



Report on the technical assessment of the proposed forest reference level of Togo submitted in 2020

Summary

This report covers the technical assessment of the voluntary submission of Togo 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 Togo covers the activities reducing emissions from deforestation and enhancement of forest carbon stocks (through reforestation and afforestation), which are among the activities included in decision 1/CP.16, paragraph 70. For its submission, Togo developed a national FRL. The FRL presented in the original submission, for the reference period 2003–2018, corresponds to 730,590 tonnes of carbon dioxide per year. As a result of the facilitative process during the technical assessment, the FRL was modified to $729,520 \pm 135,625$ tonnes of carbon dioxide per year. The assessment team notes that the data and information used by Togo in constructing its FRL are transparent, complete and in overall accordance with the guidelines contained in the annex to decision 12/CP.17. This report contains the assessed FRL and a few areas identified by the assessment team for future technical improvement in accordance with the provisions on the scope of the technical assessment contained in the annex to decision 13/CP.19.



Abbreviations and acronyms

AD	activity data
AT	assessment team
BUR	biennial update report
COP	Conference of the Parties
CO ₂	carbon dioxide
EF	emission factor
FAO	Food and Agriculture Organization of the United Nations
FREL	forest reference emission level
FRL	forest reference level
GFOI	Global Forest Observations Initiative
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
LiDAR	light detection and ranging
NFI	national forest inventory
REDD+	reducing emissions from deforestation; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks (decision 1/CP.16, para. 70)
SDG	Sustainable Development Goal
TA	technical assessment

I. Introduction and summary

A. Overview

1. This report covers the TA of the voluntary submission of Togo on its proposed FRL,¹ submitted in January 2020, in accordance with decisions 12/CP.17 and 13/CP.19. The remote TA² took place from 15 to 19 June 2020 and was coordinated by the secretariat.³ The TA was conducted by two land use, land-use change and forestry experts from the UNFCCC roster of experts⁴ (hereinafter referred to as the AT): Eder Larios Guzmán (Mexico) and Esther Mertens (Belgium). Although an expert from the Consultative Group of Experts was invited to participate as an observer during the remote session,⁵ no representative was able to attend. The TA was coordinated by Jenny Wong (secretariat).

2. In response to the invitation of the COP and in accordance with the provisions of decision 12/CP.17, paragraphs 7–15 and annex, Togo submitted its proposed FRL on a voluntary basis. The Party provided its submission in French. The proposed FRL is one of the elements⁶ to be developed in implementing the activities referred to in decision 1/CP.16, paragraph 70. Pursuant to decision 13/CP.19, paragraphs 1–2, and decision 14/CP.19, paragraphs 7–8, the COP decided that each submission of a proposed FREL or FRL, as referred to in decision 12/CP.17, paragraph 13, shall be subject to a TA in the context of results-based payments.

3. The objective of the TA was to assess the degree to which the information provided by Togo is in accordance with the guidelines for submissions of information on reference levels⁷ 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 Togo for the construction and future improvement of its FRL, as appropriate.⁸

4. The TA of the FRL submitted by Togo was undertaken in accordance with the guidelines and procedures for the TA of submissions from Parties on proposed FRELs and/or FRLs.⁹ This report on the TA was prepared by the AT following the same guidelines and procedures.

5. Following the process set out in those guidelines and procedures, a draft version of this report was communicated to the Government of Togo. The facilitative exchange during the TA allowed Togo to provide clarifications and additional information, which were considered by the AT in the preparation of this report.¹⁰ As a result of the facilitative interactions with the AT during the TA, Togo provided a modified version of its submission on 24 August 2020, which took into consideration the technical input of the AT. The modifications improved the clarity and transparency of the submitted FRL without needing to alter the approach used to construct it. This TA report was prepared in the context of the modified FRL submission. The modified submission, containing the assessed FRL, and the original submission are available on the UNFCCC website.¹¹

B. Proposed forest reference level

6. In decision 1/CP.16, paragraph 70, the COP encouraged developing country Parties to contribute to mitigation actions in the forest sector by undertaking a number of activities,

¹ The submission of Togo is available at <https://redd.unfccc.int/submissions.html?country=tgo>.

² Owing to the circumstances related to the coronavirus disease 2019, the TAs of the FREL and FRL submissions of developing country Parties in 2020 had to be conducted remotely.

³ As per decision 13/CP.19, annex, para. 7.

⁴ As per decision 13/CP.19, annex, paras. 7 and 9.

⁵ As per decision 13/CP.19, annex, para. 9.

⁶ See decision 1/CP.16, para. 71(b).

⁷ Decision 12/CP.17, annex.

⁸ Decision 13/CP.19, annex, para. 1(a–b).

⁹ Decision 13/CP.19, annex.

¹⁰ As per decision 13/CP.19, annex, paras. 1(b), 13 and 14.

¹¹ <https://redd.unfccc.int/submissions.html?country=tgo>.

as deemed appropriate by each Party and in accordance with their respective capabilities and national circumstances, in the context of providing adequate and predictable support. The FRL proposed by Togo, on a voluntary basis for a TA in the context of results-based payments, covers the activities reducing emissions from deforestation and enhancement of forest carbon stocks (through reforestation and afforestation), which are two of the five activities referred to in that paragraph. Pursuant to paragraph 71(b) of the same decision, Togo developed a national FRL that covers its entire territory. For its submission, Togo applied a stepwise approach to developing its FRL in accordance with decision 12/CP.17, paragraph 10. The stepwise approach enables Parties to improve their FRELs and/or FRLs by incorporating better data, improved methodologies and, where appropriate, additional pools.

