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

Summary

This report covers the technical assessment of the submission of Ghana, 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 Ghana 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, Ghana has developed a national FRL. The FRL presented for the reference period 2001–2015 is based on a simple historical average approach for the implementation period of 2016–2025. The FRL corresponds to 60,670,197 tonnes of carbon dioxide equivalent per year. The assessment team notes that the data and information used by Ghana in constructing its FRL are 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 FRL and a few areas identified by the assessment team for future 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 Ghana on its proposed forest reference level (FRL),[1] submitted on 3 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)): Ms. Lilian Portillo (Paraguay) and Mr. Zoltán Somogyi (Hungary). 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, Ghana submitted its proposed FRL on a voluntary basis. This 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) and/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 decision 13/CP.19, paragraphs 1 and 2, and decision 14/CP.19, paragraphs 7 and 8.

3.   The objective of this TA was to assess the degree to which information provided by Ghana 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 Ghana for the construction and future improvement of its FRELs, as appropriate.[7]

4.   The TA of the FRL submitted by Ghana 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 of the same decision, a draft version of this report was communicated to the Government of Ghana. The facilitative exchange during the TA allowed Ghana 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 session, Ghana submitted a final modified version of its FRL on 27 November 2017, which took into consideration the technical inputs by the AT. The modifications improved the clarity and transparency of the submitted FRL, and strengthened the indication that Ghana is ready to engage itself in a well-founded REDD-plus[9] programme. The modified submission altered both the approach used to construct the proposed FRL and the proposed FRL itself. This TA report was prepared based on, and in general refers only to, the modified submission. The modified

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[1]   The submission of Ghana can be found at http://redd.unfccc.int/submissions.html?country=gha.
[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]   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.

submission that contains the assessed FRL and the original submission are available on the UNFCCC website.[10]

B. Proposed forest reference 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 FRL proposed by Ghana, on a voluntary basis, for a TA in the context of results-based payments covers the activities "reducing emissions from deforestation", "reducing emissions from forest degradation" (due to legal and illegal logging, fire and woodfuel collection) and "enhancement of forest carbon stocks" (from forest plantations that have been planted on 'on-reserve'[11] forest lands and 'off-reserve' forest lands), which are three of the five activities included in decision 1/CP.16, paragraph 70. According to Ghana, more than 66 per cent of emissions came from deforestation, while legal and illegal logging made up 28 per cent of emissions. Fuelwood collection and forest fires accounted for only a minimal percentage of total emissions, at 6 per cent and 1 per cent, respectively.

7.   Pursuant to decision 1/CP.16, paragraph 71(b), Ghana has developed a national FRL for the entire national territory of Ghana, incorporating all ecological zones/forests in the country. After considering the technical inputs of the AT and utilizing data from the reference period 2001–2015 and employing a simple historical average approach (extrapolation of the average of the annual totals of historical emissions), Ghana proposed a modified national FRL of 60,670,197 tonnes of carbon dioxide equivalent (t CO_2 eq) per year[12] for the period 2016–2025. The total uncertainty for the national FRL was 11.9 per cent. Ghana noted that the historical reference period was selected based on the availability of land-cover maps and with the intention of including additional years that would better represent more recent emissions from deforestation.

8.   For all three activities (see para. 6 above), Ghana included the above- and below-ground biomass pools. For the activity "reducing emissions from deforestation", the other pools included were deadwood, litter and soil carbon. The activity "reducing emissions from forest degradation" also included the deadwood pool. Carbon stock changes in harvested wood products (HWP) from legal and illegal logging were considered only for the activity "reducing emissions from forest degradation".

9.   Historical emissions were estimated using the Intergovernmental Panel on Climate Change (IPCC) tier 2 and tier 3 data and methods. Activity data were based on Landsat satellite imagery (for deforestation), records from the Ghana Forestry Commission (GFC), and peer-reviewed literature and international databases (for forest degradation and enhancement of forest carbon stocks). Emission/removal factors were based on field data collected by GFC, forest inventories, peer-reviewed published literature and the IPCC defaults.[13]

10.   In its submission, Ghana noted that it did not wish to adjust its FRL based on national circumstances, as the reported emissions during the reference period were representative of current emissions.

11.   Ghana also indicated in its submission that it is applying a stepwise approach to its development of the FRL, in accordance with decision 12/CP.17, paragraph 10. The

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[10] http://redd.unfccc.int/submissions.html?country=gha.

[11] 'On-reserve' forest lands include all wooded vegetation demarcated and gazetted as forest reserves and national parks for the purposes of provision of environmental and ecosystem services, production of commercial timber and management of wildlife resources.

[12] In its original submission, Ghana proposed a national FRL of 104,214,571 t CO_2 eq per year based on a trend (i.e. a linear extrapolation) instead of based on an average of emissions. According to Ghana, this approach was selected because it more accurately captures the anticipated increase in emissions in the later years of the reference period, specifically in the period 2010–2015.

[13] Based on default values found in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, volume 4.

stepwise approach enables Parties to improve proposed FRELs/FRLs by incorporating better data, improved methodologies and, where appropriate, additional pools.

