REPUBLIC OF UGANDA

Ministry of Water and Environment

Proposed Forest Reference Level for Uganda

Preliminary Document

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Acknowledgments

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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
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
UWA	Uganda Wildlife Authority

Summary – the proposed FRL

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 Level (FRL) 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 FRL 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, Degradation, Sustainable Management of Forests, Conservation
Scope Gases	CO_2
Scope Pools	AGB, BGB
Construction Methodology	Historical average based on 15-year reference period (2000-2015), 5-year rolling average.

Based on the above agreed upon building blocks, the component parts of the Ugandan FRL are: Deforestation is 8.15 million tCO_2/year, Degradation is 821,415 tCO_2/year, Conservation is -699,000 tCO_2/year and Sustainable Management of Forest is -225,219 tCO_2/year. This sums to an overall FRL of 8.05 million tCO_2/year.

[1] The NCCAC , a national level multi-stakeholder body chaired the Permanent Secretary MWE replaced Climate Change Policy Committee (CCPC) as REDD+ Steering Committee since 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. Further, 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. The REDD+ Process is supported

[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 the Permanent Secretary MWE replaced Climate Change Policy Committee (CCPC) as REDD+ Steering Committee since mid-2015

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

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.

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 September 2015 (report in annex 1)	Positive recommendation at meeting on 26-27 July 2016 (report in annex 4)	Final endorsement at meeting on 24-25 November 2016 (meeting resolution in annex 5)

In addition to the above, Uganda had two meetings/consultations with all stakeholders (meeting reports in annex 6 & 7).

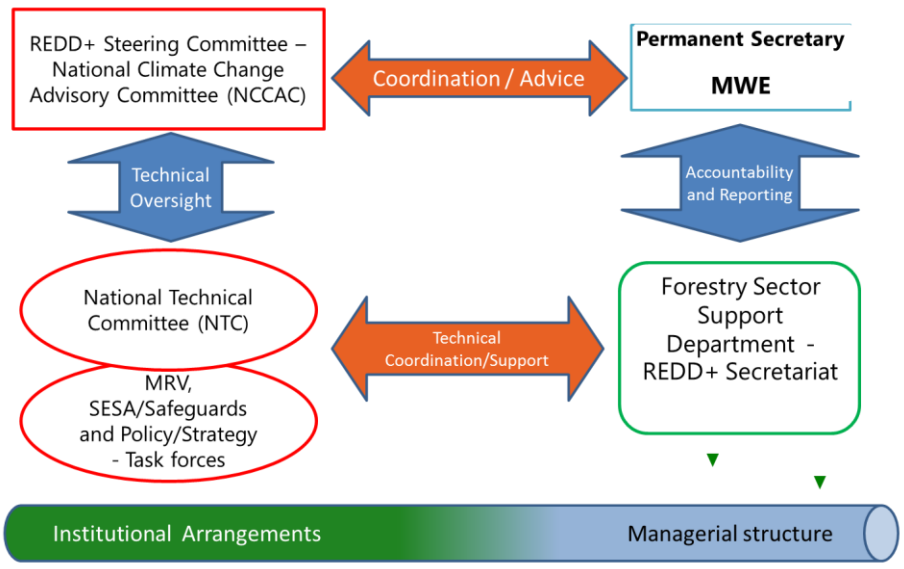

Figure 1**: REDD+ Institutional arrangements and managerial structure.**

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. 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 favourable rainfall and temperature for a diversity of fauna and flora and subsequently, human settlement and a variety of land use types (NBS, 2009).

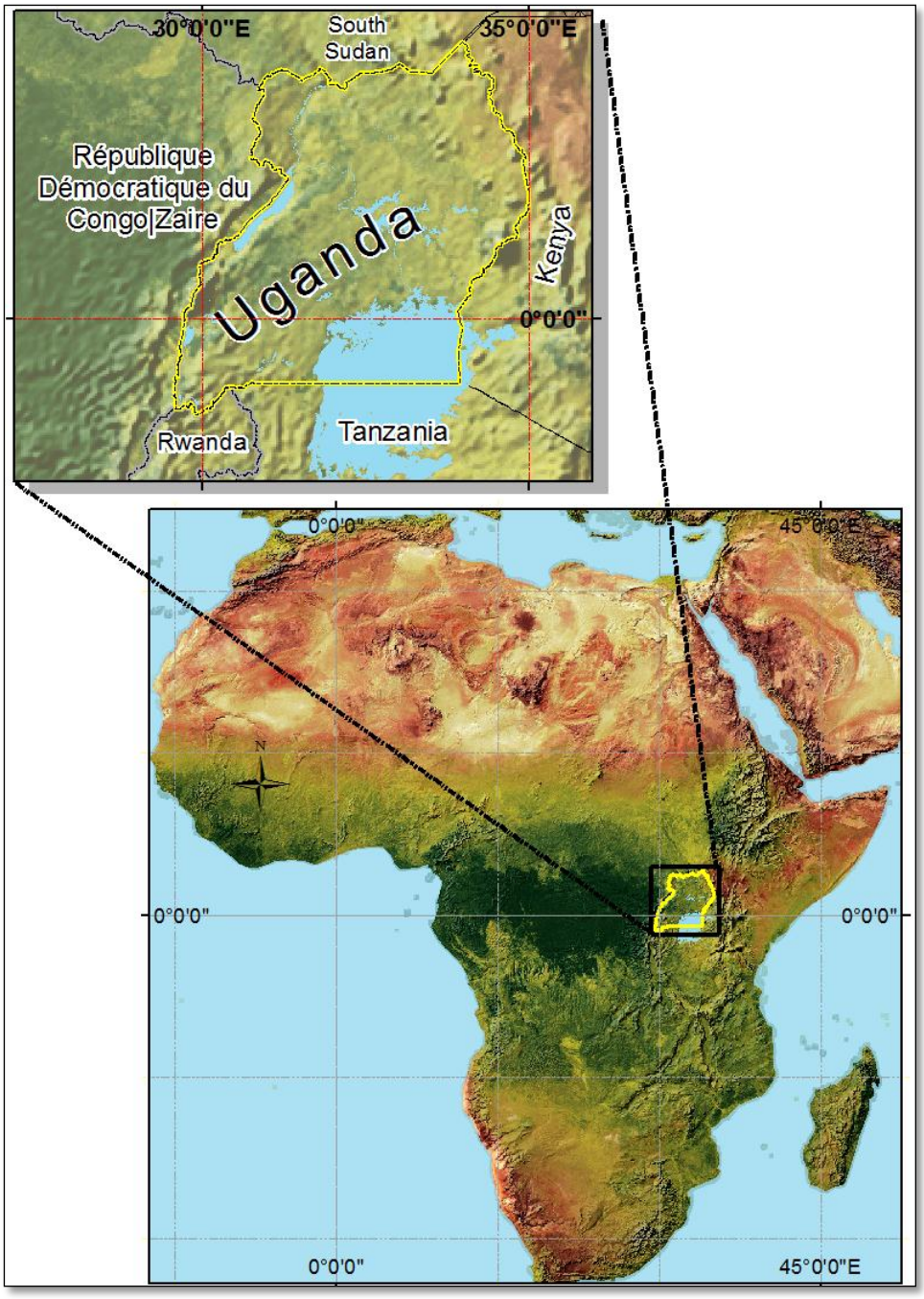

Figure 2: Map of Africa/Uganda (data from Natural Earth 2017)

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).

