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

Summary

    This report covers the technical assessment of the voluntary submission of Indonesia on its proposed forest reference level (FRL) in accordance with decision 13/CP.19 and in the context of results-based payments. The FRL proposed by Indonesia 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, Indonesia developed a national FRL. The FRL presented in the original submission, for the reference period 2006–2020, corresponds to 267,705,902 tonnes of carbon dioxide equivalent per year. As a result of the facilitative process during the technical assessment, the FRL was modified to 192,921,295 tonnes of carbon dioxide equivalent per year.

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

Abbreviations and acronyms

AD	activity data
AT	assessment team
BUR	biennial update report
CH_4	methane
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
COP	Conference of the Parties
EF	emission factor
FREL	forest reference emission level
FRL	forest reference level
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
N_2O	nitrous oxide
REDD+	reducing emissions from deforestation; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks (decision 1/CP.16, para. 70)
SOC	soil organic carbon
TA	technical assessment

I. Introduction and summary

A. Overview

1.   This report covers the TA of the voluntary submission of Indonesia on its proposed FRL,[1] submitted on 19 January 2022, in accordance with decisions 12/CP.17 and 13/CP.19. The TA took place from 21 to 25 March 2022 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): Shumpei Iida (Japan) and Carlos Riano (Colombia). In addition, Fazle Rabbi Sadeque Ahmed, an expert from the Consultative Group of Experts, participated as an observer[4] during the session. The TA was coordinated by Pierre Brender (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, Indonesia submitted its proposed FRL on a voluntary basis. The proposed FRL is one of the elements[5] to be developed in implementing the activities referred to in decision 1/CP.16, paragraph 70. Pursuant to decision 13/CP.19, paragraphs 1–2, and decision 14/CP.19, paragraphs 7–8, the COP decided that each submission of a proposed 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.   The objective of the TA is to assess the degree to which the information provided by Indonesia 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 FRL with a view to supporting the capacity of Indonesia to construct and improve its FRL in the future, as appropriate.[7]

4.   The TA of the FRL submitted by Indonesia was undertaken in accordance with the guidelines and procedures for the TA of submissions from Parties on proposed FRELs and/or FRLs.[8] This report on the TA was prepared by the AT following the same guidelines and procedures.

5.   Following the process set out in those guidelines and procedures, a draft version of this report was communicated to the Government of Indonesia. The facilitative exchange during the TA allowed Indonesia 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, Indonesia provided a modified version of its submission on 30 May 2022, which took into consideration the technical input of the AT. The modifications improved the clarity and transparency of the submitted FRL. This TA report was prepared in the context of the modified FRL submission.

B. Proposed forest reference level

6.   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 FRL proposed by Indonesia, 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

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[1]   The submission of Indonesia is available at https://redd.unfccc.int/submissions.html?country=IDN.
[2]   As per decision 13/CP.19, annex, para. 7.
[3]   As per decision 13/CP.19, annex, paras. 7 and 9.
[4]   As per decision 13/CP.19, annex, para. 9.
[5]   See decision 1/CP.16, para. 71(b).
[6]   Decision 12/CP.17, annex.
[7]   Decision 13/CP.19, annex, para. 1(a–b).
[8]   Decision 13/CP.19, annex.
[9]   As per decision 13/CP.19, annex, paras. 1(b), 13 and 14.

activities referred to in that paragraph. Pursuant to paragraph 71(b) of the same decision, Indonesia developed a national FRL that covers its entire territory, namely all inland area in 2006: 101.1 million ha forest and 89.3 million ha non-forest. For its submission, Indonesia applied a stepwise approach to developing its FRL in accordance with decision 12/CP.17, paragraph 10. The stepwise approach enables Parties to improve their FREL or FRL by incorporating better data, improved methodologies and, where appropriate, additional pools.

7.   The national FRL proposed by Indonesia for the historical reference period 2006–2020 is the annual average of the CO_2 eq emissions and removals associated with gross deforestation, forest degradation and enhancement of forest carbon stocks. Net emissions from deforestation are included as the result of the conversion of natural forest land to other land cover, excluding any subsequent emissions or removals; emissions from forest degradation are included as the result of the conversion of primary to secondary forest; and removals from enhancement of forest carbon stocks are included from the conversion of non-forest to forest, excluding secondary or plantation forest to primary forest. The AD used in constructing the FRL were extracted from a historical time series of land-cover maps for 2006 and 2020, annual maps of burned area produced by the Ministry of Environment and Forestry of Indonesia and peatland spatial data for 2019 provided by the Indonesian Ministry of Agriculture. The EFs were obtained from Indonesia's national forest inventory, related literature and IPCC guidelines. The FRL presented in the modified submission, with the aim of accessing results-based payments for REDD+ activities for 2021–2030, corresponds to 192,921,295 t CO_2 eq/year.[10]

8.   The proposed FRL includes the pools above- and below-ground biomass, dead organic matter (litter and deadwood were included only for non-CO_2 emissions from fires) and SOC (in relation to emissions from peatlands and mangroves due to deforestation, forest degradation, fires and mangrove conversion). Regarding GHGs, the submission includes CO_2, CH_4 (emissions from peat fires and biomass burning) and N_2O (emissions from biomass burning).

