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Report on the technical assessment of the proposed forest reference emission level of Paraguay submitted in 2022

Summary

This report covers the technical assessment of the voluntary submission of Paraguay 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 Paraguay covers the activity reducing emissions from deforestation, which is among the activities included in decision 1/CP.16, paragraph 70.

For its submission, Paraguay developed a national FREL. The FREL presented in the original submission, for the reference period 2012–2019, corresponds to 53,116,279.0 tonnes of carbon dioxide equivalent per year. As a result of the facilitative process during the technical assessment, the FREL was modified to 53,943,964.4 tonnes of carbon dioxide equivalent per year.

The assessment team notes that the data and information used by Paraguay in constructing its FREL are transparent, complete and 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 future technical improvement in accordance with the provisions on the scope of the technical assessment contained in the annex to decision 13/CP.19.

Abbreviations and acronyms

2006 IPCC Guidelines	*2006 IPCC Guidelines for National Greenhouse Gas Inventories*
AD	activity data
AT	assessment team
BUR	biennial update report
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
COP	Conference of the Parties
EF	emission factor
FAO	Food and Agriculture Organization of the United Nations
FREL	forest reference emission level
FRL	forest reference level
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
LULUCF	land use, land-use change and forestry
NFI	national forest inventory
NIR	national inventory report
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)
SOC	soil organic carbon
TA	technical assessment

I. Introduction and summary

A. Overview

1. This report covers the TA of the voluntary submission of Paraguay on its proposed FREL,[1] submitted on 6 January 2022, in accordance with decisions 12/CP.17 and 13/CP.19. The hybrid TA took place from 21 to 25 March 2022 and was coordinated by the secretariat.[2] The TA was conducted by two LULUCF experts from the UNFCCC roster of experts[3] (hereinafter referred to as the AT): Raúl Abad Viñas (European Union) and Javier Fernández (Costa Rica). In addition, Fazle Rabbi Sadeque Ahmed, an expert from the Consultative Group of Experts, participated as an observer[4] during the hybrid session. The TA was coordinated by Jenny Wong (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, Paraguay submitted its proposed FREL on a voluntary basis. The proposed FREL is one of the elements[5] 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. Paraguay provided its submission in Spanish. The submission is supported by seven annexes, also in Spanish, which enhance the transparency of the FREL. The annexes cover the development of land-use maps that align with the IPCC land-use categories (annex I), the methodology for determining the uncertainty and accuracy of the thematic maps (annex II), the methodology employed in the NFI for collecting data in the field and the statistical processing of these data (annex III), the estimation of the propagation of error associated with EFs and AD (annex IV), the dead organic matter carbon pool included in the NFI (annex V), the estimation of emissions (in t CO_2 eq) for the forest type "Other forest lands: Palmar coverage" (annex VI) and the progress made in developing a methodology for estimating areas affected by fires for each land-use category (annex VII).

4. The objective of the TA is to assess the degree to which the information provided by Paraguay is in accordance with the guidelines for submission of information on reference levels[6] 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 Paraguay to construct and improve its FREL in the future, as appropriate.[7]

5. The TA of the FREL submitted by Paraguay 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 Paraguay. The facilitative exchange during the TA allowed Paraguay 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, Paraguay provided a modified version of its submission on 16 September 2022, which took into consideration the technical input of the AT. The modifications improved the clarity and transparency of the submitted FREL. The FREL value in the modified submission differs slightly from the value originally reported by

[1] The submission of Paraguay is available at https://redd.unfccc.int/submissions.html?country=PY.
[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.

Paraguay owing to the incorporation of additional data from the NFI. This TA report was prepared in the context of the modified FREL submission.

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 proposed by Paraguay, 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 referred to in that paragraph. Pursuant to paragraph 71(b) of the same decision, Paraguay developed a national FREL that covers its entire territory. The FREL includes four of the five forest types considered in the NFI, excluding only emissions from deforestation taking place in areas of the Palmar forest type.[10] For its submission, Paraguay applied a stepwise approach to developing its FREL 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 national FREL proposed by Paraguay was constructed for the historical reference period 2012–2019 using the methodologies in the 2006 IPCC Guidelines and was estimated as the annual average of the CO_2 emissions associated with gross deforestation. Deforestation was defined as the conversion of an area classified as forest to another land use in a given period of time. The FREL includes only the gross emissions from deforestation that are associated with clear-cuts in native forests and excludes any subsequent emissions and removals from deforested areas. The proposed FREL also excludes emissions from deforestation that occur from the conversion of forest plantations to non-forest land uses. The FREL presented in the modified submission, with the aim of accessing results-based payments for the REDD+ activity reducing emissions from deforestation, corresponds to 53,943,964.4 t CO_2/year.[11] Paraguay did not define a period for which this FREL value is valid.[12]

9. The AD used in constructing the FREL were derived from maps of the areas of deforestation detected by the satellite terrestrial monitoring system of Paraguay's national forest monitoring system through geospatial analysis and application of the land-use categories of the 2006 IPCC Guidelines. These maps provide information on land-use categories for two periods: 2011–2013–2015 and 2015–2017–2019. EFs were estimated using dasometric information collected during the first cycle of the NFI.

10. The proposed FREL includes the pools above-ground biomass and below-ground biomass. The carbon stock of understory vegetation is also included. Dead organic matter (deadwood and litter) and SOC in mineral and organic soils were excluded. Regarding GHGs, the submission includes CO_2 only.

