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# Technical report on the technical analysis of the technical annex to the first biennial transparency report of Indonesia submitted in accordance with paragraph 14 of decision 18/CMA.1 on 24 December 2024

*Summary*

This technical report covers the technical analysis of the technical annex submitted on a voluntary basis, in the context of results-based payments, by Indonesia on 24 December 2024 through its first biennial transparency report in accordance with paragraph 45 of decision 1/CP.24 and paragraph 14 of decision 18/CMA.1. The technical annex provides data and information on the activities reducing emissions from deforestation, reducing emissions from forest degradation and enhancement of forest carbon stocks, which are three of the five activities included in paragraph 70 of decision 1/CP.16.

Indonesia reported the results of implementing these activities for 2021–2023, which amount to 68,980,679 tonnes of carbon dioxide equivalent per year and were measured against the assessed forest reference level of 192,921,295 tonnes of carbon dioxide equivalent per year.

The data and information provided in the technical annex are in overall accordance with the guidelines contained in the annex to decision 14/CP.19. The technical analysis concluded that the data and information provided by Indonesia in the technical annex are partially transparent and partially consistent with the data and information used for establishing the assessed forest reference level in accordance with paragraph 71(b) of decision 1/CP.16 and section II of decision 12/CP.17. This report contains the findings from the technical analysis and a few areas identified for capacity-building and future technical improvement in accordance with paragraph 14 of decision 14/CP.19.

# Abbreviations and acronyms

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| AD | activity data |
| AR | Assessment Report of the Intergovernmental Panel on Climate Change |
| BTR | biennial transparency report |
| BUR | biennial update report |
| $CH_4$ | methane |
| $CO_2$ | carbon dioxide |
| $CO_2$ eq | carbon dioxide equivalent |
| EF | emission factor |
| FREL | forest reference emission level |
| FRL | forest reference level |
| GHG | greenhouse gas |
| GWP | global warming potential |
| IPCC | Intergovernmental Panel on Climate Change |
| LULUCF | land use, land-use change and forestry |
| MPGs | modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement |
| MRV | measurement, reporting and verification |
| $N_2O$ | nitrous oxide |
| NFMS | national forest monitoring system |
| 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 analysis |

# I. Introduction, overview and summary

## A. Introduction

1. This technical report covers the TA of the technical annex provided by Indonesia on 24 December 2024 in accordance with paragraph 45 of decision 1/CP.24 and paragraph 14 of decision 18/CMA.1 as part of its BTR1, which was submitted in accordance with paragraph 3 of decision 18/CMA.1. In the technical annex, Indonesia provided the data and information used for estimating its anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and changes in forest carbon stock and forest area resulting from implementing REDD+ activities. The submission of the technical annex is voluntary and in the context of results-based payments in accordance with paragraph 8 of decision 14/CP.19.

2. In accordance with paragraph 14 of decision 18/CMA.1, the TA of the technical annex to the BTR is carried out concurrently with the technical expert review of the BTR referred to in Article 13, paragraph 11, of the Paris Agreement. The technical expert review team conducted the technical expert review of the information reported in the BTR1 of Indonesia as per the scope of the review defined in paragraph 146 of the MPGs,[1] resulting in a separate technical expert review report.[2]

3. Indonesia made its first (FREL) and second (FRL) submissions, in accordance with decision 12/CP.17, on 4 January 2016 and 19 January 2022 respectively, which were subject to technical assessment following the guidance provided in decision 13/CP.19 and its annex. As a result of the facilitative interactions with the LULUCF experts during the TA, the Party provided a modified version of its latest FRL submission on 30 May 2022. The latest assessed FRL was included as one of the elements of the technical annex to its BTR1 in accordance with the guidelines contained in the annex to decision 14/CP.19. The findings from the technical assessment of that FRL are included in a separate report.[3]

4. Indonesia previously submitted technical annexes to its second and third BURs on 21 December 2018 and 20 December 2021 respectively. The outcome of the TAs thereof is contained in documents FCCC/SBI/ICA/2019/TATR.1/IDN and FCCC/SBI/ICA/2022/TATR.2/IDN. Previous FRL submissions, BURs with technical annexes and associated technical assessment and analysis reports for the Party are available online.[4]

## B. Process overview

5. The technical expert review of the BTR1 of Indonesia took place from 5 to 9 May 2025 as a centralized review and was undertaken by a technical expert review team drawn from the UNFCCC roster of experts on the basis of the criteria defined in paragraphs 172–182 of the MPGs. Tertius Vitus de Kluyver (Australia) and Leticia Guimarães (Brazil) were the LULUCF experts who undertook the TA of the technical annex in accordance with paragraphs 10–13 of decision 14/CP.19. The TA was coordinated by Luca Birigazzi (secretariat).