9.   The FRL proposed by Indonesia is its second submission in the context of applying the stepwise approach in accordance with decision 12/CP.17, paragraph 10. Its previous national FREL was submitted on 4 January 2016 and was subject to a TA in March 2016;[11] it covered the activities reducing emissions from deforestation and reducing emissions from forest degradation for the reference period 1990–2012. The previous assessed FREL corresponded to 568,859,881 t CO_2 eq/year for 2013, increasing annually because of accumulating emissions from peat decomposition up to 593,329,235 t CO_2 eq for 2020, and was therefore higher than the FRL proposed in the current submission. The assessed FRL proposed in the modified 2022 submission differs from the FREL in the modified 2016 submission due mainly to the inclusion of another activity, the use of refined AD and EFs, the exclusion of inherited emissions from peat decomposition induced by drainage before the monitoring period, the change of the reference period and the addition of gases and pools.

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[10] In its original submission, Indonesia proposed a national FREL of 267,705,902 t CO_2 eq/year for 2006–2020. The difference between the original and the modified submission is due mostly to the use of adjusted areas as AD calculated using sampled-based area estimation, whereas the sample plots were used only for the accuracy assessment of the mapped area for the original submission, and to a lesser extent to the correction of minor errors identified in the calculation spreadsheets following questions from the AT (see paras. 34–35 below).

[11] See document FCCC/TAR/2016/IDN.

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

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

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

10. For constructing its FRL, Indonesia used the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, the *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands* and the *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* for estimating emissions and removals from the selected REDD+ activities. AD were generated from land-cover maps and maps of burned area from the national forest monitoring system and a peatland distribution map produced by the Ministry of Agriculture. EFs for deforestation, forest degradation and enhancement of forest carbon stocks are mainly tier 2, derived from the national forest inventory for natural forest classes, as well as from peer-reviewed papers and scientific reports for other land covers, forest fires and peat decomposition, and some default values from the IPCC guidelines mentioned above.

11. Indonesia's proposed FRL covers net emissions from gross deforestation (loss of natural forest cover below a certain threshold) and from forest degradation (change from primary to disturbed secondary forest) and removals from enhancement of forest carbon stocks (conversion of non-forest to forest, excluding secondary or plantation forest to primary forest). It covers the reference period 2006–2020. The FRL was constructed on the basis of differences in land cover between the beginning and end of the reference period, instead of using several measurement periods as for the previous FREL. The AT commends Indonesia for explaining during the TA the rationale for that methodological change. Indonesia explained that basing the FRL on the differences between only two measurements is simpler than the method used for the previous FREL owing to the ability to avoid the need to filter out polygons identified as deforested a second time within the reference period while covering forest and land-cover change during the reference period and ensuring consistency with the sample-based approach.

12. The national forest monitoring system includes description of land-cover classes and change over the years, which has been developed and updated regularly since 2000. For the FRL submission, data sets for 2006 and 2020 were used to capture land cover. The wall-to-wall land-cover maps, from which AD were derived, were produced by the Ministry of Environment and Forestry using visual interpretation of Landsat satellite images. The peatland spatial data were provided by the Ministry of Agriculture and updated in 2019 on the basis of several related maps, field surveys and ground checks. The annual maps of burned area were produced by the Ministry of Environment and Forestry using visual interpretation of medium-resolution satellite imagery for 2000–2020 to identify burn scars. In addition, several other data sets were used to support and validate the burn scars, including a moderate resolution imaging spectroradiometer, the National Oceanic and Atmospheric Administration's HotSpot product, ground truth data and a burn area model based on a normalized burn ratio. To generate AD on peat fires, the maps of burned area were overlaid with maps of peatland and annual deforestation and degradation.

