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Report on the technical assessment of the proposed forest reference emission level of Nicaragua submitted in 2019

Summary

This report covers the technical assessment of the voluntary submission of Nicaragua 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 Nicaragua covers the activities "reducing emissions from deforestation", "reducing emissions from forest degradation" and "enhancement of forest carbon stocks", which are among the activities included in decision 1/CP.16, paragraph 70. For its submission, Nicaragua developed a national FREL. The FREL presented in the original submission, for the reference period 2006–2015, corresponds to 16,510,883 tonnes of carbon dioxide per year. As a result of the facilitative process during the technical assessment, the FREL was modified to 14,436,009 tonnes of carbon dioxide per year. The assessment team notes that the data and information used by Nicaragua 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.

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Abbreviations and acronyms

AT	assessment team
COP	Conference of the Parties
CO_2	carbon dioxide
FAO	Food and Agriculture Organization of the United Nations
FCPF	Forest Carbon Partnership Facility
FREL	forest reference emission level
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
NFI	national forest inventory
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)
SPOT	satellite for the observation of the Earth
TA	technical assessment
2006 IPCC Guidelines	*2006 IPCC Guidelines for National Greenhouse Gas Inventories*

I. Introduction and summary

A. Overview

1. This report covers the TA of the voluntary submission of Nicaragua on its proposed FREL,[1] submitted on 22 January 2019, in accordance with decisions 12/CP.17 and 13/CP.19. The TA took place (as a centralized activity) from 18 to 22 March 2019 in Bonn and was coordinated by the secretariat.[2] The TA was conducted by two land use, land-use change and forestry experts from the UNFCCC roster of experts[3] (hereinafter referred to as the AT): Javier Fernandez (Costa Rica) and Craig Wayson (United States of America). In addition, Gervais Ludovic Itsoua Madzous, an expert from the Consultative Group of Experts, participated as an observer[4] during the centralized activity in Bonn. 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, Nicaragua submitted its proposed FREL on a voluntary basis. The proposed FREL is one of the elements[5] to be developed in the implementation of 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. Nicaragua provided its submission in Spanish. The submission provides information on the Party's efforts to estimate a baseline that quantifies its historical CO_2 emissions from land-use change in the forest sector.

4. The objective of the TA is to assess the degree to which the information provided by Nicaragua is in accordance with the guidelines for submissions 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 Nicaragua for the construction and future improvement of its FREL, as appropriate.[7]

5. The TA of the FREL submitted by Nicaragua was undertaken in accordance with the guidelines and procedures for the TA of submissions from Parties on proposed FRELs and/or forest reference levels.[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 Nicaragua. The facilitative exchange during the TA allowed Nicaragua 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, Nicaragua provided a modified version of its submission on 21 June 2019, which took into consideration the technical input of the AT. The modifications improved the clarity and transparency of the submitted FREL. This TA report was prepared in the context of the modified FREL submission. The modified submission, containing the assessed FREL, and the original submission are available on the UNFCCC website.[10]

[1] The submission of Nicaragua is available at https://redd.unfccc.int/submissions.html?country=nic.
[2] Per decision 13/CP.19, annex, para. 7.
[3] Per decision 13/CP.19, annex, paras. 7 and 9.
[4] 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] Per decision 13/CP.19, annex, paras. 1(b) and 13–14.
[10] As footnote 1 above.

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 Nicaragua, on a voluntary basis for a TA in the context of results-based payments, covers the activities "reducing emissions from deforestation", "reducing emissions from forest degradation" and "enhancement of forest carbon stocks", which are three of the five activities referred to in that paragraph. Pursuant to paragraph 71(b) of the same decision, Nicaragua developed a national FREL that covers its continental territory, totalling 11,941,161.62 ha. For its submission, Nicaragua 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 FRELs and/or forest reference levels by incorporating better data, improved methodologies and, where appropriate, additional pools.

8. The national FREL proposed by Nicaragua for the historical reference period 2006–2015 is the annual average of its CO_2 emissions and removals from deforestation, forest degradation and enhancement of forest carbon stocks.[11] The emissions and removals were estimated on the basis of the IPCC land use and land-use change categories forest land converted to other land uses, forest land remaining forest land, and other land uses converted to forest land. Reducing emissions from forest degradation covers both emissions and removals from forest land remaining forest land. National data derived from visual interpretation of high- and mid-resolution satellite imagery were used to estimate areas of land use and land-use change. Data from the NFI (for 2007–2008) were used to estimate carbon stock by forest class.