6. The TA of the technical annex provided by Indonesia was undertaken in accordance with the procedures contained in decisions 2/CP.17, 14/CP.19 and 20/CP.19. This technical report on the TA was prepared by the LULUCF experts in accordance with paragraph 14 of decision 14/CP.19.

7. During the TA and subsequent exchanges, the LULUCF experts and Indonesia engaged in technical discussions, and Indonesia provided clarifications in response to

[1] Decision 18/CMA.1, annex.
[2] FCCC/ETF/TERR.1/2024/IDN.
[3] FCCC/TAR/2022/IDN, published on 3 January 2023.
[4] https://redd.unfccc.int/submissions.html?country=idn.

questions raised by the LULUCF experts, in order to reach an understanding on the identification of the areas for future technical improvement.

8. Following the TA of the technical annex, the LULUCF experts prepared and shared the draft technical report with Indonesia for its review and comments. The LULUCF experts responded to the Party's comments and incorporated them into and finalized this technical report in consultation with Indonesia.

## C. Summary of results

9. In paragraph 70 of decision 1/CP.16 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 in accordance with its respective capabilities and national circumstances. In the context of results-based payments and in line with decision 12/CP.17, Indonesia, on a voluntary basis, proposed a national FRL covering the activities reducing emissions from deforestation, reducing emissions from forest degradation and enhancement of forest carbon stocks for the purpose of a technical assessment in accordance with decision 13/CP.19 and its annex. The activities are being implemented in Indonesia's national territory. The assessed FRL of Indonesia is 192,921,295 t $CO_2$ eq/year for the reference period 2006–2020 and was presented with the aim of accessing results-based payments for REDD+ activities for 2021–2030. Under the technical annex to the BTR1, Indonesia submitted results for 2021–2023.

10. The Party's FRL is based on its approach to estimating the historical $CO_2$ emissions associated with the activities reducing emissions from deforestation, reducing emissions from forest degradation and enhancement of forest carbon stocks for the historical reference period 2006–2020. Indonesia noted that it anticipates updating its FREL/FRL every 5 to 10 years. Indonesia reported the results of implementing the activities reducing emissions from deforestation, reducing emissions from forest degradation and enhancement of forest carbon stocks for 2021–2023, calculated against the FRL, which amount to emission reductions of 123,940,616 t $CO_2$ eq annually. The table contained in annex II summarizes the main features of the results in the technical annex, with the aim of accessing results-based payments for REDD+ activities, including the results period, the assessed FRL, and the pools and gases included.

11. Indonesia submitted its first FREL for technical assessment in 2016.[5] The assessed FREL, based on average historical emissions from 1990 to 2012, was 568,859,881 t $CO_2$ eq for 2013, increasing annually because of accumulating emissions from peat decomposition, and reaching 593,329,235 t $CO_2$ eq for 2020. Measured against this value, Indonesia also submitted results amounting to 48,978,427 t $CO_2$ eq annually (average of annual emissions) for 2013–2017, as included in the technical annex to its second BUR, assessed in 2019,[6] and 192,483,053 t $CO_2$ eq annually for 2018–2020, as included in the technical annex to its third BUR, assessed in 2022.[7]

# II. Technical analysis of the information reported in the technical annex

12. For the technical annex to the BTR1 submitted by Indonesia, see annex I.[8]

13. The scope of the TA is outlined in paragraph 11 of decision 14/CP.19, according to which the LULUCF experts shall analyse the extent to which:

(a) The methodologies, definitions, comprehensiveness and information provided are consistent between the assessed FRL and the results of implementing REDD+ activities;

[5] See document FCCC/TAR/2016/IDN.
[6] See document FCCC/SBI/ICA/2019/TATR.1/IDN.
[7] See document FCCC/SBI/ICA/2022/TATR.2/IDN.
[8] As per decision 14/CP.19, para. 14(a).

(b) The data and information provided in the technical annex are transparent, consistent, complete and accurate;

(c) The data and information provided in the technical annex are consistent with the guidelines referred to in paragraph 9 of decision 14/CP.19;

(d) The results are accurate, to the extent possible.

14. The table below describes the findings from the TA of the data, methodologies and procedures used by the developing country Party for estimating its anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and changes in forest carbon stock and forest area resulting from implementing REDD+ activities within the scope of the TA outlined in paragraph 13 above.

