REPUBLIC OF UGANDA

Ministry of Water and Environment

Proposed Forest Reference Emission Level for Uganda

February 2018

Acknowledgements

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List of Acronyms

AD	Activity Data
AGB	Above Ground Biomass
BGB	Below Ground Biomass
BURs	Biennial Update Report
CFRs	Central Forest Reserves
DBH	Diameter at Breast Height
EF	Emission Factors
EI	Exploratory Inventory
FAO	Food and Agriculture Organisation
FRA	Forest Resource Assessment
FCPF	Forest Carbon Partnership Facility
FREL	Forest Reference Emission level
FRL	Forest Reference level
FSSD	Forestry Sector Support Department
GFC	Global Forest Change
GFOI	Global Forest Observations Initiative
GHG	Green House Gases
IPCC	Intergovernmental Panel on Climate Change
ISSMI	Integrated Stock Survey and Management Inventory
LFR	Local Forest Reserve
LULC	Land Use Land Cover
MODIS	Moderate-Resolution Imaging Spectroradiometer
MRV	Measuring Reporting and Verification
MWE	Ministry of Water and Environment
NAMA	Nationally Appropriate Mitigation Action
NBS	National Biomass Study
NC	National Communication
NCCAC	National Climate Change Advisory Committee

NDC	Nationally Determined Contribution
NFA	National Forestry Authority
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
NTC	National Technical Committee
PLR	Policy Legal Regulatory institutional framework
PSPs	Permanent Sample Plots
REDD+	Reducing Emissions from Deforestation and Forest Degradation, Enhancement of forest carbon stock, sustainable forest management and conservation
RCMRD	Regional Centre for Mapping of Resources for Development
R-PIN	Readiness Plan Idea Note
R-PP	Readiness Preparation Proposal
SFM	Sustainable Forest Management
THF	Tropical High Forest
THFL	Tropical High Forest Low-stocked
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Programme
UTGA	Uganda Timber Growers Association
UWA	Uganda Wildlife Authority

Summary – the proposed FREL

Uganda's REDD+ Process is coordinated at policy level by the National Climate Change Advisory Committee[1] (NCCAC). Administratively the Forestry Sector Support Department (FSSD) of the Ministry of Water and Environment (MWE) serves as the National Focal Point and REDD+ Secretariat and undertakes day-to-day management and technical coordination. The REDD+ Process is supported by three Task Forces, a National Technical Committee and NCCAC which serves as the REDD+ Steering Committee.

The building blocks of this Forest Reference Emission Level (FREL) were developed mainly by the MRV Task Force, technically reviewed by the NTC and endorsed by the NCCAC. An overview of the decisions is reported in the table below:

Table 1: Key building blocks for FREL construction.

Key building blocks for FRL construction	Ugandan decision and submission
Forest Definition	A minimum area of 1 Ha, minimum crown cover of 30% of trees able to attain a height of 4 metres and above
Scale	National scale
Scope Activities	Deforestation
Scope Gases	CO_2
Scope Pools	AGB, BGB
Construction Methodology	Historical average based on 15-year reference period (2000-2015), updated whenever data are available.

Based on the above agreed-upon building blocks, Uganda is reporting on one scope activity as part of the FREL. Emissions from deforestation are estimated at 8.255 million tCO_2/year.

[1] The NCCAC, a national level multi-stakeholder body chaired by the Permanent Secretary MWE replaced Climate Change Policy Committee (CCPC) as REDD+ Steering Committee in mid-2015.

1 Introduction

Uganda wishes, in accordance with 12/CP.17[2], and on a voluntary basis, to submit its proposed forest reference emission level and/or forest reference level. Uganda's submission is premised on the following:

- The submission responds to the request in Decision 1/CP.16 paragraph 71 (b) whereby countries are requested to develop, among others, a national forest reference emission level and/or forest reference level;
- Uganda intends to use the step-wise approach to national forest reference emission level and/or forest reference level development consistent with 12/CP.19 paragraph 10; and in accordance with the modalities for FRELs and FRLs of the same and other relevant and related REDD+ decisions; including the right 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 (Decision 13/CP.19, paragraphs 1 and 2; Decision 14/CP.19 paragraph 7 and 8; and Decision 12/CP.17, paragraph 15);
- Uganda seeks to coordinate this submission with other submissions (e.g. NAMAs, NDC, NCs and BURs) made by the country or those that may be made in future and would like that this submission should not be seen to prejudge them.

2 National context

2.1 REDD+ process and national consultation on FRL endorsement process

The REDD+ Process in Uganda started in 2008, when Uganda became a Participant of the Forest Carbon Partnership Facility (FCPF) after approval of its Readiness Plan Idea Note (R-PIN). The R-PIN provided an initial overview of land use patterns and causes of deforestation, the stakeholder consultation process, and potential institutional arrangements for addressing REDD+. Uganda embarked on a Readiness Preparation Proposal (R-PP) preparation phase in March 2010, submitted an acceptable R-PP in May 2012 and commenced implementation of the R-PP in July 2013.

In Uganda, the REDD+ process is a national undertaking well positioned within the overall policy framework of Climate Change Policy and national climate change initiatives. Furthermore, Uganda is among few FCPF participating countries in Africa with dedicated budget funds to support REDD+ activities, as it has included REDD+ in her Macro-economic Investment Plan, Mid-term Expenditure Framework and Water and Environment Sector Investment Plan.

Uganda's REDD+ Process is coordinated at policy level by the National Climate Change Advisory Committee[3] (NCCAC). Administratively the Forestry Sector Support Department (FSSD) of the Ministry of Water and Environment (MWE) serves as the National Focal Point and REDD+ Secretariat and undertakes day-to-day management and technical coordination.

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[2] Decision 12/CP.17. Guidance on systems for providing information on how safeguards are addressed and respected and modalities relating to forest reference emission levels and forest reference levels as referred to in decision 1/CP.16

[3] The NCCAC, a national level multi-stakeholder body chaired by the Permanent Secretary MWE replaced Climate Change Policy Committee (CCPC) as REDD+ Steering Committee since mid-2015

The REDD+ Process is supported by three Task Forces, a National Technical Committee (NTC) and the National Climate Change Advisory Committee (NCCAC) which serves as the REDD+ Steering Committee (see Figure 1). Especially the MRV Task Force (TF) contributed to the development of the FRL.

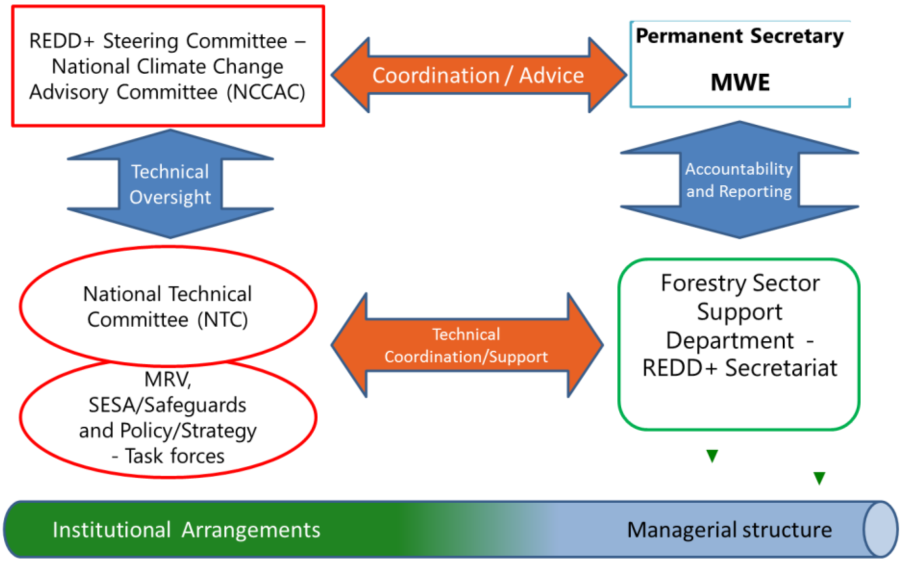

Figure 1: REDD+ Institutional arrangements and managerial structure.

The building blocks of this FRL were developed mainly by the MRV Task Force, and considered and endorsed by the NTC and the NCCAC. An overview about the dates and minutes relevant for each building block is given in Table 2 below. In addition to these meetings, Uganda had two meetings/consultations with all stakeholders (meeting reports in annex 6 & 7).

Table 2: National endorsement of FRL building blocks

FRL building block	MRV TF	NTC	NCCAC
Forest definition	Developed during meetings on 16 April 2015, 21 July 2015 and 18 September 2015 (report in annex 1)	Positive recommendation at meeting on 1-2 December 2015 (report in annex 2)	Final endorsement at meeting on 10-11 March 2016 (report in annex 3)
Scale	Developed at meeting on 18 September 2015 (report in annex 1)	Positive recommendation at meeting on 1-2 December 2015 (report in annex 2)	Final endorsement at meeting on 10-11 March 2016 (report in annex 3)
Scope	Developed at meeting on 18 September 2015 (report in annex 1)	Positive recommendation at meeting on 1-2 December 2015 (report in annex 2)	Final endorsement at meeting on 10-11 March 2016 (report in annex 3)
FRL construction methodology/ approach	Developed at meeting on 18	Positive recommendation at meeting on 26-27	Final endorsement at meeting on 24-25 November 2016

	September 2015 (report in annex 1)	July 2016 (report in annex 4)	(meeting resolution in annex 5)

2.2 Forest land in Uganda

Uganda is a land locked country in East Africa, bordered by Kenya to the East, Tanzania to the South, Rwanda to the South West, Democratic Republic of Congo to the West and South-Sudan in the North (see Figure 2). Out of the total area of 241,551 km^2, about 37,000 km^2 of Uganda is open water (NBS, 2009). Most parts of Uganda lie at an altitude between 990m and 1500m, except for the Western rift valley which is below and mountainous areas which are above the stated elevation range. The elevation and location of Uganda being close to the equator causes favorable rainfall and temperature for a diversity of fauna and flora and subsequently, human settlement and a variety of land use types (NBS, 2009).

Uganda's natural forest vegetation is categorized into three broad types: Tropical High Forest Well-stocked (THF), Tropical High Forest Low-stocked (THFL), and Woodlands, with woodlands being the predominant type in terms of area. In addition to the three natural forest types, plantations are differentiated into broadleaved and coniferous plantations.

Originally, THF occurred in mountainous areas and in most of the central region between Lake Victoria and Lake Albert, and is now mainly found in Central Forest Reserves (CFRs) in the western part of the country (Bugoma, Budongo, Kalinzu-Maramagambo, Katsyoha-Kitomi) and in national parks (Bwindi Impenetrable, Mgahinga, Rwenzori Mountains, Mount Elgon, Kibale and Semuliki). THFL is found around the shores and on the islands of Lake Victoria. Savannah woodland and bushland covered the drier parts of the country, namely the northern, central and western regions, whereas the eastern part of the country is largely forest-poor except the Mount Elgon area (NBS, 2009; FIP 2016).