9. The FREL presented in the modified submission corresponds to 14,436,009 t CO_2/year,[12] with an associated uncertainty of 14.63 per cent as reported by Nicaragua. The Party did not specify a validity period for the modified FREL. The national FREL was based on a subnational baseline developed for the FCPF Carbon Fund using its Methodological Framework.[13]

10. The proposed FREL includes the above-ground and below-ground biomass pools. Regarding GHGs, the submission includes CO_2 only.

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

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

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

11. For the construction of its FREL, Nicaragua used the methodologies provided in the 2006 IPCC Guidelines. For forest land remaining forest land, which applies to "reducing emissions from forest degradation" and "conservation of forest carbon stocks", Nicaragua applied the stock-difference method by conducting a two-time canopy cover assessment (in 2005 and 2015) and calculating the difference between the estimates. From that assessment, Nicaragua developed a linear regression model based on canopy cover data derived from the NFI to predict changes in above-ground biomass. For forest land conversion (deforestation), changes in carbon stock were also estimated using the stock-difference method. Forest carbon stocks and post-conversion stocks were derived from the NFI. For land converted to forest

[11] See table 13 of the modified submission on the FREL of Nicaragua.

[12] In its original submission (table 15), Nicaragua proposed a national FREL of 16,510,883 t CO_2/year for 2006–2015. The difference between the original and modified submission is due mostly to corrections made to the carbon stock values derived from the NFI and the increase in the number of Monte Carlo simulations to 10,000 iterations in the uncertainty assessment.

[13] See https://www.forestcarbonpartnership.org/carbon-fund.

land, which applies to "enhancement of forest carbon stocks", Nicaragua applied the IPCC gain-loss method to estimate forest carbon stock changes and used forest growth rates obtained from scientific literature (Moraes, 2001), and losses were assumed to be zero.

12. For determining land representation, land use and land-use change categories, Nicaragua conducted a two-time sampling exercise for 2005 and 2015 on the basis of visual interpretation of satellite imagery obtained from Google Earth, Bing Maps, Landsat, Sentinel, SPOT and RapidEye. A systematic sampling design was applied on the basis of the latitude and longitude grid used for the NFI. The sampling covered 5,427 plots with a distance of 2.5 by 2.5 ° or 4.5–4.8 km between them. Each plot encompassed nine Landsat pixels (90 by 90 m). A three by three point grid was located within each plot to estimate canopy cover. Land use and land-use change were visually interpreted following a protocol developed by Nicaragua that included decision trees that used ancillary information to classify land use (e.g. agricultural crops, settlements and water distribution). ArcGIS[14] and Collect Earth[15] were used as interfaces for collecting the data.

13. Nicaragua's land classification includes 44 classes that correspond to forest land, woody vegetation and non-woody vegetation. Cropland and grassland were included under non-woody vegetation, whereas wetlands, settlements and other land were all classed as non-forest. Owing to persistent cloud cover, Nicaragua created a "without information" class. The transition of permanent crops to woody vegetation was omitted as only one observation of this was found in the 5,427 sampled plots.

14. Above-ground biomass carbon stocks were estimated from data collected for Nicaragua's NFI that was implemented in 2007. The NFI included 371 sampling units on a 10 ° latitude-longitude grid following methods proposed by FAO. Each sampling unit was composed of four plots (0.5 ha each) where tree data were collected as well as a number of subplots for measuring shrubs, deadwood and other variables. Nicaragua estimated tree-level biomass by applying a method from Chave et al. (2014). Below-ground biomass per tree was estimated using a method from Cairns et al. (1997).

15. Forest growth rates used for estimating carbon stock gains in land converted to forest land were obtained from a study by Moraes (2001) based on data from broadleaf evergreen forests on the Atlantic coast of Nicaragua. The same rates were applied for dry forest. The data in Moraes (2001) were obtained from 12 plots on four sites in Bluefields in southern Nicaragua. Data from 10 of those plots were used for estimating the FREL, for which the measurement errors were reported. A different approach was followed for pine forest: on the basis of the findings of Calderón Reyes and Urbina-Solis (2012), it was assumed that pine forest reaches maximum carbon stock at 33 years. Thus, for estimating growth in pine forest, total carbon stock per ha from the NFI was divided by 33 to obtain an annual carbon accumulation rate. For permanent crops (coffee, cocoa, fruit trees and tree plantations), growth rates were obtained from Poveda et al. (2013).

