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Report of the technical assessment of the proposed forest reference level of Papua New Guinea submitted in 2017

Summary

This report covers the technical assessment of the submission of Papua New Guinea, on a voluntary basis, 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 Papua New Guinea 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. In its submission, Papua New Guinea has developed a national FRL for the period 2014–2018 with values corresponding to 43,369,737 (2014), 45,049,344 (2015), 46,728,951 (2016), 48,408,557 (2017) and 50,088,164 (2018) tonnes of carbon dioxide equivalent per year. The assessment team notes that the data and information used by Papua New Guinea in constructing its FRL are mostly transparent and complete and in overall accordance with the guidelines contained in the annex to decision 12/CP.17. This report contains the assessed FRL and a few areas identified by the assessment team for further technical improvement, according to the scope of the technical assessment in the annex to decision 13/CP.19.

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Contents

I. Introduction and summary

A. Overview

1. This report covers the technical assessment (TA) of the submission of Papua New Guinea on its proposed forest reference level (FRL),[1] submitted on 15 January 2017 in accordance with decisions 12/CP.17 and 13/CP.19. The TA took place (as a centralized activity) from 13 to 17 March 2017 in Bonn, Germany, and was coordinated by the UNFCCC 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 assessment team (AT)): Mr. Javier Fernandez (Costa Rica) and Mr. Koki Okawa (Japan). In addition, Mr. Brian Mantlana, an expert from the Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention, participated as an observer[4] during the centralized activity in Bonn. The TA was coordinated by Mr. Nalin Srivastava (UNFCCC secretariat).

2. In response to the invitation by the Conference of the Parties (COP) and in accordance with the provisions of decision 12/CP.17, paragraphs 7–15, and its annex, Papua New Guinea submitted its proposed FRL on a voluntary basis. The proposed FRL is one of the elements[5] to be developed in the implementation of the activities referred to in decision 1/CP.16, paragraph 70. The COP decided that each submission of a proposed forest reference emission level (FREL) or FRL, as referred to in decision 12/CP.17, paragraph 13, shall be subject to a TA in the context of results-based payments, pursuant to decisions 13/CP.19, paragraphs 1 and 2, and 14/CP.19, paragraphs 7 and 8.

3. The objective of this TA was to assess the degree to which information provided by Papua New Guinea was in accordance with the guidelines for submissions of information on FRELs)/FRLs[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 Papua New Guinea for the construction and future improvement of FRELs/FRLs, as appropriate.[7]

4. The TA of the FRL submitted by Papua New Guinea was undertaken in accordance with the guidelines and procedures for the TA of submissions from Parties on proposed FRELs and/or FRLs as contained in the annex to decision 13/CP.19. This report on the TA was prepared by the AT following the guidelines and procedures contained in the same decision.

5. In accordance with the process contained in the guidelines and procedures of the same decision, a draft version of this report was communicated to the Government of Papua New Guinea. The facilitative exchange during the TA allowed Papua New Guinea to provide clarifications and information that were considered by the AT in the preparation of this report.[8] As a result of the facilitative exchange with the AT during the TA session, Papua New Guinea submitted a modified version of its FRL on 10 July 2017, which took into consideration the technical inputs by the AT. The modifications improved the clarity and transparency of the submitted FRL and altered the approach used to construct the proposed FRL. This TA report was prepared based on the modified FRL submission. The modified submission that contains the assessed FRL and the original submission are available on the UNFCCC website.[9]

[1] The submission of Papua New Guinea can be found at http://unfccc.int/8414.
[2] Decision 13/CP.19, annex, paragraph 7.
[3] Decision 13/CP.19, paragraphs 7 and 9.
[4] Decision 13/CP.19, paragraph 9.
[5] Decision 1/CP.16, paragraph 71(b).
[6] Decision 12/CP.17, annex.
[7] Decision 13/CP.19, annex, paragraph 1(a) and (b).
[8] Decision 13/CP.19, annex, paragraphs 1(b), 13 and 14.
[9] See http://unfccc.int/8414.

B. Proposed forest reference level

6. The national FRL proposed by Papua New Guinea for the historical reference period 2001–2013 is the values of the carbon dioxide (CO_2) emissions for 2014–2018 projected using an equation based on a linear regression model. The FRL includes the emissions associated with deforestation, defined as the conversion of forest land to non-forest land; forest degradation, defined as the conversion from primary forest to disturbed forest; and forest carbon stock enhancement, defined as the conversion of non-forest land to forest land. The information on activity data used in the construction of the FRL was obtained from the land use and land-use change assessments conducted using Collect Earth (CE), an open-source tool developed by the Food and Agriculture Organization of the United Nations (FAO).[10] The information on emission factors was obtained from national academic literature and the Intergovernmental Panel on Climate Change (IPCC) *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines). The FRL values (in t CO_2 eq/year) for the period 2014–2018 presented in the modified submission, with the aim of accessing results-based payments for REDD-plus[11] activities for the period 2014–2018, are 43,369,737 (2014), 45,049,344 (2015), 46,728,951 (2016), 48,408,557 (2017) and 50,088,164 (2018).

