Forest Reference Emission Levels (FRELs) for the Federal Republic of Nigeria: A Jurisdictional Approach focused on Cross River State

(MODIFIED EDITION)

Federal Republic of Nigeria

Federal Department of Forestry
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List of Acronyms

AD	Activity Data
CRS	Cross River State
CRSFC	Cross River State Forestry Commission
CRSMCCF	Cross River State Ministry of Climate Change and Forestry
DCC	Department of Climate Change
EFs	Emission Factors
FAO	Food and Agriculture Organisation of the United Nations
FME	Federal Ministry of Environment
FORMECU	Forestry Monitoring and Evaluation Coordinating Unit
FRA	Forest Resources Assessment
FRELs/FRLs	Forest Reference Emission Levels/ Forest Reference Levels
FRIN	Forestry Research Institute of Nigeria
FUTA	Federal University of Technology, Akure
GHG-I	Greenhouse gas Inventory
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Landuse, Landuse Change and Forestry

MCCF	Ministry of Climate Change and Forestry
MRV	Measurement, Reporting and Verification
NAGIS	Nasarawa State Geographic Information Services
NASRDA	Nigerian Airspace Research and Development Agency
NESREA	National Environmental Standards & Regulations Enforcement Agency
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
R-PP	REDD+ Preparatory Proposal
SLMS	Satellite Land Monitoring System
SPC	State Planning Commission
UNFCCC	United Nations Convention on Climate Change

1. Introduction

The Federal Republic of Nigeria welcomes the invitation to submit a Forest Reference Emission Levels (FREL) on a voluntary basis as expressed in Decision 12/CP.17, paragraph 13. This FREL submission is in the context of results-based payments for the implementation of reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+) under the United Nations Framework Convention on Climate Change (UNFCCC).

The government has followed the guidance provided by the UNFCCC through the decisions taken at the Conference of the Parties (CP), notably the modalities for forest reference emission levels and forest reference levels in Decision 12/CP.17 and the guidelines for submission of information on reference levels in the Annex of Decision 12/CP.17. This submission does not prejudge or modify any of Nigeria's Nationally Determined Contributions (NDCs) or Nationally Appropriate Mitigation Actions (NAMAs) pursuant to the Bali Action Plan.

The Government intends to take a step-wise approach to its national FREL development as stated in Decision 12/CP.17, paragraph 10. As such, the current FRL reflects the best available information at the time of submission at sub-national level. The scope and methodologies applied can be modified whenever improved data becomes available. The historical period considered, and/or the construction approach could also be revised.

2. FREL development process

The construction of the FREL was initiated during a workshop under the auspices and coordination of the Federal Ministry of Environment's Federal Department of Forestry from 24th to 26th May 2016, with support from the FAO-UN REDD Programme. The process was chaired by the National Secretariat of REDD+ hosted within the Federal Department of Forestry. Stakeholders drawn from various ministerial departments, universities and research institutions, NGOs, and CSOs from States and Federal Government participated in the workshop. Details of those involved can be consulted in Appendices 5 and 6. The technical team for the construction of the FREL is composed of national foresters, natural and environmental scientists, GIS and remote sensing experts drawn from relevant sectors and the mapping agencies of the Government, with technical support from a team of experts and consultants from FAO.

The entire FREL process was also subjected to a wider stakeholder consultation and review to ensure that it reflects the expectations of all stakeholders, and to also consider technical inputs from this broader group.

3. Scale of FREL: Area covered

While recommending that countries develop national FREL, the UNFCCC Conference of the Parties also decided that countries may start at sub-national level as an *interim* measure, depending on national circumstances. Nigeria opted for a REDD+ programme in which the Cross River State was selected as pilot State. Nigeria's REDD+ Programme envisioned a two-track approach to achieve REDD+ readiness, based on: (i) the development of institutional and technical capacities at Federal level, and (ii) consolidating four key UNFCCC requirements for REDD+ Readiness

(Warsaw Framework for REDD+ elements) on a pilot basis in Cross River State: REDD+ Strategy, Safeguards Information System, Forest Monitoring System, and Forest Reference Levels. The FREL has therefore been developed at CRS level as an *interim* measure.

The choice of CRS as pilot State was guided by the fact that it contains almost; 50% of the remaining tropical high forest in Nigeria, and secondly, the forest policies and governance favoured forest conservation and management, with CRS Forestry Commission playing a crucial role.

3.1 Geographical location and Vegetation of Cross River State

Cross River State is situated between latitudes 5° 32'N and 4° 27'N and longitudes 7° 50'E and 9° 28'E (Figure 1) and occupies about 20,156 km^2. The ecological zones present in Cross River State (CRS) as documented by Oyebo et al. (2010) include: lowland rainforest, freshwater swamp forest, the mangrove vegetation, coastal vegetation, montane vegetation, savanna like vegetation, and wetlands (Figure 2).

The **lowland rain forest** covers extensive areas in the centre, north and east of Cross River State, and is contiguous with the forests of South West Cameroon. Although significant areas have been converted into agricultural farmlands and natural forests have been disturbed by indiscriminate felling and wood removal, the State is still home to the largest contiguous and well-preserved fragments of natural forest in Nigeria.

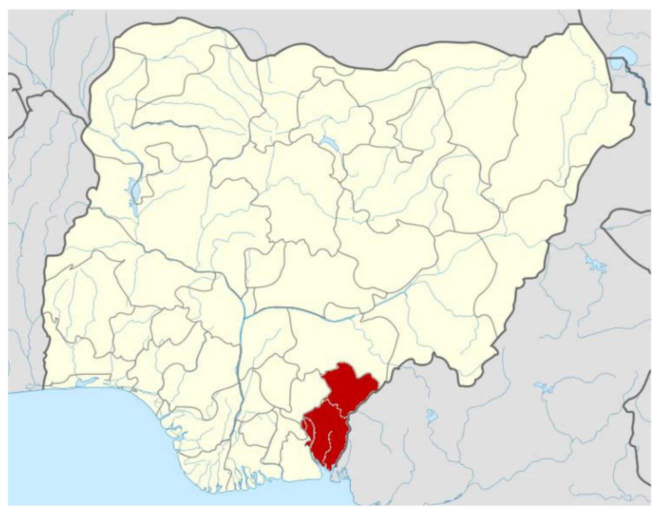


Figure 1. Map of Nigeria showing the location of Cross River State (CRS)

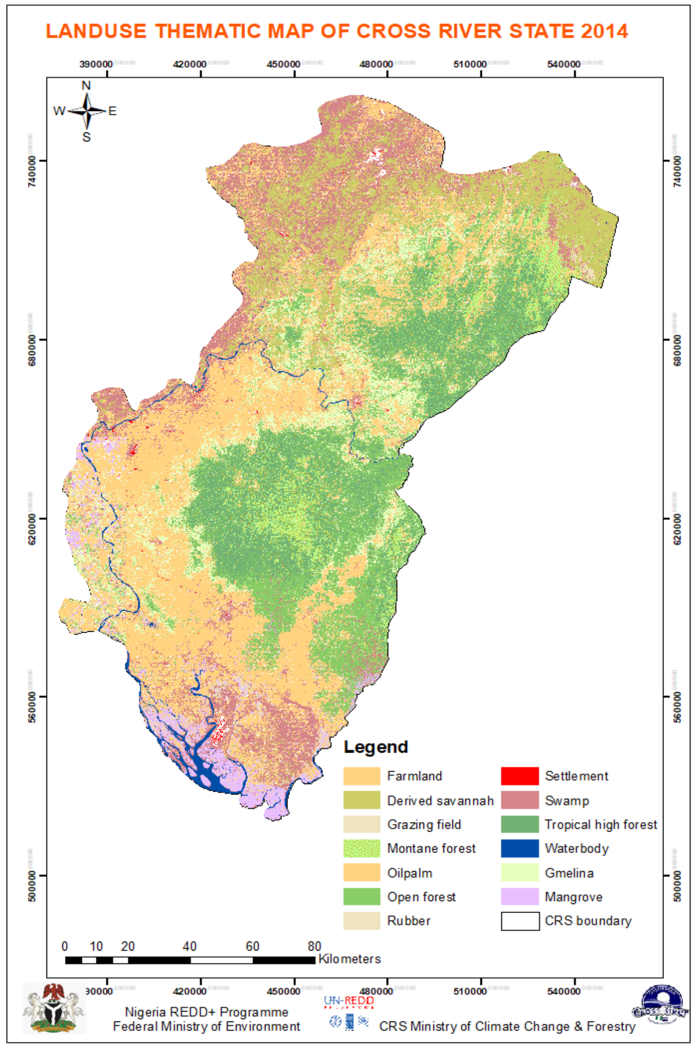


Figure 2. Landuse/Landcover Map of Cross River State
(Adapted from NASRDA and not based on Nigeria Forest Definition)

The **Mangrove forest** in the State forms a narrow belt along the coast and in the estuary of Cross River. Mangroves are dominated by the following species: *Rhizophora racemosa, R. mangle, Avicennia africana* and *Laguncularia racemosa. R. racemosa* is the biggest of the R*hizophora spp,* and can attain heights of up to 40 meters and accounts for up to 95% of the species content of the mangrove forest. However, the mangroves are threatened by the exotics Nypa Palm, *Nypa fruticans,* that was introduced into Calabar and Oron between 1906 and 1912 from South East Asia. The palm tends to form pure stands and isolate endemic mangrove trees.