16. Nicaragua conducted a canopy cover assessment on the basis of a three by three point grid on each sampling plot. For broadleaf and dry forests, three canopy cover classes were defined (open, dense and very dense forest, representing 25, 55 and 85 per cent canopy cover, respectively). For the 371 NFI plots that coincided with the visually sampled plots, a linear regression model was developed to estimate average carbon stock for those three classes. The model demonstrated the relationship between canopy cover and above-ground biomass carbon stock as measured in the NFI, which was applied to obtain biomass carbon stocks for 2005 and 2015 for the 5,427 visually interpreted plots.

17. An uncertainty assessment was conducted that took into consideration the sampling error in the estimation of areas, the error associated with the linear regression model referred to in paragraph 16 above, the error associated with the forest growth rates obtained from Moraes (2001), and the carbon densities calculated from NFI data. The uncertainty of the

[14] A platform that consists of server components, mobile and desktop applications, and developer tools for organizations to create, manage, share and analyse spatial data. See https://www.esri.com/en-us/arcgis/about-arcgis/overview.

[15] A tool that enables data collection through Google Earth. In conjunction with Google Earth, Bing Maps and Google Earth Engine, users can analyse high- and very-high-resolution satellite imagery. See http://www.openforis.org/tools/collect-earth.html.

historical emissions and removals included in the FREL was propagated using the Monte Carlo approach with 10,000 trials. For the modified submission, the confidence intervals for the propagated error were calculated from the 5th and 95th percentiles of the estimate, and the total uncertainty for net emissions and removals was reported as 14.63 per cent.

18. Nicaragua included a section in its FREL submission explaining that the information and methods presented are not consistent with those used for the most recent national GHG inventory (see section 5 of the submission). The Party plans to use the information included in its FREL to update its GHG inventory for its next submission. The AT commends Nicaragua for this, as it will ensure the consistency of the data and information used between the FREL and the national GHG inventory, in accordance with decision 12/CP.17, paragraph 8.

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

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

19. In its modified submission, Nicaragua mentioned that it applied the 2006 IPCC Guidelines and the equations therein, but it also described three equations developed nationally for estimating annual CO_2 emissions and removals from deforestation, forest degradation and enhancement of forest carbon stocks (see section 3.1, p. 20, of the modified submission). The AT notes that, to clarify how the submission adheres to the 2006 IPCC Guidelines, Nicaragua could explain how the nationally developed equations are consistent with those in the 2006 IPCC Guidelines, which would increase the transparency of its future submissions. Alternatively, Nicaragua may wish to describe its estimation procedures solely in relation to the equations used from the 2006 IPCC Guidelines for estimating emissions and removals from the activities being considered.

20. Nicaragua used the equations proposed by Cairns et al. (1997) to estimate below-ground biomass. According to the 2006 IPCC Guidelines, tier 1 default root-to-shoot ratios should be derived from Mokany et al. (2006). Following the technical exchange between the AT and Nicaragua during the TA, Nicaragua confirmed that the root-to-shoot ratio applied was selected to maintain consistency with the subnational baseline developed for the FCPF Carbon Fund. The AT considers that, in order to improve accuracy, Nicaragua may wish to apply specific root-to-shoot ratios by forest type, especially for the dry and wet forest classes, and that the default values from Mokany et al. (2006) as described in the 2006 IPCC Guidelines could be used for this. The AT notes this as an area for future technical improvement.

21. For estimating tree-level above-ground biomass, Nicaragua implemented the “fourth model” described in Chave et al. (2014). The AT reconstructed the estimation of tree-level above-ground biomass using the same equations and found the application of the equation to be correct. To increase transparency, the AT considers that Nicaragua may wish to include in future submissions a table with wood density values by species and provide references to appropriate literature.

22. For estimating CO_2 removals from land converted to forest land, specifically for dry broadleaf forest, Nicaragua used a model developed for wet forest and data from its NFI. During the TA, Nicaragua explained that it lacks sufficient information to develop a model for dry forest. Given the difference in growth rate, mortality and disturbance regime between the forest types, the AT considers that Nicaragua may wish to revise this assumption, and notes this as an area for future technical improvement.