7. In decision 1/CP.16, paragraph 70, the COP encourages 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 the provision of adequate and predictable support. The FRL proposed by Papua New Guinea, on a voluntary basis, for a TA in the context of results-based payments, covers the activities deforestation, forest degradation and forest carbon stock enhancement, which are three of the five activities included in paragraph 70 of that decision. Pursuant to paragraph 71(b) of the same decision, Papua New Guinea has developed a national FRL for its entire national territory. In this submission, Papua New Guinea applies a stepwise approach to its development of the FRL, in accordance with decision 12/CP.17, paragraph 10. The stepwise approach enables Parties to improve the FRL by incorporating better data, improved methodologies and, where appropriate, additional pools.

8. The proposed FRL includes the pools of above-ground and below-ground biomass. The deadwood, litter and soil organic carbon pools were excluded. Regarding greenhouse gases (GHGs), the submission includes CO_2 and excludes non-CO_2 gases.

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

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

1. Information that was used by the Party in the construction of the forest reference level

9. For the construction of the FRL, Papua New Guinea used the methodologies in the 2006 IPCC Guidelines on the six land-use categories. Forest land was stratified by forest type and type of disturbance. Historical annual emissions were estimated using emission factors appropriate to various forest strata, derived from scientific literature and the 2006 IPCC Guidelines, and activity data obtained using the CE methodology. FRL values for the period 2014–2018 were projected using a linear regression model.

10. The scope of the FRL includes deforestation, forest degradation and forest carbon stock enhancement. Papua New Guinea has selected 2001–2013 as the historical reference

[10] Available at www.openforis.org/tools/collect-earth.html.

[11] In decision 1/CP.16, paragraph 70, the COP encouraged developing country Parties to contribute to mitigation actions in the forest sector by undertaking the following activities: reducing emissions from deforestation; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks.

period because the most reliable land-use change data for Papua New Guinea only became available in 2001 following the launch of Landsat 7 in 1999. Deforestation is further classified in the FRL into primary deforestation, defined as the conversion of primary forest to a non-forest land use, and secondary deforestation, defined as the conversion of degraded forest to a non-forest land use. Carbon stock enhancement is defined as the conversion of non-forest land to forest land.

11. The activity data on historical land use and land-use change was obtained from the visual interpretation of satellite images using CE. This assessment aimed to identify deforestation, forest degradation and carbon stock enhancement that occurred during the period 2000–2013. Two CE assessments were carried out for Papua New Guinea, in 2013 and 2016.

12. The CE tool is linked to various applications (i.e. Google Earth, Google Earth Engine and Bing Maps). The CE tool applies point sampling (in grids of 0.04 and 0.02 degrees) with detailed assessment using satellite imagery for classification into the six IPCC land-use categories and various national subcategories. While much of the assessment has been done using Google Earth Engine, with satellite imagery from Landsat 7 and 8, the interpreters also relied on Bing maps and any other available high-resolution imagery. A set of hierarchical rules was established based on the proportions of area occupied by the different land-use categories and their definitions, and these rules were used to determine the land use by plot.

13. The emission factor applied to the deforestation of tropical rainforests is based on the average of above-ground biomass (223 t C/ha) derived from a study by Fox et al. (2010)[12] in Papua New Guinea. The emission factors for deforestation in the remaining six ecological zones (tropical rainforest, tropical moist deciduous forest, tropical dry forest, tropical shrubland, tropical desert and tropical mountain systems) were obtained from the default values in the 2006 IPCC Guidelines. The emission factor applied to forest degradation stemming from all types of disturbance and management practices assumes that the carbon stocks in degraded forests are 65.5 per cent of those in the primary forests. This percentage was estimated based on the measurements in commercially logged-over low-altitude forests conducted by Fox et al. (2010). CO_2 removals after forest disturbance are assumed to be implicitly included in the emission factor for forest degradation. The removal factor for post-deforestation regrowth in forest land converted to cropland and in forest land converted to grassland with perennial woody vegetation is based on a weighted average of default values of mean annual biomass increment for several crop types and grasslands provided in the 2006 IPCC Guidelines (5.71 t dry matter/year/ha).