For 2015, the forest cover was estimated at 12% of the total land area, or 2.4 million ha. Woodlands are the dominant forest type, accounting for 62% of the forest area, THF for 21% and plantations for 17% (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. These woody formations however provide important services to communities and through the biomass inventories it has been found that some of the non-forest land cover classes have higher biomass stocks than woodlands.

All natural forests have experienced a strong decline in area in the past decades. In 2000, forests are estimated to have covered 3.12 million hectares, and declined to 2.42 million hectares in 2015, about 11.8% of the total land area. In 1990, forest cover had been estimated at 24% of total land area.

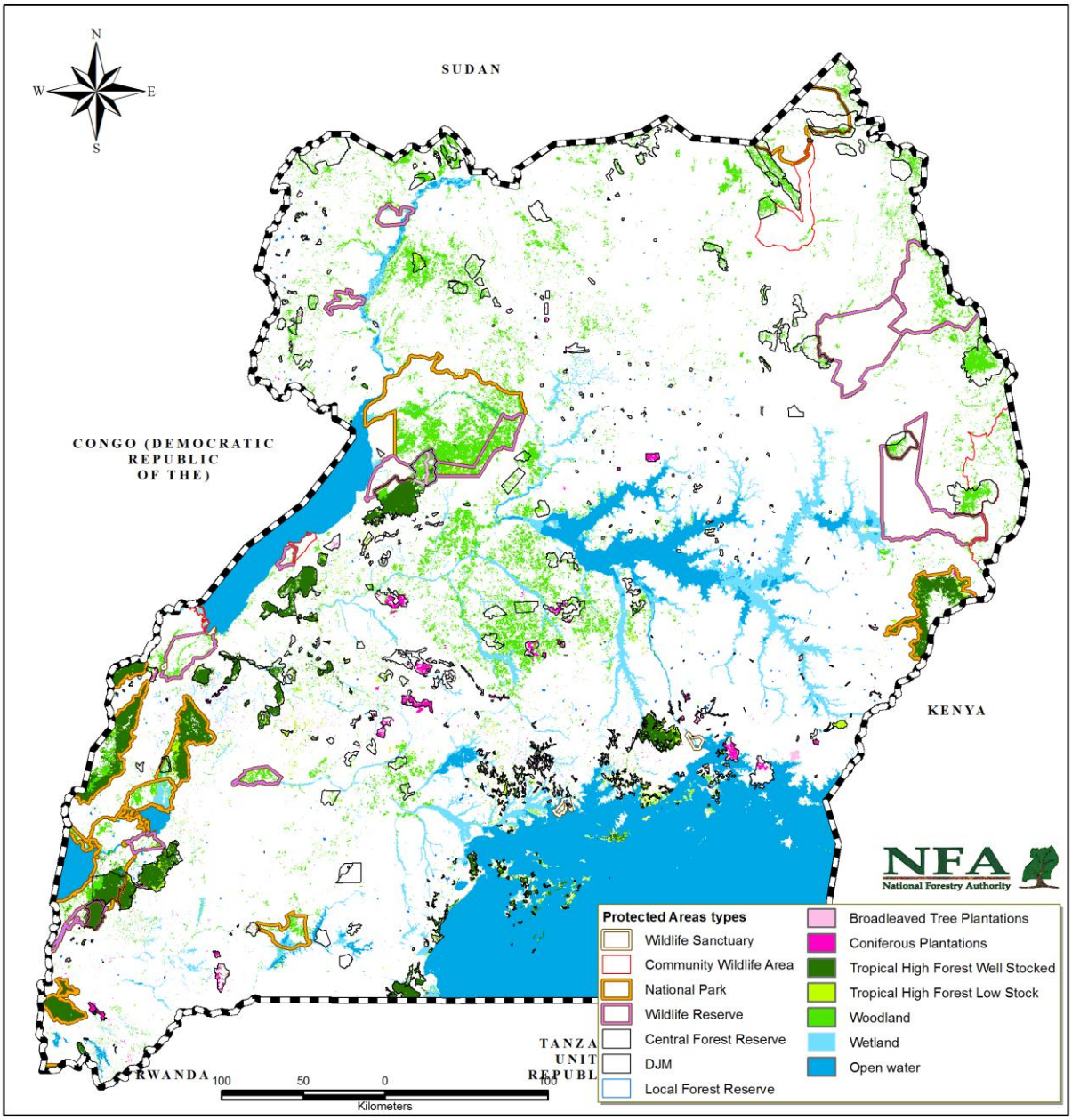

Figure 3: Forest cover and protected areas in Uganda (MoWE 2015).

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).

3 Key FRL building blocks

3.1 Forest definition

The Conference of the Parties (COP) to the UNFCCC adopted at its sixteenth session (COP-16) a milestone decision on Reducing Emissions from Deforestation and Forest Degradation (REDD+). Unlike the Clean Development Mechanism of the Kyoto Protocol under which compensation was only available for increased carbon stocks resulting from afforestation and reforestation, the REDD+ approach also allows to provide compensation for the sustainable management and conservation of forest carbon stocks, or avoiding deforestation and forest degradation.

Forest definitions will be chosen as the most appropriate for the implementation of REDD+ activities. Given the great variety of forest formations, the diversity of their characterization and the many purposes they serve, a universal definition of forest is arduous if not risky. The fact that "forest" has been defined in many ways by different countries is a reflection of the diversity of forests and forest ecosystems in the world and of the diversity of human approaches to forests. The guidance on forest definition for REDD+ is that it should be consistent with that used in the national GHG inventory and reporting to other international organizations and if not, the country must provide an explanation of why and how the definition used was chosen. In addition, the definition should be consistent over time[5].

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

[5] Decision 12/CP17p.8 and Annex (d), Decision 14/CP19p11(a)

3.1.1 Factors considered during the definition process

The criteria used to define forests are usually based on the notion of `land cover' or `land use', or sometimes a combination of the two. These two closely related notions can cause confusion in land classification, especially where different methods are employed and specific issues not addressed. Because the management of both land and tree resources is based on data referring to both land cover and land use, there is need to make a clear distinction that reconciles the two concepts.