23. For land representation, Nicaragua used a simplified approach whereby cropland and grassland were grouped into woody vegetation and non-woody vegetation for wet and dry climate zones, and wetlands, settlements and other land were classed as non-forest (see paras. 12–13 above). The AT notes that the simplified land representation approach used by Nicaragua to determine land use and land-use change is not in line with IPCC guidance (e.g. the 2006 IPCC Guidelines) and prevents the application of category-specific IPCC methods and assumptions. After consultation with the AT, Nicaragua explained that this could be an

area for future technical improvement. The AT commends Nicaragua for its continued efforts to improve land representation, and notes that adhering to the 2006 IPCC Guidelines in representing land use and land-use change may also help in achieving consistency with the national GHG inventory.

24. Nicaragua classified permanent tree crops as forest land if they met the forest definition according to the defined thresholds noted in the definition of forest. According to Nicaragua, this was the case for coffee, cocoa, fruit trees and tree plantations. The AT notes that Nicaragua's definition of forest is based on tree cover, and that the management practices in these classes of permanent tree crops vary significantly, both among themselves and in relation to other classes under forest land; therefore, these classes of permanent tree crops would be better classified as cropland with woody vegetation. For the historical reference period, the harvesting of trees in areas with permanent tree crops that led to a fall below the defined forest thresholds was classified as deforestation. The AT considers this to be an area for future technical improvement, and that Nicaragua may wish to review its land classification protocol to better reflect land management practices.

25. As part of the interpretation of satellite imagery, Nicaragua used a map of coffee plantation areas developed in 2002, which is outside the chosen historical reference period. The map was used as ancillary information for identifying land use in 2005 and 2015. During the TA, Nicaragua explained that this is the most reliable source of information for this, and that it is unlikely that coffee plantations would have been converted to forest in three years (when used in the context of aiding the interpretation of 2005 imagery). The AT considers that this assumption could be acceptable for 2005 but notes that such information was unavailable for 2015. The AT considers this to be an area for future technical improvement in terms of increasing consistency over the time series.

26. Nicaragua used ArcGIS and Collect Earth for assessing land-use change. During the TA, the AT requested examples (i.e. screenshots) of the interpretation process, especially for the beginning and end of the time series. Nicaragua shared one example with the AT. The AT considers that adding this information to the current description of activity data collection (see section 2.6.2 of the submission) could increase the transparency of the submission, and notes that Nicaragua may wish to improve its land classification protocol for future submissions.

27. Following methods developed by FAO, Nicaragua's NFI and land-use assessment were based on a latitude-longitude grid (i.e. 10 by 10 ° and 2.5 by 2.5 °, respectively). According to Nicaragua, this represents a distance of up to 0.3 km between plots towards the northern end of its territory owing to the Earth's curvature. In principle, this is a sampling design issue that affects the assumption of equal sampling probabilities and may introduce bias. The AT considers that Nicaragua may wish to estimate quantitatively the effect of this bias or systematic error, which could amount to an error of 2 per cent according to calculations by the AT. The AT considers that Nicaragua may wish to choose a sampling design following an equal area projection for future submissions.

28. In the land-use assessment, Nicaragua excluded 261 of the 5,427 total sampling points because information was not available owing to persistent cloud cover and cloud shadow. Of those 261 points, one corresponded to a low-occurrence land-use change, namely conversion of permanent crops to woody vegetation. The AT notes that, although during the historical reference period this low-occurrence class may have been negligible in terms of carbon stock change, this does not prevent it from becoming significant in the future and therefore it should not be omitted. During the TA, Nicaragua explained that this category was excluded to simplify the land-use transition matrix. The AT considers this to be an area for future technical improvement. Further, the AT considers that Nicaragua may wish to provide information on how the observations excluded from the present FREL estimation will be treated in the future in order to enhance the transparency and, potentially, the accuracy of future proposed FRELs.

29. For estimating carbon stock per ha forest, Nicaragua excluded all NFI plots with 10–39 per cent canopy cover. Following a question from the AT, the Party explained that plots with canopy cover of 30–39 per cent would comply with the definition of forest but were excluded from the estimation because of how data were collected for the NFI. The AT notes

that excluding the plots may lead to overestimation of forest carbon stock per ha and considers this to be an area for future technical improvement. The AT also considers that Nicaragua may wish to consider adjusting its NFI methods to enable the estimation of carbon stocks that would be consistent with the forest definition, as this would increase the accuracy of future FREL submissions.

30. In its original submission, Nicaragua included standing dead trees in the estimation of living biomass as part of its estimation of forest carbon stocks. During the TA, Nicaragua modified its NFI values to reflect only living trees in the estimation of biomass. This resulted in the adjustment of the forest carbon stock estimates, which also affected the FREL presented in the modified submission. The AT commends Nicaragua for increasing the accuracy of the estimation of biomass for the FREL.