11. The FREL proposed by Paraguay is its second FREL submitted in the context of applying the stepwise approach in accordance with decision 12/CP.17, paragraph 10. Its previous national FREL was submitted on 4 January 2016 and was subject to a TA in March 2016;[13] it covered the activity reducing emissions from deforestation, but information on the

[10] In its modified submission (annex VI, p.92), Paraguay acknowledged the large extent of this forest type in the country and that it possibly contributes significantly to total forest-related CO_2 emissions and removals.

[11] In its original submission, Paraguay proposed a national FREL of 53,116,279.0 t CO_2 eq/year for 2012–2019. The difference between the original and the modified submission is due mostly to the use, in the modified submission, of EFs derived from dasometric information collected during the first cycle of the NFI (which has been completed) rather than EFs derived from information from a subset of sample plots collected during the second cycle of the NFI (which is still under way).

[12] The validity period refers to the time frame during which the FREL could be applied as the benchmark.

[13] See document FCCC/TAR/2016/PRY.

validity period of the FREL was not provided. The previous assessed FREL[14] corresponded to 58,763,376.14 t CO_2 eq/year and was therefore higher than the FREL proposed in the most recent submission. The assessed FREL proposed in the modified 2016 submission differs from that in the modified 2022 submission owing mainly to the application of a new historical reference period (from 2000–2015 in the 2016 submission to 2012–2019 in the 2022 submission), the adoption of a different forest definition and the use of an improved method for satellite imagery classification.

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

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

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

12. Paraguay's second FREL was submitted with the objective of incorporating the results of recent policies implemented and efforts made by the Party to reduce emissions from deforestation. The historical reference period 2012–2019 was selected in line with this objective, as well as by taking into account the quality of the satellite imagery available for estimating AD and the results of an analysis of 10 possible FRELs. These FRELs were constructed using different reference periods, producing values that ranged from 53,943,964.4 to 62,488,673.9 t CO_2 eq/year.[15] The period with the lowest FREL value was selected as the reference period.

13. Paraguay's FREL includes CO_2 emissions from gross deforestation and excludes emissions from the conversion of reforested areas to non-forest land uses. The Party did not consider emissions or removals from the land after the deforestation event and noted that the lack of information on post-deforestation carbon stocks and their dynamics for land-use categories other than forest land prevented it from doing so.

14. In terms of carbon pools, the FREL includes above-ground biomass (stems, branches, bark, seeds and leaves, as well as living stumps) and below-ground biomass (all roots down to a diameter of 2 mm). The carbon stock of understory vegetation was also included in the calculation of the FREL, while the carbon stocks of the three pools deadwood, litter and soils (mineral and organic soils) were excluded. Paraguay acknowledged in its submission that emissions of gases other than CO_2 may be occurring as a result of deforestation activities. The AT commends Paraguay for providing information on its ongoing efforts to develop a methodology for estimating forest areas affected by fires, which will enable the inclusion of non-CO_2 GHGs in the FREL in the future.

15. Regarding land representation, Paraguay classified its forest land into the following four forest types, which fall under the definition of "native forest" according to Paraguayan law: (1) humid forests of the Eastern Region, (2) subhumid forests of the Cerrado ecoregion, (3) subhumid forests in the floodplains of the Paraguay River and (4) dry Chaqueño forests. The classification was based on biophysical, climatic and soil characteristics. These four forest types, which have already been used by Paraguay in the national GHG inventories included in its three BURs submitted as part of the UNFCCC process, were used in constructing the FREL.

16. The Party highlighted in its modified submission that, owing to a technical limitation in its national forest monitoring system, it encountered difficulties in applying its forest definition and the associated quantitative thresholds for identifying forest land (see also para. 45 below). Specifically, Paraguay explained that the resolution (30 m x 30 m) of the Landsat imagery used by the monitoring system does not allow the detection of areas of vegetation with a canopy cover of 30 per cent or less. For this reason, some areas of forest land with a

[14] Paraguay's first FREL, submitted in 2016, was based on the historical average of emissions from deforestation for 2000–2015 and was used to estimate REDD+ results for 2016–2017.

[15] See table 1 in the modified submission.

low level of canopy cover may not have been detected, and thus, if such areas were deforested, they would not have been included in the FREL. Paraguay deemed the exclusion of these areas from the FREL – namely their potential emissions – as being not significant because (1) these areas are deemed to be very small and (2) land-use change dynamics are such that deforestation occurs mainly as a result of forest land being converted to agricultural land. Nevertheless, Paraguay acknowledged that the resolution of the Landsat imagery is not suitable for classifying forest land according to its national forest definition because the definition sets a canopy threshold of equal to or greater than 10 per cent for forest areas in the Western Region and equal to or greater than 30 per cent for those in the Eastern Region.

17. Landsat satellite imagery (from the Landsat 5 Thematic Mapper and the Landsat 8 Operational Land Imager) was used for estimating AD. The images allowed the application of a minimum mapping unit of 1 ha. The Party used the Random Forest algorithm to classify land as one of the six IPCC land-use categories[16] and to determine land-use changes between them. The analysis was performed for each of the two regions that the Paraguay River divides the country into: Eastern Region and Western Region. The outcome was two raster image files of land information built from satellite images with cloud coverage of 5–10 per cent for the Eastern Region and 20–40 per cent for the Western Region.

