



Report on the technical assessment of the proposed forest reference emission level of Brazil submitted in 2023

Summary

This report covers the technical assessment of the voluntary submission of Brazil on its proposed forest reference emission level (FREL) and forest reference level (FRL) in accordance with decision 13/CP.19 and in the context of results-based payments. The FREL/FRL proposed by Brazil covers the activities reducing emissions from deforestation (for all biomes), forest degradation (for the Amazon biome only) and enhancement of forest carbon stocks (for the Amazon biome only), which are among the activities included in decision 1/CP.16, paragraph 70.

For its submission, Brazil developed a national FREL and a subnational FRL. The original submission presented only a FREL for the reference period 2016–2021, corresponding to 461,040,910 tonnes of carbon dioxide equivalent per year. As a result of the facilitative process during the technical assessment, the submission was modified, including a FREL corresponding to 673,566,463.52 tonnes of carbon dioxide equivalent per year for the reference period 2016–2021, and a FRL corresponding to –59,395,580 tonnes of carbon dioxide equivalent per year for the reference period 2014–2020.

The assessment team notes that the data and information used by Brazil in constructing its FREL/FRL were improved during the technical analysis and are transparent, complete and in overall accordance with the guidelines contained in decision 12/CP.17, annex. This report contains the assessed FREL/FRL and a few areas identified by the assessment team for future technical improvement in accordance with the provisions on the scope of the technical assessment contained in decision 13/CP.19, annex.



Abbreviations and acronyms

2006 IPCC Guidelines	<i>2006 IPCC Guidelines for National Greenhouse Gas Inventories</i>
2019 Refinement to the 2006 IPCC Guidelines	<i>2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories</i>
AD	activity data
AT	assessment team
BUR	biennial update report
C	carbon
CH ₄	methane
CO ₂	carbon dioxide
CO ₂ eq	carbon dioxide equivalent
COP	Conference of the Parties
DEGRAD	Forest Degradation Detection System for the Brazilian Amazon Forest
DETER	Near Real-Time Deforestation Detection
EBA	Improvement of Biomass Estimation Methods and Models of Estimation of Emissions by Land-Use Change
EF	emission factor
FREL	forest reference emission level
FRL	forest reference level
GHG	greenhouse gas
INPE	Brazilian National Institute for Space Research
IPCC	Intergovernmental Panel on Climate Change
LULUCF	land use, land-use change and forestry
MMU	minimum mapping unit
N ₂ O	nitrous oxide
NFI	national forest inventory
PRODES	Satellite Monitoring Programme of the Brazilian Amazon Forest
REDD+	reducing emissions from deforestation; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks (decision 1/CP.16, para. 70)
SINAFLOR	National System of Forest Products Origin Control
SOC	soil organic carbon
TA	technical assessment

I. Introduction and summary

A. Overview

1. This report covers the TA of the voluntary submission of Brazil on its proposed FREL,¹ submitted on 9 January 2023, in accordance with decisions 12/CP.17 and 13/CP.19. The TA took place from 20 to 24 March 2023 and was coordinated by the secretariat.² The TA was conducted by two LULUCF experts from the UNFCCC roster of experts³ (hereinafter referred to as the AT): Manuel Estrada (Mexico) and Giacomo Grassi (European Union). In addition, Komlan Edou, an expert from the Consultative Group of Experts, participated as an observer⁴ during the session. The TA was coordinated by Keiichi Igarashi (secretariat).

2. In response to the invitation of the COP and in accordance with the provisions of decision 12/CP.17, paragraphs 7–15 and annex, Brazil submitted its proposed FREL on a voluntary basis. The proposed FREL is one of the elements⁵ to be developed in implementing the activities referred to in decision 1/CP.16, paragraph 70. Pursuant to decision 13/CP.19, paragraphs 1–2, and decision 14/CP.19, paragraphs 7–8, the COP decided that each submission of a proposed FREL, as referred to in decision 12/CP.17, paragraph 13, shall be subject to a TA in the context of results-based payments.

3. In this context, Brazil underlines that the submission of FRELS and/or FRLs and subsequent technical annexes to the BUR and biennial transparency report on the REDD+ results are voluntary and exclusively for the purpose of obtaining and receiving results-based payments for REDD+ activities, pursuant to decisions 13/CP.19, paragraph 2, and 14/CP.19, paragraphs 7 and 81. This submission, therefore, does not modify, revise or adjust in any way the nationally determined contribution submitted by Brazil under the Paris Agreement.

4. The objective of the TA is to assess the degree to which the information provided by Brazil is in accordance with the guidelines for submissions of information on reference levels⁶ and to offer a facilitative, non-intrusive, technical exchange of information on the construction of the FREL/FRL with a view to supporting the capacity of Brazil to construct and improve its FREL/FRL in the future, as appropriate.⁷

5. The TA of the FREL/FRL submitted by Brazil was undertaken in accordance with the guidelines and procedures for the TA of submissions from Parties on proposed FRELS and/or FRLs.⁸ This report on the TA was prepared by the AT following the same guidelines and procedures.

6. Following the process set out in those guidelines and procedures, 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 additional information, which were considered by the AT in the preparation of this report.⁹ As a result of the facilitative interactions with the AT during the TA, Brazil provided a modified version of its submission on 19 June 2023, which took into consideration the technical input of the AT. The modifications improved the clarity and transparency of the submitted FREL without needing to alter the approach used to construct it. This TA report was prepared in the context of the modified FREL/FRL submission.

¹ The submission of Brazil is available at <https://redd.unfccc.int/submissions.html?country=bra>.

² As per decision 13/CP.19, annex, para. 7.

³ As per decision 13/CP.19, annex, paras. 7 and 9.

⁴ As per decision 13/CP.19, annex, para. 9.

⁵ See decision 1/CP.16, para. 71(b).

⁶ Decision 12/CP.17, annex.

⁷ Decision 13/CP.19, annex, para. 1(a–b).

⁸ Decision 13/CP.19, annex.

⁹ As per decision 13/CP.19, annex, paras. 1(b), 13 and 14.

B. Proposed forest reference emission level

7. In decision 1/CP.16, paragraph 70, the COP 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 providing adequate and predictable support. The FREL/FRL proposed by Brazil, on a voluntary basis for a TA in the context of results-based payments, covers the activities reducing emissions from deforestation (for all six biomes), forest degradation (for the Amazon biome only) and enhancement of forest carbon stocks (for the Amazon biome only), which are three of the five activities referred to in that paragraph. Pursuant to paragraph 71(b) of the same decision, Brazil developed a national FREL that covers its entire territory and a subnational FRL that covers the Amazon biome. For its submission, Brazil applied a stepwise approach to developing its FREL/FRL in accordance with decision 12/CP.17, paragraph 10. The stepwise approach enables Parties to improve their FREL or FRL by incorporating better data, improved methodologies and, where appropriate, additional pools.