**Findings from the technical analysis of the data and information used by the developing country Party for estimating its anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and changes in forest carbon stock and forest area resulting from implementing REDD+ activities**

| *Finding ID#* | *Aspect of the scope of the TA (decision 14/CP.19, para. 11)* | *Description of the issue, additional information shared by the Party during the TA and conclusions of the LULUCF experts* | *Area for future technical improvement* |
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| 1 | 11(a) Consistency with the guidelines in paragraph 3 of the annex to decision 14/CP.19 (consistency with the assessed FREL/FRL) | The LULUCF experts noted that Indonesia maintained consistency between its assessed FRL and estimated results of implementing the activities reducing emissions from deforestation, reducing emissions from forest degradation and enhancement of forest carbon stocks in 2021–2023 with regard to the following elements:<br>(a) Using consistent methodologies and data to generate EFs that are based on peer-reviewed studies, the results of which were stratified by forest type and Indonesian island and inputted into the Party's emission model based on a Monte Carlo simulation. EFs are consistent between the models used to estimate emissions for the FRL and technical annex;<br>(b) Covering the same five carbon pools: above-ground biomass and below-ground biomass for all land-cover categories; deadwood and litter for non-$CO_2$ emissions from fires; and SOC for emissions from peat decomposition and mangrove conversion;<br>(c) Covering the same gases: $CO_2$ from biomass- and soil-related emissions from the three activities, including peat fires, peat decomposition and conversion of mangroves, and $CH_4$ and $N_2O$, only from fires; and using the same GWP from the AR2;<br>(d) Applying the same set of assumptions and methodologies, as follows:<br>(i) Classifying the classes that are not mentioned in Novita et al. (2021) into other similar land-cover classes (see table 10 of the modified FRL submission and table A1-9 of the technical annex);<br>(ii) Detecting forest degradation in Landsat imagery on the basis of the assumption of a 1 km buffer for the proximity of any human influence, such as land clearing, road access, settlements, land management and forest fires;<br>(iii) Assuming that the forest-cover change occurred in the middle of the reference period, and therefore estimating the average of the EFs for the start and end years (both EFs divided by two);<br>(iv) Using a Monte Carlo simulation as the basis for the estimation of emissions and removals, assuming that all AD and EFs have a normal distribution and using a 95 per cent confidence level for estimating the random values of AD and EFs;<br>(e) Using the same forest definition: a land area of more than 0.25 ha with trees taller than 5 m at maturity and a canopy cover of more than 30 per cent, or trees able to reach those thresholds in situ (Ministry of Forestry, 2004). | |

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| 2 | 11(a) Consistency with the guidelines in paragraph 3 of the annex to decision 14/CP.19 (consistency with the assessed FREL/FRL) | The LULUCF experts noted that some data and information used by Indonesia to estimate the results of implementing the three activities were not consistent with those used for the assessed FRL. The total area included in the FRL submission (190.4 million ha) was different from the total area included in the technical annex (191.3 million ha). In the technical annex, Indonesia explained that the difference stems from an update to the base map, made in the light of coastal alterations caused by sedimentation and similar natural changes, and that the change in total area does not significantly impact the core land-category areas reported in the FRL submission.<br><br>During the TA, the Party presented examples of such changes in coastal boundaries between the 2006 and 2020 land-cover maps, indicating that some differences may also result from the reclassification of water bodies at river mouths. It explained that the national base map is regularly updated to reflect natural and human-induced land changes determined using the latest technologies, and that these updates are governed by Geospatial Information Agency regulation 18/2021 and presidential regulation 23/2021, which establish the respective latest map as the reference for development and spatial planning under Indonesia's One Map Policy. The LULUCF experts sought clarification on the extent to which emissions and removals from these newly added areas are included in the results period, and on their significance in relation to the total reported results. Indonesia explained that these areas are not part of the emission calculations for the technical annex. It also clarified that, as the updated area of 191.3 million ha was derived using the same forest definitions and classifications as those used for the second FRL, with forest gains limited to specific non-forest land-cover types, this change did not materially affect the key categories used in estimating emission reductions or substantially alter the proportional distribution of land categories such as forest, non-forest and peatlands.<br><br>The LULUCF experts commend Indonesia for its explanation, which enhances the clarity of the information reported. However, they noted that, based on the information available in the technical annex and the calculation sheets shared during the TA, it is not possible to determine the impact of the new areas on the accuracy and consistency of the results. They also noted that, in order to estimate the results, the proportion of areas under deforestation, forest degradation and forest gain, obtained through sampling, was multiplied by the updated total national area (191.3 million ha). As such, the additional area appears to have been implicitly included in the calculation. It remains unclear whether, and how, the sampling frame used for the results was adjusted to ensure consistency with the sampling frame used for the FRL. | The LULUCF experts note that enhancing consistency with regard to the total country area between the estimated results and the assessed FRL is an area for future technical improvement. |