7. The national FRL proposed by Togo for the historical reference period 2003–2018 is the annual average of the net CO₂ emissions and removals associated with deforestation, defined as the conversion of forest land to other land uses, and the enhancement of forest carbon stocks, defined as the conversion of other land uses to forest land. Deforestation is associated with harvesting that results in a decrease in the canopy cover to below 30 per cent. On deforested land, both carbon losses and the gains associated with regrowth are taken into account by determining the net change in the biomass change maps. The conversion of forest plantations and agricultural cropland that meet the forest definition (i.e. land with a canopy cover greater than 30 per cent) to other land uses is also considered as deforestation in the FRL. The enhancement of forest carbon stocks includes anthropogenic-induced afforestation and/or reforestation of other land to forest (namely naturally regenerated forests or forest plantations) with a canopy cover above 30 per cent and remaining stable in this land use for a minimum of 10 years. Fallow land and temporary regeneration that result from land-use changes but for less than 10 years are not considered as part of this activity. As for deforestation, carbon gains associated with afforestation and/or reforestation are determined by the net change in the biomass change maps. Emissions from deforestation were estimated at 845,034 t CO₂/year, while removals from the enhancement of forest carbon stocks through afforestation and/or reforestation were estimated at –115,514 t CO₂/year for the reference period 2003–2018. The net FRL value presented in the modified submission, with the aim of accessing results-based payments for REDD+ activities for 2003–2018, corresponds to 729,520 ± 135,625 t CO₂/year.¹²

8. The proposed FRL includes the above-ground and below-ground biomass pools and deadwood (including standing dead trees, lying deadwood and stumps). Regarding GHGs, the submission includes CO₂ only.

9. In its submission, the Party explained that three different types of remote sensing information and data are available to the Ministry of Environment, Sustainable Development and Nature Protection. For the purpose of developing its FRL, Togo used as a basis the series of Landsat images for 1986–2019 archived at the United States Geological Survey, which allowed for multi-temporal analyses. The AD used in constructing the FRL were obtained from forest-cover change maps produced by considering the differences between two forest-cover maps that were created using Landsat satellite images for 2003 and 2018. The EFs were developed by masking the forest-cover change maps over the above-ground biomass maps (developed on the basis of data from Togo's NFI) for the corresponding years. The EF for deforestation was calculated as the difference between the average biomass in areas affected by deforestation in 2003 and the average biomass in non-forest areas in 2018, while the removal factor for reforestation and afforestation is based on the average biomass in affected areas (forest) in 2018 minus the average biomass in non-forest areas in 2003.

10. During the TA, Togo provided the AT with access to the full online manual of its national forest monitoring system with complete information on the protocols, data analysis and institutional arrangements.¹³ This manual contains detailed descriptions of the operation of the satellite-land monitoring system, the NFI and the process for constructing the FRL.

¹² In its original submission, Togo proposed a national FRL of 730,590 t CO₂/year for 2003–2018. The difference between the original and the modified submission is due mostly to changes made in the calculation of the EFs for deforestation and reforestation.

¹³ <https://ogardi.github.io/SNSF-Togo/> (in French).

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

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

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

11. For constructing its FRL, Togo used the methodologies and guidance provided in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* and in the Methods and Guidance document (GFOI, 2020). The methods used for estimating the changes in forest carbon stocks and the FRL are based on the stock change approach of the IPCC. The assessment of deforestation is based on the criterion of canopy cover and not on land use and land-use changes, as there is no national stratification of land use. Hence, deforestation is defined as any reduction in canopy cover of forest land to below 30 per cent. The enhancement of forest carbon stocks as part of reforestation and afforestation includes conversions from non-forest land to forest land determined by any increase in canopy cover above 30 per cent for a minimum of 10 years, in order to exclude temporary regrowth of fallow land. In the case that an area of fallow land reaches 10 years, the total biomass increment observed in this area is counted as reforestation or afforestation. The reference period 2003–2018 was selected on the basis of the availability and consistency of satellite data for this period and in order to be in line with the latest methodological framework of the Forest Carbon Partnership Framework of the World Bank (i.e. a maximum reference period of 15 years is allowed).

12. The AD used by Togo are based on a wall-to-wall assessment of two forest-cover maps for 2018 (reference map) and 2003 (base map) generated from Landsat satellite images. Using the 2003 base map as a reference, Togo developed 13 forest/non-forest maps from Landsat images for 1986–2019 in order to provide a consistent time series of changes. These maps served as the basis for the finalized forest-cover maps for 1987, 2003, 2015 and 2018. These additional forest-cover maps facilitated the detection of deforestation and reforestation or afforestation based on a comparison between the 2003 and 2018 maps. The random forest algorithm was used for the forest and non-forest classification in all maps. In order to calibrate the 2018 reference map, 7,488 training points were used by employing very-high-resolution images from 2017–2018 from Google Earth. This 2018 reference map was used to calibrate the other maps for which very-high-resolution images for the years before 2018 are not available. For the calibration of the 2003 base map, 500,000 pixels were taken randomly around the forest/non-forest edge of the 2018 reference map and then used to classify land use in the 2003 Landsat images. In order to exclude the significant surface areas of fallow land (which looks like forest in some regions of Togo) before the analysis of deforestation, a temporal filter was applied to the base and reference maps so as to consider only the pixels that have been classified as forest for at least 10 years.

13. Togo conducted an accuracy assessment of the forest-cover change map for 2003–2018 on the basis of the approach of Olofsson et al. (2014). Stratified random sampling was applied to validate the forest-cover change map for 2003–2018. A sample of 4,000 validation pixels was allocated to four strata (stable forest, stable non-forest, deforested areas, and areas of reforestation or afforestation). This sample size was determined on the basis of available resources. The allocation of the sample to strata was made in accordance with the average between equal allocation and proportional allocation. For reasons of quality (e.g. cloud or shadow covering the reference images) and to reduce interpretation errors, the total effective number of sample pixels used for the validation was only 2,431. The reference data used for the 2018 reference classification were the very-high-resolution images from Google Earth, whereas the high-resolution Landsat images were employed for the 2003 reference classification.