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

12. The development of the FRL was undertaken in several steps, including the identification of technical inputs that could be used to develop historical emissions. The FRL was based on three key activities, with the activity "reducing emissions from forest degradation" divided further into four separate subcategories: degradation from legal harvest, illegal harvest, woodfuel collection and fires.

13. The total forest area in Ghana in 2000 was estimated to be 8.9 million ha. Out of this forest area, 4.7 million ha were lost in the period 2001–2015. The forest area is divided into three main ecological zones, namely, the high forest zone (HFZ), the transitional zone and the savannah zone, which have been further divided into nine ecozones. These zones have been delineated based on climatic factors, notably rainfall and temperature. In line with the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines) for the development of greenhouse gas (GHG) inventories for the agriculture, forestry and land-use sector, Ghana stratified its forest lands. The Forest Preservation Programme conducted wall-to-wall mapping of forest resources in the country, which provided baseline information on the vegetation cover that enabled forest classes to be defined. The strata are divided into nine ecozones (see figure 5 of the modified submission) and each ecozone is categorized into open and closed canopy forest types.

14. For the construction of the FRL, Ghana used the methodologies provided in the 2006 IPCC Guidelines, namely the stock difference method, to estimate changes in carbon stocks before and after deforestation. The estimation of emissions and removals, the collection of activity data and the emission and removal factors used are activity-specific. The most important data sources were derived from various remote-sensing products, ground-based surveys for ground truthing of emission/removal factors for specific ecosystem types, national statistics for various activities such as volume of wood harvested and acreage of afforestation lands, and scientific studies. Most of the values and parameters obtained from scientific literature came from studies done in Ghana's forests, and some of the values and parameters for the estimation of emissions were obtained from regional scientific literature.

15. Ghana's FRL was constructed by first estimating emissions and removals by activity for the 2001–2015 historical reference period followed by totalling annual emissions and removals (irrespective of the different directions of the trends of the various activities as indicated in figures 10, 12 and 14 of the modified submission) and averaging the total annual emissions and removals. Finally, a linear extrapolation of this average for the period 2016–2025 was applied. Ghana's FRL thus establishes a 'business as usual' baseline against which future actual emissions will be compared.

16. The AT commends Ghana for providing several key definitions in its submission, including the definitions of deforestation, forest degradation, enhancement of carbon stocks and managed lands. Deforestation is defined as the human-induced loss of forest cover below the thresholds used to define forests in Ghana (see paras. 48–50 below). Forest degradation is the utilization of forest resources in forest land remaining forest land that leads to the reduction of canopy cover but does not lead to the loss of forest cover below the minimum canopy threshold as given in the definition of forest. This reduction in canopy cover leads to a decline in the supply of benefits from the forests, including sustainable supply of wood, biodiversity, carbon and other services. In Ghana's context, forest degradation is generally driven by legal and illegal logging, fuelwood extraction and

wildfires. Enhancement of carbon stocks refers to the suite of activities that results in an increase in carbon stocks in forest land remaining forest land and through the conversion of other lands to forest land. These activities include natural and assisted regeneration, afforestation and reforestation. Ghana adopts the IPCC definition of managed lands as being land impacted by anthropogenic actions (see para. 19 below).

17.   The AT commends Ghana for analysing the drivers of deforestation as requested by the AT during the TA. These drivers of deforestation contribute roughly two thirds of all historical emissions included in the FRL. According to this analysis, the conversions are primarily driven by conversions to cropland with annual and tree crops as well as conversions to grassland. The analysis also helped to explain the evolution of the detected change over time. The historical deforestation rates were highest in the periods 2013–2015 (13.1 per cent per year), followed by 2010–2013 (4.5 per cent per year) and 2000–2010 (2.4 per cent per year). This high rate of deforestation was attributed to the recent major economic recession after years of more steady economic growth in previous periods. In fact, according to the World Bank, Ghana's gross domestic product shrank from USD 47 billion in 2013 to USD 37 billion in 2015.[14] Ghana reported that this economic downturn led to the decision by the Government to seek an Extended Credit Facility (bail-out) from the International Monetary Fund. This period was generally characterized by a high rate of unemployment (due to layoffs and lack of new employment opportunities) as well as other economic challenges. Ghana thus clarified that the 2014 value is not necessarily an outlier but depicts the average recorded emissions between 2013 and 2015.

18.   The AT notes that the above analysis on drivers is also helpful for developing projections of emissions. Ghana forecasts that the economy is likely to recover over the next few years and the high incidence of illegal mining is likely to be curbed, which could lower emissions from deforestation. On the other hand, some drivers of deforestation will prevail, including concerns over food security and demand for tree crops. In a similar fashion, Ghana foresees that forest degradation is likely to remain at about the average historical level, as the increasing demand for timber and woodfuel might be offset by an increasing shift to substitutes. These considerations led Ghana to adopt a simple historical average approach for the projection of both its deforestation rates and its national emissions that are included in its modified FRL.