8. The FREL/FRL proposed by Brazil covers the historical reference period 2016–2021 for deforestation and forest degradation and the period 2014–2020 for enhancement of forest carbon stocks.

9. Deforestation is defined as the conversion of native forest phytophysiognomies¹⁰ into other land-use categories (non-forest land) and was estimated for all biomes. The FREL includes only the gross emissions from deforestation that are associated with clear-cuts and excludes any subsequent emissions and removals from deforested areas in the Caatinga, Pantanal, Atlantic Forest and Pampa biomes, while for the Amazon and Cerrado biomes emissions from deforestation are net emissions; that is, they are the result of the difference between the gross emissions from deforestation and the carbon stocks in the post-deforestation event land-use category (cropland or grassland). Forest degradation is defined as the reduction of carbon stocks in forest land remaining forest land due to fire and disordered logging¹¹ on managed forest land and was estimated for the Amazon biome only. Enhancement of forest carbon stocks refers to the annual increase in biomass from natural forest regeneration of areas previously deforested (secondary vegetation growth) and was estimated for the Amazon biome only. The proposed FREL excludes the conversion of forest plantations to other land uses.

10. The AD used in constructing the FREL for the deforestation activity were obtained from PRODES and were extracted from a historical time series of land-use maps for the periods 2016–2017, 2017–2018, 2018–2019, 2019–2020 and 2020–2021 for all biomes. Spatial data on forest degradation comes from the INPE DETER system and includes disordered logging and fires for the whole reference period, but only in the Amazon biome. For enhancement of forest carbon stocks, areas of natural forest regeneration in areas previously deforested in the Amazon biome were obtained from the TerraClass project for 2014 and 2020 for the Amazon biome and for 2018 and 2020 for the Cerrado biome. The EFs were obtained from the fourth national GHG inventory, including data from the EBA project for the Amazon biome. The FREL and FRL presented in the modified submission, with the aim of accessing results-based payments for REDD+ activities, correspond respectively to 673,566,463.52 t CO₂ eq/year for the reference period 2016–2021 (FREL) and –59,395,580 t CO₂ eq/year for the reference period 2014–2020 (FRL).¹²

¹⁰ Phytophysiognomies is defined in the submission as the type of vegetation present in a given biome.

¹¹ Disordered logging is defined in the submission as logging activities in natural forest land that has a disordered (irregular) pattern, most likely from illegal logging activities.

¹² In its original submission, Brazil proposed a national FREL of 461,040,910 t CO₂ eq/year for the reference period 2016–2021. The difference between the original and the modified submission is due mostly to a revision of the estimates for net removals from natural forest regrowth, and their different allocation to REDD+ activities (i.e. enhancement of forest carbon stocks). Specifically, the net removals from natural forest regrowth in the Amazon biome previously included under deforestation are now included under enhancement of forest carbon stocks, while net removals from natural forest regrowth in the Cerrado biome are now not included in the modified submission.

11. The proposed FREL/FRL includes the carbon pools above-ground biomass, below-ground biomass, deadwood and litter. Regarding GHGs, the submission includes CO₂ for all the six biomes, and CH₄ and N₂O emissions from fires in the Amazon and Cerrado biomes only.

12. The FREL proposed by Brazil is its fourth FREL submitted in the context of applying the stepwise approach in accordance with decision 12/CP.17, paragraph 10. Its previous subnational FREL was submitted on 15 January 2018 and was subject to a TA in March 2018;¹³ it covered the activity reducing emissions from deforestation for the reference period 1996–2015 for the Amazon biome only. The FREL proposed in the most recent submission differs from that in the 2018 submission previously assessed due mainly to the fact that the current submission covers the six biomes found in the country while the previous submission was limited to the Amazon biome; in addition, the proposed FREL includes activities other than deforestation for certain biomes, and the proposed FREL covers the reference period 2016–2021.

13. In the current submission, Brazil included additional information for clarification/transparency purposes in the annexes to its submission but not subject to the TA. This information related to additional information on AD for deforestation and forest degradation, information on areas of natural forest regeneration (secondary vegetation), a detailed description for estimating GHG emissions/removals in all biomes, a detailed description of the estimation of the FREL/FRL, quality control and quality assurance procedures and the status of recommendations/encouragements from previous technical analyses. Brazil also provided a link to all files used in the construction of the FREL/FRL, including geospatial files and Excel files for all calculations.¹⁴

II. Data, methodologies and procedures used in constructing the proposed forest reference emission level

How each element in decision 12/CP.17, annex, was taken into account in constructing the forest reference emission level

1. Information used by the Party in constructing its forest reference emission level

14. For constructing its FREL/FRL, Brazil used the methodologies of the 2006 IPCC Guidelines. Estimates of GHG emissions and removals (measured in t CO₂ eq) result from the multiplication of AD and emission or removal factors. The activities included in the FREL/FRL are reducing emissions from deforestation for all biomes for the reference period 2016–2021, reducing emissions from forest degradation for the Amazon biome only for the reference period 2016–2021 and enhancement of forest carbon stocks for the Amazon biome only for the reference period 2014–2020. The national FREL is calculated as the sum of the FRELs for the six biomes, while the FRL is calculated only for the Amazon biome.

15. Regarding AD:

(a) PRODES was used to identify areas of deforestation caused by clear-cut with a 1 ha MMU. This represents a change compared with the previous FREL submission, for which a 6.25 ha MMU was used. PRODES has operated since 1988 and is considered the most important tropical forest monitoring programme in the world. PRODES uses Landsat-like images (NASA/USGS), with a spatial resolution of 20–30 m, complemented by SENTINEL-2 and China-Brazil Earth Resource Satellite-4/4A satellite images. In this FREL submission, deforestation covers the period 2016–2021 in all biomes;

(b) Forest degradation was calculated using data from the DETER system, with a 3 ha MMU. Since 2015, the DETER system has used imagery from the China-Brazil Earth Resource Satellite and the Amazônia-1/INPE satellite with a spatial resolution of 56–64 m and a revisiting period of five days. In the FREL submission, degradation covers only the

¹³ See document FCCC/TAR/2018/BRA.

¹⁴ See <http://redd.mma.gov.br/en/submissions>.

Amazon biome for the period 2016–2021 and includes only fires and disordered logging. To justify these choices, the Party noted that selective logging mainly affects the Amazon biome, unlike the Cerrado or the other biomes, owing to the commercial value of forest species, and that orderly logging was assumed to be associated with sustainable management;

(c) Enhancement of forest carbon stocks was estimated for the Amazon biome only based on removals from the natural regeneration of areas previously deforested, using data from the TerraClass project, with a 4 ha MMU. The TerraClass project was initiated in 2010 in the Amazon biome with the aim of understanding the dynamics of post-deforestation land cover/use identified through PRODES. Owing to data availability, this activity covers the period 2014–2020, which is slightly different to the period 2016–2020 used for deforestation and forest degradation. In 2015, the project was expanded to the Cerrado biome although not enough data have yet been collected for this to be included in the FREL/FRL.