31. For estimating land conversion to forest land, Nicaragua applied the gain-loss method but assumed the losses to be zero. The AT notes that, in order to increase the accuracy of the FREL, Nicaragua may wish to reflect any losses from wood removals, firewood or disturbance by using equation 2.11 from the 2006 IPCC Guidelines. Exclusion of such losses may lead to the underestimation of emissions, and this is considered by the AT to be an area for future technical improvement.

32. According to data submitted by Nicaragua on an independent set of satellite-based maps, annual deforestation was reduced from 2.2 per cent in 2005–2010 to 0.5 per cent in 2010–2015. This indicates a decreasing trend in emissions from deforestation. Furthermore, during the historical reference period (2006–2015), net emissions and removals decreased over time (see table 13 of the modified FREL submission). Despite this downward trend, Nicaragua defined its FREL as a historical average. During the TA, Nicaragua explained that a historical average was selected for the FREL in order to comply with the FCPF Carbon Fund Methodological Framework. The AT notes that Nicaragua may wish to collect inter-annual information on deforestation and to reassess its model. The AT is of the view that the approach of using average emissions may not be best suited to Nicaragua's historical data and considers this to be an area for future technical improvement.

33. The AT commends Nicaragua for employing the Monte Carlo error propagation method, a higher-tier approach, as part of its uncertainty assessment. At the same time, the AT identified that other potential sources of error might have been excluded from the uncertainty assessment: (1) errors in georeferencing the NFI plots in the assessment of canopy cover for building the linear regression model, (2) interpretation errors in the land-use classification (estimated by the AT to be 20 and 7 per cent for 2005 and 2015, respectively, by applying the "confidence in the interpretation" recorded by Nicaragua during data collection), and (3) errors in the root-to-shoot ratio selected (from Cairns et al., 1997). The AT considers that Nicaragua may wish to include some of these sources of error in future uncertainty assessments. The AT notes that, when assuming normal distributions in a Monte Carlo approach, the probability density functions should not be truncated at values below zero, as was reported by Nicaragua, and therefore considers this to be an area for future technical improvement.

34. During the TA, Nicaragua modified its estimation of the uncertainty of the historical emission and removal estimates from 1.28 to 14.63 per cent. The AT notes that it was unable to reconstruct the Party's calculation of the final estimate of uncertainty as presented in its modified submission. The AT also notes that Nicaragua may wish to provide a description of the methods and assumptions used in estimating the uncertainty value to increase the transparency of its future submissions.

35. Nicaragua's submission included several Excel spreadsheets electronically linked to the main report. The AT downloaded the spreadsheets and considered them as part of the TA. During the TA, the AT noted that the order of the files, and the calculations therein, could be improved to increase transparency. For example, some tables lacked titles and units, and some of the codes used were not explained. The AT considers this to be an area for future technical improvement to enhance the transparency of the information provided for the TA.

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

36. The FREL submission (section 1.3) includes descriptions of relevant policies and plans, including of the National Forest Programme, National Reforestation Plan, National Plan for the Prevention and Control of Forest Fires, National Firewood and Charcoal Strategy, and the National Environment and Climate Change Strategy. As part of the National Reforestation Plan, Nicaragua planted 1,236,878 ha in 2007–2015.

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

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

38. The pools included in the Party's FREL are above-ground and below-ground biomass. Litter, dead organic matter and soil organic carbon were not included.

39. On the exclusion of litter, Nicaragua explained that there is a lack of national information and that there is no relevant scientific literature documenting direct measurements of this pool, including relevant uncertainty estimates, in the country. The AT considers the justification provided by Nicaragua for not implementing a tier 2 approach to be acceptable. However, the AT notes that default factors and methods for using a tier 1 approach for estimating carbon stocks in the litter pool are available in the 2006 IPCC Guidelines. As no national information was available, the AT was unable to assess the significance of this pool on the basis of the information provided by Nicaragua. Thus, the AT considers this to be an area for future technical improvement.

40. On the exclusion of deadwood, Nicaragua explained that information was collected for the NFI but only for forests. The AT noted that, according to a national report shared by Nicaragua during the TA on the results of the NFI for 2007–2008, deadwood carbon stocks correspond to 10 per cent of total forest carbon stocks. The AT considers that deadwood carbon stocks may be even greater after wind damage from hurricanes and are very likely to be significant. Justifying the omission, Nicaragua explained during the TA that including the information in the FREL would be inconsistent with the treatment of deadwood in non-forest classes. The AT suggested applying tier 1 default values for non-forest classes. The AT considers that the exclusion of this carbon pool was not sufficiently justified by Nicaragua on the basis of the pool's significance and the fact that information is available to enable its inclusion. Therefore, the AT notes that Nicaragua may wish to include this pool in future submissions to enhance the accuracy of the FREL, and considers this to be an area for future technical improvement.

