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## **Report on the technical assessment of the proposed forest reference emission level of Ecuador submitted in 2020**

### *Summary*

This report covers the technical assessment of the voluntary submission of Ecuador 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 Ecuador covers the activity reducing emissions from deforestation, which is among the activities included in decision 1/CP.16, paragraph 70. For its submission, Ecuador developed a national FREL. The FREL presented in the original submission, for the reference period 2001–2014, corresponds to 23,949,392.40 tonnes of carbon dioxide equivalent per year. The assessment team notes that the data and information used by Ecuador in constructing its FREL are mostly transparent, mostly 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

|                    |                                                                                                                                                                                                                                  |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AD                 | activity data                                                                                                                                                                                                                    |
| ASTER              | Advanced Spaceborne Thermal Emission and Reflection Radiometer                                                                                                                                                                   |
| AT                 | assessment team                                                                                                                                                                                                                  |
| BUR                | biennial update report                                                                                                                                                                                                           |
| CO <sub>2</sub>    | carbon dioxide                                                                                                                                                                                                                   |
| CO <sub>2</sub> eq | carbon dioxide equivalent                                                                                                                                                                                                        |
| 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                                                                                                                                                                                                        |
| 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) |
| SEPAL              | system for earth observations, data access, processing and analysis for land monitoring                                                                                                                                          |
| SOC                | soil organic carbon                                                                                                                                                                                                              |
| TA                 | technical assessment                                                                                                                                                                                                             |

# I. Introduction and summary

## A. Overview

1. This report covers the TA of the voluntary submission of Ecuador on its proposed FREL,<sup>1</sup> submitted on 6 January 2020, in accordance with decisions 12/CP.17 and 13/CP.19. The remote TA<sup>2</sup> took place from 22 to 26 June 2020 and was coordinated by the secretariat.<sup>3</sup> The TA was conducted by two LULUCF experts from the UNFCCC roster of experts<sup>4</sup> (hereinafter referred to as the AT): Naikoa Aguilar-Amuchastegui (Spain) and Oswaldo Ismael Carrillo Negrete (Mexico). In addition, Gervais Ludovic Itsoua Madzous, an expert from the Consultative Group of Experts, participated as an observer<sup>5</sup> during the remote session. The TA was coordinated by Dirk Nemitz (secretariat).

2. In response to the invitation of the Conference of the Parties and in accordance with the provisions of decision 12/CP.17, paragraphs 7–15 and annex, Ecuador submitted its proposed FREL on a voluntary basis. The proposed FREL is one of the elements<sup>6</sup> 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 Conference of the Parties decided that each submission of a proposed FREL or FRL, as referred to in decision 12/CP.17, paragraph 13, shall be subject to a TA in the context of results-based payments.

3. Ecuador provided its submission in Spanish. The submission is supported by four annexes, also in Spanish: methods for estimating the EFs (annex 1), forest degradation results in two pilot areas of Ecuador (annex 2), improvement plan implemented in the Party's second FREL (annex 3) and improvement plan for future FRELs (annex 4). The Party also submitted an emission estimation spreadsheet; a methodological protocol for generating deforestation maps for continental Ecuador; the results of a pilot study on the assessment of forest degradation; a national forest evaluation report; the results of a soil conglomerate assessment; land-cover change data and AD accuracy assessment results for 2000–2008 and 2008–2014; and an accuracy assessment report for a 2000 land-cover and land-use map. During the technical exchange, eight additional annexes were shared with the AT, also in Spanish: thematic legend (annex 1), data structure and processing (annex 2), pre-processing (annex 3), methodology testing (annex 3.1), processing and filling data gaps (annex 4), visual editing (annex 5), deforestation estimation (annex 6), thematic accuracy assessment (annex 7), operator's manual (annex 7.1) and improvement plan (annex 8).

4. The objective of the TA is to assess the degree to which the information provided by Ecuador is in accordance with the guidelines for submissions of information on reference levels<sup>7</sup> and to offer a facilitative, non-intrusive, technical exchange of information on the construction of the FREL with a view to supporting the capacity of Ecuador for the construction and future technical improvement of its FREL, as appropriate.<sup>8</sup>

5. The TA of the FREL submitted by Ecuador was undertaken in accordance with the guidelines and procedures for the TA of submissions from Parties on proposed FRELs and/or FRLs.<sup>9</sup> 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 Ecuador. The facilitative exchange during the TA allowed Ecuador to provide clarifications and additional information, which

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

<sup>2</sup> Owing to the circumstances related to the coronavirus disease 2019, the TAs of the FREL and FRL submissions of developing country Parties in 2020 had to be conducted remotely.

<sup>3</sup> As per decision 13/CP.19, annex, para. 7.