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| | | The LULUCF experts conclude that this difference in land area impacts the consistency of the results estimated for the technical annex with the estimates presented in the FRL submission. | |
| 3 | 11(a) Consistency with the guidelines in paragraph 3 of the annex to decision 14/CP.19 (consistency with the assessed FREL/FRL) | The LULUCF experts noted that the area proportion estimates used to generate AD for the reference period are based on a total of 2,167 sample points, while estimates for the results period are based on a total of 950 sample points. It was not clear from the technical annex whether the reduction in sample size from 2,167 to 950 points was due to a methodological change, data availability or another factor. Additionally, it is unclear whether the 950 points are a subset of the original 2,167 used for the FRL or whether they represent a completely new sample for the results period.<br>During the TA, the Party clarified that the samples used for the FRL and those used for the results are different, and the latter is not a subset of the former. It also explained that some sample points had to be removed to avoid overlaps with other samples located in the same small polygons, especially for forest degradation and enhancement of forest carbon stocks. The Party further clarified that, for both the reference period and the results period, sample size was determined on the basis of the area of AD, which differed between the two periods, affecting the number of samples used for each. The LULUCF experts noted that, while the change in stratum size between the two periods may explain the different allocation of samples among strata, it does not explain why the total sample size across all strata was more than halved in the results period. | The LULUCF experts note that enhancing consistency in terms of sampling intensity between the estimated results and the assessed FRL is an area for future technical improvement. |
| 4 | 11(b) AD – Accuracy | The formal definition of forest (see finding ID# 1 above) and the working definition of forest used for estimating the results (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) are consistent between the FRL and the technical annex. However, as noted by the previous assessment team, the working definition differs from that used for the Party's reporting to the Food and Agriculture Organization of the United Nations for the Global Forest Resources Assessment. In line with the findings from the technical assessment of the FRL (see para. 44 of document FCCC/TAR/2022/IDN), the LULUCF experts note 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 LULUCF experts reiterate the finding that improving consistency of the definitions of forest used for international reporting and making the definition of forest used for reporting more consistent with the Party's formal definition of forest, identified in the report on the technical assessment of Indonesia's second FRL, are areas for future technical improvement. |
| 5 | 11(b) AD – Accuracy | The LULUCF experts sought clarification on whether areas converted from primary forest to bare land (or other non-forest land uses) in the reference period may be included as secondary forest in the results period.<br>During the TA, Indonesia presented a matrix of the allowable land-use changes included in the calculation of results. According to this matrix, conversion from | The LULUCF experts reiterate that the finding that collecting more data and using new methodologies to classify primary and secondary forest and assess conversion between those classes, |

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| | | non-forest to forest is permitted for only a limited number of land-cover change classes, namely from shrub to dryland secondary forest, from fishponds to secondary mangrove forest, and from wet shrubs or swamp to secondary swamp forest. The Party explained that the matrix outlining potential land-cover changes is based on logical transitions commonly observed under prevailing land-use dynamics in Indonesia, though it noted that other types of land-cover change cannot be entirely excluded, such as anomalous or unlikely transitions resulting from natural disasters or extraordinary events (e.g. wildfires, floods, landslides or the construction of large-scale infrastructure such as dams). Indonesia noted that the latter transitions would need to be verified using high-resolution satellite imagery or ground-truthing in order to ensure data reliability.<br><br>The LULUCF experts commend Indonesia for providing this information, which increases the transparency of the technical annex. However, the LULUCF experts also acknowledge that, as noted in the report on the technical assessment of Indonesia's second FRL (see para. 26 of document FCCC/TAR/2022/IDN), the classification approach used to distinguish between primary and secondary forest in the FRL submission is not fully adequate, and there are not enough data available for monitoring that change considering the definitions of primary and secondary forest.<br><br>The LULUCF experts conclude that future technical improvements that increase accuracy with regard to identifying land-cover classes will improve the overall assessment of land-cover change. | identified in the report on the technical assessment of Indonesia's second FRL, is an area for future technical improvement. |
| 6 | 11(a) Consistency with the guidelines in paragraph 3 of the annex to decision 14/CP.19 (consistency with the assessed FREL/FRL) and 11(b) Approaches – Accuracy | The LULUCF experts, in considering the equation for estimating annual removals from enhancement of forest carbon stocks (technical annex, p.255), noted that the Party correctly estimated an annual EF based on the 14-year transition period. However, the equation was then also used to divide that value again by three, which represents the number of years in the monitoring period. Having already been used for estimating the annual change according to the transition period of 14 years, this estimate can now be multiplied by three to give the total stock change over the monitoring period. This issue is replicated in the Monte Carlo simulation workbook and leads to an underestimation of carbon stock enhancement. Moreover, this is not consistent with the methodology applied for the FRL, where the carbon stock change is only divided by the transition period (14 years). | The LULUCF experts note that correcting the formula for estimating removals from enhancement of forest carbon stocks is an area for future technical improvement that would increase the accuracy of the technical annex and enhance consistency with the FRL. |
| 7 | 11(b) Approaches – Consistency | As noted in the report on the technical assessment of Indonesia's second FRL, the Party maintained partial consistency in the methods, data and assumptions applied between its national GHG inventory, included in the third BUR, and the FRL submission, as updated data and methods were used for the FRL. The LULUCF experts noted that the technical annex does not maintain consistency in | The LULUCF experts reiterate that the finding, identified in the report on the technical assessment of Indonesia's second FRL, that maintaining consistency in methods, data and assumptions between |

