UGANDA NATIONAL REDD+ PROGRAMME

Forest Reference [Emission] Levels (FRELs) for Uganda's REDD+

1. Introduction

REDD+ has defined FREL/FRLs as "benchmarks for assessing each country's performance in implementing REDD+ activities". The UN-REDD further interprets FRELs as gross emissions from deforestation or degradation and this is solely for activities that "reduce emissions" from deforestation and from forest degradation.

The UN-REDD interprets FRL as net emissions and removals and this includes activities from the "+" that can "enhance forest carbon stocks".

In accordance with Decision 12/CP.17 of the United Nation Framework Convention on Climate Change Conference of Parties (2011), which provides guidance on modalities relating to forest reference emission levels and forest reference levels, Uganda submitted its proposed FREL/FRLs. The submission is premised on:

- According to Decision 1/CP.16, REDD+, participating countries were requested to develop a national FREL or FRL;
- Uganda used the step-wise approach to national FREL/FRL development (with a provision to make adjustments to the proposed FRELs/FRLs based on national circumstances;
- Uganda's submission is subject to a technical assessment in the context of results-based payment;
- Uganda is to coordinate this submission with other submissions such as the Nationally Appropriate Mitigation Actions, or those that may be made in future and would like that this submission does not prejudge them.

This brief provides excerpts of Uganda's submission on FREL/FRLs.

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2. FREL/FRL Building Blocks

Key building blocks for FRL construction	Ugandan decision and admission
Forest definition	A minimum area of 1 Ha, minimum crown cover of 30% trees able to attain height of 4 metres and above.
Scale	National scale (covering the entire country)
Scope Activities	Deforestation, Degradation, Sustainable Management of Forests, Conservation of forest carbon stocks
Scope Gases	Carbon dioxide (CO_2)
Scope Pools	Above Ground Biomass, Below Ground Biomass.
Construction methodology	Historical average based on 15-year reference period (2000-2015). 5-year rolling average.

The building blocks (summarized in the above table) of this Forest Reference Level (FRL) were developed mainly by the Monitoring Reporting and Verification Task Force, technically reviewed by the National Technical Committee and endorsed by the National Climate Change Advisory Committee. These building blocks are forest definitions, scale, scope of activities, scope of gases, scope of pools and construction methodology.

Based on the above agreed upon building blocks, the component parts of the Ugandan FRL are: Deforestation is 8.15 million tCO2/year, Degradation is 821,415 tCO2/year, Conservation is -699,000 tCO2/year and Sustainable Management of Forest is -225,219 tCO2/year. This sums to an overall FRL of 8.05 million tCO2/year.

1. Forest definition;
Uganda has adopted the following forest definition for the construction of FREL/FRL for REDD+ programme. A forest is *'a minimum area of 1 Ha, minimum crown cover of 30%, and comprising trees able to attain a height of 4 metres and above'*.

In addition to the minimum threshold values, the following qualifiers apply;
* A tree - refers to perennial plant and excludes woody forms that may last for only a few seasons such as the *Solanum giganteum* or *Acanthus pubescens*;
* Bamboo is considered a special tree under REDD+ and Uganda's national interests;

* Orchards of oil palms are agricultural crops and are not included REDD+ forest definition.

The basis for the above definition takes into account the following;
* The slight modification of the definition already submitted to UNFCCC through the first two National Communications that seeks to reduce minimum expected height of trees from 5 to 4 metres.
* The revised definition is agreed upon by ALL Ugandan stakeholders and will substitute the previous definition in the third National Communication;
* There is capacity to collect and analyze data including historical data and the use of freely available Landsat satellite imagery;
* Availability of information and technology and the evolution of mapping from visual interpretation classification to computer aided interpretation and classification;
* There is considerable understanding of land-use approach and a land-cover approach; farmland with large crown agro-forestry trees is classified as farmland while temporally harvested forest plantations are considered forests. Forests that are not temporarily harvested and whose crown cover goes below the minimum threshold value are considered deforested.

