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Report of the technical assessment of the proposed forest reference emission level of Madagascar submitted in 2017

Summary

This report covers the technical assessment of the submission of Madagascar, on a voluntary basis, on its proposed forest reference emission level (FREL), in accordance with decision 13/CP.19 and in the context of results-based payments. The FREL proposed by Madagascar covers the activity "reducing emissions from deforestation", which is among the activities included in decision 1/CP.16, paragraph 70. In its submission, Madagascar has developed a national FREL. The FREL presented by Madagascar for the reference period 2005–2013 corresponds to 20,474,434 tonnes of carbon dioxide equivalent per year. The assessment team notes that the data and information used by Madagascar in constructing its FREL are overall transparent and complete, and are in overall accordance with the guidelines contained in the annex to decision 12/CP.17. This report contains the assessed FREL and a few areas identified by the assessment team for further technical improvement, according to the scope of the technical assessment in the annex to decision 13/CP.19.

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I. Introduction and summary

A. Overview

1. This report covers the technical assessment (TA) of the submission of Madagascar on its proposed forest reference emission level (FREL),[1] submitted on 16 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. Markus Didion (Switzerland) and Mr. Kamal Djemouai (Algeria). In addition, Mr. Khanyisa 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.

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, Madagascar submitted, on a voluntary basis, its proposed FREL. Madagascar provided its original submission in two languages: French and English (a translation of the official French version). The proposed FREL is one of the elements[5] to be developed in the implementation of the activities referred to in decision 1/CP.16, paragraph 70. The COP decided that each submission of a proposed FREL, and/or forest reference level (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 decision 14/CP.19, paragraphs 7 and 8.

3. The objective of the TA was to assess the degree to which information provided by Madagascar 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 FREL, with a view to supporting the capacity of Madagascar for the construction and future improvement of its FRELs/FRLs, as appropriate.[7]

4. The TA of the FREL submitted by Madagascar 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 in the same decision.

5. Following the process contained in the guidelines and procedures in the annex to decision 13/CP.19, a draft version of this report was communicated to the Government of Madagascar. The facilitative exchange during the TA allowed Madagascar to provide clarifications and information that were considered by the AT in the preparation of this report.[8] As a result of the facilitative interactions with the AT during the TA, Madagascar submitted a modified version of its FREL on 8 July 2017 (in French only), which took into consideration the technical inputs of the AT. The modifications improved the clarity and transparency of the submitted FREL and did not require an alteration of the approach used to construct the proposed FREL. This TA report was prepared in the context of the modified FREL submission. The modified submission, which contains the assessed FREL, and the original submission are available on the UNFCCC website.[9]

[1] The submission of Madagascar is available at http://redd.unfccc.int/submissions.html?country=mdg.
[2] Decision 13/CP.19, annex, paragraph 7.
[3] Decision 13/CP.19, annex, paragraphs 7 and 9.
[4] Decision 13/CP.19, annex, 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] http://redd.unfccc.int/submissions.html?country=mdg.

B. Proposed forest reference emission level

6. 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 FREL proposed by Madagascar, on a voluntary basis, for a TA in the context of results-based payments, covers the activity "reducing emissions from deforestation", which is one of the five activities included in decision 1/CP.16, paragraph 70. Pursuant to paragraph 71(b) of the same decision, Madagascar has developed a national FREL for the entire national territory and its four main phytogeographic ecoregions (i.e. eastern humid forests, western dry forests, southern spiny forests and mangroves). In its submission, Madagascar applies a stepwise approach to its development of the FREL, in accordance with decision 12/CP.17, paragraph 10. The stepwise approach enables Parties to improve the FREL by incorporating better data, improved methodologies and, where appropriate, additional pools and gases.

7. Madagascar's national FREL covers the historical reference period 2005–2013. The FREL is based on the annual average of the carbon dioxide (CO_2) emissions associated with deforestation, defined as human-induced conversion of natural forests to other land-use categories, including temporary conversion as a result of the practice of slash and burn agriculture (*tavy*). The FREL includes only the gross emissions from deforestation and excludes any subsequent emissions and removals from the deforested areas. The FREL presented in the modified submission corresponds to 20,474,434 tonnes of carbon dioxide equivalent per year (t CO_2 eq/year).