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| | | the methods, data and assumptions applied with the latest GHG inventory, contained in Indonesia's BTR1. Regarding emissions from forest fires, the LULUCF experts noted the consistency between the FRL submission and the technical annex in applying GWP values from the AR2. In its BTR1, Indonesia reported that it used GWP values from the AR5. The LULUCF experts noted that using the same version of GWP values used in the corresponding BTR for future publications of both the FRL submission and the technical annex would increase the consistency of reporting. | the national GHG inventory and REDD+ submissions is an area for future technical improvement. |
| 8 | 11(b) Approaches – Accuracy | Consistently with the 2022 FRL, the technical annex only includes deadwood and litter for non-$CO_2$ emissions from fires, while SOC is only included for emissions from peat decomposition and mangrove conversion. During the TA, Indonesia explained that field sampling and laboratory analyses for mineral soil carbon are ongoing and will inform the development of tier 2 EFs to be included in future FRL/FREL submissions. The LULUCF experts commend Indonesia for its continuing efforts to develop its data on SOC from mineral soils. The LULUCF experts welcome the Party's intention to consider including estimates of carbon stock changes in the litter and deadwood pools during deforestation and forest degradation, and in mineral soils in FRL/FREL submissions. | The LULUCF experts reiterate the finding, identified in the report on the technical assessment of Indonesia's second FRL, that including emissions from litter, deadwood and mineral soils is an area for future technical improvement. |
| 9 | 11(b) Approaches – Transparency and completeness | The LULUCF experts noted that Indonesia did not include in its technical annex all the information needed to ensure transparency and completeness.<br>During the TA, Indonesia shared additional information with the LULUCF experts, including the Monte Carlo analysis Excel file containing calculation chains, formulas and underlying data used to estimate the results. The LULUCF experts noted that the inclusion in the technical annex of methodological information, such as descriptions of the data set, approaches, methods and models used, would significantly enhance the transparency of the information and allow for the reconstruction of results.<br>The LULUCF experts commend Indonesia for sharing information during the TA and for its intention to provide more detailed methodological information in future FRL/FREL submissions in order to ensure ease of reference and further enhance transparency of reporting. The LULUCF experts conclude that including this information in the technical annex would improve completeness and transparency. | The LULUCF experts note that making the data and information used for estimating the results that were shared with the assessment team during the TA publicly available is an area for future technical improvement that would increase the reproducibility and completeness of the technical annex. |
| 10 | 11(b) AD – Accuracy | As explained by Indonesia during the TA, for the results period, the Party estimated AD for REDD+ activities across the entire country using a stratified random sample of 950 visually interpreted plots. The five strata (deforestation, forest degradation, forest gain, stable forest and stable non-forest) were derived by overlaying two land-cover maps: one for 2021 and one for 2023. The number of samples in each stratum was allocated using optimum allocation, based on | The LULUCF experts note that increasing the sampling size used for the stratified area estimation is an area for future technical improvement that would enhance the accuracy of the results. |

