("Environmental Conservation Support Program - Green Grant" - part of Brazil without extreme Poverty Plan);
- Programa de Manejo Florestal Comunitário e Familiar PMFC ("Community and Family Forest Management Program");
- ❖ Programa de Regularização Ambiental PRA ("Environmental Regularization Program");
- Programa Nacional de Fortalecimento da Agricultura Familiar PRONAF ("National Program for Strengthening Family-based Agriculture");
- Programa Terra Legal (Regular Land Program").

Each of these governmental programs have their own resources, goals, and target groups set to converge with the objectives proposed under PPCDAm, spanning from environmental

conservation to the promotion of sustainable agricultural production systems. This approach was taken after the federal government recognized that effectively tackling deforestation would entail joint and coordinated efforts in various fronts, since drivers often go beyond the environmental sector.

In addition to the federal government initiatives, the active participation of state governments through the Planos Estaduais para Prevenção e Controle do Desmatamento PPCDs (States' Plan for Prevention and Control of Deforestation), is of great importance to the implementation of the PPCDAm. The dialogue with the State governments has been gaining strength since the second phase of PPCDAm, when a coordinated strategy at the federal and state levels has become more robust with greater integration between the PPCDAm and the PPCDs.

Important results have been achieved during the first and second phases of the PPCDAm. In the Land tenure regularization and land use planning axis, 25 million hectares of Federal Protected Areas were created and another 10 million hectares of indigenous lands have been approved, mostly around the expansion front for deforestation. In addition to that, approximately 25 million hectares of state as well as municipal Protected Areas have been created since 2004, meaning that all levels of government contributed to the expansion of Protected Areas in the Amazon biome. Besides the expansion of protected areas, the Amazon Ecological-Economic Macrozoning Plan was created and 25,618 rural possessions have been georeferenced by *Terra Legal*.

The Environmental Monitoring and Control axis had hundreds of integrated law enforcement operations, based on technical criteria and territorial priorities, as well as significant improvement of environmental monitoring systems, which involved satellite imagery analysis, such as PRODES, the Sistema de Detecção do Desmatamento na Amazônia Legal em Tempo Real DETER (Real Time Deforestation Detection System) which serves as a guide for integrated enforcement operations and, more recently, the Sistema de Detecção da Exploração Seletiva de Madeira – DETEX (Selective Logging Detection System), the Mapeamento da Degradação Florestal na Amazônica Brasileira – DEGRAD ("Forest Degradation in the Brazilian Amazon Mapping System") and the TerraClass Project to assess land use and occupation dynamics of deforested areas.

On the Fostering Sustainable Production Activities axis the highlights have been the initiatives to promote a forest economy in the Amazon, with 13,852 families cared for in projects that aim at promoting sustainable management practices in rural settlements and the *Bolsa Verde* Program, whose target group is, among others, populations living in sustainable use Protected Areas. It is also noteworthy that 225,000 hectares of forests are now under concession for Sustainable Management and the creation of that the Sustainable Forest District of BR 163 has been created.

In its third phase (2012-2015), the following strategic objectives were stated for the three axes of PPCDAm (*Table 2*).

Table 2: Strategic objectives on PPCDAm's three axes Source: PPCDAm (2012-2015)

Axes	Strategic Goals
	Promote land use planning of public lands
Land tenure regularization and land use planning	Implement regional land use planning instruments to advance forest conservation
	Management of rural landholdings grid according to its diverse categories
Monitoring and Control	Speed up the licensing of forest management plans and forest concessions
	Improve the efficiency of law enforcement and deforestation command and control activities
	Enhance the government's presence in the Amazon
	Reduce administrative and criminal impunity related to illegal deforestation
	Promote environmental accountability of the main supply chains related to illegal deforestation
Fostering Sustainable Production Activities	Promote sustainable supply chains that provide alternatives to deforestation
	Promote good practices in agriculture, including replacing the use of fire as a management tool
	Increase the wood production and trade from sustainable management of forests
	Promote environmental compliance and foster sustainable production activities in agrarian reform settlements and family farming
	Generate science, technology and innovation about the Amazon to support sustainable development

PPCDAm identifies and addresses the drivers of deforestation, constituting the basis for REDD+ implementation. The implementation of REDD+ in Brazil in turn creates new positive incentives for the implementation of the PPCDAm through economic instruments that promote sustainable initiatives in the Amazon biome, thereby strengthening the third axis of PPCDAm (Fostering Sustainable Production Activities).

REDD+ has the potential to contribute to the permanence of the emission reductions achieved by reducing deforestation through PPCDAm, with new and additional resources to be raised internationally as results based payments. In addition to that, the lessons learned in the PPCDAm serve not only to improve public policies aimed at reducing deforestation in the Amazon but also in other Brazilian biomes and tropical countries.

Once approved, the ENREDD+ will tie the tactical-operational plan defined by PPCDAm, with specific REDD+ goals defined by Brazil, namely: (i) to improve the monitoring and impact assessment of public policies for REDD+, in order to maximize their contribution to global climate change mitigation, observing the Cancun safeguards; (ii) to integrate the management structures of the National Climate Change Plan and the Action Plans for the Prevention and Control of Deforestation in the biomes, seeking the convergence between climate and forest policies at the federal, state and municipal levels; and (iii) to contribute to the mobilization of international resources at a scale that is compatible with the voluntary national commitments to mitigate greenhouse gas emissions in the Brazilian biomes by 2020, as established by the National Climate Change Policy.

# 3.3. Amazon Fund

The Amazon Fund is currently Brazil's main funding instrument based on compensation for REDD+ results. Established by the Decree No. 6527 of August 1, 2008, its goal is to raise donations for non-reimbursable investments in efforts to prevent, monitor and combat illegal deforestation and to promote conservation and sustainable use of forests in the Amazon biome. Its creation was an outcome of the success achieved by the PPCDAm in reducing deforestation in the Amazon biome since 2004 and took place even before the definition of an international architecture for REDD+ under the UNFCCC.

The Amazon Fund supports **projects** in the following areas:

- Management of public forests and protected areas;
- Environmental control, monitoring and inspection;
- Sustainable forest management;
- **Economic activities created with sustainable use of forests:**
- Ecological and economic zoning, territorial arrangement and agricultural regulation;
- Preservation and sustainable use of biodiversity; and
- Recovery of deforested areas.

The Amazon Fund may use up to 20% of its resources to support the development of systems to monitor and control deforestation in other Brazilian biomes and in other tropical countries. The decree that created the Amazon Fund also recommends that the initiatives to be financed follow the guidelines of the Sustainable Amazon Plan and the PPCDAm.

The institution responsible for managing the Amazon Fund is the Brazilian Economic and Social Development Bank (Banco Nacional de Desenvolvimento Econômico e Social, BNDES), which is also in charge of fundraising results based payments, in coordination with the MMA, and contracting and monitoring the projects and actions supported. The Amazon Fund has a Guidance Committee (COFA), which is responsible for determining the guidelines and for monitoring the projects results; and a Technical Committee (CTFA), appointed by the MMA, whose role is to attest the emission reductions achieved in the Amazon.

The cap for fundraising is set annually by the MMA, taking into account the actual emission reductions from deforestation in the previous year, after being attested by the CTFA. Based on this information, the BNDES is authorized to raise donations to the Fund and in return issue certificates recognizing the contribution of the donors to the Fund. These certificates are nominal, non-transferable and do not generate rights or claims of any kind.

Entities from governments (federal, state and municipal), public and private companies and also from the civil society can submit projects to the Amazon Fund.

The following are the social and environmental safeguards applicable to the Amazon Fund projects:

- ❖ Legal Compliance
- Acknowledgement and guarantee of rights
- Distribution of benefits
- Economic sustainability, improving standards of living and reducing poverty
- Environmental conservation and remediation
- Participation
- Monitoring and Transparency
- Governance.

The document "REDD+ Social and Environmental Principles and Criteria", consolidated by Imaflora in 2010, served as a reference for defining these safeguards. The document was the result of an initiative that engaged representatives from the private sector, environmental organizations, indigenous peoples, traditional communities, smallholders and research institutions. *Table 3* presents the correlation between these Principles and Criteria and the Cancun Safeguards.