16. EFs were estimated for each forest phytophysiognomy in each biome in Brazil. For each type of forest phytophysiognomy, the total stock corresponded to the sum of the individual carbon stocks for the four carbon pools included (i.e. above-ground biomass, below-ground biomass, deadwood and litter). Biomass values were drawn from the ancient native vegetation map for each biome that was used for Brazil's fourth national GHG inventory. For the Amazon biome, additional data from the EBA project were used. In its original submission, Brazil considered that EFs for deforestation were net for the Amazon and Cerrado biomes, as carbon removals from the annual increase in biomass from the natural regeneration of areas previously deforested were considered. It did not consider the carbon stocks in the subsequent land uses. After exchanges with the AT, Brazil agreed that these were not in fact net EFs but rather a different REDD+ activity (enhancement of forest carbon stocks). Gross EFs were also applied for the rest of the included REDD+ activities. Carbon removals from the annual increase in biomass from the natural regeneration of areas previously deforested (secondary vegetation growth) were estimated for the Amazon and Cerrado biomes using data from Brazil's fourth national GHG inventory (the annual removal factor per unit area for secondary forest in pastureland). Selective logging factors (above-ground biomass loss factors) were obtained from the fourth national GHG inventory. EFs for non-CO₂ GHGs resulting from forest fires were obtained from the 2006 IPCC Guidelines.

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

(a) Methodological information, including description of data sets, approaches and methods

17. For the selection of the reference period, the AT found that the AT for the previous TA suggested applying the reference period starting from 2004,¹⁵ and asked Brazil to explain why 2016/2017 was selected as the first period of the reference period instead of 2004 as indicated in the previous TA. Brazil explained that this decision was mostly driven by criteria set by REDD+ financing channels (e.g. the Green Climate Fund). Such criteria act, in essence, as incentives for countries to set reference periods not greater than 10 years, as well as to set reference periods as close as possible to the present and to the years against which a country intends to have its results measured. The choice of starting year and extent of the reference period aims to better position Brazil for accessing current REDD+ financing opportunities. Brazil included this explanation in the modified submission. The AT further noted that another technical argument for this decision was that the DETER system began in 2016, which Brazil agreed with.

18. For the estimation of average carbon stocks, the AT asked Brazil to clarify if the carbon stocks used were the average carbon stocks for each phytophysiognomy or the average of the carbon stocks in the deforested and degraded areas in each phytophysiognomy and biome. Brazil responded that carbon stocks for the Amazon biome were average values per carbon pool in the deforested and degraded area, while carbon stocks for other biomes were average values per carbon pool for the entire biome, obtained from a bibliographic review. Brazil also mentioned that these values were the same as in the fourth national GHG

¹⁵ FCCC/TAR/2018/BRA, para. 19.

inventory. The AT considers the inclusion of this information as an area for future technical improvement.

19. For deforestation, during the TA the AT noted that different estimates of deforestation could be found in the literature for each biome. Brazil clarified that these estimates are not necessarily consistent and comparable with those included in the FREL. The reasons for the differences include the definition of forests and deforestation, the treatment of planted forest (not included in the FREL) and the use of different sensors and MMUs. The AT thanks Brazil for including these considerations in the modified submission. Furthermore, the AT commends Brazil for having used in its FREL a 1 ha MMU, compared with the 6.25 ha MMU used in the GHG inventory and in the previous assessed FRELS, and for having transparently illustrated the implications of this change.

20. When assessing deforestation estimates, the AT noted that, according to the 2006 IPCC Guidelines, land converted from one category to another (e.g. from forest to non-forest land) stays in the conversion status for a default period of 20 years, and asked Brazil to clarify whether this or another approach had been followed. Brazil responded that it has not yet adopted the 20-year transition period between land-use categories and expected that once national GHG inventory submissions become more frequent (through the biennial transparency reporting) this issue would be re-evaluated.

21. Brazil associated the EFs (i.e. carbon stocks per unit area) to each deforestation polygon through the extraction of the spatial average value from the EBA raster map (fourth national GHG inventory maps presenting each carbon pool). The AT asked Brazil to share the carbon maps (the EBA raster file) or show the AT where the maps are available. Brazil responded that the EBA maps were not yet publicly available and provided a link to files to be used only in the context of the TA. The AT accessed the maps and suggested including a link to the EBA maps in the modified submission to increase the transparency of the submission: Brazil agreed with that suggestion and made the files available.

22. The AT noted that the net deforestation in the Amazon and Cerrado biomes in the original submission included large amounts of removals from natural regrowth. During the TA, Brazil explained that net emissions from deforestation included emissions resulting from deforestation of native forest land plus removals from the regrowth of secondary vegetation following the abandonment of land. The AT noted that, where these removals derived from areas falling under the definition of forest, they could also fit into the REDD+ activity enhancement of forest carbon stocks. After a fruitful discussion during the TA, Brazil decided to follow this approach in the modified submission: for the Amazon and Cerrado biomes, the net emissions from deforestation were the result of the difference between the gross emissions from deforestation and the carbon stocks in the non-forest land-use category post-deforestation (cropland or grassland), and a new activity, enhancement of forest carbon stocks, was introduced for the emissions and removals of secondary forest vegetation, for the Amazon biome only, as discussed in paragraph 35 below.

23. In the original submission, the annual growth factors to estimate removals from forest regrowth in previously deforested areas in the Amazon and Cerrado biomes were the same as the factors used in the GHG inventory (3.03 t C/ha/year and 2.85 t C/ha/year respectively). During the TA, the AT noted that these values were within the ranges proposed by the 2019 Refinement to the 2006 IPCC Guidelines for the Amazon biome, but not for the Cerrado biome. The AT acknowledges the inclusion of a further explanation on the source of the parameters selected in the modified submission. Furthermore, the AT notes that in the modified submission, removals from previously deforested areas in the Cerrado biome are included in the calculations of net emissions from deforestation and are restricted to the conversion of forest land to grassland and cropland. Consequently, the choice of the annual growth factor of secondary forest in the Cerrado biome is not relevant for the modified FREL/FRL. The AT acknowledges again the detailed description of the steps followed in the calculations included in the modified submission, which enhanced the transparency of the FREL/FRL.