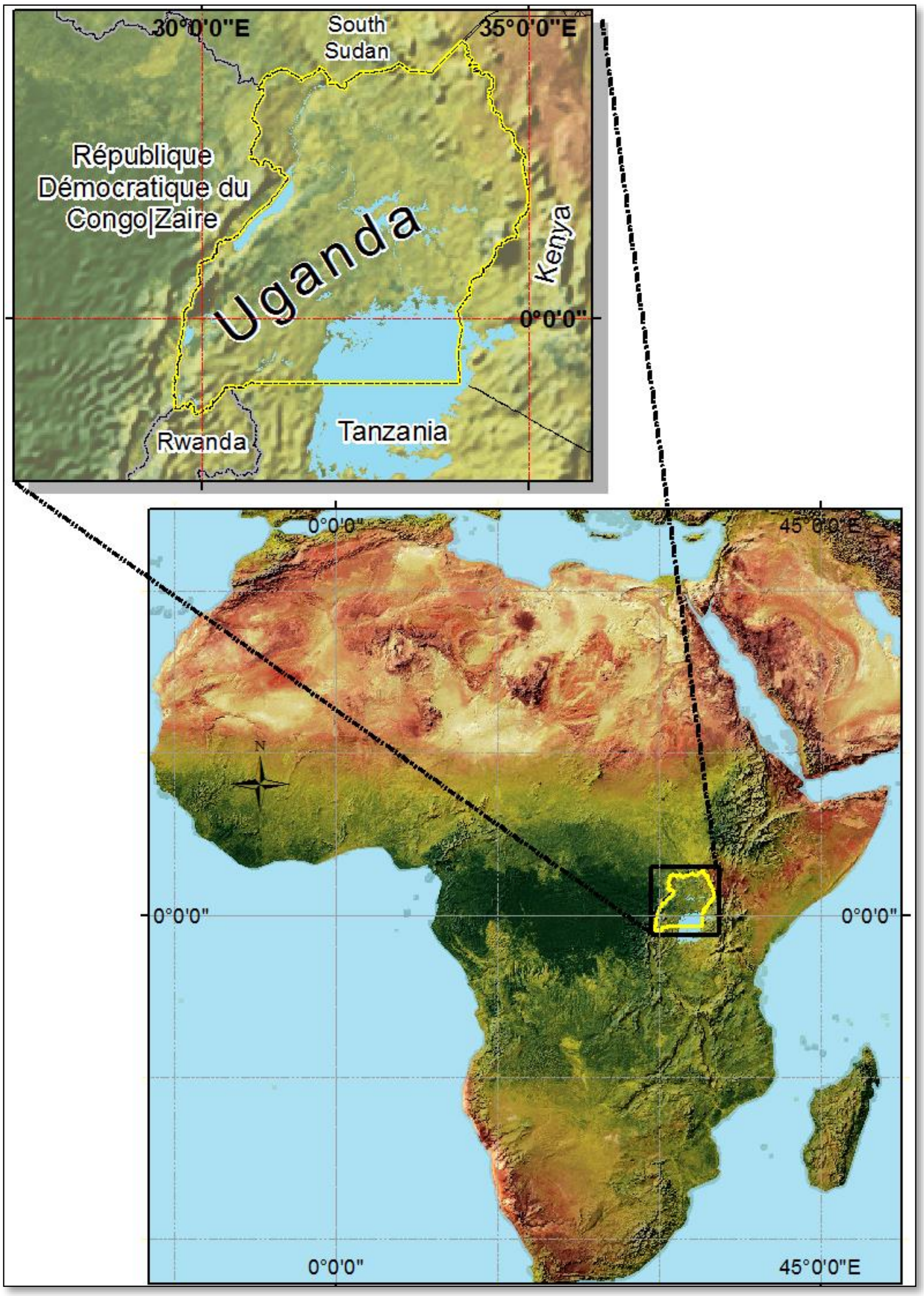

Figure 2: Geographic location of Uganda within the African continent (data from Natural Earth 2017).

For 2015, the forest cover (natural forests and forest plantations) was estimated at 12% of the total land area, or 2.5 million ha. Woodlands are the dominant forest type, accounting for 64% of the forest area, THF for 20% and plantations for 16% (see Figure 3).

In addition to trees on forest land, the term "trees outside forests" refers to a plethora of tree systems, ranging from agroforestry and silvo-pastoralism to urban, rural or community forestry that are not considered 'forest'. Uganda has a lot of woody formation that may not be mapped as forests because they are considered agricultural land or are too small to be seen on the Landsat imagery. Biomass stocks in these woody formations are monitored through National Biomass Monitoring system which is conducted in all landscapes of Uganda.

All natural forests have experienced a strong decline in area in the past decades. In 2000, forests are estimated to have covered 3.2 million hectares, and declined to 2.5 million hectares in 2015, about 12.4% of the total land area. In 1990, forest cover had been estimated at 24% of total land area.

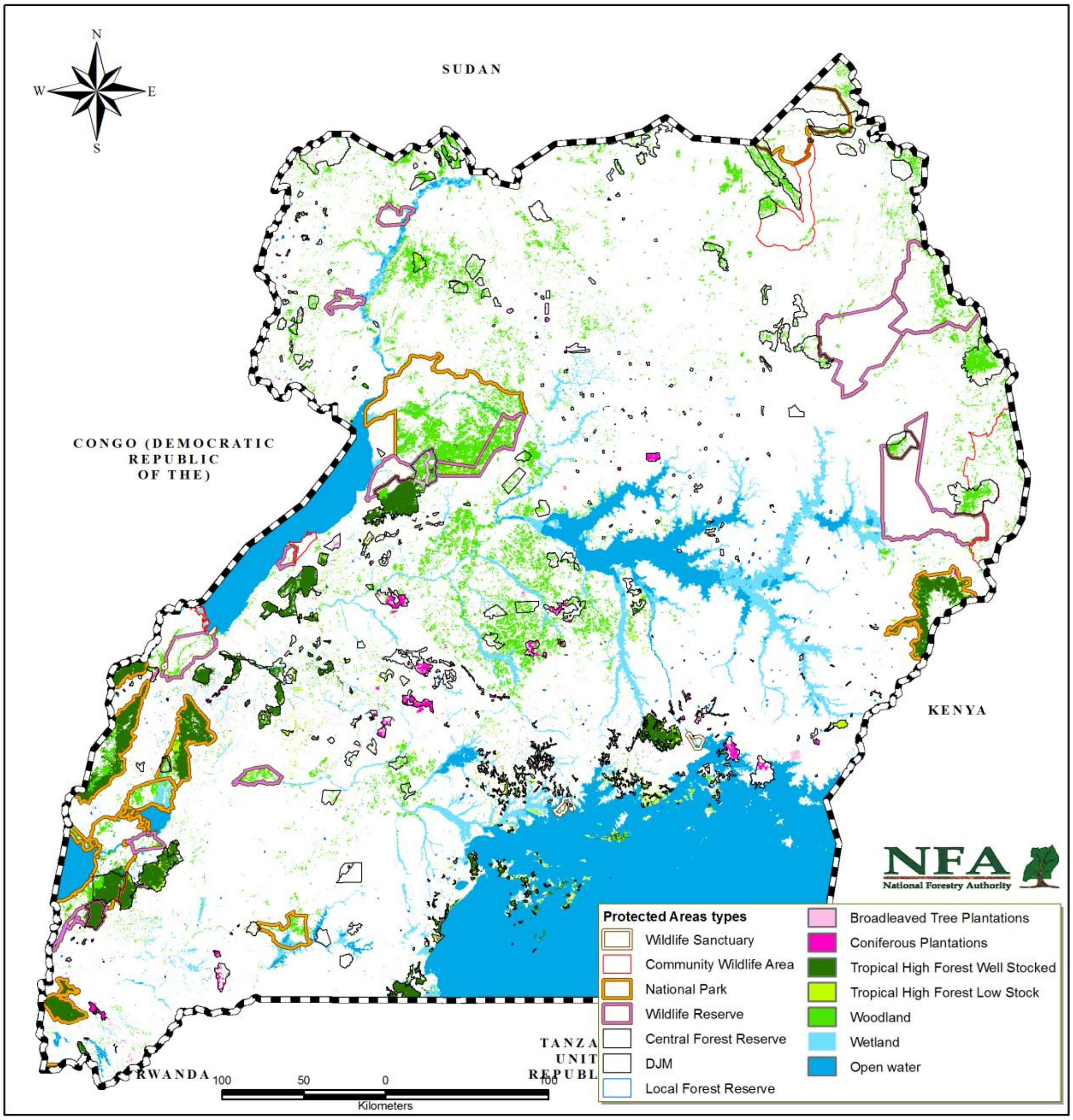

Figure 3: Forest cover and protected areas in Uganda (MoWE 2015).

2.3 Protection of forest land in Uganda

Forests occur on private and on public land. Forest resources on public land can be protected either as part of the wildlife estate, managed by UWA, or as Central Forest Reserves (CFR), managed by NFA, or Local Forest Reserves (LFR), managed by district forestry services on behalf of the local government.

The protected wildlife estate, managed by UWA, is currently comprised of 11,231 km^2 of national parks, 7910 km^2 of wildlife reserves, 713 km^2 of wildlife sanctuaries, and 3174 km^2 of community wildlife areas. Central forest reserves cover 11,123 km^2 whereas local forest reserves have a total area of 50 km^2.

Very different deforestation dynamics have been observed on private and public land since the first land cover change assessment in 2009 (NBS, 2009). Forest loss has been highest on private land and almost nonexistent in areas managed by UWA. CFRs and LFRs showed lower forest loss than forest on private land.

2.4 Drivers of deforestation and forest degradation

The key drivers of deforestation and forest degradation[4] in Uganda are: i) Expansion of commercial and subsistence agricultural into forest lands and bush lands; ii) unsustainable harvesting of tree products, mainly for charcoal, firewood and timber; iii) expanding urban and rural human settlements and impacts of refugees; iv) free-grazing livestock; v) wild fires; vi) artisanal mining operations; and vii) oil exploration activities (Oy Arbonaut Ltd 2016).

These drivers are symptoms of underlying socio-economic factors including; i) high rates of population growth and ii) levels of economic performance resulting in high dependence on subsistence agriculture, natural resources and biomass energy as well as competing economic returns from land that do not favour long-term investments such as forestry. Other underlying causes include: i) weak forest governance manifested in weak forest management, planning and regulation; ii) weak policy implementation; iii) climate change effects; and iv) land tenure systems (Oy Arbonaut Ltd 2016).

[4] Drivers of DD are will be ranked according order of severity or significance after completing the ongoing assessment of drivers.

3 Key FRL building blocks

3.1 Forest definition

Uganda conducted a wall to wall mapping and inventory of its forests before the climate change and National Green House Gas inventory were a requirement. Data maps and the forest inventory data, especially the NBS data, informed the process of formulating the forest definition.

The MRV task force used the available data to develop a forest definition options paper that informed a wide range of consultative process by a broad spectrum of stakeholders. Outcomes of these consultations were deliberated, reviewed and endorsed by NTC and NCCAC.

Uganda's forest definition for the implementation of REDD+ (and thus used in the construction of a FRL) has the following threshold parameters:

- **A minimum area of 1 Ha, minimum crown cover of 30% comprising of trees able to attain a height of 4 metres and above in *situ*.**

In addition to the above threshold values, the following qualifiers apply;

- Tree is in reference to a 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 e.g. of oil palms are considered agricultural crops and are not included REDD+ forest definition. Emissions related to carbon pools in crop and other land categories are accounted in the National Green House Inventory system
- Uganda may reconsider reducing the minimum area threshold value when the country attains capacity and technology to monitor forest areas smaller than one hectare.

Justification of changing the minimum height threshold

The definition chosen for REDD+ implementation uses a minimum height parameter of 4 metres as opposed to 5 metres that was used for CDM AR projects. The basis for this definition takes into account the following:

- The selected definition allows Uganda to report and monitor woodlands that cover big parts of in central Uganda and some parts of north and north-eastern Uganda. This is in line with the UNFCCC guidelines which encourages choosing a definition that will not exclude substantial forested areas of a country.
- The definition enables Uganda to use all the available historical data and continuous use of freely available Landsat imagery.
- The definition enables Uganda to use the same data that is used by the National Green House Gas Inventory and also use the data that was used in the second National Communication
- Uganda wants to clarify that the threshold of 5 m height has only been used for CDM AR purposes and not for any international reporting. The second National Communication makes reference to the forest definition of 5 metres height (CDM AR forest definition) but uses the NFA data which is based on 4 metres minimum height for woodland (forest).

The revised definition is agreed upon by all Ugandan stakeholders and constitutes the official definition from now on.

3.2 Scale

The diverse ecological systems in a relatively small area (24 million hectares in total) may render delineation of sub-national scales an uphill task for Uganda. Furthermore, the risk of activity displacement from areas targeted by the intervention into areas neglected, convinced stakeholders to decide, for the purpose of the implementation of REDD+, the following scale: **National scale**.

3.3 Scope: Activities, Pools and Gases included in the FRL

3.3.1 REDD+ Activities

Whereas Uganda's national REDD+ Strategy includes measures and actions to address the drivers of deforestation and forest degradation; as well as measures and actions to enhance the role of conservation, sustainable management of forests and enhancement of forest carbon stocks, not all these activities could be included in the FRL submission. Uganda choose to use a stepwise approach that allows for acquisition of additional data and monitoring capacities and technologies to eventually include the other activities. Thus the REDD+ activities in the context of Uganda are summarised below including the reasons for their inclusion or non-inclusion and steps for improvement to meet future inclusion.

REDD+ activities[5] and existing forest activities in Uganda can be categorized through two main qualifiers: Forest transition (see Table 3) and management type. Thus, the Ugandan definitions of activities take into consideration the peculiar conditions characterizing 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 (including national parks and wildlife reserves). Within all the mentioned management systems the forests are then classified into three strata, namely Tropical High Forest (THF), Woodlands and Plantations. Forest transitions can occur between these three forest strata and non-forest (see Table 4)

These definitions and qualifiers are based on a lengthy consultation process which involved the steps described in paragraph 2.1, as well as through stakeholder consultations which went beyond the institutional set-up, but which were required for a full and inclusive process (Annexes 1 to 7).