18. A thematic accuracy assessment with a pre-fixed error margin of 20 per cent was conducted to estimate the uncertainty of the maps derived from satellite imagery (see para. 17 above). The assessment returned a thematic error of 12.02 per cent for the map for the first period (2011–2013–2015) and 11.51 per cent for the map for the second period (2015–2017–2019). These values were used by the Party to adjust the raw data on areas of deforestation derived from the analysis of satellite imagery to estimate AD.

19. To develop EFs, Paraguay used dasometric information on tree diameter and tree height collected during the first cycle of the NFI. In the first cycle of the NFI, undertaken between 2014 and 2016, information was collected on 154 field sample plots randomly distributed over the entire country. The dasometric information was used in allometric equations to estimate total living biomass. Allometric equations suitable for local conditions (Sato et al., 2015a, 2015b) were used for all forest types except for the subhumid Cerrado forests, for which an equation for tropical forests generated by Chave et al. (2005) was used.

20. To estimate biomass stocks in each pool and by forest type, Paraguay grouped tree-level information from the NFI sample plots. Allometric equations were used to determine total biomass and above-ground biomass, while below-ground biomass was determined by subtracting above-ground biomass from total biomass. To estimate the carbon content in biomass, Paraguay applied the IPCC default carbon fraction of 0.47 for all parts of the tree. The carbon content of the understory vegetation was derived by the Party from biomass samples collected in the field, which were oven-dried to obtain a specific carbon fraction. To estimate CO_2 emissions from carbon, Paraguay multiplied total carbon by its stoichiometric relation (i.e. 44/12).

21. With regard to the uncertainty associated with the EFs, Paraguay's assessment was limited to the sampling error quantified by the NFI. In its modified submission, the Party acknowledged that default values and allometric equations used to develop the EFs also contribute to their total uncertainty. Paraguay included in its improvement plan the need to consider these other sources of uncertainty in future FREL submissions.

22. To determine the overall uncertainty of the FREL, Paraguay selected approach 1 from the 2006 IPCC Guidelines. The propagated uncertainty was estimated to be 23 per cent of the level of total national emissions from deforestation during the reference period 2012–2019. However, in the modified submission, Paraguay reported the error estimate associated with annual CO_2 emissions as being in the range of 40–47 per cent. The Party noted that this error estimate is likely to change as Paraguay improves its thematic accuracy assessment.

[16] Forest land, cropland, grassland, wetlands, settlements and other land.

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

23. For land representation, Paraguay used a method for satellite image analysis that combines approaches 1–3 from the 2006 IPCC Guidelines. Two land-use maps were used to derive areas of gross deforestation for each of the two periods analysed (2011–2013–2015 and 2015–2017–2019). The AT noted that the combination of approaches applied in the Party's current submission improves on the method it used for obtaining AD for its first FREL submission but still does not allow the estimation of areas for all possible land-use conversions. Further, the AT noted that using the new land representation method leads to inconsistent reporting of the total national area over time. During the technical exchange, Paraguay explained that it plans to improve its thematic accuracy assessment and expects that doing so will, in turn, help to identify areas for improvement of land representation methods. The AT is of the view that improving its land representation approach may help the Party to address some of the issues that significantly affect the accuracy of the current FREL. The AT noted that any new method applied should contribute to (1) maintaining consistency in the total national area over time; (2) improving the classification of land and land conversions in line with the IPCC land-use categories; (3) maintaining a consistent time period (calendar years) for AD acquisition; (4) incorporating into the construction of the FREL information from satellite imagery with a resolution sufficient to allow proper application of the national forest definition; (5) adopting a more accurate approach for estimating areas of Palmar forests and the associated emissions, while ensuring consistency with other data sources on Palmar forests (e.g. the NFI); and (6) improving the consistency of the FREL with the national GHG inventory. Therefore, the AT identified enhancing the approach to land representation as an important area for future technical improvement.

24. AD were obtained from two maps that were assessed for their thematic accuracy with a pre-fixed error margin of 20 per cent (see paras. 9 and 18 above). As identified by the Party in its submission and elaborated on during the technical exchange, the thematic accuracy assessment highlighted some critical inaccuracies that need to be addressed. Paraguay expressed its intention to revise the methodology and data used to produce the maps and to use new maps for future FRELs. The Party informed the AT that, for the new maps and the revised thematic accuracy assessment, it plans to increase the sample size with the aim of reducing the error margin to below 20 per cent. Given this planned improvement and the information provided during the TA, Paraguay deemed this current FREL value to be preliminary.

25. Paraguay assessed the thematic accuracy of its land-use maps using the results of checks performed by trained technicians on a sample of segments that were automatically classified by the Random Forest algorithm. If the technicians' assignment of land-use category aligned with that of the algorithm, the uncertainty of the segment was assumed to be zero. The AT noted that the results of these checks form the basis for the uncertainty assessment of the AD. However, the AT also noted that, even if the segments were assigned to the correct land-use category, their classification may still be prone to error in terms of shape and size, and that checks of potential discrepancies in segment shape and size should be included in a more comprehensive uncertainty assessment. During the TA, the AT sought clarification on this issue, and the Party stated that it plans to revise the thematic accuracy assessment in order to address the numerous inconsistencies found during its application. The AT noted that Paraguay may wish to consider checking the shape and size of segments as part of updating the assessment or introducing a new method to quantitatively assess the uncertainty of the maps. The AT considers that, to achieve a truly independent "reference classification" system (Olofsson et al., 2014), the sampling design should not be dependent on the use of higher-resolution satellite images and should not be based on pre-classified segments. In this context, the AT considers that a point-sampling approach based on a systematic grid with equal sampling probability and sufficient sampling intensity is likely a feasible option for a better uncertainty assessment and, ultimately, would provide Paraguay with a better representation of its land use and land-use change areas; therefore, it considers this to be an area for future technical improvement.