24. For the estimation of AD related to forest degradation, since 2016 the forest degradation area has been monitored through the INPE DETER system. During the TA, the AT sought a number of clarifications on the adequacy of the DETER system for estimating

emissions from degradation. The DETER system is based on moderate spatial resolution (64 m) but higher temporal resolution (a five-day revisit) imagery, whereas with PRODES the data are based on a 20–30 m spatial resolution and a 16-day repeat cycle (with the limitation that although images are available at that frequency, only one image is selected per location, and in the event of a major cloud, secondary images are used). The AT noted that independent studies (e.g. Beuchle et al., 2021) suggest that, owing to the low spatial resolution of the used satellite imagery, the DETER system likely underestimates degradation, especially for the areas affected by selective logging. Furthermore, while in Brazil's FREL emissions from degradation in the Amazon biome are less than 10 per cent of those from deforestation, recent studies suggest that emissions from degradation may be comparable with or even exceed those from deforestation (e.g. Matricardi et al., 2020; Qin et al., 2021; Assis et al., 2020; Tejada et al., 2023). During the TA, Brazil acknowledged the results of these studies, and pointed out that the difference in estimates may be attributable to the resolution of the satellite images and mapping scales, as well as to other key differences such as the definition of degradation used and whether degradation is mapped on secondary forests, while also reaffirming its commitment to continuously improving its national forest monitoring system. While acknowledging the many factors that influence estimates of degradation from various analyses and the difficulty of comparing them, the AT asked Brazil to clarify the accuracy of the DETER system, particularly in relation to selective logging and to data from the DEGRAD programme that was in place until 2016 to monitor degradation with a spatial resolution of 30 m. Furthermore, since the DETER system identifies polygons with an area greater than 3 ha, the AT asked Brazil to provide estimates or expert judgment of the degradation that occurs at smaller scales.

25. During the TA, and in response to questions raised by the AT, Brazil clarified that the main objective of the DETER system was not to provide accurate area estimates, but rather to provide early warnings of deforestation and degradation in order to trigger action on the ground by the enforcement agencies. In this regard, identifying small-scale degradation (smaller than 3 ha) is not urgent. However, the DETER system indicates where small-scale degradation is expanding, and the 3 ha MMU is considered adequate by the enforcement agencies. Overall, Brazil considered that the DETER system to be an adequate tool for monitoring degradation in the context of the FREL submission. To support this statement and address the concerns raised by the AT, Brazil provided additional information on the accuracy of the DETER system. This included a comparison between the DETER system and DEGRAD for forest fire degradation in 2016, in which it emerged that the area mapped by the DETER system was only 14 per cent smaller than in DEGRAD, because the higher temporal resolution of the DETER system (a five-day revisit time) compared with DEGRAD (a one-year revisit time) compensated for its lower spatial resolution, and results from the daily system by the National Institute for Space Research for validating the DETER system's results for deforestation and degradation through a comparison with better resolution images (5 m resolution), which showed an overall good performance of the DETER system (86 per cent of the polygons were correct), except for forest fire degradation (for which 47 per cent of the polygons were correct). The AT acknowledges Brazil's emphasis on how an increased temporal resolution may compensate for the lower spatial resolution and thanks the Party for the additional validation exercise undertaken, which increases the transparency of the FREL. Nevertheless, the AT notes that this validation exercise covers commission errors only (e.g. when an area is wrongly allocated to degradation) and not omissions errors (e.g. when a degraded area is not identified).

26. The AT noted that edge effects (due to deforestation and the resulting habitat fragmentation) and collateral tree damage (due to logging operations) are often considered as an important source of emissions in the scientific literature (e.g. Silva Junior et al., 2020). For this reason, the AT asked Brazil if these aspects are counted in the emission calculation. In the modified submission, Brazil clarified that edge effects were not considered when estimating emissions from deforestation, since the polygons of deforestation encompass only areas where clear-cut was identified, while emissions from potential collateral tree damage were assumed to be included in the degradation losses.

27. In the process of reconstructing the AD for forest degradation in the Amazon biome, the AT found a discrepancy between the data source file from the DETER system and the spreadsheet with the FREL calculations and corresponding geospatial data file. During the

TA, Brazil provided concrete examples of the spatial procedure for deriving the AD for forest degradation from the DETER system and listed the possible reasons for the differences. The AT confirmed that all additional areas eliminated in the processing of the DETER system's data were either overlapping/duplicated, outside the Amazon biome or not in forestry vegetation. In the modified submission, Brazil reviewed the DETER system's background geospatial data file made available with the modified submission to exclude all areas of forest degradation detected by the DETER system in the first half of 2022. The AT acknowledges Brazil's clarifications, which increased the transparency of the FREL.

28. The AT noted that the estimated uncertainty related to the forest areas subject to degradation from fire was 19 per cent for the Amazon biome, which seemed low given that the basis is the DETER system's alert data. The AT asked Brazil to provide more information on the commission and omission errors of the DETER system. Brazil provided an error matrix leading to a user accuracy of 87.0 per cent for degradation and 92.8 per cent for natural vegetation and a degradation area uncertainty of 18.6 per cent. The AT asked Brazil to confirm if the assumption that the error matrix was for degradation from fire and calculated that the omission and commission errors of forest degradation from the error matrix were 35 and 13 per cent respectively, which implied that the DETER system was missing a considerable area of forest degradation. Consequently, the AT asked Brazil to provide more information on how the degradation area uncertainty of 18.6 per cent had been calculated. Brazil confirmed that the error matrix provided was for degradation from fire and that no error matrix studies had been conducted for degradation from logging, and further noted that Brazil disagrees with the conclusion that it implied that the DETER system was missing a considerable area of forest degradation. Brazil clarified that the reference map was also developed based on the DETER system and that the error matrix provided the results for the accuracy of the standard interpretation process used to identify degradation by fire area, and, as such, the error matrix did not provide information on the comparison of the accuracy of the DETER system with alternative procedures. Brazil further noted that the uncertainty value of the degradation by fire area was calculated using the same methodology as that used to calculate the uncertainty of the deforestation area, and that Olofsson et al. (2014) shows in detail, given the error matrix, how to calculate the standard deviation of the proportion of area and the 95 per cent confidence interval for the area that is shown in the result presented (18.6 per cent). Brazil included additional information in the uncertainty section of the modified submission.

29. The AT notes the essential role that the DETER system plays as an alert system for the enforcement agencies. Overall, the AT agrees that the DETER system is adequate as a first step for including forest degradation in the FREL, despite its moderate spatial resolution (64 m) and the relatively large mapping unit which may lead to underestimation of the degradation area. To increase confidence on the estimates of emissions from degradation in Brazil, the AT notes the following areas for future technical improvement:

(a) Using higher resolution ("Landsat-like") images to monitor degradation and identifying polygons smaller than 3 ha. In this regard, the AT welcomes Brazil's plans, included in the revised FREL, to evaluate the possibility of having daily deforestation/degradation alerts produced using Sentinel-1/Sentinel-2/Landsat 8 and 9 images based on semi-automated image classification processes;

(b) Continuing validation activities for the results of the DETER system on forest degradation, ideally producing error matrices with both commission and omission errors separately for fires and selective logging;

(c) Evaluating the significance of emissions associated with edge effects owing to deforestation and considering their inclusion under degradation in future FRELS, if proven to be significant.

30. Emissions from orderly selective logging (regular or geometric logging) are not included in the FREL, since an orderly pattern is assumed to be associated with activities under sustainable management plans. As indicated in the FREL, once SINAFLOR is completed and validated, it will be possible to verify if orderly logging is associated with a sustainable management plan. The AT's understanding is that orderly cutting is often associated with topography, and does not necessarily indicate legality or sustainability.