The purpose of a forest definition also influences its content. Biological definitions, for example, are usually based on structural parameters, whereas legal definitions attest to the legal status of land and may ignore the vegetation and land cover. In some instances, lands legally defined as forests may be bare of trees though their status remains unchanged.

Under the legal classification, definitions are based on a legally defined land area (which could have no vegetation at all) under the jurisdiction of the national agency managing forests. Examples in Uganda are Central Forest Reserves (CFR) and Local Forest Reserves. These are areas that have been set aside for forestry activities and are referred to as forests reserves whether they have vegetation on them or not. The National Forestry and Tree Planting Act (2003) consider a forest as an area of land containing a vegetation association that is predominantly composed of trees of any size, and includes:

- forest classified under this Act;
  - Which includes central forest reserve (may or may not be forested), local forest reserve (may or may not be forested), community forest, private forest and forest under the wildlife act;
- a natural forest, woodland or plantation;
- the forest produce in a forest; and the forest ecosystem; which means any natural or semi-natural formation of vegetation whose dominant element is trees, with closed or partially closed canopy, together with the biotic and abiotic environment;

Forest definitions that are based on land cover and or land use are mainly concerned with what constitutes a forest and activities being carried on the land / forest. We consider this approach to be more applicable to REDD+ because what constitutes a forest and activities in a forest have a strong bearing on carbon stocks and or carbon stock changes.

Further national context for defining forests include:

- A physiognomic and ecological aspect that borrows from the Yangambi classification and other subsequent forest definitions / vegetation classification systems;
- Uganda's unique geographical position in Africa – being a confluence of more than four biomes;
- The socio-economic and demographic dimension of the east African region and Uganda in particular;
- The challenge of considering land cover versus land use in developing a forest definition;
- The technological feasibility of mapping and monitoring whatever is considered forest.

It is worth noting that maps of the National Biomass Study and NFA have considered woody stands of 4 metres and above that are not cropland or grassland as forests (woodlands) and those below 4 metres are considered bush.

Taking into account the above circumstances, Uganda's forest definition for the construction of FRL for REDD+ programme shall be:

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

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

- 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.

The basis for the above definition takes into account the following;

- UNFCCC guidance; slight modification of the definition already submitted to UNFCCC through the first two National Communications; the modification will encompass a reduction of minimum expected height from 5 to 4 metres. The reasoning for this change is explained in the data section;
- The revised definition is agreed upon by ALL Ugandan stakeholders and will substitute the previous definition in the third National Communication;
- Capacity to collect and analyse data including historical data and the use of freely available Landsat imagery;
- Available information and technology; evolution of mapping from visual interpretation classification to computer aided interpretation and classification;
- A combination of a land-use approach and a land-cover approach; farmland with large crown agroforestry trees is classified as farmland while temporally harvested forest plantations are considered forests. Forests that are not temporarily harvested and whose crown cover goes below the minimum threshold value are considered deforested.

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

Gases.

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

In its second national communication, Uganda reported that on average 550,000 ha of forest were burned in 2000 and that the highest non-CO_2 emissions from forest wildfires were from CO (estimated at 1,000,000 tonnes of CO) most of it attributable to burning of woodlands. CH_4 emissions were second most important of non-CO_2 emissions, estimated to release over 60,000 tonnes of 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. Current technical capacity and available resources do not allow Uganda to include non-CO2 gases in the initial submission of FRL at this time. Once area data is improved, if fire is determined to be a significant source of emissions, the estimation of non-CO2 gases from such fires would be undertaken as a future area for improvement.

Carbon Pools. The IPCC guidelines provide five pools for consideration in the FRL 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 FRL. Deadwood is expected to be included in the revised FRL submission. This decision is based on resources, data and technical capacity that Uganda has at the time of submitting its initial FRL. Mobilisation of resources and building capacity to include other carbon pools is ongoing. Details of carbon pools that are initially considered are presented below in Table 3:

Table 3: Summary of Carbon Pools included in the initial FRL 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 5 cm 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)
Dead Wood	NFI - Field measurements (Not included in initial submission because field data collection is ongoing. Will be included for THF in a modified FRL)	Measured only in Tropical High Forest	Min diameter: 10cm in THF Min diameter: 3cm in woodlands

Above ground biomass

Above ground biomass that is considered in Uganda's initial submission of FRL is living tree biomass. 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 live biomass considered is in the form of roots. Estimation 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 FRL 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 in tropical high forest and a minimum diameter of 3cm in woodlands may represent a significant quantity of biomass carbon and is thus currently measured in the ongoing forest inventory. This includes standing dead trees within the plot and dead wood lying (on the forest floor along the line-intersect). The decomposition state (e.g. sound, intermediate and rotten), and density of the lying dead wood is recorded and used to estimate carbon. This data is currently being collected in the ongoing NFI and therefore is anticipated to be included in Uganda's modified FRL submission.

Litter and Soil

Litter is not at present reported on since its contribution to total carbon emissions is not considered as 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.

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

Activities

Through a lengthy consultation process which involved the steps described in paragraph 3.1, as well as through stakeholder consultations which went beyond the institutional set-up, but was required to have a full/inclusive process (reference to annex 8 & 9 stakeholders' consultation) the activities, under REDD+, are considered with the following qualifiers as described by the table below.

Specifically, 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. Within all the mentioned management systems the forests are then classified into three strata, namely Tropical High Forest (THF), Woodlands and Plantations.

Table 4. Forest transition Matrix and REDD+ activities

	Year 2015			
Year 2000	Tropical High Forest	Woodlands	Plantation	Other land uses (non-forest)
Tropical High Forest	Conservation[6]	Degradation[7]	Degradation	Deforestation
Woodlands	Very unlikely, insignificant data available	Conservation[8]	Degradation[9]	Deforestation
Plantation	Very unlikely, insignificant data available	Very unlikely, insignificant data available	SFM[10]	Deforestation
Other land uses (non-forest)	Enhancement [11]	Enhancement	Enhancement	N/A

Deforestation. *Conversion of Forest to Non-Forest in permanent manner* or without a planned cropping cycle (example of plantation under Sustainable Management) will be considered as deforestation across ALL the management systems considered. It has been observed that Uganda has sufficient data and technical capacity to include deforestation in Uganda's initial submission of a reference level. NFA mapping unit is taking the lead on provision of Activity Data and Emission Factors derived from field inventory (both historical and on-going).

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

[7] This only considers the extreme degradation which leads to a forest strata transition. Unfortunately, available information does not allow the estimation of emissions from degradation happening within the same strata e.g. THF remaining THF or woodland remaining woodland.

[8] Same as footnote 6 above.

9 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.