13. The primary data source for deriving EFs was the national forest inventory, with more than 4,000 clusters of sample plots measured between 1990 and 2019, each including one permanent sample plot of 1 ha surrounded by eight temporary sample plots. While only permanent sample plot data for natural forest classes were used to calculate above-ground biomass in dryland and swamp forest, temporary sample plot data were also used to estimate above-ground biomass in mangrove forest. Above-ground biomass for non-natural forest classes was estimated using weighted mean data from peer-reviewed journals and scientific reports (182 observations from 57 publications). Tier 2 EFs for CO_2 and CH_4 emissions from peat fires were derived from combustion factors, bulk density of peat and peat burn depth from various studies in Indonesia; EFs for non-CO_2 emissions from biomass burning were derived from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*; EFs for

peat decomposition were based on the estimates of Novita et al. (2021), who analysed 118 sample plots on the basis of 32 research papers; and EFs for mangrove conversion were taken from Arifanti et al. (2019) and the *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*.

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

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

14. The AT noted that much of the information necessary to assess the transparency, accuracy and completeness of the FRL was contained in the annexes to the submission and in the spreadsheets shared with the AT. The AT considered the information and was able to reproduce the calculation of the FRL. This approach is consistent with the presentation of information in Indonesia's previous FREL submission. The AT considers that the additional information provided by Indonesia in its modified FRL submission significantly increases the transparency of the proposed FRL and clarifies the drivers of deforestation within the country and the forest definition. Also, major improvements were made to the text and tables for the modified submission.

15. The AT noted that Indonesia maintained partial consistency of the methods, data and assumptions applied between its most recent national GHG inventory, included in the third BUR, and the FRL submission, as updated data and methods were used in the FRL calculation, and was therefore partially in line with decision 12/CP.17, paragraph 8. The AT also noted that inconsistencies arose despite the submission dates of the third BUR and the FRL submission being close together. In the FRL submission, Indonesia clarified that estimates contained therein will not be used to revise the results calculated against the previous FREL or other previously submitted GHG reports, including its second BUR and third national communication. The AT commends Indonesia for showing commitment to improving the data and methods used for calculating successive FRELs/FRLs.

16. In its FRL submission, Indonesia described the following improvements and changes to previously submitted information in accordance with decision 12/CP.17, annex, paragraph (b):

    (a)   The FRL includes the activity enhancement of forest carbon stocks;

    (b)   The FRL is based on a reference period of 14 years, from 2006 to 2020, compared with 22 years, from 1990 to 2012, for the previous FREL. In its FRL submission, Indonesia explained that aspects such as availability of land-cover data on deforestation, forest degradation and enhancement of forest carbon stocks were considered in selecting the reference period. Responding to a question from the AT, Indonesia also explained that the new reference period was selected in line with the technical requirement of the terms of reference for the pilot programme for REDD+ results-based payments of the Green Climate Fund, which recommends 10–15 years as an ideal reference period;

    (c)   In addition to the land-cover maps and peatland distribution map used for the previous FREL, for the FRL burned area maps were used to estimate emissions from peat and biomass fires;

    (d)   More comprehensive EFs were calculated for the FRL using national allometric equations, covering additional carbon pools and gases;

    (e)   While only above-ground biomass and SOC changes due to peat decomposition were included in the previous FREL, above- and below-ground biomass, dead organic matter (litter and deadwood were included only for non-CO_2 emissions from fires) and SOC (for peat decomposition, mangrove conversion and peat fires) are included in the FRL;

    (f)   The carbon stock for non-forest land classes was considered to calculate the net emissions from deforestation for the FRL;

(g)   The inherited emissions from peat decomposition are excluded. Indonesia has limited the calculation to the emissions from peat decomposition during the reference period that are directly associated with land-cover changes measured during the same period. The AT notes that this therefore excludes emissions from peat decomposition occurring during the reference period in land converted to secondary forest or non-forest classes before the reference period and emissions from peat decomposition after the reference period caused by conversions during the reference period. The AT also notes that this change of treatment of inherited emissions has contributed significantly to the drastic reduction in reported emissions from peat decomposition (from around 200 Mt CO_2/year in the previous FREL submission to less than 10 Mt CO_2/year in the FRL submission);

(h)   As well as including peat decomposition, Indonesia included peat fires in the FRL, which had been excluded from the previous FREL. The AT notes that the peat fire related emissions are about 21 Mt CO_2/year in the FRL.

17.   In the original FRL submission, Indonesia explained that above-ground biomass of individual trees in the sample plots of the NFI was estimated using an allometric model developed for Indonesian forests (from Manuri et al., 2014, 2017). The AT noted that the model used to estimate above-ground biomass for the submission does not seem to be the one recommended in the conclusions of the article used as the reference. In the modified submission, Indonesia clarified the selection of the allometric equation (from Manuri et al., 2017), mentioning that bioregion factor is one of the most influential additional variables in explaining the variation in above-ground biomass, apart from the traditional variables, and that the equation allows use of different values and EFs for each region in the country. The AT commends the Party's efforts to clarify the rationale for selecting the allometric model used to estimate above-ground biomass and for including the additional information in its modified submission.