Consequently, the AT asked Brazil for further clarification, including information to support the assumption, preliminary information from SINAFLOR, a precise timeline for using SINAFLOR data and how a decision on whether a logging area is orderly or disordered is taken. In addition, the AT noted that areas of and emissions from orderly logging were reported in the background files of the original submission, alongside with data for disordered logging and fires. These data indicated that emissions from orderly logging represented about 20 per cent of the total emissions from degradation (orderly and disordered logging, plus fire) and that they showed an increasing trend from 2016 to 2021. The AT found this information useful and asked Brazil to include it in an annex of the modified submission, for transparency purposes.

31. Brazil noted that information from SINAFLOR would be used only when it is fully available and validated, and that the approach currently taken is considered a valid stepwise approach. The Party indicated that a precise timeline for using SINAFLOR data could not be given during the TA, owing to uncertainties regarding financial support to complete and validate the database. Furthermore, Brazil clarified that the decision of orderly/disordered logging was made by the image interpreter through visual interpretation. This information was included in the modified submission. Regarding the data on areas and emissions from orderly logging, Brazil decided not to include it in an annex of the modified submission, since it considered that the information could be misleading. Brazil further noted that when the SINAFLOR data set was completed and validated, the emissions from approved forest management plans could be reported in the REDD+ activity sustainable management of forests. Brazil affirmed the intention to further evaluate potential degradation emissions within areas with approved management plans in future submissions. While fully acknowledging the challenges of defining forest degradation in the absence of adequate data, the AT considers that the assumption that orderly logging is always sustainable is uncertain. During the TA, Brazil affirmed that the assumption that all orderly logging should be associated with degradation would also be uncertain and would be detrimental to sustainable management activities already in place. For this reason, the AT considers the completion and validation of the SINAFLOR data set as a priority area for improvement, in order that this information can be used in future FRELS to discriminate with greater confidence between degradation and sustainable management.

32. The AT asked Brazil to further elaborate on the rationale for the choice of selective logging factors for recurrent logging (i.e. 0.29, 0.27, 0.26 and 0.22 for first, second, third and fourth recurrences respectively in table 5 of the modified submission, p.42). Brazil noted that these values were used in the fourth national GHG inventory and were selected to ensure consistency with the inventory, and that these values represent the most up-to-date peer-reviewed estimates currently available in Brazil. Following the response, the AT asked Brazil if such factors were relative to the remaining biomass; Brazil confirmed this, and this was reflected in the modified submission. The AT considers that this clarification improved the transparency of the submission.

33. The AT noted that the Queimadas programme uses 30 m spatial resolution data to monitor both fire spots and burned area scars in the Cerrado biome, and noted that emissions from forest degradation due to fire in managed forest land in the Cerrado biome were relevant when compared with emissions from fire in the Amazon biome, and therefore considered the continuation of the Queimadas programme using 30 m spatial resolution as a high priority (at least in the Cerrado biome) in order to improve the completeness of future submissions. The AT asked Brazil if it had made comparisons of fire emissions (or areas) between the DETER system and the Queimadas programme at 30 m spatial resolution. Brazil responded that, at present, it has not made such comparisons owing to a lack of data from the Queimadas programme. The AT further pointed out that, to its understanding based on the information contained in the submission, results at 30 m spatial resolution were available for 2018 and 2019, and asked Brazil to clarify the reason why comparisons could not be done for these years. Brazil noted that the DETER system for the Cerrado biome delivers deforestation alerts only, and does not produce information on fire occurrence. Moreover, Brazil clarified that the Queimadas programme data sets at 30 m and 1 km resolution could be compared, but that the employed methodologies were very different and at the 1 km resolution the results were presented in the form of indicative broad regular boxes, which were very different from the results acquired at 30 m resolution (irregular polygons following

the boundaries of fire scars). The 1 km resolution data are in a validation phase by the National Institute for Space Research.¹⁶ Brazil noted that, since there was no need to use less accurate data for FREL estimations, and since such a comparison would involve additional effort not foreseen in the scope and time frame for the construction of the present submission, such a comparison was not implemented in the context of this submission. Additionally, Brazil provided the AT with links to two studies on accuracy assessments of the 1 km resolution data.

34. The AT found small differences in the CO₂ emissions from deforestation and degradation between spreadsheets shared during the TA and the original submissions (but no differences in the areas of deforestation and degradation), and asked Brazil to clarify the differences. A similar situation was found while reviewing the sum of emissions from deforestation plus degradation in table 30 of the submission, since the sum did not exactly equal the values of gross emissions in table 31 of the submission. Brazil explained that table 30 in the original submission presented values of an intermediate version of the calculations, after which corrections were made to deforestation outputs smaller than 6 ha. Brazil also asked the AT not to use the values in table 30 and to use only those in the spreadsheets. Brazil corrected the values in table 30 in the modified submission.

35. For enhancement of forest carbon stocks, as a result of an exchange between the AT and Brazil, Brazil changed the original approach of including emissions and removals from secondary vegetation following deforestation (see para. 22 above). The modified submission included an FRL with the new activity enhancement of forest carbon stocks, for the Amazon biome only, based on removals from natural forest regeneration on areas previously deforested (secondary vegetation) and on emissions due to deforestation of this secondary vegetation in the same period. The AD are from the TerraClass project for 2014 and 2020, the EF is the same as that used in the national GHG inventory (3.03 t C/ha/year) and the emissions were estimated taking into account the age of the secondary vegetation when deforestation occurred. The resulting net flux of -59,395,580 t CO₂ eq/year reflects a difference between removals of -176,847,048.87 t CO₂ eq/year and emissions of 117,451,468.66 t CO₂ eq/year for the reference period 2014–2020. The AT noted that this reference period slightly differs from the one used for deforestation and forest degradation (2016–2021), but considered it acceptable because it was justified by the availability of data. The AT noted that the area of deforestation of secondary vegetation is large (i.e. similar or greater than the area of deforestation of primary vegetation) and that the total area of secondary vegetation in the Amazon biome decreased from 2014 to 2020. Given the short period of data availability for the Cerrado biome (2018–2020), Brazil noted that removals from secondary vegetation from this biome would be included in the next submission. Furthermore, Brazil explained that, pending additional resources for the TerraClass project, it plans to estimate specific annual removals and emissions from secondary vegetation for all biomes and for each single year in future submissions.

36. The AT noted that the FREL/FRL submission included a preliminary comparison of biomass and carbon stock values derived from the NFI for selected phytophysiognomies (the Pampa and Atlantic Forest biomes) and those used in the FREL/FRL. The AT also noted that the difference of these values between the FREL/FRL and the NFI was large (i.e. around 30–40 per cent) and asked for a clarification. Brazil responded that, since the NFI data had been collected only on approximately 53 per cent of the national territory and were not yet fully validated, at present the differences illustrated reflect a preliminary analysis and cannot be confirmed. In the modified submission, Brazil further clarified that, once NFI data were complete and validated, the reasons for such differences will be evaluated. The AT thanks Brazil for the clarification provided and notes that this is an important aspect to be followed up on in the future.