<sup>4</sup> As per decision 13/CP.19, annex, paras. 7 and 9.

<sup>5</sup> As per decision 13/CP.19, annex, para. 9.

<sup>6</sup> See decision 1/CP.16, para. 71(b).

<sup>7</sup> Decision 12/CP.17, annex.

<sup>8</sup> Decision 13/CP.19, annex, para. 1(a–b).

<sup>9</sup> Decision 13/CP.19, annex.

were considered by the AT in the preparation of this report.<sup>10</sup> In September 2021, Ecuador announced the withdrawal of its 2020 FREL owing to its intention to improve its data for a future submission. Ecuador requested the AT to continue with the technical assessment of the FREL and preparation of this report, but explained that this FREL will not be used for REDD+ results-based payments.

## **B. Proposed forest reference emission level**

7. In decision 1/CP.16, paragraph 70, the Conference of the Parties encouraged developing country Parties to contribute to mitigation actions in the forest sector by undertaking a number of activities, as deemed appropriate by each Party and in accordance with their respective capabilities and national circumstances, in the context of providing adequate and predictable support. The FREL proposed by Ecuador, 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, Ecuador developed a national FREL that covers its continental territory. For its submission, Ecuador 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 or FRLs by incorporating better data, improved methodologies and, where appropriate, additional pools.

8. The national FREL proposed by Ecuador for the historical reference period 2001–2014 is the annual average of the CO<sub>2</sub> emissions associated with gross deforestation, defined as the anthropogenic conversion of natural forest to other categories of land use or land cover.

9. The FREL includes only the gross emissions from deforestation that are associated with clear-cuts and excludes any subsequent emissions and removals from deforested areas. The FREL also excludes the harvesting of forest plantations and areas in which selective tree logging is expected to be followed by natural or supported recovery of the forest. The AD used in constructing the FREL were extracted from a forest-cover map for 2000 and land-cover change maps for 2000–2008 and 2009–2014 developed by the Ministry of Environment. EFs were obtained from Ecuador's NFI. The FREL presented, with the aim of accessing results-based payments for REDD+ activities for 2015–2020, corresponds to 23,949,392.40 t CO<sub>2</sub> eq/year.

10. The proposed FREL includes the pools above-ground biomass of trees and non-trees, below-ground biomass of trees and non-trees, deadwood and litter. SOC is not included. Regarding GHGs, the submission includes CO<sub>2</sub> only.

11. The FREL proposed by Ecuador 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 14 December 2014 and was subject to a TA in February 2015;<sup>11</sup> it covered the activity reducing emissions from deforestation for 2000–2008. The previous assessed FREL corresponded to 43,418,126 t CO<sub>2</sub> eq/year and was therefore higher than the FREL proposed in the most recent submission, including when comparing it directly with the estimates for 2000–2008 included in the current FREL, which correspond to 25,605,031.85 t CO<sub>2</sub> eq/year. The assessed FREL proposed in the 2020 submission differs from that in the 2015 modified submission owing mainly to the extension of the historical reference period to include 2009–2014 (making it a 14-year period: 2001–2014) and the use of new approaches to generating AD. A forest mask was produced for 2000 as a means of ensuring consistency in assessing changes to forest cover in 2001–2014, and direct land-cover change mapping was applied for 2000–2008 and 2009–2014.

12. By way of improvement compared with its previous submission, Ecuador produced all maps using cloud-free composites based on median pixel values created for 2000, 2008 and 2014 by combining good-quality pixels from imagery for each year (within two years either side of 2000 and 2008 and within one year for 2014). These cloud-free composites were used as inputs to a random forest classifier that was trained using calibration points produced using higher spatial resolution imagery, and expert interpretation was used. This approach contrasts with the comparison of land-cover maps undertaken for the 2015 FREL

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<sup>10</sup> As per decision 13/CP.19, annex, paras. 1(b), 13 and 14.

<sup>11</sup> See document FCCC/TAR/2015/ECU.

submission. This updated method was implemented in response to the areas for future technical improvement identified by the AT during the TA of the 2015 FREL to help Ecuador improve the quality of its AD. The same EFs were used for both FRELs.

## **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**

13. For constructing its FREL, Ecuador used methodology provided in the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* as the basis for estimating changes in carbon stock for forest land converted to other land uses. Accordingly, gross emissions (not considering removals) from deforestation in 2001–2014 were estimated by combining AD (i.e. area of annual deforestation) with the appropriate EFs (i.e. CO<sub>2</sub> emissions associated with the corresponding forest type).