8. The information on activity data used in constructing the FREL was extracted from a historical time series of satellite imagery for the years 2005, 2010 and 2013. The information on emission factors was obtained from Madagascar's ecological national forest inventory (IEFN) undertaken in 1994,[10] from an inventory of the eastern humid forests in 2014 (under the Humid Forest Eco-Regional REDD+ Project (PERR-FH),[11] 2013–2015) and from a study on mangroves in 2014.[12]

9. In its original submission, Madagascar proposed a national FREL of 20,662,448 t CO_2 eq/year for the period 2005–2013, which included only CO_2 emissions from deforestation. In this submission, Madagascar explained that the practice of slash and burn agriculture is very likely a significant source of methane (CH_4) and possibly also nitrous oxide (N_2O) emissions. Madagascar further explained that there is a lack of data on the fraction of deforestation that is caused by burning and the fraction of biomass that is fully or partially burned (the combustion factor). Owing to this lack of data, Madagascar decided to be conservative in its estimates and did not include these emissions from fires. Following technical inputs from the AT on this issue, Madagascar included CH_4 and N_2O emissions in its modified submission.

10. The modified FREL of 20,474,434 ± 3,366,669 t CO_2 eq/year varies slightly from the originally proposed FREL of 20,662,448 ± 3,525,647 t CO_2 eq/year. The difference is largely attributable to:

[10] The Inventaire Ecologique Forestier National (IEFN) is the only ecological forest inventory to cover all inland ecosystems in Madagascar. Its main objective was to fill the gaps in information on the current state and the evolution of forestry resources in Madagascar, which is crucial information for sustainable and strategic management of natural forest resources at the national and regional levels. Therefore, this inventory aimed to identify the location and geographical distribution of the different forest formations. The inventory was completed in 1996.

[11] This project (in French, Projet Eco-Régional REDD+ des Forêts Humides (PERR-FH)) was implemented as part of Madagascar's REDD-plus readiness activities, undertaken by a consortium comprising the Wildlife Conservation Society, the National Office for the Environment and ETC Terra, and funded by the International Development Association and the Global Environment Facility.

[12] Jones TG, Ratsimba HR, Ravaoarinorotsihoarana L, Cripps G and Bey A. 2014. Ecological variability and carbon stock estimates of mangrove ecosystems in northwestern Madagascar. *Forests.* 5(1): pp.177–205.

(a) Application of a more accurate country-specific allometric equation to estimate above-ground forest biomass, resulting in lower emission factors for humid (approximately 2 per cent lower), dry (approximately 12 per cent lower) and spiny (approximately 7 per cent lower) forests;

(b) Revision of the emission factor for mangroves, resulting in its decrease by 20 per cent (however, as the deforested area of mangroves is relatively low, this revision produced a negligible change in the total value of the FREL);

(c) Inclusion of CH_4 and N_2O emissions from slash and burn practices.

11. The proposed FREL includes the pools above-ground and below-ground biomass of living trees and standing dead trees. Regarding greenhouse gases (GHGs), the submission includes CO_2, CH_4 and N_2O.

12. Madagascar identified limitations in its current methodology, including the lack of data, and presented policies and plans to address these current limitations that would facilitate the further development of the country's FREL.

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

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

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

13. For the construction of the FREL, Madagascar used the methodologies in the Intergovernmental Panel on Climate Change (IPCC) *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines). The FREL presents a historical average estimated for the reference period 2005–2013. The FREL considers emissions of CO_2, CH_4, and N_2O from deforestation and includes mainly emissions from slash and burn practices. The emission estimates include above-ground and below-ground biomass of living trees and standing dead trees. Madagascar considered only natural forests and did not include secondary forests or plantations in the identification of deforestation.