26. Paraguay's NFI classifies Palmar as an independent native forest type owing to its high biomass content and the significant total size of Palmar forest areas within national total forest land. In 2018, following a change to relevant legislation, Paraguay updated its forest definition, which led to the exclusion of Palmar forests from "natural forest" and their inclusion under "other forest land". During the TA, Paraguay clarified that this change to the forest definition is the main reason for excluding the Palmar forest type from the FREL. In its modified submission, Paraguay explained the inherent difficulties in spatially and explicitly identifying Palmar areas owing to the low resolution of the satellite images used in its national forest monitoring system. At the same time, it reported that emissions from the conversion of Palmar areas to other non-forest land uses contribute significantly to total national emissions from deforestation. Considering this, and also observing that information has been collected during the NFI that would be useful for estimating EFs for Palmar forests, the AT identified the potential inclusion of the Palmar forest type in future FREL submissions as an area for future technical improvement. This improvement could be considered alongside the improvement of land representation methods (see paras. 24–25 above).

27. The AT noted that Paraguay did not identify peatland as a forest type, although the modified submission describes natural forest stands of the humid forests in the Eastern Region as occurring on peatland, and Paraguay's second national communication and third BUR refer to areas of peatland or swamps in the country. During the TA, the AT sought clarification on this issue. The Party stated that there is no official information to confirm the presence of peatlands or swamps in the country. Further, during the TA, the AT shared with the Party some unofficial independent sources that indicate the presence of peatlands along the border between Paraguay and Brazil. The AT noted that Paraguay may wish to further investigate whether peatlands exist in its territory and, if they do, whether deforestation occurs in such areas. The AT identified the treatment of peatlands as an area for future technical improvement given that they might constitute a significant contribution to total emissions from deforestation, especially through SOC and methane.

28. Paraguay applied a gross deforestation approach to estimating emissions from deforestation. This approach excludes emissions and removals from the conversion of areas of reforestation or regeneration to non-forest land categories. In addition, Paraguay assumed that post-deforestation carbon stocks were zero. During the technical exchange, the Party clarified that, if resources are available, it intends to improve its current land-cover mapping by identifying non-forest land uses. This would enable a complete land representation approach following the six land-use categories of the 2006 IPCC Guidelines to be applied. The AT noted that this planned improvement, along with the acquisition of data on carbon stocks remaining after forest conversion, would increase the accuracy of estimates of emissions from deforestation; therefore, the AT identified this to be an area for future technical improvement.

29. Paraguay reported uncertainty estimates for carbon stocks in understory vegetation as being in the range of 16.74–42.41 per cent, depending on forest type. During the technical exchange, the Party explained that this high uncertainty can be attributed to some sampling units lacking understory vegetation and some experiencing field conditions (e.g. flooding) that impeded the collection of data. During the TA, the Party added that much of the uncertainty is due to outliers in the data. While the AT acknowledged that understory biomass may be highly variable owing to different natural light conditions and disturbance regimes, it noted that to obtain data for estimating carbon stocks Paraguay may wish to (1) assign zero to biomass stock in sampling units where understory vegetation is absent, and include these sampling units in the analysis; (2) document the location and number of field plots that are difficult to measure owing to field conditions; and (3) exclude outliers (i.e. data falling outside two standard deviations from the mean of the distribution), as per the methods outlined in the 2006 IPCC Guidelines. The AT identified the application of these three points in the estimation of understory biomass as an area for future technical improvement as it is linked to the accuracy of total forest carbon stock estimates.

30. The AT noted that, although the historical reference period for the FREL is 2012–2019, the land-cover maps do not cover the entire period: they exclude a few months of both 2012 and 2019. During the TA, Paraguay explained that each map is composed of a mosaic of images obtained from different dates to represent a calendar year. Considering that the

goal is to obtain cloud-free images, the satellite imagery may not cover the entire span of each calendar year. Following a request from the AT, Paraguay included in the modified submission (tables 10–11) details on all satellite image scenes used to create the land-cover mosaics. The AT commends Paraguay for providing this information, which increased the transparency of the submission. Further, the AT noted that, according to the 2006 IPCC Guidelines (vol. 1, chap. 5, p.5.8), when using non-calendar year data, it is good practice to use the same collection period consistently over the time series to avoid introducing bias. While the AT acknowledged the challenges of producing cloud-free maps in the tropics, it identified using a consistent image collection period over the entire time series as an area for future technical improvement, to be addressed as better data and methods become available.