18.   In the submission, Indonesia mentioned that the FRL will be projected in 5–10 years. In response to a question from the AT, Indonesia clarified that the FRL will be valid for 10 years by default, but could be updated in 5 years if new data and better methodologies are available by then.

19.   The AT noted that, for the original submission, Indonesia used the mapped areas as a source of AD and conducted an uncertainty analysis to estimate the standard error in the mapped areas on the basis of the approach suggested by Olofsson et al. (2014). During the TA, the AT mentioned that the results of the analysis presented by Indonesia showed that there were commission errors of more than 75 per cent for forest degradation and forest gain. For the modified submission, adjusted areas calculated following Olofsson et al. (2014) methodology were used to estimate the AD. The AT commends Indonesia for the methodological improvement, which should have increased the accuracy of the AD used for the FRL.

20.   The AT noted that it is not clear from the original submission how the distinction was made between primary and secondary forest. In response to a question from the AT, Indonesia provided some information on the definitions of primary and secondary forest. In the modified submission (annex 1), Indonesia provided a summary of its updated standard operating procedure for medium-resolution satellite imagery interpretation for national land cover to guide the land-cover mapping process. Also, it clarified in the submission (section 5.2.2) that forest degradation was estimated on the basis of Landsat imagery using a 1 km buffer around land clearing, road access, settlements, land management and forest fires. The AT commends Indonesia for including additional information regarding the methodology and results of the land-cover mapping process in the modified submission.

21.   The AT noted that the land-cover maps for recent years, including 2020, have been updated, but the map for 2006 has not. Indonesia mentioned that this is because of the lack of satellite images for 2006. In its original submission, Indonesia reported some conversion of non-forest to primary forest, which could be a consequence of the map for 2006 not being updated. In response to a question from the AT, Indonesia explained that the conversion occurred because of spatial processing, which shows afforested polygons as converted to primary forest at the perimeter of the primary forest. The AT considers updating all land-cover maps and improving the spatial processing analysis as an area for future technical

improvement, which would significantly improve consistency between the maps that are the basis for the AD, although the adjustment introduced by Indonesia in its modified submission (see para. 19 above) means that no bias was introduced into the FRL.

22.   Indonesia explained in the original submission that the second level of forest degradation (deterioration in the amount of forest cover and carbon stock as a result of human activities within a given forest strata) was excluded from its accounting owing to limited data and methodologies for accurate area estimation. During the TA, Indonesia explained that it used information about the proximity of primary (undisturbed) forest to land clearing, road access, settlements, land management and forest fires as part of producing AD for the first level of forest degradation, and this information was included in the modified submission (annex 1). However, Indonesia mentioned that accounting for the second level of degradation is not possible at the national level with the remote sensing and visual interpretation techniques available. The AT notes improving the methodology and data available to estimate the degradation within a forest type as an area for future technical improvement of the FRL.

23.   The AT noted that Indonesia used a revised data map for peatlands for 2019. During the facilitative exchange, in response to questions from the AT on how the map was used to determine the peat areas for the reference period of the FRL, Indonesia clarified that the refined peatland map was intersected with land-cover and fire maps to establish AD for peat decomposition and peat fires during the reference period without the use of direct information on peat drainage status. The AT commends Indonesia for providing this information and adding a comparison of the previous and revised peatland maps in the modified submission (annex 2).

24.   Furthermore, the AT noted that the level of error related to producing the peatland map reported in the original submission is the same as that reported for the previous FREL. During the TA, Indonesia explained that it could not find any uncertainty estimates associated with the 2019 peatland map and therefore opted for a conservative estimate consistent with that used for the previous FREL. The AT commends the Party for providing this clarification, while noting improving collection of data on peatlands and the uncertainty analysis of the peatland map as an area for future technical improvement of the FRL.

25.   In the original submission, Indonesia described the three levels of accuracy in the process to detect and delineate burned area polygons, but provided no indication of the methodology used to establish those levels of accuracy. During the TA, Indonesia explained the methodology used to detect and classify the burned areas: the AD include all polygons of high and medium accuracy, as well as those classified as low accuracy but supported by other evidence. The AT commends the Party for efforts to improve the burned area mapping and for including the methodology and results in the modified submission (annex 3).