The **freshwater swamp forest** forms a wide belt immediately north of the mangrove vegetation zone, and has more open canopy and dense tangled undergrowth. It is usually flooded during the wet season and dries out during the dry season leaving portions of dry forest floor interspersed with permanent pools of water. Much of this vegetation type has been converted to agricultural and urban lands, and the original swamp forest remains mostly on alluvial sites along the major rivers: The Cross River, Calabar River and Great Kwa River.

The **coastal vegetation** is found at the outer edges of the mangroves and is composed of a mosaic of forest, thickets, and mangroves. Prevalent species include *Chrysobalanus orbicularis, Conocarpus erectus,* and *Hibiscus tiliaceus.*

The **montane vegetation** is predominant in the north eastern parts of the State on the Oshie Ridge of the Obudu Plateau around the border with Cameroon to the east and Benue State to the north. The highest peak is about 1,819 m above sea level. The vegetation type includes the lowland rain forest in the low lying areas progressively enriched with montane elements. The common woody plant species include *Xylopia Africana, Rauvolfia vomitoria, Tabernaemontana ventricosa,* and *Voacanga trouarsii.*

The **savanna-like vegetation**, probably attenuated variants of degraded rainforest occurs in the central (Yakurr) and northern (Obudu) areas of the State. These formations are characterized by relic rain forest species such as *Celtis zenkeri, Cola gigantea, Anthonotha macrophylla* and *Treculia africana*.

The **wetlands** in Cross River State are found at the Cross River Estuary, the Cross River Flood Plains at Obubra as well as scattered swamps or flood plains. They are made up of a mixture of seasonally flooded riparian lowland forests and tall grass swamps in the catchments of Cross River and its Enyong creek tributary. Some of the plant species found in these wetland areas include: *Nymphaea lotus, Vossia cuspidata*, *Echinochloa pyramidalis, E. stagnina, Ragmites sp, Leersia hexandra, Ipomoea asarifolia* and *Mimosa pigra.*

4. Scope: Activities, Pools and gases included

4.1 Activities included

The Cancun Agreement defines REDD+ activities as follows: reduction of emissions from deforestation, reduction of emissions from forest degradation, sustainable management of forests, enhancement of forest carbon stocks, and conservation of forest carbon stocks. Deforestation is the conversion of forest land to non-forest land (cropland, grassland, settlement, wetlands and other lands). Forestland is considered as in the forest definition adopted for Nigeria (see **section 6**), and any conversion below the threshold of forest definition is considered deforestation. Forest degradation results in the loss of carbon stocks and biodiversity in the forest remaining forests category, while enhancement is the enrichment in carbon stocks and biodiversity in forest remaining forest. While forest degradation (from logging, fuel wood extraction, charcoal production, forest fires, etc.) constitute a significant source of emissions, it has not been included in the present FREL due to lack of reliable, accurate and consistent data at state and federal levels. However, it is envisaged that forest degradation will eventually be included in a stepwise manner, as data becomes available. Nigeria considers the REDD+ activity "enhancement of forest carbon stocks" to be both enrichment in carbon stocks in forest remaining forest, as well as enrichment in carbon stocks through afforestation/reforestation and natural regeneration of forest.

The country has promoted natural forest restoration and plantation silviculture that leads to reduction in emissions from deforestation and forest degradation. However, no reliable data on forest degradation is available, so this REDD+ activity has not been included in the present FREL submission. There is also no reliable data for sustainable management of forests to be included. The area of afforestation (enhancement of forest carbon stocks in forest land remaining forest land) was also assessed by Nigeria but the confidence value is currently very large and it still needs to be investigated how to assess the associated removal factor from the NFI data. Hence, only deforestation has been considered in the present FREL submission. Nigeria admits the fact that significant pools and/or activities should not be excluded from the FREL/FRL.

4.2 Pools included

While IPCC recognises five carbon pools: above ground (live tree) biomass, belowground (live tree) biomass, deadwood (standing and lying/down), litter, and soil organic carbon; only significant pools need to be included (cf. SBSTA Decision from COP17). Key category analysis is needed to determine which carbon pools should be included to capture significant emissions and removals from changes in forest cover, taking into account their magnitude and cost-effectiveness to monitor the pools. The above-ground biomass constitutes the main component/largest pool and has been included in the FRELs/FRLs. Belowground biomass constitutes a significant pool however, its estimation is expensive and was indirectly undertaken using IPCC default root-to-shoot (R/S) ratio. Deadwood may also constitute a significant pool to be included, however, the deadwood pool was not consistently estimated during the inventory. The inventory undertaken measured standing deadwood but the categories were not noted so it was difficult to analyze the data. Data for coarse woody debris (down deadwood) was collected but since standing deadwood data was incomplete, the deadwood pool was left out of this submission see section 5.2. With the present inventory design for national FRLs, data will be collected to estimate deadwood pool.

The 2006 IPCC Guidelines do not provide default values for deadwood (see Table 2.2: Chapter 2, IPCC 2006).

For tropical forests litter pools are usually small except for peatlands. According to the 2006 IPCC Guidelines, litter pool can be estimated at a tier 1 level for deforestation. The 2006 IPCC Guidelines provide a default value of 2.1 tC/ha for tropical broadleaf deciduous forests (see Table 2.2: Chapter 2, IPCC 2006). This is barely about 1.2% of the above ground biomass (175tC/ha: see updated Table 2) or 0.8% of total above and below ground biomass; and can be considered negligible or insignificant.

Soil organic carbon (SOC) is an important carbon pool, however major changes only occur when forest is converted to non-forest, and after a long time.. The conversion of Forest Land to Cropland or other non-forest land uses as a result of deforestation can result in significant emissions from the soil (IPCC 2006). According to the 2006 IPCC guidelines soil organic carbon should be estimated at a tier 1 level for all considered REDD+ activities; however this was not considered in this submission due to the data demands on the replacing landuse, its management and inputs on which Nigeria would have to make major assumptions. According to the harmonized world soil database (HWSD: Batjes, 2009) Cross River has mainly low activity clay (LAC) soils with some wetland soils in the coastal region and montane soils in the north east meaning emissions from drainage of organic soils may be negligible.

Litter and non-herbaceous biomass pools constitute a small proportion of biomass and has not been included. For tropical forests litter pools are usually small except for peatlands. According to the 2006 IPCC Guidelines, litter pool can be estimated at a tier 1 level for deforestation. The 2006 IPCC Guidelines provides a default value of 2.1 tC/ha for tropical broadleaf deciduous forests (see Table 2.2: Chapter 2, IPCC 2006). This is barely about 1.2% of the above ground biomass (175 tC/ha: see updated Table 2) or 0.8% of total above and below ground biomass; and can be considered negligible or insignificant.

4.3 Gases included

Among the three greenhouse gases associated with land use change emissions, namely carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), CO_2 is the main gas emitted in the forest sector. However, significant non-CO_2 gases (CH_4 and N_2O) can also be emitted when land use change is as a result of fire incidences. Unfortunately no data exist on forest fire. However, based on our knowledge of the region we can conclude that fires are relatively controlled and not very frequent, as such emissions from fire are not expected to be significant. Methane is also produced when mangroves are disturbed, but no data exist in Nigeria at the moment. Therefore, only CO_2 emissions have been considered in the present submission.

5 Estimation of Historical Emissions

IPCC (GPG 2003 and Guidelines for National GHG Inventories in AFOLU, 2006) provides the framework for estimating emissions and removals of CO_2 in the AFOLU sector. Two basic inputs needed are: Activity data (AD: i.e. changes in areal extent of forest land (ha/year)) and emission factors (EF: that is, emissions/removals of GHG per unit area: tCO_2/ha of deforestation). The product of AD by EF produces an estimate of the amount of emissions/removals in a given year as a result of the activity.

IPCC present three approaches (1-3) for estimating AD and three Tiers (1-3) for estimating EF. The estimation of historical emissions therefore requires estimates of historical activity data and emission factors.