14. The AD used for constructing Ecuador's FREL are based on direct pixel counts from maps produced using a forest mask created for 2000 and directly mapped land-cover changes for 2000–2008 and 2009–2014 by the Ministry of Environment. Each map was produced by analysing imagery from the Landsat 5, 7 and 8, ASTER and Sentinel 2 satellite sensors. Imagery was acquired for up to two years either side of 31 December in 2000 and 2008 and up to one year either side of 31 December in 2014. Cloud-free mosaics were produced using the median pixel value for each band, and were used as input parameters to a random forest classifier to generate the forest mask for 2000 and the land-cover change maps for 2000–2008 and 2009–2014. Separate random forest classifiers were generated on a regional basis if Ecuador deemed this necessary. The accuracy of the maps for 2000–2008 and 2009–2014 was assessed and the results were included as part of the additional annexes presented to the AT during the technical exchange.

15. With regard to EFs, carbon stock for the different forest types was estimated by combining individual tree information (e.g. diameter at breast height) from the NFI with the allometric equations of Chave et al. (2005) to estimate carbon stock at plot level, average carbon stock at cluster level and average carbon stock by forest stratum. For the reported pools (above-ground biomass, below-ground biomass, deadwood and litter), immediate oxidation was assumed following deforestation.

#### **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**

16. The FREL proposed by Ecuador is its second FREL submitted in the context of applying the stepwise approach in accordance with decision 12/CP.17, paragraph 10. The previous FREL submission was subject to a TA in 2015.<sup>12</sup> In its most recent submission, Ecuador described changes from previously submitted information in accordance with decision 12/CP.17, annex, paragraph (b). The Party described the following changes:

(a) The reference period was extended by six years from 2000–2008 to 2001–2014;

(b) AD were produced via automatic direct mapping of land-cover changes between reference periods, as opposed to via comparison of land-cover maps.

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

<sup>12</sup> See document FCCC/TAR/2015/ECU.

(a) AD were produced via direct mapping of land-cover changes between reference periods, as opposed to via comparison of land-cover maps. Methods include automatized change classification of periodic mosaics produced and processed via the FAO SEPAL platform for the pre-processing, mosaicking and classification of remote sensing data;

(b) Maps were developed on a regional basis as a means to optimize mapping inputs, such as imagery mosaics, to a region-specific model using a random forest classifier;

(c) A forest mask for 2000 (or within two years either side) was used to define the spatial scope for assessing changes to forest cover;

(d) Accuracy assessments of the maps were performed and the reports, results and resulting adjusted area estimates were shared with the AT but not used for the FREL.

18. The reference period for the 2020 FREL is 2001–2014 (14 years), expanded from the reference period of 2000–2008 (8 years) for the 2015 FREL. Ecuador did not explain the rationale for this prolonged 2001–2014 reference period, including information on political context to justify considering the period representative of future deforestation. The AT considers that including relevant explanation in the FREL submission would improve its transparency and therefore notes this as an area for future technical improvement.

19. The AT noted that a significant difference in the reported estimated emissions for 2000–2008 between the 2015 and 2020 FREL submissions, from 43,418,126 to 25,605,031.85 t CO<sub>2</sub> eq/year. Ecuador indicated that the difference resulted from improving estimation methods in response to the AT's recommendations in the TA of the 2015 FREL. The AT commends Ecuador on its progress, particularly for including an accuracy assessment as part of generating AD, but noted that the Party should explain the difference in the FREL submission, not only because of its magnitude (close to 50 per cent reduction) but also because of its significance: the difference in estimated emissions has implications for consistency between Ecuador's 2015 FREL, first BUR and results reported and assessed for 2009–2014. The AT also noted the estimated historical emissions for 2000–2008 as the 2015 FREL was used for assessing Ecuador's 4,831,679 t CO<sub>2</sub> eq/year emission reduction in 2009–2014 as reported in its first BUR (table 4). The AT considers providing a detailed and clear explanation of any differences in methodology used between the Party's 2015 FREL submission, technical annex on REDD+ results included in its first BUR and 2020 FREL submission to be necessary to facilitate understanding of the level of consistency between these reports, and therefore notes this as an area for future technical improvement.

20. The AD used for constructing Ecuador's FREL were produced using a series of tools available through the SEPAL platform developed by FAO. Ecuador used Google Earth Engine to produce the forest mask for 2000 and detect forest changes between 2000–2008 and 2009–2014. During the technical exchange, the AT asked for detailed information on how the SEPAL platform worked and the specifics of the methods used for imagery pre-processing and classification, which it considered relevant to enhancing the transparency of Ecuador's FREL submission. During the TA, the AT and Ecuador discussed the methods used to produce AD. The AT considers that the transparency of the FREL submission could be increased by adding more detailed information on (1) the metrics used for elaborating the 2000, 2008 and 2014 mosaics, including bands and statistics created and used per forest type; (2) the parameters used as input data for the random forest classifier; (3) the repository of codes (scripts) and input data used (e.g. SEPAL, GitHub and Google Earth Engine codes and assets and repositories); and (4) the training samples used for model calibration, including the data used to define sample conditions. Ecuador provided such additional details by sharing additional annexes with the AT, which clarified that Ecuador ran SEPAL, including the random forest classifier, independently for each region, as each region has its own biophysical characteristics. The AT commends Ecuador for sharing the additional information, but notes that the level of detail of the information did not enable it to thoroughly understand and reconstruct the process for estimating AD (specific inputs, assumptions, parameters and methods used) and therefore notes this an area for future technical improvement.