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

19.   The AT notes that, according to the 2006 IPCC Guidelines (volume 4, chapter 1, p.1.5), an important first step in the estimation of emissions and removals is to define the managed lands for which anthropogenic emissions by sources and removals by sinks should be identified and estimated. Emissions and removals should not be estimated for unmanaged lands. The AT acknowledges the information provided by Ghana in the modified submission on the definition of managed lands as lands where human interventions and activities (including logging, woodfuel collection and protecting areas for social and cultural purposes as well as nature conservation) are undertaken towards the attainment of specific social, cultural, environmental and economic goals. Based on this definition, Ghana considers all its forests as managed.

20.   In estimating historical emissions from deforestation, Ghana used four land-cover maps (for 2000, 2010, 2012 and 2015), with the 2000 map serving as the base map for 'year 0 forest extent' to provide the necessary activity data for the construction of the FRL. All the maps used Landsat 7 and 8 images, with the 2010 map using ALOS (Advanced Land Observation Satellite) images in addition to Landsat images. Changes in forest cover were detected at the pixel level for the years subsequent to 2000 (i.e. 2010, 2012 and 2015).

21.   Forest cover within the nine strata was identified for each of the four land-cover maps based on 30 m resolution Landsat imagery and classified using the normalized difference vegetation index. Total annual deforestation (by land cover categories after deforestation) was estimated as the sum of all pixels in the 2000 forest mask that changed

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[14] See http://data.worldbank.org/country/ghana.

to non-forest during the periods 2000–2010, 2010–2012 and 2012–2015, and divided by the number of years in the reference period (15 years).

22.   The AT notes that, in order to identify the area of land use and the different categories of land-use change, Ghana used remote-sensing imagery that captures changes in land cover. The AT acknowledges Ghana's efforts to conduct detailed ground truthing for land cover, including completing a study on separating tree crops from forests. In addition, the AT notes that the 2006 IPCC Guidelines suggest that emissions and removals in the land-use sector should be estimated on the basis of land use and land-use change, rather than land cover. Land use is a more complex concept than land cover. According to the 2006 IPCC Guidelines, "care needs to be taken in inferring land use from the land cover characteristics and vice versa" (volume 4, chapter 3, p.3.5) and

> "In order to make use of remote sensing data for inventories, and in particular, to relate land cover to land use, it is good practice to complement the remotely sensed data with ground reference data (often called ground truth data). Ground reference data can either be collected independently or be obtained from forest or agricultural inventories. Land uses that are rapidly changing over the estimation period or that have vegetation cover known to be easily misclassified should be more intensively ground truthed than other areas. This can only be done by using ground reference data, preferably from actual ground surveys collected independently. High-resolution photographs may also be useful" (volume 4, chapter 3, p.3.27).

The AT acknowledges Ghana's planned improvement to transition to monitoring land use instead.

23.   Ghana defines deforestation as losses in forest land cover. However, the AT notes that loss of tree cover, due to either natural causes or human-induced activities, might only be temporary and may not constitute land-use change. For example, Ghana reported that it identified a huge shift from grasslands to open forests between 2012 and 2015 that could be attributed to recovery. Once again, identifying whether this kind of recovery is a land-use change or just the recovery of vegetation in forest land may require additional information. The AT notes that Ghana did not monitor whether land cover change actually translated to land-use change or if these changes remained as land-cover changes. Finally, estimating gains is required by the IPCC methodology to accurately estimate carbon stock changes in the biomass pool, but the AT notes that Ghana did not estimate the regrowth.

24.   The AT also notes that, in areas with no dense human populations and where human interventions do not occur or are not probable, tree cover loss may be due to natural disturbances. In areas of abandoned lands that were under shifting cultivation, natural recovery of the vegetation on previously deforested land could also take place. Deforestation in these cases occurs only if the subsequent recovery of the vegetation is hindered by either natural processes or human interventions. In either case, it could be expected that land which has lost its forest cover recovers and such land must therefore be monitored to see whether the loss is permanent or temporary. In this sense, "temporary" should be defined. During the TA, Ghana informed the AT that it will build into its national forest monitoring system specific strategies that will allow it to continuously determine land-use change instead of land-cover change during the monitoring period. Demonstration of a change in land use through remote sensing will be attained through monitoring over several years. The AT commends Ghana for these efforts.

25.   The AT commends Ghana for providing detailed information on emission factors used for the estimation of emissions from deforestation in the modified submission. These emission factors were developed using country-specific field data that were collected through a rather complex, yet transparent sampling methodology (IPCC tier 3). Peer-reviewed published literature[15] (IPCC tier 2) and IPCC defaults (IPCC tier 1) were also used. The resulting area-specific carbon stock estimates had varying uncertainties. Higher uncertainty is associated with less significant pools, whereas lower uncertainty is associated

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[15] For example, Kongsager R, Napier J and Mertz O. 2013. The carbon sequestration potential of tree crop plantations. *Mitigation and Adaptation Strategies for Global Change*. 18(3): pp.1197–1213.

with significant pools. For example, according to the table on pages 86 and 87 in the modified submission, the confidence interval for carbon stocks in the litter pool ranges from ±47 per cent (dry semi-deciduous open forest, inner zone) to ±192 per cent (moist evergreen open forest), but the range of uncertainty values for above-ground biomass is only ±0.2 per cent (moist semi-deciduous north-west closed forest) to ±3.7 per cent (southern marginal closed forest). The AT notes that, in particular for countries with large and very diverse forests such as those in Ghana, it could be challenging to have representative samples and hence gaps might exist.