14. The EFs were derived from two biomass maps developed for 2003 and 2018. As a first step, a reference biomass map was constructed for 2015 by combining field data from Togo's first NFI, conducted in 2015–2016, and remote sensing data (Landsat 8 images from

2015 and bioclimatic variables from WorldClim 2¹⁴). To calibrate this reference map, the above-ground biomass and deadwood data (estimated from dendrometric data measured at 945 plots from the 2015–2016 NFI) were used. All trees (living and dead) with a diameter at breast height equal to or greater than 10 cm were included, and their above-ground biomass and deadwood were calculated using the most relevant allometric equation of Chave et al. (2014) for Togo, recommended by a national study (Ministry of Environment and Forest Resources, 2017). The observed data for above-ground biomass and deadwood from the NFI, together with relevant climatic variables (taken from WorldClim), were used to calibrate a regression model, which uses a random forest algorithm, on the basis of Landsat satellite images for 2015. Following this, as part of the second step, the resulting 2015 wall-to-wall above-ground biomass and deadwood map was used to prepare the above-ground biomass and deadwood maps for 2003 and 2018. To calibrate the 2003 and 2018 images, 100,000 sample pixels were randomly drawn from the 2015 above-ground biomass and deadwood map and stratified according to 10 density classes for above-ground biomass. These calibrations were also done with a random forest regression model. As a third step, Togo used the above-ground biomass data from the 2003 and 2018 maps as a basis for estimating the below-ground biomass, using the root-to-shoot ratios established by Mokany, Raison and Prokushkin (2006) for tropical dry forests.

15. The EFs were determined by crossing over the forest-cover change map for 2003–2018 with the corresponding biomass maps. To estimate the EF for deforestation, the average biomass values of pixels classified as non-forest in the 2018 map were subtracted from the biomass values of pixels classified as deforestation in the 2003 map. A similar procedure was carried out to estimate the EF for reforestation and afforestation: the biomass of pixels identified as forest in the 2018 map was deducted from the biomass of the same pixels classified as non-forest in the 2003 map. In response to comments from the AT during the TA, Togo, in its modified submission, recalculated the EFs for deforestation, and reforestation and afforestation, respectively. The new EFs are 56.1 t CO₂/ha for deforestation and 11.8 t CO₂/ha for reforestation and afforestation.

16. The construction of the FRL was based on the combination of the AD and EFs derived from a spatially explicit approach. The biomass differences for the three carbon pools considered (above-ground and below-ground biomass and deadwood) were added. Then, the biomass losses and gains were converted to CO₂ using a carbon fraction of 0.47 (IPCC default factor) and a stoichiometric ratio of 44/12 was used for the conversion of carbon to CO₂. Togo's FRL was constructed on the basis of the historical average of annual emissions from deforestation and annual removals from reforestation and/or afforestation (between 2003 and 2018) at the national level and without adjustment for national circumstances.

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

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

17. Regarding the different types of forest in Togo, the Party indicated that detailed classification was undertaken for the land-use map that was developed based on RapidEye (2014–2015 images) and produced during the NFI. However, this classification is available only for 2015 because, according to the Party, it was not possible to reproduce such classification for other years owing to data unavailability. The forest-cover maps used in the FRL consider only two classes (forest and non-forest), which are the classes that can be distinguished consistently with Landsat images. Following this approach, Togo did not distinguish between managed and unmanaged forests or between primary and secondary forests when establishing the forest definition applied in constructing the FRL. The applied definition also does not make a distinction between natural forests and perennial tree crops (including forest plantations and perennial agricultural crops). In response to a question from the AT, the Party clarified that most of the country's forests, including protected forest areas, are subject to some form of management. Hence, all the forests in the country can be

¹⁴ WorldClim is a database of high spatial resolution global weather and climate data that can be used for mapping and spatial modelling. Available at <https://www.worldclim.org/>.

considered managed forests. Togo also explained that perennial tree crops that meet the forest definition are considered as forests and thus are included in the deforestation areas should there be a reduction in canopy cover to less than or equal to 30 per cent. Conversely, these perennial crop areas are included in reforestation or afforestation areas if their canopy cover increases above 30 per cent. The AT commends Togo for providing these clarifications and notes the stratification of Togo's territory according to different land uses (or at least to differentiate natural or planted forest from perennial agricultural crops) as an area for future technical improvement.

18. In addition, the Party noted the need to investigate the extent to which different forest strata can be consistently identified using Landsat images and higher-resolution products, such as RapidEye 2015, as a basis and to assess whether, in this context, the country is able to distinguish plantations from natural secondary forests. Togo also indicated that consistent forest stratification over time (based on the NFI forest classes) would allow a direct use of NFI data. The AT notes that such stratification and direct use of NFI biomass data would improve the consistency and accuracy of estimates in future submissions and identifies this as an area for future technical improvement.

19. Togo conducted a wall-to-wall change detection between 2003 (base map) and 2018 (reference map) from pixel composites covering 1985–2018. In response to a question from the AT, Togo noted that, in order to reduce bias in the change detection, the selection of training data for the creation of the maps has been carried out on an objective basis. Using the case of a 7 x 7 m grid, if 15 points (equivalent to 30 per cent of the grid) fall on tree canopy, the land is classified as forest. In addition, the selection of training data uniformly covered the range of normalized difference vegetation index classes. Togo produced the time series on the basis of the 13 forest/non-forest maps using the base map of 2003. The availability of relatively high-quality training data allowed the construction of high-quality maps. Subsequently, on the basis of the 2018 map and the comparison of changes between the change maps, the 2003 map was produced. Togo informed the AT that, with this technique, it was able to ensure consistent change detection across the period considered. The AT notes that change detection (i.e. detection based on comparing satellite images at different points in time instead of detection based on maps) could reduce the bias that would otherwise be introduced owing to mapping inaccuracies. In developing a land-use monitoring system for the establishment of FRELs or FRLs, the Methods and Guidance document (GFOI, 2020) notes combining remote sensing and ground-based observations as a best practice. During the TA, Togo noted several reasons why the comparison of 13 map products has been favoured over change detection at the subset level of high-resolution imagery. For example, it emphasized that land-cover change detection would classify all pixel changes, including inconsistencies, as conversions and would therefore introduce greater bias into the results. However, the AT notes that the disadvantage of this method is that the maps are correlated with and thus similar to each other, thereby introducing systematic errors that may lead to the underestimation of AD for deforestation and afforestation areas. The AT acknowledges the efforts made by Togo to reduce bias in the AD developed from a wall-to-wall method in constructing the FRL. The AT also notes that data quality could continue to be improved if wall-to-wall mapping were combined with change detection. The AT is of the view that image interpretation could also consider land use, in addition to land-cover aspects, for example by interpreting land management practices. The AT notes this as an area for future technical improvement.