31. In its modified submission (table 9), Paraguay described the methodological changes introduced since construction of the FREL submitted in 2016. The AT commends Paraguay for providing this information. However, the AT noted discrepancies in the levels of and trends in emissions from deforestation for the overlapping years (i.e. 2012–2015) of the 2016 and current FREL. The peak in emissions from deforestation for 2012–2013, as reported in the 2016 FREL submission, has seemingly shifted to 2014–2015 according to the current FREL submission.[17] As such, this peak in emissions was incorporated in the reference period used in the construction of the current FREL. The AT sought clarification on the reasons for the shifting of the peak. In response, Paraguay stated that its intended revision of the thematic accuracy assessment will also enhance its understanding of the drivers behind the shifting of the peak in emissions but the Party assumes that they are largely driven by the new methodology for acquiring AD implemented for the current submission. The AT identified the revision of the estimates of emissions from deforestation and of the thematic accuracy assessment as areas for future technical improvement, noting that the revision is expected to clarify differences in the level of and trend in emissions between the two FREL submissions.

32. The AT commends Paraguay for conducting an uncertainty assessment and including information related to the accuracy of the FREL value in its submission. The uncertainty assessment was based on the thematic accuracy assessment (for the AD) and the sampling error of the NFI (for the EFs). The AT noted that this represents a simplified uncertainty assessment as it does not include all of the potential sources of uncertainty identified by the Party. The AT therefore identified (1) assessing and including additional sources of uncertainty that may be contributing to total uncertainty and (2) using an independent data set of higher-resolution images to assess the uncertainty of the AD (see para. 23 above) as areas for future technical improvement.

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

(a) The adoption of a new forest definition;

(b) The use of different allometric equations for estimating living biomass;

(c) The use of a complete data set of dasometric information from the first cycle of the NFI for estimating living biomass;

(d) The update of land-cover maps in line with the new forest definition;

(e) The development of a specific map for delineating areas of Palmar forests in order to exclude this forest type from the FREL.

34. During the TA, the AT identified the following differences in methods and data used between Paraguay's previous and most recent FREL submission:

(a) The use of new data and parameter values to update the uncertainty assessment;

(b) The application of a conservative approach to estimating AD;

(c) The implementation of a thematic accuracy assessment as the basis for estimating uncertainty in AD;

[17] See figure 10 (p.39) of the modified submission, which shows the time series for gross deforestation as included in both the 2016 and the current FREL submissions.

(d) The definition of a new historical reference period.

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

35. Paraguay provided a description of its national circumstances relevant to the construction of the FREL and to REDD+ implementation. This information included descriptions of the country's updated nationally determined contribution (2021), the 2030 National Development Plan, the National Forest Strategy for Sustainable Development, the Climate Mitigation National Plan, National Forestry Plan and the Agriculture Strategic Framework,[18] as well as references to other national policies on energy, climate change and forestry. Paraguay also provided a description of the main drivers of deforestation and a brief clarification on inter-annual variability during the reference period in deforested areas of each of the four forest types included in the FREL.

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

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

37. The pools included in the Party's FREL are above-ground biomass and below-ground biomass. The deadwood, litter and soil pools were not included.

38. With regard to emissions from deadwood and litter (i.e. dead organic matter), the AT requested clarification of the reasons for omitting the pools. In response, Paraguay explained that the pools were not included because it lacks data on the carbon stocks for all land-use categories following deforestation for these pools. The Party considered that assuming full loss of carbon stocks from dead organic matter as a result of a deforestation event would lead to an overestimation of emissions. The AT noted that data on dead organic matter were collected during the NFI and that the national GHG inventory that was part of the country's third BUR submission includes estimates of emissions from dead organic matter. The AT also noted that in the modified FREL submission Paraguay did not include information on the significance of these pools to justify their exclusion, only mentioning that they were excluded on the basis of the magnitude of the uncertainty of the available data. However, the AT observed that the uncertainty estimates for carbon stocks in dead organic matter (see table 16 of the modified submission) are of the same order of magnitude as, or sometimes lower than, the uncertainty estimates for carbon stocks in living biomass (trees and understory vegetation). The AT considers that emission estimates for dead organic matter are relevant to the accurate estimation of total forest carbon stocks and, in this context, noted that Paraguay may wish to assess the significance of the pools in terms of emissions resulting from deforestation by using the already available data. The findings of the assessment could either serve to justify the exclusion of these pools from the FREL or, if the pools are found to be significant, indicate that Paraguay may wish to collect carbon stock data for dead organic matter for land-use categories following deforestation in order to reduce uncertainties in the estimation of forest carbon stocks and avoid applying the assumption of full instantaneous oxidation. Further, the AT considers that as part of the stepwise approach, in the interim and until data on carbon stocks in forest conversions and non-forest land become available, the Party may assume full loss of carbon stocks in dead organic matter following a deforestation event. This assumption is based on the consideration that the main components of dead organic matter are likely to be removed from the land or oxidized in a relatively short time frame. The AT is of the view that applying this assumption would lead to a more accurate estimate of forest carbon stocks and, ultimately, of emissions from deforestation. Therefore, the AT identified the treatment of emissions from dead organic matter as an area for future technical improvement – which could also help to increase the consistency of the FREL with the national GHG inventory.