In this forest reference emission level, Uganda reports on one out of the five activities: deforestation (see Table 3). All five activities as defined by Uganda are explained below, including reasons for inclusion or exclusion of reporting on this activity in this FREL.

[5] REDD+ activities are defined by the UNFCCC, and this section aims to explain how Uganda handles and interprets each of the activities within the national context.

Table 3: Forest transition matrix for REDD+ activities in FREL.

	Year 2015			
Year 2000	Tropical High Forest	Woodlands	Plantation	Other land uses (non-forest)
Tropical High Forest	Conservation[6] and Degradation	Very unlikely, insignificant data available	Degradation	Deforestation
Woodlands	Very unlikely, insignificant data available	Conservation[7] and Degradation	Degradation[8]	Deforestation
Plantation	Very unlikely, insignificant data available	Very unlikely, insignificant data available	SFM	Deforestation
Other land uses (non-forest)	Enhancement	Enhancement	Enhancement	N/A

Deforestation. *Conversion of Forest to Non-Forest* is considered as deforestation across all management systems. Uganda has sufficient data and technical capacity to include deforestation in Uganda's initial submission of a reference level, and has therefore included it in its initial and revised submission of the FREL. Details on the national assessment of deforestation relevant for this FREL submission are presented in activity data section.

Forest degradation. *Forest remaining forest with a permanent reduction of forest carbon stocks..* Forest degradation encompasses activities that result in, as far as can be assessed, 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. Repeated inventory plot measurements in private and NFA managed forest lands show that on average there is degradation in the private forest lands and no proven degradation in the NFA managed forest lands (see Annex 9). There are currently no repeated measurements available for UWA land to assess changes in carbon stock but these lands are considered to experience net removals rather than emissions due to the fact that UWA land is under very different management and therefore shows dissimilar dynamics compared to the other two management types (also seen by the rate of deforestation). They are therefore included under the activity conservation (see also definition of conservation of forest carbon stocks).

[6] Only areas under UWA, with a conservation management system, are currently considered for conservation and other areas (under NFA and Private land) are assumed to be degrading . Depending on data about carbon stock changes in these areas becoming available, this distinction between the management types could be reconsidered.

[7] Same as footnote 7 above.

[8] Uganda recognizes the safeguard (1/CP.16, Appendix 1, paragraph 2e) that states "actions are consistent with the conservation of natural forests and biological diversity' and that positive incentives, such as payments, should not be 'used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services". In this regard, Uganda intends to develop a MRV system that separates natural forests from plantations and to ensure that "results" do not provide incentives for conversion of natural forests to plantation.

In the initial FREL submission, degradation was only included for transitions between forest strata[9]. After re-assessing data of repeated measurements on private and NFA land, Uganda has decided not to report on degradation of forests.

Conservation of forest carbon stocks. *Forest remaining forest recorded only under the specified management systems (e.g., UWA), and restricted to natural forests*. Uganda only considers conservation of forest carbon stocks for areas that have established conservation systems in place, which is only land under UWA management. This may also be happening on NFA managed lands but repeated inventory measurements did not show net removals that are significantly different from zero (see Annex 9). In this FREL submission, conservation of forest carbon stocks is not reported on due to lack of repeated measurements of carbon stocks in UWA areas. However, there are existing baseline measurements and plans to collect new data in UWA lands when funding becomes available. Furthermore, UWA has dedicated forest restoration and enhancement programmes in place. Conservation had been included in the initial submission, however after advice from the assessment team and further internal consultations, Uganda considers the removal factors applied as not sufficient to meet the guidelines.

Sustainable Management of Forest (SFM). *Forest remaining forest, .* Currently there is insufficient data to consider any forest type under SFM category. This FREL is different from the initial submission where a mean annual increment (MAI) had been applied to stable plantations on NFA and UWA land, but not on private land.

Enhancement of forest carbon stocks. Nonforest becoming forest. After consultations with the assessment team and further internal consultations, Uganda considers there is insufficient data to meet requirements of including enhancement of forest carbon stocks in the FREL.

In its national development goals, Uganda has the ambitious plan of restoring its forest area estate to the level of 1990. This can only be achieved through afforestation/reforestation programmes of the deforested areas, so Uganda strongly likes to include enhancement of forest carbon stocks in future submission of FREL.

A summary of all possible activities related to forest transition are presented in Table 4. Out of the many possible transitions, only conversion of forest to non-forest is considered in this FREL.

[9] In the initial FRL submission, transitions from THF to WL were included and accounted for as degradation. However, this transition is ecologically not likely to occur. Anthropogenic processes leads to forest degradation within THF, or ultimately conversion to bushland or other NF land, but not to woodland. The classification mistakes in the activity data have therefore been corrected.

Table 4: Possible Forest transitions and attributed REDD+ activities by management type including explanatory remarks.

Forest transition	Detailed transition	REDD+ Activity by management type			Explanatory remarks
		Private land	**NFA**	**UWA**	
Forest remaining forest	Plantation – Plantation	SFM	SFM	SFM	Forest plantations remaining forest plantations in the reference period are considered SFM.
	Plantation – THF	**	**	**	Very unlikely to occur, data insignificant.
	Plantation – Woodland	**	**	**	Very unlikely to occur, data insignificant.
	THF – Plantation	Degradation	Degradation	Degradation	Conversion from natural forest to plantation usually occurs after encroachment of the natural forest. Forest strata transition from high to a lower carbon content is recorded under degradation. To avoid incentivizing conversion of natural forests to forest plantations, carbon offsets accruing from conversion of natural forests to forest plantations are discounted to zero.
	THF – THF	Degradation	Degradation/Conservation	Conservation	Degradation is observed on all THF remaining THF apart from UWA where conservation efforts seem to be working. Apart from the known conservation practice there is not empirical data to estimate removal factor
	THF – Woodland	**	**	**	Ecologically not likely to occur. Anthropogenic processes lead to forest degradation within THF, or ultimately conversion to bushland or other NF land, but not to woodland.
	Woodland – Plantation	Degradation	Degradation	Degradation	Conversion from natural forest to plantation usually occurs after encroachment of the natural forest. Though forest plantations record higher carbon stock than woodlands, for consistency this transition is recorded under degradation. As in THF, carbon offsets accruing from conversion of natural forests to forest plantations are discounted to zero.
	Woodland – THF	**	**	**	Very unlikely to occur, data insignificant.
	Woodland – Woodland	Degradation	Degradation/Conservation	Conservation	Degradation is observed on all WL remaining WL apart from UWA where conservation efforts seem to be working. Apart from the known conservation

					practice there is not empirical data to estimate a removal factor.
Forest becoming nonforest	Plantation – Nonforest land	Deforestation	Deforestation	Deforestation	Conversion of forest plantations to nonforest on any land is considered deforestation. However this is very unlikely to occur on public land where management systems ensure that plantations remain plantation.
	THF – Nonforest land	Deforestation	Deforestation	Deforestation	
	Woodland – Nonforest land	Deforestation	Deforestation	Deforestation	
Nonforest becoming forest	Nonforest land – Plantation	Enhancement	Enhancement	Enhancement	Reviewing of the data showed evidence of nonforest being converted to plantation. However, information on plantation species by age classes was lacking. Accounting for removals by sinks was not possible due to lack of clarity and guidance on how to account carbon stock enhancements under such circumstances.
	Nonforest land – THF	Enhancement	Enhancement	Enhancement	This type of enhancement is not observed in the reporting time period, but monitoring these changes will be included in the national plan for NFMS.
	Nonforest land – Woodland	Enhancement	Enhancement	Enhancement	This type of enhancement is not observed in the reporting time period, but monitoring these changes will be included in the national plan for NFMS.

** Very unlikely to occur, data insignificant

3.3.2 Carbon Pools

The IPCC guidelines provide five pools for consideration in the FREL and these are: above ground biomass, below ground biomass, soil, dead wood and litter. Uganda is including above ground biomass and below ground biomass in its initial submission of a FREL. Deadwood is expected to be included in the revised FREL submission. This decision is based on resources, data and technical capacity that Uganda has at the time of submitting its initial FREL. Mobilisation of resources and building capacity to include other carbon pools is ongoing. Details of carbon pools that are initially considered are presented below in Table 5:

Table 5: Summary of carbon pools included in the initial FREL submission.

Pools	Source of data	Strata	Qualifiers for Uganda
Above Ground Biomass	NFI - Field measurements	All forest strata: Tropical high forest (THF), Woodlands, Plantations	Min DBH 10cm for THF Min DBH 3cm for Woodlands Min DBH 5cm for Plantations Min height in all forests: 4m
Below Ground Biomass	NFI field measurements plus IPCC root-shoot values	All forest strata: Tropical high forest (THF), Woodlands, Plantations	Root-shoot ratio of 0.24 applied to AGB derived from NFI field measurements (IPCC, 2006)

Above ground biomass.

Above ground living tree biomass is considered in Uganda's initial FREL submission. This is carbon stocks of live trees, with a minimum DBH of 10 cm for tropical high forests and 3 cm for woodlands. Above ground biomass is calculated from the available NFI data (NBS, EI & PSP surveys).

Below ground biomass

Below ground living biomass 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 aboveground live biomass, known as default values provided by the IPCC. Unlike living trees and deadwood, there are no direct field measurements of roots. Below ground biomass considered in Uganda’s initial submission of FREL is calculated applying a root-shoot conversion factor of 0.24 (IPCC 2006) to the above ground biomass acquired from the available NFI data.

Deadwood

Fallen deadwood was only recorded in PSPs, 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 EI measurements for REDD+ (which started in 2016) fallen deadwood is recorded. Deadwood with a minimum diameter of 10 cm THF and a minimum diameter of 3 cm in woodlands may represent a significant carbon pool. 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 collected in the ongoing NFI and therefore is to be included in Uganda's subsequent FREL submission.

Litter and Soil

Litter is not at present reported on since its contribution to total carbon emissions is not considered significant. According to IPCC default values, litter of mature forests account for 2.1-5.2 tC/ha in tropical broadleaf and needle leaf evergreens (Table 2.2, 2006 IPCC Guidelines). As a percentage of AGB and BGB in THF, this amounts to approximately 1.4 - 3.5% of total carbon. Furthermore, there is no data from previous inventories to be able to use for reporting on emissions from this carbon pool.

Soil is not at present reported on for similar reasons. According to IPCC default values, soil accounts for 0.82-3.82 tC/ha (Table 4.6, 2006 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. Uganda already has plans of collecting data that will improve estimation of soils related GHG emissions.

Although neither soil nor dead organic matter (litter and deadwood) are reported on in the current FREL, Uganda intends to include these pools in future submissions once the data becomes available.

3.3.3 Gases

Uganda only includes CO_2 gases in its initial submission of a FREL.

Uganda currently uses burnt area data from NASA and IPCC default factors to estimate non-CO_2 emissions such as Methane (CH_4), Carbon Monoxide (CO) and Nitrous Oxide (N_2O). As the forest area dwindles, emissions from wildfires will increasingly 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[10] (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 CH_4.

Uganda's FRA 2015 report 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. An estimate of non CO_2 gases from fires is given in Appendix 10 but Uganda does not include non-CO_2 gases in the initial submission of FREL at this time. Once area data is improved and 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.

[10] CO is not considered as a direct GHG but is recognized as a pre-cursor gas.

3.4 **Historical** data (Activity data and Emission factors)

Uganda has a very long history of monitoring biomass stocks in the country, known as the "National Biomass Study" (NBS) (Forest Department 2002, NFA 2009). These studies have always relied on using a combination of mapping land use/land cover and forest inventory. The NBS forest inventory was used to assign biomass stock values to certain land use/land cover classes, which were then mapped out to estimate their extent.

The first biomass assessment was conducted in the 1990s, with the results published in 2002 (Forest Department 2002). The second NBS was concluded in 2009, but not officially published (NFA 2009). Results from these studies are, however, used by government. Since the second NBS, further work has been undertaken. This as well as other forest inventories such as the Exploratory Inventory (EI) and permanent sample plots (PSPs) in plantations and natural forests all form the basis for the historical data for this FREL.