5.1 Activity Data

Activity data is mostly obtained from land use change studies using satellite imagery. Several land use studies have been undertaken in Nigeria; however, their use is limited due to the fact that they were sample-based (not '*wall-to-wall*'), and used different methodologies and classification systems. The only study that produced wall-to-wall estimates of land use change was the 1976/78 and 1993/95 Vegetation and Landuse Assessment by FORMECU, Federal Department of Forestry. The study also produced a national classification system for Nigeria that is being used for reporting of global forest assessment (e.g. FRA2015 for Nigeria). In the absence of consistent datasets, the National Space Research and Development Agency (NASRDA) of Nigeria was contracted by FAO to design and undertake a "*wall-to-wall*" spatially-explicit study at Cross River State. The study led to the production of land use and land use change data and maps for 2000-2007-2014 time periods or epochs (NASRDA 2015). The national classes were also aggregated into the six IPCC classes. However, change in the NASRDA map was assessed through post-classification which risks to result in high uncertainties for the change assessed (Tewkesbury et al 2015). Initially accuracy assessment was done only for each time period and not between time periods or for transitions. An initial verification of the change assessed by the map was done comparing the loss found by NASRDA between 2000-2014 with loss found by the Global Forest Change product from the University of Maryland (Hansen et al 2013) between 2000-2014. NASRDA assessed deforestation between 2000-2014 at 332,338 ha (or 23,738 ha/yr), while the GFC map assesses 51,174 ha (or 3,655 ha/yr) for the same period. The large discrepancy between these two assessments suggested the need for an accuracy assessment of change (loss) as assessed by both maps. The method proposed by Olofsson et al 2014 is applied to evaluate whether one of the two maps could form an appropriate input for AD. The Olofsson method is described in the proceeding paragraphs.

For its January 2018 FREL submission, Nigeria performed an accuracy assessment on the NASRDA and global forest change map (also referred to as Hansen map) for the classes stable forest, stable non forest, forest loss and forest gain. The overall weighted accuracy of both the NASRDA map and the Hansen map, were 33% and 83% respectively. However, user and producer accuracy for loss and gain were low (<20%) for both maps providing an indication that neither of the map areas (or pixel counts) are sufficiently accurate to directly translate into AD. For this reason, Nigeria proposes to use area statistics based on reference data following the procedure described in Olofsson et al 2014 which can be considered a combination of a wall-to-wall map including change classes and sample-based reference data. In this method, one of the maps is used to stratify the reference data points to be collected to ensure sufficient representation in the rare classes of change (forest loss and forest gain). The resulting area statistics are referred to as stratified area estimations. Reference data concerns interpretations of satellite data of greater quality with respect to both resolution and accuracy than remote sensing-based map data. GFOI (2016) suggests for accuracy assessment and estimation to be valid for an area of interest using the familiar design or probability-based framework (McRoberts, 2014), the reference data must be collected using a probability sampling design, regardless of how the training data used to classify for example a satellite image are collected. Probability sampling designs to consider are simple random (SRS), systematic (SYS), stratified random (simple random sampling within strata) or systematic sampling within strata (STR), and two-stage and cluster sampling. Nigeria used stratified random sampling using the Hansen map for stratification into forest loss, forest gain, stable forest and stable non-forest. The minimum number of reference data points to be collected per stratum were assessed following the formulas by Cochran (1977 in Olofsson et al 2014). This method assesses the accuracy of the map and stratified area estimates based on the reference data with associated confidence intervals.

For the initial FREL submission in January 2018, Nigeria considered the period 2004-2014 in the submission seeking to be in line with the FCPF methodological framework which suggests 10 years as the preferred historical period for a FREL. During the technical assessment of the initial FREL submission, Nigeria decided to submit a modified FREL as an improvement on the initial submission. Since Nigeria found the accuracy of the change classes in both the NASRDA and Hansen maps to be poor, it started to create a new and improved direct change detection for a more accurate map. As the country was creating mosaics for the two years marking this period, it was discovered that no sufficient good quality imagery was available around the year 2004. As such, due to technical constraints, the period 2000-2014 was selected instead. The direct change detection was started by Nigeria in the SEPAL platform (https://sepal.io) but has not been finalized in time for the modified FREL submission, reason why currently Nigeria used the Hansen map for stratification for its modified FREL submission. Creating a more accurate map of forest area change is identified by Nigeria as an area for improvement and the country intends to continue to work on this.

Nigeria created a map with stable forest, stable non-forest, forest loss and forest gain based on the Hansen map with a tree cover threshold of 15% and a loss period from 2000-2014 (Figure 4). The AD is however derived from the reference data, the Hansen map is only used for stratification and the final estimates do not correspond to the areas in the Hansen map. The map in Figure 4 most likely included loss of forest cover where trees grow back and the use remains forest, i.e. it will likely include temporary destocked forest lands (unless the forest was lost shortly after the year 2000 and cover was restored in the year 2014). As there's quite some oil palm plantations, including older stands, in Cross River State, harvesting of these (i.e. cropland remaining cropland) could result in false detection of forest loss in the map since oil palm could be incorrectly detected as forest. This necessitates the use of visual interpretation to ensure a land use classification rather than a land cover classification. As explained, for the collection of its AD, Nigeria used the stratified area estimator approach, a methodology which is explained in Olofsson et al 2014. In this approach, the actual data collection was based on reference data which was stratified along the classes in the map. For the collection of reference data, Nigeria used all available imagery including 2016 imagery, if available of high resolution. In case the imagery revealed replanting or restoration with tree sapling establishment the reference samples are interpreted as stable forest. Therefore, we expect the deforestation estimate not to include temporarily destocked forest or to a minimal extent.

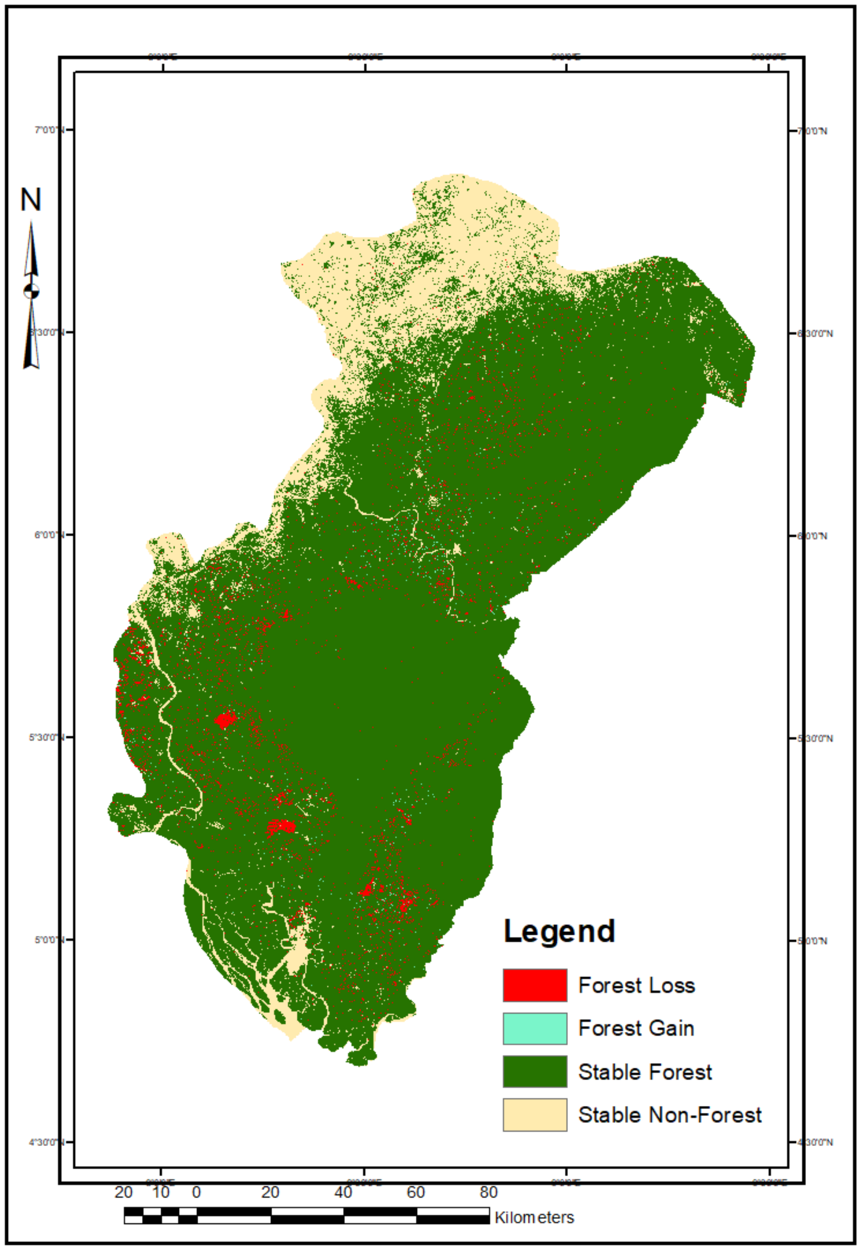


Figure 3. Change Detection Image (2000 - 2014) from Hansen Map

The AD collection for the modified FREL submission saw the country interpreting a total of 1,021 samples used for the final stratified area estimates using the Hansen map in Figure 3 for stratification and focussing on 2000 – 2014 as loss layer. The reference data were as usual, generated and interpreted by the Nigeria REDD+ Team with the aid of Collect Earth tools. The error matrix and the stratified area estimates for the four classes (Stable Forest, Stable Non-forest, Forest Loss and Forest Gain) is calculated in excel applying the formulas as found in Olofsson et al 2014. The results of the AA are found in Table 1, Figure 4 and Appendix 1.