21. Ecuador used a forest mask for 2000 to define the spatial scope of the assessment of deforestation in 2001–2014. During the technical exchange, the AT sought a number of clarifications: (1) the rationale for using the forest mask, particularly in view of the fact that Ecuador indicated in its submission that the FREL is national in scope, unlike the scope of

the forest mask; (2) how the forest mask was created, including method, use of forest definition, and exclusion of oil palm and other non-qualifying plantations; (3) what the mask is and which map was used for it; and (4) how the mask was used in constructing the FREL. The AT noted that discrepancies among the three separate forest-change maps used in constructing the FREL could have been caused by the fact that different random classifier models were used for each map. The AT also noted that the land-cover map for 2000 that was shared with it differs from that shared with a third party to assess its accuracy: the mapped area estimates reported in the accuracy assessment do not match the information Ecuador provided with the FREL, differing by over 200,000 ha. Furthermore, the AT observed that the accuracy assessment of the forest mask indicated an overestimation of the forest area by 167,737.31 ha. The AT raised concerns that using the mask as the reference framework for detecting land-use changes could have led to biased deforestation estimates, which is of particular relevance since Ecuador established its FREL using (biased) mapped area estimates and not the (unbiased) adjusted ones. Ecuador explained that internal policies obliged it to keep using the mask as the basis for constructing the FREL, as several local monitoring projects need to be nested within the national approach. The AT considers that using a forest mask has implications for completeness (only forest area is monitored and not the complete territory), accuracy (use of bias estimates) and transparency (insufficient information to replicate the elaboration of the mask) and therefore notes this as an important area for future technical improvement.

22. Ecuador used the pixel-count-based estimates from its forest mask for 2000 and land-cover change maps for 2000–2008 and 2009–2014 as the basis for its AD estimates. The AT noted that, in line with good practice, adjusted area estimates resulting from an accuracy assessment are a better option as they are statistically inferred from an unbiased estimator whereas pixel-count-based estimates are not. In line with IPCC guidance to neither under-nor overestimate deforestation, the AT considers using such adjusted estimates to be a more accurate methodological option. The Party explained its reasons for not using the adjusted AD estimates: (1) legal provisions in Ecuador require geographically explicit deforestation data; (2) Ecuador experienced difficulties in relating the adjusted area estimates, which are global, to the nine forest strata in the NFI and their derived EFs; and (3) it considers pixel count data to be of better quality than the statistically inferred estimates, which it considers to be unrepresentative of reality. Ecuador expressed concerns regarding the impact of omission errors on its area estimates.

23. Ecuador indicated its intention to carry out additional tests that include a larger sample size in the stable forest class to mitigate the potential impact of omission errors on the uncertainty estimates and adjusted area estimates. During the technical exchange, the AT and Ecuador agreed that the transparency of the FREL submission would be increased by including a detailed explanation and justification of how the Party established that pixel counting results in more accurate deforestation estimates than unbiased estimators of AD, as well as a detailed explanation of the legal requirements obliging the Party to derive AD from pixel counts.

24. The accuracy of the AD was assessed using a web-based tool developed by a third-party organization. The AT asked to be given access to the tool to enable it to better understand how the accuracy assessment was conducted. Ecuador shared documentation regarding the protocols used and the location of the samples used for the accuracy assessment. The AT was not able to reconstruct the accuracy assessment process with the input data and the reference data used for the assessment of each sample. During the technical exchange, Ecuador indicated that it does not have access to the third-party tool. The AT considers that this affects transparency and therefore notes this as an area for future technical improvement.

25. During the TA, the AT observed that the results of the accuracy assessment, conducted following the method proposed in Olofsson et al. (2013), indicated large uncertainties in adjusted AD and a high number of omission and commission errors affecting user and producer accuracies. These resulted in large adjustments to estimated areas, representing, in some instances, up to 300 per cent increases in the deforestation estimates. The AT expressed concerns about these results, in particular the use of pixel count estimates to obtain AD. Ecuador explained that it considers the relevant method proposed by Olofsson et al. (2013) to be flawed, and that it is working on a solution in collaboration with FAO, which involves considering a larger number of samples in the stable forest stratum to mitigate the impact of omission errors. The results were not yet available to be shared with the AT. The AT

considers that (1) a detailed technical explanation of why the Party considers the Olofsson et al. (2013) method to be flawed would increase the transparency of the FREL and (2) not underestimating deforestation would increase the accuracy of the FREL, and therefore notes these as areas for future technical improvement.