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

Methodological information, including description of data sets, approaches and methods

14. In relation to decision 12/CP.17, paragraph 8, the AT noted that there is no consistency in the methods, data and assumptions employed by Papua New Guinea between its most recent national GHG inventory (included in its second national communication submitted in 2015) and the submitted FRL. During the TA, Papua New Guinea clarified that the national GHG inventory was not developed using the same data sets as those used for the FRL. Papua New Guinea also informed the AT that it was making efforts to incorporate the improved data sources used for the FRL into the national GHG inventory, national communications and the biennial update report. The forthcoming biennial update report, planned for late 2018, is expected to include a GHG inventory that includes consistent data sources and methodologies. The AT notes this as an important area for future improvement.

15. Papua New Guinea reported information on the methodology used for estimating the FRL, including methodological information, in the main text of the modified submission (chapters 6 and 7), together with references to the FAO online materials and Bey et al.

[12] Fox JC, Yosi CK, Nimiago P, Oavika F and Pokana JN. 2010. Assessment of aboveground carbon in primary and selectively harvested tropical forest in Papua New Guinea. *Biotropica*. 42(4): pp.410–419.

(2016)[13] for additional information on the implementation of the CE tool. During the TA, with the aim of providing sufficient information for the AT to reconstruct the FRL, Papua New Guinea provided additional information on the data and methodology used for the estimation of the FRL, including land-use change and emission factor matrices, together with information on the CE methodology, which greatly enhanced the AT's understanding. The AT notes, however, that Papua New Guinea's modified FRL submission did not provide a clear description of the statistical procedure for the estimation of activity data from the CE sample plots. The AT is of the view that this is an area of improvement and that Papua New Guinea may wish to include this information to increase the transparency of future submissions. The AT also considers that including the detailed information on the data and methodology used for the estimation of the FRL, which was provided by Papua New Guinea during the TA, would enhance the transparency of future FRL submissions.

16. The AT noted that, through the CE tool, interpreters use different types of satellite imagery with varying resolutions, with higher-resolution imagery being more available in the later part of the historical reference period. The AT considered that this could lead to time-series inconsistency over the entire historical time period. Further, the AT noted issues with regard to the identification of forest areas subject to disturbances other than logging, as high-resolution imagery makes it more likely that these types of disturbances are detected. In response to a question from the AT, Papua New Guinea explained that it uses high-resolution satellite imageries from various years (e.g. RapidEye for 2011) as reference information in the CE tool to identify land uses. Based on the identification of land uses with high-resolution satellite imagery, Papua New Guinea determined the current land use and change in the land use over the historical time period using Landsat 7 and 8 image sets, which are available in Google Earth Engine. The AT commends Papua New Guinea for the efforts made in the quality control of CE data and considers that the approach addresses the time-series consistency issues arising from the availability of higher-resolution imagery towards the end of the time series used for estimation of the FRL.

17. As mentioned in the FRL submission (section 7.1.3), Papua New Guinea applied quality assurance/quality control (QA/QC) procedures to ensure the integrity and consistency of measurements made with CE used to derive the activity data for the FRL. During the TA, Papua New Guinea provided the AT with detailed information on the QA/QC procedures. The AT noted that, as part of the QA/QC procedures applied, 16,213 of the 25,729 plots (63.0 per cent) were found to have "errors" (differences between the measured and the actual values), which led to a modification of the land-use category in 15.6 per cent of the reassessed plots. After several rounds of QA/QC, Papua New Guinea corrected 9,345 of the 16,213 plots identified with errors (57.6 per cent). The AT commends Papua New Guinea for its efforts to increase the accuracy of the activity data used in the FRL and notes the assessment and correction of the remaining CE plots as an area of further improvement for Papua New Guinea. The AT further considers that, to further increase transparency, Papua New Guinea may wish to include in the FRL submission a summary of the information on QA/QC presented to the AT during the TA.

18. Papua New Guinea estimated emission factors for deforestation by deducting the removals from post-deforestation biomass regrowth in cropland and grasslands calculated using a weighted average of the mean annual increments of above-ground biomass and a root–shoot ratio of 0.37 for coconut, palm oil, shifting cultivation and permanent subsistence agriculture (section 6.4 of the modified FRL submission). In the modified submission, Papua New Guinea explained that this approach is an approximation and may be refined in future submissions. During the TA, Papua New Guinea explained that it implicitly assumes that past observations provide a good basis for predicting expected emissions over a five-year time horizon. The AT commends Papua New Guinea for including post-deforestation regrowth in its methodology for estimating emissions and removals from deforestation. However, the AT considers that, to further increase accuracy, Papua New Guinea may wish to use crop-specific post-deforestation biomass growth rates for non-forest land uses, as presented in table 6.3 of the modified FRL submission, and

[13] Bey A, Diaz AS, Maniatis D, Marchi G, Mollicone D, Ricci S, Bastin J, Moore R, Federici S, Rezende M, Patricia C, Turia R, Gamoga G, Abe H, Kaidong E, and Miceli G. 2016. Collect Earth: Land use and land cover assessment through augmented visual interpretation. *Remote Sensing*. 8: pp.807–830.

notes this as an area of future technical improvement.