26.   In its original submission, Indonesia explained that it excluded the increment of forest carbon resulting from conversion of secondary to primary forest because the classification approach used to distinguish between primary and secondary forest is not suitable. During the facilitative exchange, Indonesia further explained that there are not enough data available for monitoring that change considering the definitions of primary and secondary forest. The AT considers collecting more data and using new methodologies to classify primary and secondary forest and assess conversion between those classes as an area for future technical improvement that could allow for further improvement of the accuracy of the FRL in the future.

27.   In the original submission, Indonesia mentioned that, to estimate removals from enhancement of forest carbon stocks, the stock-difference approach between broad forest strata was used. During the facilitative exchange, the Party clarified that this approach was used because it does not require annual land-cover change data. The AT noted that this practice could result in an overestimation of removals from the transition of non-forest land to forest land since the transition in reality occurs over a number of years, but such overestimation might be partially mitigated if the same assumptions are used in the result period as well. Indonesia noted its intention to exercise the use of gain–loss method for estimating removals from enhancement of forest carbon stocks in its next FRL submission. The AT commends Indonesia for the planned improvement, and notes this as an area for

future technical improvement in order to increase the accuracy of the removal estimates for enhancement of forest carbon stocks.

28.   The AT noted that the references for table 4 of the original submission (table 5 of the modified submission), which presents estimated ratio value of sapling, understorey biomass and root to above-ground tree biomass for each forest type, consider only specific regions although the table covers all regions in Indonesia. During the facilitative exchange, Indonesia explained that one author for one of the references mentioned for a study in central Kalimantan conducted similar analyses in other regions, which were considered as well to support the estimates presented in the submission. The AT commends Indonesia for sharing the clarification during the TA.

29.   Table 9 of the original submission (table 10 of the modified submission) mentions different EFs for peat decomposition for various land-cover types. The AT noted that not all EFs mentioned in the table are those included in the article mentioned as the source. During the facilitative exchange, the Party clarified that an assumption was made that primary forest produces zero emissions or emissions that occurred naturally and should be excluded from accounting, as this ecosystem is not affected by human intervention or canal development. Also, the Party mentioned that emissions from secondary dryland forest and secondary swamp forest are assumed to be similar. Finally, Indonesia used the EF for peatlands from the previous FREL for other land-cover classes that are not mentioned in the data source. The AT commends Indonesia for providing this clarification in the modified submission, and notes estimating the EF for peatlands for the other land-cover classes as an area for future technical improvement.

30.   The AT noted that it is not clear from the original submission how the EFs for non-natural forest, such as plantation forest or estate crop, were calculated or how species of plantation and estate crop were selected in the weighting score method applied. In its modified submission, Indonesia provided information on the weighting score method for non-natural forest, but there is still a lack of clarity; for example, on how the ratio of fast-growing species (70 per cent) to slow-growing species (30 per cent) in plantations was estimated. The AT commends Indonesia for providing additional information on the weighting score method, while noting the inclusion of further information about it in future FRL submissions as an area for future technical improvement.

31.   The AT noted in the original submission different reported total inland areas of the country. During the TA, Indonesia explained to the AT that this is due to the exclusion of plantation forest from table 1 and the inclusion of waterbodies in the area reported in the table in annex 1.3. The AT commends Indonesia for reporting a consistent total inland area of the country in the modified submission.

32.   The AT noted that the original submission includes AD for individual activities and land-use information, but no summary land-use change matrix. In response to a question from the AT, Indonesia provided such information in spreadsheet format to the AT. The AT notes that this information allows for the reconstruction of the FRL.

33.   The AT noted that the content of annex 1 to the original submission was similar to that in the annex to the previous FREL submission and there was no additional information on maps for after 2016. Following questions from the AT, Indonesia completely updated annex 1 for the modified submission, adding technical details about the acquisition of land-cover data and the use of maps to produce AD and calculate uncertainties. The AT commends Indonesia for providing the detailed information, which increases the transparency of the FRL.

34.   The original submission includes a brief description of the Monte Carlo simulations used to perform the uncertainty analysis and its results, but the description is not detailed enough to allow the AT to assess whether it was accurate. During the facilitative exchange, the AT sought clarifications on the data and method used, including on the calculation spreadsheet shared by Indonesia with the AT, most importantly in relation to the use of mapped areas and not adjusted areas as AD to construct the FRL (see para. 19 above). The overall uncertainty of the FRL reported in the modified submission with a 95 per cent confidence interval is +/–19 per cent with a standard deviation of 18,838,198 t CO_2 eq/year. The AT commends the Party's efforts to improve the transparency of the estimation of

uncertainties, including by providing a comprehensive description of the uncertainty analysis of AD in an annex to the modified submission. The AT notes assessing the uncertainty of the peatland maps as an area for future technical improvement (see para. 24 above).