26. During the technical exchange, the AT noted that Ecuador has the accuracy analyses needed to estimate uncertainties and include them in its FREL submission, but had not done so. The AT considers that including information on assumptions, methods and results in relation to uncertainty estimation would increase the transparency of Ecuador's FREL and therefore notes this as an area for future technical improvement.

27. During the technical exchange, Ecuador indicated that the forest mask includes both young and mature forest for 2000 onward. The AT noted that this could affect estimates as EFs may not incorporate such variation within the strata used as per the methods of the NFI, potentially resulting in the overestimation of emissions from young forest. Noting that identifying young forest is listed as an area for future technical improvement in the report on the TA of the Party's 2015 FREL, the AT notes that this remains an area for future technical improvement.

28. During the TA, the AT observed that the number of plots reported per cluster differed in some instances, which made it difficult to understand whether the sample unit was the cluster or the plot. Ecuador explained that, in some instances, the plots to be assessed for a given cluster were not accessible in the field. The AT and Ecuador agreed that including additional details explaining sample unit locations and the process for generating biomass estimates and confidence intervals would greatly improve the transparency of Ecuador's FREL submission and therefore the AT notes this as an area for future technical improvement.

29. During the technical exchange, Ecuador indicated that the cluster is the sample unit and that cluster plot averages, extrapolated to 1 ha, were used to inform cluster estimates (use of a means of means). The AT explained that, by using the average of the plots for each cluster rather than the total biomass estimated for all plots and then rescaling it to 1 ha, the plots effectively become the sampling unit instead of the cluster, and this has implications for any estimates for which the sample size is relevant, such as EFs. Another concern raised by the AT is the matter of spatial autocorrelation among plots of the same cluster as non-independent samples used were being used as independent samples to generate the cluster mean estimates. The AT considers this to be an area for future technical improvement.

30. Ecuador explained that, in some instances, the discrepancies in the number of plots per cluster were caused by "outlier plots", which are located within one stratum but their floristic composition suggests that they should belong to another. In such cases, the plot and its data were reassigned and used to inform the biomass estimates for the stratum corresponding to the floristic composition and not the location. The AT pointed out that such reassignment of plot data jeopardizes the relation between EFs and AD required for the combination to be used in the approach selected by Ecuador to estimate its emissions. Also, the AT observed how discrepancies between the stratifications used for the NFI (established in 2009), the estimation of AD (regional random forest classifiers) and EFs have implications for the under- or overestimation of EFs, as per Birigazzi et al. (2018). The AT and Ecuador agreed that the Party could use methods such as those proposed in Birigazzi et al. (2018) to resolve this matter in a statistically unbiased way and increase the accuracy of its FREL. Therefore, the AT considers this to be an area for future technical improvement.

31. In accordance with decision 13/CP.19, annex, paragraph 2(a), the AT reviewed the consistency of the data and methods used in constructing the FREL with those used for the LULUCF GHG inventory in Ecuador's first BUR, and noted that there are important differences in the AD used. Specifically, a new approach to generating AD was used for the FREL in response to recommendations from the report on the TA of the previous FREL. Furthermore, additional changes to the data and the accuracy assessment of those data have led to inconsistency between the current FREL, the latest LULUCF GHG inventory in the first BUR, and the 2015 FREL. The AT considers that the Party should ensure consistency between the data to be used for its second BUR and those used for the current FREL. Ecuador assured the AT that all data and methods used in constructing its FREL are being reviewed to ensure consistency with the calculations in its next national GHG inventory as part of its second BUR. The AT considers improving consistency of the data and methods used for the



FREL with those used for the LULUCF GHG inventory to be an area for future technical improvement.

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

32. Ecuador briefly described the following policies and plans:

(a) The Magna Carta of Ecuador, approved in 2008, provides for the formation of a plurinational and intercultural State. Within this framework, Ecuador recognizes the rights of nature in its Constitution and establishes that the State will adopt adequate and cross-cutting measures for governing use of its natural resources and mitigating climate change by limiting its GHG emissions;

(b) REDD+ measures are being carried out through PROAmazonía, the Amazonian Integral Forest Conservation and Sustainable Production Program;

(c) In 2016, Ecuador issued its REDD+ strategy, the REDD+ “Forests for Good Living” Action Plan. The Party is seeking to integrate measures and actions within and outside the forest into national and local policies, programmes and initiatives, as well as to generate multiple environmental and social benefits.

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

33. 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.