19. Papua New Guinea derived the emission factors for forest degradation from the above-mentioned scientific study by Fox et al. (2010). In this study, the carbon stocks in selectively harvested forests were estimated based on random sampling of plots in selectively harvested forests that had been subject to harvesting within the last four years. As confirmed by Papua New Guinea during the TA, it was assumed that forest regrowth following forest degradation is implicitly included in the emission factors used for estimating emissions from forest degradation. The AT, however, noted that in tropical regions biomass may quickly accumulate, thus making it very difficult to determine to what extent the emission factors include forest regrowth because plots may have been established a few months or up to four years after logging. In response to a request for clarification, Papua New Guinea acknowledged that this approach may have significant uncertainty and may result in the underestimation of CO_2 removals in the historical reference period. During the TA, Papua New Guinea explained that this approach is based on the most comprehensive and reliable data set currently available in the country to estimate GHG emissions from logging activities. The AT notes the accurate determination of the extent of forest regrowth included in the emission factor for degradation as an area of future technical improvement and commends Papua New Guinea for the ongoing field work, as part of a national forest inventory, to update these emission factors within two to three years, in further improving the accuracy of future FRL submissions.

20. Based on data by Fox et al. (2010) for commercial logging, Papua New Guinea estimated the emission factors for forest degradation by assuming that all disturbance types (i.e. logging, fire, grazing, gardening, 'wokabaut' or portable sawmill, others) cause the loss of 34.5 per cent of total biomass carbon stocks of primary forests (this assumption is different only for mangroves). The AT noted that this assumes that all types of disturbance affect forest carbon stocks in the same way as commercial logging. The AT noted that this assumption may reduce the accuracy of the estimation of the emissions from forest degradation. Given that disturbances other than logging affect 12.8 per cent of the total forest area in Papua New Guinea, the AT considers that accurate determination of the losses of biomass carbon stocks resulting from different types of disturbances including through further research would enhance the accuracy of the FRL and notes this as an area of future improvement. The AT further notes in this regard that, as communicated by Papua New Guinea during the TA, the ongoing national forest inventory covers different disturbance types and as such could potentially provide the data needed to implement this approach.

21. For the estimation of emissions and removals from forest degradation, Papua New Guinea assumes that forest degradation occurs only once (i.e. when it is first observed through CE) and that there are no subsequent degradation events in forest areas already subject to degradation. The AT noted that this assumption potentially underestimates the total emissions from forest degradation by excluding emissions from subsequent forest degradation in such areas. During the TA, Papua New Guinea explained that there are minimal emissions from disturbances other than logging in the reporting period and that the emission factor for forest degradation will be improved based on the results of the national forest inventory. Given that disturbances other than logging affect 12.8 per cent of the total forest area in Papua New Guinea, the AT considers that the tracking of lands subject to degradation and the inclusion of emissions from degradation events subsequent to the first occurrence of degradation in the estimation of emissions from the degradation activity would further increase the accuracy of the FRL and notes this as an area of future improvement. The AT commends Papua New Guinea for its efforts in improving the emission factor for degradation based on the results of the ongoing national forest inventory.

22. Papua New Guinea identified gardening as a management practice leading to forest degradation in 8.2 per cent of the forests in Papua New Guinea. During the TA, Papua New Guinea confirmed that forests subject to gardening include small degraded patches of forest isolated from villages and croplands with less possibility of natural disturbance (e.g. gentle slope). Papua New Guinea explained that these areas could also be abandoned agricultural lands or temporary gardens (e.g. those stemming from road construction) and it was impossible to accurately identify the land use through remote sensing assessment. Papua New Guinea further clarified that it did not report emissions from further degradation of degraded forest owing to technical limitations and that all the disturbance that was reported

during the reference period occurred in primary forests. The AT noted that this implied that all forests subject to gardening were assumed to be primary forests. The AT, however, noted that these regrown forest patches are not likely to contain biomass carbon stocks comparable to primary forests and thus this assumption may overestimate emissions from forest degradation. The AT, therefore, considers that Papua New Guinea may wish to estimate and use the actual values of biomass carbon stocks in forests subject to gardening before the disturbance rather than those for primary forests and considers this to be an area of future technical improvement. In this regard, the AT notes the current efforts by Papua New Guinea to implement its national forest inventory.