2. Scale
The diverse ecological systems in a relatively small area (24 million hectares in total) render delineation of sub-national scales an uphill task for Uganda. The scale of REDD+ implementation

in Uganda is therefore a National Scale and it is further supported by the fact that there is risk of activity displacement from areas targeted by the intervention into areas neglected under REDD+ implementation.

3. Scope

Gases - The submitted scope of gases is carbon dioxide. Uganda currently does not have sufficient data on non-CO_2 emissions such as Methane (CH_4), Carbon Monoxide (CO) and Nitrous Oxide (N_2O). These gases are mostly attributable to wildfires, and mainly occur in rangeland and wood formations not included in the definition of forest.

In its second national communication, Uganda reported that on average 550,000 ha of forest were burned in 2000 and that the highest non-CO_2 emissions from forest wildfires were from CO (estimated at 1,000,000 tonnes of CO) most of it attributable to burning of woodlands. CH_4 emissions were second most important of non-CO_2 emissions, estimated to release over 60,000 tonnes of CH4.

Uganda's Forest Restoration Assessment Report, 2015, also includes data on area of forest fires using MODIS. The report cites a range of areas burned from 2003-2012, including a high of 293,920 ha in 2003 to a low of 35,670 ha in 2008.

There is not high confidence in the accuracy of the data on hectares of forest burned annually. Current technical capacity and available resources do not allow Uganda to include non-CO_2 gases in the initial submission of FRL at this time. Once area data is improved, if fire is determined to be a significant source of emissions, the estimation of non-CO_2 gases from such fires would be undertaken as a future area for improvement.

Carbon Pools - The Intergovernmental Panel on Climate Change guidelines provide five pools for consideration in the FRL and these are: Above Ground Biomass (AGB), Below Ground Biomass (BGB), Soil, Dead wood and litter.

Uganda is including above ground biomass and below ground biomass in its initial submission of a FRL. Deadwood is expected to be included in the revised FRL submission. This decision is based on resources, data and technical capacity that Uganda had at the time of submitting its initial FRL. Mobilisation of resources and building capacity

to include other carbon pools is ongoing. Details of carbon pools that are initially considered are presented below:

Above Ground Biomass pool:
The AGB that is considered in Uganda's initial submission of FRL is living tree biomass. This is carbon stocks of live trees.

- **Source of data** - National Forestry Inventory - Field measurements
- **Strata** - ALL forest strata (Tropical High Forest Woodlands and Plantations
- **Qualifier for Uganda** - Minimum DBH 10cm for Tropial High Forest, Minimum DBH 3cm for Woodlands, Minimum DBH 5 cm for Plantations and Minimum height in all forests: 4m

Below Ground Biomass pool:
Below BGB considered is in the form of roots. Estimation is based on roots that are 2mm in size and above. Root biomass is estimated using standard relationships with above ground live biomass, known as default values provided by the Intergovernmental Panel on Climate Change (IPCC). Unlike living trees and deadwood, there are no direct field measurements of roots. Below ground biomass considered in Uganda's initial submission of FRL is calculated applying a root-shoot conversion factor of 0.24 applied to the above ground biomass acquired from the available National Forestry Inventories data.

- **Source of data** - National Forestry Inventories field measurements plus IPCC root-shoot values.
- **Strata** - ALL forest strata: (Tropical high forest (THF), Woodlands, Plantations
- **Qualifier for Uganda** - Root-shoot ratio of 0.24 applied to AGB, derived from National Forestry Inventories field measurements (IPCC, 2006)

Dead wood pool:
This pool is not considered in the initieal FRL submission. However, in future Uganda will consider fallen deadwood recorded in Permanent Sample Plots (PSP), however PSP data is not representative for deadwood carbon pool estimation due to the small number of observations and missing deadwood diameters in the data.
In the new Exploratory Inventories measurements for REDD+ (which started in 2016) fallen deadwood

is recorded. Deadwood with a minimum diameter of 10 cm in tropical high forest and a minimum diameter of 3cm in woodlands may represent a significant quantity of biomass carbon and is thus currently measured in the ongoing forest inventory. This includes standing dead trees within the plot and dead wood lying on the forest floor along the line-intersect). The decomposition state (e.g. sound, intermediate and rotten), and density of the lying dead wood is recorded and used to estimate carbon.