20. Togo defines reforestation as human-induced and not as a result of uncontrolled natural regeneration (see p.5 of the modified FRL submission). On the basis of the information in the submission, the AT notes that it is unclear what type of reforestation is occurring (whether these areas are plantations or controlled natural regeneration or regeneration through seeding) and where, and that the data provided are not associated with the administrative data based on ongoing reforestation activities. In response, Togo clarified that it has not provided information regarding the plantation types of the reforested areas in its submission owing to a lack of information collected to date. The total area of plantations managed by the State amounts to two fifths of the total plantation area in the country. In addition, Togo noted that it will include such information in its next submission. The AT notes that using administrative data from areas reforested through planting, seeding or assisted natural regeneration can support the reconstruction of data from land monitoring and

information related to tree species, tree spacing and future reforestation plans could be useful for the stratification of land use. In addition, the AT notes that it would be useful for Togo to provide more information on how the operational definition of reforestation distinguishes assisted natural regeneration from uncontrolled natural regeneration. Such information could also be highly beneficial for calibration data used in the remote sensing change detection process. The AT notes these as areas for future technical improvement.

21. To construct the FRL, Togo matched each pixel of deforestation or reforestation and/or afforestation on the forest-cover change map of 2003–2018 with the biomass decrease or increase on the biomass maps for the same years. In the event of disagreement, namely when biomass increases in a deforested area pixel, Togo, in its initial assessment, assumed the biomass change as zero instead of the value indicated by the biomass map. In the case of an afforested pixel associated with a biomass decrease, the change was also assumed to be zero. In some cases, deforested areas with regrowth on fallow land might remain as non-forest. This methodology would underestimate the regrowth on deforested land. On the basis of a comment from the AT, for its modified submission Togo recalculated¹⁵ the emission estimates for deforestation (845,034 t CO₂/year) and the removal estimates for reforestation/afforestation (–115,514 t CO₂/year) by including all changes happening on deforested and reforested and/or afforested land. In addition, the AT notes that, by stratifying the land areas and their EFs, Togo may facilitate assigning more representative area changes with the respective carbon stock changes by stratum. The AT notes that Togo improved the transparency of its submission by providing clarifications on the pixel range and frequency of use of the EFs derived from the biomass change maps assigned to deforestation and reforestation. However, the AT notes that further technical improvements that reduce errors related to false associations are an area for technical improvement in future FRL submissions.

22. Togo uses a spatially explicit approach to estimate emissions (from deforestation) and removals (from reforestation and afforestation). For losses and gains in forest land between 2003 and 2018 (based on the forest-cover change maps), the difference in above-ground biomass stocks between 2003 and 2018 was used as the basis for developing the EFs. The Party clarified that, owing to the difficulty of distinguishing between forest and non-forest lands, it intends to move towards monitoring the biomass of trees throughout its national territory. New remote sensing instruments (e.g. LiDAR instruments that produce high-resolution observations, such as the Global Ecosystem Dynamics Investigation¹⁶) are being explored to facilitate the generation of accurate biomass maps. In order to employ new remote sensing technologies for biomass mapping, AD will also need to be spatially explicit. Togo's goal is to produce land-use change maps that are as accurate as possible for the purpose of the additional stratification of land-use areas. The AT acknowledges Togo's intention to improve its future approach to estimating AD in accordance with its needs and capacities, and commends the Party for its intention to improve its methodological approaches over time as part of the stepwise approach. The AT also commends Togo for its plans to use radar and LiDAR data to improve the accuracy of biomass maps.

23. Togo used stratified random sampling in conducting the accuracy assessment of the 2003–2018 land-cover change map. According to the modified submission, a total of 4,000 validation pixels were randomly drawn and stratified in accordance with the transition classes applied in constructing the FRL. However, for reasons of quality (e.g. cloud or shadow covering the images), Togo noted that the total effective number of validation pixels that could be used for the accuracy assessment was only 2,431. In the original submission, the procedure Togo followed to calculate this sample size was not clear. As a result of the facilitative exchange during the TA, Togo clarified the reason for this choice of sample size: the total number of samples was defined in accordance with the technical resources available for sampling (such as the availability of photo interpreters). At the request of the AT, the Party included the following additional information in the modified submission: (1) the reasons behind the choice of sample size; (2) a table with the distribution of the samples for each aggregate stratum (deforestation, reforestation/afforestation, stable forest and stable non-forest); (3) the sample allocation procedure (the allocation of the sample to strata was

¹⁵ The original submission included estimated total emissions from deforestation of 944,475 t CO₂/year and total removals from reforestation/afforestation of –213,885 t CO₂/year.

¹⁶ See <https://gedi.umd.edu/>.

made in accordance with the average between equal allocation and proportional allocation); and (4) future technical improvements identified to increase the amount of reference data (for the accuracy assessment and the calibration of maps). The AT commends Togo for including this information in the modified submission and considers that this improved the transparency of the FRL submission.