23. To obtain the FRL values for 2014–2018, Papua New Guinea employed a linear regression model that extrapolates the increasing trend in emissions observed during the period 2001–2013. The AT noted that, although this model is simple and transparent, it is based on 13 observations only (annual estimates of emissions in the period 2001–2013) and thus may have significant statistical errors, leading to low accuracy. The AT noted that other regression models may be constructed with the same data that could yield different results. The AT noted that, in its submission, Papua New Guinea presented information on national circumstances and drivers of deforestation and forest degradation that largely supported the expectation of increasing emissions in the period 2014–2018. The AT considers that Papua New Guinea may wish to use this information to support the selection of the model, with a view to demonstrating its accuracy and consistency with the national circumstances presented as an area of improvement.

24. During the TA, the AT sought clarification on specific data sets referred to in Papua New Guinea's FRL submission (e.g. those on the areas under special agricultural and business leases, forest plantations and viable concessions, as identified by the Papua New Guinea Forest Authority). The AT considered that this information is particularly useful to understand the accuracy of Papua New Guinea's FRL. However, this information was not provided in a timely manner to the AT during the TA. The AT notes that Papua New Guinea may wish to include this information in future FRL submissions to increase transparency.

Description of relevant policies and plans, as appropriate

25. In its FRL submission, Papua New Guinea provided a detailed description of relevant policies and plans. Section 8 of the modified submission includes information on national circumstances, including the national economic and policy context, drivers of forest cover at the national level (e.g. commercial and small-scale logging, forest fires, fuelwood collection, mining, reforestation and conservation), future trends in land use and how policies might affect these trends. The AT commends Papua New Guinea for providing such a detailed description of relevant policies and plans covering the historical reference period.

26. Papua New Guinea defined 2001–2013 as the historical reference period used to estimate the FRL, considering it to be the most appropriate for predicting future emissions under a 'business as usual' scenario because it is very unlikely that there was REDD-plus intervention before the year 2013. During the TA, Papua New Guinea explained that it has been building national and regional capacities to implement REDD-plus activities since 2009 and that the Climate Change and Development Authority has been assessing the drivers of deforestation with the aim of developing a national REDD-plus strategy that will include specific policies and measures. In May 2015, the Government of Papua New Guinea passed the Climate Change (Management) Act to implement a law that will minimize the effects of climate change owing to infrastructure development. This instrument will act as a legal tool to monitor and evaluate the effectiveness of implementing all related domestic policies and legislation among relevant agencies or stakeholders.

27. Papua New Guinea explained that its FRL submission is in line with its nationally determined contribution. Papua New Guinea's nationally determined contribution refers to the National Climate Action Plan, in which targets for emission reductions in the land use and forest sector have not been identified but mitigation actions derived from its national policies, Vision 2050 and the Medium-Term Development Strategy 2030 are set out.

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

28. According to decision 12/CP.17, annex, subparagraph (c), reasons for omitting a

pool and/or activity from the construction of the FRL should be provided, noting that significant pools and/or activities should not be excluded.

29. Papua New Guinea included above-ground biomass and below-ground biomass carbon pools and excluded deadwood, litter and soil organic carbon pools from the FRL.

30. The AT noted that emissions from deadwood may be significant, because 85 per cent of the population in Papua New Guinea utilizes fuel wood with very high consumption levels (1.8 m^3 per person per annum, nearly six times that of other Asia-Pacific countries, as noted in the modified submission). According to data reported by Papua New Guinea, consumption is expected to increase in the future. The AT also noted that, according to the data set used by Papua New Guinea to estimate emission factors (Fox et al., 2010), deadwood in Papua New Guinea may account for 10–25 per cent of total carbon stocks in primary forests and logged forests, respectively, based on field observation (not measurements). The AT noted that Papua New Guinea did not provide a justification for the exclusion of the deadwood pool in the FRL submission based on its insignificance. However, during the review, Papua New Guinea explained (in the modified FRL submission) that deadwood was excluded owing to a lack of reliable data or default values in the 2006 IPCC Guidelines, and mentioned that country-specific data on deadwood will be available within one to two years from the ongoing national forest inventory. Given the potential significance of deadwood as observed by Fox et al. (2010), the AT considers that including emissions from deadwood is an area of improvement, as it may increase the accuracy of the FRL. The AT commends Papua New Guinea for the ongoing work on collecting data on deadwood pools as part of its national forest inventory, which should enable it to include deadwood in future FRL submissions.

31. Papua New Guinea did not include litter in the FRL owing to a lack of reliable data. The AT noted that Fox et al. (2010) did include litter based on field observations (not measurements). In its modified FRL submission, Papua New Guinea provided the explanation that, based on the default value for litter in broadleaf deciduous forest in the tropical region provided in the 2006 IPCC Guidelines in (2.1 t C/ha), litter constitutes only 1.5 per cent of the average carbon stocks in total living biomass in primary forests in Papua New Guinea, and is therefore not a significant carbon pool. The AT notes the justification provided by Papua New Guinea and commends it for its ongoing work on collecting country-specific data on litter as part of the national forest inventory, which should enable it to include litter in future FRL submissions.