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| | | methods reported by Cochran (1977) and ensuring that at least 150 or so plots were included in each stratum; specifically, 147 for deforestation, 149 for forest degradation, 152 for forest gain, 249 for stable forest and 253 for stable non-forest.<br><br>The LULUCF experts noted that, for the larger strata, such as stable forest (covering 91,299,115 ha) and stable non-forest (94,001,575 ha), this sampling design results in a relatively low sampling intensity. In these strata, each plot represents an average area of about 3,700 km² and is located, on average, some 60 km from the nearest neighbouring plot. Given that land-cover change is expected to be a rare event in these two strata, this level of sampling may not be sufficient to accurately capture land-cover change dynamics. In this assessment, no omission errors were identified for the deforestation class, which may reflect a limitation in the sampling design's ability to capture this type of transition. | |
| 11 | 11(b) AD – Accuracy | The LULUCF experts noted that the technical annex, in contrast to the FRL submission, does not include a detailed description of uncertainty by activity type (e.g. degradation versus deforestation).<br><br>Indonesia provided this information during the TA, when the LULUCF experts also sought clarification on the increase in uncertainty between the reference period and the results period for deforestation, which rose from 25.3 to 38.5 per cent, and for degradation, which rose from 34.6 to 41.9 per cent. The LULUCF experts also sought clarification on the high level of uncertainty for enhancement of forest carbon stocks and the possibility of including areas that were converted in the reference period and previously classed as primary forest as enhancement of carbon stocks in the results period. Indonesia explained that the plots used for the reference and results periods were of different sizes, which may, in part, explain these differences. | |
| 12 | 11(b) AD – Transparency and completeness | From the information reported in the technical annex, it was not clear whether the AD for deforestation, forest degradation and enhancement of forest carbon stocks were obtained through a pixel count of a wall-to-wall land-cover change map, or through a sample-based area estimation, as in the modified FRL submission.<br><br>During the TA, Indonesia clarified that these AD were obtained using a sample-based area estimation. The LULUCF experts noted that the technical annex does not provide information on the procedure for estimating AD using the sample, such as the sampling design, sample size, interpretation protocols, data sources or quality assurance/quality control procedures. In response to a request from the LULUCF experts, Indonesia shared additional information regarding the interpretation protocols and sampling design used for the sample-based area estimation, including the standard operating procedure used for conducting the accuracy assessment and uncertainty analysis of land-cover changes. The Party | The LULUCF experts note that providing clearer information on the methods and protocols for estimating AD, and the underlying data set used is an area for future technical improvement that would increase the transparency and completeness of the technical annex. |

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| | | also clarified that, in conducting uncertainty assessments, Indonesia follows a three-step process. First, sample points for assessing land-use change are distributed across the areas of interest. Second, the sample points are independently analysed by interpreters, and third, the results of the analyses are validated through quality control and cross-checking. | |
| 13 | 11(b) AD – Transparency and accuracy | The 950 visually interpreted plots were used to estimate the total national area under deforestation, forest degradation, stable forest and stable non-forest. To determine the proportion of these areas falling under each land-use subcategory or forest type (primary or secondary dryland, swamp, or mangrove forests), information was drawn from land-cover maps for the initial and final years of the results period. For each of the strata, the proportion of each subcategory or forest type relative to the total stratum area was estimated from the land-cover map, and the proportion was then applied to the area estimated from the sample. However, information on the accuracy of the land-cover maps used to estimate land-cover class proportions, including on the accuracy of the individual land-cover classes, was not included in the technical annex.<br><br>During the TA, Indonesia shared the results of an accuracy assessment for the land-cover map developed for 2022 on the basis of 5,000 visually interpreted sample points. The map had an overall accuracy of 82 per cent, with omission errors for the forest classes ranging from a minimum of 8 per cent for plantation forest to a maximum of 23 per cent for secondary mangrove forest. Indonesia subsequently published two documents showing the results of the 1990–2016 accuracy calculations on its NFMS web platform (www.simontana.kehutanan.go.id).<br><br>The LULUCF experts commend Indonesia for providing this additional information and making it publicly available, which enhances the transparency of the technical annex. | The LULUCF experts note that providing clearer information on the methods and protocols for estimating the accuracy of the underlying land-cover data set is an area for future technical improvement that would increase the transparency of the technical annex. |
| 14 | 11(c) Consistency with the guidelines in paragraphs 1–2 of the annex to decision 14/CP.19 (summary information and results) | Indonesia provided information on the assessed FRL, the activities implemented, the territorial forest area, the date of the FRL submission, the date of the final technical assessment report, the period of the FRL and the results in t $CO_2$/year. | |
| 15 | 11(c) Consistency with the guidelines in paragraph 4 of the annex to decision 14/CP.19 (NFMS) | The LULUCF experts noted that Indonesia provided a description of the NFMS and a transparent summary of the roles and responsibilities of the agencies and institutions involved in MRV of the results in the technical annex, together with weblinks for accessing further information.<br><br>The NFMS covers the entire country, equalling 191.3 million ha. The system assesses deforestation, forest degradation, peat decomposition under deforestation and forest degradation, peat fires, mangrove conversion, and | |