[10] Only areas under NFA and UWA are considered under SFM, being managed with a cycle of cutting and replanting (Plantation → Plantation). Plantation on private lands are too scattered and too small in size to currently be estimated.

[11] Enhancement is insignificant in the reporting time-period and there are no reliable data available for the definition of a removal factor for each of the strata.

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

Uganda has sample plots for monitoring mean annual increments:

- For Tropical High Forests, reference is made to the study "Thirty-eight years of change in a tropical forest: plot data from Mpanga Forest Reserve, Uganda (Taylor et al. 2008).
- For Woodlands, reference is made to the National Biomass Study Report 2002

Sustainable Management of Forest. Carbon sequestration within growing Forest Plantations (mainly from NFA and NFA) will be considered. Data available are sufficient to account for the plantations and to differentiate between plantation under the different management systems, NFA and UWA. With regards to plantation on private land, they are too scattered, of small size and there is no plan for sustainable replanting.

Forest degradation. 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. Degradation is assumed to occur only in natural forests (both THF and Woodland) but there are not sufficient data to account for degradation happening within the same forest's strata. Uganda currently estimates only the extreme degradation that leads to a forest strata transition. Unfortunately, the available information and system does not allow to account for the degradation happening within the same strata e.g. THF remaining THF, Woodland remaining woodland.

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

According to the activity definition, forest transitions can be attributed to certain activities depending on which management system they occur (see Table 5).

Table 5: Forest transitions and attributed REDD+ activities.

Forest transition	**Detailed transition**	**REDD+ Activity**			**Explanatory remarks**
		Private land	**NFA**	**UWA**	
Forest remaining forest	Plantation – Plantation	*	SFM	SFM	Plantations on private land cannot be assumed to be sustainably managed
	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 and a differential EF (EF THF minus EF Plantation) is applied.
	THF – THF	*	*	Conservation	Only UWA has management practices in place that aim at conservation of forests and it's carbon stocks.
	THF – Woodland	Degradation	Degradation	Degradation	Forest strata transition, from high to low carbon stock, is considered Degradation and a differential EF (EFwoodland minus EF Plantation) is applied.
	Woodland – Plantation	Degradation	Degradation	Degradation	Forest strata transition, from high to low carbon stock, is considered Degradation and a differential EF (EFwoodland minus EF Plantation) is applied. In the case of Uganda Plantation records higher carbon stock than Woodlands. For consistency and using a conservative approach this is reported under degradation though resulting in a removal
	Woodland – THF	**	**	**	Very unlikely to occur, data insignificant.
	Woodland – Woodland	*	*	Conservation	Only UWA has management practices in place that aim at conservation of forests and it's carbon stocks.
Forest becoming nonforest	Plantation – Nonforest land	Deforestation	Deforestation	Deforestation	Conversion of plantations to nonforest 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	Nonforest land – Plantation	Enhancement	Enhancement	Enhancement	Enhancement is insignificant in the reporting time-period and there are no reliable data available for the definition

forest					of a removal factor for each of the strata.
	Nonforest land – THF	Enhancement	Enhancement	Enhancement	Enhancement is insignificant in the reporting time-period and there are no reliable data available for the definition of a removal factor for each of the strata.
	Nonforest land – Woodland	Enhancement	Enhancement	Enhancement	Enhancement is insignificant in the reporting time-period and there are no reliable data available for the definition of a removal factor for each of the strata.

* Area estimate available, but not reported in REDD+ activities because it is assumed to have zero emission or removals due to lack of data.

** Very unlikely to occur, data insignificant

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 FRL.

3.4.1 Activity Data

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 FRL 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.

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.

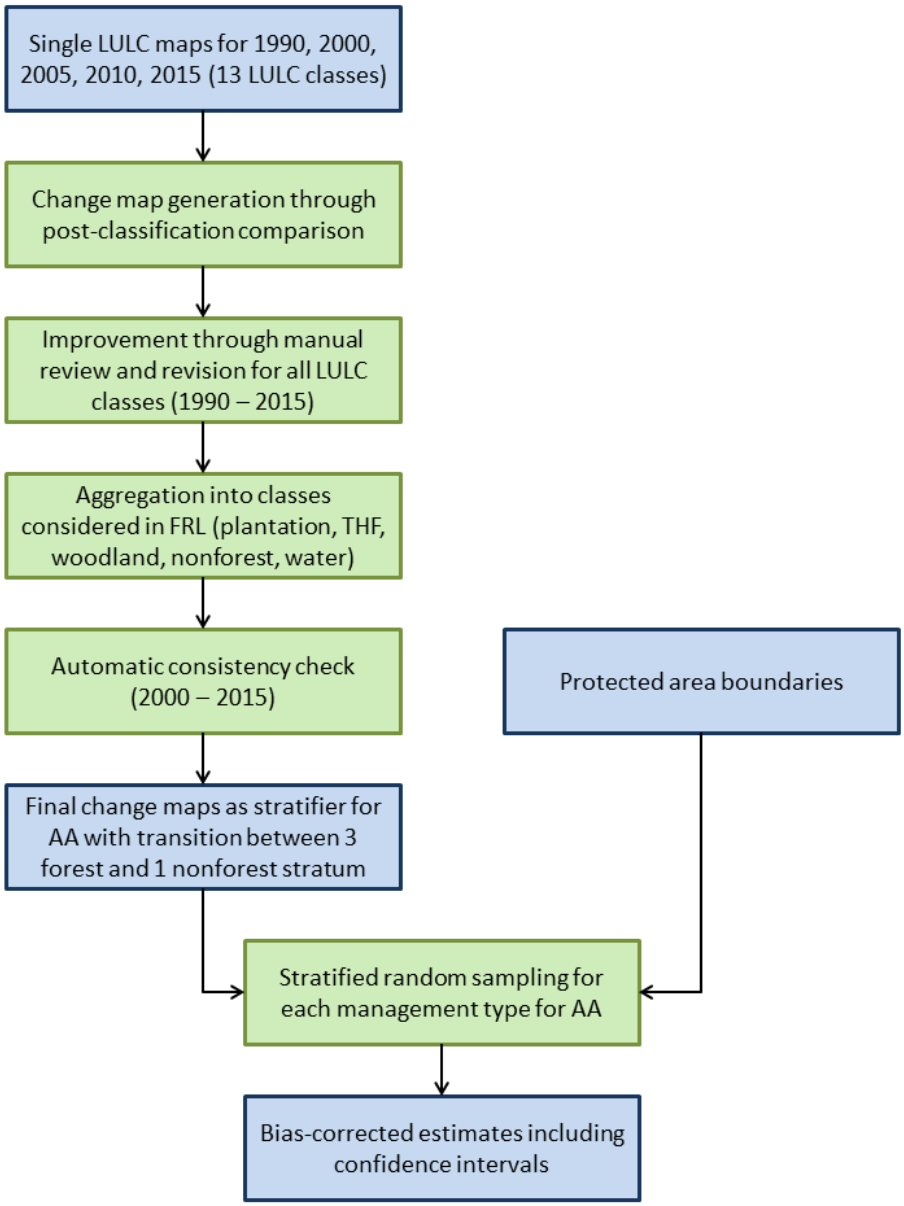

Figure 4 Work flow for creation of change maps and bias-corrected estimates. Data products are depicted in blue, processes in green.