41. On the exclusion of soil organic carbon, Nicaragua did not provide a justification for omitting the pool on the basis of its significance. During the TA, Nicaragua confirmed the availability of a national soils map that would enable implementation of a tier 1 estimation approach following the 2006 IPCC Guidelines. Nicaragua explained that, as part of its improvement plan, it intends to collect national data that would allow application of a tier 2 approach for estimating carbon stock for this pool. The AT commends Nicaragua for its efforts to obtain additional field data as part of the stepwise approach and considers this to be an area for future technical improvement.

42. Nicaragua did not estimate non-CO_2 gases from biomass burning, providing the justification that spatially explicit information on the location of fires is not available, and that, according to the national GHG inventory included in the Party's third national communication, non-CO_2 emissions amount to less than 1 per cent of its total emissions. The AT considers the treatment of non-CO_2 gases to be an area for future technical improvement so as to maintain consistency with the national GHG inventory and given that relevant national information is available.

43. The AT acknowledges that Nicaragua's FREL (including emissions and removals from biomass in forest land remaining forest land, land converted to forest land, and land converted from forest land) serves as a benchmark for the most significant REDD+ activities according to decision 1/CP.16, paragraph 70, and decision 12/CP.17, paragraph 7, in

accordance with its national capabilities and circumstances. The AT notes that Nicaragua may wish to include in its FREL litter, deadwood, soil organic carbon and non-CO_2 emissions, as well as to distinguish carbon stock changes in non-forest land-use changes, in order to enhance the accuracy of its future FREL submissions.

4. Definition of forest

44. Nicaragua provided in its submission the definition of forest used in the construction of its FREL. The definition is different from the one that the Party uses for its national GHG inventory and its reporting to FAO for the Global Forest Resources Assessment. For this submission, forest was defined as a continuous area, equal to or greater than 1 ha, with an arboreal cover equal to or greater than 30 per cent, and an average tree height greater than 4 m. This definition includes bamboo ecosystems, mangroves, natural palms, dry forests, riparian vegetation and permanent crops with shade trees. The Party did not provide a justification for the differences in definitions used in reporting under the various processes. The AT notes that, in accordance with decision 13/CP.19, annex, paragraph (g), Nicaragua should provide information on how and why the definition of forest for the construction of the FREL was chosen, in order to increase the transparency of the submission. The AT notes this as an area for future technical improvement.

45. Nicaragua defines permanent tree crops as forest. On the basis of this definition, any conversion of land with permanent crops to another non-forest land use would be considered as deforestation. The AT notes that Nicaragua may wish to revise its definition to classify permanent crops instead as cropland, considering that the management practices applied differ from those applied for forest land. The AT notes that, according to Nicaragua's modified submission, no transition from permanent crops to non-forest land occurred in 2006–2015. However, the AT also notes that such land-use transition could occur in the future. The AT considers this to be an area for future technical improvement that could help increase the accuracy of the emission and removal estimates associated with forest land conversion (deforestation).

46. The classification of permanent tree crops as forest also affects the estimation of land converted to forest land. According to Nicaragua's modified submission, 11,001 ha non-forest land (woody and non-woody vegetation) was converted to land with permanent crops. Given the current forest definition, this has been reported as land converted to forest land. Considering the rationale provided by the AT referred to in paragraph 45 above, the AT notes that such transition could be better categorized as cropland remaining cropland or grassland converted to cropland and considers this to be an area for future technical improvement.

III. Conclusions

47. The information used by Nicaragua in constructing its FREL for "reducing emissions from deforestation", "reducing emissions from degradation" and "enhancement of forest carbon stocks" is transparent, complete and in overall accordance with the guidelines for submissions of information on reference levels.

48. The FREL presented in the modified submission, for the reference period 2006–2015, corresponds to 14,436,009 t CO_2/year. A validity period for the proposed FREL was not specified by Nicaragua. The AT notes that this FREL will not remain representative of Nicaraguan conditions indefinitely and considers specifying such a validity period to be an area for future technical improvement.