3.4.1 Activity Data

Activity data as part of emission/removal estimates should follow the IPCC good practice principle of neither over- nor underestimating emissions/removals and reducing uncertainties as far as is practicable. Methods that estimate areas from maps alone provide no assurance that these principles are met since they do not account for (systematic) classification errors. Therefore, it is common practice to compare the map classes against carefully classified reference data (e.g. 'truth') to provide such assurance. The reference data, also called accuracy assessment data, helps to correct for systematic map classification errors and provides the information necessary for estimating the uncertainty of map classes and construction of confidence intervals. Correcting for map bias and transparently reporting uncertainty of the estimates enhances compliance with IPCC good practice guidance (GFOI 2016).

This section about activity data includes the historical map data, the derivation of bias-corrected area estimates as compliant with IPCC good practice guidance, and results of the bias-corrected area estimates.

3.4.1.1 Historical land use/land cover maps

The basis for activity data are the national land use land cover maps that 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 (see Table 7).

The legend of all maps contains 13 main LULC classes (see Table 6), five of which are considered forest. The NBS 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).

Table 6: Main stratum 13 LULC classes in the national LULC maps.

	LULC class
Forest	Plantations broadleaved
	Plantations coniferous
	Tropical high forest well-stocked
	Tropical high forest low-stocked
	Woodland

Non-forest	Bushland
	Grassland
	Wetland
	Subsistence farmland
	Commercial farmland
	Built up areas
	Water
	Impediment

All maps from 2000 onwards relied on Landsat data, only the one for 1990 was produced using Spot I and II imagery (Forest Department 2002, NFA 2009). The 1990, 2005, 2010 and 2015 maps were produced using the best methodologies and satellite imagery available at that point in time, with emphasis on visual interpretation and ground-truthing as part of the map generation (see Table 7). The map for year 2000 was produced using a slightly different methodology, using the existing 1990 and 2005 maps to generate training data for a forest-nonforest mask. This mask was then combined with the Africover 2000 LULC data set in order to create the 13 classes LULC classification. NFA team members were involved in the creation of the Africover 2000 LULC data set.

Table 7: Overview of methodologies used to produce national LULC maps.

LULC map target year	Date of production	Publication of results	Satellite imagery used	Legend	Methodology overview
1990	2002	Forest Department, Ministry of Water Lands and Environment (2002)	SPOT I and II	Main stratum 13 LULC classes, plus substrata (biomass stocking, bush type, wetness)	Manual feature drawing and visual interpretation on hard copy transparencies against diapositives Digitised on Calcomp digitiser High intensity ground-truthing
2000	2015	--	Landsat (best pixel composite for 1999 – 2001)	Main stratum 13 LULC classes	1) Supervised classification for creation of F-NF mask on pixel level with training data from LULC1990, LULC2005 maps and GFC data 2) Translation of Africover map into 13 classes 3) Landsat mosaic segmented, 13 classes of Africover assigned to segments, F-NF mask used to identify areas which had been omitted as forests (especially woodlands) in Africover map
2005	2008	NFA (2009, unpublished)	Landsat 7	Main stratum 13 LULC classes, plus substrata (biomass stocking, bush type, wetness)	On-screen digitising and visual interpretation Low intensity ground-truthing
2010	2015	--	Landsat 5	Main stratum 13 LULC classes, plus substrata (biomass stocking, bush type, wetness)	Automated segmentation and supervised classification Visual validation of results, with LULC map 2005 as backdrop Low intensity ground-truthing
2015	2016	--	Landsat 8	Main stratum 13 LULC classes	Automated segmentation and supervised classification Visual validation of results, with LULC map 2010 as backdrop Low intensity ground-truthing

3.4.1.2 Land cover change assessment

Land cover change maps can be produced in two ways:

- Post-classification change assessment: Maps that were produced independently for different points in time are compared to each other after the classification of each point in time. It is a widely used approach, but the quality of the results depends entirely on the quality of the original maps (Tewkesbury et al. 2015).
- Spectral (direct) change detection: The satellite imagery for two points in time is analysed for spectral similarities and dissimilarities. Pixels are flagged as change where direct comparison of spectral differences between time periods indicates a likely change in land cover. Identification of changed pixels is done independently of any pre-existing map classification.

Uganda decided to use the post-classification approach in order to build upon the existing national map data. The national historical LULC maps used for previous National Communications contain detailed information on 13 LULC classes, and their production went hand in hand with field inventories that are used for estimating emission factors in this submission. Furthermore, the maps had not been produced completely independently from each other. For year 2000, training data was derived from the 1990 and 2005 map, and for year 2010 and 2015, the previous LULC map has always been used as backdrop in the visual validation.

In order to minimize uncertainties in the estimates of forest area change due the propagation of classification errors, two measures were taken – first a manual review and revision, and secondly an automatic consistency check (see Figure 4). The final estimates were obtained from a combination of this improved map data and reference data where the reference data corrects the map for classification errors. This approach is further described in section 4.4.1.3 and recommended by GFOI's Methods and Guidance Document (GFOI 2016).

The entire procedure of analyzing the series of historical land maps for each epoch (e.g. 2000, 2005, 2010 and 2015) to produce final, bias-corrected estimates of activity data (see Figure 4) was as follows: First, the five existing LULC maps were rasterized to a spatial resolution of 30mx30m which is in line with the main source of satellite imagery used in their production – Landsat. These were then combined into one single raster file and vectorized again because directly overlaying the polygons was not feasible with available computer power. All polygons where forest had been mapped for one of the years were taken into account for manual review and revision. Due to time constraints, the polygons were later filtered to polygons with an area of 20ha and above in order to minimize the number of polygons while at the same time covering an area as big as possible, namely half of the area that had been mapped as forest cover for one of the time periods.

The manual review and revision was aided by Landsat mosaics for all relevant epochs (1990, 2000, 2005, 2010, 2015). Where applicable, the same imagery used in the map production was used for review and revision. Where applicable and practical, very high resolution imagery available in Google Earth was also used to aid in the visual interpretation. All 13 LULC classes were taken into account.

For the purpose of the FREL construction, the visually validated map data was aggregated into five classes – namely three forest classes, one non-forest class and water. The forest classes are plantations (consisting of broadleaved and coniferous plantations), THF (consisting of THF well-stocked and low-stocked), and woodland. The aggregation was done based on differences in carbon stock, and the ability to distinguish them with sufficient level of accuracy by visual interpretation of very high resolution imagery. Also they were limited to the time period 2000 – 2015 which is in line with the reference period chosen. This resulted in six stable forest classes, three forest loss class, one forest gain class and stable nonforest.

The automatic consistency check served to eliminate unrealistic change trajectories that were not dealt with in the manual review and revision. Most of these unrealistic change trajectories covered very small areas, with 386 out of the 431 class combinations present in the map covering just 1% of the map area. An example of an unrealistic change trajectory would be "THF – WL – THF – THF" because a conversion from THF to woodland and back is very unlikely. In this case, the trajectory was changed to "THF – THF – THF – THF".

The following principles were applied in the automatic consistency check:

- Areas of 'No data' were replaced with the previous epoch's LULC label except for epoch 2000, where 'No data' was replaced with the label from epoch 2005.
- If water was detected in any epoch, the class label was applied to all other epochs unless the area was classified as forest in at least 3 epochs, in which case the area was classified as forest.
- Areas exhibiting a single-epoch change in class label then reverting to the previously designated class label were made consistent by re-labelling the 'odd' epoch to match the majority (i.e. THF – WL –THF becomes THF – THF – THF).
- Areas where natural forest was detected after an epoch mapped as nonforest, also the nonforest epoch was reclassified to natural forest. This was not applied to plantations.

The resulting change maps served as basis for stratification of the map accuracy assessment.

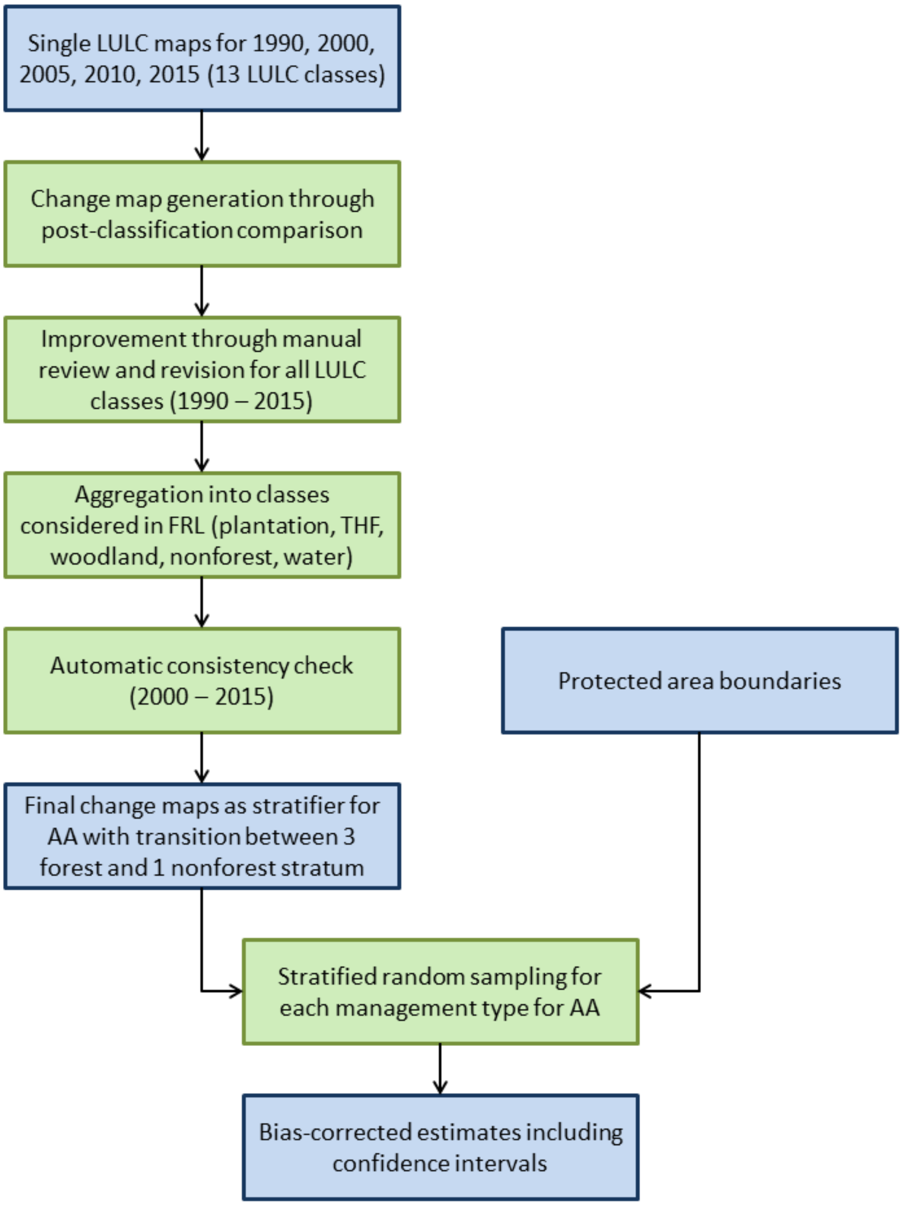

Figure 4: Work flow for creation of change maps and bias-corrected estimates. Data products are depicted in blue, processes in green.

3.4.1.3 Bias-corrected area estimates

A stratified sample of reference data was collected using the national map as stratification for the dual purposes of producing stratified area estimates with the best possible precision and for assessing the accuracy of mapped classes.

This was done following the methodology of “Good practices for estimating area and assessing accuracy of land change” by Olofsson et al. (2014) and “Map Accuracy Assessment and Area Estimation – A Practical Guide” (FAO 2016).

The accuracy assessment was conducted for the time period 2000 – 2015, separately for the three management types: private land, land managed by NFA and land managed by UWA.

As map classes, all transitions as defined in the REDD+ activities were considered. Even though maps are available for 2005 and 2010, the accuracy assessment was only conducted for changes between the years 2000 and 2015.

3.4.1.3.1 Sampling design and spatial assessment unit

As spatial assessment unit, polygons were chosen for two reasons. First of all, it is difficult to visually assess change on pixel level. Secondly, the polygon better represents the nature of the maps which were not created on pixel level, but on segments with a minimum mapping unit of 2 ha. Furthermore, the object-based assessment is less influenced by geolocation errors (Radoux et al. 2010) which could be an important error source taking into account the different map methodologies.

Random stratified sampling method was chosen for the sampling of the reference data locations, with the map strata being the ones as discussed under section 4.2 “Map data”. The minimum sample size for all classes was calculated using the formula provided (Cochran, 1977). It takes as input the map areas for the classes to be assessed, a target standard error for overall accuracy, and expected user accuracies. A target standard error for overall accuracy of 0.01 has been used in the computation. For stable classes (NF remaining NF, Pl remaining Pl, THF remaining THF, and WL remaining WL), the estimate of expected UA has been set to 0.9, while it has been set to 0.7 to all other classes. The result is the overall minimum sample size.