39. With regard to emissions from soils (i.e. SOC), the AT requested clarification of the reasons for omitting the pool. In response, Paraguay explained that the pool was not included because information is available only for forest soils. Owing to this lack of data, any estimates of carbon stock changes from land-use conversion would be highly uncertain. The AT

[18] Paraguay provided web links to these documents in chapter 4 of the modified submission.

acknowledged this explanation provided by the Party. The AT noted that the significance of this pool in terms of total LULUCF emissions, as estimated by Paraguay on the basis of information from the NFI and reported in its first BUR, is 39.1 per cent. Paraguay opted to exclude this pool from its second BUR and in that BUR mentioned its plan to collect the data necessary to capture the carbon dynamics of the pool for inclusion in the next GHG inventory. For the third BUR, Paraguay used default EFs from the 2006 IPCC Guidelines to estimate carbon stock changes in soils and included the results in the GHG inventory submitted as part of that report.

40. The AT commends Paraguay for the inclusion of information on SOC stocks, and their associated uncertainties, in its modified submission (see table 16). According to this information, carbon stock values for soils and their uncertainties are of the same order of magnitude as those for the total living biomass used to construct the FREL. While bearing this comparison in mind and appreciating that biomass and soil pools behave differently when forest land undergoes deforestation, the AT is of the view that the exclusion of SOC from the FREL based on its significance was not properly justified. At the same time, the AT acknowledges the reason for the exclusion, as explained by the Party, and recognizes the challenges associated with estimating emissions from soils, such as the need for a large amount of financial resources. The AT considers the collection of data that allow a more accurate assessment of the significance of SOC in terms of emissions from deforestation is in line with the stepwise approach and identified this as an area for future technical improvement.

41. Although Paraguay reported areas of organic soils in its second national communication, according to the modified FREL submission, there is internal disagreement as to whether organic soils occur in the country or if all such areas are in fact areas of mineral soils. The AT noted that the Party may wish to investigate further whether organic soils do occur in the country and, if they do, whether any areas of organic soils are classified as forest land and, if they are, whether such forests are subject to anthropogenic actions (for instance, deforestation) that could enhance the oxidation of the carbon stocks. With a view to the Party reporting in accordance with decision 12/CP.17, annex, paragraph (c), the AT identified the acquisition of data that enable assessment of the significance of emissions from organic soils arising from deforestation as an area for future technical improvement.

42. With regard to non-CO_2 emissions, the AT requested clarification of the reasons for omitting these GHGs. The AT noted that (1) in the modified submission the Party reported that slash-and-burn farming is common in the country and potentially leads to significant non-CO_2 emissions from biomass burning and (2) in the second national communication the Party reported areas of organic soils that may be subject to deforestation, potentially leading to non-CO_2 emissions. Therefore, the AT identified the treatment and potential inclusion in the FREL of non-CO_2 emissions as an area for future technical improvement.

43. The AT acknowledges that Paraguay included in its FREL the most significant activity, reducing emissions from deforestation, of the five activities identified in decision 1/CP.16, paragraph 70, in accordance with its national capabilities and circumstances. The AT notes that other activities could also be significant, in particular reducing emissions from forest degradation and enhancement of forest carbon stocks. The AT also notes that the Party included in its modified submission information on its ongoing efforts with regard to including other REDD+ activities in its FREL, including its preparation of a preliminary methodology for identifying geospatially explicit areas of forest degradation due to wildfires.

44. Paraguay stated that other REDD+ activities were not included in its current FREL owing to the lack of information and resources needed to reach an adequate level of accuracy in the estimates of emissions and removals. The AT noted that in its third BUR (2021) the Party reported information on carbon stock changes for forest land remaining forest land and land converted to forest land covering the time series 1990–2017 (see table 6.3 of the NIR (2022) and the third BUR). Both land-use categories are relevant to REDD+ activities, and on the basis of these data the emissions of both categories appear to be significant (11.2 and 13.4 per cent for forest land remaining forest land and land converted to forest land respectively) when compared with the emissions from deforestation for 2017. In this context, the AT is of the view that the current submission does not include sufficient justification for the exclusion of the other REDD+ activities based on their significance. The AT observed

that information is available in Paraguay that could be used to assess the significance of these activities in terms of the level of and trend in emissions during the reference period. Thus, the AT noted that Paraguay may wish to perform an assessment of the significance, in terms of emissions and removals, of the REDD+ activities excluded from the FREL and, depending on the findings, consider including those REDD+ activities associated with forest land remaining forest land and land converted to forest land in future FREL submissions.

4. Definition of forest

45. Paraguay provided in its submission the definition of forest used in constructing its FREL. The definition is different from that used by the Party for its first FREL submission, its national GHG inventory, its reporting to FAO for the Global Forest Resources Assessment (2020) and its LULUCF activities under the clean development mechanism. The forest definition adopted for the current FREL refers to a biodiverse ecosystem, managed or not managed, which presents natural or technically assisted regeneration with native species that provide goods and services and with a minimum area of 1 ha, a tree height of 3 m for the Western Region and 5 m for the Eastern Region, and a minimum crown cover of 10 per cent for the Western Region and 30 per cent for the Eastern Region.

46. Paraguay's forest definition was updated for the construction of the current FREL following decree 175/2018, which defines "forest zones" as including natural forests, productive forest land and other forest land. Regarding the differences between the forest definition adopted for the current FREL and the definitions applied for other purposes (see para. 45 above), Paraguay stated in its modified submission that, to date, there has been no consensus on a forest definition among forest authorities.