24. Regarding the response design of the accuracy assessment, Olofsson et al. (2014) indicate that there are two criteria for ensuring that the reference classification is of higher quality than the map classification: (1) criterion 1 refers to the reference source being of higher quality than what was used to create the map classification and (2) criterion 2 applies if the same source material is used for both the map and the reference classifications and thus requires the process of creating the reference classification to be more accurate than the process used in creating the map classification that is to be evaluated. During the TA, Togo clarified that criterion 1 was met only for the 2018 forest/non-forest classification map, using very-high-resolution satellite images from Google Earth. The forest/non-forest classification maps for 2015, 2003 and 1987 (and the corresponding land-cover changes) were verified using the same source (Landsat imagery) that was used to create the maps. This means that criterion 1 was not met for the entire time series of the reference period. However, Togo identified some areas for future technical improvement to better meet the requirements of criterion 1 by exploring (1) the use of better-quality historical images instead of Landsat images, which were used for the classification; (2) the possible use of the RapidEye images acquired during the first NFI in 2015 instead of Landsat images; (3) whether images in the archives of Google Earth Pro are available for 2003; and (4) the feasibility of using available aerial photographs for 1985. In response to a question from the AT, Togo provided, in its modified submission, a justification for the lack of spatial data (vector data) that would allow a more precise validation for the different years, and clarified the limitations of other images (e.g. images from the Yandex.Maps and Bing Maps platforms) for the accuracy assessment. The AT considers that this additional information in the modified submission increases the transparency of the methodology used to construct the FRL.

25. In response to a question from the AT, Togo clarified that the procedure of reference classification (based on the photo interpretation of images of the validation points) is less accurate than automated classification, which uses a random forest algorithm to generate a series of land-cover maps based on six spectral Landsat bands, vegetation indices and WorldClim climatic data, coupled with subsequent filtering of noise. The accuracy of the forest-cover change maps is expected to increase through the use of the algorithm, as it is able to process much more information than a photo interpreter can take into consideration. In its clarification, Togo indicated that criterion 2, referred to in paragraph 24 above, was also not met. However, the AT notes that the purpose of the accuracy assessment is to reduce the bias in an automated mapping process and other sources of error by correcting the product for statistical purposes before it is applied in the construction of the FRL. This is because any algorithm repeats its mistakes consistently (even if such mistakes are small in number), which would not be the case if the evaluation were undertaken by several independent interpreters. Togo indicated that the reference classification of Landsat images has been a challenge for photo interpreters. As part of its future technical improvements, Togo also indicated that the accuracy of the process of creating the reference classification can be improved through complementary training and through more practice in photo interpretation and exchanges between photo interpreters. The AT commends Togo for including this as an area for future improvement in the modified submission. Togo also highlighted that it will likely be difficult to meet criterion 2, as the classification approach applied took into account a time series of 13 Landsat images for 1986–2019 and produced better results than photo interpreters did. The AT notes that, if it is not possible to meet criterion 2 to make the reference classification more accurate than the classification produced by the algorithm, a significant challenge will be faced in assessing the accuracy of maps (particularly maps for years prior to 2015) in which the same images were used to construct and validate them. The AT adds that, according to Olofsson et al. (2014), photo interpretation is key to conducting an accuracy assessment.

26. The AT highlights the importance of the response design (and particularly of the reference data) applied in the accuracy assessment. Since neither of the two criteria regarding reference data mentioned in paragraph 24 above was met for the entire time series, the

assessment of the reference map and the map classifications is biased and thus the accuracy assessment is also biased. In addition, Togo did not use the adjusted areas estimated in the accuracy assessment. In section 5.1.5 of the modified FRL submission, Togo provided reasons for not using the adjusted areas to derive AD, namely that it considered classification as more accurate than the use of validation data because the photo interpreters were not able to use all of the information on which the map classification was based (e.g. spectral bands, vegetation indices, climatic data, the chronosequence of 13 forest/non-forest maps) and there was an increase in the number of errors in validation points, in particular when the year of the pixel points was further from the mapping year. The Party added that the adjusted areas resulted in larger areas of deforestation and reforestation and/or afforestation being estimated, and this was considered not representative of the actual conditions in Togo and not comparable with other data sources, and as a result it chose to underestimate emissions instead of overestimating by using the adjusted areas. It also noted that map classification provided spatially explicit AD for use in the approach to determine changes in the biomass of forest areas and in the creation of biomass maps. In response to a request from the AT, Togo elaborated on why the adjusted areas were so far off when compared with the mapped areas. Togo indicated that the photo interpreters tended to interpret changes in the spectral characteristics of a pixel as changes in land cover, probably because they knew in advance that they were validating a change map. This explains the higher estimates or overestimates of deforestation and reforestation. Togo also indicated that errors in the classification of reference data are reflected in the accuracy of the maps. Therefore, the actual accuracy of the maps should be higher. Finally, to calculate the emissions and removals for developing the FRL, Togo decided to use the mapped areas. The AT notes that these clarifications enhanced the transparency of Togo's submission.

27. However, to calculate the FRL uncertainty, the Party used the uncertainties calculated from the adjusted areas. The AT notes that this is an inconsistency, because in the methodology of Olofsson et al. (2014) the calculation of uncertainties can be associated only with estimated areas (i.e. adjusted areas) and not mapped (or non-adjusted) areas. Therefore, the derived confidence intervals do not fully correspond with the mapped areas used for constructing the FRL. The AT notes that avoiding inconsistencies in the calculation of the FRL uncertainty is an important area for future technical improvement. However, the AT notes that, in the case of Togo's FRL, using mapped areas instead of adjusted areas to determine deforestation and reforestation is conservative, as net losses are lower with mapped areas than with adjusted areas.

28. The confidence intervals associated with the EFs do not include the error in the correlation between the two biomass maps. In response to a question from the AT, Togo clarified that the accuracy of the biomass change maps was not estimated owing to missing data points for 2013. The AT notes that Togo may wish to conduct an accuracy assessment that eliminates the bias generated from calculating net emissions or removals by directly comparing the two biomass maps (i.e. a wall-to-wall approach), considering, for example, the use of spatially explicit methods, such as a pixel-based method, as described in section 2.4.2.1 of the Methods and Guidance document (GFOI, 2020).