32. Regarding soil organic carbon, Papua New Guinea confirmed that potentially significant emissions may occur from the loss of carbon in soils owing to deforestation (e.g. 20–40 per cent of total carbon stocks during the conversion of forest land to cropland). In its modified FRL submission, Papua New Guinea explained that, even though the 2006 IPCC Guidelines provide methods for estimating CO_2 emissions from soil organic carbon, it is currently not possible to estimate emissions from the soil carbon pool using the default values provided in the 2006 IPCC Guidelines because the forest soils in Papua New Guinea have not been classified into the soil types provided in the 2006 IPCC Guidelines. The AT considers that the inclusion of soil carbon pool is an important area of improvement and notes that the 2006 IPCC Guidelines also provide higher-tier methods for estimating changes in soil organic carbon that can be used with country-specific emission factors. In this context, the AT commends Papua New Guinea for the efforts made to rapidly collect country-specific data on soils through the national forest inventory, which should enable it to include soil carbon in future FRL submissions.

33. Papua New Guinea included CO_2 emissions in the FRL, but excluded from it the non-CO_2 emissions from biomass burning. The AT noted that Papua New Guinea reported that 3.1 per cent of all its forests are affected by fires (figure 7.3 of the modified FRL submission) and provided information on fire hotspots and location of fires for the period 2002–2014. Papua New Guinea also referred to "large spikes" in levels of burning during El Niño years. Further, in the modified submission, Papua New Guinea predicted that fires are likely to increase owing to the trends in population and shifting agriculture. As part of the stepwise approach the AT considers that Papua New Guinea may wish to monitor and potentially include the non-CO_2 emissions from biomass burning in future FRL submissions, if considered significant. The AT further notes in this context that non-CO_2 emissions were included in Papua New Guinea's second national communication (the most recent submission), which amounted to nearly 2 per cent of the total land use, land-use

change and forestry emissions in 2002.

34. The AT acknowledges that Papua New Guinea included the most significant activities in terms of emissions (reducing emissions from deforestation, reducing emissions from degradation and forest carbon stock enhancement) of the five activities identified in decision 1/CP.16, paragraph 70, in accordance with national capabilities and circumstances. However, the AT notes that, based on a comparison of net removals in forest land in Papua New Guinea's national GHG inventory in its second national communication, as part of the stepwise approach, the country may wish to broaden the scope of the FRL by also assessing the significance of any other activities and considering their inclusion, especially the conservation of forest carbon stocks and sustainable management of forests that were excluded owing to lack of data to currently enable estimation (section 3 of the modified FRL submission).

4. Definition of forest

35. Papua New Guinea provided a definition of forest used in the construction of the FRL: land spanning more than 1 ha, with trees higher than 3 m, a canopy cover of more than 10 per cent and excluding predominantly agricultural or urban land. In its FRL submission, Papua New Guinea explained that, although there are differences with the forest definition used for reporting to FAO, these do not affect the actual data obtained through the assessment conducted using remote sensing technologies. The AT, however, noted that the difference in the minimum area considered as forest (0.5 or 1 ha) may have an important bearing on the total forest area. For example, the minimum area is often used to establish a criterion for visual interpretation of satellite images to classify into different land uses.

36. During the TA, Papua New Guinea explained that although its national forest definition was established in 2014 for application to all the national reports on forest and land use, the *Global Forest Resources Assessment 2015*[14] report for Papua New Guinea was produced by FAO prior to the endorsement of the national forest definition. Importantly, significant areas of fallow land with tree cover were classified as forest in the above-mentioned report but classified as cropland in the FRL submission. Thus, the national forest cover in Papua New Guinea's FRL submission (76.2 per cent) is smaller than that reported in the *Global Forest Resources Assessment 2015* report (83.8 per cent). In addition, although the report was prepared using the wall-to-wall mapping method, the FRL submission was prepared using the point sampling method. The AT noted that in accordance with the reference material on CE methodology (Bey et al., 2016), the plot size used for the analysis is consistent with the minimum mapping area required to apply Papua New Guinea's national forest definition. The AT considers that the inclusion of the information clarifying the difference between the forest definitions used for reporting to FAO and for the FRL would increase the transparency of future FRL submissions.