47. The AT noted that land representation was determined using medium-resolution (30 m) Landsat imagery. Considering that Paraguay's forest definition requires canopy cover of 10–30 per cent (depending on region), the AT sought clarification of whether the Party was able to accurately identify and distinguish forests with canopy cover at or below the regional thresholds. During the technical exchange, Paraguay acknowledged that implementing the forest definition presented some challenges, for example in (1) accurately identifying areas of Palmar forests, especially for buffer areas transitioning from Palmar forest to other forest types, and (2) identifying forest areas with canopy cover of about 30 per cent or below. Further, the Party explained that the magnitude of these issues and their impact on the FREL value are still unknown. The Party informed the AT that it lacks the resources to use higher-resolution imagery that could help to address these issues. The AT noted that Paraguay may wish to address these issues in a comprehensive manner together with related land representation and forest area identification issues (see paras. 23–26 above), and that ensuring the consistency of the different forest definitions currently used by the Party would ensure feasible implementation of the methods used for AD and EF acquisition. The AT identified the consistent application of the forest definition as an area for future technical improvement.

48. The AT commends Paraguay for providing information on the change in the forest definition used for the current submission (see para. 46 above). However, the AT noted inconsistencies throughout the current submission in how the Party refers to forest areas used in the construction of the FREL. In its first submission (2016), Paraguay referred to "native forest", but in the current submission forest areas are categorized as either "native forest" (e.g. in table 4) or "natural forest" (e.g. in section 3.3.1). The AT thus identified the consistent application of one term when referring to the forest areas used in constructing the FREL as an area for future technical improvement, which will increase the transparency of the submission.

III. Conclusions

49. The information used by Paraguay in constructing its FREL for reducing emissions from deforestation is transparent and complete and in overall accordance with the guidelines for submissions of information on reference levels.

50. The FREL presented in the submission is Paraguay's second FREL. The previous FREL was submitted on 4 January 2016 and was subject to a TA in 2016; it covered the activity reducing emissions from deforestation for 2000–2015.

51. The FREL presented in the most recent modified submission, for 2012–2019, corresponds to 53,943,964.4 t CO_2 eq/year.

52. The AT acknowledges that Paraguay included in its FREL the most significant activity and the most significant pools in terms of emissions from forests. The AT considers that, in doing so, Paraguay followed decision 1/CP.16, paragraph 70, on activities undertaken, and decision 12/CP.17, paragraph 10, on applying the stepwise approach.

53. As a result of the facilitative interactions with the AT during the TA, Paraguay provided a modified submission that took into consideration the technical input of the AT. The AT notes that the transparency and completeness of the information provided were significantly improved in the modified FREL submission and commends Paraguay on its efforts. The new information provided in the modified submission increased the reproducibility of the FREL value.

54. The AT notes that, overall, Paraguay did not maintain consistency, in terms of sources of AD and EFs used for its FREL, with those used for the GHG inventory included in its third BUR (2021).[19]

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

(a) Improving the land representation approach (see para. 23 above);

(b) Adopting a point-sampling approach based on a systematic grid with equal sampling probability and sufficient sampling intensity to enable a better uncertainty assessment resulting in a better representation of land use and land-use change areas (see para. 25 above);

(c) Improving the treatment of Palmar forest areas and assessing their potential inclusion in future FRELs, taking into consideration the overlap of this forest type with other forest types in transition zones (see para. 26 above);

(d) Investigating whether peatlands occur in the country and, if so, whether deforestation occurs in those areas (see para. 27 above);

(e) Adopting a land-classification approach that enables the estimation of post-deforestation land uses, and increasing the accuracy of emission estimates from deforestation by acquiring data on carbon stocks left in situ and any vegetation regrowth after forest conversion (see para. 28 above);

(f) Improving the analysis of data on the biomass of understory vegetation in order to derive EFs for understory vegetation that can be used to increase the accuracy of total forest carbon stock estimates (see para. 29 above);

(g) When using non-calendar years in the collection of satellite images used for producing cloud-free maps, using them consistently over the time series in order to avoid introducing bias (see para. 30 above);

(h) Revising both the estimates of emissions from deforestation and the thematic accuracy assessment in order to clarify the differences in the levels of and trends in emissions from deforestation between the two FREL submissions (see para. 31 above);

(i) Assessing and including additional sources of uncertainty that may be contributing to the total uncertainty of the FREL, and using an independent data set of higher-resolution images to assess the uncertainty of the AD (see para. 32 above);

(j) Ensuring consistent application of the forest definition (see para. 47 above);

(k) Ensuring consistent application throughout the FREL submission of the term used for identifying forest areas (i.e. "native forest" or "natural forest") (see para. 48 above).

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

56. Pursuant to decision 13/CP.19, annex, paragraph 3, the AT identified the following additional areas for future technical improvement regarding pools and gases excluded from the FREL:

(a) Treatment of emissions from dead organic matter (i.e. including the pools deadwood and litter or providing more information to justify their omission) (see para. 38 above);

(b) Treatment of SOC (i.e. including the pool or providing more information to justify its omission) (see paras. 39–40 above);

(c) Acquisition of data for assessing the significance of emissions from organic soils arising from deforestation (see para. 41 above);

(d) Treatment of non-CO_2 gases and their potential inclusion in the FREL in order to maintain consistency with the GHG inventory (see para. 42 above);

(e) Assessment of the significance, in terms of emissions and removals, of the REDD+ activities currently excluded from the FREL and, depending on the findings, consideration of their inclusion in future FREL submissions (see para. 44 above).