37. The AT noted that, overall, Brazil maintains consistency in terms of data sources used for its FREL/FRL and those used for the national GHG inventory included in its fourth national communication and fourth BUR. However, while the EFs are consistent, the AT noted some differences in the AD. During the TA, the AT asked for additional clarifications from Brazil to explain the differences between emissions in the FREL and those reported in

¹⁶ See <https://queimadas.dgi.inpe.br/queimadas/aq1km/>.

the national GHG inventory for the coincident year (e.g. 2016). Brazil clarified that these differences can be explained by a change in the biome's geographical boundaries, and the use of a 1 ha MMU to map deforestation in the Amazon biome compared with a 6.25 ha MMU used in the national GHG inventory. Brazil also noted that the AD in the BUR were obtained from land-cover maps for 1994, 2002 and 2005 (Amazon biome), 2010 and 2016, whereas the FREL used yearly deforestation and forest degradation maps. During the TA, Brazil expressed its intention to evaluate how to incorporate improvements in the next GHG inventory, including the 1 ha MMU, taking into consideration the longer time series of the GHG inventory and the need to ensure its consistency over time. The AT commends Brazil for providing this additional information in the modified submission, including the plans to improve consistency between the FREL/FRL and the GHG inventory.

38. In its most recent FREL/FRL submission, Brazil described the following changes from previously submitted information in accordance with decision 12/CP.17, annex, paragraph (b):

- (a) The inclusion of all six Brazilian biomes;
- (b) The inclusion of forest degradation in the Amazon biome;
- (c) The inclusion of enhancement of forest carbon stocks in the Amazon biome;
- (d) The estimation of net emissions from deforestation in the Amazon and Cerrado biomes;
- (e) The change in the biomes' geographical boundaries using the most recent official data;
- (f) The use of a 1 ha MMU for the identification of deforestation polygons in all Brazilian biomes (instead of a 6.25 ha MMU);
- (g) The reference period calculated using five years of data;
- (h) The improvement of the uncertainty analysis.

(b) Description of relevant policies and plans, as appropriate

39. Brazil included a brief summary of the policies and plans relevant to REDD+ being implemented in the country. These include the forest code (law 12.651/2012) and the national strategy for REDD+, which was established in 2015 with the aim of scaling up the implementation of the policies being applied in the Amazon and Cerrado biomes. The recent upward trend in deforestation in the Amazon biome, which reflects the conclusion of previous plans, shows the need to develop more effective solutions to prevent and counter illegal deforestation. In this context, taking into consideration the search for new solutions in addition to those that have performed well, in 2019 there was a transition to the new Plan to Control Illegal Deforestation and Recovery of Native Vegetation, which encompasses the entire territory and was approved by the Commission for the Control of Illegal Deforestation and Recovery of Native Vegetation (decree 10.142/2019). The Commission for the Control of Illegal Deforestation and Recovery of Native Vegetation provides guidelines for combating deforestation based on three cross-cutting themes: business environment, innovation and technological solutions, and financing for sustainable practices. In order to support coordination and integration of these themes, the plan was structured on five pillars: zero tolerance for deforestation and forest fires, land tenure regularization, land management, the bioeconomy, and payment for environmental services. Also of mention are the approval of the National Policy for Payments for Environmental Services (law 14.119/2021) and, in 2022, the fundraising limits and eligibility criteria for the entities of the Cerrado biome (decree 10.144/2019), based on the results of reducing deforestation in this biome verified by the UNFCCC. Brazil also noted that it has recently resumed the development of action plans for the prevention and control of deforestation that are biome specific. An action plan is already under implementation in the Amazon biome and plans are under development for the other biomes. Brazil expects this shift and its reinforced commitment to control deforestation will place it on track to obtain new REDD+ results and to meet the targets set under its NDC.

3. Pools, gases and activities included in constructing the forest reference emission level

40. According to decision 12/CP.17, annex, paragraph (c), reasons for omitting a pool or activity in constructing the FREL/FRL should be provided, noting that significant pools and activities should not be excluded.

41. The pools included in the Party's FREL/FRL are above-ground biomass, below-ground biomass, deadwood and litter. The SOC pool was not included.

42. The rationale for the exclusion of the SOC pool noted in Brazil's original FREL submission is that, while the largest changes in SOC result from the conversion of forest land to other land-use categories (e.g. cropland, grassland), in this submission the land-use category post-deforestation was not identified. The AT noted that net emissions from deforestation in the Amazon and Cerrado biomes were estimated, which implied identifying post-deforestation land uses (through the TerraClass project). Therefore, the AT asked Brazil to clarify why the SOC pool was not included for the Amazon and Cerrado biomes. Brazil responded that the fourth national GHG inventory indicates that SOC contributed only 2.5 per cent to the total net emissions in the LULUCF sector during 2010–2016. It was decided that, taking into consideration the low contribution of SOC to the total emissions and that this submission is national, SOC would not make a significant contribution to the national FREL and hence was not considered.

43. Brazil included in its FREL both CO₂ and non-CO₂ emissions from biomass burning linked to deforestation in the Amazon and Cerrado biomes and linked to forest degradation in the Amazon biome. During the TA, the AT requested further justification for the exclusion of non-CO₂ emissions from deforestation in the remaining biomes. Brazil clarified that non-CO₂ emissions from deforestation in other biomes were expected to be relatively insignificant and, pending additional resources for the Queimadas programme, planned to re-evaluate this assessment in the future and, if demonstrated significant, include these emissions in future submissions.

44. The AT acknowledges that Brazil included in its FREL/FRL the most significant activities reducing emissions from deforestation (in all biomes), reducing forest degradation (only in the Amazon biome) and enhancement of forest carbon stocks (only in the Amazon biome) of the five activities identified in decision 1/CP.16, paragraph 70, in accordance with its national capabilities and circumstances. During the TA, the AT requested justification for the exclusion of GHG emissions from forest degradation in the Cerrado biome, in particular those linked to fires. Brazil included in the modified submission a rough estimate of GHG emissions from forest fires in the Cerrado biome obtained from the Queimadas programme. According to this preliminary estimate, these emissions could have reached 60.9 Mt CO₂ eq in 2018–2019, a magnitude more than three times greater than the emissions from forest degradation in the Amazon biome included in the FREL for the same years (around 16.6 Mt CO₂ eq). Therefore, the AT considers the inclusion of GHG emissions from forest degradation in the Cerrado biome as a priority area for future technical improvement.