29. According to decision 13/CP.19, annex, paragraph 2(a), the TA of the proposed FREL/FRL should assess the extent to which the FREL/FRL maintains consistency with corresponding anthropogenic forest-related GHG emissions by sources and removals by sinks reported in the national GHG inventory. Togo indicated in its modified submission that the methods, data and scope of estimation of emissions and removals from forest land in its national GHG inventory included as part of its first BUR are not consistent with those applied in constructing the FRL. In the case of the national GHG inventory (for inventory year 2013), emissions from the agriculture, forestry and other land use sector were estimated at 17,098,024 t CO₂, while the average emissions from deforestation between 2003 and 2018 included in the FRL are less than 1 Mt CO₂/year. The Party noted that the differences are due to incomplete AD and default EFs being applied when estimating emissions for its national GHG inventory. However, owing to the large difference between these values, the AT sought further clarification. In response, Togo stated that the differences are related to the following factors: (1) different forest definitions were used; the GHG inventory took into account all forest land (with canopy cover greater than 10 per cent, based on the FAO definition), while only forest with canopy cover greater than 30 per cent was considered for the FRL; (2) the

GHG inventory includes emissions from soil organic carbon; (3) general estimates were used for land area changes in the GHG inventory, instead of information based on spatial analysis; and (4) IPCC default EFs were used in estimating emissions from the land use, land-use change and forestry sector for the national GHG inventory and post-deforestation carbon stocks were not considered. Togo indicated that the data and methods considered in constructing the FRL will be considered for future GHG inventories. The AT commends Togo for including this information in its modified FRL submission and considers that it increases the transparency of the submission.

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

30. Togo indicated in its submission that, in order to respond to the problems of deforestation and forest degradation, it began participating in the Forest Carbon Partnership Facility of the World Bank in 2013 and the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries in 2014. Since 2015 it has been implementing its REDD+ readiness proposal, which was submitted to these two programmes. The FRL is one of the products resulting from its participation in these two programmes. The information and data prepared for the FRL will also be used to update the information in the national GHG inventory. Togo indicated that 2018 marked the beginning of the implementation of its national development plan, in which issues related to REDD+ are addressed. This development plan serves as a framework for implementing the 2030 Agenda for Sustainable Development in the country. The Party noted that SDG 7 on affordable and clean energy and SDG 15 on life on land and biodiversity are well reflected in its national REDD+ actions.

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

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

32. The pools included in the Party's FRL are above-ground biomass, below-ground biomass and deadwood. Litter and soil organic carbon were not included. During the TA, Togo clarified that both the litter and soil organic carbon pools were omitted owing to a lack of reliable data. Togo added that deforestation and afforestation are likely to have a positive effect on litter carbon stocks, and thus the omission of the pool can be considered conservative. On the basis of the clarifications from the Party, the AT concludes that emissions from litter are likely to be insignificant and their non-inclusion is therefore justified.

33. With regard to emissions from soil organic carbon, the AT requested clarification of the reasons for omitting the pool in accordance with decision 13/CP.19, annex, paragraph 2(f). In response, Togo explained that there was an error in its presentation of the omission of the carbon pool in the original submission. The Party corrected the error in its modified submission, noting that the non-inclusion of the pool was due to a lack of data, specifically country-specific soil organic carbon stocks as a reference and relevant findings on the impact of different land uses on soil. Furthermore, Togo provided additional information to the AT related to its areas of land stratified by soil type. The Party also shared its data on deforested areas and reforested areas classified according to the different IPCC soil types¹⁷ for 2003 and 2018, which the AT notes could be used as a basis for estimating soil organic carbon stock changes in the future. The AT acknowledges that the non-inclusion of the soil organic carbon pool was adequately justified by Togo during the TA and in the modified submission. Furthermore, the AT notes that the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* provides a method for estimating carbon stock changes in soils and the corresponding default EFs. The AT considers the treatment of emissions from soil carbon (i.e. the inclusion of the pool or the provision of more information justifying its omission), in line with the stepwise approach, as an area for future technical improvement of Togo's FRL.

¹⁷ The soil data were generated from international data sources (obtained from <https://soilgrids.org>) and combined with the forest-cover change maps developed by Togo.

34. Togo included only CO₂ in its submission. Non-CO₂ gases, in particular those associated with biomass burning on forest land, were not estimated owing to a lack of data. In response to a question from the AT related to non-CO₂ emissions from fire, Togo clarified that most fires occur on agricultural land or grassland rather than on the forest land included in the FRL. The Party added that some fires occurring on forest land were not taken into account in the construction of the FRL. The emissions from fires included in the latest GHG inventory in the Party's first BUR and national inventory report (2017)¹⁸ are associated with agricultural residue burning and savannah burning. However, as forest fires occur mostly in degraded forests or are a driver of degradation (rather than deforestation), Togo noted that it will consider including these emissions in future submissions when it includes the activity reducing emissions from forest degradation in the construction of its FREL/FRL. The AT notes this as an area for future technical improvement of the FRL.

35. The AT acknowledges that Togo included the most significant activities, reducing emissions from deforestation and enhancement of forest carbon stocks by reforestation and afforestation, of the five activities identified in decision 1/CP.16, paragraph 70, in accordance with its national capabilities and circumstances. The AT notes that other activities could also be significant, in particular forest degradation. According to Togo, forest degradation can be a significant activity in the country, but its exclusion has been adequately justified in the submission by a lack of accurate data. In addition, the Party indicated that gains and losses of carbon stocks within forests are probably more important than those associated with deforestation and reforestation. Togo also mentioned in its submission that the REDD+ activities reducing emissions from forest degradation, enhancement of forest carbon stocks, conservation of forest carbon stocks and sustainable management of forests will be included in future submissions.

36. The AT acknowledges and commends the Party's intention to include additional carbon pools, gases and activities in order to improve future FREL/FRL submissions when new and adequate data and better information become available, as part of the stepwise approach.