This data is currently being collected in the ongoing National Forestry Inventories and therefore is anticipated to be included in Uganda's modified FRL submission.
- *Source of data* - National Forestry Inventories field measurements (Not included in initial submission because field data collection is ongoing. This will be included for THF in a modified FRL).
- *Strata* - Measured only in Tropical High Forest
- *Qualifier for Uganda* - Minimum DBH 10cm in Tropial High Forest, Minimum DBH 3cm for Woodlands,

Litter and Soil pool:
Litter is not considered in the contribution to total carbon emissions. There is no data from previous inventories to be able to use for reporting on emissions from this carbon pool.

However, litter of mature forests account for 2.1- 5.2 tC/ha (as per the IPCC guidelines) in tropical broad leaf and needle leaf evergreens. As a percentage of AGB and BGB in THF, this amounts to approximately 1.4 - 3.5% of total carbon.
Soil is not at present reported on for similar reasons. Soil accounts for 0.82-3.82 tC/ha (as per the IPCC guidelines), or 0.6 – 2.6% of AGB and BGB

in THF, which represents a very low contribution to total carbon emissions.
In addition, there is a lack of quantitative data available to understand emissions on soil after land use conversion, making it challenging to accurately report on this carbon pool.

Although neither soil nor litter are reported on in the current FRL, Uganda intends to include these pools, in addition to harvested wood products, in future submissions once the data becomes available.

4. Activities
Ugandan definitions of activities take into consideration the peculiar conditions for the different management systems and applied to the different forest strata. This differentiation illustrates the efforts of Ugandan institutions in the implementation of their mandates and defines how Uganda is linking these efforts to the different activities of REDD+.

The management systems considered are:
- private ownership,
- public ownership managed by the National Forestry Authority (including Central and Local Forest Reserves) and
- public ownership managed by the Uganda Wildlife Authority.

Within all the mentioned management systems the forests are then classified into three strata, namely Tropical High Forest (THF), Woodlands and Plantations. The matrix below provides the overall consideration of the managements systems for comparison between the reference year 2000 and year 2015.

Year 2000	Year 2015			
	Tropical High Forest	Woodlands	Plantations	Other landuses (non-forest)
Tropical High Forest	Conservation	Degradation	Degradation	Deforestation
Woodlands	Very unlikely, insignificant data available	Conservation	Degradation	Deforestation
Plantations	Very unlikely, insignificant data available	Very unlikely, insignificant data available	Sustainable Forest Manageent	Deforestation
Other landuses (non-forest)	Enhancement	Enhancement	Enhancement	Not Applicable

1. **Deforestation** means conversion of Forest to Non-Forest in a permanent manner or without a planned cropping cycle (example of plantation under Sustainable Management). This is the case for all management systems. Uganda has sufficient data and technical capacity to include deforestation in Uganda's initial submission of a reference level and the Mapping Unit at the National Forestry Authority takes lead on provision of Activity Data and Emission Factors derived from field inventory (both historical and on-going).

2. **Conservation** of forest carbon stocks (in the remaining forests under specified management systems such as Uganda Wildlife Authority (UWA)). For this initial FRL submission, estimates of removals from conservation will be included only in areas that have established conservation systems and for which Uganda can be sure of the current dynamics occurring in the forest stand. There is evidence that although Uganda has a long history of forest conservation, the pressure and threat on protected forests is greater than ever, especially as the resource dwindles and population increases. The exhaustion of forests in privately owned land, will lead forest consumers to redirect interest towards public resources, especially as a source of energy. Therefore Uganda considers Conservation as a *Forest remaining Forest* within protected areas specifically within areas under UWA's management;

3. **Sustainable Forest Management.** Here carbon sequestration within growing Forest Plantations (mainly from NFA and UWA) will be considered. Data available are sufficient to account for the plantations and to differentiate between plantation under the different management systems, NFA and UWA. With regards to plantation on private land, they are too scattered, of small size and there is no plan for sustainable replanting and are therefore not considered.