The improvement implemented by Nigeria during the technical assessment resulted in a lower (more conservative) estimate of deforestation and saw the confidence interval reduced from +/- 34% to +/- 24% (see Table 1). The accuracy of the Hansen map remained poor (overall weighted and accuracy of the change classes), in line with expectations since no improvements were made to the map. The gain estimate was equally improved with the confidence interval dropping from 57% to 45%. Nigeria intends to include the activity of enhancement of forest carbon stock by the conversion of non-forest land into forest land (afforestation/reforestation) in the future and identified this as an area for improvement**.** Overall Nigeria is of the opinion that these results are an improvement compared to the initial submission and provided important lessons learned for the preparation of the national level FREL.

Table 1. Results of Accuracy Assessment and Stratified Area Estimation for Forest Classes

	Results stratified area estimates for initial submission using Hansen (428 samples)	**Results stratified area estimates for modified submission using Hansen (1021 samples)**
Weighted overall accuracy Hansen map (%)	**83**	**73**
Stratified Area Estimate loss (ha/year)	**15,440**	**9,176**
Confidence Value loss (%)	**+/- 34**	**+/- 24**
Stratified Area Estimate gain (ha/year)	**6,029**	**2,858**
Confidence Value gain (%)	**+/- 57**	**+/- 45**
Forest area	**1,668,352 ha**	**1,366,929**

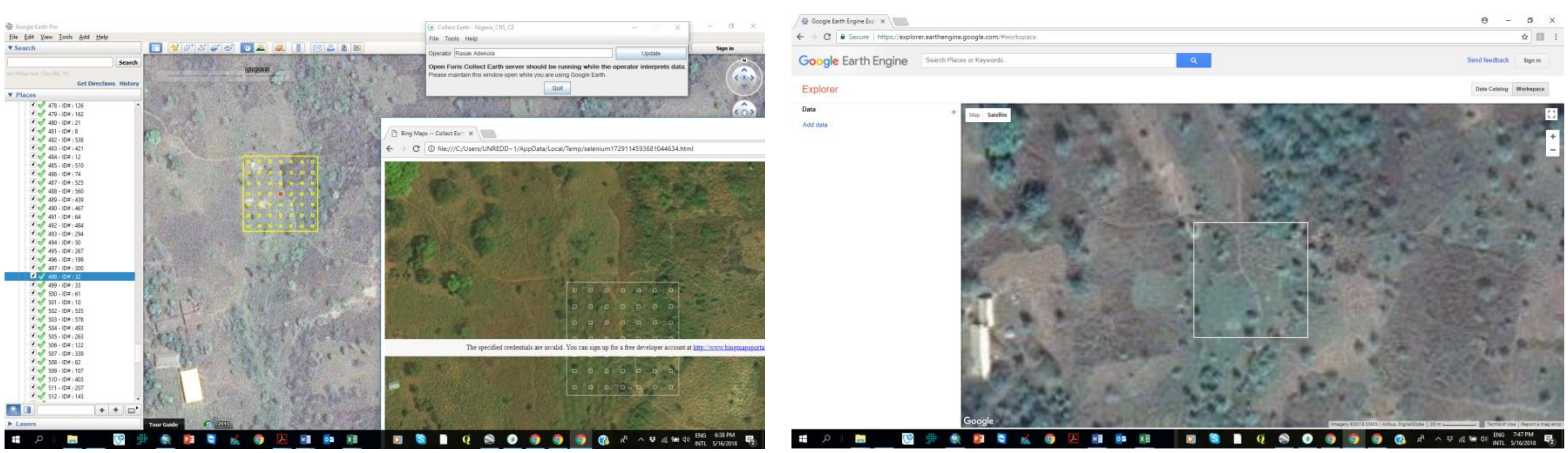
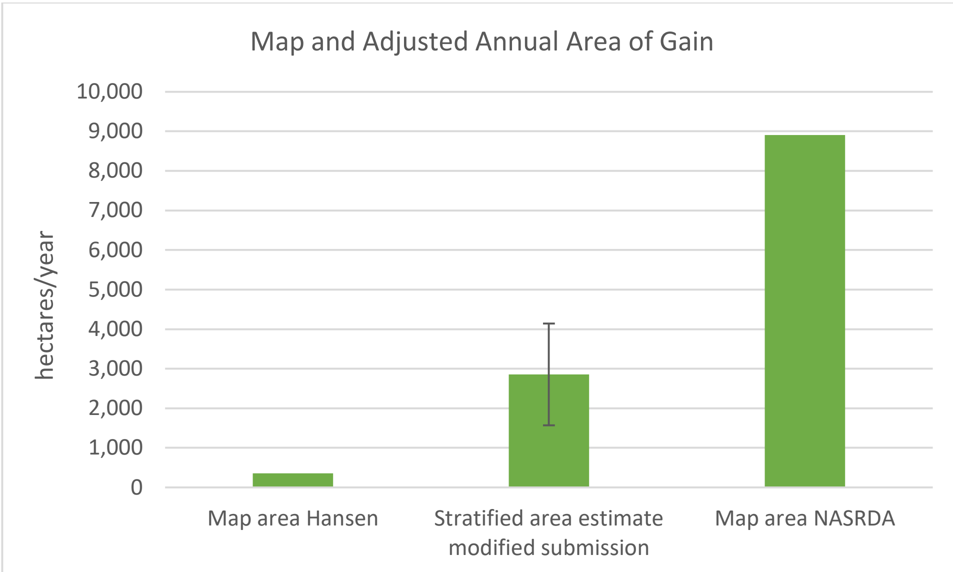


Figure 4. Screenshots of Collect Earth Platform with High Resolution Image of a Reference Point



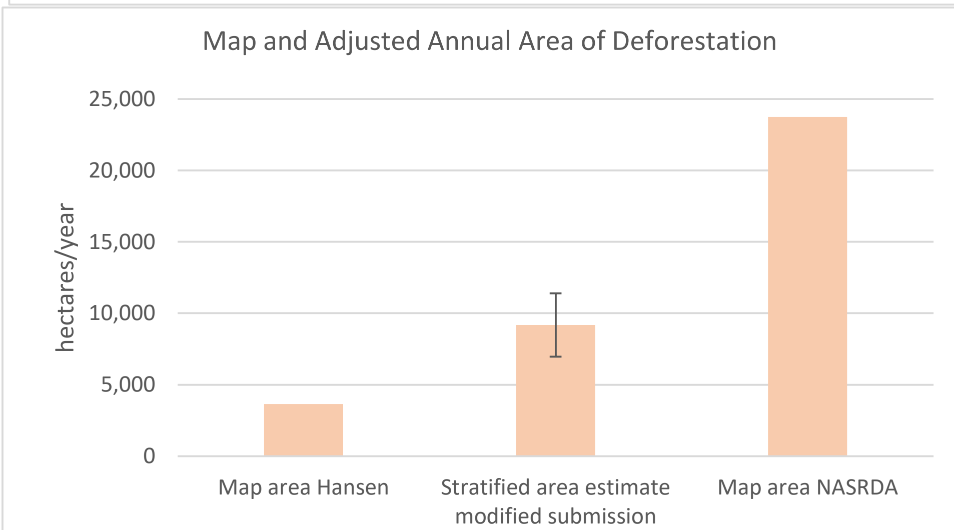


Figure 5. Map areas and stratified area estimates gain

5.2 Emission factor estimation

Emission factors are derived from forest inventory data. However, a review of historical inventories in Nigeria and CRS indicated a lot of limitations in their usage for biomass estimation, and carbon stocks; and hence, their use for estimating emission factors for REDD+ purposes. The inventories were originally designed for timber volume estimation for commercial tree species and not for all tree species, and estimations were limited to bole volume, and not all carbon pools. In order to circumvent this situation a forest carbon inventory was designed and implemented at CRS. The study was jointly funded by UN REDD Programme and GCF (Governors Climate Fund). A total of 80 sample plots were established for field data collection. The spatial distribution of the plots is shown in Figure 3. The sampling frame was overlaid on the 2014 land use map produced by NASRDA (2015) while information from a preliminary inventory by Winrock International was used to optimize the design. 5

5.2.1 Inventory Design

The sampling design consisted of nested sample plots that were randomly distributed across 13 land use categories of CRS as depicted in the current 2014 land use thematic map for the state, prior to the commencement of the field work. The plot distribution aspect was guided by two criteria – (i) extent of each of the 13 land use categories; and (ii) carbon contribution in each of the land use categories. 16 plots were established in the tropical high forest, 12 in the open forest, 13 in farm land/fallow lands, 8 in mangroves, 11 in swamps, 6 in montane forest, 5 in derived savanna, 3 in Gmelina plantations and 3 in grazing fields. A **stratified random sampling design** was used in order to capture spatial variability of land-use types and forest carbon stocks.