4. Definition of forest

37. Togo provided in its submission the definition of forest used in constructing its FRL. The definition is based on the country's forest code and the IPCC land-use categories applied in its national GHG inventory. When it reported to the Global Forest Resources Assessment (2015), the Party applied the forest definition of FAO, which is based on the following thresholds: a minimum area of 0.5 ha, height of 5 m or more and at least 10 per cent canopy cover. The Party applies the same forest definition in the context of REDD+ and within the framework of its NFI.

38. However, the operational definition of forest used in constructing the FRL includes any land with tree cover greater than 30 per cent, occupying a minimum area of 0.5 ha and with trees that have reached or can reach a height of 5 m. Since the assessment of forest areas was based on Landsat images, the Party indicated that, in its assessment, it applied a canopy cover threshold of greater than 30 per cent. The AT notes that the operational forest definition of the FRL is based on land cover criteria instead of on land use (see also para. 11 above).

39. The Party's national GHG inventory included in its first BUR does not contain a definition of forest. Instead, the AD for the land use, land-use change and forestry sector in the inventory were based on the forest definition of FAO. In addition, the AT notes that the GHG inventory classifies agricultural crops and agroforestry under cropland. Responding to a question from the AT, the Party provided information on its efforts to monitor other "wooded land" with canopy cover between 10 and 30 per cent as part of its national satellite-land monitoring system. The AT commends Togo for identifying this as an important area for future technical improvement. In addition, the AT notes that Togo can further improve the transparency of its submission by providing greater clarity on how it intends to harmonize the AD and the forest definition applied for the FRL with the AD and forest definition used

¹⁸ Available at <https://unfccc.int/BURs>.

for estimating emissions and removals for the land use, land-use change and forestry sector in the national GHG inventory (see also para. 29 above).

III. Conclusions

40. The data and information used by Togo in constructing its FRL for reducing emissions from deforestation and enhancement of forest carbon stocks by reforestation and afforestation are transparent, complete and in overall accordance with the guidelines for submissions of information on reference levels.

41. The FRL presented in the modified submission, for the reference period 2003–2018, corresponds to $729,520 \pm 135,625$ t CO₂/year.

42. The AT acknowledges that Togo included in its FRL the most significant activities at the national level and the most significant pools in terms of emissions from forests. The AT considers that, in doing so, Togo followed decision 1/CP.16, paragraph 70, on activities undertaken, and decision 12/CP.17, paragraph 10, on applying the stepwise approach. The AT commends Togo for providing information on its ongoing work to develop FRLs for other activities.

43. As a result of the facilitative interactions with the AT during the TA, Togo provided a modified submission that took into consideration the technical input of the AT. The AT notes that the transparency and completeness of the information provided were significantly improved in the modified FRL submission, without having to alter the general approach used to construct the FRL. The modified submission took into consideration improved calculations of EFs, and the AT commends Togo on its efforts. The new information provided in the modified submission, including the data made available online¹⁹ and the justifications associated with methodological choices, in particular for the accuracy assessment and the use of AD, increased the reproducibility of the FRL calculations.

44. The AT notes that, overall, the FRL does not maintain consistency, in terms of sources of AD and EFs, with the GHG inventory included in Togo's first BUR²⁰ (see para. 29 above).

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

(a) Stratifying the national territory in accordance with different land uses to differentiate natural or planted forests from perennial agricultural crops, and plantations from natural secondary forests (see para. 17 above);

(b) Stratifying on the basis of the NFI forest classes to allow direct use of NFI biomass data in order to improve the consistency and accuracy of emission estimates (see para. 18 above);

(c) Considering land-use aspects (e.g. by interpreting land management practices), in addition to land-cover aspects, in image classification, and using higher-resolution imagery, if and when available, to improve data quality (see para. 19 above);

(d) Using administrative data on reforested areas to support the reconstruction of data from land monitoring and to provide useful information on tree species (see para. 20 above);

(e) Providing more information in future submissions on how the operational definition of reforestation allows distinguishing assisted natural regeneration from uncontrolled natural regeneration and using such information in the change detection process (see para. 20 above);

(f) Identifying ways to reduce errors of false association when comparing the biomass change maps with the forest-cover change map (see para. 21 above);

¹⁹ <https://www.reddtogo.tg/index.php/composantes/niveau-de-reference> (in French).

²⁰ In reference to the scope of the TA, as per decision 13/CP.19, annex, para. 2(a).

(g) Improving compliance with criteria 1 and 2 indicated by Olofsson et al. (2014) and increasing the amount of reference data for deforestation and reforestation to ensure smaller standard errors as part of efforts to improve the accuracy assessment (see paras. 23–25 above);

(h) Avoiding inconsistencies in the calculation of the FRL uncertainty in future submissions (see para. 27 above);

(i) Conducting an accuracy assessment that eliminates the bias from estimates of net emissions or removals, and considering using spatially explicit methods instead (see para. 28 above);

(j) Harmonizing the data applied in constructing the FRL with the data applied in estimating emissions and removals from the land use, land-use change and forestry sector for the national GHG inventory to maintain consistency between the two submissions (see paras. 29 and 39 above).

46. Pursuant to decision 13/CP.19, annex, paragraph 2(f), in assessing the pools and gases included in the FRL, the AT noted that the pools and gases excluded by Togo are likely not to be significant in the context of the FRL. Nevertheless, pursuant to decision 13/CP.19, annex, paragraph 3, the AT identified the following additional areas for future technical improvement regarding pools and gases that could be included in future FRL submissions:

(a) Analysing changes in soil organic carbon on the basis of IPCC default stock change factors and reference soil organic carbon values from representative literature and considering the inclusion of the soil organic carbon pool in future submissions (see para. 33 above);

(b) Analysing the impacts of bushfires in the country and the relationship between such fires and deforestation activities, and, if this is found to be significant, considering the inclusion of associated non-CO₂ emissions (see para. 34 above).