26.   The AT found that the total annual area of wet evergreen closed forest (the forest type with the highest carbon content) converted to other land uses was 21,030 ha per year and that, according to table 13 of the modified submission (p.98), 28 trees were destructively sampled in this ecozone. The AT also found that tree crop plantations (i.e. cocoa, rubber, oil palm and citrus) were assessed in just one part of the country, but Ghana reported that these tree crops exist mainly in Ghana's HFZ. Although the data collection did not cover all the ecological zones within the HFZ, Ghana reported that the results are representative of plantations across the zone. Given the number and layout of all current sample plots (altogether 1,200 plots across all nine ecological zones, of which 600 are permanent sample plots in the HFZ), the AT notes that Ghana may wish to consider additional sampling in order to verify reported carbon stock estimates. Such additional information could increase both the accuracy and the transparency of the data to be provided in future FRL submissions (see para. 25 above).

27.   Ghana indicated in its modified submission that pre-deforestation carbon stocks included all carbon pools. Carbon stocks estimates were mostly derived from the results of a forest biomass mapping and inventory project.[16] It noted that only the deadwood pool was not included in the pre-deforestation carbon stocks. The project revealed that deadwood carbon stocks when extrapolated to per-hectare values were unrealistically high (in other words, overestimated). According to Ghana, as a result of the overestimation of this carbon pool, it applied the default factor of 0.06 for deadwood as provided in the guidelines by the clean development mechanism Afforestation and Reforestation Working Group[17] (i.e. above-ground carbon stocks multiplied by 0.06; p.85 of the modified submission). The AT notes that accumulation of carbon in deadwood and litter pools during regrowth is not included and this could lead to an overestimation of emissions.

28.   With regard to post-deforestation carbon stocks (reported in the table beginning on p.117 of the modified submission), the AT notes that the cropland values for above- and below-ground biomass are sometimes much higher than the IPCC default value (i.e. 10 t C/ha). During the TA, Ghana reported that the cropland category includes fallow areas and agroforestry systems that have relatively high carbon stocks. Ghana also indicated that its use of country-specific values for estimating carbon stocks is methodologically superior compared with reliance on IPCC default values. The AT notes that Ghana's efforts to estimate carbon stocks using country-specific values considerably increase the transparency of the proposed FRL.

29.   Concerning carbon stock changes in soils, Ghana applied a 'committed emissions' approach. Ghana claims that non-committed emissions are difficult to use in the context of a reference level (versus annual GHG inventories) and that the 2006 IPCC Guidelines (volume 4, chapter 2, equation 2.25) require estimated emissions be divided by 20 years as a default. However, in the context of reference levels, strict application of this IPCC guideline would lead to errors because the reference period is 15 years. The IPCC approach would thus only include between 1 and 15 years of the 20 years of emissions and, as it is linear, that would only include between 5 and 75 per cent of emissions. Therefore, using this equation would artificially underestimate the reference level and overestimate every year of deforestation reduction during the monitoring period. For this reason, Ghana

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[16] Conducted under the Forest Preservation Programme, with the support of the Government of Japan.

[17] Executive Board of the clean development mechanism. 2012. *Afforestation/Reforestation Methodological Tool (version 2.0): "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"*. Report on the 67th meeting of the Executive Board, annex 23, p.14.

believes that, in the context of a reference level, the committed approach more accurately reflects the reality on the ground.

30.   For estimating emissions from legal timber harvest (resulting in forest degradation), Ghana reports that it follows the method outlined by Pearson et al. (2014),[18] which combines data on harvest volume (as activity data) with an emission factor associated with emissions from logging (derived from field measurements by GFC). A committed emissions approach was employed, meaning that all emissions are accounted for in the year of the logging event. In response to a question by the AT, Ghana referred to the study by Pearson et al. (2014), which indicated that gains might not occur after timber harvest (as well as from all other forms of forest degradation) because anthropogenic forest degradation opens forests for more incursions by humans, and entry of invasive species and various conditions such as species type, development phase and conditions of logging may affect the growth of remaining trees. However, the cited study acknowledged that "further detailed studies on a chrono-sequence of previously logged areas could determine whether or not a positive regrowth factor exists". The AT notes that Ghana may wish to consider estimating gains using the methods provided by the 2006 IPCC Guidelines (i.e. using the equations for the gain-loss method). Furthermore, Ghana agreed that additional studies are needed based on its national context in order to find out whether gains are occurring and, if so, at what rate.

31.   The approach used for estimating emissions from illegal timber harvest (which is responsible for almost 22 per cent of all emissions included in the FRL) is considered a proxy method as it relies on activity data from a published study for one point in time.[19] The emission factors used are IPCC tier 2 and follow the same assumptions as legal logging. Ghana noted that the estimates provided by the study serve as useful proxies but the study has not been replicated to date. Thus, Ghana is embarking on a systematic approach to assessing the impact of this activity on "total emissions in the forest sector". The AT commends Ghana for its efforts to monitor and gather data on illegally logged timber (p.82 of the modified submission).