37. Papua New Guinea classified savannah and scrub as forest, describing these as forest types composed of vegetation up to 6 m in height. In response to a question from the AT on how Papua New Guinea ensured that these forest types met the tree height threshold used for the forest definition (3 m), Papua New Guinea provided the explanation that the threshold of tree height was chosen to include savannah and scrub in forest to provide appropriate management to these vegetation types. Land with trees shorter than 3 m is classified as non-forest (e.g. grassland and wetland). Since visual interpretation of tree height through remote sensing/geographical information systems is not accurate, several provincial foresters apply their extensive local knowledge on land use in their own provinces to make a reasonably accurate determination of the land use by conducting an assessment that also uses CE. The AT, however, noted that such visual identification of forest areas based on local knowledge may not be optimal because some areas that do not meet the definition of forests may be classified as forest land. Papua New Guinea indicated that this issue will be further examined when 1,000 CE plots are visited during the implementation of the national forest inventory. The AT commends Papua New Guinea for this planned initiative and notes that a more robust methodology to identify savannah and scrub areas meeting the definition of forest would contribute to further enhancing

[14] Available at http://www.fao.org/3/a-i4808e.pdf.

confidence in future FRL submissions.

III. Conclusions

38. The information used by Papua New Guinea in constructing its FRL is mostly transparent and complete and is in overall accordance with the guidelines for submission of information on FRLs (as contained in the annex to decision 12/CP.17).

39. The AT acknowledges that Papua New Guinea included in the FRL the most significant activities and the most significant pools in terms of emissions from forests. However, based on a comparison with the data presented in Papua New Guinea's national GHG inventory in its second national communication, the AT notes that Papua New Guinea may wish to include the other significant pools excluded (deadwood and soil carbon) as well as to broaden the scope of the FRL by assessing the significance of and including other potentially significant activities that may have been excluded. By including deforestation, forest degradation and the enhancement of forest carbon stocks, the AT considers that Papua New Guinea followed decision 1/CP.16, paragraph 70, on activities undertaken, paragraph 71(b), on the elaboration of a national FRL, and decision 12/CP.17, paragraph 10, on implementing a stepwise approach. The AT commends Papua New Guinea for the information provided on the ongoing work towards the inclusion of the other activities, carbon pools and gases in the development of the FRL.

40. As a result of the facilitative interactions with the AT during the TA, Papua New Guinea submitted a modified submission that took into consideration the technical inputs of the AT. The AT notes that the transparency and completeness of information improved significantly in the modified FRL submission, which resulted in the alteration of the approach and values used to construct the FRL, and commends Papua New Guinea for the efforts made. The new information provided in the modified submission, together with the additional material provided by the Party (e.g. calculation spreadsheets and matrices), increased the reproducibility of the FRL calculations. The AT, however, notes that some information needed to fully reconstruct the FRL was not included in the submission, such as on the sample set collected through CE and on the statistical methods used to derive the activity data from this sample set, including the areas of primary and secondary deforestation.

41. The AT notes Papua New Guinea's plans to achieve full coherence in data and methods in the national GHG inventory to be included in the forthcoming biennial update report submission planned for late 2018 with the FRL. Currently, the FRL does not maintain consistency with the GHG inventory included in Papua New Guinea's second national communication from 2015.[15]

42. The AT notes that emissions from forest degradation account for 74–95 per cent of the annual emission estimates used to construct the FRL. While noting the considerable uncertainty around the emission factors for forest degradation and lack of transparency on some of the methods employed (see paras. 19–22), the AT considers that these represent the best data available and that Papua New Guinea plans to revise them following the ongoing work on its national forest inventory.

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

(a) Improvement in the consistency of the FRL with the national GHG inventory, including the selection of methods, data and assumptions following the guidance provided in the relevant set of the IPCC guidelines (para. 14);

(b) Inclusion of a detailed, step-by-step description of the FRL estimation procedure, including how activity data on land use and land-use change are derived from CE (e.g. information on the statistical methods to derive activity data from the CE assessments) to enable the reconstruction of the FRL (para. 15);

(c) Correction of the errors in the remaining CE plots found with errors (6,868) according to the results presented by Papua New Guinea during the TA and inclusion of a

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

summary of the QA/QC procedures applied that were presented during the TA (para. 17);

(d) Use of crop-specific post-deforestation biomass growth rates for non-forest land uses, as presented by Papua New Guinea in the modified submission to estimate the emission factor for deforestation (para. 18);

(e) Improvement of emission factors for forest degradation including through full implementation of the national forest inventory by:

(i) Accurate determination of the extent of forest regrowth included in the above-ground biomass carbon stocks in selectively logged forest (para. 19);

(ii) Accurate determination of the losses in biomass carbon stocks in forest areas subject to disturbances other than logging (para. 20);

(iii) Tracking of forest land subject to degradation and the inclusion of emissions and removals from forest degradation events subsequent to the first occurrence of degradation (para. 21);

(iv) Use of the actual values of pre-disturbance forest biomass carbon stocks rather than those for primary forests in the estimation of emissions factors for gardening (para. 22);

(f) Use of the information on national circumstances and the drivers of deforestation and forest degradation presented to support the selection of the model used to construct the FRL, with a view to demonstrating its consistency with the national circumstances presented (para. 23);

(g) Inclusion of the information clarifying the difference between the forest definition used for reporting to FAO and that used for the construction of the FRL (para. 36);

(h) Exploring a more robust methodology to identify savannah and scrub areas meeting the definition of forest (para. 37).