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

(a) Include the activities reducing emissions from forest degradation, enhancement of forest carbon stocks within forests, conservation of forest carbon stocks and sustainable management of forests in future submissions;

(b) Use new monitoring techniques for developing AD and more historical high-resolution data (including the improvement of validation data) in addition to interpreting Landsat imagery.

48. In conclusion, the AT commends Togo for showing strong commitment to continuously improving its FRL estimates in line with the stepwise approach. A number of areas for the future technical improvement of Togo's FRL have been identified in this report. At the same time, the AT acknowledges that such improvements are subject to national capabilities and policies, and notes the importance of providing adequate and predictable support.²¹ The AT also acknowledges that the TA was an opportunity for a rich, open, facilitative and constructive technical exchange of information with Togo.

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

²¹ As per decisions 13/CP.19, annex, para. 1(b); and 12/CP.17, para. 10.

Annex I

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

	<i>Main features of the FRL</i>	<i>Remarks</i>
Proposed FRL	729 520 t CO ₂ /year	Annual average net CO ₂ emissions and removals associated with deforestation and enhancement of forest carbon stocks. Emissions from deforestation were estimated at 845 034 t CO ₂ /year and removals from enhancements were estimated at –115 514 t CO ₂ /year (see para. 7 of this document)
Type and reference period of FRL	FRL = net emissions and removals for historical reference period 2003–2018	A national FRL that covers the entire territory (see paras. 6–7 of this document)
Application of adjustment for national circumstances	No	
National/subnational	National	See paragraph 6 of this document
Activities included	Reducing emissions from deforestation Enhancement of forest carbon stocks	On deforested land, both carbon losses and the gains associated with regrowth are considered by determining the net change in the biomass change maps. The conversion of forest plantations and agricultural cropland that meet the forest definition to other land uses is also considered as deforestation in the FRL. The enhancement of forest carbon stocks includes afforestation and/or reforestation of other land to forest with a canopy cover above 30 per cent and remaining in this land use for a minimum of 10 years (see paras. 7 and 35 of this document)
Pools included	Above-ground biomass Below-ground biomass Deadwood	Litter was not included as this pool was not considered significant. Soil organic carbon was excluded owing to a lack of reliable data (see paras. 32–33 of this document)
Gas included	CO ₂	Non-CO ₂ gases associated with biomass burning on forest land were not included owing to a lack of data (see para. 34 of this document)
Forest definition	Included	The operational definition of forest applied in constructing the FRL refers to any land with tree cover above 30 per cent, occupying a minimum area of 0.5 ha and with trees that have reached or can reach a height of 5 m. The forest definition used for compiling the national GHG inventory is based on that of FAO (see paras. 11 and 37–39 of this document)

<i>Main features of the FRL</i>		<i>Remarks</i>
Consistency with latest GHG inventory	Methods used for estimating the FRL are not consistent with those used for the latest GHG inventory	The methods, data and scope of estimation of emissions and removals from forest land in the latest national GHG inventory (2013) are not consistent with those applied in constructing the FRL (see para. 29 of this document)
Description of relevant policies and plans	Included	See paragraph 30 of this document
Description of assumptions on future changes to domestic policies, if included in the construction of the FRL	Not applicable	
Description of changes to previous FREL or FRL	Not applicable	
Identification of future technical improvements	Included	Several areas for future technical improvement were identified (see paras. 45–46 of this document)

Annex II

Documents and information used during the technical assessment

A. Reference documents

First BUR and 2017 national inventory report of Togo. Available at <https://unfccc.int/BURs>.

“Guidelines and procedures for the technical assessment of submissions from Parties on proposed forest reference emission levels and/or forest reference levels”. Annex to decision 13/CP.19. Available at

<https://unfccc.int/sites/default/files/resource/docs/2013/cop19/eng/10a01.pdf#page=36>.

“Guidelines for submissions of information on reference levels”. Annex to decision 12/CP.17. Available at

<https://unfccc.int/sites/default/files/resource/docs/2011/cop17/eng/09a02.pdf#page=19>.

IPCC. 2003. *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. J Penman, M Gytarsky, T Hiraishi, et al. (eds.). Hayama, Japan: Institute for Global Environmental Strategies.

Available at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html>.

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

Original and modified FRL submission of Togo. Available at

<https://redd.unfccc.int/submissions.html?country=tgo>.

B. Other documents

The following references have been reproduced as received:

Chave J, Réjou-Méchain M, Búrquez A, et al. 2014. Improved allometric models to estimate the aboveground biomass of tropical trees. *Global Change Biology*. 20(10): pp.3177–3190. Available at <https://doi.org/10.1111/gcb.12629>.

FAO. 2015. *Global Forest Resources Assessment 2015*. Rome: Food and Agriculture Organization of the United Nations.

Available at <http://www.fao.org/forest-resources-assessment/past-assessments/fra-2015/en/>.

Gardi O, Dangbo F, Dzigbod S and Bakabima D. 2020. *République Togolaise —Système Nationale de Surveillance des Forêts: Manuel de référence. Version NRF v1.1*. In case of questions, contact: *La Coordination Nationale REDD+ du Togo*.

GFOI. 2020. *Integration of Remote-Sensing and Ground-based Observations for Estimation of Emissions and Removals of Greenhouse Gases in Forests: Methods and Guidance from the Global Forest Observations Initiative*, Edition 3.0. Rome: Food and Agriculture Organization. Available at: <https://www.reddcompass.org/mgd>.

Ministry of Environment and Forest Resources (MERF). 2017. *Définition de la Méthodologie et des Outils pour l'évaluation de la Biomasse Végétale dans les Différents Compartiments au Togo*. (unpublished national report).

Mokany K, Raison RJ and Prokushkin A. 2006. Critical analysis of root:shoot ratios in terrestrial biomes. *Global Change Biology*. 12(1): pp.84–96. Available at <https://doi.org/10.1111/j.1365-2486.2005.001043.x>.

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

Available at <http://dx.doi.org/10.1016/j.rse.2014.02.015>.