35.   During the revision of the calculation of emissions shared by Indonesia, the AT noted some inconsistencies in figures between the submission and the spreadsheet, in particular for CH_4 and N_2O emissions from biomass and dead organic matter burning in deforested and degraded forest. Indonesia included correction of its estimates of emissions from those activities and pools in its modified FRL submission. The AT commends the Party for the corrections. which contribute to a more accurate estimation of its FRL.

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

36.   Indonesia provided information on policies and plans related to enhancement of forest carbon stocks, mangrove conversion and peat fires in its original submission. In response to a question from the AT about other policies and plans related to deforestation and forest degradation, Indonesia added a more exhaustive presentation of policies and plans for reducing GHG emissions from the forestry and other land use sector in its modified submission: the legal framework includes forest restoration and rehabilitation, acceleration of the establishment of forest plantations, restoration of degraded peatlands and mangroves, wetland management, and land and forest fire controls; Indonesia is starting to pave the way to achieving a national peaking of GHG emissions by 2030 with forestry and other land use as a leading sector in line with the objectives of its Long-Term Strategy for Low Carbon and Climate Resilience 2050; and the Ministry of Environment and Forestry has established an operational plan for 2030 to strengthen efforts to reduce emissions from forestry and other land use and to convert the sector to a net sink.

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

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

38.   The pools included in the Party's FRL are above-ground biomass, below-ground biomass, litter and deadwood (both only for non-CO_2 emissions from fires) and SOC (for emissions from peatlands and mangroves).

39.   The AT noted that Indonesia excluded changes in SOC in mineral soils from its original submission. During the TA, Indonesia explained that changes in SOC in mineral soils were not considered because the common period of change in mineral soils is 20 years, which is longer than the FRL reference period of 14 years. The AT asked the Party about the possibility of including SOC in mineral soils using IPCC default values and the average duration between the change of land-cover strata and the end of the reference period as an assumption. In response, Indonesia explained its intention to include SOC in mineral soils in the next FRL submission as part of future technical improvements. The AT commends the Party for considering inclusion of SOC in mineral soils in its next FRL submission and notes this as an area for future technical improvement.

40.   The treatment of emissions from deadwood was identified as an area for future technical improvement in relation to Indonesia's previous FREL, while the low biomass volume of litter was noted as an indication of the low significance of the pool. The AT noted that the FRL includes emissions of CH_4 and N_2O from litter and deadwood associated with fires in line with the stepwise approach. The AT also noted that Indonesia continued to exclude emissions from carbon stock changes in litter and deadwood for the FRL but noted in its improvement plan the need for studies to enable their inclusion. The AT commends the Party's partial inclusion of emissions from litter and deadwood in the FRL and its intention to include emissions from litter and deadwood associated with deforestation and forest degradation in the future, and notes this as an area for future technical improvement.

41.   The inclusion of non-CO_2 emissions was identified as an area for future technical improvement in relation to the Party's previous FREL. The AT commends Indonesia's efforts to include in the FRL CH_4 and N_2O emissions associated with fires as part of the stepwise

approach and notes that Indonesia mentioned that non-CO_2 emissions from peat decomposition could be included in future FRL submissions.

42. The AT acknowledges that Indonesia included in its FRL the most significant activity (reducing emissions from deforestation) among the three activities included in its FRL. The AT notes that other activities could also be significant. According to Indonesia, sustainable management of forests and conservation of forest carbon stocks are not included in the FRL because this would require a robust and accurate methodology to monitor the annual emissions and removals and more detailed EFs and AD to differentiate emissions between already included activity and additional activity, for example between forest degradation and sustainable management of forests. The AT commends Indonesia for its plan to include additional REDD+ activities as part of future technical improvements when new and adequate data become available.

4. Definition of forest

43. Indonesia provided in its submission the definition of forest used in constructing its FRL. While Indonesia defines forest as a land area of more than 0.25 ha with trees taller than 5 m at maturity and canopy cover of more than 30 per cent, or trees able to reach these thresholds in situ (the formal definition, as defined by the Ministry of Environment and Forestry, 2004), the working definition used in constructing the FRL is a land area of more than 6.25 ha with trees taller than 5 m at maturity and canopy cover of more than 30 per cent. While the working definition is the same as that used by the Party for its national GHG inventory and REDD+ technical annex to its BUR, it is different from that used for its reporting to the Food and Agriculture Organization of the United Nations for the Global Forest Resources Assessment. In response to a question from the AT, Indonesia clarified that, with the medium-resolution Landsat images used to construct the land-cover maps, it is not possible to differentiate forest on the basis of the parameters in the formal definition. However, in its modified submission, Indonesia clarified that land-cover data samples derived from high-resolution satellite imagery were used as reference to accurately interpret the land-cover classes, and that such images could be used to estimate tree density and provide indications of tree height from shadow. While commending Indonesia for explaining the application of the forest definition and the use of higher-resolution satellite imagery in its analysis of land cover, the AT considers continuing to improve the consistency of the definitions of forest used for its international reporting, given the clarification of the ability to use higher-resolution satellite imagery to construct land-use maps, as an area for future technical improvement.