14. Madagascar defined deforestation as a direct anthropogenic conversion, temporary or permanent, of a continuous area of at least 0.36 ha from forest land to non-forest land. The areal extent of deforestation during the reference period 2005–2013 was derived from Landsat data based on land-use changes between 2005–2010 and 2010–2013.

15. Activity data were obtained using Landsat satellite imagery of 30 × 30 m resolution. Imagery was obtained for 2005, 2010 and 2013. In total, 35 scenes covering the full extent of Madagascar's territory were obtained. Because imagery for all scenes was not available for the same dates, there is some variation in the length of the reference period for the 35 scenes. For all 35 scenes, the mean length of the reference period was 8.31 years, with a minimum period of 5.94 years (i.e. imagery available for 2007, 2011 and 2013) and a maximum period of 9.82 years (i.e. imagery available for 2005, 2009 and 2014).

16. The satellite data were processed to identify forest land defined as a minimum area of 1 ha. Only natural forests were considered, and they were stratified into humid forests, dry forests, spiny forests[13] and mangroves. Based on the change maps between two points in time, deforestation of forest land was identified as a cluster of 0.36 ha or larger. To verify and to ensure the accuracy of the classification of forest land in the Landsat scenes, fine resolution data from Google Earth and SPOT-5 were used. Landsat images were processed in several steps, as follows: (1) geometric and atmospheric correction; (2) minimization of errors due to cloud cover; (3) application of a supervised classification

[13] In French: *Forêt Epineuse de Madagascar*.

approach to calibrate the classification algorithm in order to define four land cover classes (natural forest, cropland/grassland, wetlands, settlements/other land); and (4) post-processing to identify areas of natural forests of 1 ha minimum size and deforested areas of 0.36 ha minimum size.

17. Emission factors for the four forest types were estimated based on data from various sources: the IEFN (for dry and spiny forests), the inventory under PERR-FH (for humid forests), and a study on mangroves (see para. 8 above). Madagascar is in the process of conducting a national forest inventory as part of its stepwise approach for further developing its FREL.

18. For each of the four forest types, separate emission factors were estimated. Estimates were based on the difference between: (1) biomass in an intact forest, as the sum of above-ground and below-ground biomass of living trees and standing dead trees; and (2) biomass of the land cover after deforestation. With the exception of mangroves, the biomass estimates for intact forests were derived from single inventories (i.e. the IEFN and PERR-FH) for each forest type (see para. 17 above).

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

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

19. The gross area deforested over the period 2005–2013 was estimated based on satellite data of land cover change from forest to non-forest land from two successive periods, that is, land cover changes between 2005–2010 and between 2010–2013. The total deforested area was 852,203 ha, or 102,551 ha annually. The annual deforestation rate was approximately 1.1 per cent, and there was large variability across the four forest types (see table 12 of the submission). The AT notes that this area of deforestation is considerably greater than that presented in Madagascar's report to the 2015 Global Forest Resources Assessment (FRA) of the Food and Agriculture Organization of the United Nations (FAO).[14] However, the values are not in fact comparable owing to different forest definitions being used (see para. 33 below). Furthermore, over the last two decades there has been a decreasing trend in deforestation rates, as also observed in the data from a study by Grinand et al. (2013), who used a comparable methodology.[15]

20. Madagascar used historical data that date back to 2005. The AT notes that satellite data from the same source and of the same quality as those used by the Party in its FREL submission are available for before 2005 (e.g. Grinand et al., 2013). The use of a longer time series for constructing the FREL may be appropriate because the inventory data used by Madagascar to estimate emission factors date back to 1996.

21. Annual deforestation was estimated as the change in the area of forest land to non-forest land over the mean length of the reference period for all 35 scenes (8.31 years; see para. 15 above). During the exchange with the Party, the AT identified this method of estimation as a potential issue related to accuracy. The AT considers it would be more accurate to calculate the annual change individually for each scene based on the actual length of the period between two images.