4. **Forest degradation.** Activities that result in, a permanent reduction of forest carbon stocks while the structure of the tree stand does not fall below the threshold values in Uganda's forest definition. Degradation is assumed to occur only in natural forests (both THF and Woodland) but there are not sufficient data to account for degradation happening within the same forest's strata. Uganda currently estimates only the extreme degradation that leads to a forest strata transition. Unfortunately, the available information and system does not allow to account for the degradation happening within the same strata e.g. THF remaining THF, Woodland remaining woodland.

5. **Enhancement of forest carbon stocks.** There are currently no significant efforts in Uganda to measure reforestation, which occurs in small, scattered areas which make the monitoring of forest cover increases extremely difficult. Mapping and monitoring of areas under carbon stock enhancement is included in Uganda's plan for the National Forest Monitoring System (NFMS). This activity will thus be included in future reporting.

5. Construction methodology

1. National circumstances - Uganda has experienced dramatic forest loss in the past 15 years. From 3.1 million ha or 15.3% of land area in 2000, the total forest area of Uganda has reduced to 2.4 million ha or 11.8% of land area in 2015. Also it has been observed that the dynamics are very different between the management types of forests – namely private land, NFA and UWA.

Stratifying into private versus protected is more realistic to Uganda's circumstances because the pressure on forest resources in protected areas might increase as forest resources on private land keep disappearing.

Stratifying between private and protected areas in general (with high forest loss on private land and low forest loss in protected areas) help to continuously monitor the different dynamics in such lands. Further stratifying the protected areas by management type, namely protected areas under UWA and CFRs and LFRs captures the dynamics even better as forest reserves show higher rates of forest loss than areas managed by UWA.

2. Combining Activity Data, Emission Factors and Removal Factors - Uganda has determined that it will include in its initial FRL the following REDD+ activities: deforestation, degradation, sustainable management of forests and conservation of forest carbon stock. Emission and

removal factors have been estimated for tropical high forests, woodlands and plantations.

In order to combine Activity Data (AD) and Emission Factor, (EF) bias corrected areas matrices showing forest loss/gain/stable estimates per forest type and REDD+ activity (associated with management systems) have been calculated..

EFs for woodlands and THF were calculated using the field inventory data from EI, NBS and PSP surveys and then applying the Chave et al. (2014) biomass equation. EF for plantations is dependent on age, species and silivcultural treatment. These EFs were developed using NFA tree planting statistics area data and applying Alder et al. (2003) yield models which provide cumulative yield estimate -for various age classes. Removal Factors RF) were developed for conservation and sustainable management of forests using Uganda-specific estimates. In the case of THF, RFs from a long-term research site in Mpanga Forest Reserve were utilized (Taylor et al, 2008). For woodlands estimates are based on Biomass growth plot data (NBS 2002).Combining these two matrices results in the cumulative emissions/removals of tCO_2 over the 15 year reporting period shown in the table below.

Year 2015				
Year 2000	Tropical High Forest	Woodlands	Plantation	Other land uses(non-forest)
Tropical High Forest	-354,322.4	16,591,927	794,979	68,772,323
Woodlands		-10,130,888	-5,065,670	52,239,075
Plantation			-3,378,286	1,242,179
Other land uses (non-forest)	N/A	N/A	N/A	

3.   Historical Data.

1. The National Biomass Studies and Inventories.

The National Biomass Study (Forest Department 2002, and NFA 2009) form the historical database. These studies relied on using a combination of mapping land use/land cover and forest inventory. The studies assigned biomass stock values to certain land use/land cover classes, which were then mapped out to estimate their extent.

Since the second NBS, further work has been undertaken. This is in addition to forest inventories such as the Exploratory Inventory (EI) and Permanent Sample Plots (PSPs) in plantations and natural forests that form the basis for the historical data for Uganda's FREL/FRL.

2. Land use and land cover maps.

National land use land cover maps were produced for the years 1990, 2000, 2005, 2010, 2015. All but the map for year 2000 were produced as part of the NBS studies. The year 2000 map was produced in 2015 to close the gap between the maps of 1990 and 2005.