The formula provided by Cochran et al. (1977) usually applies to pixel-based assessment, so the sample size is in terms of pixels that need to be sampled. The spatial assessment unit for Uganda is not the pixel, but polygon, so the overall sample size was distributed in polygons. As polygons cover a bigger area than single pixels, this procedure seemed appropriate as it would rather result in over- than in undersampling, and thus decrease the uncertainties even further.

The minimum sample size was distributed proportionally between the classes, but applying a minimum sample size of at least 20 samples per class to ensure that rare transition classes were sufficiently sampled.

After drawing the sample, polygons with an area of smaller than 0.5 ha were excluded for three reasons:

- The same as pixels, such small polygons are very difficult to assess visually.
- These small polygons would have had very little or no influence on the results anyway because the area of the polygons is taken into account in the analysis
- All maps were produced using a minimum mapping unit (MMU). In most cases, the MMU was 2 ha. Overlaying the maps can result in smaller polygons. However, such small polygons are often rather the result of small geolocation errors or inaccuracies than of real features in the landscape.

3.4.1.3.2 Response design

The response design encompasses all steps of the protocol that lead to a decision regarding agreement or disagreement of the reference and map classifications (Olofsson et al., 2014). It has four major features: the spatial unit for assessment (discussed under sampling design), the sources of information used to determine the reference classification, the labeling protocol, and a definition of agreement.

Sources of reference data

The reference data must be of better quality than the map data, which can be achieved in two ways (Olofsson et al. 2014):

- The reference source has to be of higher quality than what was used to create the map classification (i.e. higher resolution satellite imagery)
- The process to create the reference classification has to be more accurate than the process to create the map classification if both processes use the same source material (i.e. if both classifications rely on Landsat data)

For reference data collection, a custom survey in Open Foris Collect Earth was used (see Figure 5). Collect Earth “facilitates access to multiple freely available archives of satellite imagery, including archives with very high spatial resolution imagery (Google Earth, Bing Maps) and those with very high temporal resolution imagery (e.g., Google Earth Engine, Google Earth Engine Code Editor)” (Bey et al. 2016, p. 1). This open-source tool developed by FAO has been widely used to collect reference data for map accuracy assessment. In addition, time-series images of Landsat and Sentinel-2 imagery were used to facilitate the assessment of the land cover dynamics (see Figure 6). This combination of very high resolution imagery, mainly available through Google Earth, and time-series of medium and high resolution imagery, including spectral bands characteristic for the discrimination of vegetation, improves the quality of the visual interpretation drastically.

For Uganda, a custom survey in Collect Earth was developed taking into consideration the spatial assessment unit (polygon) and the three objectives of the accuracy assessment. Therefore, the survey collects information on the following variables:

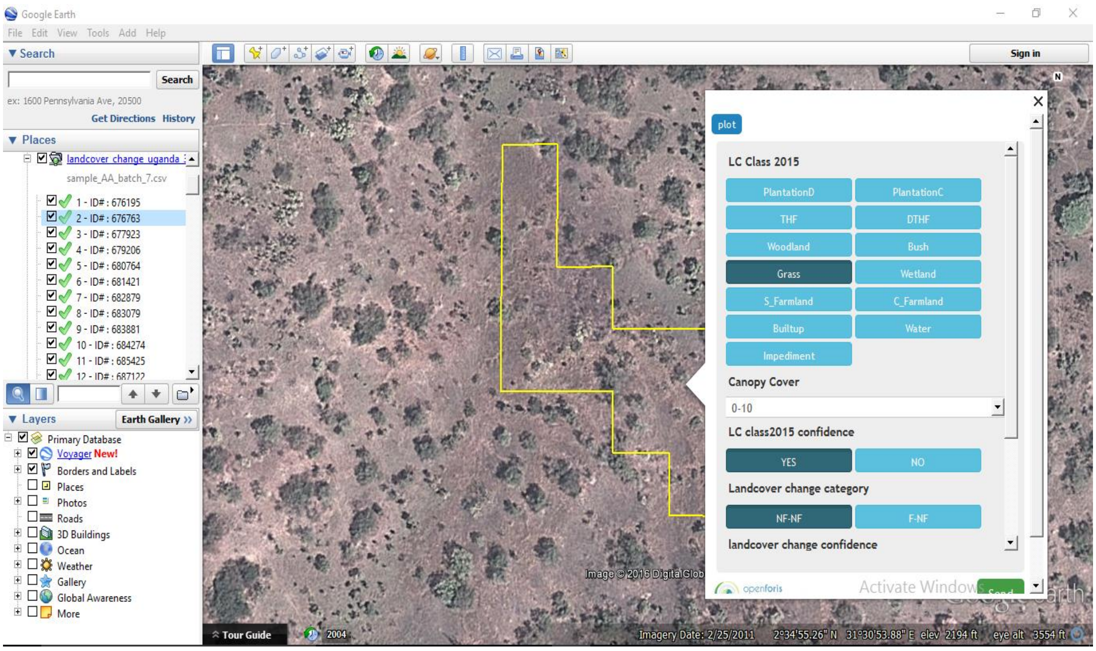

Figure 5: Survey used for reference data collection with Collect Earth survey interface.

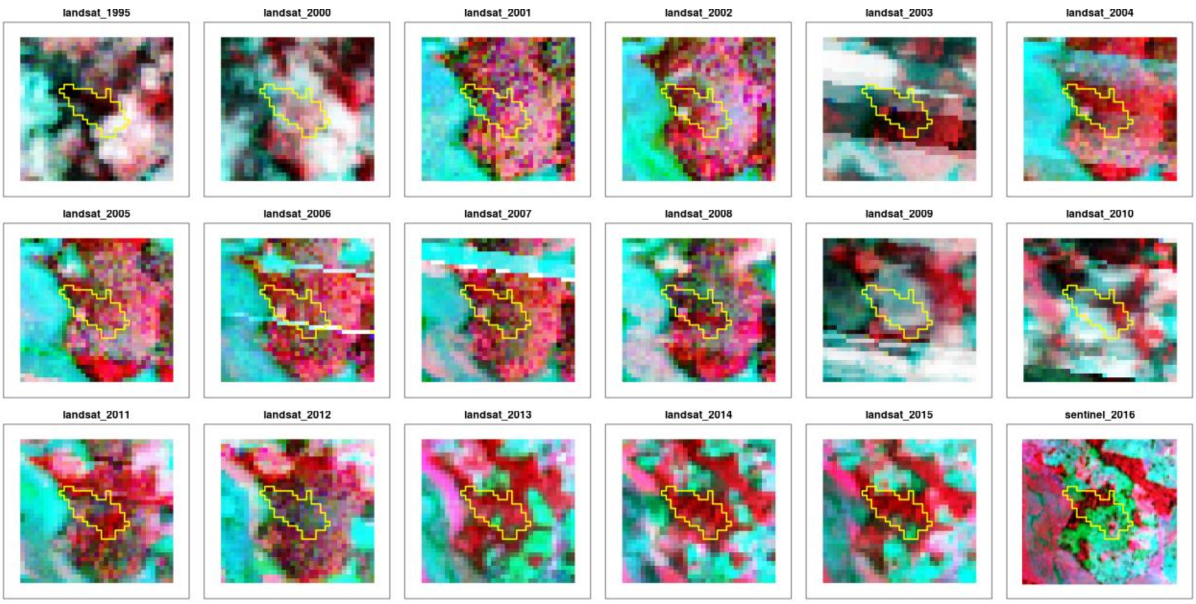

Figure 6: Landsat and Sentinel-2 false-colour composite snippets for one example polygon. The forest area, shown in red, is disappearing from 2013 onwards.

Labelling protocol

The NFA GIS team has a lot of experience in the visual interpretation of satellite imagery, especially for the purpose of creating LULC maps, and links them to their experience from intensive ground-truthing. In addition to the well-established routines and ongoing discussions on the interpretation of certain spectral signatures, the following rules were established for the purpose of map accuracy assessment:

- If a polygon covers more than one class, the majority class is assigned. If no majority class exists, the polygon is marked as no confidence for the respective variable, and hence excluded from analysis.
- Tree cover estimation was aided by a square grid of 50x50m.
- Protected area boundaries were loaded in Google Earth in order to make use of the local knowledge, especially regarding CFRs and the establishment of plantations within them.
- If more than one change was observed, the original and final LULC class were recorded, omitting the intermediate class. For example in CFRs, multiple changes were observed - mainly encroachment on natural forests that were then replanted as plantations. The change from natural forest to subsistence farmland to plantation was therefore recorded only as change from natural forest to plantation.

All samples were distributed randomly between the interpreters in order to avoid bias.

Defining agreement

The data collected through Collect Earth can easily be translated into the map classes - both in terms of LULC 2015 and in terms of forest – nonforest change. Therefore, agreement between reference and map data was defined as when the respective classes (LULC 2015 or forest change) matched.

3.4.1.3.3 Analysis and results

The analysis follows the guidance by Olofsson et al. 2004 and was done in R, based on scripts developed by FAO. It is based on the creation of a confusion or error matrix, a simple cross-tabulation of the class labels allocated by the classification of the map data against the reference data (Olofsson et al. 2014). For polygon-based assessments, the confusion matrix can either be a cross-tabulation based on object-counts (number of polygons allocated by the classification of the map data against the reference data), or area-weighted (sum of the area of the polygons allocated to a certain map versus reference data combination). The area-weighted area matrix was chosen because the objective was to evaluate the proportion of the map that is correctly classified, and not the proportion of objects being correctly classified (Radoux et al. 2010). The resulting confusion matrices per management type are shown in Annex 8.

Based on these confusion matrices, bias-corrected area estimates were derived using the formula provided by Olofsson et al. (2014). In addition to bias-corrected area estimates, the main aim of this methodology, accuracy estimates were derived (see Annex 8 for results).

Overall, this methodology is expected to reduce the size of confidence intervals for several reasons. First of all, using polygons as spatial assessment unit and taking their size into account covers a bigger area than assessing the same amount of pixel-based samples. Secondly, the stratification into several forest types and between management types reduces the variability within each stratum, and therefore overall uncertainty.

3.4.1.4 Results Forest Area Change

The results in forest area change are reported as bias-corrected area estimates as obtained from the map accuracy assessment. The detailed results of the map accuracy assessment, including map area estimates, are available in Annex 10 to this submission.

Table 8 presents the bias-corrected area estimates in terms of map strata by each management type as they were obtained straight from the map accuracy assessment. Forest transitions which are unlikely changes and areas that are not estimated due to lack of available data are marked accordingly.

Table 8: Bias-corrected area estimates for 2000 – 2015 (in ha), split by management type and forest transitions. Only area estimations for transitions relevant for this FREL submission i.e., deforestation marked in red are reported.

Forest transition	Detailed transition	Area in ha		
		Private land	**NFA**	**UWA**
Forest remaining forest	Plantation – Plantation	231,051 ± 14,746	20,771 ± 1263	9478 ± 1157
	Plantation – THF	**	**	0 ± 0
	Plantation – Woodland	**	**	0 ± 0
	THF – Plantation	464 ± 213	3382 ± 415	0 ± 0
	THF – THF	83,356 ± 7759	272,109± 1520	150,152 ± 3769
	THF – Woodland	0 ± 0	0 ± 0	0 ± 0
	Woodland – Plantation	8108 ± 3059	9165 ± 912	118 ± 19
	Woodland – THF	**	**	**
	Woodland – Woodland	898,431 ± 28,469	165,645 ± 3399	558,512 ± 6517

Forest becoming nonforest	Plantation – Nonforest land	3450 ± 905	3217 ± 427	396 ± 48
	THF – Nonforest land	112,087 ± 7874	9629 ± 662	2685 ± 523
	Woodland – Nonforest land	497,652 ±22,619	115,061 ± 3204	8026 ± 969
Nonforest becoming forest	Nonforest land – Plantation	74,273 ± 9487	37,485 ± 1178	21,663 ± 1893
	Nonforest land – THF	0 ± 0	0 ± 0	0 ± 0
	Nonforest land – Woodland	0 ± 0	0 ± 0	0 ± 0

* Area estimate available, but not reported in REDD+ activities.** Very unlikely to occur, data insignificant

Deforestation

Overall, in terms of deforestation, 124,401 ± 7919 ha of THF were lost, 620,739 ± 22,866 ha of woodlands, and 7,063 ± 1002 of plantations.