22. Forest and non-forest biomass estimates were used to establish emission factors for each of the four forest types. Basic inventory data for humid forests were obtained from PERR-FH, for dry and spiny forests from IEFN and for mangroves from Jones et al. (2014).[16] In humid, dry and spiny forests, above-ground biomass was estimated based on allometry of tree diameter at breast height (DBH), height and conversion of volume based on a wood density of 0.5, which is in the lower range for tropical tree species. A country-

[14] Available at http://www.fao.org/documents/card/en/c/ae13755a-3c4a-4353-b3b9-8b48f81b2214/.

[15] Grinand C, Rakotomalala F, Gond V, Vaudry R, Bernoux M and Vieilledent G. 2013. Estimating deforestation in tropical humid and dry forests in Madagascar from 2000 to 2010 using multi-date Landsat satellite images and the random forests classifier. *Remote Sensing of Environment.* 139: pp.68–80.

[16] As footnote 12 above.

specific allometric equation[17] was used that was consistent with the 2006 IPCC Guidelines and, where appropriate, there was a preference for IPCC higher-tier methods. Below-ground biomass was estimated based on values of root-to-shoot ratios in the literature.[18] Separate ratios were applied for low- and high-biomass stands. The biomass of intact natural mangrove forests was based on a published study that included several case study plots in mangrove forests in northwestern Madagascar (Jones et al., 2014).[19] Madagascar applied the IPCC default biomass carbon fraction for tropical and subtropical trees of 0.47 to convert woody biomass to carbon stocks.

23. The carbon stocks of the land cover after deforestation were based on Andriamananjara et al. (2016)[20] for humid forests and Raharimalala et al. (2012)[21] for dry and spiny forests. In mangrove forests, the post-deforestation carbon stock was based on the same study as that from which the forest biomass was obtained (Jones et al., 2014).[22] The AT notes that the planned inventories (see table 58 in the modified submission, which is a summary of the actions planned for addressing methodological issues and improving data and information for future submissions of the FREL, including new forest inventories for dry and spiny forests and mangroves) will improve the accuracy of the current estimates.

24. Estimates of non-CO_2 emissions were included in the modified submission. The AT commends Madagascar for its effort to make the submission more comprehensive. The AT notes that the accuracy of the emission estimates could be improved in future submissions by providing a more accurate estimation of the area affected by slash and burn practices and an evaluation of the suitability of using the IPCC default emission factors for Madagascar's forests. The AT acknowledges the Party's plans to address these issues in its efforts to improve the FREL (see para. 23 above).

25. Madagascar thoroughly assessed the uncertainty associated with its FREL estimate following the 2006 IPCC Guidelines. The uncertainty associated with the use of different inventories for establishing emission factors in the four forest types was not included in the uncertainty assessment. The AT acknowledges that it is difficult to assess this uncertainty, and notes that, given the planned national forest inventory, this source of error is expected to be minimized in future submissions. The AT considers, however, that the uncertainty assessment can be presented more transparently, for example by showing how the errors in the biomass estimates and the resulting emission factors were obtained.

26. The AT acknowledges the effort made by Madagascar to provide transparent, complete, consistent and accurate information. In its modified submission, Madagascar addressed several of the most important findings of the AT during the TA. The modifications resulted in a generally more transparent, complete, consistent and accurate FREL. The AT notes that Madagascar may wish to address the additional findings by the AT in its future submissions in order to further improve transparency, completeness, consistency and accuracy, specifically by:

(a) Improving the consistency and accuracy of activity data by:

[17] Vieilledent G, Vaudry R, Andriamanohisoa SFD, Rakotonarivo OS, Randrianasolo HZ, Razafindrabe HN, Bidaud Rakotoarivony C, Ebeling J and Rasamoelina M. 2012. A universal approach to estimate biomass and carbon stock in tropical forests using generic allometric models. *Ecological Applications.* 22: pp.572–583.

[18] Mokany K, Raison RJ and Prokushkin AS. 2006. Critical analysis of root : shoot ratios in terrestrial biomes. *Global Change Biology.* 12: pp.84–96.

[19] As footnote 12 above.