5.2.2. Sample plots layout and data collection

Each plot was composed of four nested sub-plots of 35m x 35m (**Nest 1**), 25m x 25m (**Nest 2**), 7m x 7m (**Nest 3**), and 2m x 2m plot (**Nest 4**) (**Figure 4**). In **Nest 1** all living and dead standing trees greater than 50 cm dbh were measured for dbh. Trees between 20 cm and 50 cm were measured in **Nest 2**, while those between 5 cm and 20 cm were measured in **Nest 3**. Saplings were identified by species and counted on a 2m x 2m (**Nest 4**). Standing and lying dead wood was collected, but was not used because decomposition classes were not consistently assessed in all plots.

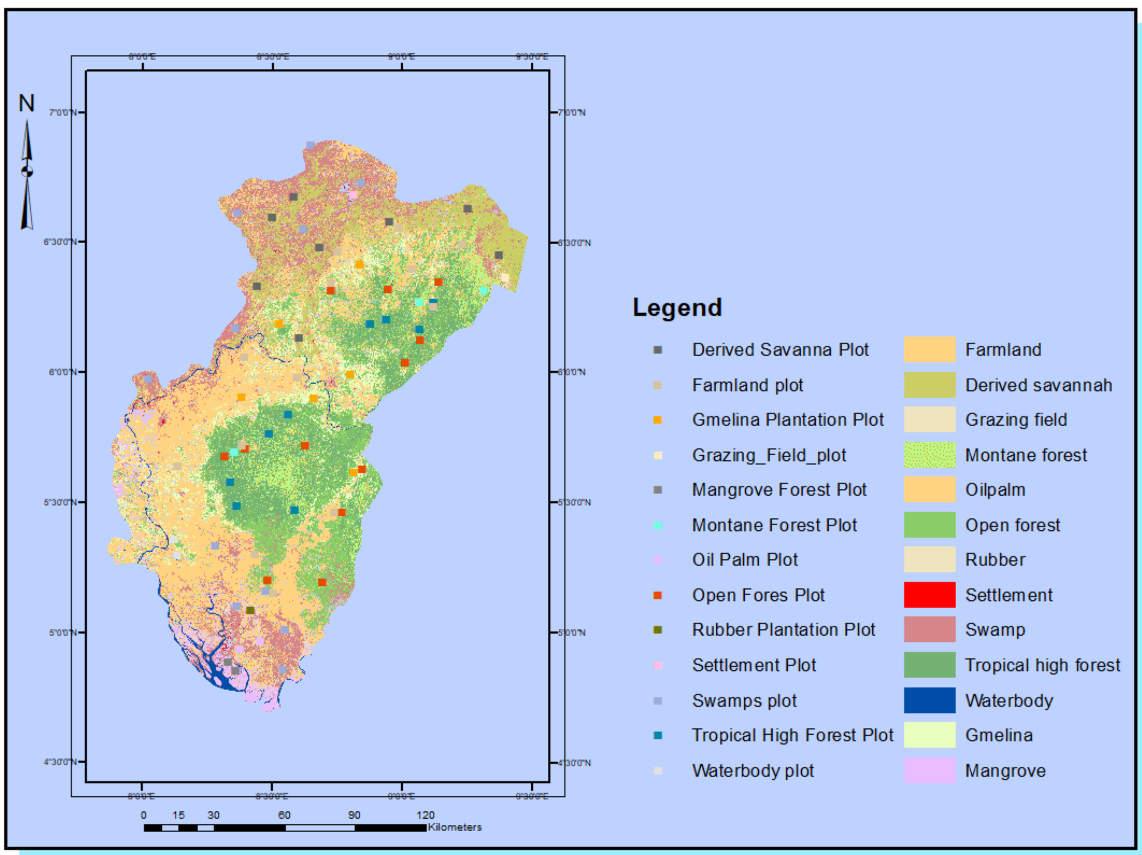


Figure 6. Spatial distribution of stratified sample plots used in estimating emission factors

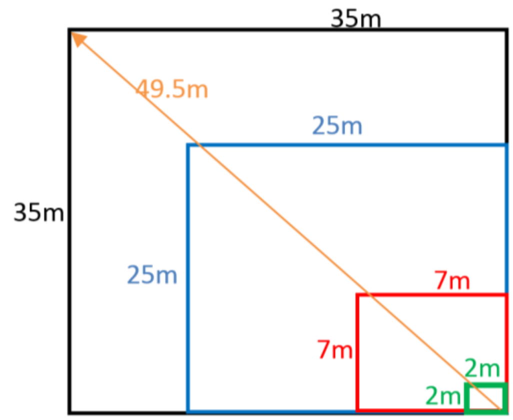


Figure 7. Nested plot design for data collection

For data collection in mangroves, three (10x20 m) plots were laid on 100 m transects at 10 m intervals as shown in **Figure 9** (cf. Ajonia 2008).

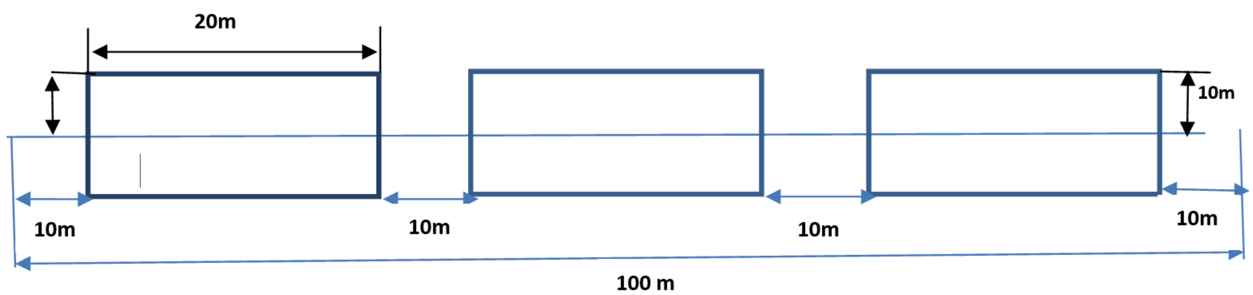


Figure 8. Transect sample plots for mangroves data collection

5.2.3 Data Analysis

5.2.3.1 Above Ground Biomass

The conversion of field data collected to biomass and carbon stocks require the use of biomass allometric equations. In the absence of country-specific allometric equations, a pan-tropical allometric equation by Chave *et al* (2014) below was used to estimate above ground biomass from field measurements.

$$AGB_{est} = (0.0673\rho D^2 H)^{0.976}$$

Where:

AGB_{est} = above ground biomass (kg)

ρ =species wood density (g/cm3)

D=diameter at breast height (cm)

H=tree height (m)

The equation also requires an estimate of tree height, and wood density. Given that tree heights were not measured during the inventory, we resorted to the use of a height-diameter equation developed by Feldpausch *et al* (2012) for West Africa:

H=53.133*(1-EXP(-0.0331*DBH^0.839),

while wood density estimates were obtained from Zanne *et al*. (2009).

For above ground biomass of mangroves the following equations for all mangrove species by Komiyama *et a*l (2005) is the most widely used (cf. Komiyama et *al*. 2008; Kauffman and Donato, 2012; Allemayehu et *al*. 2014.):

For above ground biomass (including stilt): $W_{top} = 0.251.\rho.D^{2.46}$: R^2=0.98, n=104

5.2.3.2 Below Ground Biomass

The estimation of below ground biomass (BGB) is difficult and expensive to undertake in most tropical high forest, and few country-specific allometric equations exist for BGB. Most projects or studies therefore resort to the use of a proxy root-to-shoot (R/S) ratios (Kauffman and Donato, 2012). In the present study we used a ratio equation for moist tropical forests developed by Mokany *et al*. (2006; also reported in the IPCC 2006 AFOLU), which predicts below ground biomass (BGB) based on above ground biomass (AGB) as follows:

$$\boldsymbol{BGB} = \begin{cases} \mathbf{0.235} * \boldsymbol{AGB\ if\ AGB} > 62.5\boldsymbol{t\ C/ha} \\ \mathbf{0.205} * \boldsymbol{AGB\ if\ AGB} \le \mathbf{62.5\ t\ C/ha} \end{cases}$$

Belowground biomass for **mangroves** (excluding stilt) was estimated using the following equation by Komiyama *et al* (2005) :

$$W_{root} = 0.199.\rho^{0.899}D^{2.22}$$

R^2=0.95; n=26.