3.4.1.3 Map accuracy assessment

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).

The revised vector maps were assessed for accuracy 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 detailed methodology is explained in the document "Map accuracy assessment methodology for establishing Uganda's FRL", Annex 8.

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 (see table 5) 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. It is intended to enhance this analysis in the future by taking into account the time periods of 2005 and 2010 in order to give a more detailed picture of the trends in forest area change dynamics.

For reference data collection, a custom survey in Open Foris Collect Earth and time-series images of Landsat and Sentinel-2 imagery were used. The spatial assessment unit was a polygon whose size was taken into account in the analysis, thus giving a higher weight to bigger polygons.

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 presented in terms of forest transitions consistent with Table 4 (Forest transitions and attributed REDD+ activities).

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 2000 – 2015 (in ha), split by management type and forest transition. Only area estimations for transitions that are relevant for this FRL submission are reported.

Forest transition	**Detailed transition**	**Area in ha**		
		Private land	**NFA**	**UWA**
Forest remaining forest	Plantation – Plantation	290,772 ± 554*	64209 ± 62	33718 ± 76
	Plantation – THF	**	**	0 ± 0

	Plantation – Woodland	**	**	0 ± 0
	THF – Plantation	0 ± 0	2812 ± 13	0 ± 0
	THF – THF	76985 ± 248*	268959± 49*	153247 ± 127
	THF – Woodland	33874± 223	2826± 6	0 ± 0
	Woodland – Plantation	8406 ± 101	21499 ± 56	0 ± 0
	Woodland – THF	**	**	**
	Woodland – Woodland	739859 ± 849*	168453 ± 116*	552092 ± 218
Forest becoming nonforest	Plantation – Nonforest land	1756 ± 11	2943 ± 14	73 ± 1
	THF – Nonforest land	116259 ± 267	7653 ± 22	2737 ± 18
	Woodland – Nonforest land	504341 ±757	62399 ± 82	7828 ± 32
Nonforest becoming forest	Nonforest land – Plantation	0 ± 0	0 ± 0	0 ± 0
	Nonforest land – THF	0 ± 0	0 ± 0	0 ± 0
	Nonforest land – Woodland	0 ± 0	0 ± 0	0 ± 0

* Area estimate available, but not reported in REDD+ activities because it is assumed to have zero emission or removals due to lack of data.
** Very unlikely to occur, data insignificant

Table 9 presents the area estimates aggregated on a national level by forest transition and REDD+ activity.

Table 9 : Bias-corrected area (Ha) estimates by Land Use Change transition and REDD+ activities

	Year 2015			
Year 2000	Tropical High Forest	Woodlands	Plantation	Other land uses (non forest)
Tropical High Forest	153,247 ± 127[12]	36,700 ± 223[13]	2,812 ± 13	126,649 ± 269
Woodlands		552,092 ± 218[14]	29,906 ± 115	574,567 ± 762
Plantation			97,927 ± 98[15]	4,772 ± 18
Other land uses (non forest)	Insignificant data[16]	Insignificant data	Insignificant data	N/A

	Deforestation	Sustainable Management (SFM)	
	Degradation	Enhancement	
	Conservation	Illogical changes	

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

[12] Only areas under UWA, with a conservation management system are estimated and other areas (under NFA and Private land) are assumed to have no carbon stock change.
[13] This only considers the extreme degradation that leads to a forest strata transition; at this time there is insufficient information to estimate carbon stock changes happening within the same strata e.g. THF remaining THF, Woodland remaining woodland.
[14] Same as footnote 6 above.
[15] Only areas under NFA and UWA are considered under SFM, being managed with a cycle of cutting and replanting (Plantation – Plantation); plantation on private land are too small and scattered to monitor effectively at this time.
[16] Enhancement is insignificant in the reporting time-period and there are no reliable data available for the definition of a removal factor for each of the strata. This is an area of improvement.

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 **Error! Reference source not found.**). 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 which often retains a high tree cover, especially if it is agricultural land expanding in formerly forest-covered areas. Furthermore, banana/matoke plantations 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.

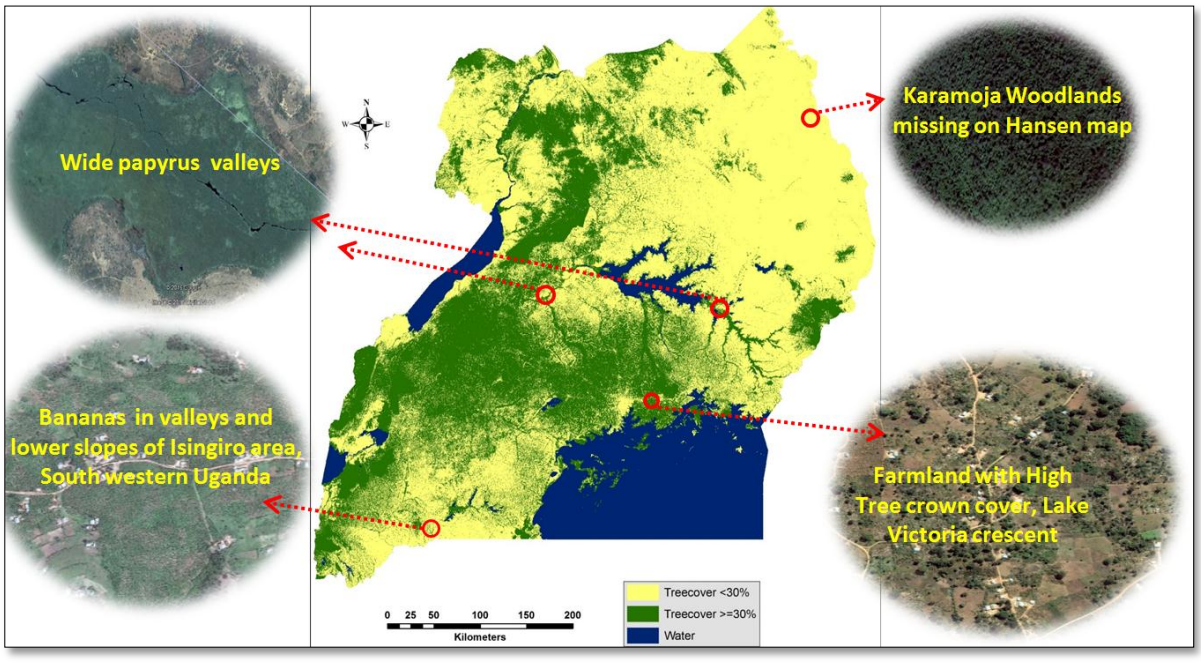

Figure 5: Extent of areas with tree cover above and below 30 % according to GFC data, and examples of disagreement between GFC tree cover map and national LULC maps on forests.