44. In response to a question from the AT, Indonesia explained that, when updating the land-cover maps, before merging the polygons with an area of less than 6.25 ha to the neighbouring polygon, the area was allocated to land cover that implies the absence of land-cover change (stable forest and non-forest). Also, all areas of 1–6.25 ha that were to be merged in the same classes were checked manually to assess whether a land-cover change had actually occurred. Indonesia clarified that this means that a minimum mapping unit of 1 ha is effectively used for land-cover change resulting from deforestation. The AT notes that the transparency of the FRL submission would be improved by including this detail regarding the forest definition, and that moving to a minimum mapping unit of 1 ha instead of 6.25 ha for forest degradation and enhancement of forest carbon stocks, as well as fires associated with deforestation, could increase accuracy. The AT considers this an area for future technical improvement as part of the stepwise approach.

III. Conclusions

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

46. The FRL presented in the submission is Indonesia's second submission. The previous FREL was submitted on 4 January 2016 and was subject to a TA in 2016; it covered the

activities reducing emissions from deforestation and reducing emissions from forest degradation for 1990–2012.

47.   The FRL presented in the modified submission, for the reference period 2006–2020, corresponds to 192,921,295 t CO_2 eq/year.

48.   The AT acknowledges that Indonesia included in its FRL the most significant activities and the most significant pools in terms of emissions from forests. The AT considers that, in doing so, Indonesia 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 Indonesia for providing information on its ongoing work to develop FRLs for other activities as a step towards constructing a more detailed FRL.

49.   As a result of the facilitative interactions with the AT during the TA, Indonesia 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 FRL submission and commends Indonesia on its efforts. The new information provided in the modified submission and the revised spreadsheet shared by Indonesia with the AT increased the reproducibility of the FRL calculations.

50.   The AT notes that, overall, Indonesia maintained partial consistency, in terms of sources of AD and EFs used for its FRL, with those used for the GHG inventory included in its third BUR (2021).[12]

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

(a)   Updating all land-cover maps and improving the spatial processing analysis (see para. 21 above);

(b)   Improving the methodology and data available to estimate degradation within a forest type (see para. 22 above);

(c)   Estimating the uncertainty of the peatland map (see para. 24 above);

(d)   Collecting more data and using new methodologies in order to classify primary and secondary forest and any conversion between them (see para. 26 above);

(e)   Improving the accuracy of the estimates of removals associated with enhancement of forest carbon stocks (see para. 27 above);

(f)   Estimating EFs for peatlands for the other land-cover classes (see para. 29 above);

(g)   Including further clarification on the weighting score method for calculating the EFs for non-natural forest (see para. 30 above);

(h)   Improving consistency of the definitions of forest used for international reporting (see para. 43 above);

(i)   Making the definition of forest used for reporting more consistent with the Party's formal definition of forest (see para. 44 above).

52.   Pursuant to decision 13/CP.19, annex, paragraph 2(f), in assessing the pools and gases included in the FRL the AT noted that the pools and gases excluded by Indonesia are likely to be insignificant in the context of the FRL. Nevertheless, pursuant to decision 13/CP.19, annex, paragraph 3, the AT identified additional areas for future technical improvement regarding pools and gases excluded from the FRL, namely treatment of:

(a)   SOC in mineral soils (see para. 39 above);

(b)   Emissions from litter and deadwood (see para. 40 above);

(c) CH_4 and N_2O emissions from peat decomposition (see para. 41 above);

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

(d) Sustainable management of forests and conservation of forest carbon stocks (see para. 42 above).

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

(a) Continue to work on updating data and improving methodologies for the FRL and describing the differences in those used between the FRL and the national GHG inventory for the BUR and the national communication (see para. 15 above);

(b) Exercise the use of the gain–loss method for estimating removals from enhancement of forest carbon stocks in its next FRL (see para. 27 above).

54. In conclusion, the AT commends Indonesia for showing strong commitment to continuously improving its FRL estimates in line with the stepwise approach. A number of areas for the future technical improvement of Indonesia's FRL have been identified in this report. At the same time, the AT acknowledges that such improvements are subject to national capabilities and policies, and notes the importance of providing adequate and predictable support.[13] The AT also acknowledges that the TA was an opportunity for a rich, open, facilitative and constructive technical exchange of information with Indonesia.