[20] Andriamananjara A, Hewson J, Razakamanarivo H, Andrisoa RH, Ranaivoson N, Ramboatiana N, Razafindrakoto M, Ramifehiarivo N, Razafimanantsoa MP, Rabeharisoa L, Ramananantoandro T, Rasolohery A, Rabetokotany N and Razafimbelo T. 2016. Land cover impacts on above-ground and soil carbon stocks in Malagasy rainforest. *Agriculture, Ecosystems and Environment.* 233: pp.1–15.

[21] Raharimalala O, Buttler A, Schlaepfer R and Gobat J-M. 2012. Quantifying biomass of secondary forest after slash and burn cultivation in Central Menabe, Madagascar. *Journal of Tropical Forest Science.* 24(4): pp.474–489.

[22] As footnote 12 above.

(i) Reconsidering the assumptions in the classification of land use and land-use change based on satellite imagery in the case of cloud cover;

(ii) Demonstrating that the assumptions about land cover change in the case of cloud cover are appropriate and are consistently applied;

(iii) Using the period length of individual scenes rather than the average period length (see paras. 15 and 21 above);

(b) Improving the consistency and accuracy of emission factors by applying a standardized methodology for the inventory of all forest lands. Currently, the estimates for the four forest types are based on three different sources. The AT notes that Madagascar has plans for a national forest inventory that would facilitate the derivation of more consistent estimates;

(c) Considering the treatment of wildfires to enhance the transparency, consistency and accuracy of estimates. Madagascar stated in its country report to the 2015 FRA (chapter 1.3.2) that fires are among the main causes of deforestation in the country. However, the Party stated that owing to the lack of data it was not possible to include emissions from wildfires in the modified FREL submission. The AT notes that in Madagascar's second national communication,[23] emissions from fires on forest land were provided but the source of these fires, whether natural or human-induced (e.g. burning of fuelwood or intentional burning to clear land), were not identified. The methodology used in the second national communication may nevertheless provide guidance for estimating CO_2 and non-CO_2 emissions from wildfires for constructing the FREL. If not, in accordance with decision 13/CP.19, annex, paragraph 2(f), Madagascar should justify the omission of emissions from wildfires in future FREL submissions;

(d) Ensuring consistency of the FREL estimates with the corresponding anthropogenic forest-related GHG emissions by sources and removals by sinks as contained in the national GHG inventories, and providing justification for any differences found in the data reported in, among others, national communications and the FRA. For example, there is a significant difference between the estimates of emissions from forest land reported in Madagascar's second national communication and those presented in the FREL. These differences relate to: (1) the considerable difference in CO_2 emissions from deforestation reported for the year 2000 in the second national communication and the emission estimates for the FREL; and (2) the reporting of non-CO_2 gases. During the exchange between Madagascar and the AT, the Party provided sufficient and reasonable justification for these differences, including methodological improvements, data availability and changes in the definition of forest. The Party confirmed that it will ensure consistency between the estimates provided in its GHG inventory in future national communications and FRELs. Madagascar has already partially addressed this consistency issue in its modified submission, in which CH_4 and N_2O emissions from slash and burn practices were included. The AT notes that the inclusion of non-CO_2 emissions in the modified submission also improved the comprehensiveness and accuracy of the data and information used in the construction of the FREL;

(e) Enhancing transparency, consistency and completeness in the presentation of data. In order for the submission to be considered complete, all relevant data used for constructing the FREL should be included so as to allow it to be reconstructed. The AT commends Madagascar on its efforts to improve the transparency and completeness of the original submission through its modified submission.

Description of relevant policies and plans, as appropriate

27. The AT notes that no assumptions about future changes to domestic policies were explicitly included in the FREL submission of Madagascar. The Party noted in its submission that as part of its readiness for REDD-plus[24] implementation, it has established

[23] Available at http://unfccc.int/essential_background/library/items/3599.php?rec=j&priref=7326#beg.