Table 3: Comparative Matrix of the Cancun Safeguards and REDD+ Social and Environmental Principles and Criteria conceived by the Brazilian civil society

CANCUN SAFEGUARDS [8]	REDD+ SOCIAL AND ENVIRONMENTAL PRINCIPLES AND CRITERIA
(A) That actions complement or are consistent with the objectives of national forest	1.1 REDD+ actions shall respect the Brazilian labor legislation, including requirements on health and safety and repression of any form of slave and child labor, while respecting the distinctiveness of the organization of labor of Indigenous Populations, smallholders and local communities.
programs and relevant international conventions	<ol> <li>1.2 REDD+ actions shall respect the Brazilian environmental legislation.</li> </ol>
and agreements.	1.3 REDD+ actions shall respect all international social, environmental, cultural, labor and commercial agreements ratified by Brazil.
(C) Respect for the	2.1 There shall be the recognition and respect of the constitutional, statutory and customary rights associated with land ownership, the official designation of occupied lands, and the use of natural resources of Indigenous Peoples, smallholders, including complete respect to the UN Declaration on the Rights of Indigenous Peoples, to the FAO Treaty on Agriculture and Food, and to the ILO Convention 169.
knowledge and rights of indigenous peoples and members of local communities, by taking	2.2 REDD+ actions shall recognize and value the socio- cultural systems and traditional knowledge of Indigenous Peoples, smallholders and local communities.
into account relevant international obligations, national circumstances	2.3 REDD+ actions shall respect the rights to self- determination of the Indigenous Peoples and local communities.
and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration	2.4 In the areas where REDD+ actions are implemented, lawful ownership and possession rights shall be respected, as well as those rights associated with the use of land and natural resources.
on the Rights of Indigenous Peoples.	2.5 There shall be formal mechanisms for conflict resolution associated with REDD+ actions, through dialogues that include the effective participation of all involved stakeholders.
	3.1 Benefits generated by REDD+ actions shall be accessed in a fair, transparent and equitable form by those who hold the rights to the use of land and/or natural resources and promote activities related to conservation, sustainable use and forest restoration.

CANCUN SAFEGUARDS [8]	REDD+ SOCIAL AND ENVIRONMENTAL PRINCIPLES AND CRITERIA
(E)That actions are consistent with the conservation of natural forests and biological diversity, ensuring that the actions referred to in paragraph 70 of this decision are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits.	<ul> <li>5.1 REDD+ actions shall contribute to the conservation and recovery of natural ecosystems and avoid causing significant negative impacts to biodiversity and ecosystem services</li> <li>5.2 Species or ecosystems that are rare, endemic or threatened with extinction, as well as any other high conservation value attribute, shall be previously identified, protected and monitored.</li> <li>5.3 In case of restoration activities in degraded areas, REDD+ actions shall use native species.</li> </ul>
(D) The full and effective participation of relevant stakeholders, in particular indigenous peoples and local communities.	<ul> <li>6.1 Conditions for the participation of the beneficiaries shall be ensured in all phases of REDD+ actions and in the decision making processes, including the identification, negotiation and distribution of benefits.</li> <li>6.2 Decision making processes relating to REDD+ actions shall effectively ensure the right to free, prior and informed consent, considering local representatives and respecting the traditional forms of electing representatives by Indigenous Peoples, smallholders and local communities.</li> <li>6.3 Populations living in areas affected by REDD+ actions shall be informed about them.</li> </ul>

CANCUN SAFEGUARDS [8]	REDD+ SOCIAL AND ENVIRONMENTAL PRINCIPLES AND CRITERIA
	7.1 Beneficiaries shall have free access to information relating to REDD+ actions, in simple language, so they can participate in the decision making process in a previously informed and responsible manner.
(B) Transparent and effective	7.2 Transparency of information about REDD+ actions shall be guaranteed, including at least those related to the methodology, location and size of the area, definition and participation of involved and affected stakeholders, activities to be executed, time length of the project and conflict resolution mechanisms.
national forest governance structures, taking into account national legislation and sovereignty.	7.3 In public lands, protected areas and in other areas that involve Indigenous Peoples, smallholders and local communities, or in REDD+ actions supported by public funds, there shall be ensured transparency of information regarding the raise, use and distribution of benefits generated by REDD+, as well as periodic financial reporting.
	7.4 There shall be periodic monitoring of the socio- environmental, economic and climate related impacts and benefits of REDD+ actions, while respecting the traditional way of life and practices of Indigenous Peoples, smallholders and local communities, and results of this monitoring shall be made publicly available.
	8.1 REDD+ actions shall be coordinated and consistent with national, state, regional and municipal policies and program on climate change, conservation, sustainable development and deforestation prevention.
(B) Transparent and effective national forest governance	8.2 REDD+ actions shall meet the requirements of state or national REDD+ policies.
structures, taking into account national legislation and sovereignty.	8.3 Emission reductions and carbon sequestration generated by REDD+ actions shall be quantified and registered in a way to avoid double counting.
	8.4 REDD+ government actions shall contribute to strengthen public instruments and processes for forestry and territory management.

CANCUN SAFEGUARDS [8]	REDD+ SOCIAL AND ENVIRONMENTAL PRINCIPLES AND CRITERIA
	4.1 REDD+ actions shall promote economic alternatives based on standing forest valorization and on the sustainable use of natural resources and deforested areas.
(F) Actions to address the risks of reversals.	4.2 REDD+ actions shall contribute to poverty alleviation, social inclusion and improvement of livelihoods for people who live in REDD+ implementation areas and in areas affected by it.
(G) Actions to reduce displacement of emissions.	5.1 REDD+ actions shall contribute to the conservation and recovery of natural ecosystems and avoid causing significant negative impacts to biodiversity and ecosystem services.
	8.3 Emission reductions and carbon sequestration generated by REDD+ actions shall be quantified and registered in a way to avoid double counting.

This summary of information presents some information on the Amazon Fund's safeguards procedures. The risks and impacts assessment is a major component of BNDES' review process for the Amazon Fund projects. All the projects submitted to the BNDES receive an environmental risk rating, and social and environmental recommendations to be observed during the analysis process. Across the wide array of institutions and types of projects supported by the Fund, there is an effort to ensure compliance with standards and guidelines from public policies associated with each project, while taking into consideration the territorial and social particularities of the region.

The cases in which greater territorial impact is identified, specific actions are implemented. Apart from the direct impacts, the assessment of a project aims at measuring and fostering the positive externalities or co-benefits, and avoiding or minimizing potential risks of negative impacts. The risks and impacts encountered in the project assessment are discussed with the applicants, to explore ways to eliminate or reduce them to an acceptable level. This assessment can lead to changes in the design, in the text of a given agreement with other entities or even lead to tailoring specific contractual clauses.

# **3.4 Implementation of the Warsaw Framework for REDD+ by Brazil**

In early 2014, a Technical Working Group on REDD+ was established by the MMA, comprised of renowned experts in fields of climate change and forests to provide inputs for the development of high quality technical submissions and to support the federal government team during the assessment of such submissions by the experts appointed by the UNFCCC. The group had three meetings in 2014.

On June 6, 2014 in Bonn, Germany, Brazil submitted its Forest Reference Emission Level (FREL) for reducing emissions from deforestation in the Amazonia biome for REDD+ results-based payments under the UNFCCC. This submission was developed with support from the Technical Working Group on REDD+ and marked the beginning of the implementation of the Warsaw Framework for REDD+, one of the major outcomes of the COP 19 held in Poland on November, 2013.

Brazil's FREL focuses on the gross emissions from deforestation, defined as clear-cutting, in the Amazon biome between 1996 and 2005. Brazil has a consistent forest monitoring time series from PRODES (INPE), which made this submission possible. Gross CO<sub>2</sub> emissions were spatially calculated, having as a reference the carbon map from Brazil's Second National Inventory of Greenhouse Gas Emissions, the latest available when the FREL was submitted to the UNFCCC. The submission included the carbon pools below and above ground and litter, the calculation of emissions followed the IPCC guidelines and methodologies (2003).

Between August and November 2014 Brazil's FREL underwent a rigorous evaluation process conducted by two LULUCF experts appointed by the UNFCCC. This facilitative process contributed to improve the clarity of the submission and also identified areas that will require further technical development for future submissions.

In December 2014, Brazil submitted to UNFCCC its results reducing emissions from deforestation in the Amazon biome, since 2006, through a technical annex to the BUR. The document, developed with support from the Technical Working Group on REDD+, will undergo the international consultation and analysis process (ICA) in 2015 (*Figure 4*).



Figure 4: Process that developing countries go through to obtain the recognition of their REDD+ results under the UNFCCC. **Note:** The purple boxes represent initiatives from developing countries that strive for recognition of their REDD+ results and the green boxes represent the initiatives from the UNFCCC Secretariat.

## 4. THE SAFEGUARDS OF CANCUN IN THE BRAZILIAN CONTEXT

Although the PPCDAm (2004) and the Amazon Fund (2008) were launched before decision 1/CP. 16 (2010), parallels can be drawn between the Cancun safeguards and the processes and actions undertaken during the implementation of activities under such initiatives. The sections below present an interpretation of the seven Cancun safeguards in the Brazilian context and a brief analysis of how they were treated throughout the implementation of the PPCDAm, which drove Brazil's REDD+ results since 2006, and the financing of projects by the Amazon Fund.