32.   In estimating emissions and removals associated with legal and illegal logging, the method applied by Ghana also tracks the biomass in the timber logs that have been extracted from the forest, thus capturing HWP. In the committed emissions approach, the assumption applied is that storage in wood products is the stock estimated to be still in use 100 years after harvest. This stock is considered to be permanently sequestered. Ghana applied the IPCC methodology that uses a decay curve approach with the IPCC default of a 30-year half-life period (for solid wood products) for estimating emissions and removals from HWP. Based on the additional information provided by Ghana during the technical exchange, the AT was able to reproduce the proposed methodology for calculating the mass remaining in use after 100 years and based on a decay coefficient (K year^{-1}) of 0.69/t. However, the AT understands that the application of the IPCC methodology for estimating emissions and removals from HWP would require such monitoring to start in 1900. If, for instance, such monitoring only began in 2001, then the emissions from HWP might be underestimated. The AT also notes that the use of 100 years is not a standard period proposed by the IPCC. The half-life value for solid wood products applies to all non-paper products and already assumes that there are wood products with a lifetime of 100 or more years as well as including products with a lifetime of one to two decades.

33.   Ghana applied the WISDOM (Woodfuel Integrated Supply/Demand Overview Mapping) approach in the estimation of emissions from woodfuel collection and use. It noted that the analysis was conducted for a single point in time (i.e. annual emissions for 2009 were used to represent annual emissions for the reference period) and considered as a proxy-based approach. Ghana added that the WISDOM model estimates the proportion of total fuelwood removed that is not renewable and that the estimates were therefore done on

[18] Pearson TRH, Brown S and Casarim F. 2014. Carbon emissions from tropical forest degradation caused by logging. *Environmental Research Letters*. 9(3).

[19] Hansen CP, Damnyag L, Obiri BD and Carlsen K. 2012. Revisiting illegal logging and the size of the domestic timber market: the case of Ghana. *International Forestry Review*. 14(1): pp.39–49. Available at http://www.bioone.org/doi/full/10.1505/146554812799973181.

the basis of live trees extracted and not deadwood. The AT notes that, in many parts of the world, deadwood is sometimes collected from forests as fuelwood. Nevertheless, during the TA, Ghana maintained that the WISDOM approach models demand and supply and consequently incorporates all sources of woodfuel. Ghana reported in its modified submission (p.11) that during the measurement, reporting and verification phase of its REDD-plus implementation, the WISDOM model for estimating emissions from woodfuel extraction will also be customized to meet Ghana's specific national circumstances and needs. Future work is expected to produce annual data to increase the accuracy of woodfuel use estimates and improve the time series of such emissions. The AT commends Ghana for planning such efforts, in line with the stepwise approach.

34.   Emissions from forest degradation as a result of forest fires were measured using spatial data to capture area burned annually. Emission factors were derived from IPCC defaults. The MODIS burned area product was used to identify areas that were burned in the period 2001–2015. Only fires in areas that remained as forests or that did not undergo land-use change were included in the estimation. Default emission/combustion factors for tropical forests from the 2006 IPCC Guidelines were applied for all three gases, CO_2, methane (CH_4) and nitrous oxide (N_2O). The AT sought clarification on whether CO_2 emissions from fires could be double counted since Ghana also estimated emissions from the biomass pools in deforestation. Ghana clarified this and noted in its modified submission that, for deforested areas that were also burned, it used equation 2.27 from the 2006 IPCC Guidelines for calculating emissions from CH_4 and N_2O. As such, there was no overlap or double counting of emissions.

35.   The AT notes that Ghana undertook uncertainty analysis (using an error propagation approach) for every source of emissions (i.e. deforestation, forest degradation due to fire, fuelwood collection, and legal and illegal logging) and removals from the activity enhancement of forest carbon stocks, activity data and emission/removal factors. The AT commends Ghana for reporting detailed uncertainties of the various land-use and land-use change categories in the modified submission (see appendix A to the submission). The AT notes that conducting an uncertainty analysis of the areas from each land-use change category might be useful to reduce uncertainties in the future. The AT further notes that the current uncertainty analysis does not address some of the issues relating to over- or underestimation and accuracy detailed above, and therefore the true uncertainties could be higher than reported. Also, the AT notes that uncertainties in the trend were not estimated and that Ghana may wish to consider this in future submissions because such analysis might also provide useful information for improving the accuracy of data and estimates.