5.2.4 Estimation of Carbon content

The carbon content of biomass was estimated by applying a conversion factor of **0.47** to total biomass, 0.47 is default carbon fraction or conversion factor applicable for tropical and sub-tropical species (range 0.44 - 0.49) (see Table 4.3 Chap. 4. IPCC 2006), while the carbon dioxide equivalent (CO_2e) was computed by multiplying the carbon content by **3.67** (44/12) (IPCC 2003, 2006). **Table 2** presents summary results for the estimation of above ground biomass (AGB), below ground biomass (BGB) and carbon stocks for different forest types at Cross River State. Biomass and carbon stocks for **Forestland** was estimated as a weighted average of the mean values estimated for different forest types (open forest, tropical high forest, montane forest, mangrove forest, etc.) using stratified sampling technique (cf. Freese 1976; Avery and Burkhart, 2002).

Table 2. Summary results for above ground biomass (AGB), below ground biomass (BGB) and carbon stocks for different forest types at Cross River State

Land use Type	ABG (t/ha)	ABG (tC/ha)	BGB (tC/ha)	ABG (tCO2/ha)	BGB (tCO2/ha)	Total Biomass (tCO2/ha)
Derived Savanna (4)	99.65±132.6	46.84±62.30	20.91±28.4	171.73±228.5	76.67±104.20	248.0±332.6
Farmland(9)	80.58±56.8	37.87±26.69	16.52±11.64	138.86±97.87	60.57±42.69	199.4±140.5
Gmelina	162.85±54.3	76.54±25.56	34.11±8.98	280.64±93.71	125.08±32.92	405.72±126.00
Montane (5)	**528.46**±240.91	**248.37**±113.23	**112.10**±53.32	**910.70**±415.18	**411.04**±195.52	**1321.74**±610.49
Open Forest (14)	311.41±119.72	146.36±56.27	67.57±27.45	536.67±206.32	247.76±100.66	784.43±306.92
Swamp (7)	76.42±51.94	35.92±24.41	15.67±10.65	131.70±89.51	57.44±39.04	189.15±128.55
Tropical High Forest (15)	531.71±190.17	249.90±89.38	115.82±43.66	916.32±327.73	424.68±160.10	1341.00±487.78
Mangroves (7)	380.57±210.64	178.87±99.00	163.15±72.24	655.85±363.00	598.23±264.89	1254.08±626.59
Forest Land*	373.48±68.16	175.53±31.39	89.65±16.05	643.63±115.11	328.74±58.86	972.37±173.9

*Forest Land values were calculated as a weighted average of the means from the different forest type estimates.

6. Forest Definition

When submitting a FRELs/FRLs to the United Nations Framework Convention on Climate Change (UNFCCC), countries are expected to provide a definition of what they mean by forest in their FREL/FRL construction and, demonstrate how the definition is in line with the definition used in the national GHG inventory or in other international reporting. Forest definition in the context of REDD+ has to take into account UNFCCC thresholds which are currently defined as follows:

- Minimum tree crown cover between 10 and 30%
- Minimum land area between 0.05 and 1 hectare
- Minimum tree height between 2 and 5 meters (at maturity *in situ*)

Nigeria had no country-specific forest definition, but had been using the FAO FRA default definition for forests, which is defined as follows: *"Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use".*

During the workshop of 24th to 26th May 2016, participants went through brain storming sessions in order to craft a forest definition for FREL purposes. An initial stage involved an appraisal of existing definitions and/or descriptions of forest in the forest laws, policies and Acts and other documents. After general heated discussions, a technical working group was tasked to work on the draft version (see **Appendix 5**). They explored and reviewed some policy documents, at Federal and State levels, in order to have an in-depth understanding of what the law and policies documents consider as forest across the different States. Based on the above background information, participants arrived at the following functional forest definition for FREL/FRL in Nigeria.

*An ecological community predominated by trees and other layers of woody plants with a minimum area of **0.5ha**, a minimum tree height of **3metres**, and a minimum tree canopy cover of **15%**, or stands with potentials to reach the above thresholds in situ.*

The above Forest Definition applies to the entire country and was provided after due consideration for the ecological variations including the characteristic strong latitudinal zones which become progressively drier as one moves north from the coast. In other words, the definition has to a large extent, taken care of the progressive variations from the Mangrove Swamp and Coastal Vegetation in the south to the Sahel Savanna in the north. It is important to note that, the definition would be used in future GHG inventory reporting such as national communications and the Biennial Update Reports (BUR).

Table 3. CRS Ecological zones and their Tree species

S/N	Ecological zones	Area (Km2)	Description
1	*Lowland Rain Forest*	8,307	Characteristically stratified into three layers: 1) the upper or emergent layer (40 to 50 m high) consists of scattered, very tall trees that do not form a continuous canopy, 2) the middle layer (16 to 40 m high) is also discontinuous, but taken together with the upper layer forms a continuous canopy, and 3) the lower tree layer (10 to 16 m high) forms a more or less continuous canopy below the tree layers are the shrub and herb layers that contain more young trees and seedlings than mature shrubs the drier northern areas are characterised by the presence of the *Sterculiaceae* family (e.g., *Triplochitonscleroxylon, Sterculia tragacantha,* S. *rhinopetala,* S. *oblonga, Nesogordonia papaverifera, Mansonia altissima, Cola gigantea,* C. *millenii, Pterygota macrocarpa,Hildegardia barteri)* and *Terminalia superba, Ricinodendron heudelotii, Aubrevillea kerstingii* and *Khaya grandifoliola* • the families *Ulmaceae* and *Moraceae* are also well represented by *Celtis brownii,* C. *mildbraedii,* C. *zenkeri, Holoptelea grandis, Trema guineensis, Morus mesozygia, Chlorophora excelsa, Antiaris a.fricana, Ficus spp.* and *Bosqueia angolensis* • some species (i.e., *Triplochiton scleroxylon* and *Terminalia superba)* also extend into the wetter parts of the Lowland Rain Forest where they usually behave as serval species colonizing open abandoned farmland • in the wetter, more southern areas of the Lowland Rain Forest Ecological Zone, the families *Meliaceae* and *Leguminosae* are predominant • common species are the valuable mahogany timbers *(Khaya ivorensis, Entandrophragma spp., Lovoa trichilioides, Guarea cedrata* and G. *thompsonii)* and leguminous trees such as *Cy/icodiscus gabunensis, Gossweilerodendron balsamiferum, Hylodendron gabunense, Distemonanthus benthamianus* and *Piptadeniastrum a.fricanum* • in wetter coastal areas the family *Sapotaceae (i.e., Mimusops spp., Omphalocarpum spp.)* assumes an important place, and the timber trees *Lophira alata* and *Nauclea diderrichii* are often abundant
2	*Freshwater Swamp Forest*	438	• most extensive freshwater wetland type found in Nigeria • consist entirely of slender trees (30 to 50 m high) many of which have stilted roots typically, the main canopy is rather open and in the gaps, dense tangles of shrubs and lianes form an almost impenetrable undergrowth • climbing palms *(Ancistrophyllum, Eremospatha* and *Calamus)* with hooked spines are particularly characteristic as are clumps of aroids such as *Cyrtosperma senegalense* • large trees (up to 45 m tall) such as *Mitragyna ci/iata, Spondianthus preussii, Lophira alata,* (on better drained parts only), *Anthostema aubryanum,* and *Alstonia congensis* occur together with smaller trees (up to 20 m tall) such as *Nauc/ea gilletii, Berlinia auriculata, Grewia coriacea, Uapaca spp.* and *Carapa procera* • a number of the trees have stilt roots • the outer fringe vegetation is less than 14 m high and is composed mostly of *Raphia* palm with *Lonchocarpus griffonianus* • :in creeks and lagoons the waterlily *Nymphaea lotus* is often abundant, so too are floating communities of *Pistia stratiotes, Lemna, Salvinia* (a tiny water fern), *Jussiaea repens vardiffusa,* species of *Ipomoea* and *Impatiens,* and grasses
3	Montane Forest	113	• located above altitudes of 1000 m • characterised by a tree canopy that is often irregular and discontinuous • composed of such species as *Polyscias ferruginea, Entandrophragma angolense, Turraeanthus africanus* and at higher altitudes *Schejjlera hookeriana,* and species of *Ficus* and *Conopharyngia* • may be referred to as "mist forest" because it is commonly enveloped in mist for long periods of time which results in a profusion of mosses and various kinds of epiphytes such as orchids and begonias • tree fern *(Cyathea manniana)* is abundant especially in more open areas • at 1500 to 1800 m the forest is drier and more stunted - *Syzygium staudtii, Schejjlera abyssinica, S. mannii, Lachnopylis mannii* and *Pittosporum mannii* are typical trees • lichens beard the tree branches • tall, shrubby Acanthaceousplant *Mimulopsis violacea,* plus one or two other *Acanthaceae,* form an extensive understorey • this class also includes the transition area between true forest and montane grasslands, where marginal forest and thickets are more dominant than grassland • marginal forest occurs in clumps and along old lava streams • in marginal forest *Lasiosiphon, Hypericum* and *Agauria* cover considerable areas - all trees are covered with masses of white lichen. • the shrub *Mimulopsis* is often dominant in the marginal forest • dense 2 m high thickets of *Adenocarpus mannii* are extremely common and are associated with *lndigofera atriceps, Hypericum, Philippia* and *Myrica* • thickets of *Philippia,* up to 3 m high, mixed with stunted *Hypericum, Agauria* and *Myrica* also occur along old lava streams
4.	Mangrove Swamp and	383	• occurs on the muddy banks of creeks and in tidal channels in the upper portion of the zone of saltwater influence where the water is brackish • three species of *Rhizophora* (red mangrove) with their stilted roots are dominant and include: *R. mangle, R. racemosa* and *R. harrisonii*