# (a) That actions complement or are consistent with the objectives of national forest programs and relevant international conventions and agreements

In order to understand what this safeguard means in the Brazilian context and the means for its effective implementation, the Technical Panel sought to ascertain what are the national programs and international agreements relevant to REDD+ that have been ratified by Brazil. The Technical Panel also took into consideration administrative proceedings, institutions and working groups that could assist in ensuring consistency or complementarity with the implementation of relevant policies and international agreements.

Brazil has numerous programs and initiatives to promote the reduction of deforestation and forest degradation, conservation, sustainable management of forests and reforestation (REDD+ activities). Among them: the Federal Constitution, the Native Vegetation Protection Law (New Forest Code), National Policy on Territorial and Environmental Management of Indigenous Territories, Public Forests Management Law, National Environmental Policy, National Climate Change Policy, Amazon Region Protected Areas Program, Ecologic-Economical Macrozoning, Rural Environmental Registry, National Biodiversity Policy, Amazon Degraded Areas Recovery Program, National Community and Family Forest Management Program, National Agrarian Reform Program, Brazil Quilombola Program, the United Nations Declaration on the Rights of Indigenous Peoples, ILO-Convention 169, Convention on Biological Diversity, Ramsar Convention, Agenda 21, among others.

The complementarity and consistency of these actions in the Amazon biome is driven by the PPCDAm. PPCDAm aims to coordinate and direct the policies and initiatives identified as linked to the dynamics of deforestation. The three axes of PPCDAM serve as a means of harmonizing such policies.

Among those safeguards adopted by the Amazon Fund, the one concerning "Governance" is the one more closely related to this Cancun safeguard. The Amazon Fund has a Guidance Committee in its operating structure, COFA, which sets the guidelines and priorities to be adopted for analyzing project applications. One of the conditions for approval is whether projects can demonstrate clear consistency with actions planed in the PPCDAm and the PPCDs. In addition to that, the compliance with the Fund's environmental and social safeguards is assessed through the reports to monitor the project activities.

# (b) Transparent and effective national forest governance structures, taking into account national legislation and sovereignty

When assessing compliance with this safeguard, the Technical Panel set basic criteria for evaluating the transparency and effectiveness of existing governance structures related to REDD+ activities. Note that this set of criteria does not preclude the inclusion of new criteria, as appropriate.

The criteria were divided into two categories to ease the collection of information: (i) institutional arrangements and (ii) transparency. For institutional arrangements, the information gathered covered the composition (e.g. parity between government and civil society), regularity (number of meetings), assignments, structure, decisions guided by these structures, capillary and gender issues. Regarding transparency, information about availability and publicity of data were considered.

PPCDAm's current governance model is divided into three spheres: Executive, Consultative and Transparency (*Figure 5*).

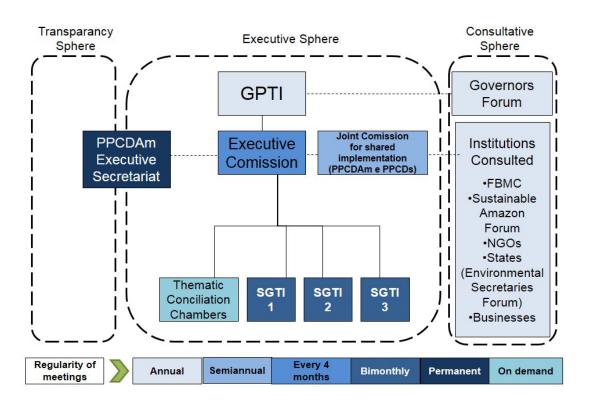


Figure 5: PPCDAm's phase 3 governance structure.

The Executive Sphere is where decision-making, guidance, implementation and monitoring of activities take place, whereas the Consultative Sphere promotes dialogue with State governments and civil society, which is vital to the success of the PPCDAm. The Transparency Sphere aims to give greater publicity to the PPCDAm implementation, using several means to reach out to other government entities and the Brazilian society by publicizing the monitoring of activities carried out.

The Grupo Permanente de Trabalho Interministerial ("Permanent Inter-Ministerial Working Group" - GPTI) created by the Decree of **July 3**, **2003** is responsible for decision-making and proposing strategic measures. The GPTI consists of 17 ministries (initially they were 13) under the coordination from the MMA since 2013 (it was initially coordinated by the Chief of Staff of the Presidency).

The PPCDAm also has an Executive Committee, coordinated by the Chief of Staff of the Presidency between 2004 and 2013 and by the MMA since then. The Executive Committee is responsible for monitoring and proposing measures to overcome the challenges associated with the implementation of the activities planned under the PPCDAm and the ones defined by the GPTI. The Committee has representatives from the Ministries involved. The MMA has the role of Executive Secretariat, responsible for examining and monitoring the PPCDAm implementation. The Executive Committee is tied to the Legal Amazon Environment Secretaries Forum in a Joint Committee for Shared Implementation (PPCDAm and PPCDs).

Dialogue with civil society pervades the whole design of the PPCDAm, especially by taking advantage of already established channels such as the **Sustainable Amazon Forum**, which also includes representatives from the business sector. This dialogue was further developed during the technical-scientific seminars designed for deforestation data analyses. The aim is to strengthen the channels for communication with key Brazilian stakeholders in order to promote the effective implementation of PPCDAm activities.

Another innovation of PPCDAm was the creation of Subgroups for each thematic Axis, creating a space for constant monitoring and problem solving to meet the targets - although each subgroup has its own dynamics and regularity of meetings, mainly determined by how the items on the agenda progress in a subgroup.

As for the Amazon Fund, the COFA determines the guidelines for supporting projects and monitoring the results achieved. COFA has representatives from the Federal government, the State governments in the Legal Amazon region and the civil society (see composition in *Table 4* below). Voting rights in the COFA are granted only to those State governments with a PPCD. This conditionality helped the PPCDAm in getting the State governments engaged with implementing actions to reduce deforestation.

Table 4: Amazon Fund Guidance Committee composition.

Blocks	Entity
	Ministry of the Environment
	Ministry of Development, Industry and Foreign Trade
	Ministry of External Relations
	Ministry of Agriculture, Livestock and Food Supply
Federal Government	Ministry of Agrarian Development
	Ministry of Science, Technology and Innovation
	Chief of Staff of the Presidency of the Republic Office
	Strategic Affairs Secretariat of the Presidency of the Republic
	Brazilian Economic and Social Development Bank - BNDES
	Acre
	Amapá
	Amazonas
	Maranhão
Amazonian states	Mato Grosso
	Pará
	Rondônia
	Roraima
	Tocantins
	Brazilian Forum of NGOs and Social Movements for Environment and Development - FBOMS
	Brazilian Amazon Indigenous Organizations Coordination Office - COIAB
Civil Society	National Confederation of Industry - CNI
	National Forum of Forest-Based Activities - FNABF
	National Confederation of Agricultural Workers - CONTAG
	Brazilian Society for the Progress of Science - SBPC

To ensure transparency in the Amazon Fund's decision-making processes, COFA meetings are recorded in "Technical Provisions Registries" - Registros de Encaminhamento Técnico (RETs) made available on the Amazon Fund's website: <a href="http://www.fundoamazonia.gov.br/FundoAmazonia/fam/site\_pt/Esquerdo/Fundo/cofa.html">http://www.fundoamazonia.gov.br/FundoAmazonia/fam/site\_pt/Esquerdo/Fundo/cofa.html</a>. Furthermore, to give publicity and transparency to the

projects in progress and/ or in implementation, the Amazon Fund offers a section for consulting the projects approved, fortnightly bulletins with an overview of the projects submitted and annual activity reports on its website.

(c) Respect for the knowledge and rights of indigenous peoples and members of local communities, by taking into account relevant international obligations, national circumstances and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration on the Rights of Indigenous Peoples

The Technical Panel focused on determining which norms contemplate the rights of indigenous peoples, traditional communities and smallholders, as well as on the rights associated with traditional knowledge, taking into account relevant international obligations, national circumstances and law and the United Nations Declaration on the Rights of Indigenous Peoples.

Fourteen instruments that provide for rights and respect for knowledge and customs were identified, among them, the ILO Convention 169, the Federal Constitution, the National Policy on Territorial and Environmental Management of indigenous lands (Política Nacional de Gestão Territorial e Ambiental de Terras Indígenas, PNGATI), National Policy for the Sustainable Development of Traditional Peoples and Communities and the Indigenous Peoples Statute (Law 6,001 / 1973). Among the rights mapped out, some of the most important are the rights for free, prior and informed consent, rights to the territory, rights to the use of resources and benefit-sharing.