36.   The AT notes that Ghana, in its most recent national GHG inventory (2015),[20] reported emissions from deforestation for the land-use categories forest land converted to cropland and forest land converted to grassland. Summing up the numbers provided in the inventory for both CO_2 emissions (approximately 15 and 6 million t CO_2 for the two land-use change categories, respectively) and non-CO_2 emissions (approximately 2 million t CO_2 eq) for 2012 results in an approximate sum of 23 million t CO_2 eq. This value is much smaller than the emissions reported for (all) deforestation (also including forest land converted to wetlands, forest land converted to settlements and forest land converted to other land) for the same year in the modified submission on the FRL, with an emission total of about 40 million t CO_2 eq. During the TA, Ghana informed the AT that a number of reasons were behind this difference in estimates. First, the GHG inventory was based on data sets for the period 1990–2010. The 2012 data sets were extrapolated based on this stated period. However, for the FRL, a new map for 2013 was developed to provide the annual estimates for 2010–2013. In addition, for the FRL, any pixel that was deforested cannot be detected as forest in a future year. This is done to avoid capturing regrowing tree crops and to be consistent with Ghana's decision to protect its natural forests during its implementation of REDD-plus activities (i.e. to avoid the occurrence of deforestation in the first place). The methodology used for estimating emissions in the GHG inventory, that is pixels that were deforested are allowed to return to forest land in subsequent years, leads to a much lower net deforestation than in the FRL.

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[20] Ghana's national GHG inventory report is available at http://unfccc.int/files/national_reports/non-annex_i_parties/biennial_update_reports/application/pdf/nir1_to_bur1_ghana.pdf.

37.   While the AT notes that, according to decision 12/CP.17, paragraph 8, proposed FRELs/FRLs should maintain consistency with anthropogenic forest-related GHG emissions and removals as contained in a country's national GHG inventories, it also notes that Ghana's latest GHG inventory was developed in 2015, a few years prior to the submission of the proposed FRL. The FRL was constructed based on improved data and methodologies. Ghana informed the AT that consistency between the FRL and the national GHG inventory is likely to be attained during the current GHG inventory cycle that commenced recently and which will also report GHG emissions and removals for 2015. This process of ensuring consistency between the GHG inventory and the FRL has started, and Ghana is taking steps to achieve greater consistency in the data and information reported in future GHG inventories that will be submitted after 2018. Ghana also indicated that the emission data that will be reported in a future national GHG inventory submission will be in line with the historical emissions reported in the FRL. The AT further notes that maintaining this consistency in future FRL and GHG inventory submissions is important for ensuring methodological accuracy and transparency.

38.   The AT commends Ghana for its considerable effort in providing transparent information on the majority of the methodological and other technical issues identified during the TA.

Description of relevant policies and plans, as appropriate

39.   The AT noted that, during the TA, Ghana provided more information on its National REDD+ Strategy. According to Ghana, the National REDD+ Strategy seeks to reduce emissions from deforestation and forest degradation over the next 20 years by addressing threats to the forest ecosystems and maximizing co-benefits from the forests. The strategy also outlines the key programmes that Ghana intends to undertake during the implementation phase of REDD-plus, including the Ghana Cocoa Forest REDD+ Programme and the Shea Savanna Woodland Programme (both aimed at addressing the drivers of deforestation), and Emissions Reduction Programmes for the Transitional Zone, the Coastal Mangroves and the Togo Plateau.

40.   In addition, Ghana, in its modified submission, provided a comprehensive overview of relevant national policies, strategies and development priorities that create an enabling environment for the implementation of activities targeted at reducing emissions from the country's forest sector (see table 2 in the modified submission). These policies and measures include the National Climate Change Policy (2012), the revised Forest and Wildlife Policy (2012) and the Low Carbon Development Strategy (2016). Ghana indicated that the National Climate Change Policy and the revised Forest and Wildlife Policy acknowledge REDD-plus as one of the key climate change mitigation actions to be undertaken in Ghana. The AT acknowledges this information provided by Ghana on its national plans, policies and measures, thereby increasing the transparency of the data and information, in accordance with decision 12/CP.17, annex, subparagraph (b), in the modified submission and commends Ghana for these national efforts.

41.   Ghana also noted its active engagement in REDD-plus since 2008 through its participation as a member country of the World Bank Forest Carbon Partnership Facility. Since 2010, as part of its readiness programme with the facility, Ghana has been building the needed capacity, knowledge, architecture and systems to support the implementation of REDD-plus projects and programmes.

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

42.   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.

43.   Ghana's proposed FRL includes emissions and removals from forests in all nine ecozones of the country. The FRL includes both CO_2 and non-CO_2 emissions (namely CH_4 and N_2O). Non-CO_2 gases were included in the estimates of emissions from fires.

44.   Carbon pools were selected separately for each of the three activities included in the FRL. The selection was based on the expected magnitude of change in carbon stocks in a

given pool as a result of the selected activity. Resource requirements to collect accurate data were also taken into consideration. All three activities included the above- and below-ground biomass pools. The deadwood pool was taken into account in the estimation of emissions from deforestation and the subactivities of forest degradation due to legal and illegal logging and forest fires. The litter pool was taken into account in the estimation of emissions from deforestation and forest degradation due to fires. Soil organic carbon was considered in the estimation of emissions from deforestation. HWP was taken into account in the estimation of emissions and removals from forest degradation due to legal and illegal logging.