| *Finding ID#* | *Aspect of the scope of the TA (decision 14/CP.19, para. 11)* | *Description of the issue, additional information shared by the Party during the TA and conclusions of the LULUCF experts* | *Area for future technical improvement* |
|---|---|---|---|
| | | enhancement of forest carbon stocks involving primary and secondary dry or swamp forests, and primary and secondary mangrove forests. Non-forest land classes are considered in the conversion from non-forest to forest classifications.<br><br>According to paragraph 4(b) of decision 11/CP.19, the NFMS should enable the assessment of different types of forest in the country, including natural forest. Specific non-forest classes included in the assessment of forest gain involve the following land-class transitions: shrubs, wet shrubs and mixed agriculture transitioning to secondary and plantation forests; bare lands converted to plantation forests and secondary mangrove forests; and fishponds changing to secondary mangroves. The AD were produced by comparing land-cover maps, each comprising 23 land-cover classes, from two consecutive monitoring periods: the previous period (2020) and the current period (2023). The land-cover maps, developed from temporally aligned satellite imagery from Landsat and SPOT satellite imagery, are manually classified.<br><br>During the consultation process, Indonesia explained that the land-cover classes are aligned with the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* subcategories but, because detailed carbon stock values are used for its land-cover classes, these were used directly for more accurate estimation of GHG emissions and removals. Indonesia also explained that the quality assurance/quality control process that underpins the uncertainty analysis associated with the development of land-cover maps and land-transition analysis was not described in the technical annex but is consistent with and fully integrated into the national MRV system and the processes described in and used for the second FRL submission. | |
| 16 | 11(d) Accuracy of the results proposed in the technical annex | Indonesia estimated the uncertainty of its results using the Monte Carlo simulation. The description of the method in the technical annex was not detailed enough to assess whether it was accurate.<br><br>During the facilitative exchange, the LULUCF experts sought clarification on the data and method used, including on the Monte Carlo analysis Excel file, which was shared by Indonesia (see finding ID# 9 above). The overall uncertainty of total emissions for 2021–2023 reported in the technical annex with a 95 per cent confidence interval is +/–29.4 per cent, with a standard deviation of 10,235,595 t $CO_2$ eq/year. The overall uncertainty of the emission reduction estimates for the results period is +/– 32.5 per cent, with a standard deviation of 20,609,619 t $CO_2$ eq/year.<br><br>The LULUCF experts commend the Party for sharing the Monte Carlo analysis file, which enhances the transparency of the technical annex. | |

# III. Conclusions

15. The LULUCF experts conclude that Indonesia reported the results of implementing three activities, namely reducing emissions from deforestation, reducing emissions from forest degradation, and enhancement of forest carbon stocks. The results include the pools above-ground biomass, 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 technical annex includes $CO_2$, $CH_4$ (emissions from peat fires and biomass burning) and $N_2O$ (emissions from biomass burning).

16. The LULUCF experts also conclude that the results presented of implementing the activities are partially consistent with the assessed FRL (see finding ID#s 1–3 in the table above).

17. The LULUCF experts further conclude that Indonesia provided the information necessary for reconstructing the results of implementing the activities. The data and information provided in the technical annex are considered to be consistent over time within the results period, partially transparent (see finding ID#s 9, 12 and 13 in the table above), mostly complete (see finding ID#s 9 and 12 in the table above) and mostly accurate (see finding ID#s 4, 5, 6, 8, 10, 11 and 13 in the table above), to the extent possible.

18. The LULUCF experts acknowledge that the technical annex includes summary information from the final report containing the assessed FRL; results in t $CO_2$ eq/year; a description of the forest monitoring system and institutional roles and responsibilities in MRV of the results; and a description of how the elements contained in paragraph 1(c–d) of decision 4/CP.15 have been taken into account. The LULUCF experts conclude that the data and information provided in the technical annex are consistent with the guidelines referred to in paragraph 9 of decision 14/CP.19.

19. The results are mostly accurate based on the assumptions used (see finding ID#s 4, 5, 6, 8, 10, 11, 13 and 16 in the table above).

20. Pursuant to paragraph 14 of decision 14/CP.19, the LULUCF experts identified areas for future technical improvement (see the table above). The LULUCF experts conclude that the following areas for future technical improvement identified in the report on the technical assessment of Indonesia's second FRL also apply to the provision of information on the results:

(a) Updating all land-cover maps and improving the spatial processing analysis;

(b) Improving the methodology and data available to estimate degradation within a forest type;

(c) Estimating the uncertainty of the peatland map;

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

(e) Improving the accuracy of the estimates of removals associated with enhancement of forest carbon stocks;

(f) Estimating EFs for peatlands for the other land-cover classes;

(g) Including further clarification on the weighting score method for calculating the EFs for non-natural forest;

(h) Improving consistency of the definitions of forest used for international reporting;

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

21. During the TA, Indonesia informed the LULUCF experts that it has already begun to address several of the areas for improvement identified in paragraph 20 above by enhancing

its NFMS and capacity-building programmes and that it will reflect its progress in future FREL/FRL submissions. The LULUCF experts acknowledge and welcome the Party's intention and action to address these areas for improvement, as well as to develop methodologies and EFs for estimating changes in mineral SOC.

22. In conclusion, the LULUCF experts commend Indonesia for showing strong commitment to continuously improving the data and information used for calculating the results, in line with the stepwise approach. Some areas for future technical improvement have been identified in this report. At the same time, the LULUCF experts acknowledge that such improvements are subject to national capabilities and circumstances and note the importance of adequate and predictable support.[9] The LULUCF experts also acknowledge that the TA process was an opportunity for a facilitative and constructive technical exchange of views and information with Indonesia.[10]

[9] As per decision 2/CP.17, para. 57.