To understand how this safeguard was respected during the implementation of the PPCDAm it is necessary to evaluate how the right for free, prior and informed consent was exercised, the occurrence and allegations of environmental crimes and of violation of rights, the demarcation of indigenous and quilombola lands, management plans, processes submitted to the **Conselho de Gestão do Patrimônio Genético** ("Genetic Heritage Management Council" CGEN in Portuguese) from MMA's Biodiversity and Forests Secretariat.

Throughout the PPCDAm's implementation, 10 million hectares of indigenous lands were demarcated between 2004 and 2011. However, the experts from the Technical Panel pointed out that although the data on demarcation of indigenous lands is relevant to the context of this safeguard, it does not suffice for assessing its compliance. For example, there is no mention of data on conflicts and violence related to demarcation, approval and recognition of indigenous lands in the reports from the National Indigenous People's Foundation (Fundação Nacional do Indio - FUNAI) and civil society institutions. A more comprehensive assessment of processes that provides more details on how this safeguard is being respected is required.

The Amazon Fund, in partnership with the MMA and FUNAI, launched in May 2014, a Call for Proposals to select applicants for non-reimbursable financial support for the development and implementation of Territorial and Environmental Management Plans (Planos de Gestão Territorial e Ambiental de Terras Indígenas - PGTAs) in indigenous lands in the Amazon biome. This Call for Proposals contributes directly to the implementation of the PNGATI. The total amount of resources for this call is up to R\$ 70 million and up to ten projects will be selected for the design and implementation of PGTAs in the Amazon. The design of PGTAs must take into consideration

the document "Guidelines for designing Land and Environmental Management Plans for Indigenous Lands" by FUNAI [9].

**FUNAI** has actively participated in the Inter-Ministerial Working Group for the ENREDD+ and, along with the MMA, has prepared the document with the premises for developing of REDD+ activities in indigenous lands. In addition to that, throughout the 4 years of the ENREDD+ drafting process, a series of meetings with representatives from the Brazilian Amazon Indigenous Organizations Coordination Office (**Coordenação das Organizações Indígenas da Amazônia Brasileira** - COIAB) and the National Articulation of the Indigenous People of Brazil (**Articulação dos Povos Indígenas do Brasil** — APIB). The MMA's technical team participated in a series of meetings on climate change organized by indigenous representations in the Amazon states and by the FUNAI to present the context and development of REDD+ under the UNFCCC and in Brazil.

The absence of a national regulation on the ILO 169, of a forum or specific body to file representations (charges) about violation of rights in REDD+ initiatives was identified as an area that requires improvements on the Brazilian government side, for the effective implementation of this safeguard.

(d) The full and effective participation of relevant stakeholders, in particular indigenous peoples and local communities, in the actions referred to in paragraphs 70 and 72 of this decision

#### PROCESSES AT THE FEDERAL LEVEL

Full and effective participation depends on the availability of information that is qualified, accessible, transparent and adequate to REDD+ stakeholders. The Technical Panel interpreted that a fundamental condition for the full and effective participation of stakeholders is to ensure that indigenous peoples and traditional communities have representativeness in decision-making processes for the design and implementation of REDD+ policies and initiatives. Representatives of indigenous peoples and local communities should be considered and encouraged to take leading roles in REDD+ initiatives in their territories.

During the preparation of PPCDAm's third phase, a series of meetings for designing the elements of each axis took place with stakeholders' participation. A Consultative Sphere was established in the governance structure, enabling the participation of a wide range of social sectors. The Governors Forum tied to the GPTI and to the **Brazilian Forum on Climate Change** at the executive level, the Sustainable Amazon Forum, NGOs, the Environment Secretaries Forum and the productive sector. It should be noted that this Consultative sphere was created and functioned solely during the preparation of the third phase of PPCDAm; it will not be in place for its evaluation.

Members of the Technical Panel point out that in spite of the opportunities opened for participation, such debates were predominantly technical. Therefore these forums do little to truly engage grassroots organizations, putting the voice and protagonism of some stakeholders in jeopardy. In recent years, thematic workshops regularly organized by FUNAI have brought basic information to this audience, enabling more qualified engagement from indigenous leaders in discussions on climate change, forests and indigenous peoples.

When considering the Amazon Fund's project proposals review process, guidance on the effective participation of stakeholders is provided by their social and environmental safeguards. COFA is structured as a tripartite committee, composed by: the federal government, state governments and civil society. Each block being entitled to one vote for the decisions.

The resolutions must be approved by consensus. COFA has representatives from the following segments of civil society: (1) **Fórum Brasileiro de ONGs e Movimentos Sociais para o Meio Ambiente e o Desenvolvimento** ("Brazilian Forum of NGOs and Social Movements for Environment and Development" FBOMS in Portuguese), (2) the COIAB, (3) the **Confederação Nacional dos Trabalhadores na Agricultura** ("National Confederation of Agricultural Workers" CONTAG in Portuguese), (4) the **Sociedade Brasileira para o Progresso da Ciência** ("Brazilian Society for the Progress of Science SBPC in Portuguese), (5) the **Confederação Nacional da Indústria** ("National Confederation of Industry" CNI in Portuguese), (6) the **Fórum Nacional das Atividades de Base Florestal** ("National Forum of Forest-Based Activities" FNABF in Portuguese).

The Fund guidelines approved by COFA state that: (1) the project must include acceptance by all partners and co-executors; and (2) projects involving traditional communities and indigenous peoples must necessarily present a document to demonstrate free, prior and informed consent from those communities or their representative institutions.

The development of the ENREDD+, by its turn, involved a broad and participatory process that lasted four years. The process began in 2010 when the federal government created three Working Groups [10] with stakeholders; they generated the "Synthesis report with multi-stakeholder input for preparing the National Strategy". The main recommendation from this dialogue with society was that the federal government should institute a formal process to develop a National REDD+ Strategy.

In the course of the process to develop Brazil's National REDD+ Strategy, a series of formal and informal meetings were held with various segments of society, including representatives from indigenous communities, state governments, the private sector and civil society organizations. Among the opportunities for discussion, the highlights were the workshop on "The implementation of social and environmental safeguards in the ENREDD+" and the discussion about safeguards with indigenous peoples in the COIAB event held in Manaus, in 2011 (see the details in the Annex I of this document).

All the information was made available on the MMA's REDD+ website (www.mma.gov.br/redd) to promote transparency and the participation of the Brazilian stakeholders throughout the process. It is expected that in 2015, when the ENREDD+ is launched, the dialogue process with the society will intensify.

Despite the provisions for participation both in the PPCDAm governance structure and in the Amazon Fund, some representatives of the Brazilian civil society, in response to the publication of the draft of this summary on the web (from 27 October to 7 November), emphasized that the participation of non-state and state government actors in REDD+ processes should be further fostered by the federal government [11].

#### CARBON PROJECTS AND HARMFUL CONTRACTS

Decision 1 / CP. 16 UNFCCC brings, among other things, the definition of the scope of REDD+ actions. REDD+ results are measured and reported at the national level, based on a national forest monitoring system. On an interim basis, developing countries may opt for a sub-national implementation, being the responsibility of the federal government to communicate with the UNFCCC and to obtain the recognition for the national REDD+ results. Since Cancun, the carbon projects approach to REDD+ has been dropped.

Following UNFCCC guidance, the implementation of REDD+ in Brazil will be carried out at the biome level as an interim measure. This scale was defined for the purpose of maintaining consistency with the action plans for prevention and control of deforestation. Hence, when preparing its National REDD+ Strategy, Brazil made the option to centralize in the federal government the measuring and reporting of REDD+ results. The carbon projects and jurisdictional approaches were rejected.

Since 2009, it is noteworthy the implementation of voluntary carbon projects in Brazil and other tropical countries. In some of these voluntary carbon projects involving indigenous populations and territories, the agreements signed between indigenous peoples representatives and international private companies had unconstitutional provisions that violated the Cancun Safeguards, especially with regards to legal requirements and relevant international agreements, such as:

- ❖ Project activities in violation of Art. 231, § 2 of the Federal Constitution and of Art. 18 of the Indian Statute (Law 6,001 / 1973) that determine the right of exclusive use by indigenous peoples of indigenous lands traditionally occupied by these communities.
- Negotiations between the parties that disregarded the full and effective participation of relevant stakeholders, such as indigenous peoples, as well as free, prior and informed consent.
- Lack of evidence on record of any inclusive initiative towards indigenous communities.
- Lack of evidence on record of FUNAI participating as an interested party, capable to supervise or interfere.
- Lack of any clarification on technical issues regarding the implementation of such project and on the measures to be adopted for ensuring its effectiveness in terms of emission reductions and the environmental integrity of the activities in question.
- Lack of detail about aspects related to the commercialization of carbon credits and the risks assumed by the parties in such transactions.