45. In response to a question raised by the AT, Brazil noted that, at present, Brazil did not have information regarding the forest regeneration of previously deforested areas in biomes other than the Amazon and Cerrado biomes, which together constitute approximately 70 per cent of the national territory. The AT noted that the TerraClass project provided valuable information to estimate more accurately the GHG emissions from deforested lands, and pointed out that it would be ideal if Brazil could extend its use to all biomes, with results possibly made available every two years. The AT further suggested Brazil add this information to the future improvement section in the modified submission. Brazil included text in box 4 of the modified submission stating that, pending additional resources for the TerraClass project, Brazil plans to estimate specific annual removals from secondary vegetation for all biomes and for each single year in future submissions.

46. On the basis of the information provided by the Party, the AT notes that other activities are likely to be significant, in particular forest degradation in the Cerrado biome and possibly enhancement of forest carbon stocks (secondary forest regeneration) in biomes other than the Amazon biome, and sustainable forest management (i.e. emissions from orderly logging) in all biomes. According to Brazil, these activities will be included in future FREL/FRL submissions if found to be significant.

4. Definition of forest

47. Brazil provided in its submission the definition of forest used in constructing its FREL/FRL. The definition is the same as that used by the Party for its national GHG inventory and its reporting to the Food and Agriculture Organization of the United Nations for the Global Forest Resources Assessment (i.e. a minimum area of 0.5 ha, a height of 5 m or more and at least 10 per cent canopy cover).

48. The AT understood that the forest definition in the FREL/FRL was the same as that in the Global Forest Resources Assessment. However, the AT found that the phytophysionomy classes differed and appeared to be more disaggregated in the Global Forest Resources Assessment and included, for example, classes of planted forest. In response to a question on this matter, Brazil clarified that forest plantations were not included in the FREL/FRL submission, and that the FREL/FRL submission only concerned natural forests and the phytophysionomy characteristics of these forest types and subsequently included a clarification in the modified submission noting that forest plantations (as presented in the Global Forest Resources Assessment) are not included in this FREL/FRL submission, which only encompasses natural forests and their phytophysionomies.

49. In response to a question from the AT, Brazil explained that biophysical thresholds were defined by Brazil in relation to the Kyoto Protocol (i.e. a minimum area of 1 ha, a minimum canopy cover of 30 per cent and a minimum height of 5 m), but that, for the purposes of the FREL/FRL submission, these thresholds were not necessarily applied to different forest types in different biomes. Brazil further noted that, since this submission covered all six biomes in the country, which included different forest types with a wide variety of biophysical thresholds, it would not be possible to use such biophysical thresholds in a definition in the FREL covering the entire national territory. Hence, Brazil relied on its official vegetation map and spectral characteristics of Landsat-type imagery (i.e. colour, texture) to identify and map the forest formations. The AT sought clarification from Brazil regarding the statement that the thresholds did not necessarily apply to different types of forest in different biomes. Brazil clarified that, for the FREL/FRL, the threshold values were applied as follows: each vegetation class was assessed comprehensively in relation to threshold values related to the forest definition, based on this assessment each vegetation type was associated with one category (forest, other wooded lands and grasslands) and once this association was made, the results were transferred to the vegetation map, where each polygon in the map was assigned to a respective category.

50. The AT noted that, according to the description of the managed land proxy in the 2019 Refinement to the 2006 IPCC Guidelines, anthropogenic GHG emissions and removals by sinks are defined as all those occurring on 'managed land'; that is, "where human interventions and practices have been applied to perform production, ecological or social functions". During the TA, Brazil indicated that it has followed the IPCC managed land proxy in all its national GHG inventories, as well as in its FREL/FRL submission. According to the fourth national GHG inventory (and the FREL/FRL submission), "managed forest lands are those occurring within protected areas (Conservation Unit or Indigenous Lands) and unmanaged forest lands are those occurring outside protected areas and where human action did not cause significant changes in its characteristics". In addition, the AT noted that the fourth national GHG inventory also estimated anthropogenic GHG emissions and removals for other forest categories, namely secondary forests, forests subject to selective logging and reforestation (forest plantations). The same categories are also partly included in the FREL/FRL submissions, except forest plantations.

51. The AT notes that the definition of managed land provided in the 2019 Refinement to the 2006 IPCC Guidelines (i.e. land for which anthropogenic emissions and removals are reported) has been adequately used by Brazil to include:

(a) Emissions from deforestation and forest degradation (selective logging and forest fires) in forest land remaining forest land, including emissions in demarcated Indigenous lands and protected areas regulated by domestic legislation which cover approximately 50 per cent of the forest land of the Amazonia biome;

(b) Removals from enhancement of forest carbon stocks in secondary forests in areas previously deforested.

52. The AT acknowledges that the focus of Brazil is on processes related to all natural forests, and hence forest plantations are not included in the FREL, although they are considered in the national GHG inventory.

III. Conclusions

53. The information used by Brazil in constructing its FREL/FRL for reducing emissions from deforestation (for all biomes), forest degradation (for the Amazon biome only) and enhancement of forest carbon stocks (for the Amazon biome only) is transparent and complete, and is in overall accordance with the guidelines for submissions of information on reference levels.

54. The FREL presented in the submission is Brazil's fourth FREL (previous submissions covered only the Amazon and Cerrado biomes). The previous FREL was submitted on 15 January 2018 and was subject to a TA in 2018; it covered the activity reducing emissions from deforestation for the reference period 1996–2015 for the Amazon biome only.

55. The FREL presented in the modified submission, for the reference period 2016–2017 to 2020–2021, including the activities reducing emissions from deforestation for all six biomes and reducing emissions from forest degradation for the Amazon biome, corresponds to 673,566.463.52 t CO₂ eq/year.

56. The AT acknowledges that Brazil included in its FREL/FRL the most significant activities for the most important biomes, and the most significant pools in terms of emissions from forests. The AT considers that, in doing so, Brazil followed decision 1/CP.16, paragraph 70, on activities undertaken, and decision 12/CP.17, paragraph 10, on applying the stepwise approach. The AT commends Brazil for providing information on its ongoing work to develop FRELs and FRLs for activities currently not included, in particular for reducing emissions from forest degradation in the Cerrado biome and enhancement of forest carbon stocks in all biomes, as a step towards constructing a national FREL for the most important REDD+ activities.

57. As a result of the facilitative interactions with the AT during the TA, Brazil provided a modified submission that took into consideration the technical input of the AT. Notably, Brazil modified the allocation of removals from secondary forest vegetation managed after deforestation events in the Amazon biome, originally included in the FREL and then part of the new activity enhancement of forest carbon stocks. The original FREL submission therefore became a FREL/FRL in the modified submission. The AT notes that the transparency and completeness of the information provided were significantly improved and commends Brazil for its efforts. The new information provided in the modified submission, including the data made available online,¹⁷ the underlying maps used and the steps of how estimates for each activity were calculated, increased the reproducibility of the FREL/FRL calculations. The AT commends Brazil for the high level of transparency of its submission.

58. The AT notes that, overall, Brazil maintained consistency, in terms of sources of AD and EFs used for its FREL/FRL, with those used for the GHG inventory included in its national communication and BUR.¹⁸ The differences in emissions between the FREL/FRL and the GHG inventory were clarified during the TA.