[24] In decision 1/CP.16, paragraph 70, the Conference of the Parties encouraged developing country Parties to contribute to mitigation actions in the forest sector by undertaking the following activities:

a National REDD+ Coordination Office within the Ministry of Environment, Ecology and Forests, which has the objective of piloting and coordinating all initiatives related to REDD-plus. Madagascar is currently undertaking several initiatives as part of its readiness for REDD-plus implementation; for example, PERR-FH (see para. 8 above) and submission of a REDD-plus readiness proposal to the Forest Carbon Partnership Facility (which has been approved and support for which has been granted). Madagascar informed the AT that a fraction of the readiness grant will be allocated to the improvement of the national FREL through the undertaking of inventories in dry and spiny forest ecoregions and in mangroves. The Party also expressed its intention to establish a national measurement, reporting and verification programme.

28. Madagascar in its submission acknowledged that the "the scope of the submission and the methodologies applied will need to be modified in the future when new methodologies, data and products become available" and stated that it "wishes to adopt a progressive approach for the development of its national FREL as indicated in decision 12/CP.17, paragraph 10".

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

29. According to decision 12/CP.17, annex, subparagraph (c), the reasons for omitting a pool and/or activity from the construction of the FREL should be provided, noting that significant pools and/or activities should not be excluded. The AT notes that Madagascar constructed its FREL based on the above-ground and below-ground biomass of living trees and standing dead trees. The Party stated that it selected only these two pools owing to the lack of data for lying deadwood and litter. It reported that good quality data are available for the soil organic carbon pool, but as they cover only the country's eastern humid forest ecoregion, this pool was not included.

30. The AT notes that Madagascar considered both CO_2 emissions and non-CO_2 emissions, including CH_4 and N_2O, in its submission. The AT also notes that according to the information presented by the Party in the national GHG inventory contained in its second national communication, carbon monoxide (CO) and nitrogen oxide (NO_x) emissions from the land use, land-use change and forestry sector were included in that inventory. In accordance with decision 12/CP.17, paragraph 8, and decision 13/CP.19, annex, paragraph 2(a), the FREL should maintain consistency with corresponding anthropogenic forest-related GHG emissions by sources and removals by sinks as contained in the national GHG inventories. The AT hence encourages Madagascar to consider including CO and NO_x emissions as well as all significant carbon pools in its future FREL estimates as part of the stepwise approach.

31. The AT acknowledges that Madagascar included the most significant activity (reducing emissions from deforestation) of the five activities identified in decision 1/CP.16, paragraph 70, in accordance with national capabilities and circumstances. According to the Party, the reason for the non-inclusion of the other activities in this submission is the lack of data. Madagascar recognized in its submission that emissions due to forest degradation may be significant, in particular in the dry forest and spiny forest ecoregions. The AT notes that Madagascar stated that it would consider including other significant activities, in particular, reducing emissions from forest degradation, conservation of forest carbon stocks and enhancement of forest carbon stocks, in future FREL submissions.

32. The AT notes that the current exclusion of the other activities from the FREL appears to lead to a conservative emission estimate; that is, true emissions are underestimated. Nevertheless, the AT commends Madagascar overall for the data and information provided in its FREL submission, and acknowledges the intention expressed by Madagascar to improve future FREL submissions when new, adequate data and better information become available as part of the stepwise approach.

reducing emissions from deforestation; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks.

4. Definition of forest

33. Madagascar provided in its submission the definition of forest used in the construction of the FREL as minimum tree canopy of 30 per cent, minimum land cover area of 1 ha and minimum tree height of 5 m. The AT notes that this definition differs from the one the Party used in its reporting for FRA in the values for minimum tree canopy and minimum land cover area. During the TA, Madagascar explained that the differences result from the fact that the Party used the FAO definition of forests for its country report to FAO. However, Madagascar was able to develop its own forest definition for the construction of its FREL, which it also used for its clean development mechanism projects and for the project to mitigate GHG emissions from eastern humid forests (see para. 8 above). The Party provided the rationale behind the choice of parameters that define its forests, specifically on the minimum tree height of 5 m, that rationale being that it is widely observed that trees in all the country's forests are able to reach 5 m in height. The Party stated that it may consider changes in its forest definition for future FREL submissions. The AT acknowledges Madagascar's plan to re-evaluate the forest definition within the National REDD+ Coordination Office to ensure the use of a consistent definition in future FRELs and GHG inventories.