The need to address these cases of contracts that harm indigenous rights led Brazilian governmental agencies to organize a quick response. In 2011, FUNAI compiled a list of around 20 companies that tried to sign contracts with indigenous communities with no regard to the minimum criteria established by national legislation.

The MMA has been keeping track of some cases of foreign private companies attempts to sign illegal contracts witth indigenous communities for the development of carbon projects, in collaboration with the Federal Attorney General's Office and the Comissão Pro-Índio de São Paulo CPISP (São Paulo Pro-indigenous Comission). The surveillance proved to be successful, as in the years 2013 and 2014 fewer cases were reported.

(e) That actions are consistent with the conservation of natural forests and biological diversity, ensuring that the actions referred to in paragraph 70 of this decision are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits

This safeguard indicates that REDD+ actions should be consistent with the conservation of native forests and biodiversity, ensuring that the risk of conversion of natural forests are averted, especially in regards to the increase of carbon stocks.

Brazil currently has specific legal instruments for biodiversity conservation, such as the Política Nacional da Biodiversidade ("National Biodiversity Policy - Decree 4339/2002), the Programa Nacional da Biodiversidade e a Comissão Nacional da Biodiversidade ("National Program for Biological Diversity and the National Biodiversity Commission" - Decree 4703/2003), Decree 2519, which enacts the Convention on Biological Diversity (CBD), the Política Nacional do Meio Ambiente ("National Environmental Policy" - Law 6938/1981), the Plano Nacional de Promoção das Cadeias de Produtos da Sociobiodiversidade ("National Plan for the Promotion of Sociobiodiverse Supply Chains" - Interministerial Ordinance by the Ministry of Agrarian Development/ Ministry of Social Development/ Ministry of Environment 239/2009), among others. The effective implementation of these instruments is a condition for promoting this safeguard.

Throughout PPCDAm's implementation, 50 million hectares of Protected Areas were created, 25 million by the federal government and 25 million by the State Governments.

These Protected Areas shelter high biodiversity and were created in areas under deforestation pressure (Figure 6).

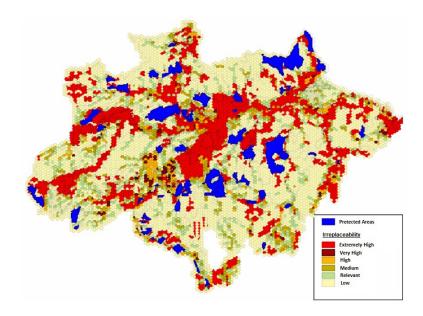


Figure 6: Amazon biome map of Priority areas for conservation, according to their biodiversity and irreplaceability. Source: http://www.mma.gov.br/estruturas/chm/\_arquivos/biodiversidade31.pdf

Following the trend of the Amazon biome, deforestation in Protected Areas has significantly reduced in the past decade. In 2011, deforestation in Protected Areas managed by the federal government was reduced by 86% in comparison with 2004. In state managed Protected Areas, deforestation in 2011 was 69% lower than in 2004 (MMA, 2013).

**Figure 7** shows the historical deforestation series in federal and state Protected Areas in the Amazon (2001-2011). The contribution of federal Protected Areas to the total deforestation in the period remained below 4% for federal areas and 6% in state areas throughout the whole period.

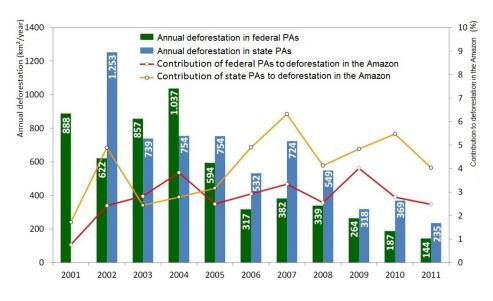


Figure 7: Deforestation in Protected Areas in the Brazilian Amazon

Despite the significant areas designated as Protected Areas in the Amazon biome - which can stop land grabbing, an initial step in the deforestation process - Technical Panel members pointed out that an important step for the respect of this Cancun safeguard is the full implementation and consolidation of protected areas and their surroundings.

As for the Amazon Fund, respect for this safeguard is expressed in its lines of action. The Amazon Fund must support, among other categories, (1) Management of public forests and protected areas; (2) Recovery of deforested areas; and (3) Conservation and sustainable use of biodiversity. The conservation and recovery of natural ecosystems, biodiversity and ecosystem services is essential to the very existence of the Amazon Fund.

### (f) Actions to address the risks of reversals

Among Brazil's existing instruments to ensure the continuity of the REDD+ results achieved, are the Native Vegetation Protection Law (New Forest Code), which states that landholders should keep 80% of the area of a property covered with native vegetation, as Legal Reserve, in those rural properties located in originally forested areas; the Programa de Fomento às Atividades Produtivas Rurais\_("Fostering Rural Productive Activities Program - Law n.12,512 / 2011); and the programs and vegetation monitoring systems that assist in the enforcement and implementation of existing laws (Project PRODES, DETER, etc.).

REDD+ results-based payments are a key incentive to address the risk of reversal. The emission reductions results from the Amazon biome were largely achieved through the environmental monitoring and law enforcement activities financed by the federal budget.

At present, deforestation affects predominantly areas smaller than 25 hectares (*Figure 8*), which impairs the effectiveness of the command and control approach. Land management initiatives and fostering sustainable production activities (PPCDAm's axes 2 and 3) become more and more relevant. In this context, it is necessary to create new and additional incentives for achieving a paradigm shift in the regional economy, thus ensuring the permanence and expansion of REDD+ achieved results. This paradigm shift can be triggered with investments made with REDD+ results based payments received.

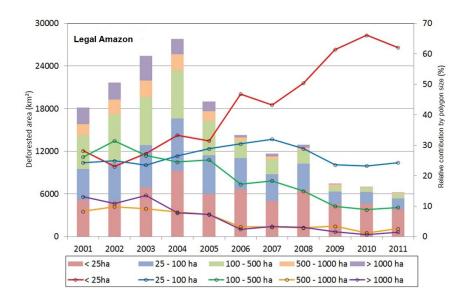


Figure 8: Deforested areas by polygon size in the Brazilian Amazon

# (g) Actions to reduce displacement of emissions

Initiatives to eliminate leakage risks should include a robust, comprehensive and constant monitoring of the forest cover, ensuring the environmental integrity of REDD+. In Brazil, just as with the reversal safeguard, PRODES data provides information on the scale of implementation of actions to combat deforestation – i.e. within the Legal Amazon. The Federal Government established, with **Decree 6321**, of **December 21**, 2007, a number initiatives to prevent, monitor and control illegal deforestation in the Amazon.

Besides monitoring deforestation, Brazil also has a forest degradation monitoring system for the Amazon biome. INPE developed the **DEGRAD** to map the occurrence and progression of degraded areas in the Amazon using satellite imagery (Landsat-class, with spatial resolution of up to 30 meters).

DEGRAD has a time series with annual data for the period 2007-2013. The maps generated by DEGRAD, with evidence of forest degradation, are also available to the public as part of INPE's open data distribution policy (http://www.obt.inpe.br/degrad/). The causal relationship between the reduction of deforestation in some areas and the increase in forest degradation in other areas cannot be determined. *Table 5* presents DEGRAD and PRODES 2007-2013 data to assess the extent to which the areas affected by forest degradation in a year are converted to clear-cut in subsequent years.

Table 5. Share of degraded areas identified by DEGRAD that were subsequently converted to clear-cut (deforestation) and included in the PRODES, 2007-2012.

	version of the area			PRODE	S (year)		
clea	ded (DEGRAD) to r cut (PRODES)	2008	2009	2010	2011	2012	2013
(year)	2007	12	2	2	2	1	2
Š	2008		1	2	1	1	1
	2009			2	2	2	2
R A	2010				3	1	2
DEGRAD	2011					2	4
D	2012						4

One of the initiatives in place to ensure the permanence of the reductions achieved in the Amazon biome and to reduce the risk of leakage is the **Priority Municipalities List**. The name of this initiative is due to the fact that these municipalities will be prioritized by measures to integrate and improve monitoring and control actions from federal bodies, land tenure and land use planning actions and incentives to environmentally sustainable economic activities (*Figure 9*).