3.4.1.5 Comparison of National data with data from GFC (Hansen)

The Global Forest Change (GFC) product provides estimates of global tree cover and tree cover changes on an annual basis from 2000 through 2014 based on Landsat satellite imagery (Hansen et al. 2013). It shows significant differences to the national data in terms of tree cover/forest cover, but similar trends in terms of tree cover loss/forest cover loss.

To compare the tree cover extent versus forest extent, a tree cover threshold of 30% was applied to the GFC data. This is in line with the national forest definition of Uganda. GFC data shows an area of 8 million ha for the year 2000 with a tree cover above 30%. This is considerably higher than the national forest area estimate for year 2000 which is 3.1 million ha. GFC data maps a lot of the wetlands and subsistence farmlands as high tree cover (see Figure 7). On the other hand, the GFC data omits some of the woodlands in northern Uganda which are captured by the national data.

The big differences can be explained by the different definitions used for mapping. Whereas GFC maps tree cover, the national data maps land use/land cover whereby some classes can potentially have tree cover above 30%, but still be mapped as non-forest. This applies in particular to subsistence agriculture with agro- forestry e.g. a mix of banana, coffee and shade trees. Furthermore, banana/matoke plantations in narrow valleys can be mistaken for trees by the GFC data. That wetlands show up as high tree cover in the GFC data is due to their spectral signature. Especially papyrus can easily be mistaken for tree cover. Also the omission of woodlands in the GFC data can be attributed to the confusing spectral signature, especially for woodlands on bare soils with high reflectance.

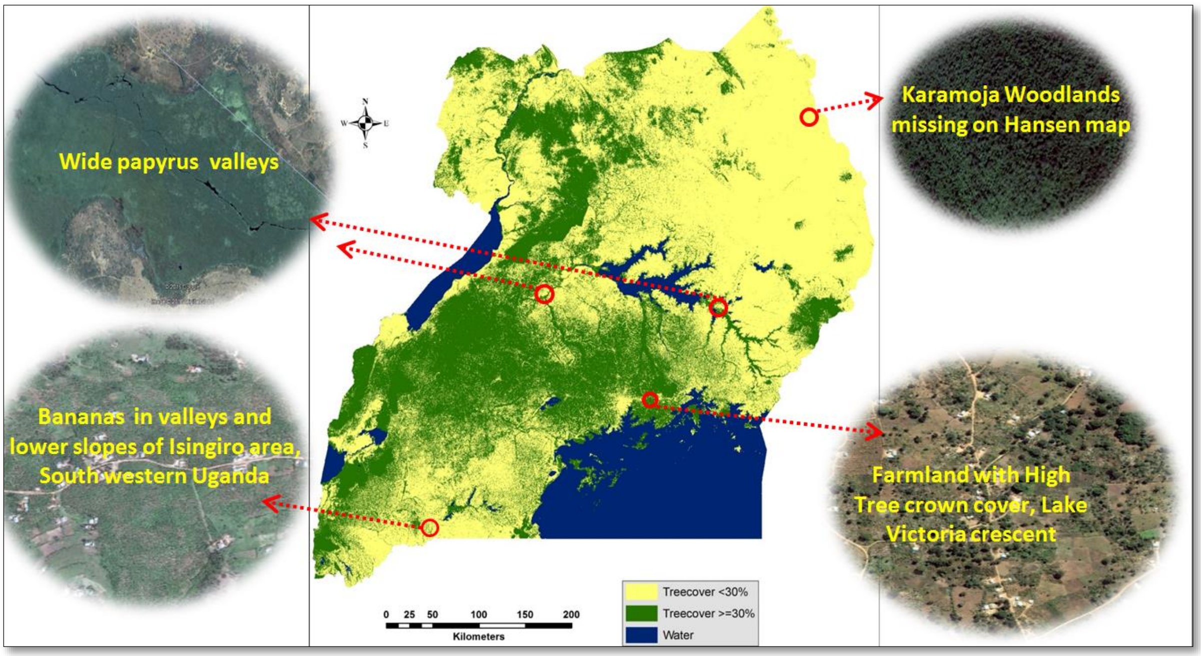

Figure 7: Extent of areas with tree cover above and below 30 % according to GFC data, and examples of disagreement between GFC tree cover map and national LULC maps on forests.

Regarding tree cover loss, both data sets show similar dynamics. Over the period of 2000 to 2015 the bias-corrected estimates show an average annual forest loss of 50,147 ha/year which is similar to the annual tree cover loss found by GFC maps for the period 2000 – 2014 at 38,767 ha/year. The lower loss rate found in the GFC maps could be due to the fact that GFC data might omit a lot of conversion from forest to subsistence agriculture because the succeeding land use retains a high tree cover, and is therefore not picked as “full tree cover loss” as defined by the GFC data. It is also noticed that woodlands in the northern parts of Uganda like in Moroto district are mapped as very low tree cover by GFC data and thus show no tree cover loss for the whole period.

3.4.2 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.

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 datasets, AGB and BGB are derived. Current data collection is ongoing and is expected to include estimates on deadwood and to improve estimates on woodlands.

3.4.2.1 Uganda Forestry Inventory description of the different models.

The purpose of these Forest inventories in Uganda can be grouped into four broad categories and these are:

1) National Biomass Study (NBS),
2) Stock assessment inventories (Exploratory Inventory and Integrated Stock Survey),
3) Permanent Sample Plot (PSP) for growth and yield monitoring, and
4) Special purpose inventories (e.g. biodiversity, carbon assessment and research studies).

The summary of datasets is presented in Table 9.

Table 9: Main characteristics of forest inventory data.

Inventory	Year	Number of cycles	Number of sample plots *	Main habitat type	Tenure/ management	Plot design
National Biomass Study	1995 – 2002 (revisits until 2010)	1–5	5 333	Subsistence Farmland (63%) Grassland (18%) Woodland (13%)	Private land	2500 m^2 square
Exploratory Inventory	2000 – 2009	1	16 781	Tropical High Forest (77%)	Public land (NFA)	500 m^2 circular
PSP – Natural Forest	1999 – 2015	1–4	115	Tropical High Forest	Public land (NFA)	1 ha square
PSP – Plantation Forest**	2006, 2011	1	125	Forest Plantation	Public land (NFA)	400 m^2 square
Carbon assessment in National Parks (Semuliki & Kibale)**	2011	1	606	Tropical High Forest	Public land (UWA)	100 m^2 square

* Number of unique plots in the NFA database
** Data not utilized in calculation of EF

National Biomass Study (NBS)

The purpose of this forest inventory was to assess biomass stock in Uganda. The project was carried out between 1990–2004. The inventory was funded by the Norwegian Government and it was implemented by the National Biomass Study under the Forest Department (up to 2003) and later in NFA. The assessment mainly focused on areas outside gazetted areas (see Figure 8) which were presumed to be sources of woody biomass mainly for energy purposes, i.e. wood fuel. In some instances this data can also be useful for planning and permitting timber harvesting licences on private lands by the Forestry Sector Support Department (FSSD).

Figure 8: Spatial distribution of Uganda's National Inventory data sets.

Stock Surveys (EI and ISSMI)

Stock surveys have been carried out in Forest Production zones within NFA gazetted lands since year 2000 and they target the generation of information for timber harvesting purposes. These stock surveys are carried out at two levels. Level 1 is called Exploratory Inventory (EI) and provides information on forest stocks in production zones[11]. After EI, Integrated Stock Survey and Management Inventory (ISSMI) is carried out only in forest blocks that are found with sufficient stocks to warrant timber harvesting.

Permanent Sample Plots (PSPs)

Permanent sample plots (PSPs) are 1 ha research plots and intended to generate information on forest growth rates, biomass dynamics and yields. This information can be later used for e.g. forest management planning. Together with other data sources (e.g. from ISSMI) information from PSPs may help in making decisions on level of timber extraction.

There are two types of PSPs established: plots in natural forests and in plantation forests, which fall within NFA gazetted lands. These data have different content and structure in the database. Plantation forest plots have been visited only once (in 2006 or 2011), natural forest plots have been visited 1 – 6 times between 1999 – 2015 depending on the age of the PSP and site. PSPs in the natural forest typically fall within tropical high forests.

Data from PSPs in plantations was used for initial calculations on biomass stock, but the stand age was so young that results were not considered representative of plantations overall. Therefore, NFA tree planting statistics from concessions was utilized rather than the PSP data. NFA planting statistics 1990 – 2015 contains information about planted species, area (in hectares) and planting year in NFA managed lands. Because the recommended rotation time of main planted species vary from 14 to 20 years, only the areas planted after 1999 were taken into the analysis.

3.4.2.2 Analysis of NFI data

Inventory data was developed for different purposes at different times and thus analysis and outputs relate to the respective inventory objectives. All historical inventory data however have

[11] Some areas of Forest Reserves may be put under conservation, as nature reserves, where harvesting is not allowed.

the basic parameters (independent variables) that can be used to estimate biomass and thus carbon stocks.

Forest type attributions were determined in the field for NBS and PSP data sites and for EI plots, where this data was provided. In those EI plots where forest type was not recorded, it was instead acquired from land use/land cover map based on satellite image interpretation from the 2005 map. LC2005 map was applied because most of the field measurements have taken place around year 2005.

In Uganda, the biomass equations developed by NBS (1992) and later adjusted by Velle (1997) for the subsequent NBS and by Begumana (2000) have, over time, been used to compute the biomass stocks often used for carbon estimates. Comparison of the widely used NBS equation with several other equations found out that there were no significant differences in the AGB estimated by the model of Chave *et al.* (2014) and that of NBS. It was thus decided that Chave *et al.* (2014) equation be used because it comparable to locally developed equations and, unlike the NBS biomass equation, does not require crown diameter measurements.

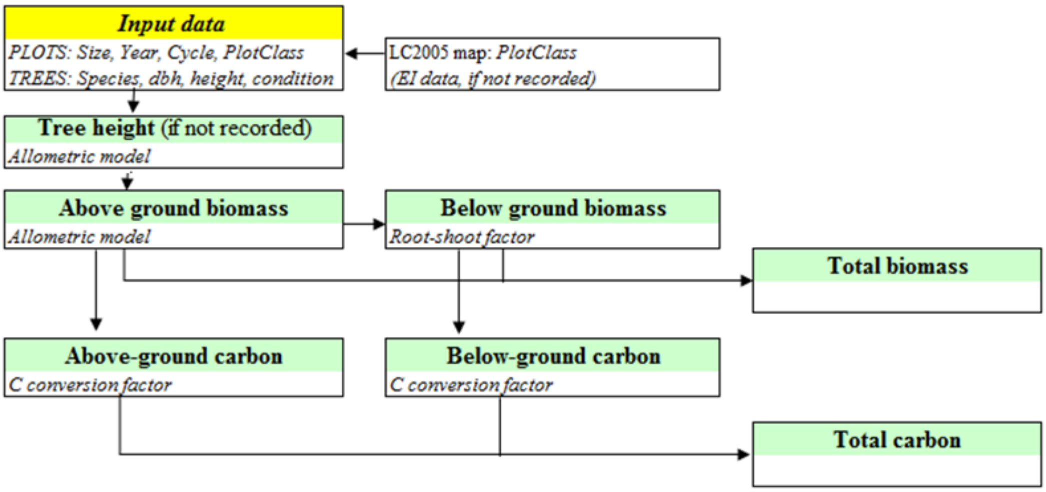

Figure 9: Tree carbon computing steps.

Tree and plot level results were computed using R scripts (see Figure 9). Final results with combined plot data and some graphs were computed using MS Excel. QGIS was used for spatial analysis and visualization.

3.4.2.3 Estimating Emission Removal Factors for THF and Woodlands

Using the aforementioned data analysis, tree carbon stock – both for living and dead standing trees was estimated by combining data from PSPs, EI and NBS. This provided carbon stocks or emission factors for THF and woodland. The average of carbon stock for high and low stocked tropical forests has been calculated using an area weighted mean whereby the mapped area proportions of THF high and low stocked from the 2015 LULC map were applied. The 2015 LULC map was used for this purpose because it is assumed to provide the most accurate data because of most advanced technologies in conjunction with the usual ground-truthing procedures.

NBS data on woodlands is biased towards areas outside the protected areas (see Figure 8)[12] which are degrading at a fast rate, and thus may cause very low carbon stock recorded under this strata.

The historical data has been used to estimate emissions factors but is not considered good enough to provide information on carbon stock changes in THF and woodlands. The ongoing re-measurement of growth plots in tropical high forests and woodlands will provide up to date data on removal/emission factors for stable natural forest classes. The new biomass survey which covers all woodlands will improve these estimates.