	Coastal Vegetation		• white mangrove *(Avicennia nitida)* and the shrub *Laguncularia racemosa* are much less abundant • each species requires different growing conditions to thrive, thus forming separate communities • *Rhizophora racemosa* is the most common species, it is usually found at the edge of the alluvial salt swamp and may reach a height of 45 m • often cut for fuel wood, *R. racemosa* rarely reaches maturity and forms a dense tangle, up to 9 min height • *R. harrisonii* prefers the wetter areas of the mangrove forest • *R. mangle* is found only on the drier, inner limit of the *Rhizophora* zone and grows as a healthy shrub, up to 5 m high
5.	Derived Savanna	167	The northern limit of the Derived Savanna Ecological Zone is the probable climatic limit of the Lowland Rain Forest Ecological Zone. The impact of man has been so intense in this area that areas left to regrow tend to grow savanna type grasses that are susceptible to fire and therefore they limit the lowland species that can regenerate in this area, creating a "derived savanna". Remnants of the high forest may be present in upland or rocky areas that are not suitable for agriculture. This zone is found in a densely populated east-west band between the Guinea Savanna and the Lowland Rain Forest ecological zones.

Source: The Assessment of Vegetation and Landuse Changes in Nigeria (FORMECU/FDF, 1995)

7. Transparent, complete, consistent and accurate information

7.1. Transparent information

During the development of the FREL document, all processes followed and methodologies used for the estimation of activity data and emission factors were documented in a transparent manner. Some information is provided in the appendices to this document. All maps used for estimating activity data have been referenced, and both metadata and spatial datasets are available in a spatial database. Also for the estimation of emission factors, based on forest inventory data, all calculations have been done in a transparent manner. The spreadsheets are available, and some detail results have been included in the Appendix to this document.

7.2. Complete information

Annex I in Decision 12/CP.17 indicates that complete information means information provided that allows for the reconstruction of forest reference emission levels and/or forest reference levels. All information used in the context of the construction of the present FREL has been developed by Nigeria, and allows for the reconstruction of the FREL and is publicly available. Nigeria also ascertains that all information used for the construction of Nigeria's FREL will be uploaded to the website and is available for download.

7.3. Consistent information

Consistency with the national greenhouse gas inventory paragraph 8 in Decision 12/CP.17 establishes that FRELs and/or FRLs shall maintain consistency with anthropogenic forest related greenhouse gas emissions by sources and removals by sinks as contained in the country's national greenhouse gas inventory. Compared to the second National GHG Inventory (NGHGI) submitted by Nigeria in its Second National Communication, there was no clear forest definition used. The second NGHGI did not include a forest definition and was using data available at the time which concerning forests is likely to have been focussed on tropical high forest only.

7.4. Accurate information

7.4.1 Accuracy of the estimated activity data

The qualitative assessment of land use maps for the years 2014 produced from the spatially explicit study by NASRDA (2015) was done. Same process was repeated for Hansen maps for the purpose of comparison. The results of the comparative analysis informed the decision to opt for

Hansen datasets for the creation of new change layer through direct change assessment using FAO-SEPAL platform at FAO Rome. Reference data were generated by Nigeria REDD+ technical team for the accuracy assessment using NASRDA and Hansen maps stratifications. (**Appendix 1**)

7.4.2. Uncertainty of the estimated emission factor

The estimation of emission factors is associated to many sources of uncertainty, including the use of default values, sampling errors and bias from field measurements, etc. All biomass estimates (**Table 2**) from the inventory were reported with 95% uncertainty values associated with the estimates (**Appendix 2**). Also, **Table 3** gives 95% uncertainty estimates for above and below biomass carbon pools for different land use types. The Derived savannah has a very high uncertainty values (> 100%), followed by farmland

(>70%), Swamp (>60%) and mangroves (>40%). The high uncertainties are also linked to the small sample sizes for those land uses. However, the weighted average for all forest land estimates has an uncertainty value of 17.2%.

Table 4. Uncertainty estimates (95% confidence intervals) for carbon pools by land use types

Land use Type	**ABG tCO2/ha**	**BGB tCO2/ha**	**Total Biomass tCO2/ha**
Derived Savanna	133.0%	135.9%	133.9%
Farmland	70.5%	70.5%	70.5%
Gmelina	33.4%	26.3%	31.1%
Montane	34.6%	34.6%	34.6%
Open Forest	38.4%	40.6%	39.1%
Swamp	68.0%	68.0%	68.0
Tropical High Forest	35.8%	37.7%	36.4%
Mangroves	55.3%	44.3%	50.0%
Forest Land (Weighted Average)	**17.2%**	**17.2%**	**17.2%**

8. FREL/FRL Construction

8.1. Reference Period

The initial reference period will include data from 2000 to 2014, and annual historical deforestation rates will be considered during this period.

8.2. Average Method

The calculations gave a weighted average CO_2 equivalent of **972.37±173.9** tons of CO_2e/ha (**Se=17.9%=**Uncertainty); and the GFC estimated annual deforestation rate for the period 2000-2014 was **9,176 ± 24%** ha/yr (Activity Data).

Therefore, the annual emissions for the period 2000-2014 was estimated as the product of the average annual deforestation (Activity Data: AD) and the estimated CO_2 e per hectare (Emission Factor) as follows:

Annual Emissions [Total Biomass] = AD x EF = **(9,176** x **972.37 = 8, 922,467.1±** tons CO_2e/yr; and the 95% confidence interval is [**13,042,489.3 or 5,568,338.15**] tons CO_2e/year.

Table 5. Summary of Total Annual Emissions

	Activity Data (ha/yr)	Emission Factor (tC/ha)	Annual Emissions (tons of CO_2e/yr)	Annual Emissions (Higher level – 95% CI (tons of CO_2e/yr)	Annual Emissions (Lower level – 95% CI (tons of CO_2e/yr)
Absolute value	9, 176	972.37	**8, 922,467.1**		
Higher confidence value	11,378.2	1,146.27		**13,042,489.3**	
Lower confidence value	6,973.76	798.47			**5,568,338.15**

9. Areas for future improvement

The initial inventory was designed to collect data for standing live and dead trees as well as lying deadwood. Data was collected for deadwood, unfortunately the decomposition classes for standing deadwood were not noted, so the data could not be analysed, and has been left out in the present FREL submission.

As an improvement, future work will include the deadwood carbon pool, for example, in the ongoing FCPF project, FAO is supporting Nigeria to undertake a forest carbon inventory at National Level in order to up-scale the present sub-national FREL, measures will be put in place to ensure the best data is collected. Furthermore, height measurements during the study were ocularly appreciated, so were not used as inputs into the biomass estimation allometric equation. During the on-going study, laser dendrometers (TruPulse 200B) will be used to measure tree height in the field.

Checking the quality of reference data for the estimation of Activity Data is another area for future improvement. By this, we intend to adopt a third-party interpretation of the reference data where disagreements between two first-hand interpreters to further validate and improve accuracy of the data. Furthermore, we will also want to stratify the Activity Data in the future by forest type.

The creation of a more accurate map for the change classes applying direct change detection is another area for improvement. This map should improve the stratification of the reference data and is expected to increase both the accuracy and precision of the AD.

Expanding the scope of the submission both in terms of area and activities covered.

Area covered: Nigeria is planning to scale up to a national FREL applying the same methodology with improvements, where the subnational submission and subsequent technical assessment process is viewed by the country as an important learning exercise

Scope of activities: Nigeria intends to increase the scope of the FREL adding REDD+ activities which are both significant in terms of historical emissions/removals and in terms of envisioned implementation of the REDD+ strategy. Furthermore, activities will be added based on whether the data collected is sufficiently robust to allow monitoring of the emissions and/or removals associated with it.