34. The pools included in the Party’s FREL are above-ground biomass of trees and non-trees, below-ground biomass of trees and non-trees, deadwood and litter. SOC is not included.

35. Ecuador used the same information to estimate biomass for both its 2020 and its 2015 FREL. On that basis, the AT considers that the relevant observations included in the report on the TA of the 2015 FREL remain valid.

36. As the data used remain the same as for the 2015 FREL, the 2020 FREL includes CO<sub>2</sub> only. Slash harvesting of wood and burning of a fraction of the biomass remains the most common deforestation practice in Ecuador, resulting in methane and nitrous oxide emissions. However, the available data on the emissions of non-CO<sub>2</sub> gases are insufficient to allow for the inclusion of accurate estimates in the FREL. The TA considers this to be an area for future improvement.

37. The AT acknowledges that Ecuador included 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. The results of a test for the production of relevant AD were shared with the AT, and their accuracy was assessed at close to 50 per cent. Ecuador explained that it is working on including the activity forest degradation in future FRELs. Similarly, enhancement of forest carbon stocks, conservation of forest carbon stocks and sustainable management of forests were excluded. The AT considers this to be an area for future technical improvement.

38. Regarding afforestation and restoration, Ecuador shared with the AT AD that include forest cover gain, but these activities were not included in the FREL. Ecuador explained that forest cover gain is outside the scope of its forest mask and therefore also outside the scope of the assessment of future net emissions. The AT considers that explaining why the FREL uses the forest mask and excludes forest cover gain would increase the transparency of the FREL, and therefore notes this as an area for future technical improvement.

**4. Definition of forest**

39. Ecuador provided in its submission the definition of forest used in constructing its FREL. The definition is the same as the one that the Party uses for its national GHG inventory and its reporting to FAO for the Global Forest Resources Assessment, that is a minimum area of 1 ha, height of 5 m or more, including natural and planted forests, bamboo areas and native palms, and at least 30 per cent canopy cover, excluding oil palm plantations and fruit tree plantations.

40. The AT asked for details about how the minimum mapping unit, as defined in the forest definition, was used by both the AD producers and the third-party AD evaluators to assess forest condition in any location. Ecuador explained that the minimum mapping unit was applied by considering areas of at least 1 ha overall, irrespective of spatial arrangement (in some instances linear), for AD classes. In the case of the accuracy assessment, a  $3 \times 3$  Landsat pixel arrangement (0.81 ha) sample was used under a stratified random sampling approach, following the Olofsson et al. (2013) method. The AT observed that discrepancies between the AD arrangement and the accuracy assessment arrangement could result in poor estimates of AD accuracy and inaccurate statistically inferred adjusted area estimates. The AT therefore requested access to the interface used for the accuracy assessment to better understand how it was carried out; but, since the assessment was conducted by a third party, Ecuador was not able to give the AT access to the interface. The AT considers that having access to the reference data for the accuracy assessment would enhance the transparency of the FREL and therefore notes this as an area for future technical improvement.

41. Concerning the distribution of the samples used for the accuracy assessment, the AT observed that some samples overlap or are too close to one another owing to existing spatial autocorrelation, affecting their independence and therefore introducing bias into the estimates. It considers that a minimum distance should have been used to avoid the spatial agglomeration of samples and thus also avoid autocorrelation. Therefore, the AT considers this to be an area for future technical improvement.

42. Regarding the application of Ecuador's forest definition, the AT observed that the forest mask excludes oil palm and fruit trees plantations. During the technical exchange, Ecuador mentioned using higher spatial resolution imagery from 2014 (RapidEye) with additional ancillary data to distinguish forest areas from oil palm and fruit trees plantations. The AT considers that providing (access to) information on how the plantation data for 2014 were used to estimate the plantation areas for 2000 and 2008 would increase the transparency and completeness of the FREL submission, and therefore notes this as an area for future technical improvement.

43. In Ecuador's definition of the activity reducing emissions from deforestation, forest plantation logging does not qualify as deforestation. The AT noted that Ecuador did not explain in its FREL submission how plantation logging was distinguished from deforestation. During the TA, Ecuador explained that ancillary data were used in some instances. However, it was not clear which ancillary data were meant or how such data were used to distinguish temporarily unstocked areas due to logging from land-use change due to deforestation. On the basis of this, the AT considers this to be an area for future technical improvement.

### III. Conclusions

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

45. The FREL presented in the submission is Ecuador's second FREL. The previous FREL was submitted on 8 December 2014 and was subject to a TA in 2015; it covered the activity reducing emissions from deforestation for 2000–2008.

46. The FREL presented in the most recent submission, for the reference period 2001–2014, corresponds to 23,949,392.40 t CO<sub>2</sub> eq/year.