45.   The AT notes that Ghana included three of the five activities identified in decision 1/CP.16, paragraph 70, in accordance with its national capabilities and national circumstances. Ghana's FRL includes the activities "reducing emissions from deforestation", "reducing emissions from forest degradation" (from legal logging, illegal logging, woodfuel collection and fires) and "enhancement of forest carbon stocks". The AT also notes that, with regard to the FRL, and according to Ghana's estimates, the most significant activities in Ghana's FRL are deforestation (accounting for about 66 per cent of total historical emissions) and forest degradation from illegal logging (accounting for about 21 per cent). The AT notes that Ghana may also wish to consider including other activities referred to in decision 1/CP.16, paragraph 70, in future submissions.

46.   The AT commends Ghana for its efforts to improve the monitoring of deforestation and to develop land-use maps that can support more accurate emission estimations. Additionally, the AT commends Ghana for taking steps to improve the measuring and monitoring of removals from forest carbon stock enhancement (e.g. developing a centralized, comprehensive database of carbon stock enhancements under the National Forest Plantation Development Strategy).

47.   The AT notes that reporting the share of emissions and removals according to pools and non-CO_2 emissions could further improve the transparency of data and information in future submissions. The AT considers that the exclusion of some pools from this submission is adequately justified by Ghana. The AT commends Ghana for its efforts to obtain better information on these pools in the future, especially on the deadwood pool for "forest degradation from fuelwood" and the soil pool for "enhancement of forest carbon stocks", and, more generally, improved data on emissions from illegal logging and fuelwood collection, with the aim of including these as part of the stepwise approach.

4.   Definition of forest

48.   Ghana provided its definition of forest used in the construction of the FRL in its submission. According to this definition, which represents a national consensus after intense consultation processes, a forest has a minimum of 15 per cent canopy cover, a minimum (potential) height of 5 m and a minimum area of 1 ha. This definition is based on thresholds set by the 2006 IPCC Guidelines and is in line with the definition used in Ghana's most recent national GHG inventory report (see para. 36 above).

49.   Ghana also noted in its submission that it considers timber tree plantations, agroforestry systems (where shade trees meet the forest definition parameters) and early-stage forest plantations as forests. However, the definition excludes mono-cropped agricultural tree crops, including cocoa, citrus, oil palm and rubber plantations.

50.   The AT notes that the definition of forest in the FRL submission is different from the definition reported by Ghana to the Food and Agriculture Organization of the United Nations (FAO) for the Global Forest Resources Assessment. Ghana explained that FAO applies a uniform forest definition with strict parameters for defining forests to meet its purpose of comparing forests across all countries. Hence, Ghana noted that it may be difficult for it to harmonize its national definition of forests with the one reported to FAO. In accordance with decision 12/CP.17, annex, subparagraph (d), in its FRL submission, Ghana explained why and how the forest definition was chosen based on a consultation process. The AT notes that Ghana may wish to report the differences (the 'why' and the 'how') between the definition of forest used in the construction of its FRL and the

definition of forest it uses to report to other international organizations, in accordance with decision 13/CP.19, annex, paragraph 2(g).

III. Conclusions

51.   The information used by Ghana in constructing its FRL for the three activities selected is in general transparent and complete and is in overall accordance with the guidelines for submissions of information on FRELs/FRLs (as contained in the annex to decision 12/CP.17).

52.   The AT acknowledges that Ghana included in the FRL the most significant activities, the most important ecozones and the most significant pools in terms of emissions from forests. In doing so, the AT considers that Ghana followed decision 1/CP.16, paragraph 70, on activities undertaken, paragraph 71(b), on elaboration of a national FRL and decision 12/CP.17, paragraph 10, on implementing a stepwise approach. The AT commends Ghana for the information provided on the ongoing work to improve the development of FRLs for future submissions.

53.   As a result of the facilitative interactions with the AT during the TA session, Ghana submitted a modified submission that took into consideration the technical inputs by the AT. The AT notes that the transparency and completeness of information improved significantly in the modified FRL submission, in which Ghana altered the approach and the values used to construct the FRL, and commends Ghana for the efforts made. The new information provided in the modified submission increased the completeness of the FRL estimates.

54.   The AT notes that the FRL is currently not consistent, in terms of the activity data and the reference period, with the GHG inventory, the latter having been developed as part of Ghana's third national communication, which was submitted in 2015[21] (see paras. 36 and 37 above).

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

        (a)   Better definition of what constitutes a land-use change (e.g. a permanent loss of forest cover where "permanent" is explained in terms of the maximum number of years during which forest cover would be restored in non-deforested areas) (see paras. 22–24 above);

        (b)   Collection of more information to identify land-use change rather than land-cover change (see paras. 22–24 above);

        (c)   Collection of information on the rate of recovery after a loss of forest cover (see paras. 23, 24 and 28 above);

        (d)   Continuation of the collection of country-specific emission factors (instead of using IPCC default values and values from the literature), as appropriate (see para. 25 above);

        (e)   Collection of more data and information that increase the representativeness of data collected from samples (e.g. biomass volumes) from which emission factors are calculated as well as to increase the robustness of the estimates (see paras. 25 and 26 above);

        (f)   Collection of more information on the possible carbon gains in degraded forests due to the recovery of the vegetation (see paras. 30 and 34 above);

        (g)   Collection of more up-to-date data on woodfuel collection (that are more recent than the 2009 data used in the submission) (see para. 33 above);

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[21] Ghana's third national communication, submitted in July 2015, is available at http://unfccc.int/national_reports/non-annex_i_natcom/items/10124.php. See footnote 20 above for the link to the national GHG inventory.