49. As a result of the facilitative interactions with the AT during the TA, Nicaragua 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 Nicaragua for its efforts. The new information provided in the modified submission increased the transparency of the FREL calculations.

50. The AT notes that, overall, the FREL does not maintain consistency, in terms of sources of activity data and emission factors, with the GHG inventory included in Nicaragua's third national communication.[16]

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

(a) Clarifying how the equations developed nationally for estimating emissions and removals are consistent with the equations in the 2006 IPCC Guidelines (see para. 19 above);

(b) Using more specific root-to-shoot ratios for wet and dry forest types, such as the tier 1 default values from Mokany et al. (2006), as described in the 2006 IPCC Guidelines (see para. 20 above);

(c) Documenting the wood density values used in the allometric equation provided in Chave et al. (2014) (see para. 21 above);

(d) Improving the model used for estimating carbon stock change in dry forest on the basis of NFI data by revising the assumptions applied and avoiding the use of models developed for wet forest types (see para. 22 above);

(e) Following IPCC guidance on land representation, especially for the land-use categories cropland and grassland, to facilitate use of adequate IPCC methods for the respective land-use category (see para. 23 above);

(f) Considering classifying coffee, cocoa, fruit trees and tree plantations under cropland to better reflect their management practices and to enhance the accuracy of the estimates of emissions and removals from forest land (see para. 24 above);

(g) Exploring classification of permanent tree crops as cropland to avoid considering their conversion as deforestation or their restoration as forest enhancement (see para. 24 above);

(h) Maintaining consistency in the classification of coffee plantation areas throughout the time series (see para. 25 above);

(i) Including visual examples to improve the classification protocol for satellite imagery (see para. 26 above);

(j) Estimating the effect of using the latitude-longitude grid applied in the NFI on the FREL estimates; in the future, Nicaragua may wish to use an equal area projection method for its NFI and land-use assessment (see para. 27 above);

(k) Clarifying how the sampling points excluded from the land-use assessment owing to persistent cloud cover will be treated in the future (see para. 28 above);

(l) Including low-occurrence land-use changes in the land-use transition matrix (see para. 28 above);

(m) Avoiding the exclusion of NFI plots with forests with 30–39 per cent canopy cover from the estimation of carbon stocks (see para. 29 above);

(n) Considering carbon losses from wood removals, firewood or disturbance in the estimation of emissions and removals from land converted to forest land to increase the accuracy of the FREL (see para. 31 above);

(o) Reassessing the choice of historical average emissions for the FREL, such as by collecting inter-annual information on deforestation to better understand the trend and to inform the definition of the FREL, considering the downward trend in emissions and removals from deforestation in 2006–2015 (see para. 32 above);

(p) Improving the uncertainty estimation by including the errors associated with the georeferencing of the NFI plots, the human interpretation error and the root-to-shoot ratio applied during the land-use assessment (see para. 33 above);

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

(q) Improving the transparency of the estimation of uncertainty by explaining the specific methods and assumptions used (see para. 34 above);

(r) Defining the period for which the FREL will be considered representative of Nicaraguan conditions, as it cannot be assumed to remain accurate permanently (see para. 48 above).

52. Pursuant to decision 13/CP.19, annex, paragraph 2(f), in assessing the pools and gases included in the FREL, the AT noted that some of the pools excluded by Nicaragua may be significant in the context of the FREL. During the TA, Nicaragua explained that additional pools were not included in this FREL so as to avoid introducing inconsistencies with the country's baseline under the FCPF Carbon Fund. Pursuant to decision 13/CP.19, annex, paragraph 3, the AT identified the following additional areas for future technical improvement regarding the exclusion of pools and gases from the FREL:

(a) Treatment of litter (i.e. including the pool or providing more information to justify its omission) (see para. 39 above);

(b) Treatment of deadwood (i.e. including the pool or providing more information to justify its omission) (see para. 40 above);

(c) Treatment of soil organic carbon (i.e. including the pool or providing more information justifying its omission) (see para. 41 above);

(d) Treatment of non-CO_2 gases (i.e. maintaining consistency with the GHG inventory included in the Party's most recent national communication) (see para. 42 above).

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

(a) Develop automated preprocessing of satellite imagery;

(b) Develop biomass allometric equations by climate zone;

(c) Conduct research on forest growth and carbon sequestration in secondary forests;

(d) Estimate soil organic carbon for forest and non-forest classes and include the pool in future FRELs;

(e) Expand current studies on forest degradation using satellite imagery.