47. The AT acknowledges that Ecuador 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, Ecuador followed decision 1/CP.16, paragraph 70, on activities undertaken, and decision 12/CP.17, paragraph 10, on applying the stepwise approach. The AT commends Ecuador for providing information on its ongoing work to develop FRELs for other activities.

48. The AT notes that, overall, the FREL does not maintain consistency, in terms of sources of AD and EFs, with the GHG inventory included in Ecuador's first BUR.<sup>13</sup>

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

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

(a) Providing a detailed explanation and justification of the rationale for the 2001–2014 reference period, including information on political context to explain why Ecuador considers the period representative of future deforestation (see para. 18 above);

(b) Providing a clear explanation of the differences between the Party's 2015 FREL submission, technical annex on REDD+ results included in its first BUR and 2020 FREL submission to facilitate understanding the level of consistency among these reports (see para. 19 above);

(c) Providing detailed information to facilitate understanding and reconstruction of the process for estimating AD (specific inputs, assumptions, parameters and methods used) (see para. 20 above);

(d) Providing more detailed and transparent information on how the implications for the completeness and accuracy of the FREL of using a forest mask were addressed (see para. 21 above);

(e) Providing more detailed information on inputs, assumptions, methods and results in relation to the accuracy assessment, as well as the adjusted area estimates, and an explanation of why the Party considers its AD maps to present an unbiased estimation of AD even though the accuracy assessment results suggest otherwise (see para. 24 above);

(f) Making major improvements, particularly regarding omission and commission errors, to the post-processing of fully automatized classifications so as to enhance the quality of the AD maps subsequently to be used as stratifiers for producing statistically inferred AD (see para. 25 above);

(g) Providing a detailed technical explanation of the criteria and standard operating procedures used for assessing accuracies following the Olofsson et al. (2013) method for the accuracy assessment (see para. 25 above);

(h) Including information on assumptions, methods and results in relation to uncertainty estimation (see para. 26 above);

(i) Identifying young forest accurately to prevent overestimation of emissions (see para. 27 above);

(j) Including additional details on sample unit locations, and the process of generating biomass estimates and confidence intervals (see para. 28 above);

(k) Addressing potential bias caused by autocorrelating plots within each cluster and using the wrong sample size in generating estimates (see para. 29 above);

(l) Justifying the reassignment of plot data on the basis of floristic composition and explaining how the data were used to inform the biomass estimates for strata defined on the basis of floristic composition, and used for the FREL (see para. 30 above);

(m) Addressing discrepancies between the stratifications used for the NFI (established in 2009), the estimation of AD (regional random forest classifiers) and EFs (see para. 30 above);

(n) Increasing consistency of the data and methods used for the FREL with those used for the LULUCF GHG inventory (see para. 31 above);

(o) Including methane and nitrous oxide emissions, in particular those resulting from slash-and-burn (see para. 36 above);

(p) Collecting data to enable the inclusion, or justification of exclusion, of additional REDD+ activities, in particular reducing emissions from forest degradation (see paras. 37–38 above);

(q) Providing details on how the minimum mapping unit, as defined in the forest definition, was used by both the AD producers and the third-party AD evaluators to assess forest condition in any location (see para. 40 above);

(r) Using sample units that do not overlap and are far enough from one another to avoid spatial autocorrelation and any resulting bias in the estimates (see para. 41 above);

(s) Providing a detailed technical explanation of the accuracy assessment process, access to the interface and an explanation of how the interpretation of Ecuador's forest definition is consistent between both the maps and the accuracy assessment (see para. 41 above);

(t) Providing information on the data used to exclude oil palm and fruit tree plantations from the FREL in accordance with the forest definition, in particular for 2000 and 2008 (see para. 42 above);

(u) Providing documentation on how temporarily unstocked areas due to forest plantation logging were distinguished from land-use change due to deforestation (see para. 43 above).

50. In conclusion, the AT commends Ecuador for showing commitment to continuously improving its FREL estimates in line with the stepwise approach. A number of areas for the future technical improvement of Ecuador'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.<sup>14</sup>

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

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<sup>14</sup> 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 Ecuador