(h)   Monitoring and collection of more data and information from areas under forest carbon stock enhancement in order to increase the transparency of the reported carbon stock change estimates with regard to disturbances that might occur in such plantations and/or to enable reporting of losses of carbon stocks, for example, losses that may be due to changes in the use of these lands (see para. 46 above).

56.   In assessing the pools and the gases included in the FRL, pursuant to decision 13/CP.19, annex, paragraph 2(f), the AT notes that the current omissions of pools and gases are likely to be conservative in the context of the FRL. Nevertheless, the AT identified the following additional areas for future technical improvement:

(a)   Treatment of emissions from woodfuel consumption (the AT notes that further data should be collected to support claims on emissions; if deforestation is thought to stay at a high level as projected by the FRL, it is also possible that emissions from woodfuel consumption could also stay high or even increase) (see para. 33 above);

(b)   Improve the consistency between the emission estimates of the national GHG inventory and the FRL submission (see para. 37 above).

57.   Overall, the AT commends Ghana for the data and information provided in its modified submission. The AT acknowledges and welcomes the intention expressed by Ghana:

(a)   To update activity data for deforestation biennially;

(b)   To consider remote-sensing images from sources other than Landsat, especially radar-derived products such as PALSAR (Phased Array type L-band Synthetic Aperture Radar) that eliminate the issue of cloud cover, which is a common occurrence in Ghana;

(c)   To further develop land-use maps as well as increase monitoring and ground truthing to facilitate the conversion of land-cover maps (currently used as a proxy for land use) to land-use maps;

(d)   To develop enforceable land-use plans backed by the requisite legislation and more realistic land-use maps;

(e)   To conduct research on post-deforestation carbon stocks within Ghana to quantify post-logging gains, to develop more accurate emission factors and to replace the present values derived from literature-based carbon stocks used for this FRL;

(f)   To undertake studies at a national scale (off- and on-reserve forest lands) with the aim of developing removal factors, identifying species diversity and estimating growth rates associated with natural regeneration after deforestation and forest degradation events;

(g)   To collect more activity data on illegal logging.

58.   In conclusion, the AT commends Ghana 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 improvement of Ghana'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.[22] The AT also acknowledges that the assessment process was an opportunity for a rich, open, facilitative and constructive technical exchange of information with Ghana.

59.   The table contained in the annex summarizes the main characteristics of Ghana's proposed FRL.

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[22] 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 features of the FREL		Remarks
Proposed FRL (in t CO_2 eq/year)	60 670 197	Covers the nine forest ecozones of the country. To be applied for the implementation period 2016–2025 (see para. 7 of this document)
Type and duration of FRL	FRL = simple historical average approach (using data for 2001–2015)	The approach was chosen based on the assessment of how the drivers of deforestation will play out in the future (see section 2.6 of the modified submission and paras. 7, 17 and 18 of this document)
Adjustment for national circumstances	No	Not applicable (see page 32 of the modified submission and para. 10 of this document)
National/subnational[a]	National	The national FRL includes a reference level developed for Ghana's Cocoa Forest REDD+ Programme submitted to the Forest Carbon Partnership Facility of the World Bank (see page 26, section 2.3, of the modified submission and para. 7 of this document)
Activities included[b]	Deforestation and forest degradation (from legal and illegal logging, woodfuel collection and fires) Enhancement of forest carbon stocks from on- and off-reserve forest plantations for land planted under the National Forest Plantation Development Programme	Deforestation is the most important and significant source, followed by forest degradation from illegal logging (see paras. 6 and 45 of this document)
Pools included[b]	AB, BB, DW, L, SOC, HWP (depending on the activity)	Exclusion of some pools is adequately justified (see paras. 44 and 47 of this document)
Gases included	CO_2, N_2O, CH_4	Non-CO_2 gases were estimated for forest fires (see para. 43 of this document)
Forest definition[c]	Included	Minimum canopy cover of 15 per cent, minimum height of 5 m and minimum area of 1 ha (see para. 48 of this document)
Relationship with latest GHG inventory	Methods used for FRL are not consistent with latest (2015) GHG inventory	The methods and approaches used for the national FRL will form a basis for Ghana's next GHG reporting for the agriculture, forestry and other land-use sector, and consistency will be fully attained in Ghana's next GHG inventory and future FRL submissions (see paras. 36 and 37 of this document)

Main features of the FREL		Remarks
Description of relevant policies and plans[d]	Included	Eighteen policies were outlined (see paras. 39–41 of this document)
Description of assumptions on future changes in policies[d]	Not applicable	
Descriptions of changes to previous FRL	Not applicable	
Future improvements identified	Yes	Several areas for future technical improvement were identified (see paras. 55 and 56 of this document)

Abbreviations: AB = above-ground biomass, BB = below-ground biomass, DW = deadwood, FRL = forest reference level, GHG = greenhouse gas, HWP = harvested wood products, L = litter, SOC = soil organic carbon.

[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.

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