3.4.2.4 Estimating Emission Factors for plantations

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. Alder *et al.* (2003) pine and Eucalyptus yield models are considered to provide the best estimate of carbon stocks estimates in forest plantation by age.

Mean annual yields (i.e., stem volume per hectare) and mean annual increment 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. NFA tree planting statistics were used to estimate proportions of *Pinus* and 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 and mean annual yields which 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 species distribution of these areas was expected to be similar to NFA tree plantations.

3.4.2.5 Results and proposed Emission Factors

The results for carbon stocks in Uganda forests shows that tropical high forests have a mean total carbon stock of 143 tons per hectare, whereas it is 25 tons per hectare for woodlands and 71 tons per hectare for forest plantations (see Table 10).

Table 10: Carbon stock for Uganda’s three main forest classes.

Stratum no	1 & 2	3 & 4	5
Stratum name	Plantations	Tropical High forests	Woodlands
Data source	NFA statistics	EI, NBS, PSP	EI, NBS
Number of plots	-	15 047	1169
Number of trees (/ha)	-	234.4	278.3
AG Carbon (tons/ha)	57.2	115.7	20.0
BG Carbon (tons/ha)	13.7	27.8	4.8
Total Carbon (tons/ha)	70.9	143.4	24.8
AGC, Relative SE (%)	-	0.6 %	3.0%
T-value	-	1.960	1.962
AGC, CI lower (tons/ha)	-	114.2	18.8
AGC, CI upper (tons/ha)	-	117.1	21.2
AGC, Relative CI (%)	-	1.3 %	5.9%

[12] The National Biomass Study was primarily meant to generate data on biomass stocks for fuelwood and that assumption then was that biomass in protected areas was not accessible.

3.4.2.6 Comparison of NFI results and secondary data sources

The carbon stock results fall within the range of default values provided by IPCC 2006. Tropical high forest (equivalent to African rainforest) values for above ground carbon in forests give a range of 61-240tC/ha, while woodlands (equivalent to both tropical shrubland and tropical dry forest) range from 9-94tC/ha and plantations 9-71tC/ha.

3.5 FREL construction methodology/approach

3.5.1 National circumstances

As detailed in section 3.4.1 on Activity Data, Uganda has experienced dramatic forest loss in the past 15 years (see Figure 10). From 3.2 million ha or 15.4% of land area in 2000, the total forest area of Uganda has reduced to 2.5 million ha or 12.4% 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.

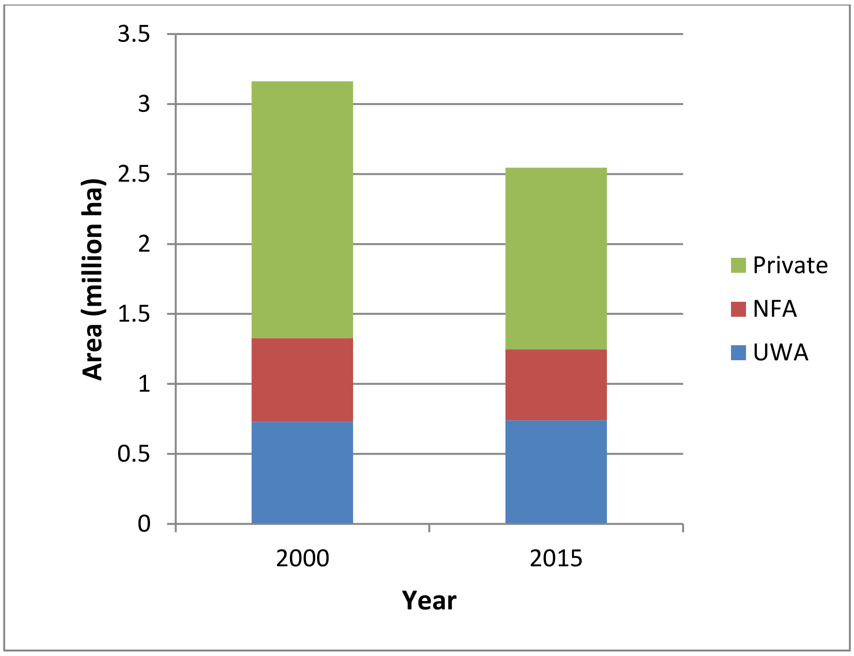

Figure 10: Forest area in terms of bias-corrected area estimates for years 2000 and 2015 split by management type.

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, but protection is expected to be effective enough to not allow for a complete depletion of protected forest resources. At the same time, at current rates of forest loss in private lands, forests may be depleted in the coming years if policies are not undertaken to change the current trajectory.

Stratifying between private and protected areas in general (with high forest loss on private land and low forest loss in protected areas) helps 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, summarised as under NFA, captures the dynamics even better as forest reserves show higher rates of forest loss than areas managed by UWA.

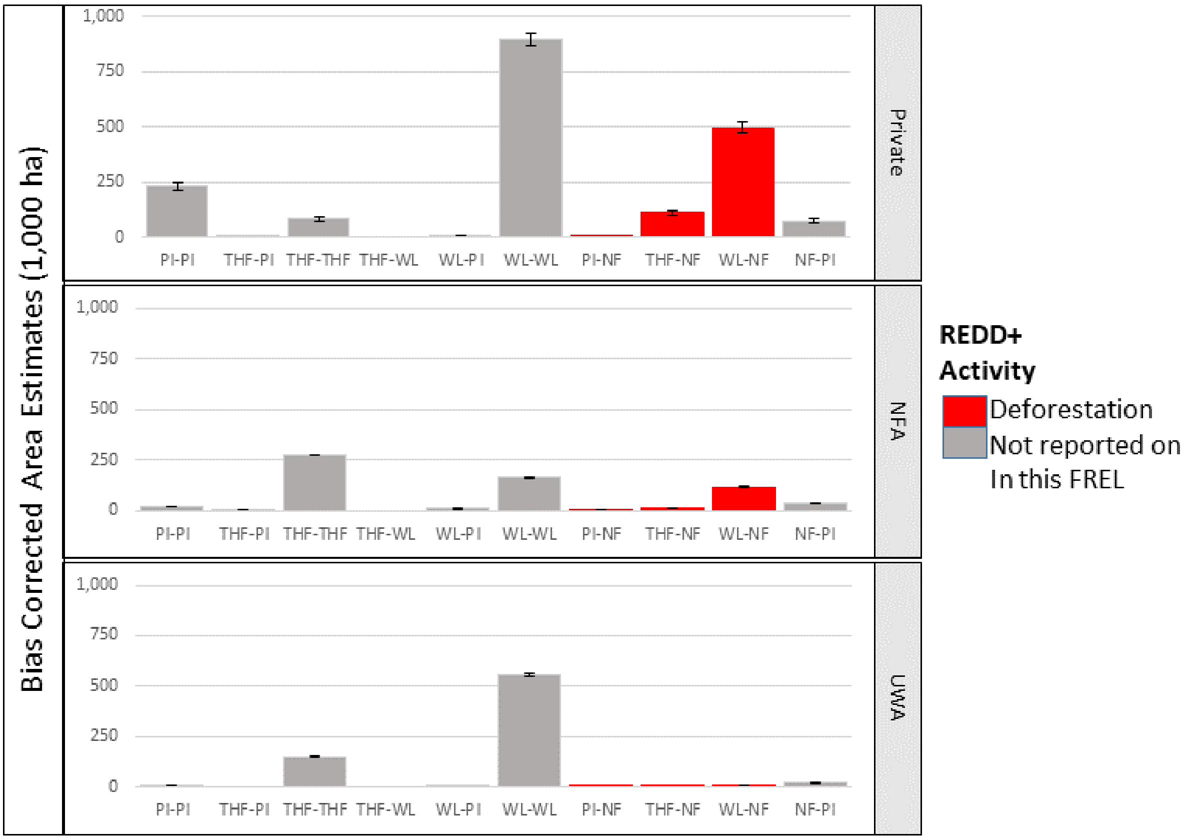

Figure 11: Bias-corrected area estimates for the three management types.

3.5.2 Combining Activity Data and Emission Factors

Uganda has determined that it will include only deforestation in its initial FREL. Emission factors for deforestation have been estimated for tropical high forests, woodlands and plantations (see paragraph 3.4.2 Emission Factors). The area of deforestation of the forest stratum is then multiplied with the respective emission factor to obtain emissions for the 15 year reference period (see Table 11).

Table 11: Combining activity data and emission factors to estimate cumulative emissions from deforestation (2000 – 2015).

Land use change transition (2000 – 2015)	Total area (private land, NFA, UWA) [in ha]	Emission factor [in tCO_2/ha]	Cumulative emissions (2000 – 2015) [in tCO_2]
Plantation – NF	7,063	260.2	1,837,793
THF – NF	124,401	526.4	65,484,647
WL – NF	620,739	91.0	56,497,181
Total			**123,819,621**

4 Proposed FREL

Uganda proposes a national Forest Reference Emission Level for the REDD+ that only accounts for deforestation. Deforestation is based on average emissions over the period 2000-2015 assessed by AD * EF. Uganda will include other activities of REDD+ in subsequent submissions and the plan for these improvements is presented in Table 14. In order to update and improve upon the accuracy of the FREL, Uganda proposes that the FREL be revised whenever there are improvements in data.

Annual emissions from deforestation account for 8,254,641 tCO_2/year (see Table 12).

Table 12: Annual emissions and removals for each reported REDD+ activity.

REDD+ activity	tCO_2/year
Deforestation	8,254,641

5 Relevant Policies, Plans and future changes (the REDD+ strategy and its options)

Presented below (see Table 13) is a summary of selected examples providing an outlook on how Policy Legal Regulatory institutional framework are supportive of REDD+ options (in the REDD+ strategy) and their implications for the FREL now and going forward. The column titled “RELEVANT PLRs outlook” summarises the interpretation of the likelihood of the proposed intervention being carried forward to completion and what is needed to do so successfully.

Table 13: Summary of selected examples providing an outlook on how PLRs are supportive of REDD+ options (in the REDD+ strategy) and their implications for the FRELs now and going forward.

REDD+ Activity	REDD+ Drivers & options	Corresponding main strategic options for addressing the DD	Relevant PLRs outlook
Reducing emissions from deforestation	1. Expansion/encroachment of small-holder agriculture into forests and bushlands 2. Unsustainable woodfuel extraction (charcoal and firewood) 3. Unsustainable timber harvesting 4. Large-scale commercial agriculture 5. Livestock free-grazing 6. Wood harvesting conducted by refugees 7. Wild fires 8. Artisanal mining operations and oil extraction	Strategic option 1: Climate smart agriculture	Agriculture is largest recipient of land lost to deforestation in Uganda. Current national efforts encourage sustainable land management (SLM) and climate smart agriculture (CSA). The proposed option is in full agreement with the agricultural sector intentions and is therefore likely to be sustained. Moreover, the proposed options also include recognition of the role of trees and shrubs on the same piece of land.
		Strategic option **8**: Strengthening of policy enforcement in REDD+ implementation	This strategic option supports efforts to addressing the drivers of deforestation and forest degradation. It envisages (1) linking REDD+ Measures and Actions to the existing "Office of the Prime Minister (OPM)'s policy enforcement unit"; (2) ensuring that the Ministry of Finance, Planning & Economic Development provides financing for REDD+ policy implementation; and (3) adequate & skilled staffing. This outlook is considered too be applicable for all the REDD+ activities
Reducing emissions from forest degradation		Strategic option 7: Livestock management in the cattle corridor	More than half of the country's land area is dedicated to Livestock management, together with management of wildlife. Rangelands improvement practices (supported by both the agriculture and wildlife/tourism sectors) are likely to continue. Again, the proposed options also include recognition of the role of trees and shrubs on the same piece of land.
		Strategic option 2: Sustainable fuel wood and (commercial) charcoal use	This option is one, of the several energy – supply mix possibilities with high potential for emissions abatement. However, the current practice requires considerable positive incentives to support full and effective implementation of existing and proposed policy approaches.
		Strategic option **5**: Energy efficient cooking stoves	Energy efficient cooking stoves have received considerable acceptability but their use has not reached a critical mass to be private sector supported. They still need for significant positive incentives even though there are reasonably adequate policy approaches for use of efficient cooking stoves. This option is supported by the national renewable energy and forestry policies.
		Strategic option **6**: Integrated wildfire management	Fire affects more than half of the country land area. Fire (irrespective of the intention of the origin) contributes to forest degradation and may create conditions for deforestation. Integrating fire management is common practice in wildlife and plantation management but it requires additional positive incentives to be scaled up to all rangeland management.
Conservation of forest carbon stocks		Strategic option **4**: Rehabilitation of natural forests in the landscape	Protection of natural forests is a national priority. Natural forests contribute to national economy & rural livelihoods through their provisioning services; they support the tourism sector through their provision of habitat for wildlife (the mountain gorilla is a forest

REDD+ Activity	REDD+ Drivers & options	Corresponding main strategic options for addressing the DD	Relevant PLRs outlook
			dependant); they support hydro-power generation and have high carbon stocks. The options proposed will require strong positive incentives and additional policy approaches with emphasis on conservation of forest carbon stocks
Sustainable management of forests		Strategic option **4**: Rehabilitation of natural forests in the landscape	Rehabilitation of natural forests in the landscape to provide all the services mentioned under the "Conservation of forest carbon stocks" but with emphasis on harvested wood and non-wood products. In addition, the options proposed will require strong positive incentives and additional policy approaches with emphasis sustainable management of forests on privately owned lands and protected areas where production of wood and non-wood products is the object of management (Namely protected areas under the National Forestry Authority and Local Forest Reserves under the local government).
Enhancement of forest carbon stocks		Strategic option **3**:: Large-scale commercial timber plantations	Uganda intends to join the lower middle income category by early next decade. This will definitely will increase the demand for harvested wood products and their value chains will benefit productive forests (including for the natural wood harvested products); in turn, enhancing forest carbon stocks. Non-carbon benefits to this arrangement will be seen through contribution to the GDP, mitigation and employment benefits. In the strategy options proposed, Commercial eucalypt transmission pole and timber plantation, and Commercial pine pole and sawlog plantation are common practice while the third, namely Improved charcoal kiln working next to timber plantations is not wide spread. While there is reasonably adequate policy approaches, the significant positive incentives are required.