59. Pursuant to decision 13/CP.19, annex, paragraph 2(f), in assessing the pools and gases included in the FREL/FRL the AT noted that the pools and gases excluded by Brazil are likely to be insignificant in the context of the FREL/FRL.

60. Pursuant to decision 13/CP.19, annex, paragraph 3, the AT identified the following additional area for future technical improvement regarding pools and gases excluded from the FREL/FRL: the inclusion of both CO₂ and non-CO₂ emissions from forest degradation in the Cerrado biome.

¹⁷ <http://redd.mma.gov.br/en/submissions>.

¹⁸ In reference to the scope of the TA, as per decision 13/CP.19, annex, para. 2(a).

61. Pursuant to decision 13/CP.19, annex, paragraph 3, the AT also identified the following areas for future technical improvement:

(a) Clarifying that, for the estimation of carbon stocks, for the Amazon biome average values per carbon pool in the deforested and degraded area are presented, while carbon stocks for other biomes represent average values per carbon pool for the entire biome, obtained from a bibliographic review (see para. 18 above);

(b) Using higher resolution images to monitor forest degradation, and identifying polygons smaller than 3 ha (see para. 29 above);

(c) Continuing validation activities for the results of the DETER system on forest degradation, including error matrices with both commission and omission errors separately for fires and selective logging (see para. 29 above);

(d) Evaluating the significance of emissions associated with edge effects due to deforestation, and considering their inclusion under forest degradation in future FRELs, if proven to be significant (see para. 29 above);

(e) Completing and validating the SINAFLOR data set on approved sustainable management plans so that this information can be used in future FRELs to discriminate between degradation and sustainable management (see para. 31 above);

(f) Evaluating the reasons for the difference between the values of carbon stocks used in this FREL/FRL and those in the NFI, once the latter is fully complete, and assessing the implication for future FREL/FRL submissions (see para. 36 above);

(g) Including GHG emissions from forest degradation in the Cerrado biome (see para. 44 above).

62. The AT acknowledges and welcomes the Party's intention to:

(a) Develop country-specific uncertainty estimates for the carbon content for all carbon pools in all biomes and phytophysiognomies;

(b) Develop country-specific uncertainty estimates for the parameters used in the natural regeneration and degradation calculations (e.g. biomass growth yearly rate, combustion factor);

(c) Continue monitoring forest degradation in order to assess whether the reduction of deforestation is leading to the displacement of emissions, and include emissions from forest degradation beyond the Amazon biome in future FREL submissions when new and adequate data and better information are available;

(d) Estimate emissions and removals for all GHGs and carbon pools for all biomes.

63. In conclusion, the AT commends Brazil for showing strong commitment to continuously improving the completeness, transparency and accuracy of its FREL/FRL estimates in line with the stepwise approach. A number of areas for the future technical improvement of Brazil's FREL/FRL have been identified in this report. At the same time, the AT acknowledges that such improvements are subject to national capabilities and policies, and notes the importance of providing adequate and predictable support.¹⁹ The AT also acknowledges that the TA was an opportunity for a rich, open, facilitative and constructive technical exchange of information with Brazil.

64. The table contained in annex I summarizes the main features of Brazil's proposed FREL/FRL.

¹⁹ As per decisions 13/CP.19, annex, para. 1(b); and 12/CP.17, para. 10.

Annex I

Summary of the main features of the proposed forest reference emission level based on information provided by Brazil

	<i>Main features of the FREL/FRL</i>	<i>Remarks</i>
Proposed FREL/FRL	673 566 463.52 t CO ₂ eq/year from deforestation and forest degradation –59 395 580 t CO ₂ eq/year from enhancement of forest carbon stocks	Deforestation (all biomes), forest degradation (Amazon biome only) and enhancement of forest carbon stocks (Amazon biome only) (see para. 10 of this document)
Type and reference period of FREL/FRL	FREL = average of historical emissions in 2016–2021 FRL = average of historical removals in the Amazon biome in 2014–2020	See paragraph 8 of this document
Application of adjustment for national circumstances	No	
National/subnational	National	The FREL covers the six biomes in Brazil (see para. 7 of this document)
Activities included	Reducing emissions from deforestation Reducing emissions from forest degradation (Amazon biome only) Enhancement of forest carbon stocks (Amazon biome only)	Emissions from degradation and removals from enhancement of forest carbon stocks are only included in the Amazon biome owing to a lack of data for the other biomes (see paras. 7 and 44 of this document)
Pools included	Above-ground biomass Below-ground biomass Deadwood Litter	The SOC pool was not included and was deemed not to be significant (see paras. 11 and 42 of this document)
Gases included	CO ₂ , CH ₄ and N ₂ O	Non-CO ₂ GHGs included only for the Amazon and Cerrado biomes (see paras. 11 and 43 of this document)
Forest definition	Included	Minimum area of 0.5 ha with trees of minimum height of 5 m and a minimum canopy coverage of 10 per cent, or trees capable of reaching these limits in situ. Does not include areas predominantly used for agricultural or urban purposes. Forest plantations are not included as forest (see paras. 47–48 of this document)
Consistency with latest GHG inventory	Methods used for estimating the FREL/FRL are not consistent with those used for the latest GHG inventory	There is overall consistency in terms of data sources used for its FREL/FRL and those used for the national GHG inventory included in its fourth national communication and fourth BUR. However, there are differences between the estimates provided in the fourth national GHG inventory and this FREL/FRL submission owing to more updated and accurate data and information being available at the time of developing the FREL/FRL (see para. 37 of this document)

<i>Main features of the FREL/FRL</i>		<i>Remarks</i>
Description of relevant policies and plans	Included	The summary mentions the national strategy for REDD+, the forest code, the action plans for the prevention and control of deforestation in all Brazilian biomes, the National Policy for Payments for Environmental Services, and decree 10.144/2019 on results-based payments (see para. 39 of this document)
Description of assumptions on future changes to domestic policy, if included in constructing the FREL/FRL	Not applicable	
Description of changes to previous FREL/FRL	Included	Mentioned changes include the inclusion of all six Brazilian biomes, the inclusion of forest degradation and enhancement of forest carbon stocks in the Amazon biome, and the reference period calculated using five years, among others (see para. 38 of this document)
Identification of future technical improvements	Included	Several areas for future technical improvement have been identified (see paras. 60–61 of this document)

Annex II

Reference documents

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B. UNFCCC documents

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C. Other documents

The following references may not conform to UNFCCC editorial style as some have been reproduced as received or as cited in the submission:

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Silva Junior et al. 2020. Persistent collapse of biomass in Amazonian forest edges following deforestation leads to unaccounted carbon losses. *Science Advances*, 6(40), eaaz8360.

Tejada et al. 2023. CO₂ emissions in the Amazon—are bottom-up estimates from land use and cover datasets consistent with top-down estimates based on atmospheric measurements? *Frontiers in Forests and Global Change*, 6, 1107580.