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

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[13] 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 level based on information provided by Indonesia

Main features of the FRL		*Remarks*
Proposed FRL	192 921 295 t CO_2 eq/year	See paragraph 7 of this document
Type and reference period of FRL	FRL = based on average historical emissions and removals in 2006–2020	See paragraph 7 of this document
Application of adjustment for national circumstances	No	–
National/subnational	National	The FRL covers the entire inland area of Indonesia in 2006: 101.1 million ha forest and 89.3 million ha non-forest (see para. 6 of this document)
Activities included	Reducing emissions from deforestation Reducing emissions from forest degradation Enhancement of forest carbon stocks	The FRL includes net emissions from deforestation (conversion of natural forest to other land cover), emissions from forest degradation (conversion of primary to secondary forest) and enhancement of forest carbon stocks (conversion of non-forest to forest) (see para. 7 of this document)
Pools included	Above-ground biomass Below-ground biomass Deadwood Litter SOC	Biomass is included for all land-cover categories; deadwood and litter are included for non-CO_2 emissions from fires; SOC is included for emissions from peat decomposition and mangrove conversion (see paras. 8 and 38–40 of this document)
Gases included	CO_2, CH_4, N_2O	CO_2 emissions derive from biomass and soil-related emissions from deforestation, forest degradation and enhancement of forest carbon stocks, including peat fires, peat decomposition and conversion of mangroves; CH_4 and N_2O emissions derive only from fires (see paras. 8 and 41 of this document)
Forest definition	Included	Minimum area of 6.25 ha with trees taller than 5 m at maturity and canopy cover of more than 30 per cent, or trees able to reach these thresholds in situ (see paras. 43–44 of this document)
Consistency with latest GHG inventory	Methods used for estimating the FRL are partially consistent with those used for the latest GHG inventory in the third BUR (2021)	See paragraph 15 of this document
Description of relevant policies and plans	Included	See paragraph 36 of this document

Main features of the FRL		*Remarks*
Description of assumptions on future changes to domestic policy, if included in constructing the FRL	Not applicable	–
Description of changes to previous FREL/FRL	Included	For changes identified in the FRL submission, see paragraph 16 of this document
Identification of future technical improvements	Included	Several areas for future technical improvement have been identified (see paras. 51–52 of this document)

Annex II

Reference documents

A. Reports of the Intergovernmental Panel on Climate Change

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

IPCC. 2014. *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands.* T Hiraishi, T Krug, K Tanabe, et al. (eds.). Geneva: IPCC. Available at https://www.ipcc.ch/publication/2013-supplement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories-wetlands/.

IPCC. 2019. *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.* E Calvo Buendia, K Tanabe, A Kranjc, et al. (eds.). Geneva: IPCC. Available at https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/.

B. UNFCCC documents

Modified FREL submission and modified FRL submission of Indonesia. Available at https://redd.unfccc.int/submissions.html?country=IDN.

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

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

Report on the TA of the proposed FREL of Indonesia submitted in 2016. FCCC/TAR/2016/IDN. Available at http://unfccc.int/resource/docs/2016/tar/idn.pdf.

C. Other documents

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

Arifanti VB, Kauffman JB, Hadriyanto D, et al. 2019. Carbon dynamics and land use carbon footprints in mangrove-converted aquaculture: The case of the Mahakam Delta, Indonesia. *Forest Ecology and Management.* 432: pp.17–29.

Manuri S, Brack C, Nugroho NP, et al. 2014. Tree biomass equations for tropical peat swamp forest ecosystems in Indonesia. *Forest Ecology and Management.* 334: pp.241–253.

Manuri S, Brack C, Rusolono T, et al. 2017. Effect of species grouping and site variables on aboveground biomass models for lowland tropical forests of the Indo-Malay region. *Annals of Forest Science.* 74(1): pp.23.

Ministry of Environment and Forestry. 2004. Peraturan Menteri Kehutanan Nomor : P.14/Menhut-II/2004 Tentang Tata Cara Aforestasi dan Reforestasi Dalam Kerangka Mekanisme Pembangunan Bersih.

Novita N, Lestari NS, Lugina M, et al. 2021. Geographic Setting and Groundwater Table Control Carbon Emission from Indonesian Peatland: A Meta-Analysis. *Forests.* 12(7): pp.832.

Olofsson P, Foody G, Herold M, et al. 2014. Good practices for estimating area and assessing accuracy of land change. *Remote Sensing of Environment.* 148: pp.42–57.

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