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 47,066 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 10.

Table 10: 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 –	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 Inventory

The purpose of this forest inventory was to assess biomass stock in Uganda. The project was carried out between 1995–2002. The inventory was funded by the Norwegian Government and it was implemented by the National Biomass Study under the Forest Department. The assessment mainly focused on areas outside gazetted areas (Fig. 6 a) 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).

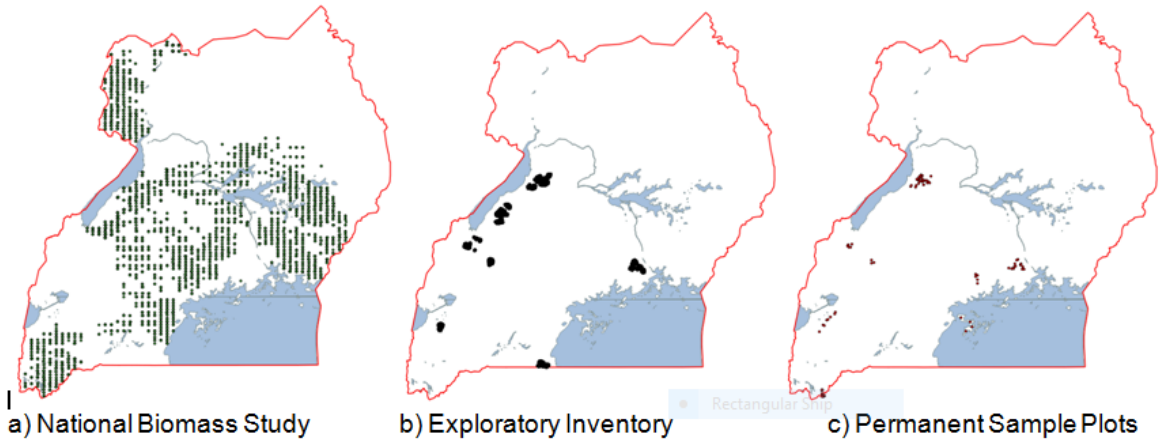

Figure 6. Spatial Uganda's National Inventory data sets

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) in (figure 6 b. EI provides information on forest stocks in production zones[17]. 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 (figure 6 c).

Permanent Sample Plots

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.

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

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 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 been taken place around year 2005.

In Uganda, the biomass equations developed by NBS (1992) and later adjusted by Velle (1997) and 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.

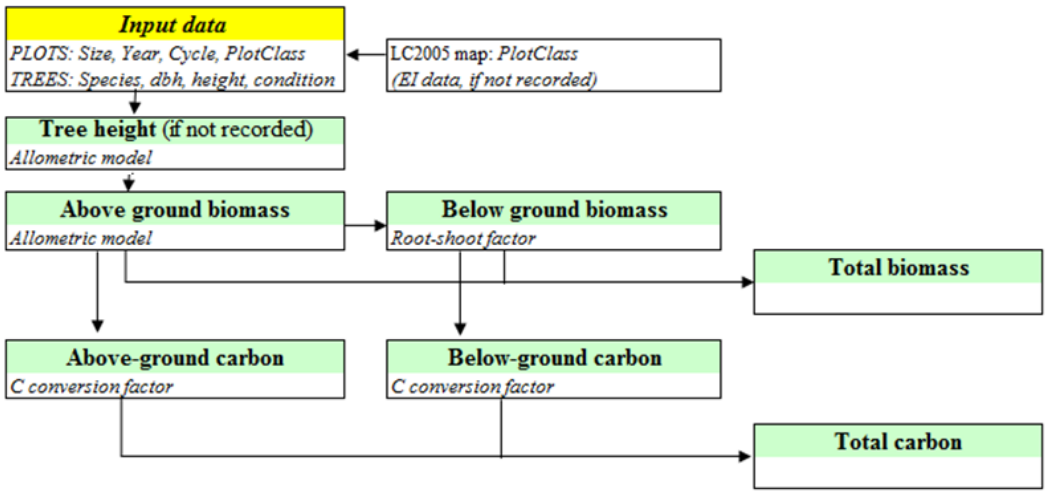

Figure 7. Tree carbon computing steps

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

In NBS for REDD+, fallen deadwood will be recorded on transects and is anticipated to be included in the revised submission in 2017.

3.4.2.3 Results and proposed Emission Factors

The results for carbon stocks in Uganda forests shows that tropical high forests may have carbon stocks of up to 150 tons per hectare (Table 11). PSP data on forest plantations (both coniferous and hardwoods) are not considered representative because data was recorded on young plantations that had just been established. Instead, it has been agreed to use NFA tree planting statistics that can provide area data and Alder *et al.* (2003) yield models which can provide cumulative yield estimate for various age classes.

Table 11. Carbon stock for in Uganda's four main forest classes

Stratum no	1 & 2	3 & 4	5
Stratum name	Plantations	Tropical High forests	Woodlands
Data source	NFA statistics[18]	EI, NBS, PSP	EI, NBS
Number of plots	-	15 047	1169
Number of trees (/ha)	-	237.5	278.3
AG Carbon (tons/ha)	57.2	119.3	20.0
BG Carbon (tons/ha)	15.2	28.6	4.8
Total Carbon (tons/ha)	72.4	148.0	24.8
AGC, Relative SE (%)	-	0.6 %	3.0%
T-value	-	1.960	1.962
AGC, CI lower (tons/ha)	-	117.9	18.8
AGC, CI upper (tons/ha)	-	120.7	21.2
AGC, Relative CI (%)	-	1.2 %	5.9%

The NBS data on woodlands is biased towards areas outside the protected areas (figure 6)[19] which are degrading at a fast rate, which is the main causes of a very low carbon stock recorded under this strata. The new biomass survey which covers all woodlands will improve theses estimates.

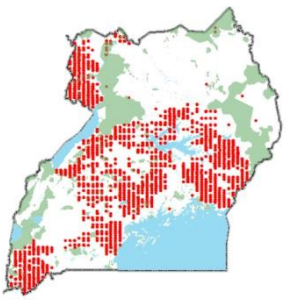

Figure 8. NBS plots spatial distribution

In addition, the ongoing re-measurement of growth plots in Tropical High forests will provide up to date data on removal factors. Current emission factors on Tropical High Forest does not differentiate between degraded and normally stocked THF. The planned mapping of degraded THF is expected to improve estimation of EF for THF.