34. The AT notes that Madagascar may wish to consider clarifying what is considered as a "natural forest" (*forêt naturelle*) and to present the information that was provided to the AT during the TA (e.g. that trees with DBH greater than 45 cm are harvested) in future FREL submissions. Regarding this, the Party informed the AT that it is launching a land occupancy and use system (in French, "Système d'Occupation et Utilisation de Terres") that will provide definitions of forest types, including natural forest. The AT considers that in the future, Madagascar may also wish to consider stratifying forests with and without management interventions so as to, for example, account for differences in growth rates. The provision of such information would enhance the transparency and accuracy of the data and information used for the construction of future FRELs.

III. Conclusions

35. The AT notes that Madagascar's submission is in overall accordance with the guidelines for submission of information on FRELs (as contained in the annex to decision 12/CP.17).

36. In its assessment, the AT notes several areas in which Madagascar could further improve in terms of the transparency and accuracy of the data and information to be provided in future submissions (see paras. 20–21 and paras. 25–26 above). In addition, the AT notes that the Party has identified and/or is undertaking several activities that will further improve the transparency and accuracy of its data and information (see paras. 27 and 28 above and 41 and 42 below).

37. The AT acknowledges that Madagascar included in the FREL the most significant activity, the most important ecoregions and the most significant pools in terms of emissions from forests. In doing so, the AT considers that the Party followed decision 1/CP.16, paragraph 70, on the activity undertaken and decision 12/CP.17, paragraph 10, on implementation according to a stepwise approach.

38. As a result of the facilitative interactions with the AT during the TA, Madagascar submitted a modified submission that took into consideration the technical inputs of the AT. The AT notes that the transparency of information improved significantly in the modified FREL submission, without the need to alter the approach or values used to construct the FREL, and commends Madagascar for the efforts made. The new information provided in the modified submission, and the examples of how estimates of CO_2 emissions from deforestation were calculated, increased the reproducibility of FREL calculations.

39. The AT notes that, with few exceptions (e.g. non-CO_2 emissions and the soil organic carbon pool), the FREL maintains consistency, in terms of sources for the activity data and the emission factors, with the GHG inventory included in Madagascar's second national

communication.[25] The differences were explained and justified during the technical exchanges with the AT (see para. 26(d) above).

40. Pursuant to decision 13/CP.19, annex, paragraph 3, the AT identified several areas for future technical improvement (relating to activity data, emission factors and emissions from wildfires) that would enhance the transparency, accuracy and consistency of the data and information provided in future FREL submissions (see para. 26(a–c) above).

41. In terms of assessing the pools and the gases included in the FREL, and pursuant to decision 13/CP.19, annex, paragraph 2(f), the AT notes that the current omissions of the pools lying deadwood, litter and soil organic carbon and the non-CO_2 gases CO and NO_x are likely to be conservative in the context of the FREL. The AT encourages Madagascar, as part of its future technical improvements, to maintain consistency of the data and information used for its FREL with those used for its national GHG inventories as reported in its national communications. The AT commends the Party for the efforts made in making data and information available and in considering actions to improve its future FREL submissions. The AT acknowledges and welcomes the intention expressed by Madagascar to further develop several aspects of its FREL, including to:

(a) Re-evaluate the forest definition;

(b) Delineate more accurately the identification of forests and land cover change;

(c) Analyse the feasibility of inclusion of the soil organic carbon pool;

(d) Improve the estimation of CH_4 and N_2O gases through the subnational emission reduction programme (for the eastern humid forest ecoregion), and include these estimates in the proposal that will be submitted to the Forest Carbon Partnership Facility's Carbon Fund for consideration;

(e) Conduct a new national forest inventory using a standardized methodology, including sampling of post-deforestation land use;

(f) Collect data for estimating the effect of forest enhancement activities on estimates of emissions and removals of net deforestation.