| <i>Main features of the FREL</i>                     |                                                                 | <i>Remarks</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Proposed FREL                                        | 23 949 392.40 t CO <sub>2</sub> eq/year                         | The FREL includes gross emissions from deforestation (i.e. those associated with clear-cuts but not any subsequent emissions or removals from deforested areas) within a forest mask based on a land-cover map for circa 2000 (see para. 9 of this document)                                                                                                                                                                                                                                                                                            |
| Type and reference period of FREL                    | FREL = average of historical emissions in 2001–2014             | Estimates were produced by updating estimates for 2000–2008 and incorporating estimates for 2009–2014. Updates were due mainly to improved generation of AD, although estimates reported are based on AD map pixel counts (see para. 11 of this document)                                                                                                                                                                                                                                                                                               |
| Application of adjustment for national circumstances | No                                                              | Ecuador used a forest mask to define the scope of the AD assessment owing to the domestic legal implications associated with the mask (see para. 20 of this document)                                                                                                                                                                                                                                                                                                                                                                                   |
| National/subnational                                 | National                                                        | Ecuador indicated that its FREL is national in scope, but AD reported cover only the area classified as forest in 2000 and used for the forest mask (see paras. 8 and 21 of this document)                                                                                                                                                                                                                                                                                                                                                              |
| Activity included                                    | Reducing emissions from deforestation                           | Ecuador defines gross deforestation as the conversion of natural forest to other land uses, excluding conversion of forest plantations to other land uses and conversion of natural forest to natural wetlands. In addition, the FREL includes conversion of natural forests to forest plantations (see para. 9 of this document)<br><br>Forest degradation is not included owing to lack of quality data, but the results of a test for producing relevant AD were presented as part of the annexes shared with the AT (see para. 37 of this document) |
| Pools included                                       | Above-ground biomass, below-ground biomass, deadwood and litter | Data used are the same as for the 2015 FREL. For the reported pools, it is assumed that the carbon immediately after deforestation is zero. SOC is not included owing to lack of accurate data (see para. 37 of this document)                                                                                                                                                                                                                                                                                                                          |
| Gas included                                         | CO <sub>2</sub>                                                 | As in the 2015 FREL, CO <sub>2</sub> was the only gas included (see para. 36 of this document)                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Forest definition                                    | Included                                                        | Minimum tree crown cover of 30 per cent; minimum land area of 1 ha; minimum tree height of 5 m, including natural and planted forests, native palms                                                                                                                                                                                                                                                                                                                                                                                                     |

| <i>Main features of the FREL</i>                                                                               |                                                                                                             | <i>Remarks</i>                                                                                                                                                                                                                                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                |                                                                                                             | and bamboo areas, and excluding oil palm and fruit plantations (see paras. 39–43 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 (2016) | Methods for generating AD have been improved following recommendations since the 2015 FREL. Additionally, owing to other changes made to AD and their accuracy assessment, there is a lack of consistency between the 2020 FREL, technical annex on REDD+ results included in the first BUR and 2015 FREL (see para. 31 of this document)                                     |
| Description of relevant policies and plans                                                                     | Not included                                                                                                |                                                                                                                                                                                                                                                                                                                                                                               |
| 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                                                                        | Included                                                                                                    | The 2015 FREL corresponded to 43 418 126 t CO <sub>2</sub> eq/year for 2000–2008. For the same period, the 2020 FREL includes estimated emissions corresponding to 25 605 031.85 t CO <sub>2</sub> eq/year. The difference is likely due to the use of new approaches to generating the AD (i.e. direct change mapping versus map comparison) (see para. 19 of this document) |
| Identification of future technical improvements                                                                | Included                                                                                                    | Several areas for future technical improvement were identified (see para. 50 of this document)                                                                                                                                                                                                                                                                                |

## Annex II

### Documents and information used during the technical assessment

#### A. Reference documents

First and second FREL submission of Ecuador. Available at <https://redd.unfccc.int/submissions.html?country=ecu>.

“Guidelines and procedures for the technical assessment of submissions from Parties on proposed forest reference emission levels and/or forest reference levels”. Annex to decision 13/CP.19. 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”. Annex to decision 12/CP.17. Available at <https://unfccc.int/sites/default/files/resource/docs/2011/cop17/eng/09a02.pdf#page=19>.

IPCC. 2003. *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. J Penman, M Gytarsky, T Hiraishi, et al. (eds.). Hayama, Japan: Institute for Global Environmental Strategies. Available at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html>.

Report on the TA of the proposed FREL of Ecuador submitted in 2014. FCCC/TAR/2015/ECU. Available at <https://unfccc.int/resource/docs/2015/tar/ecu.pdf>.

#### B. Other documents

The following references have been reproduced as received:

Birigazzi, L., Gamarra, J.G.P. & Gregoire, T.G. Unbiased emission factor estimators for large-area forest inventories: domain assessment techniques. *Environ Ecol Stat* 25, 199–219 (2018). <https://doi.org/10.1007/s10651-018-0397-3>.

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

Pontus Olofsson, Giles M. Foody, Stephen V. Stehman, Curtis E. Woodcock, Making better use of accuracy data in land change studies: Estimating accuracy and area and quantifying uncertainty using stratified estimation, *Remote Sensing of Environment*, Volume 129, 2013, Pages 122-131, ISSN 0034-4257, <https://doi.org/10.1016/j.rse.2012.10.031>.