Art. 2 of **Decree 6,321 / 07** states the MMA is responsible for issuing an annual Ordinance with the list of municipalities considered as priorities for prevention and control of deforestation in the Amazon. The criteria for listing a municipality are: (1) total area of forest cleared in the municipality; (2) total area of forest cleared in the last three years; and (3) increases in the rate of deforestation in at least three out of the last five years.

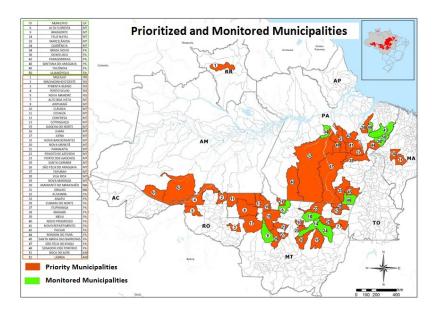


Figure 9: Priority and Monitored Municipalities

Besides the Ordinance with the list, an Ordinance defining the criteria for municipalities to leave the priority list is also published in the Diário Oficial (the government's official communication channel).

Once listed, the municipality will be monitored and receive support from the federal government in the implementation of actions aimed at reducing deforestation rates, whereas seeking to facilitate the transition to a sustainable based economy. As a result, it is expected that the municipality can be taken out from the list, being reclassified as a municipality where deforestation is monitored and under control.

Improving the forest monitoring systems for other biomes is a fundamental step to ensure the effective implementation of this safeguard. Brazil is planning on expanding its forest monitoring system for the Amazon (PRODES) to other biomes. It is expected that by 2016 Brazil will have a national forest monitoring system that provides data on an annual basis.

To date, monitoring data for the Cerrado biome from the **Projeto de Monitoramento do Desmatamento dos Biomas Brasileiros por Satélite** ("Brazilian Biomes Satellite Monitoring Project" PMDBBS in Portuguese) indicates that a reduction of deforestation took place in that biome in 2009 and 2010 compared to the average area measured between 2002 and 2008. However, such data still requires improvements, which is why Brazil chose to submit only the Amazonian deforestation reduction results at this moment.

Moreover, the ENREDD+ aims to expand Brazil's REDD+ actions from the biome (PPCDAm and PPCerrado) to the national level, in order to avert the risk of carbon emissions leakage coming from REDD+ activities. Brazil is also investing on the expansion of the Amazon monitoring system to all biomes.

## **5. EXISTING INFORMATION SYSTEMS IN BRAZIL**

The information gathered by the Technical Panel described a series of information systems and databases already established in Brazil, which can meet the information systems requirements for some of the Cancun Safeguards, although in an independent and uncoordinated manner. They should eventually serve as a basis to feed the SIS REDD+.

**Table 6** presents Brazil's main existing environmental information systems, which can be used and/or adapted for data collection to feed the SIS REDD+. It is necessary to analyze these systems and their implementation in more detail, in order to provide inputs for identifying potential interoperability opportunities with the SIS REDD+.

Table 6: Relevant environmental information systems for the REDD+ SIS

Systems	Goal	Type of information
SINIMA (MMA)	Information management under the National Environmental System.	Environmental licensing (PNLA), net carbon emissions (PNIA)
SNIF (SFB / MMA)	Identification, recording and analysis of information related to natural and planted forests of Brazil (SINIMA integrated).	Stocks, structure, diversity, distribution, forest dynamics and forest-based supply chains, licenses to clear native vegetation, management plans.
PRODES (INPE/MCTI)	Satellite Monitoring of vegetation cover, with regular reports to society.	Annual deforestation rates in the Amazon
DETER (INPE/MCTI)	Warning system to assist environmental enforcement and deforestation control.	Monthly report of clear-cut areas and areas in process of forest degradation by deforestation.
PMDBBS (IBAMA / MMA)	Satellite Monitoring of vegetation cover	Deforestation data on the Cerrado, Caatinga, Atlantic Forest, Pantanal and Pampas biomes (periods: prior to 2002 and between 2002 and 2008).
SiBBr (MCTI)	To integrate information from several national and foreign sources, providing inputs for research and support for formulating and implementing public policies.	Biodiversity and Brazilian ecosystems.
SISUC (Collaborative public system)	Assessment, planning and environmental monitoring, in order to strengthen participatory management and to advance social control.	Environmental services, nature conservation, human welfare, agro-extractive production, participatory management.
SICAR (MMA)	Integrate spatial information on rural landholdings to ensure the implementation of the Native Vegetation Protection Law.	Information from the Rural Environmental Cadastre.
SNIRH (ANA)	This is a broad collection system, treatment, storage and retrieval of information on water resources and intervening factors for its management.	

NOTE: THE SYSTEMS ALREADY IN FULL OPERATION ARE IN ITALICS.

#### The SIS REDD+ shall:

- Be national, simplified, reliable, comparable and cost effective.
- Be created and implemented by the Brazilian government and coordinated by the MMA.
- Be periodically reviewed and adapted to new challenges and priorities.
- Ensure transparency, understanding, effectiveness and consistency.
- ❖ Be an online system that integrates information on how the REDD+ safeguards are implemented, promoted and respected.
- Support REDD+ initiatives, and support decision makers in the creation and implementation of public policies.

# 6. DEVELOPING AND IMPLEMENTING BRAZIL'S NATIONAL REDD+ SAFEGUARDS INFORMATION SYSTEM (REDD+ SIS)

In 2015, Brazil will initiate the development of the SIS REDD+. This process will draw upon this summary of information on safeguards and on the dialogue processes with relevant stakeholders.

Arranging information of diverse nature and from different sources is a challenge for the implementation of the SIS REDD+. It is necessary to make use of different computational resources to automate data provision to the SIS, which would entail a gain in quality and timeliness of information. To ensure proper functioning of the SIS REDD+ careful consideration is necessary from the time of its planning, through its computer modeling, to the validation of its functionality and its routine maintenance stage.

Integrating different sources of information will be the first step in the development of the SIS REDD+, to ensure better availability of information and reduce operation costs. The development of an integrated information system depends, among other factors, on establishing connections between its modules with the existing databases and information systems (interoperability). Investigating the best way to establish such integration between systems is a complex step for the SIS REDD+ construction, due to the diversity of information and of implementation status of the information sources readily available.

Throughout the time preceding the introduction of this information system in its digital and open for analyses format, descriptive information on how the safeguards are being implemented in Brazil will continue to be available on Brazil's REDD+ website (http://mma.gov.br/redd/index.php/en/security/what-are-safeguards).

# **ANNEXES**

#### ANNEX I: REDD+ IN THE BRAZILIAN CONTEXT

# **Social and Environmental Principles and Criteria**

In 2009, several organizations meeting at the Katoomba Seminar held in Cuiaba, decided to start a process for developing social and environmental safeguards for REDD+ programs and projects in Brazil. The event enabled the production of a document to provide references for developing and implementing forest carbon projects, government REDD+ programs and for independent evaluation and validation of REDD+ projects in Brazil.

The process of conceiving the document comprised the following steps:

- Creating a multistakeholder steering committee for development and revision of the Principles and Criteria;
- Development of the first version of the Principles and Criteria by this committee;
- Submission of the first version to public consultation for a period of 150 days (December 1st, 2009, to April 31st, 2010), open to all sectors of society concerned with the subject;
- Holding regional meetings in the Amazon with representatives of traditional communities and Indigenous Peoples to present the document and record the contributions from these stakeholders;
- Meetings with several stakeholders involved in or affected by REDD+ issues in Brazil to present the document and record their contributions;
- Preparation of the final version of the Principles and Criteria by the steering committee, incorporating all the comments received during the public consultation period.

As a result of this process, the following eight principles and criteria have been defined:

- 1. Legal Compliance: meeting the legal requirements and relevant international agreements;
- 2. Rights Recognition and Guarantees: recognizing and respecting the rights to lands, territories and natural resources:
- 3. Benefit Sharing: fair, transparent and equitable distribution of the benefits resulting from REDD+ actions;

- 4. Economic sustainability, improvements in quality of life and poverty alleviation: contributing to diversify the economic and sustainable use of natural resources;
- 5. Environmental conservation and recovery: contributing to the conservation and recovery of natural ecosystems, biodiversity and environmental services;
- 6. Participation: participation of stakeholders in the development and implementation of REDD+ actions and in decision making processes;
- 7. Monitoring and transfer: full availability of information related to REDD+ actions;
- 8. Governance: promoting better governance, coordination and alignment with national, regional and local policies and guidelines.