The legend of all maps contains 13 main LULC classes, five of which are forest types. The National Biomass Study maps in addition contain data at sub-strata level in terms of biomass stock (low/medium/high), bush type, and wetness (normal, seasonally wet, permanently wet).

3. Forest Area Change

Forest area change in terms of forest transitions and attributed REDD+ activities have been attempted through a map accuracy assessment. Area estimates in terms of map strata by each management type as they were obtained straight from the map accuracy assessment have been submitted. Forest transitions which are unlikely changes and areas that are not estimated due to lack of available data are marked accordingly.

Area estimates aggregated on a national level by forest transition (land use change transition) and REDD+ activity have also been calculated (see table below).

Forest transition	Detailed transition	Area in hectares		
		Private land	NFA	UWA
Forests remaining forest	Plantation to Plantation	290,772 ± 554*	64,209 ± 62	33,718 ± 76
	Plantation to Tropical High Forest	**	**	0 ± 0
	Plantation – Woodland	**	**	0 ± 0
	THF – Plantation	0 ± 0	2812 ± 13	0 ± 0
	THF – THF	76,985 ± 248*	268,959 ± 49*	153,247 ± 127
	THF – Woodland	33,874 ± 223	2,826 ± 6	0 ± 0
	Woodland – Plantation	8,406 ± 101	21499 ± 56	0 ± 0
	Woodland – THF	**	**	**
	Woodland – Woodland	739,859 ± 849*	168,453 ± 116*	552,092 ± 218

Forest becoming non-forest	Plantation – Nonforest land	1,756 ± 11	2943 ± 14	73 ± 1
	THF – Nonforest land	116259 ± 267	7653 ± 22	2737 ± 18
	Woodland – Nonforest land	50,4341 ±757	62,399 ± 82	7,828 ± 32
Nonforest becoming forest	Nonforest land – Plantation	0 ± 0	0 ± 0	0 ± 0
	Nonforest land – THF	0 ± 0	0 ± 0	0 ± 0
	Nonforest land – Woodland	0 ± 0	0 ± 0	0 ± 0

4. Emission Factors

Uganda's diverse forest inventory and monitoring systems that have been found useful in estimating Emission Factors (EFs) are: Exploratory Inventory (EI), Permanent Sample Plot (PSP) assessment (containing different data collecting systems for natural forests and plantation forests), and National Biomass Study (NBS)- that collects data in all landscapes including cropland and built up areas.

Year 2015				
Year 2000	Tropical High Forest	Woodlands	Plantation	Other land uses (non forest)
Tropical High Forest	153,247 ± 1271	36,700 ± 2232	2,812 ± 13	126,649 ± 269
Woodlands		552,092 ± 2183	29,906 ± 115	574,567 ± 762
Plantation			97,927 ± 984	4,772 ± 18
Other land uses (non forest)	Insignificant data16	Insignificant data	Insignificant data	Not Applicable

1 Only areas under UWA, with a conservation management system are estimated and other areas (under NFA and Private land) are assumed to have no carbon stock change.

2This only considers the extreme degradation that leads to a forest strata transition; at this time there is insufficient information to estimate carbon stock changes happening within the same strata e.g. THF remaining THF, Woodland remaining woodland.

3Only areas under UWA, with a conservation management system, are currently considered and other areas (under NFA and Private land) are assumed to have no carbon stock change.

4 Only areas under NFA and UWA are considered under SFM, being managed with a cycle of cutting and replanting (Plantation – Plantation); plantation on private land are too small and scattered to monitor effectively at this time.

These historical data sets, filtered to include data falling within the stated reference period 2000-2015, have been used to estimate tree carbon stock for living standing trees of Uganda's forests. From these data sets, Above Ground Biomass and Below Ground Biomass are derived. Current data collection is ongoing and is expected to include estimates on deadwood and to improve estimates on woodlands.

The results for carbon stocks in Uganda forests shows that tropical high forests may have carbon stocks of up to 150 tons per hectare. PSP data on forest plantations (both coniferous and hardwoods) are not considered representative because data was recorded on young plantations that had just been established. Instead, it has been agreed to use NFA tree planting statistics that can provide area data and Alder et al. (2003) yield models which can provide cumulative yield estimate for various age classes. The carbon stock in Uganda's four main forest classes based on the above estimates is shown in the table below.