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

[19] 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

3.4.2.4 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 FRL 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. From 3.1 million ha or 15.3% of land area in 2000, the total forest area of Uganda has reduced to 2.4 million ha or 11.8% of land area in 2015. Also it has been observed that the dynamics are very different between the management types of forests – namely private land, NFA and UWA.

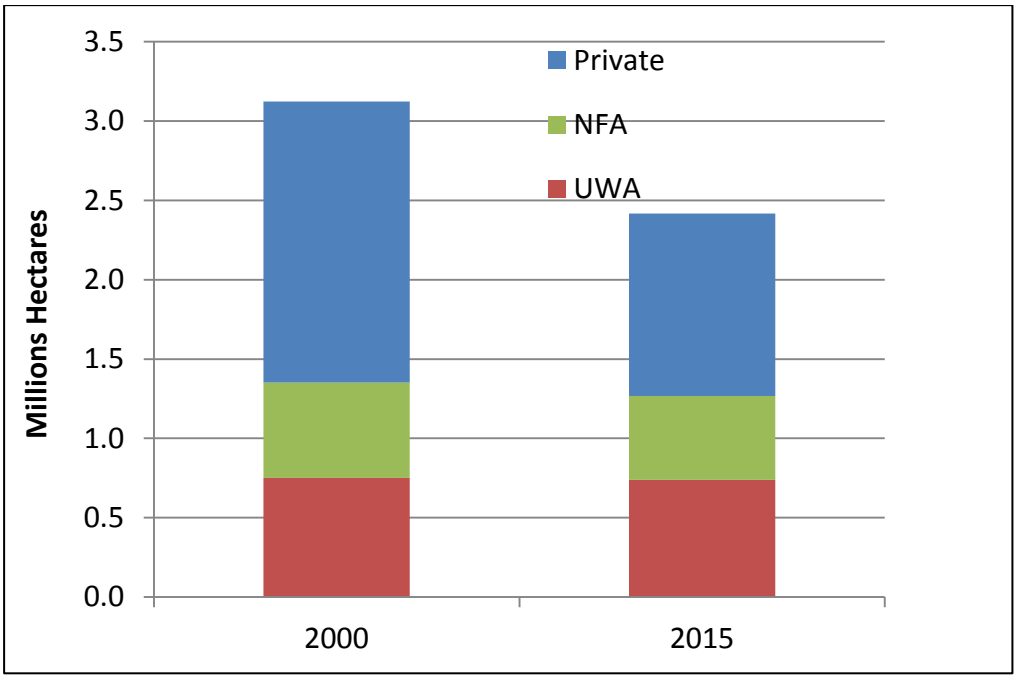

Figure 9: Forest area per year divided by management system.

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) help to continuously monitor the different dynamics in such lands. Further stratifying the protected areas by management type, namely protected areas under UWA and CFRs and LFRs captures the dynamics even better as forest reserves show higher rates of forest loss than areas managed by UWA.

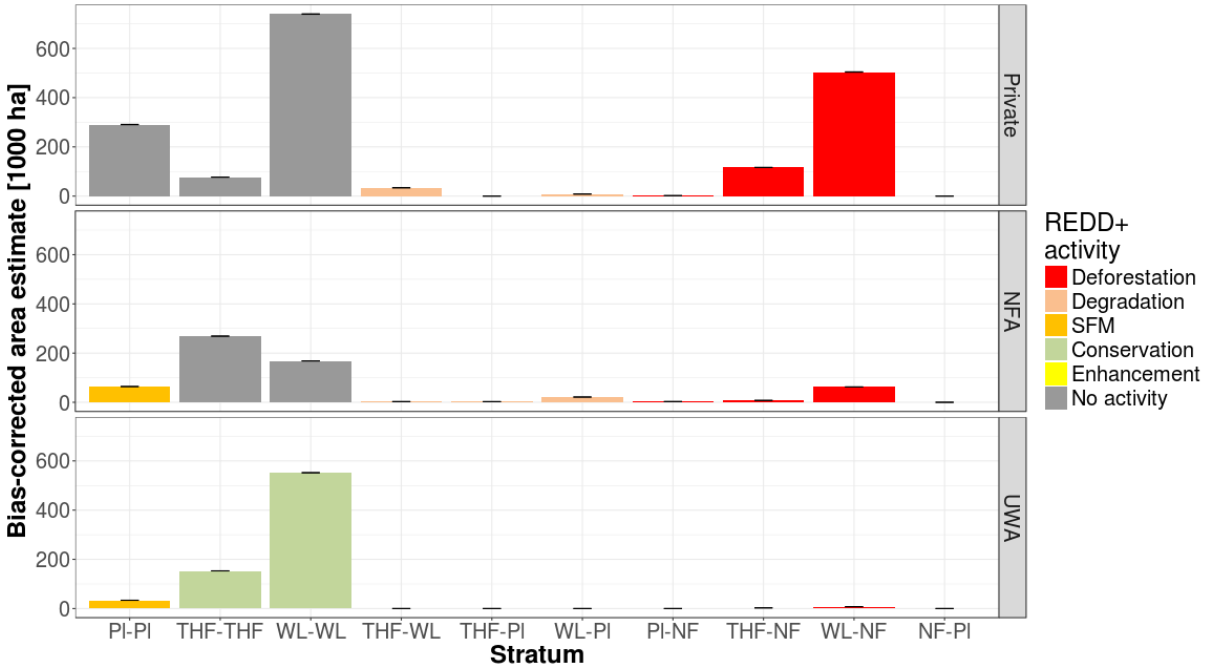

Figure 10: Bias-corrected area estimates for each management stratum, excluding stable nonforest, and attributed to the REDD+ activities as defined in Uganda's proposed FRL.

3.5.2 Combining Activity Data and Emission Factors

Uganda has determined that it will include in its initial FRL the following REDD+ activities: deforestation, and to the extent possible at this current time, degradation, sustainable management of forests and conservation of forest carbon stock. Emission and removal factors have been estimated for tropical high forests, woodlands and plantations.

In order to combine AD and EF, the bias corrected areas matrix (table 9), which provides forest loss/gain/stable estimates per forest type and REDD+ activity (associated with management systems) was combined with the EF/RF matrix below (Table 12).