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11. Appendices

Appendix 1. Statistical details of the Stratified Area Estimation for Forest Gain and Forest Loss

Error matrix (values in matrix are samples)							
2000-2014		Reference data					
		Forest loss	Forest gain	Stable Forest	Stable non-forest	**Total samples in map class**	User's accuracy
Map data	Forest loss	6	1	23	13	43	14%
	Forest gain	2	2	20	3	**27**	7%
	Stable Forest	39	13	579	148	779	74%
	Stable non-Forest	18	5	20	129	**172**	75%
Total reference samples per class		**65**	**21**	**642**	**293**	**1021**	
Producer's accuracy		9%	10%	90%	44%	**Overall accuracy**	**70%**
Weighted PA		6%	0.9%	95%	41%	Weighted overall accuracy	73%
Proportional error matrix (samples in agreement/diagreement divided by total samples in map class)							
		Reference data					
		Forest loss	Forest gain	Stable Forest	Stable non-forest	Map area (ha)	
Map data	Forest loss	0.14	0.02	0.53	0.30	51,174	
	Forest gain	0.07	0.07	0.74	0.11	4,947	
	Stable Forest	0.05	0.02	0.74	0.19	1,747,297	
	Stable non-Forest	0.10	0.03	0.12	0.75	319,887	
						2,123,304	
Weighed proportional error matrix in ha (proportional agreement/disagreement weighed by area class)							
		Reference data					
		Forest loss	Forest gain	Stable Forest	Stable non-forest		
Map data	Forest loss	7,140	1,190	27,372	15,471	51,174	
	Forest gain	366	366	3,664	550	4,947	
	Stable Forest	87,477	29,159	1,298,697	331,964	1,747,297	
	Stable non-Forest	33,477	9,299	37,196	239,915	319,887	
	SAE	128,460	40,015	1,366,929	587,900		
	Annual SAE	9,176	2,858				

	More step by step adjusted area for deforestation:						
	Map area	Commission errors	Omission errors	Adjusted area = map area - overdetection + misses		loss/year	
	51,174	44,033	121,320	128,460.42		9,176	
Error matrix of standard error							
		Reference data					
Map data	Forest loss	1.66E-06	3.1414E-07	3.44064E-06	2.917E-06		
	Forest gain	1.432E-08	1.4317E-08	4.00889E-08	2.062E-08		
	Stable Forest	4.14E-05	1.4283E-05	0.000166098	0.000134		
	Stable non-Forest	1.244E-05	3.7463E-06	1.36392E-05	2.489E-05		
	Total	**5.551E-05**	**1.8358E-05**	**0.000183217**	**0.0001618**		
	Standard error	15,819	9,098	28,741	27,007		
	95%Confidence Interval	31,006	17,831	56,332	52,933		
	95%Confidence Interval as percent of adjusted area	24%	45%	4%	9%		

Appendix 2. Results for Data Analysis of Forest land using stratified sampling formulae

Total Biomass(tCO2/ha)	**Gmelina**	**Montane Forest**	**Open Forest**	**Tropical High Forest**	**Mangrove**	**Total**				
Surface Area	157742.4	93874.41	312291.4	236029.9	49152.25	849090.36				
nh(sample size for stratum)	3	7	14	15	7	46				
nh-1	2	6	13	14	6	41				
Plot Size	0.1225	0.1225	0.1225	0.1225	0.06	0.55				
Nh(Stratum Size)	1287693	766322	2549318	1926775	819204	7349311		N		
mean	405.72	1321.74	784.43	1341	1254.08					
SD (Standard Deviation)	50.72	610.49	531.56	880.81	677.5					
(Nh*Sh)^2	4.26563E+15	2.18867E+17	1.83634E+18	2.8802E+18	3.08037E+17					
(Nh*Sh)^2/nh	1.42188E+15	3.12666E+16	1.31167E+17	1.9201E+17	4.40053E+16	3.99876E+17		sy	86.04306777	Std err
Nh*mean	522442828.8	1012878063	1999761167	2583804864	1027347561	7146234484	Sum(Nh*mean)	**Yst**	**972.367927**	
								t	2.02	
							95% Confidence Interval=t*sy	tsy	173.8995268	

							95% CI_Lower		798.47	
							95% CI_Upper		1146.27	
							Uncertainty =(CI/mean)* 100		**17.9%**	
							Coeficient of variation (CV)		**8.8%**	

Appendix 3. Summary of FREL Development Process

S/N	Activities	Remarks
1	**Stakeholders workshops** chaired by the National Secretariat of REDD+ hosted within the Federal Department of Forestry. Stakeholders drawn from various ministerial departments, universities and research institutions, NGOs, and CSOs from States and Federal Government participated in the workshop. The technical team for the construction of the FREL is composed of national foresters, natural and environmental scientists, GIS and remote sensing experts drawn from relevant sectors and the mapping agencies of the Government, with technical support from a team of experts and consultants from FAO	
2.	**Crafting of functional Definition of Forest**	
3.	**Activiities included:** The only activity included in the present FREL submission is deforestation. There is also no reliable data include any other REDD+ activities.	Other activiites to be considered in future submission
4	**Pools and Gases included:** The above-ground biomass constitutes the main component/largest pool and has been included in the FRELs/FRLs. Belowground biomass constitutes a significant pool; however, its estimation is expensive and was indirectly undertaken using IPCC default root-to-shoot (R/S) ratio. Deadwood also constitutes a significant pool to be included. Of the three greenhouse gases associated with land use change emissions, namely carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), CO_2 is the main gas emitted in the forest sector. Therefore, only CO_2 emissions have been considered in the present submission.	Acitivity in line with relevant IPCC guidelines
5.	**Analysis of historical data:** **Activity Data (AD) Estimation –** Decision on reference years representative of future deforestation; Development fo methodology for AD analysis, collection and procesing of imagery for forest cover change assessemnts ; development of training data for image classification; Collection and interpretation of reference data for accuracy assessment of available maps and for stratified area estimates analysis including staistical information on annual deforestation values and confidence values, error matrices, etc. **Emission Factors Estimation –** Composition of forest inventory teams, Design of sampling protocol and technical training in sampling techniques, sample plot lay-out, data collection, analysis and estimation of carbon content. Computation of above ground biomass and belowground biomass; quality assurance/control; computation of carbon-dioxide equivalent and confidence values per forest class	Acitivity in line with relevant IPCC guidelines
6.	**FREL construction:** Taking into account reference period and calculation of annual emissions – Estimation of emission factors per hectare for deforestation; estimation of annual forest loss per hectare (activity data); combination of emission factors for deforestation and activity data to estimate annual emissions.	Acitivity in line with relevant IPCC guidelines
7.	**Areas for future improvement:** As an improvement, future work will include the deadwood carbon pool, for example, in the ongoing FCPF project, FAO is supporting Nigeria to undertake a forest carbon inventory at National Level in order to up-scale the present sub-national FREL, measures will be put in place to ensure the best data is collected. Furthermore, height measurements during the study were ocularly appreciated, so were not used as inputs into the biomass estimation allometric equation. During the on-going study, laser dendrometers (TruPulse 200B) will be used to measure tree height in the field.	Acitivity in line with relevant IPCC guidelines

	Checking the quality of reference data for the estimation of Activity Data is another area for future improvement. By this, we intend to adopt a third-party interpretation of the reference data where disagreements between two first-hand interpreters to further validate and improve accuracy of the data. Furthermore, we will also want to stratify the Activity Data in the future by forest type.	
8.	**Technical Assessment by UNFCCC** Assessment Team jointly develop timetable and agree on channel of communication with Nigeria REDD+ team for technical assessment; Interactive and question and answer sessions with the assessment team; provision of required materials and documentation as necessary; Assessmnet appraisal b Nigeria.	
9.	**Implementation of UNFFCC TA team recomemndations and submission of modified FREL.** Implementation of recommendations, improvement of data and FREL construction process as well as redratfing and submission of modified FREL.	
10	**Endorsement and publication of the Nigeria FREL on UNFCCC official website**	

Appendix 4. List of participants at the drafting of the FREL

Nigeria REDD+ Programme
National Technical Workshop on Forest Reference Emission Levels for Nigeria
24 – 26 May, 2016, Reiz Continental Hotel, Abuja
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Nigeria REDD+ Programme
National Technical Workshop on Forest Reference Emission Levels for Nigeria
24 – 26 May, 2016, Reiz Continental Hotel, Abuja
ATTENDANCE

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Nigeria REDD+ Programme

National Technical Workshop on Forest Reference Emission Levels for Nigeria

24 – 26 May, 2016, Reiz Continental Hotel, Abuja

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Nigeria REDD+ Programme

National Technical Workshop on Forest Reference Emission Levels for Nigeria

24 – 26 May, 2016, Reiz Continental Hotel, Abuja

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Appendix 5. List of participants at the validation of the Draft FREL and Draft NFMS documents

Nigeria REDD+ Programme

Validation Workshop on the Draft NFMs Action Plan & Forest Reference Emission Levels for Nigeria

29– 30 September, 2016, at Reiz Continental Hotel, Abuja

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List of annexures

1. Harmonised AT's question/answers and recommendations
2. Stratified Area Estimate Excel sheets
3. Stratified carbon estimate calculations in Excel
4. Uncertainty calculations for emission factor and annual emissions