[10] As per decision 14/CP.19, paras. 12–13.

# Annex I

## Technical annex to the biennial transparency report

Owing to the complexity and length of the submitted technical annex to the BTR, and in order to maintain the original formatting, the technical annex has not been reproduced here; it is available at https://unfccc.int/first-biennial-transparency-reports.

# Annex II

## Summary of main features of reported results of implementing activities referred to in paragraph 70 of decision 1/CP.16 based on information provided by Indonesia

| *Key element* | | *Remark(s)* |
|---|---|---|
| Results reported | 123 940 616 t $CO_2$ eq/year | See paragraph 10 of this document |
| Results period | 2021–2023 | See paragraph 10 of this document |
| Assessed FRL | 192 921 295 t $CO_2$ eq/year | See document FCCC/TAR/2022/IDN and the modified version of the Party's latest FRL submission of May 2022. See paragraph 9 of this document |
| Reference period | 2006–2020 | See paragraph 9 of this document |
| National/subnational | National | See paragraph 9 of this document. See also finding ID# 2 in the table in this document |
| Activities included | Reducing emissions from deforestation<br>Reducing emissions from forest degradation<br>Enhancement of forest carbon stocks | See paragraph 10 of this document |
| Pools included | Above-ground biomass<br>Below-ground biomass<br>Deadwood<br>Litter<br>Soil organic matter | 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 finding ID# 1 in the table in 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 finding ID# 1 in the table in this document |
| Consistency with assessed FRL | Methods, definitions and information used for the assessed FRL are mostly consistent with those used for the results | See finding ID#s 1–3 in the table in this document |
| Description of NFMS and institutional roles | Included | See finding ID# 15 in the table in this document |
| Identification of future technical improvements | Not included | Several areas for future technical improvement have been identified (see finding ID#s 2–8, 10 and 12–13 in the table in and paras. 20–21 of this document) |

# Annex III

## Reference documents

### A. Reports of the Intergovernmental Panel on Climate Change

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

### B. UNFCCC documents

First and second modified FREL/FRL submissions 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". 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 elements to be included in the technical annex referred to in decision 14/CP.19, paragraph 7". Annex to decision 14/CP.19. Available at https://unfccc.int/sites/default/files/resource/docs/2013/cop19/eng/10a01.pdf#page=42.

"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.

Report on the technical assessment of the proposed FRL of Indonesia submitted in 2022. FCCC/TAR/2022/IDN. Available at https://unfccc.int/sites/default/files/resource/tar2022_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 technical annex:

Anna Tosiani, Arsyi Rahman Mohammad, Gamma Nur M. Sularso, et al. 2020. STANDARD OPERATING PROCEDURES: Calculation of Accuracy and Uncertainty of Land Cover Change. Bogor City, Indonesia.

Belinda Arunarwati Margono. 2020. Interpretation of medium resolution satellite images to update national land cover data. Indonesia: Directorate of Forest Resources Inventory and Monitoring, Directorate General of Forestry Planology and Environmental Order, Ministry of Environment and Forestry.

Calculation spreadsheet used for estimating results, FRL, and conducting uncertainty analysis using a Monte Carlo simulation.

Cochran W. 1977. Sampling techniques. Wiley publication in applied statistics. New York: Wiley.

Example Discrepancy of the Total Land Area: insignificant impact to the total emission estimation.

Land cover data for the 2021–2023.

Haruni Krisnawati, Rinaldi Imanuddin, Wahyu Catur Adinugroho, et al. 2015. Standard Methods for estimating greenhouse gas emissions from the forestry sector in Indonesia (version 1). Bogor, Indonesia: Research and Development Center for Conservation and Rehabilitation, Forestry Research and Development Agency.

Ministry of Environment and Forestry. Recalculation of Indonesia's Land Cover in 2022. Jakarta: Directorate of Forest Resources Inventory and Monitoring. Directorate General of Forestry Planning and Environmental Management. Ministry of Environment and Forestry.

Ministry of Forestry. 2004. Peraturan Menteri Kehutanan Nomor: P.14/Menhut-II/2004 Tentang Tata Cara Aforestasi dan Reforestasi Dalam Kerangka Mekanisme Pembangunan Bersih. (p. 1. article 1). Ministry of Forestry. Jakarta.

National Land Cover Data Accuracy Book 1990-2016.

Land Cover Recalculation Book.

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.

Standard operating procedure used for conducting the accuracy assessment and uncertainty analysis of land-cover changes.

The raw data related to the visually interpreted points for the FRL and for the results period.