Stratum no	1 & 2	3 & 4	5
Stratum name	Plantations	Tropical High forests	Woodlands
Data source	NFA statistics1	EI, NBS, PSP	EI, NBS
Number of plots	-	15 047	1169
Number of trees (/ha)	-	237.5	278.3
Above Ground Carbon (tons/ha)	57.2	119.3	20.0
Below Ground Carbon (tons/ha)	15.2	28.6	4.8
Total Carbon (tons/ha)	72.4	148.0	24.8
AGC, Relative SE (%)	-	0.6 %	3.0%
T-value	-	1.960	1.962
AGC, CI lower (tons/ha)	-	117.9	18.8
AGC, CI upper (tons/ha)	-	120.7	21.2
AGC, Relative CI (%)	-	1.2 %	5.9%

1Mean annual yields (i.e., stem volume per hectare) were taken from the report of Alder et al. (2003) using information of Pinus caribeae for all Pinus species, and Eucalyptus grandis for all other species. The site index was set to match with "poor site type" in order to use conservative yield estimates. The yield estimates were presented as a function of tree age, and tree volumes were converted into above-ground biomasses using Biomass Expansion Factor (BEF) 1.3 for pines, and 1.5 for other species (IPCC 2006, tropical moist forest default value). There are tree plantations outside of NFA areas in Uganda, but age class distribution of these areas was expected to be similar to NFA tree plantations.

5. Proposed FRL and frequency of update

Uganda proposes a national Forest Reference Level based on average emissions and removals over the period 2000-2015 assessed by Activity Data (AD) * Emission Factor (EF) for the following REDD+ activities: deforestation, forest degradation (partial), sustainable management of forests (partial) and conservation (partial). In order to update and improve upon the accuracy of the FRL, Uganda proposes that the FRL be revised every 5 years. Total emissions/removals for each REDD+ activity are provided in the table below

REDD+ Activity	tCO2/year
Deforestation	8,150,238
Degradation	821,415
Conservation	-699,014
SFM	-225,219
Enhancement	No data
FRL (all activities combined)	8,047,420

6. Areas of improvements

Degradation: Uganda can estimate emissions only partially for the degradation of forests and therefore Forest degradation remains an important improvement for Uganda's FRL. Several efforts are already ongoing in order to obtain a realistic estimate to integrate this activity in the future updates to the FRL. A number of actions are proposed within the REDD+ strategy (e.g. promotion of more efficient cooking stoves, support non-wood and alternative energy sources, etc) in order to reduce emissions which can be better recorded under degradation.

Assessing forest degradation, however, will also depend upon better and more cost-effective technologies to allow for more consistent measuring and monitoring of emissions from this activity.

Carbon pools: As stated in the relevant section, deadwood is anticipated to be included in the revised submission. Inclusion of soil organic carbon and litter pools may be included in future submissions, depending on available resources.

Emission Factors/Removal Factors: Uganda is currently collecting more forest inventory data, particularly in areas of the country previously inaccessible. This updated forest inventory data will allow for more geographically representative values for EF of THF and woodlands overall. Therefore, these values are anticipated to be improved upon. With the development of EF/RFs based on future inventories, forest carbon stock change within the same forest type may be estimated more robustly in future submissions

Activity Data: For future Land use and land cover mapping cycles, image change detection to be used instead of the current post classification approach.

Monitoring, Review and Verification; Uganda will continue improving its MRV system especially in the area of tracking change in forest area. This will include a registry system that is being used by REDD+ pilot projects in a bid to encourage wider participation and aggregation of small patches that are less than one hectare. Uganda may redefine its forest definition when capacity to monitor these forests is attained;

Uganda submitted a request for additional funds to the FCPF and received a financing approval by the 21st policy committee, held in Washington 3-5 May 2016. Of the approved USD $3.75 million in funds, $2.1 million will be supporting improvements in emissions and removal estimations and enhance Uganda's monitoring capacity.