Table 12: Estimation of EF and RF (tCO2/ha)

	Year 2015			
Year 2000	Tropical High Forest	Woodlands	Plantation	Other land uses (non forest)
Tropical High Forest	-2.31[20]	452.1[21]	282.7[22]	543.0
Woodlands		-18.4[23]	-169.4[24]	90.9
Plantation			-34.5[25]	260.3

20 In Tropical High the removal factor applied derives from the study "Thirty-eight years of change in a tropical forest: plot data from Mpanga Forest Reserve, Uganda (Taylor et al. 2008)
21 calculated as a difference EFthf minus EF woodland
22 calculated as a difference EFthf minus EF plantations
23 In woodlands the removal factor applied derives from the National Biomass Study Report 2002
24 calculated as a difference EFthf minus EF plantations. In the case of Uganda Plantation records higher carbon stock than Woodlands. For consistency and using a conservative approach this is reported under degradation though resulting in a removal
25 MAI used as RF. Becky to add a line (if needed)

Other land uses (non-forest)	No sufficient data [26]	No sufficient data	No sufficient data	

	Deforestation	Sustainable Management (SFM)	
	Degradation	Enhancement	
	Conservation		

As described above, EFs for woodlands and THF were calculated using the field inventory data from EI, NBS and PSP surveys and then applying the Chave et al. (2014) biomass equation. EF for plantations is dependent on age, species and silivcultural treatment. These EFs were developed using NFA tree planting statistics area data and applying Alder et al. (2003) yield models which provide cumulative yield estimate -for various age classes. Removal factors were developed for conservation and sustainable management of forests using Uganda-specific estimates. In the case of THF, RFs from a long-term research site in Mpanga Forest Reserve were utilized (Taylor et al, 2008). For woodlands estimates are based on Biomass growth plot data (NBS 2002).

Combining these two matrices results in the cumulative emissions/removals of tCO2 over the 15 year reporting period (Table 13).

Table 13: Cumulative emissions/removals of tCO2

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

	Deforestation	Sustainable Management (SFM)	
	Degradation	Enhancement	
	Conservation	Unlikely transitions	

4 Proposed FRL and updating frequency

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

26 Not sufficient data to estimate an appropriate EF for these three transitions.

Total emissions/removals for each REDD+ activity are provided in Table 14 and further illustrated in Figure 10 below.

Table 14: Total emissions/removals for each REDD+ activity

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

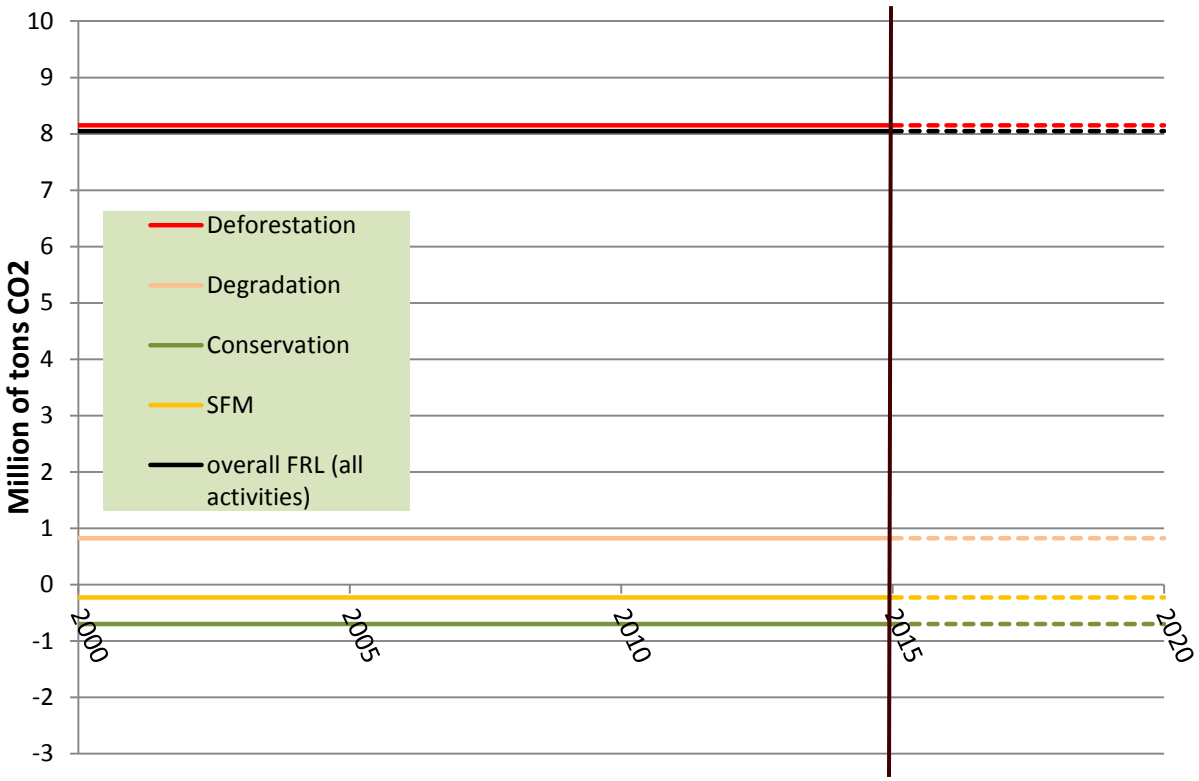

Figure 11: Graphical representation of emission/removals for each REDD+ activity and liner projection to 2020

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

Presented below (Table 15) 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 FRL 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 15: Summary of selected examples providing an outlook on how PLRs are supportive of REDD+ options (in the REDD+ strategy) and their implications for the FRLs 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.
Reducing Emissions from forest degradation		Strategic option 2: Livestock management	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 3: 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 6: Rural electrification and renewable energy solutions	Renewable energy is a national priority. Already two of the three components of this renewable energy as proposed in the redd+ strategy options (namely Off- or on-grid small or mini-hydropower plants; and Solar photovoltaic (PV) power plants or systems) are being promoted while, the third (namely Wood-fired gasification plants) requires considerable positive incentives.
		Strategic option 7: 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.
		Strategic option 8: 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.

REDD+ Activity	REDD+ Drivers & options	Corresponding main strategic options for addressing the DD	RELEVANT PLRs outlook
Conservation of forest carbon stocks		Strategic option 5: 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 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 5: 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 4: Large-scale commercial timber plantations	Uganda intends to join the lower middle income category be 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

Degradation: Uganda can estimate emissions only partially for the degradation of forests as detailed in the relevant paragraph above, and therefore Forest degradation remains an important improvement for Uganda's FRL. Several efforts are already ongoing in order to obtain a realistic estimate to integrate this activity in the future updates to the FRL. A number of actions are proposed within the REDD+ strategy (e.g. promotion of more efficient cooking stoves, support non-wood and alternative energy sources, etc) in order to reduce emissions which can be better recorded under degradation. Assessing forest degradation, however, will also depend upon better and more cost-effective technologies to allow for more consistent measuring and monitoring of emissions from this activity.

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

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

AD: For future LULC mapping cycles, image change detection to be used in instead of the current post classification approach.

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

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

8 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 FRL.

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