44. In assessing the pools and the gases included in the FRL, pursuant to decision 13/CP.19, annex, paragraph 2(f), the AT identified the following additional areas for future technical improvement:

(a) Treatment of emissions from deadwood (i.e. the inclusion of this pool or the provision of more information on the justification for its exclusion) (para. 30);

(b) Inclusion of emissions from soil organic carbon (para. 32);

(c) Monitoring of non-CO_2 gases from biomass burning and their potential inclusion, if considered significant (para. 33);

(d) Broadening of the scope of the FRL by assessment of the significance and inclusion of any other potentially significant activities excluded owing to lack of data, in line with the national GHG inventory (para. 34).

45. The AT acknowledges and welcomes the intention expressed by Papua New Guinea to:

(a) Complete a national forest inventory to inform the development of more accurate emission factors for all REDD-plus activities;

(b) Consider non-CO_2 gases from biomass burning;

(c) Include additional carbon pools: deadwood, litter and soil organic carbon;

(d) Improve the understanding of the drivers of forest degradation;

(e) Estimate emissions and removals at the local level for use by local governments;

(f) Include the conservation of forest carbon stocks and the sustainable management of forests (REDD-plus) activities in the FRL;

(g) Improve the methods for the estimation of emissions and removals from the enhancement of forest carbon stocks.

46. In conclusion, the AT commends Papua New Guinea for showing a strong commitment to the continuous improvement of its FRL estimates in line with the stepwise

approach. A number of areas for future technical improvements of Papua New Guinea's FRL have been identified in this report. The AT acknowledges that these improvements are subject to national capabilities and policies, and notes the importance of adequate and predictable support.[16] The AT also acknowledges that the assessment process was an opportunity for a rich, open, facilitative and constructive technical exchange of information with Papua New Guinea.

47. The table contained in the annex summarizes the main characteristics of Papua New Guinea's proposed FRL.

[16] Decision 13/CP.19, annex, paragraph 1(b), and decision 12/CP.17, paragraph 10.

Annex

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

Main feature of the FRL		*Remarks*
Proposed FRL (in t CO_2 eq/year)	43 369 737 for 2014 45 049 344 for 2015 46 728 951 for 2016 48 408 557 for 2017 50 088 164 for 2018	This projection was based on the linear regression model: annual emission (t CO_2 eq) = 1 679 607 x year – 3 339 358 085
Type and duration of FRL	FRL = historical emissions 2001–2013	
Adjustment for national circumstances	No	
National/subnational[a]	National	
Activities included[b]	Deforestation Forest degradation Enhancement of forest carbon stocks	The emissions and removals from enhancement of forest carbon stock are reported as zero during the historical reference period
Pools included[b]	Above-ground and below-ground biomass	Papua New Guinea did not include deadwood, litter or soil organic carbon owing to lack of reliable data (see paras. 30–32 of this document). The Party provided a justification for the insignificance of litter
Gases included	CO_2	
Forest definition[c]	Included	Minimum area: 1.00 ha; minimum forest canopy cover: 10%; minimum height of trees: 3.00 m (see para. 35 of this document). Only areas with predominant forest land use are considered forests. The forest definition used in the FRL differs from the one used in the national GHG inventory and for reporting to Food and Agriculture Organization of the United Nations
Relationship with latest GHG inventory	The methods used for the FRL are not consistent with the latest GHG inventory	Papua New Guinea confirmed that it will work to achieve consistency with the national GHG inventory in the future
Description of relevant policies and plans[d]	Included	
Description of assumptions on future changes in policies[d]	Included	Summary of information included for information purposes (see paras. 25–27 of this document)
Descriptions of changes to previous FRL	Not applicable	This is Papua New Guinea's first FRL submission
Future improvements identified	Yes	Several areas for future technical improvements were identified (see paras. 44 and 45 of this document)

Abbreviations: FRL = forest reference level, GHG = greenhouse gas.

[a] If subnational, comments should include information on the treatment of displacement of emissions.

[b] In the case of omitted pools or activities, comments should include the justification provided by the country.

[c] The forest definition should be summarized, and it should be stated if it differs from the definition used in the GHG inventory or in reporting to other international organizations.

[d] May be relevant to the description of national circumstances, which is required in the case of adjustment.