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

(a) Develop methods that enable the inclusion of forest degradation in the FREL;

(b) Improve the application of the forest definition;

(c) Consider the inclusion in the FREL of additional REDD+ activities that may be significant;

(d) Consider the inclusion in the FREL of additional carbon pools and GHGs;

(e) Improve the allometric equations used for estimating living biomass.

58. In conclusion, the AT commends Paraguay for showing strong commitment to continuously improving its FREL estimates in line with the stepwise approach. A number of areas for the future technical improvement of Paraguay's FREL 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 provision of adequate and predictable support.[20] The AT also acknowledges that the TA was an opportunity for a rich, open, facilitative and constructive technical exchange of information with Paraguay.

59. The table contained in annex I summarizes the main features of Paraguay's proposed FREL.

[20] 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 Paraguay

Main features of the FREL		*Remarks*
Proposed FREL	53 943 964.4 t CO_2 eq/year	The FREL includes emissions from deforestation and excludes any subsequent emissions and removals from deforested areas (see para. 8 of this document)
Type and reference period of FREL	FREL = average of historical emissions in 2012–2019	See paragraph 8 of this document
Application of adjustment for national circumstances	No	
National/subnational	National	See paragraph 7 of this document
Activity included	Reducing emissions from deforestation	Paraguay implemented a gross deforestation approach, without considering post-deforestation carbon stocks. Emissions from forest conversion that may have occurred in areas of reforestation or regeneration were not considered (see para. 7 of this document)
Pools included	Above-ground biomass Below-ground biomass	Paraguay excluded dead organic matter (deadwood and litter) to avoid overestimation of emissions from deforestation because of the inherent uncertainty of the data available. SOC (soils) was excluded as information on post-deforestation SOC values is not available (see paras. 10 and 38–41 of this document)
Gas included	CO_2	See paragraph 10 of this document
Forest definition	Included	The forest definition differs from the one adopted for the national GHG inventory and for other international reporting purposes (e.g. FAO Global Forest Resources Assessment) (see para. 45 of this document)
Consistency with latest GHG inventory	Methods used for estimating the FREL are not consistent with those used for the latest GHG inventory in the 2022 NIR	Some of the data sources used for the FREL submission and the GHG inventory are the same; however, the treatment of data, assumptions, carbon pools and GHGs is not consistent between the submission and the inventory (see paras. 38–39 of this document)
Description of relevant policies and plans	Included	Paraguay included a description of relevant policies and national strategies for REDD+, as well as a description of the main drivers of deforestation (see para. 35 of this document)
Description of assumptions on future changes to domestic policy, if included in constructing the FREL	Not applicable	
Description of changes to previous FREL	Included	See paragraphs 34–35 of this document
Identification of future technical improvements	Included	Several areas for future technical improvement have been identified (see paras. 55–56 of this document)

Annex II

Reference documents

A. Reports of the Intergovernmental Panel on Climate Change

IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. S Eggleston, L Buendia, K Miwa, et al. (eds.). Hayama, Japan: Institute for Global Environmental Strategies. Available at http://www.ipcc-nggip.iges.or.jp/public/2006gl.

B. UNFCCC documents

First and second, including modified, FREL submissions of Paraguay. Available at https://redd.unfccc.int/submissions.html?country= PY.

First, second and third BURs of Paraguay. Available at https://unfccc.int/BURs.

"Guidelines and procedures for the technical assessment of submissions from Parties on proposed forest reference emission levels and/or forest reference levels". Decision 13/CP.19, annex. Available at https://unfccc.int/sites/default/files/resource/docs/2013/cop19/eng/10a01.pdf#page=36.

"Guidelines for submissions of information on reference levels". Decision 12/CP.17, annex. Available at https://unfccc.int/sites/default/files/resource/docs/2011/cop17/eng/09a02.pdf#page=19.

Report on the TA of the proposed FREL of Paraguay submitted in 2016. FCCC/TAR/2016/PRY. Available at https://redd.unfccc.int/submissions.html?country=PY.

Second national communication of Paraguay.
Available at https://unfccc.int/non-annex-I-NCs.

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:

Chave J, Andalo C, Brown S, et al. 2005. Tree allometry and improved estimation of carbon stocks and balance in tropical forests. *Oecologia*. 145:87–99. Available at https://doi.org/10.1007/s00442-005-0100-x.

FAO. 2020. Global Forest Resources Assessment 2020. Rome: Food and Agriculture Organization of the United Nations. Available at https://www.fao.org/forest-resources-assessment/2020/en/.

Olofsson P, Foody G, Herold M, Stehman S et al. 2014. Good practices for estimating area and assessing accuracy of land change. *Remote Sensing of Environment*, 148:42–57. https://doi.org/10.1016/j.rse.2014.02.015.

Sato T, Saito M, Ramírez D, Pérez L, et al. 2015a. Development of allometric equations for tree biomass in forest ecosystems in Paraguay. FFPRI/UNA/INFONA, Asunción, PY.

Sato T, Saito M, Ramírez D, Pérez L, et al. 2015b. Allometric equations for bottle-shaped tree (*Ceiba chodatii*) in the Chaco region, western Paraguay. FFPRI/UNA/INFONA, Asunción, Paraguay.