# **Developing the ENREDD+ (2010-2014)**

Between July and December 2010, the MMA coordinated a dialogue process that supplied the initial inputs for developing Brazil's ENREDD+. With the schedule of activities set, four meetings were held and three working groups organized to address the following topics:

- GT1: Coordination, Institutional Arrangements and Participation
- GT2: Benefits Sharing, Dominion and Safeguards
- GT3: Funding sources and Financial Mechanisms

The working groups open to public and private organizations consisted of 120 representatives from 58 institutions. In December 2010, each group presented a report of their contributions to the process of drafting the ENREDD+, as well as valuable context information. The final report titled "REDD+: Synthesis Document with multi-stakeholder inputs for the preparation of a National Strategy, has as its main elements:

- Identifying REDD+ related federal public policies and state initiatives;
- Assimilating the social and environmental principles and criteria proposed by Brazilian civil society REDD+;
- Preliminary analysis of operational principles for a REDD+ mechanism;
- Identifying possible funding sources and financing mechanisms for REDD+ activities;
- Proposal of a tentative schedule for the development of the ENREDD+.

The synthesis document provided guidance to MMA's coordination work as of 2011, which had been assigned by the Executive Group on Climate Change (GEx), by means of coordinating an Interministerial Working Group on REDD+ (GT REDD+) for drafting the National SREDD+ Strategy (ENREDD+). Since then, the activities have involved building understanding among the Ministries, dialogue with civil society through meetings and thematic workshops, and inputs provision, in the form of specific studies.

During this period, even prior to the approval of the Warsaw Framework for REDD+, the issue of the safeguards was discussed by the federal government with various stakeholderts at different moments, obtaining important input from the workshop on the Implementation of Social and Environmental Safeguards in the ENREDD+, held in Brasilia in November 2011. Approximately 60 participants from various civil society organizations attended the event to: (1) identify the main risks associated with the implementation of REDD+ in Brazil; and (2) formulate recommendations on the implementation and the approach for REDD+ safeguards in Brazil, based on their experiences.

Throughout the two days of work, the group shared their visions and experiences, which resulted in recommendations about the public consultation process for Brazil's ENREDD+. The main guideline stated that regional workshops should be organized, in order to seek integration with other agendas and to optimize the discussion forums at events already programed.

In 2012, the MMA assembled the Technical Panel with experts from civil society whose goal was to address the issue of the safeguards in the Brazilian context. The details from this study have been reported by this summary.

## **State frameworks for REDD+**

Since 2009, the Brazilian government received demands from Brazilian stakeholders to institutionalize REDD+ operation in the country, which also included a great deal of expectations. Some viewed this as a way to give legitimacy to the initiatives already underway, others as a means to provide structure for operating in a voluntary market for REDD+ projects.

While the process to develop the ENREDD+ was underway at the federal level, the states turned their attention to building their own legal frameworks for climate change and forests.

The study REDD +: Initiatives and Challenges for the integration of sub-national and national policies in Brazil, commissioned by the MMA in 2012, aimed to present an overview of the status of climate change, environmental services and REDD+ related policies and initiatives, in seven out of the nine states in the Brazilian Amazon.

In addition to identifying the actions in place, a section that discusses the challenges of integrating national and sub-national policies is among the main elements from this study. It is possible to draw a parallel between the challenges identified and specifically two of the safeguards of Cancun:

- Complementarity or consistency with policies, programs and international agreements: it is necessary to harmonization commitments to reduce deforestation made on the federal and state level.
- ❖ Benefit sharing and social and environmental impacts on local communities: the study states as a recommendation that the funds o originating from REDD+ initiatives must be equitably distributed among the social actors involved. It should also be ensured that initiatives to promote forest conservation do not generate negative social and environmental impacts on local communities whose livelihoods dependent on natural resources.

#### ANNEX II: AMAZON FUND'S SOCIAL AND ENVIRONMENTAL SAFEGUARDS

Transcribed below is the information provided by the Amazon Fund on its safeguards. The texts are available in Portuguese at: <a href="http://www.fundoamazonia.gov.br/FundoAmazonia/fam/site\_pt/Esquerdo/Fundo/Salvaguardas">http://www.fundoamazonia.gov.br/FundoAmazonia/fam/site\_pt/Esquerdo/Fundo/Salvaguardas</a>

# i. Legal Compliance

BNDES adopts, in accordance with its general rules, several procedures to verify legal compliance and the eligibility of beneficiaries, which are also applicable to the projects submitted to the Amazon Fund. Among these procedures, we may highlight:

- Eligibility checking to verify whether an applicant is listed on the Registry of employers convicted for keeping workers under conditions analogous to slavery;
- Applicants must present documents certifying that they have not received any administrative sanction or been sentenced with a final decision from the Judiciary on cases related to gender or racial discrimination, child or forced labor, moral of sexual harassment or environmental crimes.:
- ❖ Beneficiaries must abide, during the term of the contract, to the legislation applicable to persons with disabilities; and
- The environmental license for project installation, officially published, must be presented, whenever it is applicable to a given intervention type. As well as keeping all operations in accordance with the obligations prescribed by the environmental agencies during the term of the contract.

# ii. Acknowledgement and guarantee of rights

Acknowledgement and respect for rights related to land tenure and use of territories and natural resources are guiding principles to the Amazon Fund, the Priority Guidelines include:

- Consolidate protected areas, especially the Conservation Units for Sustainable Use and Indigenous Land (A2.d);
- Defining a destination for Public Forests that have not yet been assigned one, with priority to community forest initiatives (A2.e); and
- Efforts to address illegal appropriation of land, to promote land-title regularization and land-use planning, preferably in areas with a higher concentration of wealth and/or conflicts (A2.f).

## iii. Distribution of benefits

The commitment to fair, transparent and equitable distribution of benefits is among the Amazon Fund guidelines. In order to achieve that the following criteria have been established:

- Implement payment for environmental services systems associated with the maintenance of and/or increase in forest coverage and/or forest and agro-forestry systems (A2.b);
- Projects with economic purposes should deliver collective and public use benefits (B14); and
- ❖ Concentration in the allocation of resources should be avoided, no states or category of applicants (public agencies, research institutions, civil society organizations etc.) should be privileged (E1 and E2).

# iv. Economic sustainability, improving standards of living and reducing poverty

Cracking down on illegal deforestation is not enough. Building decent alternatives for employment and income generation is essential in the Amazon, while placing environmental and social sustainability as central issue.

In line with this need, the Amazon Fund gives priority to sustainable productive activities and scientific and technological development projects that can facilitate the development of a suitable development model for the region. The guidelines set out the following priorities:

- ❖ Promote and increase the scale of production of timber and non-timber forest products from sustainable forest management, including management plans, research, innovation, science and technology dissemination, market development, training and qualification (A2.a); and
- Projects involving direct benefits for traditional communities, agrarian reform settlements and small landholders / family farmers (A4).

## v. Environmental conservation and restoration

Among the Amazon Fund's attributions, established by the Presidential Decree 6527 of 2008, are (i) management of public forests and protected areas; (ii) restoration of deforested areas; and (iii) the conservation and sustainable use of biodiversity. The conservation and restoration of natural ecosystems, biodiversity and ecosystem services is fundamental to the Amazon Fund's very existence. Therefore when structuring the Amazon Fund's Logical Framework, an instrument that supports planning, management and monitoring of impacts, the following aspects have been contemplated:

- Expansion of protected areas;
- Consolidate the management of public forests and protected areas; and
- Support for the restoration of deforested and degraded areas, rendering them suitable for economic use or ecological conservation.

Accordingly, the Amazon Fund's guidelines set as priorities:

- Consolidate protected areas, especially the Conservation Units for Sustainable Use and Indigenous Land (A2.d); and
- Sevelop and implement recovery models for Permanent Protection Areas (APPs in Portuguese) and Legal Reserve (both are provisions from the Forest Code), with an emphasis on economic use (A2.c).

# vi. Participation

The COFA is responsible for establishing the Amazon Fund's Guidelines and Criteria for Selection, as well as for approving the Amazon Fund's Annual Report and the communications on resource allocation. It is structured as a tripartite committee, composed by: the federal government, state governments and civil society. Each block is entitled to one vote and the decisions are reached by consensus.

The COFA also has the role of ensuring the initiatives supported by the Amazon Fund are consistent with its goals, with the policies from the PPCDAm and PPCDs and the Sustainable Amazon Plan strategic guidelines.

The Amazon Fund's guidelines, approved by this committee, state that:

- Projects must include an agreement between all partners and co-executors (B2); and
- Projects involving traditional communities and indigenous people must necessarily present documents to certify the free, prior and informed consent from these communities or their representative institutions. (B3).

# vii. Monitoring and transparency

Being a donation only Fund, the full disclosure of information on its actions and on supported initiatives is essential.

In order to meet this condition, the Amazon Fund publishes a full annual report of its activities the "Amazon Fund's Annual Report", which after being approved by the COFA is made available on its website in three languages (Portuguese, Spanish, and English).