42. The AT notes Madagascar's efforts to harmonize:

(a) The forest-related data presented in the FREL with the data on the land use, land-use change and forestry sector, which have been used to establish Madagascar's nationally determined contribution under the Paris Agreement;

(b) Data and estimates presented in the FREL, the national GHG inventory and the nationally determined contribution as well as those communicated to the Forest Carbon Partnership Facility.

43. In conclusion, the AT commends Madagascar for showing a strong commitment to continuous improvement of its FREL estimates, in line with the stepwise approach. Areas for future technical improvement of Madagascar's FREL have been identified in this report. At the same time, the AT acknowledges that such improvements are subject to national capabilities and policies, and notes the importance of adequate and predictable support.[26] The AT also acknowledges that the assessment process was an opportunity for a rich, open, facilitative and constructive technical exchange of information with Madagascar.

44. The table contained in the annex summarizes the main characteristics of Madagascar's proposed FREL.

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

[26] 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 emission level based on information provided by the Party

Main features of the FREL		*Remarks*
Proposed FREL (in t CO_2 eq/year)	20 474 434 ± 3 366 669	Madagascar estimated its FREL as the total gross emissions from the four forest ecoregions, which were identified as homogeneous strata and for which emissions were estimated separately (see paras. 7 and 10 of this document)
Type and duration of FREL	FREL = historical emissions 2005–2013	Madagascar constructed its FREL based on estimates of annual change in biomass for the historical reference period 2005–2013, adjusted to an average of 8.31 years to reflect and justify the use of satellite images from this period (see paras. 7 and 15 of this document)
Adjustment for national circumstances	No	
National/subnational[a]	National	Madagascar's FREL covers the whole national territory (see para. 6 of this document)
Activities included[b]	Deforestation	The area of deforestation was identified separately for each of the four forest types (i.e. humid forest, dry forest, spiny forest and mangroves) (see para. 6 of this document)
Pools included[b]	AB, BB	All pools were considered by Madagascar, but the FREL was constructed based on above-ground biomass and below-ground biomass only. Owing to the lack of data for lying deadwood, litter and soil organic carbon, these pools were not included. Madagascar indicated the availability of good quality data for the soil organic carbon pool, but only for the eastern humid forest ecoregion (see para. 29 of this document)
Gases included	CO_2, CH_4 and N_2O	CO and NO_x emissions included in the second national communication were not considered by Madagascar for the construction of its FREL (see para. 30 of this document)
Forest definition[c]	Included	Minimum tree canopy of 30 per cent, minimum land cover area of 1 ha and minimum tree height of 5 m (see para. 33 of this document)
Relationship with latest GHG inventory	Methods used for construction of the FREL differ from those used in the latest GHG inventory (submitted in 2010) and reported in the Party's second national communication, which uses 2000 as the base year	The difference is due to the use of the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* for the construction of Madagascar's FREL as compared with the use of the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* for its second GHG inventory (see para. 26(d) of this document)
Description of relevant policies and plans[d]	Included	Madagascar reported on its policies and plans in section 8.2 of its modified submission (see para.

Main features of the FREL		*Remarks*
		27 of this document)
Description of assumptions on future changes in policies[d]	Not applicable	
Descriptions of changes to previous FREL	Not applicable	
Future improvements identified	Yes	Areas for future technical improvement of Madagascar's FREL were identified and planned actions were presented in chapter 8 of its modified submission (see paras. 26, 41 and 42 of this document)

Abbreviations: AB = above-ground biomass, BB = below-ground biomass, CH_4 = methane, CO = carbon monoxide, FREL = forest reference emission level, GHG = greenhouse gas, N_2O = nitrous oxides, NO_x = nitrogen oxide, t CO_2 eq/year = tonnes of carbon dioxide equivalent per year.

[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 greenhouse gas 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.