6 Areas of improvements

Whereas Uganda's national REDD+ Strategy includes measures and actions to address the drivers of deforestation and forest degradation; as well as measures and actions to enhance the role of conservation, sustainable management of forests and enhancement of forest carbon stocks, not all these activities could be included in the FREL submissions. Uganda chooses to use a stepwise approach that will allow the country to acquire additional data and monitoring capacities and technologies to eventually include the other activities. Thus the areas of improvement are summarised in Table 14. Some of these areas have plans and actions already in place, so they can be accomplished in the short term, whereas for others, they will only be realised in the long term, also depending on availability of resources.

Table 14: Areas of improvement to the FREL in short and long term.

FREL Building Block	Current Status	Approach	Immediate action (1 to 2 years)	Medium to long term action (5 years ++)
Forest Definition	Forest Definition agreed upon and approved by the highest policy decision making body	A minimum area of 1 Ha, minimum crown cover of 30% comprising of trees able to attain a height of 4 metres and above in situ.	Explore use of higher resolution satellite imagery, i.e. Sentinel-2, improve accuracy on forest loss and gain	Revision of minimum area threshold is possible only if capacity to map and monitor woodlots smaller than 1 hectare is developed
Scale	National scale agreed upon and approved by the highest policy decision making body	Pilot REDD+ jurisdictional projects allowed. However reporting to UNFCCC at a national level	None foreseen	None foreseen
Scope 1: Activities				
Activity 1: Deforestation	Deforestation accounted for in 2017 FREL	Map area change approach used in the 2017 FREL. Satellite change detection analysis to be used in the future	Explore use of higher resolution satellite imagery, i.e. Sentinel-2, to improve accuracy on forest loss	Continued exploration of emerging technologies.
Activity 2: Forest Degradation	Forest Degradation not accounted for in the 2017 FREL. The NBS reports and the second national communication indicate that degradation is significant.	So far could be estimated based on PSPs in THF and NBS repeated measurements in woodlands. Results were inconclusive for several reasons. 1) Data not available in some key areas like those under UWA. 2) Little data is within the reference period i.e., 2000 to 2015. 3) Analysis of this data could not give the required statistical evidence i.e. there was high uncertainty associated with the data and thus could not be included in the FREL. (refer to Annex 9 of FREL submission)	Data improvements being made are; updating of the PSPS and NBS Database with most recent measurements, a plan for more field data collection plus making use of data from other stakeholders such as UWA, WCS and UTGA is in place. Uganda is taking advantage of new remote sensing technologies that use dense time-series analysis. BFAST and timeSync are already being tested. Testing of LIDAR \ RADAR technology is also considered. Proxy data e.g., biomass energy	Continued exploration on emerging technologies in mapping and assessing degradation both direct measurements i.e. remote sensing and repeated field measurements plus use of proxy data e.g., timber and biomass extraction data.

FREL Building Block	Current Status	Approach	Immediate action (1 to 2 years)	Medium to long term action (5 years ++)
			extraction records will also to be included in the analysis.	
Activity 3: Conservation of carbon stocks	Conservation of forest carbon stocks not accounted for in the 2017 FREL. Was included in the initial submission but not in revised submission. Results were inconclusive mainly because the data used lies outside the major conservation areas, which are under UWA.	Estimation of Removal Factor (RF) was based on PSPs in THF and NBS repeated measurements in woodlands. More data in conservation areas is needed.	Gain access to inventory data held by UWA and other stakeholders. Coordinate with UWA and WCS on inventory methodology and plan revisits to those sites where they have baseline measurements that MRV team could build upon. Use new and emerging technologies mentioned above	Continued coordination & consultation with UWA and WCS on field data collection on UWA lands and validation of AD results on those lands
Activity 4: Sustainable management of forest carbon stocks	Sustainable management of forest carbon stocks not accounted for in the 2017 FREL. Was included in the initial submission but not in revised submission. Plantations established by year 2000 are assumed to have constant C stocks and therefore are not accounted for.	The rotation age of plantations in Uganda is between 8 years (for Eucalyptus) and 15 years (for Pine). Forests established before 2000 have attained the rotation age. For Eucalyptus the general practice is harvesting and regrowth. For pine the general practice is harvesting and replanting. This situation implies a carbon flux or an average constant C stock in the reference period and in the future. Estimation in natural forests requires data on extraction versus rate of natural replenishment. This data is not available.	Establishment of a system to monitor and measures (MRV) existing forests both Natural and forest plantations has already started.	Build a strong NFMS system that monitors all existing forest. Inclusion of the Integrated Stock Survey and Management inventory (ISSMI) data base as part of the MRV system. Field verification to confirm proper implementation of ISSMI. Continued improvements in the MRV system for existing forests both Natural and forest plantations
Activity 5 Enhancement of forest carbon stocks:	Enhancement of forest carbon stocks not accounted for in the 2017 FREL. Currently there is a lack of detailed data on forest	A big percentage of area under small woodlots was estimated by statistical approach i.e., Bias-corrected area estimate. The results lack information on age and species.	Uganda is taking advantage of emerging technologies mentioned above to monitor new forest establishments.	A registry system to track small woodlots to be put in place under the MRV system of the NFMS

FREL Building Block	Current Status	Approach	Immediate action (1 to 2 years)	Medium to long term action (5 years ++)
	plantations by species and age class which is a key requirement to estimate removal factors. Uganda is carrying out ECS in some pilot natural forests on a project based approach. This data is not yet available for use in FREL.	Uganda proposed accounting ECS only for new forest plantations established in the reporting/results period. An analysis of several approaches demonstrated that the proposed approach neither over- nor under-estimated carbon stock removals (refer to *CO2_Accounting_OptionsUganda .xlsx*). This approach, however, was not favoured by the Assessment Team. There is currently a lack of clarity and guidance on how to account for ECS and thus this activity is not included in the 2017 submission.	Locations (geospatial coordinates) of successfully established plantations to recorded. This data to provide training points for the improvement of the LULC map classification. This work has already started by SPGS (Sawlog Production Grant Scheme). Plans to involve Local governments, NFA and other institutions as part of the MRV system are in place. Improvement of spatial resolution of RS data to capture small newly established plantation areas.	
Scope 2: Carbon Pools				
Above ground	Above ground carbon stocks in living biomass used in the estimation of carbon	Above ground biomass data collected in the historical period (2000 to 2015) for the estimation of biomass and EI (timber stocks Assessment) used to estimate carbon stock	Plans for continuous data collection and improvement on representativeness in place	The strategy is to explore emerging technologies to speed up field data collection
Below ground	Below ground carbon stocks in living biomass used in the estimation of carbon	IPCC root to shoot ratios were applied to the above ground biomass	No immediate plans of collecting country specific root to shoot ratios	
Litter	Carbon stocks in Litter not estimated	Historical data on litter not available and new data has been collected	No immediate plans of collecting data on litter	Carbon pools in litter may be included in future subject to availability of resources.
Dead wood	Carbon stocks in Deadwood not estimated	Historical data on deadwood not available. Data collection on deadwood has started but not yet	Data on dead wood is currently being collected in the ongoing field inventory	Continued data collection of found plausible

FREL Building Block	Current Status	Approach	Immediate action (1 to 2 years)	Medium to long term action (5 years ++)
		sufficient for use in the estimation of carbon stocks	cycle and will therefore be available for inclusion in the subsequent FREL submission.	
Soil carbon	Carbon stocks in soils not estimated. Second national communication provided expert judgement on soil emissions for completeness. However, these estimates were not robust enough for inclusion in the FREL.	Historical data on soil carbon is not available and new data has to be collected. As a starting soils, Uganda soils will be grouped into IPCC soil categories and an estimate of soil carbon stock and soil carbon stock by land management and practice be established	National Agricultural Research Organisation (NARO) has started creating a digital database of soils and grouping them into IPCC broad soil categories. Default emission factors to be used initially.	Soil organic may be included in future FREL submissions subject to availability of resources.
Scope 3: Gases				
CO_2 gases	CO_2 estimated in the FREL	Standard IPCC methodologies used to estimate CO_2 in carbon pools mentioned above	Latest recommended IPCC approached to be used	Latest recommended IPCC approached to be used
Non-CO_2 gases	Non-CO_2 not included in emission estimates for the FREL	N/A	Use data on burnt areas from NASA and IPCC default factors to estimate non-CO_2 emissions such as Methane (CH_4), Carbon Monoxide (CO) and Nitrous Oxide (N_2O).	South to South collaboration with RCMRD Kenya expected to improve estimation of burnt areas. Kenya already resampling the 500m by 500 m Modis data using Landsat 30m by 30m to improve on this estimate.
Data 1: Activity Data	Uganda aims at reducing the mapping cycle from 5 to 2 years and has started creating a year 2017 LULC map using spectral (direct) change detection. Accuracy assessment will be	Activity Data estimated in terms of forest area conversion to non-forest (include the reverse). Changes in forest remaining forest to be monitored in the future	Explore use of higher resolution satellite imagery, i.e. Sentinel-2, to map small woodlots.	Continued exploration on emerging technologies.

FREL Building Block	Current Status	Approach	Immediate action (1 to 2 years)	Medium to long term action (5 years ++)
	mainstreamed in the production process			
Data 2: Emission Factors	Historical data (2000 to 2016) used to estimate above ground biomass carbon stocks used in the FREL.	Inventory data is used to estimate carbon stocks or Emission Factors. Repeated measurement to be used to estimate Removal factors as well. Improvements in are being made targeting filling data gaps.	Additional forest inventory is planned in the forthcoming FCPF funding. An updated forest inventory data will enable more statically sound and improved geographical representation EFs and RFs. This expected to result in general improvement of the Monitoring, Measurement, Reporting and Verification (M & MRV) system including tracking changes in forests remaining forests.	Continuous improvements subject to availability of funds

7 Annexes

(all annexes provided in a dedicated folder)

Annex 1: Summary of the three MRV taskforce meetings held between April and September 2015

Annex 2: National Technical Committee meeting report (1st-2nd December 2015)

Annex 3: National Climate Change Advisory Committee meeting report (10th -11th March 2016)

Annex 4: National Technical Committee meeting report (July 26th -27th 2016)

Annex 5: Summary of the resolutions from the National Climate Change Advisory Committee meeting (24th -25th November 2016)

Annex 6: First Stakeholder consultation meeting report

Annex 7: Second Stakeholder consultation meeting report to consider and identify suitable option for the “Construction of the Forest Reference Emissions Level and/or Forest Reference Levels (FREL/FRLs)

Annex 8: Map accuracy assessment methodology and results for establishing Uganda’s

Annex 9: Estimating emissions from forest degradation in Uganda

Annex 10: Non-CO2 emissions from fires in Uganda

Annex 11: FREL calculation (Excel sheet)

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