The Amazon Fund also provides information on projects proposals, their status in BNDES' assessment process, the total budget that they have applied for, their purpose, as well as detailed information about the

projects under implementation. This information can be found on its website, which also provides detailed monthly project portfolio bulletins and newsletters covering Fund related issues, events and activities.

Two external audits are carried out annually: a financial audit and a compliance audit, to verify and certify the accounting and financial management of the Fund's resources and its correct allocation.

The Fund's guidelines state that supported projects must:

- Offer some platform to publicize their implementation on the Internet (B11);
- Include measurable results indicators that are directly related to the Amazon Fund's goals (B1).

#### viii. Governance

An important feature of the Amazon Fund is its sound governance, which is due to its integration into one of the largest development banks on the global stage, but also to its effective instruments for participation, monitoring and transparency. Such efforts are extended to the projects supported, with a view to promote better governance in their structures and alignment and integration with national, regional and local policies and guidelines.

Besides the COFA, the Amazon Fund has a Technical Committee that assembles notorious experts in forest carbon emissions, whose main task is to verify and attest the measurements of reduced emissions from deforestation carried out by the MMA. The results are then used to back the Amazon Fund's annual fundraising efforts.

The Fund has set in its guidelines the following conditionalities and priority criteria:

- Projects must present clear evidence that they are consistent with PPCDAm and PPCDs' actions (B5);
- Projects must present clear evidence that they are consistent with the Sustainable Amazon Plan (B6);
- Priorities:
  - Provide support for structuring the state agencies responsible for environmental management (A2.g);
  - Provide support to the implementation of municipal monitoring and environmental enforcement systems (A2.h);
  - Help the development and integration of control systems for forest management, for rural properties environmental licensing process and for tracking the chain of custody of agricultural, livestock and forestry products (A2.i);
  - Supporting more comprehensive and robust deforestation and forest degradation monitoring systems (A2.j); and
  - Projects involving actors from multiple sectors, i.e. public sector, private sector, NGOs or local communities, shall have a shared governance structure (A3).

ANNEX III. SUMMARY OF THE RESULTS FROM THE SURVEY ON THE INFORMATION AND SOURCES REQUIRED FOR THE SIS REDD+ AND RECOMMENDATIONS FROM THE PANEL OF EXPERTS TO THE MMA

Safeguard	Instruments	What should be done	Sources	Information Description	Opportunities for further improvement
Complementarity or consistency with policies and programs	19 relevant instruments have been identified. e.g. CBD, Ramsar Convention, Forest Code, National Protected Areas Registry (SNUC in Portuguese), Programa Nacional de Florestas ("National Forest Program"), PGTAs.	Assessment of goals, targets, content and implementation of these instruments in order to identify complementarity and consistency with REDD+ actions. Promote federative integration.	Public institutions related to the implementation these instruments, as well as national communications, committees, commissions and working groups.	Consistency and complementarity between the instruments and REDD+ actions. Assessment of the Implementation of Forest Concession Plans, PGTAs, protected areas management plans etc.	There is no provision analogous to the PGTA for territorial and environmental management on Quilombola areas. There is no guarantee that these instruments will be implemented.

Transparent and effective governance structures	have been identified (the focus was on committees only). e.g. Interministerial Committee on Climate Change, Public Forests Management Committees, PPCDAm's and PPCerrado's executive committees, PAs's Management Boards, PNGATI management Committee, ombudsmen.	Identify and assess the availability of relevant information.	Activity reports, meeting minutes, reports, bulletins and websites published by these structures. Independent systems.	Composition, structure (e.g. joint), regularity of meetings, attributions, decisions guided by these structures, capillarity, gender issues, data disclosure.	Implementation of the Lei de Acesso à Informação ("Access to Information Law") which makes online information disclosure by public institutions mandatory.
Rights and respect for knowledge	14 instruments have been identified, they address rights and respect for knowledge and customs, biodiversity conservation and benefit-sharing. e.g. ILO 169, CBD, The Federal Constitution, PNGATI, the National Biodiversity Policy.	Ensure that REDD+ policies, programs and projects are in line with established rights. Evaluate whether the ombudsman model is suitable for REDD+. National regulation of ILO 169.	Public institutions related to the implementation of these instruments, as well as committees, commissions and working groups. Independent systems.	Evaluating the implementation of free, prior and informed consent, complaints and incidents related to environmental offenses and violation of rights, indigenous and Quilombola lands demarcation, PAs management plans CGEN proceedings.	Lack of national regulation on the ILO 169, lack of a forum or specific body to file representations (complaints) about violation of rights in REDD+ initiatives.

Keep forests standing	12 instruments have been identified. e.g. Ramsar Convention, Forest Code, National Climate Change Policy, Lei da Mata Atlântica ( Atlantic Forest Law ), ENREDD+, Amazon Fund and Climate Fund.	Assessing the implementation, scope and impact matrix of these instruments.	Public institutions related to the implementation of these instruments, as well as committees, commissions and working groups. Independent systems.	Annual rate of deforestation, Ramsar sites, PAs management plans, licenses to clear vegetation, CAR and PRA data, sustainable management of forests plans and PES programs for carbon.	Consolidation at the federal level of data on the licensed areas cleared in all states. Annual rate of deforestation in all biomes. Setting targets for native forests recovery and data collection.
Carbon emissions displacement	9 instruments have been identified. e.g. Forest Code, Environmental Licensing, vegetation monitoring systems, ENREDD+.	Monitoring the rural landholdings registered on the CAR, impact assessment of the Sustainable Forest Management Plans (PMFS in Portuguese), and assessment of Economical-Ecological Plans (EEZs).	Secretariats and departments of public institutions related to the implementation of these instruments, as well as committees, commissions and working groups. Independent systems.	TerraClass Project data (biennial), State EEZs, PMFS licenses and plans under implementation, priority municipalities list.	Updated DEGRAD data, systems or analysis to assess emissions displacement.

- [1] (a) That actions complement or are consistent with the objectives of national forest Programmed and Relevant international conventions and agreements;
- (B) Transparent and effective national forest governance structures, taking into account national sovereignty and Legislation;
- (C) Respect for the knowledge and rights of indigenous peoples and members of the local communities, by taking into account Relevant international obligations, national laws and Circumstances, and noting the United Nations General Assembly has ADOPTED the United Nations Declaration on the Rights of Indigenous Peoples;
- (D) The full and effective participation of Relevant stakeholders, in particular indigenous peoples and communities place, in the actions Referred to in paragraphs 70 and 72 of this decision;
- (E) That actions are consistent with the conservation of natural forests and biological diversity, Ensuring the actions Referred to in paragraph 70 of this decision are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and Their ecosystem services, and to Enhance other social and environmental benefits;
- (F) Actions to address the Risks of reversals;
- (G) Actions to reduce displacement of emissions.
- [2] http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf
- [3] (a) Be consistent with the guidance Identified in decision 1 / CP.16, appendix I, paragraph 1;
- (B) Provide transparent and consistent information accessible by all That Is Relevant stakeholders and updated on a regular basis;
- (C) Be transparent and flexible to allow for improvements over time;
- (D) Provide information on how all of the safeguards Referred to in appendix I to decision 1 / CP.16 are being Addressed and respected;
- (E) Be country-driven and Implemented at the national level;
- (F) Build upon existing systems, as appropriate.
- [4] http://unfccc.int/resource/docs/2011/cop17/eng/09a02.pdf
- [5] http://unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf#page=33
- [6] http://www.mma.gov.br/redd/index.php/nivel-referencia
- [7] Safeguarding forest and People. A Framework for Designing a National System to Implement REDDO Safeguards. Daviet & Larsen, 2012. Available on <a href="http://www.wri.org/publication/safeguarding-forests-and-people">http://www.wri.org/publication/safeguarding-forests-and-people</a>.
- [8] The letters in parentheses in the first column refer to the text format in Annex I to the Decision 1/CP.16 of the UNFCCC.
- [9] More information on: http://www.fundoamazonia.gov.br/FundoAmazonia/export/sites/default/site\_pt/Galerias/Arquivos/Chamada\_PNGATI\_23\_09\_14.pdf

[10] The three working groups were divided into the following areas: GT1 - Coordination, Institutional Arrangements and Participation, GT2 - Benefits Distribution, Dominion and Safeguards, GT3 - Funding Sources and Financial Mechanisms.

[11] For more details about the letter sent by the Observatório do Clima ("Climate Observatory") regarding the summary of information on the safeguards and the Brazilian government's response see: http://mma.gov.br/redd/index.php/pt/salvaguardas/ sum% C3% A1rio-on-safeguards

BRAZILIAN GOVERNMENT Ministry of the **Environment**