54. In conclusion, the AT commends Nicaragua for showing strong commitment to the continuous improvement of its FREL estimates in line with the stepwise approach. A number of areas for the future technical improvement of Nicaragua'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 providing adequate and predictable support.[17] The AT also acknowledges that the TA was an opportunity for a rich, open, facilitative and constructive technical exchange of information with Nicaragua.

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

[17] Per decision 13/CP.19, annex, para. 1(b), and decision 12/CP.17, para. 10.

Annex I

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

Main features of the FREL		*Remarks*
Proposed FREL	14 436 009 t CO_2/year	This corresponds to net emissions; units are in CO_2, as non-CO_2 gases were not included (see para. 9 of this document)
Type and reference period of FREL	FREL = average of historical net emissions in 2006–2015	A historical average was selected, even though a downward trend in net emissions was observed in the historical data (see para. 8 of this document)
Application of adjustment for national circumstances	No	
National/subnational	National	The FREL covers the entire continental area of Nicaragua (11 941 161.62 ha) (see para. 7 of this document)
Activities included	Reducing emissions from deforestation, reducing emissions from forest degradation and enhancement of forest carbon stocks	The activities largely coincide with the IPCC categories forest land converted to other land uses, forest land remaining forest land, and land converted to forest land (see para. 7 of this document)
Pools included	Above-ground and below-ground biomass	Dead organic matter, litter and soil organic carbon in mineral soils were excluded (see paras. 10 and 38–41 of this document)
Gas included	CO_2	The FREL excludes non-CO_2 emissions (see para. 42 of this document)
Forest definition	Included	The definition differs from the definition in the Party's most recent national GHG inventory, both of which differ from the definition adopted for its reporting to FAO (see para. 44 of this document)
Consistency with latest GHG inventory	Methods used for estimating the FREL are not consistent with the GHG inventory included in the third national communication	Nicaragua identified in its submission several areas of inconsistency with its latest national GHG inventory (see para. 18 of this document)
Description of relevant policies and plans	Included	See paragraph 36 of this document
Description of assumptions on future changes to domestic policies, if included in the construction of the FREL	Not applicable	
Description of changes to previous FREL	Not applicable	This is Nicaragua's first FREL submission (see para. 2 of this document)
Identification of future technical improvements	Included	Several areas for future technical improvement were identified (see paras. 51–53 of this document)

Annex II

Documents and information used during the technical assessment

A. Reference documents

Cairns M, Brown S, Helmer E, et al. 1997. Root biomass allocation in the world's upland forests. *Oecologia*. 111(1): pp.1–11. Available at https://doi.org/10.1007/s004420050201.

Calderón Reyes D and Urbina-Solis D. 2012. *Cuantificacion del carbono almacenado en tres fincas en tree estados de desarrollo del bosque de pino (Pinus oocarpa, L.) Diplito, Nueva Segovia, Nicaragua.* Título de Ingeniero Forestal thesis. Managua, Nicaragua: Universidad Nacional Agraria. Available at http://www.fao.org/fileadmin/user_upload/training_material/docs/3_tnk10c146.pdf.

Chave J, Réjou-Méchain M, Búrquez A, et al. 2014. Improved allometric models to estimate the aboveground biomass of tropical trees. *Global Change Biology*. 20(10): pp.3177–3190. Available at https://doi.org/10.1111/gcb.12629.

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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.

Mokany K, Raison RJ and Prokushkin A. 2006. Critical analysis of root:shoot ratios in terrestrial biomes. *Global Change Biology*. 12(1): pp.84–96. Available at https://doi.org/10.1111/j.1365-2486.2005.001043.x.

Moraes Ferreira C. 2001. *Almacenamiento de carbono en bosques secundarios en el Municipio de San Carlos, Nicaragua*. Magister Scientiae thesis. Turrialba, Costa Rica: Tropical Agricultural Research and Higher Education Center. Available at http://www.bio-nica.info/Biblioteca/Moraes2001AlmacenamientoDeCarbono.pdf.

Poveda V, Orozco-Aguilar L, Medina C, et al. 2013. Almacenamiento de carbono en sistemas agroforestales en cacao en Waslala, Nicaragua. *Agroforestería en las Américas*. 49: pp.42–50. Available at http://hdl.handle.net/11554/5760.

B. Additional information provided by the Party

The following documents[1] were provided by the Party in response to requests for clarification or additional information during the TA:

Nicaragua. Resultados del Inventario Nacional Forestal, Nicaragua 2007-2008.

[1] Reproduced as received from the Party.